Bat Mitigation Guidelines for Ireland

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DEPARTMENT OF THE ENVIRONMENT, HERITAGE AND LOCAL GOVERNMENT

Bat Mitigation Guidelines for Ireland

Conor Kelleher and **Ferdia Marnell**

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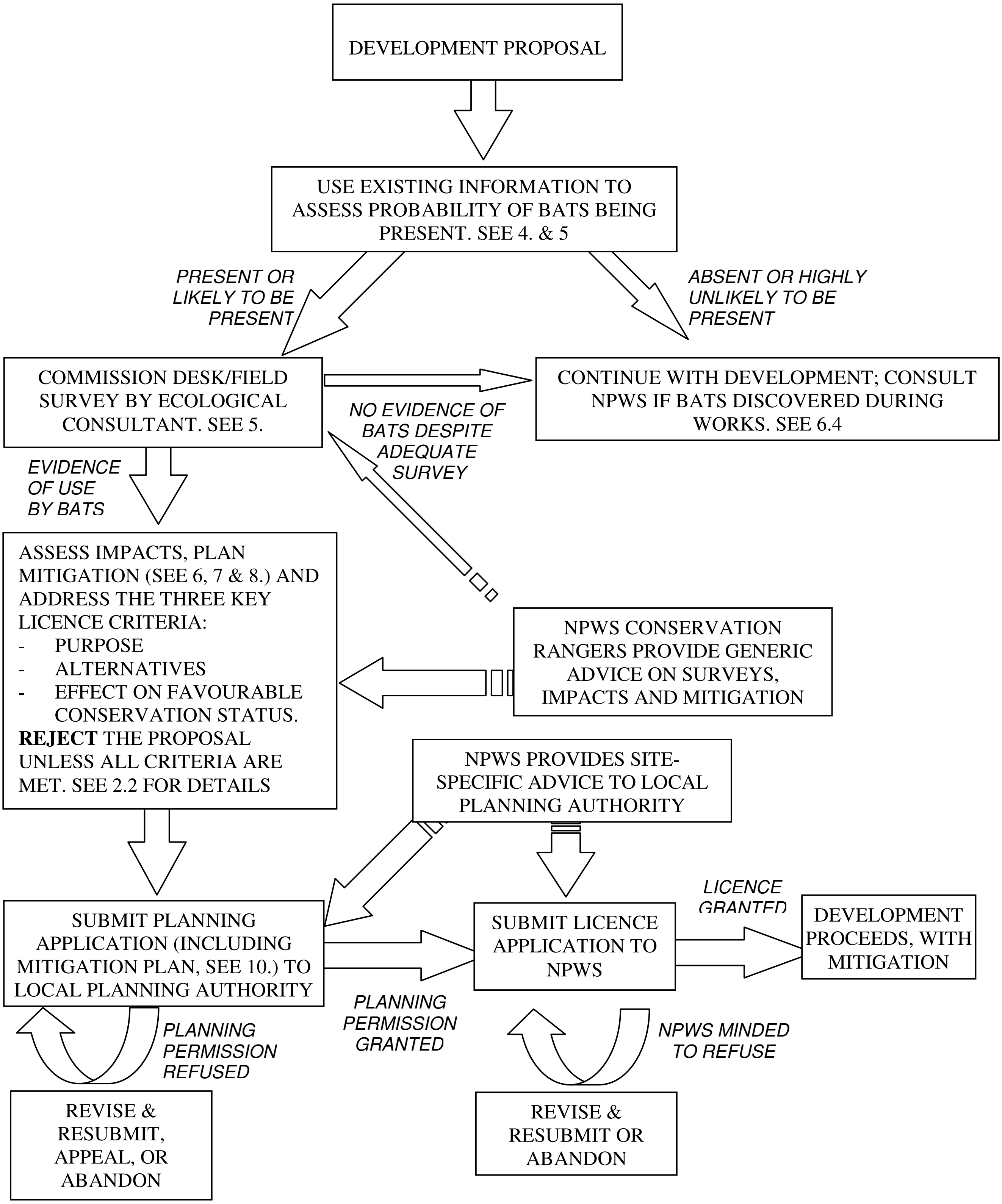
Key messages for developers

- Bats and their roosts are protected by Irish and EU law because all species have declined and some are threatened or endangered.
- There are 10 known species of bats in Ireland, each with its own lifestyle and habitat requirements. They use a wide variety of roosts, including buildings of all sorts, trees and underground places.
- Many bat roosts are used only seasonally as bats have different roosting requirements at different times of the year. During the summer, females of all species gather in colonies to give birth and rear their young; these maternity roosts are often in places warmed by the sun. During the winter bats hibernate, often in places that are sheltered from extremes of temperature.
- When planning a development it is advisable to check for the presence of bats as early as possible so that any planning and licensing issues can be addressed before resources are committed. Bat surveys require specialist knowledge and equipment.
- Planning authorities are required to take account of the presence of protected species, including bats, when considering applications for planning permission and may refuse applications on the grounds of adverse effects on these species or if an assessment of the impact of the development on protected species is inadequate. Planning conditions or agreements may be used to ensure the conservation status of protected species is maintained.
- A grant of planning permission does not constitute a licence or permit to disturb bats or interfere with their breeding or resting places.
- Application may be made to the National Parks and Wildlife Service for a derogation licence to permit actions affecting bats or their roosts that would normally be prohibited by law. The applicant must demonstrate that there is no satisfactory alternative and that the action will not adversely affect the favourable conservation status of the bats. Each case is considered on its particular circumstances, and an application may be refused.
- Mitigation to reduce or compensate for any impact of development is generally a condition of the licence and must be proportionate to the impact. Mitigation measures will be proportionate to the impact and may require particular timing of operations, protection of existing roosts or the creation of new roosts to replace ones being lost. In some cases, a considerable period of time may be required to carry out this work. Monitoring of the effect of the mitigation is usually required.
- The protected species legislation applies independently of planning permission, so licences are likely to be necessary for operations that affect bats but do not require planning permission.
- The National Parks and Wildlife Service strongly advises developers to seek the services of a professional ecological consultant with appropriate experience in assessing bat populations when contemplating a development proposal that would affect bats or their roosts.
- This document gives generic technical advice on assessing impacts and developing mitigation plans. It does not give a comprehensive explanation of the legislation and developers may wish to seek their own legal advice.

Figure 1 Main steps involved in ensuring that bat issues are properly considered in developments requiring planning permission



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1.1 Background

These guidelines have been developed to assist those involved with land-use planning and development operations (in the widest sense) where bats are known or suspected to occur. Although the emphasis is on developments that fall within the remit of the planning system, the guidelines apply equally to other sorts of developments and contain elements of good practice that apply to a wide range of situations. In developing these guidelines, we have drawn on a wide range of expertise, and believe that the advice given is the best that is currently available. The basis for mitigation proposals is scientific experience and opinion and we hope that the publication of these guidelines will stimulate the collection of more information about the success or failure of mitigation projects that can be used in improving mitigation and conservation measures for bats.

Although changes to both the planning system and wildlife legislation are made from time to time, many of the principles of survey and mitigation will continue to apply, though developers should satisfy themselves that any proposals comply with current legislation.

These guidelines do not include the planning and development of national roads. For information on the conservation of bats during the planning and construction of roads please see the National Roads Authority documents: *Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes* and *Guidelines for the Treatment of Bats During the Construction of National Road Schemes* (www.nra.ie).

1.2 Conservation status of bats

Populations and population trends in bats are particularly difficult to measure and there are few historical data on which to base any assessment of change. The fragmentary evidence available for Europe supports the view that bat populations have declined over the last century or so. In some cases, such as lesser horseshoe bats, contractions of range are well documented, but as some species were not even described until relatively recently, historical data on distribution is lacking.

Because of their conservation importance and their value as biodiversity indicators Species Action Plans are being devised for all Irish bat species; these contain objectives relating to the maintenance and restoration of bat populations and habitats.

A national bat monitoring programme covering some, though not all, species is now in place, so some data about population trends are now becoming available. It is generally accepted that bat populations remain at risk and that the objectives of planning and licensing should be to prevent any further losses and this is reflected in national and EU law.

1.3 Legal status and its implications for developers

In view of their status across Europe, all species of bat have been listed on Annex IV of the EC 'Habitats and Species Directive' (see 2.1 Legislation) and some, such as the lesser horseshoe bat, are further listed on Annex II. The domestic legislation, which implements this directive, combined with the Wildlife Acts (1976 & 2000), ensures that individual bats and their breeding sites and resting places are fully protected, and this has important implications for those who own or manage sites where bats occur.

Guidance on the consideration that Local Planning Authorities should give to nature conservation interests is contained in Directive 2001/42/EC of 27 June 2001, commonly known as the SEA Directive. The presence of a protected species is a material consideration when the authority is considering a developmental proposal. The protected status afforded to bats means planning authorities may require extra information (in the form of surveys, impact assessments and mitigation proposals), before determining planning applications for sites used by bats. Planning authorities may refuse planning permission solely on grounds of the predicted impact on protected species like bats. Designations of various kinds, both statutory and non-statutory, may further protect individual sites. Although the presence of bats does not in most instances preclude a land parcel from development, planning and licensing controls may limit the extent of disturbance, the timing of activities, and may well stipulate compensatory measures. Planning conditions are often used to this end. However, the grant of planning permission does not authorise the disturbance of bats or interference with their breeding or resting places. A separate derogation licence is required.

1.4 Development, mitigation and compensation

In this document, the term ‘development’ is used to cover a wide range of operations that have the potential to impact negatively on bats and bat populations. Typical examples would be the construction, modification, restoration or conversion of buildings (some of which require planning permission), as well as infrastructure or mineral extraction projects (which may constitute permitted development and hence not require planning permission) and site clearance and demolition (which may not need planning permission). Likewise, the term ‘developer’ is used to cover individuals, companies or organisations responsible for undertaking these activities, and not simply members of the construction industry.

Where the proposed development will affect sites known to be used by bats, consideration needs to be given to the likely impact on the population(s). Even when planning permission is given, or the activity does not require such permission, the wildlife legislation, including the Habitats Regulations, applies; bats and their places used for breeding or resting are still protected. In some cases, this situation may be resolved by the issuing of a derogation licence to facilitate mitigation, which is the term used to cover measures to protect the bat population from damaging activities and to reduce or remove the impact of development. Normally, compensation for the loss of breeding or resting places is also required, and this often takes the form of roost creation, restoration or enhancement. Such a programme of mitigation and compensation should allow the conservation status of bats to be maintained or enhanced following development, thus meeting one of the licensing criteria (see 2.2 Exceptions and licensing). Note that in this document, the term ‘mitigation’ is generally used in its broad sense, to encompass both compensation and mitigation.

1.5 Responsibility for achieving successful outcomes

In order to successfully address development issues where bats are involved, a number of stages are necessary; these are outlined in Figure 1 and the roles of each key player are given in 3. Roles and responsibilities. The National Biodiveristy Plan confers general responsibilities on all participants in the development process to take account of protected species. Some important messages resulting from these responsibilities are given here:

For developers: Sustainable Development should be a guiding principle when progressing proposals, and resolving wildlife issues requires specialist ecological knowledge. The National Parks and Wildlife Service (NPWS) recommends that developers seek the services of a professional advisor (ecological consultant) when protected species issues arise in connection with a proposed development. Contact details for ecological consultants can be obtained from a number of sources, including professional bodies. One such directory is: the *Directory of Ecologists and Environmental Managers* (IEEM http://www.ieem.co.uk). Some consultants are also members of local bat groups which may be contacted via Bat Conservation Ireland (046-9242886; www.batconservationireland.org).

For consultants: In order to successfully resolve most bat issues, consultants should have a sound knowledge of, and experience with, the species. A thorough grounding in bat ecology can be crucial to good survey and mitigation planning. Although a derogation licence to disturb bats for scientific purposes is not essential for every type of survey, it is strongly recommended that consultants possess such a licence so they do not need to withdraw if bats are found at a site. Consultants are expected to apply population ecology principles so that the local circumstances relating to a particular development proposal can be interpreted using these generic guidelines. The outline mitigation plan structure (see 10. Presenting mitigation plans) should be used where appropriate. It is expected that consultants will provide advice to clients, and information to the National Parks and Wildlife Service, planners and others, in an impartial and accurate manner. Should cases come to light where consultants appear to have wilfully or negligently misrepresented a situation or site details, the NPWS will consider bringing its concerns to the attention of the relevant client and, if applicable, the professional body. The Irish Government has emphasised its obligations under international wildlife legislation by making it an offence under Section 69 of the Wildlife Act 1976 (& amendment 2000) to knowingly or recklessly make false statements for the purpose of obtaining a licence, whether for oneself or for another.

General: These guidelines are intended to provide generic information and advice and are not meant to be taken as a rigid set of rules. Individual sites vary considerably in terms of species present, population status, roost type and so on, and the potential impacts of different types of development also vary, so it would be impossible to develop an all-encompassing document. Decisions should be made on a site-by-site basis. The methods described are those considered to be practical and effective based on past experience, but this does not mean that other methods are ineffective, inappropriate or unlawful. Similarly, the levels of mitigation effort suggested herein are based on available information, and do not necessarily constitute a statement of the lawful minimum. It would be for a court to decide whether an offence has been committed in any particular case. The legislation does not specify mitigation methods; it prohibits certain actions. Developers and their consultants may wish to take their own legal advice to provide an interpretation of the law. Notwithstanding the above caveats, these guidelines are currently the most detailed readily available source of information on mitigation for bats and it is strongly recommended that developers and consultants take them into consideration. Should legal proceedings be initiated, these guidelines will be used as a record of the National Parks and Wildlife Service’s approach to best practice, which may have a bearing on the definition of reasonable effort.

2 Legislation and licensing

Note: The information given in this section is intended as general guidance on the law relating to bats and development, and is not comprehensive. When dealing with individual cases, readers should consult the full texts of the legislation, and obtain their own legal advice if necessary. Web addresses for the texts of legislation are given in 11. Further reading.

2.1 Legislation

2.1.1 The Wildlife Acts 1976 and 2000

All bat species are protected under the Wildlife Act (1976) and Wildlife [Amendment] Act (2000) which make it an offence to wilfully interfere with or destroy the breeding or resting place of these species; however, the Acts permit limited exemptions for certain kinds of development.

All species of bats in Ireland are listed on Schedule 5 of the 1976 Act, and are therefore subject to the provisions of Section 23, which make it an offence to:

- Intentionally kill, injure or take a bat
- Possess or control any live or dead specimen or anything derived from a bat
- Wilfully interfere with any structure or place used for breeding or resting by a bat
- Wilfully interfere with a bat while it is occupying a structure or place which it uses for that purpose

2.1.2 The Habitats Regulations 1997-2005

The EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (Habitats Directive 1992), seeks to protect rare and vulnerable species, including all species of bats, and their habitats and requires that appropriate monitoring of populations be undertaken. All species of bat found in Ireland are listed on Annex IV of the Directive, while the lesser horseshoe bat is further protected under Annex II. The latter Annex relates to the designation of Special Areas of Conservation (SACs). Inclusion on Annex IV ('European protected species') means that member states are required to put in place a system of strict protection as outlined in Article 12. The Habitats Directive is transposed into Irish law by the European Communities (Natural Habitats) Regulations 1997. These Regulations substantially strengthen the protection provided by the Wildlife Acts, and in particular they remove all of the exemptions provided in Section 23(7) of the Wildlife Act insofar as they relate to Annex IV species, including all species of bats. All bats species are listed on the First Schedule and Section 23 of the Regulations makes it an offence to:

- Deliberately capture or kill a bat
- Deliberately disturb a bat
- Damage or destroy a breeding site or resting place of a bat

It is essential that developers note that, in regard to the third bullet point above, the onus of satisfying themselves that a development will not damage or destroy a breeding site or resting site of a bat rests with the developer, as the defence that the action was not done deliberately does not apply in this instance.

Provision is made in the Regulations (Regulation 25 (1) of the 1997 Habitats Regulations, 1997) for the Minister to grant, in strictly specified circumstances set out in that Regulation, a derogation licence permitting any of the above activities "where there is no satisfactory alternative and the derogation is not detrimental to the maintenance of the populations of the species to which the Habitats Directive relates at a favourable conservation status in their natural range".

Two of these circumstances are of particular interest to developers:
- "in the interests of protecting wild fauna and flora and conserving natural habitats"
- "in the interests of public health and public safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment"

Two, in addition to that in the bullet points above, are of particular interest to wildlife professionals working with bats
- "for the purpose of research and education, of repopulating and reintroducing these species and for the breeding operations necessary for these purposes …"
- "to allow, under strictly supervised conditions, on a selected basis and to a limited extent, the taking or keeping of certain specimens".

It is worth noting that in some cases in which derelict buildings are being restored, there are opportunities to enhance conditions for bats and assure the availability in the future of suitable breeding and resting places. It is for this reason that the first of the four bullet points above may, in some circumstances, be relevant to developers.

Across Europe, bats are further protected under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1982), which, in relation to bats, exists to conserve all species and their habitats. The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979, enacted 1983) was instigated to protect migrant species across all European boundaries. The Irish government has ratified both these conventions.

2.2 Derogation licences.

Licences permit otherwise unlawful activities and can only be granted for certain purposes.

The National Parks and Wildlife Service issues derogation licences for scientific, educational and conservation purposes. Surveys for bats which involve otherwise unlawful acts (such as intentional disturbance or taking) may be authorised for scientific and educational purposes; this includes surveys of potential development sites.

A licence is required for the capture of bats for educational or scientific purposes, releasing a rehabilitated bat back to the wild, photography and filming near a breeding place and for retaining in captivity disabled bats which cannot survive in the wild.

In order to obtain a licence to allow the destruction of bat roosts etc, in advance of any otherwise legitimate development which may impact on the favourable conservation status of bats, Section 25 of the Habitats Regulations must be satisfied.

It must therefore be demonstrated by the applicant that all reasonable steps have been taken to minimise the impact and that any remaining damage will be adequately compensated for. The first aim of the developer, working with professional advice, should be to entirely avoid or minimise the potential impact of a proposed development on bats and their breeding and resting places. Current NPWS advice is that there should be no net loss in local bat population status, taking into account factors such as population size, viability and connectivity. Hence, when it is unavoidable that a development will affect a bat population, the mitigation should aim to maintain a population of equivalent status in the area.

One of the key aims of the Directive is to encourage member states to maintain at, or restore to, favourable conservation status those species of community interest (Article 2(2)).

'Favourable conservation status' is defined in the Habitats and Species Directive (Article 1(i)). Conservation status is defined as "*the sum of the influences acting on the species concerned that may affect the long term distribution and abundance of its population within the territory*." It is assessed as favourable when:
"*population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitats, and*
the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
there is, or will probably continue to be, a sufficiently large habitat to maintain its populations on a long term basis."

Note that even though there is apparent overlap between the Wildlife Acts and the Habitats Regulations, they run concurrently. No action in relation to bats that would not be permitted under the Habitats Regulations may be licensed under the Wildlife Acts. Derogation licences granted under the Regulations include reference to the relevant provisions of the Wildlife Acts to ensure that all requirements for licensing are covered in the one document. It should also be noted that a licence only allows what is permitted within its terms and conditions; it does not legitimise all actions related to bats at a given site.

2.2.1 When is a licence required?

The National Parks and Wildlife Service is frequently asked by consultants whether a derogation licence is required for a particular activity. Ultimately, however, this is a decision to be made by the consultant or client. A licence simply permits an action that is otherwise unlawful. To ensure that no illegal activities are undertaken, it is recommended that a licence is applied for if, on the basis of survey information and specialist knowledge, it appears that:

- the site in question is a breeding site or resting place for bats
- the proposed activity could result in an offence

No licence is required if the proposed activity is unlikely to result in an offence. The advice given in this document should assist the consultant in arriving at a decision on this matter, though it must be recognised that determining whether a particular site is used as a breeding or resting place can be problematic for such mobile animals as bats. Note that if the proposed activity can be timed, organised and carried out so as to avoid committing offences then no licence is required (see also 8.3).

Examples of works that are likely to need a licence because they may result in the destruction of a breeding or resting place and/or disturbance of bats include:

- Demolition of buildings known to be used by bats
- Conversion of barns or other buildings known to be used by bats
- Restoration of ruined or derelict buildings
- Maintenance and preservation of heritage buildings
- Change of use of buildings resulting in increased ongoing disturbance

- Removal of trees known to be used by bats, when carried out as part of a development
- Significant alterations to roof voids known to be used by bats

Examples of works that, if carefully planned, may not need a licence include:
Re-roofing, if carried out while bats are not present and the access points and roosting area are not affected;
Remedial timber treatment, carried out with the correct (non-toxic to bats) chemicals while bats are not present.

Figure 1. Tree removal by manual dismantling to safeguard bats

2.2.2 Actions affecting Special Areas of Conservation (SACs)

Particular statutory requirements apply to operations of activities to be carried out in SACs (including candidate SACs). For each designated site there is a list of notifiable actions which may not be carried out unless written consent has been given by the Minister (Regulation 14 of the Habitats Regulations 1997). Application for such consent is made to the National Parks and Wildlife Service regional staff. It may be refused, and if granted, there are likely to be mitigation requirements as a condition of the consent.

Furthermore, Regulation 18 of the 1997 Regulations prohibits operations or activities outside an SAC, but that are liable to have an adverse effect on the integrity of the site concerned, either alone or in combination with other operations or activities. The Regulations require the carrying out of an appropriate assessment in respect of such a proposed operation or activity. If the Minister, having regard to the conclusion of the assessment, is of the opinion that the operation or activity will adversely affect the integrity of the site concerned, the Minister shall make application to a court of competent jurisdiction to prohibit the continuance of the operation or activity.

It will be apparent, therefore, that a developer proposing to carry out any operation or activity that constitutes a notifiable action or that, even though outside the boundary of an SAC, may adversely impact on the integrity of that SAC, needs to ensure beforehand that all of the necessary consents and clearances are in place before the operation or activity commences.

2.3 Interpretation and enforcement

As the legislation applies to a wide range of species, its provisions are generic in nature and there are no detailed definitions of, for instance, exactly what constitutes a 'resting place' for a bat, nor what has to be proved to establish that an act was wilful. Were a breach of the law to be alleged, a court would have to decide whether an offence did in fact occur. Note that under the Wildlife Acts wilful interference at a breeding site or resting place is an offence. However, there are currently no legal precedents that are helpful in interpreting what constitutes a place used for breeding and resting.

The National Parks and Wildlife Service Conservation Rangers are the main enforcement body for wildlife offences. The maximum penalty for summary conviction has been increased to €1,904 and/or 12 months imprisonment and, on indictment, is €63,487 and/or two years imprisonment. Note that fines may be imposed in relation to each offence committed, so operations involving many animals or repeated offences can potentially accrue large fines. In addition, items which may constitute evidence of the commission of an offence may be seized and detained.

Figure 2. Insect prey remains in brown long-eared bat roost

3 Roles and responsibilities

3.1 Introduction

In order for bats to be protected successfully when development is planned, a number of organisations will need to interact. Each organisation has its own role, and in some cases its statutory duties, to carry out. This section spells out the roles and responsibilities of the main players connected with development, with the intention of promoting more effective liaison.

3.2 National Parks and Wildlife Service

The National Parks and Wildlife Service is the Government's statutory nature conservation advisor. In the current context it has the following functions:

- Provision of advice to Local Planning Authorities on protected species issues, including consultations on planning applications where bats are thought to occur;
- Provision of general advice to developers, consultants and others on protected species cases (through documents such as the current one; NPWS Conservation Rangers may also provide site-specific advice, though this will vary with local circumstances);
- Provision of advice to Local Planning Authorities on forward planning (e.g. commenting on Local Plans);
- Provision of generic advice to Local Planning Authorities, including the legal background to protected species casework;
- Determining applications for licences for bat survey work (scientific and conservation licences);
- Provision of advice about bats in dwelling-houses;
- Statutory consultee over planning issues affecting designated conservation sites;
- Keeping and updating the National Lesser Horseshoe Bat Database;
- Management of National Parks.

Contact details (head office): The National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, 7 Ely Place, Dublin 2; Tel 01-8882000; Locall: 1890-202021; Fax: 01-8883272; web: www.npws.ie; Email: natureconservation@environ.ie [for initial discussions about individual sites, the relevant local Conservation Ranger should be contacted; contact details for Rangers are available from the head office, website or within the State Directory section of local telephone directories].

3.3 Developers and ecological consultants

The developer and their advisor(s) share the responsibility for the following:

- Ensuring that they provide to Local Planning Authorities a satisfactory and accurate assessment of application sites, including surveys for bats if their presence is suspected;
- Applying for a derogation licence to NPWS, should they judge one to be required;
- Providing a sound and objective assessment of the potential impact of proposed development on bat populations;
- Where necessary, designing and implementing a mitigation scheme that meets planning and licensing requirements, and in particular will ensure as far as possible the long term future of any populations affected; such schemes should employ 'best practice';
- In many cases, monitoring affected populations after completion of development, as required under the terms of a derogation licence

3.4 Local Planning Authorities

Local Planning Authorities have the following roles:

- Ensuring that protected species issues are taken into account as a material consideration when determining planning applications. This may involve refusal, deferral, conditions or agreements;
- Satisfying themselves that in submitting plans, developers have satisfactorily assessed the presence of bats and the potential impact on bats of the proposed development
- Ensuring that protected species issues are taken into account in preparation of Local Plans, etc. (this is best addressed through species protection policies in development plans);
- In order to achieve the above, developing means of assessing information on the presence of bats, in order to better inform planning decisions; this may include consultation with the National Biological Records Centre, ENGOs or liaison with local voluntary groups;
- Raise awareness of protected species in their area;
- According to information available, advising developers about statutory species protection provisions affecting an application site;
- Enforcement of planning obligations.

Figure 3. Training in bat ecology and conservation

3.5 Other organisations

The *National Biological Records Centre* will have useful information on the location of bat roosts and can provide such details to consultants, developers and Local Planning Authorities. Contact details: National Biological Records Centre, Beechfield House, Waterford Institute of Technology Campus, Carriganore, Co. Waterford. Similarly, local bat groups often collect data and may be able to provide a more detailed assessment of status; some may also be willing to undertake bat surveys in advance of planning applications. These voluntary groups are associated with *Bat Conservation Ireland*, which has a national database on all known species' roosts and sightings. Contact details: Bat Conservation Ireland, Deerpark House, Tierworker, Kells, Co. Meath; Tel: 046-9242882; Email: batline@eircom.net ; website: www.batconservationireland.org . The Vincent Wildlife Trust has details of lesser horseshoe bat in the west of Ireland and within its reserves. Contact details: Dr. Kate McAney, The Vincent Wildlife Trust, Donaghpatrick, Headford, Co. Galway; Tel/Fax: 093-35304; Email: katemcaney@vwt.org.uk .

Figure 4. Examining bat specimen during a Bat Conservation Ireland bat identification workshop

4 An introduction to bats

4.1 General

In order to understand the potential effects of development work and plan effective mitigation, it is essential to have knowledge of bat ecology. This knowledge is likely to be most relevant to ecological consultants, whose role it is to undertake site surveys, predict impacts and propose mitigation. The National Parks and Wildlife Service and Local Planning Authority staff will also benefit from such understanding. This section is not intended as a comprehensive description of bat ecology, as consultants are expected to have developed their own knowledge through study and field experience. It is meant as a general introduction, mainly for developers, to the life-cycle of bats and aspects of their biology. A range of more detailed references is given in 12: Further reading.

Bats are the only true flying mammals. Like us, they are warm-blooded, give birth and suckle their young. They are also long-lived, intelligent and have a complex social life. Although they're often thought of as flying mice, they're not closely related to mice but form a special group of their own: the Chiroptera. World-wide, there are over 1,100 different sorts of bat, ranging from the tropical flying foxes, with a wing-span of almost 2 metres (6'), down to the hog-nosed bat of south-east Asia, which is little bigger than a large bumble-bee.

In Ireland, currently, there are 10 known species, of two families (Vespertilionidae and Rhinolophidae) all of which are small (many weigh less than a €2 coin) and eat insects and spiders:

Vespertilionidae:

Common pipistrelle *Pipistrellus pipistrellus*

This species was only recently separated from its sibling, the soprano or brown pipistrelle *Pipistrellus pygmaeus*, which is detailed below (Barratt, E. M., Deauville, R. Burland, T. M., Bruford, M. W., Jones, G., Racey, P. A. & Wayne, R. K., 1997). The common pipistrelle's echolocation calls peak at 45 kHz. The species forages along linear landscape features such as hedgerows and treelines as well as within woodland.

Soprano pipistrelle *Pipistrellus pygmaeus*

The soprano pipistrelle's echolocation calls peak at 55 kHz, which distinguishes it readily from the common pipistrelle on detector. The pipistrelles are the smallest and most often seen of our bats, flying at head height and taking small prey such as midges and small moths. Summer roost sites are usually in buildings but tree holes and heavy ivy are also used. Roost numbers can exceed 1,500 animals in mid-summer.

Nathusius' pipistrelle *Pipistrellus nathusii*

Nathusius's pipistrelle is a recent addition to the Irish fauna and, so far, has mainly been recorded from the north of the island in Cos. Antrim, Down and Longford (Richardson, P, 2000) but is assumed to be spreading as single specimens have been recorded in Kerry and Cork and elsewhere and the known resident population is enhanced in the autumn months by an influx of animals from Scandinavian countries. The status of the species has not been determined.

Leisler's bat *Nyctalus leisleri*

This species is Ireland's largest bat, with a wingspan of up to 320mm; it is also the third most common bat, preferring to roost in buildings, although it is sometimes found in trees and bat boxes. It is the earliest bat to emerge in the evening, flying fast and high with occasional steep dives to ground level, feeding on moths, caddis-flies and beetles. The echolocation calls are sometimes audible to the human ear being around 15 kHz at their lowest. The audible chatter from their roost on hot summer days is sometimes an aid to location. This species is uncommon in Europe and as Ireland holds the largest national population the species is considered as Near Threatened here.

Figure 5. Leisler's bat

Natterer's bat *Myotis nattereri*

This species has a slow to medium flight, usually over trees but sometimes over water. It usually follows hedges and treelines to its feeding sites, consuming flies, moths, caddis-flies and spiders. Known roosts are usually in old stone buildings but they have been found in trees and bat boxes. The Natterer's bat is one of our least studied species and further work is required to establish its status in Ireland.

Daubenton's bat *Myotis daubentonii*

This bat species feeds close to the surface of water, either over rivers, canals, ponds, lakes or reservoirs but it can also be found foraging in woodlands. Flying at 15 kilometres per hour, it gaffs insects with its over-sized feet as they emerge from the surface of the water - feeding on caddis flies, moths, mosquitoes, midges etc. It is often found roosting beneath bridges or in tunnels and also makes use of hollows in trees.

Whiskered bat *Myotis mystacinus*

This species, although widely distributed, has been rarely recorded in Ireland. It is often found in woodland, frequently near water. Flying high, near the canopy, it maintains a steady beat and sometimes glides as it hunts. It also gleans spiders from the foliage of trees. Whiskered bats prefer to roost in buildings, under slates, lead flashing or exposed beneath the ridge beam within attics. However, they also use cracks and holes in trees and sometimes bat boxes. The whiskered bat is one of our least studied species and further work is required to establish its status in Ireland.

Brandt's bat *Myotis brandtii*

This sibling species to the whiskered bat is known from four recent specimens found to date in Cos. Wicklow, Cavan, Clare and Tipperary. A fifth specimen was identified in Killarney National Park, Co. Kerry in August 2005 (Kelleher 2005). Its status is unknown.

Brown long-eared bat *Plecotus auritus*

This species of bat is a 'gleaner', hunting amongst the foliage of trees and shrubs, and hovering briefly to pick a moth or spider off a leaf, which it then takes to a sheltered perch to consume. They often land on the ground to capture their prey. Using its nose to emit its echolocation, the long-eared bat 'whispers' its calls so that the insects, upon which it preys, cannot hear its approach (and hence, it needs oversize ears to hear the returning echoes). As this is a whispering species, it is extremely difficult to monitor in the field as it is seldom heard on a bat detector. Furthermore, keeping within the foliage, as it does, it is easily overlooked.

Rhinolophidae:

Lesser horseshoe bat *Rhinolophus hipposideros*

This species is the only representative of the Rhinolophidae family in Ireland. It differs from our other species in both habits and looks, having a unique nose leaf with which it projects its echolocation calls. It is also quite small and, at rest, wraps its wings around its body. Lesser horseshoe bats feed close to the ground, gleaning their prey from branches and stones. They often carry their prey to a perch to consume, leaving the remains beneath as an indication of their presence. The echolocation call of this species is of constant frequency and, on a heterodyne bat detector, sounds like a melodious warble. The species is confined to six counties along the Atlantic seaboard: Mayo, Galway, Clare, Limerick, Kerry and Cork – see Figure 2. The current Irish national population is estimated at 12,500 animals. This species is listed on Annex II of the EC Habitats Directive and 41 SACs have been designated in Ireland for its protection.

Figure 6. Torpid lesser horseshoe bats within roost

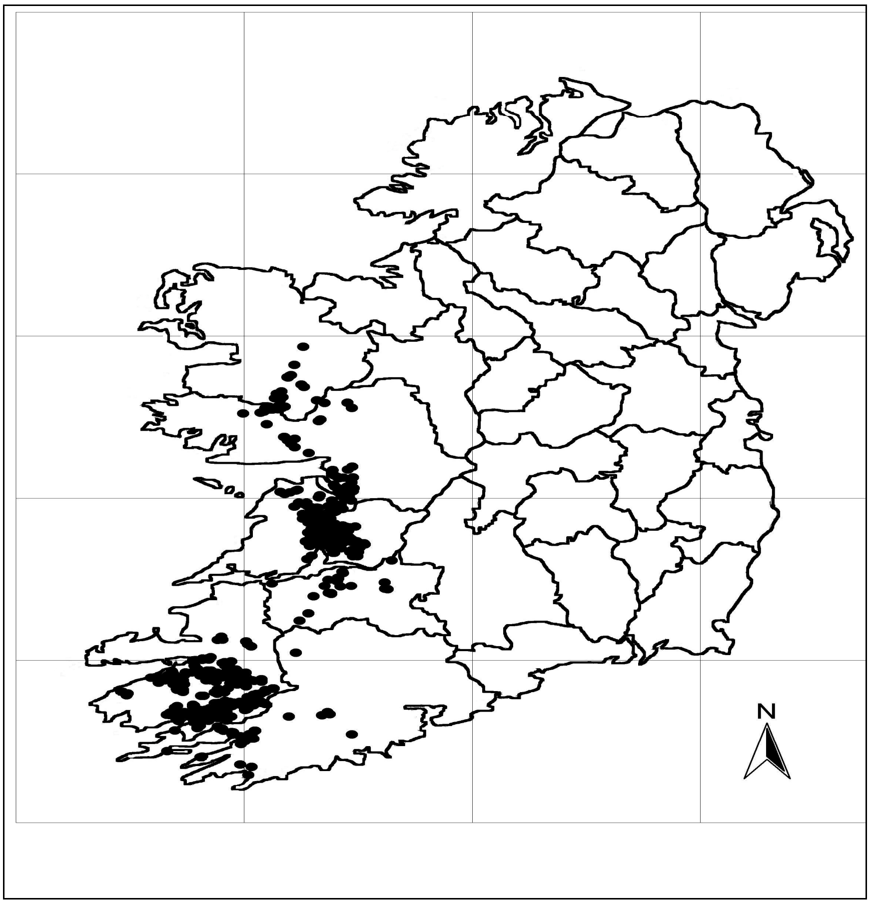


Figure 7. Lesser horseshoe bat distribution in Ireland (source: NPWS database)

Bats have evolved a number of unusual features, mainly connected with their ability to fly. Their wings are formed from a web of highly elastic skin stretched over greatly elongated finger bones, the legs and tail, though their thumbs remain free to help them cling on when roosting. Bats have also developed a highly sophisticated echolocation system that allows them to avoid obstacles and catch tiny insects, even in complete darkness. When they're flying, bats produce a stream of high-pitched calls and listen to the echoes to produce a sound picture of their surroundings. Most of these echolocation calls are too high pitched for us to hear, but electronic bat-detectors that pick up these calls and turn them into sounds that we can hear are now widely used by specialists. In most cases, it is possible to identify the bat species from the type of sounds produced.

In cool climates such as Ireland, bats eat only insects and other invertebrates such as spiders, which they catch in flight or pick off water, the ground or foliage. Some bats specialise in catching large insects such as beetles or moths but others eat large numbers of very small insects, such as gnats, midges and mosquitoes, every night. Bats gather to feed wherever there are lots of insects, so the best places for them include traditional pasture, woodland, marshes, ponds and slow moving rivers.

During the winter there are relatively few insects available, so bats hibernate. In September and October they put on weight and then, as the weather gets colder, they seek out appropriate sheltered roosts, let their body temperature drop to close to that of their surroundings and slow their heart rate to only a few beats per minute. This greatly reduces their energy requirements so that their food reserves last as long as possible. Bats don't hibernate right through the winter but may wake up and go out to feed and drink on mild evenings when some insects are about. Even on very cold nights, bats may be seen on the wing as they move to more sheltered roosts. Waking up and flying in winter uses up lots of energy which the bats can't easily replace, so hibernating bats should not be disturbed as this might reduce their chances of surviving the winter.

Bats have a unique way of fitting their breeding cycle in with hibernation. They mate during the autumn and winter, but the female stores the sperm alive in her body and only becomes pregnant the following spring. Pregnancy lasts for six to nine weeks and can vary in length depending on the weather. Usually only one baby is born each year. This is looked after carefully and suckled for between four and five weeks until it is old enough to fly out and hunt for itself. Bats don’t build nests and don't bring food back to the roost to feed their young, so the baby lives only on its mother's milk until it is old enough to fly.

During this spring and summer period female bats gather together into maternity colonies for a few weeks to give birth and rear their babies. Once the baby is independent, the colony breaks up and the bats generally move to other roosts. Bats may gather together from over a large area to form these colonies, so any disaster at this summer breeding site can affect all the females from this area. Many of these maternity sites are used every summer and bats have a strong tradition of returning to the same site year after year.

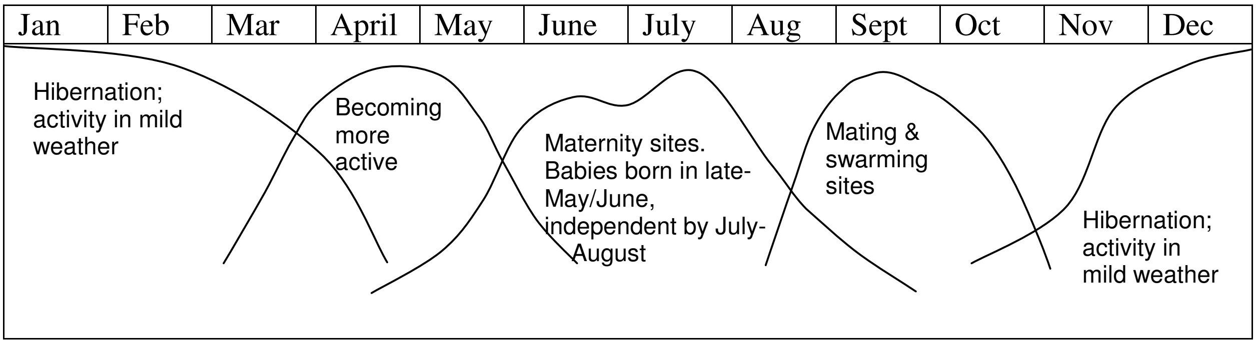


Figure 8. The bat year. Although there are species-specific differences, the bat year can be divided into the two major phases of breeding and hibernation, with other activities interspersed.

4.2 Roost requirements

Because their metabolic and social requirements vary throughout the year, most bats will use a variety of roosts of different types. Some species are particularly closely associated with tree roosts, the majority use a range of roosts which includes trees, buildings and underground sites and some species use primarily buildings and underground places. Classifying such sites can be difficult because of the varying conditions they provide and the way in which bats select sites. For example, Natterer’s bat has frequently been recorded in mortise joints in churches, old barns and similar buildings; from the bats’ perspective, such sites must appear very similar to crevices in trees underneath a thick tree canopy. Other species too, show a similar tendency to roost in contact with timber rather than stone or brick.

Some species, such as the brown long-eared bat, are frequently recorded in underground sites during the winter, but the small number of individuals recorded at any one site suggests that this common species does not depend heavily on underground sites. Rather few trees are ever searched for bats and it seems likely that many species hibernate in tree cavities or under bark and so are significantly under-recorded.

The lesser horseshoe bat clearly has the strongest affinity with underground sites. In winter, it is rarely found in any other type of site and the species has even been recorded breeding underground, though the great majority of maternity sites are now in the roof voids of buildings. Other species which are considered typical hibernators in underground sites are Natterer's bat, Daubenton's bat, whiskered bat, Brandt's bat and brown-long-eared bat.

Species	**Trees**		**Buildings**		**Underground**	
	Maternity	Hibernation	Maternity	Hibernation	Maternity	Hibernation
Lesser horseshoe bat *Rhinolophus hipposideros*	L	L	H	M	L	H
Brandt's bat *Myotis brandtii*	L	L	H	H?	N	H
Daubenton's bat *Myotis daubentonii*	M?	L?	M	L	M?	H
Whiskered bat *Myotis mystacinus*	M?	M?	H	L	N	H
Natterer's bat *Myotis nattereri*	M?	M?	H	L	L	H
Nathusius' pipistrelle *Pipistrellus nathusii*			H?			
Common pipistrelle *Pipistrellus pipistrellus*	M	M	H	H	N	L
Soprano pipistrelle *Pipistrellus pygmaeus*	M	M	H	H	N	L
Leisler's bat *Nyctalus leisleri*	M	M	H	L	N	N
Brown long-eared bat *Plecotus auritus*	H	H	H	H	N	M

Trees – includes all types of crevice and hollow as well as bat-boxes attached to trees
Buildings – above-ground areas, with an emphasis on roof voids and other areas warmed by the sun.
Underground – anywhere that provides cool humid conditions buffered against rapid temperature change. Includes caves, mines, tunnels, souterrains, fortifications, cellars, ice-houses, lime kilns etc.

N – not recorded in recent times
L – low dependence; unusual, but has been recorded
M – some usage recorded, though perhaps not the most important type of site
H – the most frequently recorded type of site for this species/activity

Table 4.1 Species associations with roost types.

Many species of bats are closely associated with the built environment, both for breeding and hibernation and some species have rarely been recorded anywhere else. The majority of species form maternity roosts in the roofs of buildings to take advantage of the heat provided by the sun, as during this phase of their life-cycle breeding females are seeking areas with high temperatures to minimise the energy cost of maintaining a high body temperature. Some species, such as the common pipistrelle, show a clear preference for confined roost sites, such as soffit-boxes, eaves or under hanging tiles, whereas others, such as the lesser horseshoe and long-eared bats are more typically associated with open roof voids that they can fly in. There are many exceptions and many species have been recorded from a wide range of situations. In winter, bats of most species have been recorded hibernating in various parts of buildings, such as inside cavity walls, around window frames, under ridge-tiles and in cooler areas with stable temperatures.

4.3 Habitat associations

As well as suitable sites for roosting, bats also need suitable food resources. All species eat insects, or similar small invertebrates, though they hunt them in a variety of ways and a variety of places. Some species specialise in catching small insects in flight, some specialise in larger insects such as moths and beetles and some get part of their food by picking insects off foliage or even spiders' webs. Understandably, the highest densities of bats occur where insects are most plentiful and surveys of hunting bats have shown that areas of wetland and woodland edges are particularly good for bats.

Bats need to be able to move freely around the countryside between roosts and feeding areas. Research has shown that many species, particularly the smaller ones, follow linear features, such as hedges, tree-lines or waterways, and are reluctant to cross wide open spaces. This behaviour means that activities which sever these sorts of connections are likely to have consequences for bats.

Recent studies using radio-tracking have shown that bats are very variable in the distances that they travel from their roosts to forage. For example, at some roost sites for Daubenton's bats activity took place within 2 km of the roost whereas at other roosts some individuals travelled up to 19 km to forage. Brown long-eared bats appear to be a relatively sedentary species, with few individuals travelling more than 2 km whereas other species such as Leisler's bat will frequently travel more than 5 km. Travelling distances are even greater between summer and winter roosting sites when distances of 100+ km have been recorded for certain species.

Figure 9. Deciduous woodlands favoured by bats

5 Survey objectives, methods and standards

5.1 The importance of a good survey

The importance of a thorough site survey prior to considering development cannot be over-emphasised. The following descriptions of survey techniques and their correct application are aimed at assisting consultants (to appreciate the type of survey that is expected), the developer (to be assured that their consultant is recommending a survey to help them meet legal and policy requirements), and planning officers and National Parks and Wildlife Service staff (to be sure that an accurate assessment of the site and the extent of its bat interest has been made). Without a sound survey that includes an assessment of all available evidence, it is difficult to predict the likely impact of development.

From the developer's perspective, the primary objective of a survey for protected species is to ensure that any development can proceed without breaking the law. The consequences of not carrying out a survey on sites which subsequently prove to have a significant protected species interest can be severe and may include delays, additional costs and, in exceptional cases, the cancellation or curtailment of projects.

5.2 Some general points on surveys

A survey for bats may be indicated when background information on distribution and occurrence suggests that they may be present. More detailed indicators are:

- any recent or historical records for bats on the site, or bat roosts in the general area, though note that bats are very under-recorded;
- built structures, which appear to have a high probability of use by bats;
- underground structures such as abandoned mines, tunnels, souterrains, kilns, cellars or fortifications which provide appropriate hibernation conditions;
- trees with a high probability of use by bats.

Some factors influencing the probability of particular places being used by bats are listed in Table 5.1. However, it should be emphasised that this can, at best, only highlight sites with a high probability of bats being present and the high mobility of bats means that it is virtually impossible to rule out any type of structure. In addition, regional variation in building styles and species' distributions means that some local interpretation of these guidelines may be needed

It is the responsibility of the developer to produce, normally via a consultant, evidence on the presence of bats on a site at which works are proposed. It is for the consultant to decide on the level of survey required (taking these guidelines into account). The National Parks and Wildlife Service will not generally agree or endorse the methods and effort prior to a survey, as this is not the NPWS's role, and site circumstances vary considerably. However, if the NPWS or the Local Planning Authority considers that insufficient survey work has been carried out to enable the determination of a planning or licence application, further work may be required of the developer and consultant. NPWS staff will generally visit sites only where there is an exceptional need to do so, so it is crucial that survey reports are thorough.

Considering the great variation between sites, it is not possible to give exact prescriptions for survey work here that will cover all circumstances. Therefore, survey plans need to be formulated on a site by site basis and the experience of the consultant should help shape this.

Surveys must be carried out by licensed personnel, where there is a risk of bats being disturbed, and should not entail undue site damage or disturbance to roosts.

Factors affecting the probability of a building being used by bats in summer	
Increase probability	Disused or little used; largely undisturbed Large roof void with unobstructed flying spaces Large dimension roof timbers with cracks, joints and holes Uneven roof covering with gaps, though not too draughty Entrances that bats can fly in through Hanging tiles or wood cladding, especially on south-facing walls Rural setting Close to woodland and/or water Pre-20th century or early 20th century construction Roof warmed by the sun Within the distribution area of horseshoe bats
Decrease probability	Urban setting or highly urbanised area with few feeding places Small or cluttered roof void (esp. for brown long-eared bat) Heavily disturbed Modern construction with few gaps around soffits or eaves (but be aware these may be used by pipistrelles in particular) Prefabricated with steel and sheet materials Active industrial premises Roof shaded from the sun
Factors affecting the probability of trees being used by roosting bats	
Increase probability	In ancient woodland or parkland Large trees with complex growth form Species that typically form cavities, such as beech, willow, oak or ash Visible damage caused by rot, wind, lightning strike etc. Loose bark providing cavities
Decrease probability	Coniferous plantation with no specimen trees Young trees with simple growth form and little damage
Factors affecting the probability of underground sites being used by roosting bats	
Increase probability	Large enough to develop stable temperature in winter High humidity Undisturbed Close to woodland or water (but note that bats will also use upland sites) Many cracks and crevices suitable for bats
Decrease probability	Small and draughty Heavily disturbed In urbanised areas Smooth surfaces with few roosting opportunities

Table 5.1. Factors affecting the probability of bats being present.

Survey reports are expected to:

- State what the survey objective was, what work was done, by whom, and when. A suggested outline for survey reports within mitigation plans is given in 10. Presenting mitigation plans.
- Be clear and unambiguous, with appropriate evidence to support conclusions.
- Contain relevant raw data as well as processed data, and any negative results obtained
- Contain contextual information, such as weather conditions, which may have affected results
- Contain good site descriptions, plans and maps enabling a proper assessment of the proposal.
- Include a summary which is understandable by people without detailed knowledge of bats.
- Be accessible to third parties. Note that as survey reports are used in the decision-making process for planning applications and licences, they should not be confidential.

5.3 Setting survey objectives

Before setting foot in the field, it is important to define the purpose of the survey; in other words, why is it being undertaken? In turn, objectives for field survey can be set, the two most common objectives in relation to development being:

- Presence/absence survey: is there evidence that bats use a particular site or structure?
- Investigation of the type, extent and pattern of usage by bats as a precursor to the development of a mitigation proposal.

The former may be a first stage, when assessing potential development sites and the latter will normally be required prior to determination of planning permission, to inform an opinion as to what effect development will have on a particular site (see 6. Predicting the impact of development). In practice, the two objectives are often combined, particularly when the conservation significance of the site is low.

Presence/absence surveys may be further subdivided into surveys designed to detect whether bats are present on a site (and thus trigger a more detailed investigation) and surveys to demonstrate beyond reasonable doubt that bats are not present. Although these may appear to be similar objectives, the effort (sampling intensity) required to demonstrate the negative may be much higher than conventionally accepted to detect the positive.

5.4 Survey area

As a minimum, the survey should normally cover any land or structures which are proposed for development. For phased developments, the entire site should be surveyed, not just the area of the first phase, and considered as a whole unit when assessing impacts and possible mitigation. This will help to avoid the undesirable situation where mitigation methods implemented during an earlier phase are likely to be affected by a later phase. Remember that as well as construction work itself, there are other development-related activities which can affect bat sites (see 6.2 Major types of impact and their effects on populations). However, certain parts of the land may be excluded from survey if it is considered that bat roosts are highly unlikely to be present or development on that area would not affect them. Examples of such areas might include playing fields or arable land (excluding trees) which present no opportunities for roosting. Although foraging areas and commuting routes are not legally protected, the effects of development proposals on these may be taken into consideration when assessing the impact of the proposal on the maintenance of favourable conservation status. Similarly, they may be taken into account by planning authorities, certainly where specially protected sites are involved. For example, the impact of planning proposals close to SACs (Natura 2000 sites) for bats is likely to receive close attention.

5.5 Desk study

The following sources can be consulted for existing information on local bat roosts (perhaps within 5 km of the area): Local Planning Authorities (e.g. on 'constraint plans'), National Biological Records Centre, Bat Conservation Ireland, local bat group and, for lesser horseshoe data, NPWS. This consultation can result in lists of recent sightings and an indication of status and distribution in the general area. However, it should only be used as background information, because such archives are likely to become out-of-date quite quickly and should never be considered as a substitute for a field study.

5.6 Field survey methods

This section describes the main methods used to detect and record bats or evidence of bats. This manual does not provide a substitute for training and experience and should not be considered a definitive guide to bat surveys. Although a licence to disturb bats for scientific purposes is not essential when looking for previously unknown roosts, the requirement to withdraw if bats are discovered will limit the ability of the surveyor to carry out this work. For this reason, it is advisable for surveyors to be licensed.

5.6.1 Inspection of buildings or other structures

The most commonly used survey method for both presence/absence surveys and detailed usage surveys is close inspection of sites or structures for bats or evidence of bats. To undertake such surveys to a high standard, surveyors need training and experience, both in identifying bats and knowing where bats, or signs of bats, are likely to be found. Surveys for signs can be carried out at any time of year, but bats are most likely to be seen or heard in roofs during the summer or autumn or seen in subterranean areas during the winter.

Figure 10. Disused ice-house - such structures are often used by hibernating bats

A typical approach to surveying buildings would include the following elements:

- Allow sufficient daylight hours to permit a thorough inspection of each structure;
- Ensure that all parts of the structure can be inspected. This may require prior arrangement with owners, occupiers, caretakers etc. Access and inspection equipment, such as ladders, binoculars and a good torch, should always be available;
- Carry out a risk analysis and ensure safe working methods are adopted;
- Ask appropriate people (owners, neighbours etc.) whether there is any history of bats using the site;
- Carry out an external inspection of the structure looking for bat droppings on the ground or stuck to walls, suitable entry and exit points around eaves, soffits, flashing, under tiles etc.;
- Carry out an internal inspection of the structure. This should focus particularly on areas which provide appropriate environmental conditions for bats. This may include warm darker areas, joints and crevices in wood, ridge beams and hips as well as cool subterranean areas suitable for torpor or hibernation. Listen for bats; be aware of the characteristic smell of a bat roost; examine floors, walls and structural elements for droppings; check for other signs of bat use, such as corpses or skeletons, oily marks (from fur) around possible access points and roost areas, lack of cobwebs along beams, feeding remains such as moth wings or other insect parts;
- Record any signs of bats found on a plan of the structure and collect samples of droppings, bones or feeding remains for comparison with a reference collection.

Example: Specification for surveys in relation to planning applications affecting possible lesser horseshoe bat feeding habitat. Note that the objective is to detect commuting routes and feeding areas rather than roosts.

The following specification is recommended in relation to development proposals of 1ha or more within 4km of lesser horseshoe bat roosts. A similar specification may be appropriate for smaller development proposals, which because of disturbance (e.g. light and noise pollution) or proximity to a roost may be significant.

(i) Surveys should pay particular attention to known lesser horseshoe bat feeding habitat such as hedgerows, coppice, woodland fringe, tree lines and areas of scrub and pasture, and linear landscape features such as drainage ditches, earth banks, fencing, walls, hedges etc that may provide flight lines.
(ii) Surveys should be carried out on two separate evenings each month from May to September, as the bats' favoured foraging areas may alter across the summer period.
(iii) Surveys should be carried out on warm (>10 °C, but >15°C in late summer), still evenings that provide optimal conditions for foraging (insect activity is significantly reduced at low temperatures). Details of temperature and weather conditions during surveys should be included in final report.
(iv) Surveys should cover the period of peak activity for bats from sunset for at least the next 3 hrs.
(v) Surveys should preferably be with broadband detectors as these provide a record of echolocation signals, although appropriately tuned heterodyne detectors (105-111 kHz) will be sufficient. Details of echolocation should be provided within the final report along with details of the type of the detector used.
(vi) Surveys should be carried out by suitably qualified and experienced persons. Numbers of personnel involved should be indicated in any report and be sufficient to thoroughly and comprehensively survey the size of site in question.
(vii) Surveys should also include desktop exercises in collating any records and past data relating to the site via Bat Conservation Ireland, Vincent Wildlife Trust, NPWS, bat group etc.
(viii) All bat activity should be clearly marked on maps and included within the report.
(ix) Basic details of records for the site should be passed to Bat Conservation Ireland after determination of the application.

5.6.2 Inspection of trees

Surveying trees presents particular problems at any time of the year as bats will use a wide variety of roost sites in cavities, splits, cracks, knotholes and under loose bark, many of which are not easily detected from the ground. A careful survey using high-quality binoculars may pinpoint potential or actual roost sites and some species, most notably Leisler's, may be quite noisy at times during the summer. Endoscopes may also be useful for inspecting likely cavities, though their use may be limited by the need for access equipment. Confirmation of the presence of bats may be attempted by using bat detectors for an emergence survey at an appropriate time of the year (see 5.6.3), but the nomadic nature of tree-dwelling bats means that the success rate is likely to be very low. Detector surveys just before dawn, which aim to detect bats returning to their roost, have a slightly higher chance of success as bats will often swarm around a roost for some time before entering.

5.6.3 Use of bat detectors

Bat detectors provide a sensitive way of detecting active bats in some situations and can be a useful adjunct to the search methods described in 5.6.1. Considerable expertise is needed to identify bats to the species level, though the technology to assist with this task has improved significantly in recent years. Guidance on the use of detectors is available from the UK Bat Conservation Trust (http://www.bats.org.uk/batinfo/batdets.htm) and this methodology is widely used in national surveys by Bat Conservation Ireland. Different types of detector are appropriate for different types of survey and broadband detectors are probably best for surveys of new areas.

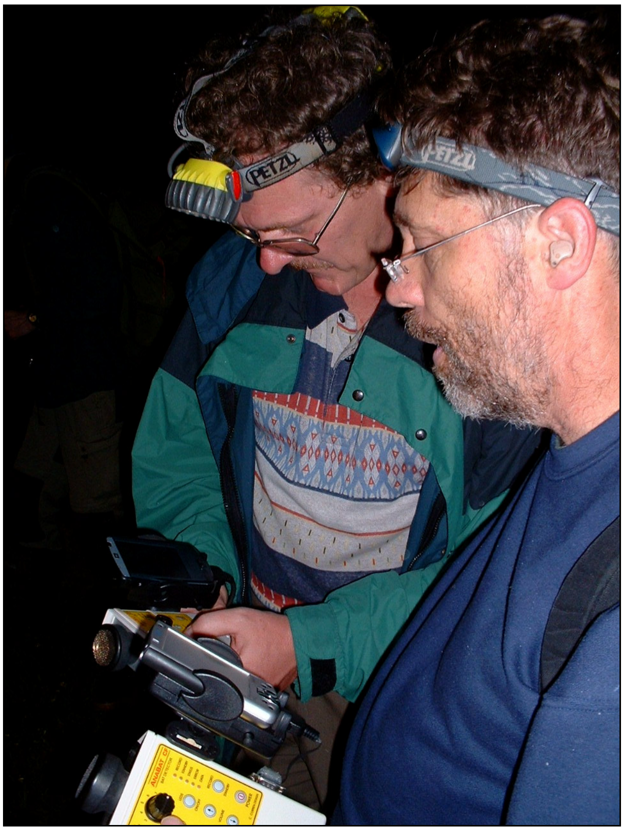


Figure 11. Using heterodyne and time-expansion bat detectors in the field

The seasonal and daily pattern of bat activity and the use of different types of roost at different times of the year will impact on the appropriateness of this methodology. Handheld detectors can be used on visits to roosts between dusk and dawn during the summer (buildings and trees) or autumn (some underground roosts) to detect active bats entering or leaving the site. The optimum time for dusk surveys at buildings, particularly during early summer is for the two hours after the first bats emerge as this will cover the emergence period as well as the first return to the roost for some species. The time of first emergence varies between species, with Leisler's leaving around sunset and Natterer's bats leaving about 1 hour after sunset. Bats using underground sites during the summer may not emerge till much later, perhaps even 4 hours after dark. Towards dawn, many bats swarm outside their roosts and surveys beginning about 90 minutes before sunrise and continuing until 15 minutes after sunrise ('sunrise surveys') are recommended. In autumn, it is possible to detect the social calls of males of some species of bats, notably Leisler's and pipistrelles. Surveys at this time of the year should begin about 30 minutes after the species' emergence time and it may be necessary to set the bat detector to record lower-frequency social calls.

Automated detectors linked to data-loggers have proved useful in some situations, particularly recording bats moving in and out of underground sites. The box below provides information on some systems that have been used successfully by one consultancy, though the technology is changing all the time.

STATIC BAT DETECTOR SYSTEMS

A static bat detector system is a system that will record bat calls in the absence of a person. It includes a bat detector, preferably a broad-band detector, so that all types of bat calls are recorded. In addition, the approximate time of a recorded bat call should be discernable.
No single system is suitable for all situations & needs, but the following systems have been used:

Detector	Timer method	Call storage	Internal battery time limit (hours)	Water Splash rejection	Notes
Tranquility II Now replaced by Transect	NONE. Needs external talking clock (1 hour interval)	Needs voice-activated tape or digital recorder	38 hours	No	€600+
Tranquility III (code TIII)	NONE. Needs external talking clock (1 hour interval)	Internal 200 unit digital store, or external as above	38 hours	No	€1,000+ plus cost extras
Eco Mega (code EM)	Internal timer (0.5 hour interval)	Internal 500 unit digital store, or external digital recorder as above	38 hours	Yes	€2,500+ plus cost of extras

All stored calls need analysis using software such as Batsound (Pettersen Elektronik) or Adobe Audition.

EQUIPMENT SOURCES

1) Tranquility & EM detectors: David Bale, 7B The Mount, Belfast, Co. Down, N. Ireland, BT5 4NA
2) Sony ICD-B15: Electrical retailers such as Dixons, Comet. (c€130)
3) Talking clock: Argos (c€10)
4) Connectors/leads: Maplins or RS Components.

Roger D. Ransome
March 2002

5.6.4 Netting and harp-trapping

Mist netting and the use of harp traps to catch bats are well-established research methods. However, it is rarely necessary to catch bats in flight for the purposes of surveys associated with development, although there may be occasions when the positive identification of species is required. These methods are invasive, time-consuming and require specialist training. It would be wise to discuss survey requirements with the National Parks and Wildlife Service before undertaking such work.

5.6.5 Radio-tracking

Radio-tracking provides the most powerful way of determining what foraging areas are used by bats from a particular roost or whether the bats from a particular roost have alternative roosts nearby. Bats can be caught at, or close to, the roost, fitted with miniature radio transmitters and then tracked as they move to, and between, foraging areas or other roosts. Such a technique is unlikely to be necessary for the majority of developments, but may be required when development which may affect a Natura 2000 site for bats is proposed. The need for such surveys should be discussed with the NPWS before commissioning any work. Radio-tracking can also be used to help locate unknown roosts. This would require foraging bats to be captured, using harp traps or mist nets, fitted with radio transmitters and tracked back to their roost. Such work is unlikely to be required as part of a development proposal, but has been used successfully to locate the roosts of rare species.

Figure 12. Using radio-telemetry to track bats has proven a successful method for roost location

5.6.6 Timing of surveys

As indicated above, bat survey methods vary in their applicability to different types of roost at different times of the year. Careful inspection of buildings due for demolition, alteration, repair or redevelopment is probably the most frequently required survey method and it is fortunate that this method is applicable throughout the year. However, interpreting the results can be difficult during the winter when bats are unlikely to be present in large numbers. In particular, the distribution and appearance of the droppings does not always lead to an unambiguous conclusion as to which species is present and further work may be required to determine this.

The table below gives a summary of when the two main survey methods may be applicable. A more detailed table of species and habitats and survey effort and methods is given in the Appendices.

Season	Roost type	Inspection	Bat detectors and emergence counts
Spring (Mar – May)	Building	Suitable (signs, perhaps bats)	Limited, weather dependent
	Trees	Difficult (best for signs before leaves appear)	Very limited, weather dependent
	Underground	Suitable (signs only)	Static detectors may be useful
Summer (June-August)	Building	Suitable (signs and bats)	Suitable
	Trees	Difficult	Limited; use sunrise survey
	Underground	Suitable (signs only)	Rarely useful
Autumn (September – November)	Building	Suitable (signs and bats)	Limited, weather dependent
	Trees	Difficult	Rather limited, weather dependent; use sunrise survey?
	Underground	Suitable (signs, perhaps bats)	Static detectors may be useful

Winter (December-February)	Building	Suitable (signs, perhaps bats))	Rarely useful
	Trees	Difficult (best for signs after leaves have gone)	Rarely useful
	Underground	Suitable (signs and bats)	Static detectors may be useful

Table 5.2. The applicability of survey methods.

5.7 Survey standards

It is for the person planning the survey to decide what level of effort is required, according to the objective of the survey and local conditions. However, this section gives guidelines on reasonable minimum standards for survey methods and effort. Deviation from these guidelines should be justified by a supporting statement, giving reasons for the use of a different set of methods, or level of effort. Obviously, for presence/absence surveys, in many cases bats will be detected in much less time than the number of visits indicated here (sometimes within a few minutes of a site visit commencing), and there may be no need to undertake the full effort indicated if the objective is purely to determine presence.

5.7.1 Presence/absence surveys

Figure 13. Derelict building with bat potential

5.7.1.1 Buildings

The presence of a significant bat roost (invariably a maternity roost) can normally be determined on a single visit at any time of year, provided that the entire structure is accessible and that any signs of bats have not been removed by others. However, a visit during the summer or autumn has the advantage that bats may be seen or heard. Buildings (which for this definition exclude cellars and other underground structures) are rarely used only for hibernation, so droppings deposited by active bats provide the best clues. Roosts of species which habitually enter roof voids are probably the easiest to detect as the droppings will normally be readily visible. Roosts of crevice-dwelling species may require careful searching and, in some situations, the opening up of otherwise inaccessible areas. If this is not possible, best judgement might have to be used or caveats put in the report with recommended contingency measures should bats be found during development. Roosts used by a small number of bats, as opposed to maternity sites, can be particularly difficult to detect and may require extensive searching backed up (in summer) by bat detector surveys or emergence counts. The time spent searching will vary greatly with the situation, but as a guide the roof areas (void, gables and soffits) of a normal-sized unexceptional domestic property could probably be searched thoroughly in 1-2 person-hours whereas a large building complex such as a hospital or stately home is likely to take more than 1 person-day and may take several days if there are many buildings. Evening surveys with bat detectors at an appropriate time of year may be helpful in narrowing down the area to be searched.

If the entire building is not accessible or signs of bats may have been removed by others, or by the weather, bat detector or exit count methodologies may be required to back up a limited search. In this case, the season available for the work is significantly curtailed. If surveys of open structures, such as barns, are undertaken during the winter, there is a significant chance that signs of bats will have been removed by weathering and extra care will be required to detect bat usage. If there is doubt as to whether a structure is used by bats, further visits during the summer or autumn will be required (see Table 5.2).

5.7.1.2 Trees

Except in the simplest cases, it is extremely difficult to survey trees and be certain that any bat roosts have been detected. Tree cavities (which includes under bark or in splits or cracks) are used throughout the year by a variety of species, many of which are known to move unpredictably between roosts. Suitable cavities include rot cavities that orient upwards from the entrance, long splits where limbs have fallen and places where the bark has separated from the underlying trunk.

Figure 14. Decaying tree showing loose bark with potential for bat roosting

Whilst maternity colonies of some species such as Leisler’s may be relatively easy to detect, small summer roosts of other species or hibernating bats leave few clues to their presence. The best time to carry out surveys for suitable cavities is between November and April, when the trunk and branches are not obscured by leaves. If inspection suggests that the tree has suitable cavities or roost sites, a bat detector survey at dusk or dawn during the summer may produce evidence of bats, though the nomadic nature of most tree-dwelling species means that the success rate is very low. It can also be difficult to pinpoint exactly which tree a bat emerged from. A dawn survey is more likely to be productive than a dusk one as swarming bats returning to the roost are much more visible than those leaving the roost.

Because tree-dwelling bats move roosts frequently, a single bat-detector survey is unlikely to provide adequate evidence of the absence of bats in trees that contain a variety of suitable roosting places. Several dawn or dusk surveys spread over a period of several weeks from June to August will greatly increase the probability of detecting significant maternity roosts and is recommended where development proposals will involve the loss of multiple trees.

Climbing trees to look for roosts, using appropriate equipment and safety precautions, is a possible approach for small numbers of trees with a high probability of bats, but the results of radiotracking studies of some species suggest that bats may use cracks or crevices that are far from obvious.

5.7.1.3 Caves, mines and other underground structures

Underground structures are used mainly for hibernation, so surveys should generally be carried out during the winter, though it would be unwise to proceed with the destruction or modification of such sites without a prior inspection. Presence/absence surveys for hibernating bats are most productive during January and February for most species, though bats are likely to be found between November and March, depending on the weather. For sites used by significant numbers of bats (> 5-10), a single survey during cold weather in January or February has a high probability of detecting at least one bat, but outside these core months two or three visits between November and March are recommended. As well as looking for bats, careful inspection for droppings or oil staining around cracks and crevices may also yield evidence of use. The probability of seeing bats is influenced by the nature of the site, as most species except horseshoe bats tend to conceal themselves in crevices, if available. Activity loggers, as described in 5.6.3, may also be used.

Figure 15. Lesser horseshoe bat hibernating underground

Daubenton's and lesser horseshoe bat, have been recorded breeding in underground sites in the UK and may do so in Ireland on occasion, so surveyors should be aware of this possibility and record the presence of any significant accumulations of droppings or stained or marked areas indicating the presence of large numbers of bats. Revisits during the summer may be required in these rare cases. There is also the possibility of finding small numbers of bats using underground sites as night roosts during the summer.

Some underground sites are also used as swarming sites during the autumn. This behaviour, which is believed to have a social function, begins in early August, peaks in mid-August to mid-September and ends in October. During this period, many bats may arrive at the site after dusk, stay a few hours then leave, so few bats may be present at the site during the day. The species composition of swarming bats may be very different from that of hibernating bats found at the site, though *Myotis* species are most frequently recorded. Surveys for swarming bats can be carried out during August, September and October beginning at dusk (1 hour after sunset) and continuing through the night as most activity has been recorded in the hours prior to dawn. Bats can be recorded using detectors or by netting or harp-trapping, though the latter two techniques are highly invasive and more suitable for detailed studies.

5.7.2 Extent and pattern of usage

Confirming the extent and pattern of usage can be difficult in some cases. Where significant quantities of droppings (piles which cover areas of the floor) are present in the roof void of a building, it is reasonable to assume that this is a maternity site, unless there are clear indications to the contrary. Interpreting the status of sites in buildings with lesser quantities can be difficult and here there are two options; either assume a ‘worst-case scenario’ that the site is a maternity site, or carry out further survey work in the appropriate season to either prove or disprove the existence of a maternity site. Sites with very small quantities of scattered droppings are unlikely to be of high conservation significance as they are unlikely to be maternity sites.

5.8 Interpreting and evaluating survey results

5.8.1 Low numbers and absence

‘Presence/absence’ surveys may determine presence but in fact it can be extremely difficult to demonstrate absence for highly mobile animals such as bats. The guidance here is designed to suggest a reasonable level of effort that, at the majority of roosts, will detect the presence of bats. However, where survey conditions are difficult, buildings are large or inaccessible or where populations are small, it can be exceedingly difficult to detect bats, particularly at some times of year. It is feasible, for example, that for winter visits to sites used by few bats, several visits could be carried out with no bats detected, but a further visit might find them. In many sites, usage is heavily influenced by the external temperature.

It is for the consultant to decide on the level of effort to employ according to site conditions; the fundamental issue is that the survey should be able to provide the National Parks and Wildlife Service and the Local Planning Authority with an assessment of the effects of development.

5.8.2 Site, colony or population size class assessment

Most surveys of bat roosts attempt to estimate the number of bats using the site and, from this, come to a conclusion about the way the site is used and its importance to the local population of the species recorded. These estimates are most frequently based on the number of bats seen on a visit or the size of any accumulated pile of droppings, allied, perhaps, with other clues from the site.

It is very difficult to establish the true size of a population of bats using a roost, due to a range of factors including:

- the variable sampling efficiency attained in different types of roost,
- the complex population dynamics involved,
- the differing habits of males, females and juveniles (especially at maternity sites),
- the seasonal nature of occupation of most roosts,
- species-specific factors.

At one end of the spectrum lie maternity roosts for a site-faithful species such as the lesser horseshoe bat, where a reasonable estimate for the size of population (or colony) associated with the site might be possible, even though few males will ever be seen. At the other, lie large complex hibernation sites, where only an unknown fraction of the bats present might be visible and where individual bats come and go throughout the winter.

Given these difficulties, it is important that the underlying data on which any conclusions are based are included in the method statement. Significant information items include:

- species identification details, including bat detector information,
- dated counts of bats, either in the roost or exit counts
- position of bats in roost (clustered, dispersed etc.),
- pattern and extent of any accumulation of droppings, with information about their age,
- presence of food remains, such as moth wings

Except in exceptional circumstances, it will be necessary to provide a map or plan of the site, indicating where any bats or signs of bats were encountered.

Figure 16. Pipistrelle droppings on window sill beneath roost access point

5.8.3 Factors influencing survey results

The presence of bats in a particular roost on a particular day is, of course, influenced by all the factors referred to in 5.8.2. In addition, the recent and current weather can have a marked effect. During the winter, bats will move around to find sites that present the optimum environmental conditions for their age, sex and bodyweight and many species will only be found in underground sites when the weather is particularly cold. During the summer, bats may be reluctant to leave their roost during heavy rain or when the temperature is unseasonably low, so exit counts should record the conditions under which they were made. Similarly, there may be times when females with young do not emerge at all or emerge only briefly and return while other bats are still emerging thus confusing the count. Within roosts, bats will move around according to the temperature and may or may not be visible on any particular visit. Bats also react to disturbance, so a survey the day after a disturbance event, may give a misleading picture of roost usage.

Care must also be exercised when recording signs of bats. The volume and layout of droppings and food remains can provide important information about roost usage, but depend on these clues remaining undisturbed. It is essential to check whether disturbance, such as floor sweeping or tidying up has taken place, as this could have a significant impact on the conclusions drawn.

5.8.4 Site status assessment

Patterns of roost use can be complex, but a basic starting point is to consider whether bat usage of a site falls clearly into one or more of the following categories:

- maternity site, where babies are born and raised to independence,
- hibernation site, where bats may be found during the winter,
- mating site, where males and females gather during the autumn,
- feeding site (night roost), where bats rest between feeding bouts during the night but are rarely present by day,
- transitional (or swarming) site, where bats may be present during the spring or autumn,
- satellite roost, used by males and non-breeding females.

Figure 17. Bridge repair works which may impact bat roosting sites

5.9 Sub-optimal surveys

In some circumstances, for example where the presence of bats is discovered only after a development project has commenced, it may be necessary to conduct surveys in sub-optimal conditions, such as where some disturbance has already taken place or where evidence of bats has been compromised or destroyed. The conditions under which the survey was done, and any constraints, should be carefully noted in the survey report and any interpretation of the results should be qualified by these constraints. Unless there is clear evidence to support an alternative interpretation, it should be assumed that any significant bat roost is a maternity site and configure the mitigation accordingly.

6 Predicting the impact of development

6.1 Introduction

In order to determine what impact the proposed development will have, it is important to examine the survey information, and compare this with the proposals for development. This task is made easier by good survey information and detailed plans, showing pre-development and post-development site layout and roosts. Sometimes called impact assessment, this is a critical phase of mitigation planning, since the type and extent of mitigation required will depend on the likely impacts on roosts. Impact assessments can also help in considering alternative sites or alternative site layouts. Even when a statutory impact assessment is not required, Local Planning Authorities do have powers to direct developers to provide any information they may reasonably require to enable them to determine the application. Ideally, an impact assessment should inform the drawing up of detailed development plans, so that impacts can be avoided where possible. It is therefore important that this stage is undertaken as early as possible in the planning process. Guidance on structure for setting out impacts is given in 10. Presenting mitigation plans.

It is important to consider impacts both at the site level and in a wider perspective. The latter element relates to the assessment of the overall importance of the site (see 5.8.5 Site status assessment). The development 'context' of the site should also form part of the impact assessment. For example, if the site is part of a larger phased development the potential consequences for the target population(s) need to be considered. Building a replacement roost only to have it destroyed during a later phase of development does not constitute mitigation.

Figure 18. Brown long-eared bat roosting within crevice beneath bridge

6.2 Major types of impact and their effects on populations

6.2.1 Short-term impacts: Disturbance

Works associated with development or building work are likely to lead to an increase in human presence at the site, extra noise and changes in the site layout and local environment.

All these may have a detrimental effect on the bats, which seek particular environmental conditions, such as a low incidence of direct human disturbance, particular temperature and humidity regimes and a stable internal and external layout so they can continue to follow established flight-paths.

6.2.2 Long-term impacts: Roost modification

Modifications to roost sites, which includes the construction of new entrances, the reduction of roost space available to the bats, changes to ventilation and air-flow etc., can have a significant impact on the bats' use of the roost and thus damage it. In some cases, roosts can be carefully adapted and altered to create new entrances and flight paths; in others, reduction in the space available to the bats has resulted in the desertion of roosts (see Briggs (2002) for examples). There are clear species-specific differences in the extent to which bats will accept changes to their roost (including entrances and flight paths) and these should be taken into account when considering such operations.

6.2.3 Long-term impacts: Roost loss

The impact of the loss of roosts on bat populations is poorly understood and difficult to study, though it is believed to be an important factor in the decline of bat populations generally. For some species which are known to move between roosts, and which rely less heavily on sites with special characteristics, the loss of a single maternity or hibernation roost may be less critical than for more specialised species. For example, pipistrelles, which are crevice roosters and are known to move between maternity sites, may find it easier to locate suitable new roost sites than long-eared bats, which favour buildings with large unobstructed roof voids of a type not commonly associated with modern building methods. Hibernation sites used by significant numbers of bats may be a critical resource for the local bat population, particularly in times of cold weather, and may be used by bats from a wide area.

Figure 19. Removal of older buildings with potential as bat roosting sites

In view of the uncertainties in predicting the effect of roost loss on bat populations, the continuous attrition of the stock of suitable roosts should be avoided and our view is that there should be no overall loss of roosts. The only exceptions to this may be that the loss of very minor roosts, such as feeding perches, can be tolerated, provided there is no overall loss of habitat. Development proposals that would result in the loss of roost sites with no proposed mitigation would require substantial supporting evidence to demonstrate clearly that there would be no adverse effect on favourable conservation status.

6.2.4 Long-term impacts: Fragmentation and isolation

Recent radio-tracking and bat detector studies have demonstrated clearly the importance of linear features in the landscape to many species of bats. Features such as hedges, treelines and waterways are used by bats to navigate between roosts and feeding areas and the continuity of such features is important to them. Most bats, other than high-flying species such as Leisler's, tend to fly close to linear features or close to a tree canopy, so the presence of protected flight routes around roosts is important. The loss of linear features, leaving roosts isolated in the landscape can thus be damaging. A typical example may be where a maternity roost is protected from development but is left isolated from feeding areas when surrounded by high density housing, roads or car parking areas.

6.2.5 Post-development interference impacts

The long-term impact of increased human activity around a roost should be considered when deciding on appropriate mitigation. In particular, the placement of external lighting close to roost entrances should be avoided as this may impact on the emergence behaviour of bats. Many bat species show a clear preference for avoiding well-lit areas, so shaded flight paths joining the roost to habitats such as woodland or hedgerows are recommended. Fitting small access hatches (450 x 450 mm) to lofts dedicated as bat roosts will reduce the chance of them being used for storage.

Figure 20. Woodland track used as foraging area and connective element by bats

6.3 Temporal and spatial considerations

Most bats show clear seasonal changes in behaviour and roost selection, so the impact of development may vary seasonally. This is perhaps most easily understood when considering the impact of direct disturbance on seasonally used roosts, but timing can have other impacts as well. If a traditional roost is to be lost to development, the replacement must not only be suitable in terms of its internal environment, but it must also be known to the bats, which generally have a strong attachment to their traditional roost. Consideration of the timing of operations is therefore fundamental to the development of a mitigation strategy.

6.4 Poor data situations and 'last-minute' discoveries

It is difficult to predict impacts accurately when no or few data are available. Local Planning Authorities may refuse or defer planning permission in such cases. Where attempts have been made to predict impacts based on poor data, mitigation plans will be assessed in the light of the information contained in this section and the previous section on surveys; should the impact assessment not adequately address these points it is unlikely that the proposals will be viewed favourably. A recommendation for further survey is likely in such circumstances. One exception would be where other evidence strongly indicates that the area to be affected by development is of very low importance, and the impacts will be negligible; in this case, a lower standard of survey might be acceptable (though of course detailed survey is always preferable).

In the case where bats are discovered after planning permission has been granted, or after development has commenced, works that would be likely to lead to a breach in the law should cease, and a survey undertaken (note that species protection legislation applies even when planning consent has been granted). Mitigation plans should be developed, recognising that in some cases the potential for mitigation will be reduced. Where a sound survey has been undertaken prior to the development and this failed to detect bats, it is understandable that a developer might feel frustrated at having to delay works or incur significant extra costs. In such circumstances – effectively where the presence of bats could not reasonably be predicted – mitigation plans might be scaled down from the normal expectations. However, where there was no prior survey, or the survey was undertaken to a poor design, it seems likely that the developer would have insufficient grounds for a defence should prohibited activities be undertaken subsequent to the discovery of bats; hence, normal mitigation procedures would probably apply. This might mean that a development needs to be delayed for several months in order to undertake adequate surveys, devise appropriate mitigation and obtain a licence from the NPWS. Cases like this are legally complex and each should be considered on its own merits; the National Parks and Wildlife Service should be contacted for advice on the best way to proceed.

6.5 Summarising the scale of site level impacts

The table below gives a simple classification of the scales of impact for the most commonly encountered development effects. In general, the greater the predicted impact, the greater the level of mitigation will be required. When viewing this table, there are a number of important caveats to consider:

- The scale of impact here refers to impact at the site level; it does not consider the consequences of the development effects in a wider context (for which, see 5.8.5 Site status assessment and 7.2 Key principles of mitigation).
- The assessment here relates to impacts on roosts in terms of likely damage to population viability, and should not be confused with an assessment of the risk of killing or injuring individuals.
- Development effects will be cumulative to some degree, so that a number of low impact effects may combine to increase the overall impact. However, as there is so much variation in the level of impact, and as the ways in which development effects interact to

influence populations is complex, a simple additive relationship cannot be derived. In other words, it would be inappropriate to conclude that, for example, two low impact effects always combine to give a medium impact. A judgement on the combined impact should be derived by assessment and reasoning on a case specific basis.

- "Low" impact as stated here does not mean no impact. Generally some mitigation will still be required. However, there will be cases where a given development effect will have no (or negligible) effect on the population or on individuals, and will not therefore require mitigation.

Roost type	**Development effect**	**Scale of impact**		
		Low	**Medium**	**High**
Maternity	Destruction			✓
	Isolation caused by fragmentation			✓
	Partial destruction; modification		✓	
	Temporary disturbance outside breeding season	✓		
	Post-development interference			✓
Major hibernation	Destruction			✓
	Isolation caused by fragmentation			✓
	Partial destruction; modification		✓	
	Temporary disturbance outside hibernation season	✓		
	Post-development interference			✓
Minor hibernation	Destruction			✓
	Isolation caused by fragmentation			✓
	Partial destruction, modification		✓	
	Modified management		✓	
	Temporary disturbance outside hibernation season	✓		
	Post-development interference		✓	
	Temporary destruction, then reinstatement	✓		
Mating	Destruction		✓	
	Isolation caused by fragmentation		✓	
	Partial destruction	✓		
	Modified management	✓		
	Temporary disturbance	✓		
	Post-development interference	✓		
	Temporary destruction, then reinstatement	✓		
Night roost	Destruction	✓		
	Isolation caused by fragmentation	✓		
	Partial destruction	✓		
	Modified management	✓		
	Temporary disturbance	✓		
	Post-development interference	✓		
	Temporary destruction, then reinstatement	✓		
NB This is a general guide only and does not take into account species differences. Medium impacts, in particular, depend on the care with which any mitigation is designed and implemented and could range between high and low.				

Table 6.1. The scale of main impacts at the site level on bat populations.

7 Planning mitigation and compensation

7.1 Why mitigate?

This section is intended to assist consultants and developers decide *what* mitigation is required, whilst 8: Mitigation and compensation methods, gives guidance on *how* to undertake it.

The aim of the consultant and developer should be to seek to achieve one of the following outcomes, in decreasing order of preference. Each of these scenarios should be designed to satisfy Section 25 of the Habitats Regulations (see 2.2 Exemptions and licensing):

- Avoidance of impact; no negative impact on bat populations or existing roosts and hence bat populations
- On-site mitigation; compensation by the improvement of existing roosts or the provision of new roost opportunities within the site or building
- Off-site compensation; where on-site mitigation is not possible, the creation of new roosts of an appropriate type in an appropriate nearby location.

The potential impacts of the development should be considered at the outset, so that, where possible, plans can be modified in order to achieve the first outcome listed above (no impact). This could entail the use of alternative sites, or the repositioning of structures to avoid impacts. Note that derogation licences to destroy breeding or resting places can only be obtained where there is no satisfactory alternative to that course of action. If impacts can be avoided completely, the Habitats Regulations are not contravened and no licence is required.

7.2 Key principles of mitigation

The term ‘mitigation’ is frequently used to refer to all works required to comply with the legislation when developing areas occupied by protected species (indeed, these guidelines use the term mitigation in this broad sense). Strictly speaking, there are two elements to this process:

- Mitigation - which, in this strict sense, refers to practices which reduce or remove damage (e.g. by changing the layout of a scheme, or altering the timing of the work)
- Compensation – which refers to works which offset the damage caused by the development (e.g. by the creation of new roosts).

Both of these elements need to be considered, with the overall aim being to ensure that there will be no detriment to the conservation status of bats. In practice, this means maintaining and preferably enhancing populations affected by development. The following points should be considered when planning mitigation:

Mitigation should be proportionate. The level of mitigation required depends on the size and type of impact, and the importance of the population affected. This is a complex site- and species-specific issue, but the following table gives general guidance as to what the National Parks and Wildlife Service would consider an appropriate starting point for preparing a mitigation scheme.

Conservation significance	Roost status	Mitigation/compensation requirement (depending on impact)
Low	Feeding perches of common/rarer species Individual bats of common species Small numbers of common species. Not a maternity site	Flexibility over provision of bat-boxes, access to new buildings etc. No conditions about timing or monitoring
	Feeding perches of Annex II species Small numbers of rarer species. Not a maternity site	Provision of new roost facilities where possible. Need not be exactly like-for-like, but should be suitable, based on species' requirements. Minimal timing constraints or monitoring requirements
	Hibernation sites for small numbers of common/rarer species Maternity sites of common species	Timing constraints. More or less like-for-like replacement. Bats not to be left without a roost and must be given time to find the replacement. Monitoring for 2 years preferred.
Conservation significance	Maternity sites of rarer species Significant hibernation sites for rarer/rarest species or all species assemblages	Timing constraints. Like-for-like replacement as a minimum. No destruction of former roost until replacement completed and usage demonstrated. Monitoring for at least 2 years.
High	Sites meeting SAC guidelines Maternity sites of rarest species	Oppose interference with existing roosts or seek improved roost provision. Timing constraints. No destruction of former roost until replacement completed and significant usage demonstrated. Monitoring for as long as possible.

Figure 21. Guidelines for proportionate mitigation. The definition of common, rare and rarest species requires regional interpretation.

Plans should be based on adequate knowledge. Sound survey, site assessment and impact assessment is required. The plan should take each predicted impact and address how it can be avoided, lessened and/or compensated for.

Mitigation should aim to address the characteristics picked up by the site assessment, as follows:

- Quantitative characteristics: There should be no net loss of roost sites, and in fact where significant impacts are predicted there will be an expectation that compensation will provide an enhanced resource compared with that to be lost. The reasoning behind this concept is that the acceptability of newly created roosts by bats is not predictable (see 6.2.2 Long-term impacts: Habitat loss).
- Qualitative characteristics: the plans should aim to replace like with like. As an extreme example, it would be unacceptable to replace maternity roosts with hibernation sites.
- Functional characteristics: compensation should aim to ensure that the affected bat population can function as before. This may require attention to the environment around the roost.

Figure 22. Riparian and woodland habitat frequented by bats

Preparing an appropriate replacement site (or sites) may require considerable time and effort. The success of the scheme will depend to a great extent on this decision. For high impact schemes, additional land may need to be purchased or buildings constructed, and hence the costs of compensation can be considerable. Depending on the circumstances, a considerable period of time may be needed to demonstrate the acceptability of the new roost to the bats if this is required by the licence. Although planning permission is needed as usual, no derogation licence is required to build a new replacement roost and developers are encouraged to construct these, where necessary, well in advance of the main development. Specialist advice will be required to ensure the design is fit for purpose.

The long-term security of the population should be assured. Mitigation should aim to ensure that the population will be free from further disturbance, and is subject to adequate management, maintenance and monitoring. Any proposals should be confirmed, ideally by a legal agreement or planning obligation, and not left as open-ended options. This may require careful attention when the end result is a dwelling-house and is an argument in favour of providing dedicated facilities.

Mitigation plans will be open to public scrutiny. The National Parks and Wildlife Service will make plans available to third parties on request wherever possible, because they are part of a decision-making process for a statutory function (licensing) and because freedom of information legislation requires this. If submitted as part of a planning application, they will also be held on file by Local Planning Authorities and therefore be available for public viewing.

Mitigation plans should address the impacts of all phases in phased developments. Individual phases will normally be mitigated for individually, but there should be an overall plan which takes the impacts for the entire scheme into consideration. Although no licence is required to construct a new dedicated bat roost, the restoration of an existing roost as mitigation must be licensed along with the accompanying disturbance, exclusion or roost destruction; for example it is not acceptable to undertake post hoc mitigation via a National Parks and Wildlife Service conservation licence.

Precautionary mitigation, i.e. going ahead with mitigation before a proper survey has been undertaken, is not normally acceptable. Only in certain limited cases, notably where there is good evidence to indicate that the site is of very low importance and there will be negligible impacts, will it be acceptable to submit mitigation plans based on little or no survey (see section 6.4 Poor data situations and 'last-minute' discoveries).

Figure 23. Tall structures such as wind turbines may act as obstacles for bats

7.3 Main components of mitigation

Mitigation for bats normally comprises the following elements:

- Avoidance of deliberate, killing, injury or disturbance – taking all reasonable steps to ensure works do not harm individuals by altering working methods or timing to avoid bats. The seasonal occupation of most roosts provides good opportunities for this
- Roost creation, restoration or enhancement – to provide appropriate replacements for roosts to be lost or damaged
- Long-term habitat management and maintenance – to ensure the population will persist
- Post-development population monitoring – to assess the success of the scheme and to inform management or remedial operations.

Figure 24. Post-construction monitoring of bat boxes to ensure effectiveness

8 Mitigation and compensation methods

8.1 Introduction

This section gives advice on the methods commonly used for mitigation and compensation, paying particular attention to effort and timing. Note that these are not the only methods which could be used, but they are known to be generally effective in appropriate circumstances. They should be applicable to the majority of development schemes. As sites vary in their individual characteristics, and developments differ in their impacts, the information presented is generic rather than prescriptive; consultants may make a case for different techniques and levels of effort on a site by site basis.

It is the responsibility of the applicant (normally consultant and client) to make sure that any proposed mitigation meets other legal requirements. For example, the incorporation of bat access points into new or refurbished buildings must comply with planning requirements and building regulations. Additional requirements may also be imposed by insurance or warranty organisations.

8.2 Avoidance of disturbance, killing and injury

Although mitigation proposals must meet the test of no adverse effect on the favourable conservation status of populations, the Habitats Regulations are constructed to give protection to individuals as well as breeding sites and resting places. This means that precautions must be taken to avoid the deliberate killing or injury of bats which is most unlikely to be permitted under the terms of the licence. Disturbance of bats or the destruction of roosts may be permitted under licence, but conditions are likely to apply.

The most common and effective method of avoiding these offences is to carry out the work at an appropriate time of the year. The great majority of roosts are used only seasonally, so there is usually some period when bats are not present. Although there are differences between species, maternity sites are generally occupied between May and September and hibernation sites between October and March, depending on the weather. An adequate survey and good understanding of the seasonal activity patterns of the particular species involved will help in determining the optimum time to carry out the proposed work. The recommended times shown in the table below should be modified in the light of site-specific species information. For example, some species, most notably long-eared and lesser horseshoe bats, tend to remain in summer sites until well into autumn or even winter, so care may be needed when drawing up works timetables where these species are present. The period of works may be extended if the way in which the bats use the site is well understood.

Bat usage of site	**Optimum period for carrying out works (some variation between species)**
Maternity	1st October – 1st May
Summer (not a proven maternity site)	1st September – 1st May
Hibernation	1st May – 1st October
Mating/swarming	1st November – 1st August

Table 8.1 Optimum season for works in different types of roosts.

Bats are at their most vulnerable in buildings during the summer, when large numbers may be gathered together and young bats, unable to fly, may be present. Operations to known breeding sites should therefore be timed to avoid the summer months. Very large rebuilding or renovation projects may take many months to complete and may need to continue through the summer, which is the favoured season for re-roofing. The best solution in such cases is to complete and secure the main roosting area before the bats return to breed. If this is not possible, work should be sufficiently advanced by May or June for returning bats to be dissuaded from breeding in that site for that year. As part of the mitigation, alternative roosts appropriate to the species should be provided in a nearby location. Another possible solution is to divide the roof with a temporary barrier and work on one section at a time. This procedure has been used successfully on a number of occasions.

Where the same structure is used throughout the year, the optimum time for works of all types is likely to lie outside the main breeding season, to avoid times when non-flying babies may be present, and the main hibernation season, to avoid times when disturbance may impact on survival or bats may not be sufficiently active to get out of the way. Spring and autumn generally provide the optimum period for such operations.

The presence of scaffolding during the active bat season may hamper bat access and this should be considered during siting especially if also using plastic sheeting. Access points of appropriate size may need to be opened in sheeting to allow bats to pass through while the scaffolding is in place (Reiter & Zahn 2006).

The best times for building or re-roofing operations are spring and autumn. At these times of the year the bats will be able to feed on most nights and may be active or torpid during the day, depending on weather conditions, but will not have begun giving birth. Active bats will usually keep out of the way of any operations, but torpid bats may need to be gently moved to a safe place, preferably without causing them to fly out in daylight. Wherever possible, the objective should be to persuade bats to move of their own accord and they should be physically moved only as a last resort. Repeated disturbance to bats during the winter can seriously deplete their food reserves, but, unless significant numbers of bats are known to be hibernating in a building, there is no advantage in requesting a deferment of scheduled works.

Figure 25. Re-roofing operations may require timing restrictions

If there are overriding reasons for carrying out works during a sensitive period, for example in roosts that are used throughout the year, it will be necessary to structure and time the works so as to ensure that the bats always have some undisturbed and secure areas. This may involve the installation of temporary partitions and adopting working practices that minimise disturbance to sensitive areas.

In many cases it is not easy to determine if a building is used for hibernation, except occasionally in the case of lesser horseshoe and long-eared bats in cellars. Where bats are known to be present, significant disturbance during the winter must be avoided and work should be delayed until after hibernation if possible.

Works on other sorts of bat roosts, such as trees, should follow the same strategy of trying to avoid works at a time of year when bats are most likely to be present.

Further guidance on the timing of works and the action to be taken if bats are discovered is given in the Bat Workers' Manual (Mitchell-Jones & McLeish, 1999).

8.2.1 Remedial timber treatment

Repair and restoration of old or derelict buildings often requires remedial timber treatment against infestations of wood-boring insects. Although most treatment chemicals now in general use are safe once dry, the application of products must be avoided when bats are present. In most cases, this is a matter of timing the work so as to avoid the summer months, but there may be occasions where small numbers of bats must be persuaded to move away. The Bat Worker's Manual gives further details of the remedial timber treatment process and the precautions to be taken.

8.3 Avoiding damage to existing roosts

Avoiding damage to existing roosts is the preferred option in all cases. If, in the consultant's opinion, measurable disturbance to bats can also be avoided this would mean that a licence is not required as no offence is being committed. If this appears to the consultant to be the case, then a method statement detailing the work to be carried out and any working practices or precautions necessary to avoid breaking the law should be provided to the client. The existence of this method statement helps to establish a defence against prosecution for intentional or deliberate disturbance of bats or damage to roosts. In such cases, it should be noted that the failure of the client, or anyone working under the client's direction, to follow the method statement may result in a breach of the law and leave the client or others open to prosecution.

8.4 Incorporating existing roosts into refurbished buildings

Projects such as the refurbishment of derelict or semi-derelict buildings, barn conversions, alterations to non-domestic premises, including churches, or other structures used by bats can all provide opportunities to incorporate existing roosts into the final structure. This option is generally to be preferred to the destruction of an existing roost and the provision of a new roost in compensation, though there may be physical constraints which militate against this course of action.

Apart from the timing of the works (see 8.2), the two most critical issues in maintaining a roost in-situ are the size and suitability of the final roost and the disposition of the entrances and flight paths, including the location of any exterior lighting or vegetation.

8.4.1 Roost size

The size of roost required depends on the species, as some require voids sufficiently large to fly into whereas others are more likely to roost in crevices and use direct exterior access. In addition, lesser horseshoe bats require light-sampling areas where they can fly in and out before finally emerging. The table gives an indication of roost preferences, though there is a great deal of variation; the objective should be to maintain the roost size as close to the original as possible.

Species	**Summer/maternity roosts**	**Hibernation sites**
Lesser horseshoe bat *Rhinolophus hipposideros*	Horseshoe bats require large roost areas with flight access into them, where they hang free. Normally require associated sheltered light-sampling areas.	Most dependent on underground sites. May use cellars or other areas with appropriate temperature and humidity
Brandt's bat *Myotis brandtii*	Crevice dweller, but may enter roof voids and fly around	Found hibernating underground, though most individuals probably elsewhere
Daubenton's bat *Myotis daubentonii*	Hole dweller. May enter roof voids and roost at apex. Relatively rare in houses, but may use castles, tunnels etc.	Found hibernating underground, though many individuals probably elsewhere
Whiskered bat *Myotis mystacinus*	Crevice dweller, but may enter roof voids and fly around	Found hibernating underground, though most individuals probably elsewhere
Natterer's bat *Myotis nattereri*	Crevice/hole dweller; may require light-sampling areas. Frequent in crevices in timbers in old barns.	Found hibernating underground, though most individuals probably elsewhere
Nathusius' pipistrelle *Pipistrellus nathusii*	Crevice dweller.	Rarely recorded. In buildings? In quite exposed places
Common pipistrelle *Pipistrellus pipistrellus*	Crevice dweller, but sometimes enters roof voids. Does not normally require light-sampling areas	Hibernates in a variety of places, which may be quite exposed. Frequently in cavities in buildings, rarely underground
Soprano pipistrelle *Pipistrellus pygmaeus*		
Leisler's bat *Nyctalus leisleri*	Crevice/hole dweller. Sometimes in buildings, but unlikely to fly inside.	Little known; probably tree cavities, occasionally underground
Brown long-eared bat *Plecotus auritus*	Hole dwellers. Readily fly within roof voids. Often in crevices by day, although sometimes in the open.	Found in tree holes, roofs and underground.

Table 8.2 Species-specific roost types.

For species that fly within roof voids, notably lesser horseshoe and brown long-eared bats, it is essential that a sufficiently large space, unobstructed by constructional timbers, is available for the bats to fly in. Based on a sample of known roosts, it is unlikely that a void height (floor to ridge board) of less than 2 m will provide sufficient volume or that an apex length or width of less than 4 m will provide sufficient area. An ideal roof void would have an apex height in excess of 2.8 m and a length and width of 5 m or more. These species are generally found in older roofs of traditional construction giving a large uncluttered void, so typical trussed rafter construction must not be used. Suitable construction methods are purlin and rafter ('cut and pitch') with ceiling ties or possibly attic trusses, which are designed to give a roof void large enough to be used as a room.

Some recent studies on Natterer's bats in barns due for conversion have illustrated some of the difficulties of maintaining appropriate roosts. In these cases, bats were roosting in mortise joints, which presumably mimic tree cavities, and using the void of the barn as a light-sampling area. In several cases, the bats abandoned the site after conversion, probably because insufficient 'indoor' flight opportunities remained. Full details and recommendations can be found in Briggs (2002).

8.4.2 Roost entrances

Lesser horseshoe bats generally prefer entrances they can fly through (see the Bat Workers' Manual, Chapter 11 for details and designs), but other species will generally use smaller holes or slits to crawl through. Wherever possible, it is preferable to maintain entrances in their original position so the bats will have no difficulty finding them. External lighting, such as security lights or road or path lighting, close to roost entrances must be avoided and it may be necessary to make arrangement to prevent the later erection of external lighting through the use of restrictive covenants.

Figure 26. Roost entrance for brown long-eared bats but also large enough for lesser horseshoe bats

8.5 Incorporating new roosts into buildings

The extent to which new roosts can easily be incorporated into new or refurbished buildings depends on the species of bat and the type of building. For those species that require a large roof void to fly in, principally lesser horseshoe and long-eared bats, careful attention must be paid to the design in order to provide a suitable roof void. See Section 8.4 for guidance on roost size and construction and note that trussed rafter construction should be avoided (unless specified so as to leave a large roof void). For species that typically roost in crevices, roosting opportunities can be provided in a variety of ways including:

- access to soffit boxes and eaves via a small gap (15-20 mm) between soffit and wall
- timber cladding mounted on 20-30 mm counter battens with bat access at the bottom or sides
- access to roof voids via bat bricks, gaps in masonry, soffit gaps, raised lead flashing or purpose-built bat entrances
- access to roof voids over the top of a cavity wall by appropriately constructed gaps.

As well as suitable access points, bats also need suitable roosting sites and an appropriate temperature regime.

Most species of bats appear to prefer roosting on timber rather than brick, stone or other similar materials, so the provision of rough timber surfaces may be helpful. Bats may also roost by clinging on to roof lining materials, especially around the roof apex and 1m or more down the slope. Some types of modern plastic roof linings are too smooth for bats to cling to and should be avoided where possible. If their use is essential, rough timber planks should be placed along the ridge beam to provide roosting opportunities.

For maternity roosts, bats appear to prefer maximum daytime temperatures of between 30º and 50ºC, so it is important that the roof receives full sunlight for a large part of the day. This can be assisted if the roof has two ridges at right angles, oriented to capture sunlight throughout the day. As an alternative, a combination of baffles and electric heaters can be used to produce pockets of warm air at the apex of the roof. This technique has been used successfully with horseshoe bats and would probably be suitable for other species as well.

Where space permits; large 'bat-boxes' can be built into existing roofs. This approach has the advantage of providing some segregation between the bats and the human occupants of the building. Detailed guidance is given in the *Scottish National Heritage* publication *The Design and Construction of Bat Boxes in Houses.*

One problem with providing roosts in buildings intended as dwellings may be acceptability to the future inhabitants and for this reason planners and developers are often reluctant to adopt this solution. There is much to be said for providing a dedicated bat roost as these problems of acceptability can be greatly reduced.

8.6 Providing new roosts

8.6.1 Bat boxes

Where roosts of low conservation significance (see 7.2) are to be lost to development, bat boxes may provide an appropriate form of mitigation, either alone or, preferably, in combination with the provision of new roosts in buildings. In such cases, the type of bat box provided should be appropriate to the species. Bat boxes are generally inappropriate substitutes for significant roosts in buildings and do not constitute 'like for like' replacement.

Species	**Summer/ maternity**	**Summer/non breeding**	**Hibernation***	**Notes**
Rhinolophus hipposideros	N/A	N/A	N/A	Horseshoe bats cannot use bat boxes
Myotis brandtii	H	H		
Myotis daubentonii	H	H		
Myotis mystacinus	H	H		
Myotis nattereri	H	?		
Pipistrellus nathusii	H	H		
Pipistrellus pipistrellus	C	C/H	C	H are rarely used as maternity roosts.
Pipistrellus pygmaeus	C	C/H	C	
Nyctalus leisleri	H	H	H?	
Plecotus auritus	H	H		Maternity roosts

Key * Large well-insulated hibernation boxes may be more successful N/A -not applicable; bat boxes should not be considered as replacement roosts H – tree hollow-type box, providing a void in which bats can cluster C – tree crevice-type box, with 25-35mm crevices ? – few data on which to base an assessment

Table 8.3 The types of bat box used by different species.

At present, there are few data about the conservation value of large crevice-type bat-boxes intended for use as maternity roosts, such as the 'bat houses' developed in the USA (Tuttle & Hensley, 1993), so these cannot yet be considered adequate replacements for significant maternity roosts of any species. However, including boxes like these in a mitigation scheme may generate useful information about their value as replacement roosts.

Figure 27. Heated bat boxes under trial

In an attempt to provide temperature conditions similar to those in roof spaces, recent research in Scotland has concentrated on developing a heated bat house suitable for maternity colonies of crevice-seeking bats, particularly pipistrelles. It is based on the American design, modified to include a heating system. Simple coil heaters are situated in side chambers, which also house a control circuit, and the house is mounted either on the outer wall of the building from which bats have to be excluded, or on a pole. Power for the heating system is via a power pack from the mains for the wall-mounted version and by solar power in the pole-mounted one. The roosting crevices are maintained at a minimum temperature of 27-28^{o}C. Field trials are ongoing.

Woodcrete (cement and sawdust) bat boxes, such as those manufactured by Schwegler (available from Alana Ecology at www.alanaecology.com) appear to be at least as successful as wooden boxes in attracting bats and have the advantage of being far more durable and thus needing less maintenance. They should be considered wherever standard sized boxes are being specified. A mixture of bat box types, perhaps 3 per tree should be specified to cater for seasonal and species requirements.

8.6.2 Bat houses or 'bat barns'

Where a careful appraisal of the options indicate it is not feasible to maintain roosts in situ, purpose built bat houses or bat barns may be considered as an alternative. In view of the limited experience of the use of this compensation technique, it is essential that the risks of non-adoption by bats are minimised through careful design and site selection. One option might be to translocate an entire roof, or part of a roof, as this may have a good chance of success. Monitoring of success is built into the method statement and is important because it contributes to our understanding of the factors that determine success or failure.

The following design principles need to be considered when developing a proposal for ex-situ roost conservation.

- The replacement roost should normally be situated as close as possible to the roost to be lost and match it closely in terms of size, height and aspect. However, indications are that a replacement roost with a footprint of less than about 5 m x 4 m and a total height of less than 5 m seems unlikely to be successful.

- The location of the replacement roost should be chosen to maximise the chances of the bats finding and adopting it. Ideally, it should be close to existing flightlines and have an entrance close to appropriate habitat. Many bat species prefer to fly in dark areas straight into vegetation, so external lighting on the site should be avoided.

- The roosting areas should be designed to take account of the requirements of the species concerned. For example, crevice-dwelling species should be provided with suitable crevices of an appropriate width whereas species which fly within roof voids require a large unobstructed void with a floor to apex height of at least 2 m, preferably more. The roosting areas should match those to be lost as closely as possible.

- The building should be designed so as to provide a suitable thermal regime. For maternity sites, this is likely to require a fairly steeply pitched roof (42º is optimum) with one pitch facing south, so as to achieve high temperatures (up to 50ºC maximum) in summer but with a choice of roosting temperatures. Dark-coloured roof coverings, such as black slates, will help to produce high temperatures. In certain cases, artificial heat sources may need to be considered. Hibernation sites should be sufficiently large to achieve stable winter temperatures of 0-6ºC for Vespertilionid bats and 6-10ºC for Rhinolophids and need to be sufficiently large for bats to fly and turn comfortably.

- Opportunities should be taken to provide a variety of roosting opportunities and thermal regimes so as to maximise the value of the building to bats. For example, buildings can be designed with an upper part suitable for use as a maternity site and a lower part suitable for hibernation.

Figure 28. Purposely renovated old schoolhouse for lesser horseshoe bats on Ennis bypass road route, Co. Clare

- Consideration should be given to making the building as resistant to damage by vandalism as possible. Doors can be reinforced and sited some way above ground level to make it difficult to attack them; rainwater goods can be carried internally; flammable materials that can be reached from ground level should be avoided. Planting thorny shrubs around the building may help to discourage trespass by making access difficult.

- Consideration should be given to installing remote monitoring systems to facilitate detailed follow-up monitoring with minimal disturbance.

- Arrangements must be in place for securing the long term integrity and security of the replacement roost. This may require planning agreements or the transfer of ownership of the building to a suitable organisation such as the Vincent Wildlife Trust.

- In developing proposals for replacement bat roosts, due regard must be paid to any planning requirements. If planning permission is needed, this may take time to acquire and conditions may be imposed by the planning authority. Such requirements need to be clarified and any planning issues resolved before a replacement roost can be proposed as part of a mitigation proposal. In addition, replacement roosts, depending on their position and construction, may be subject to the requirements of the Building Regulations. Again, any such requirements should be clarified before a licence application is made.

Figure 29. Roof apex of bat house showing two thermo-statically controlled infra-red heaters and remote controlled CCTV monitoring system

Building replacement roosts

Lesser horseshoe bats

Lesser horseshoe bats are almost always found in roosts where they can fly directly to their roosting location without landing. They tend to be found in large roofs, typically 3-4m high (or more) although the route bats take through the buildings to the roosting sites, can be very small. Lesser horseshoe bats often fly in the spaces between rafters and ceilings and ceilings and floors (e.g. 280 x100mm). The larger clusters of bats are found at locations which have a variety of roosting conditions, either in the same building or in close proximity. Most important are warm conditions as found in roofs or around boilers or hot water tanks and cold roosts such as a cellar, icehouse, mine or cave.

Mitigation should aim to provide cold and warm conditions in one structure so the bats do not need to fly outside when changing roosts. Especially for lesser horseshoes, there is a rough relationship between the overall volume of roost with the number of bats which can live there. The aim should be to create at least 400m^3 of mostly unobstructed flying area on two or preferably three levels (including a cellar which can be partly above ground but well insulated).

Roof structure

Roofs should be constructed traditionally with a ridge board but not with trusses. Roofing felt should be traditional bitumastic and hessian which allows bats to hang from almost any point. Plastic membranes are mostly unsuitable because bats have difficulty hanging up, so wind-break netting stretched beneath the membrane would be necessary. Assuming the inside roof height is at least 2.5m, then internal partitioning of the apex allows a variety of secluded spaces to be created. Use a 50mm thick insulation board (many types), with a rough surface to facilitate bats landing, fitted to rafters and hanging down about one metre. These can be installed at about two metre intervals, perhaps five in a roof.

Bat entrance

Lesser horseshoe bats prefer an open entrance to fly into the structure. This can best be provided on the sheltered side of the building with trees and shrubs only two or three metres away. Coppiced species are best as management can include regular coppicing, providing a suitable vegetative structure near the building without allowing large trees to grow which could threaten the building. The coppice should not grow higher than the apex height of the building.

Entrances should be about 600mm wide and 300 - 400mm high. If entry by vandals is likely to be a problem then one or two horizontal bars may be needed. The top and bottom of the entrance should be sloped down outwards with a canopy above and waterproofing (for example lead lining similar to roof valleys) below to prevent ingress of rain and snow. The entrance should be positioned about 400mm above the loft floor but not so high that hot air which gathers at the apex is lost to the outside.

Lofts need to have quality flooring so that monitoring and roost adjustments are simplified. A gap in the floor, best positioned near the entrance but to one side, will allow bats to fly down into the ground floor space. The opening should be about one metre square and, if necessary, have a single rail around the edge for safety. The same hole could be the access route used for monitoring, with a fixed timber (quieter than metal) ladder in place on one side.

Cold place - cellar

A fully below-ground space is best, measuring at least 4 x 4m x 2m high, but ground conditions including possible flooding may make this impractical. The roof can be made of stressed concrete beams e.g. Bison beams, or other flooring such as pre-stressed concrete beams with concrete block infill. A cast *in situ* floor is possible. At least 200mm of good quality insulation should be used above so the cellar becomes and stays cool. Roosting places should be placed near corners with netting or other facilities for roosting. These sites can be about 600 x 600mm and 300mm deep walls to allow bats to fly up into them and achieve seclusion. An access should be provided for monitoring with fixed ladder.

Places where horseshoes become torpid generally require relative humidity to be over 90%, so a means of producing this humidity should be provided. This might include a 30mm thick layer of coarse sand spread over the floor with a means of wetting it periodically. If the ground slopes it may be possible to use natural ground water to seep in one side with a sump letting out the excess. Omitting any damp-proofing in below-ground areas will also assist in raising the humidity.

If a below-ground cellar is not practical it is possible to create a similar space by building a chamber with at least 600mm thick insulated walls and 800mm of insulation above. This can be constructed using insulated concrete blocks (hollows filled with expanded polystyrene) dry laid to 1.72m high (8 blocks) with the roosting chamber being one block higher (1.935m). It is best to have some cool/heat trapping arrangement in the entrance passage to ensure the internal temperature does not change too quickly. The entrance should have an insulated drop down half door dropping one metre from the top, then two metres further in a barrier rising from the floor for one metre. These barriers can be slotted or hinged to allow easy, quiet access for monitoring. The barriers should be about 300mm thick and constructed of quality insulation material.

Ground floor roosting sites
As far as possible, maintain a large free flying space. Lesser horseshoe bats like to roost in many places, spending short or long periods at the various sites. Wind break netting from garden centres (black netting with holes 5x8mm and intervening plastic 2-3mm thick) is ideal for providing roosting opportunities. Finer netting must not be used because bats' claws can become tangled in the mesh and it does not last long. Wind break netting has survived over 20 years without significant deterioration. Provide at least ten roosting sites between ceiling joists, each about 300x300mm placed in corners and a scatter of other places.

Vespertilionid bats

These are to varying extents all crevice dwellers. However, many of them fly around inside roosts, grooming and having social interactions, while others fly out directly from their crevice roosts. Pipistrelles (all species) and Leisler's rarely fly in roosts but brown long-eared, Daubenton's, Natterer's, whiskered and Brandt's all do so. Most summer clusters and individuals of these species are found in warm sites, usually beneath roofs, but also around or above hot water tanks, pipes or boilers. Re-surveys of abandoned properties showed bats declined in number or left completely once the heating had been turned off, illustrating that bats like even minimal heating which percolates into insulated roof spaces.

Walls
Walls can be faced with any type of brick or block, but if hanging tiles or weather boarding is not to be installed, then the face should be rough to facilitate landing by bats before they crawl into the roost. Walls should be of standard hollow construction as these areas are used as roosts by most species. Part of the inner walls on the north, cool side of the building, should be thickened with an additional 220mm thick hollow block wall spaced 30mm away from the normal inner wall. There will need to be various small gaps leading into the wall through the mortar lines to allow bats to crawl into crevices. During construction, timber battens measuring 15 x 50mm should be inserted between blocks, both horizontal and vertical mortar lines and these battens can be withdrawn a few hours after laying the blocks to create access crevices into the hollows.

Roof structure
Bats tend to search for roost entrances around the apexes of gable ends. This is where most roost entrances are found. The aim is to provide a number of gables (usually four for each roost) to give adequate opportunities for bats to adopt their preferred aspect. Also, by having gable ends there is the convenience of installing roosting space behind hanging tiles or weather boarding, both being favoured roosting sites for several crevice dwelling species.

Within the roof there should be unobstructed flying space with a floor and hole leading to the ground floor. The roof can be constructed similarly to the horseshoe type with minor modifications to accommodate the crevice roosting habits. Roofing felt should be traditional bitumastic and hessian. The top slate/tile batten needs to be placed 20mm from the ridge board. At about two metre intervals along the ridge the roof felt should have 30 x 100mm slots cut out beside the ridge boards to allow bats access to the ridge tiles (where most loft dwelling bats prefer to roost). When the ridge tiles are laid it is important to ensure the space within the ridge tiles remains unfilled with mortar and that there are lengths of tile which remain unobstructed. Some blockages in the ridge are needed to prevent through draughts. In addition it is useful to have a few small torn holes through the felt at several levels from apex to half way down the roof slope to allow bats into the space between tile and felt (40 x 60mm holes torn on three sides and one end allowed to hang down).

Roofs often have double beams or rafters with small gaps between which provide crevices preferred by bats. Features such as these are most easily installed by the bat consultant after the roof has been constructed. One metre lengths of rafter can be added alongside the roof timbers spaced 20-25mm away with half bridged over to create a long enclosed cavity. It is always worth closing one end completely and always the upper end if the roost is adjacent to a rafter. If timbers can be recovered from the structure being replaced, this is the ideal time to introduce them.

The gable ends should have an overhanging style with soffits to give bats a sheltered approach to the entrance. When the roof felt is being placed over the end of the wall it should be supported by thin slate to ensure it does not fall by fatigue onto the brickwork, thus blocking the route bats gain access to the roof space. The work will need inspecting by the bat consultant before tiles are fixed.

Roosts on walls
A variety of crevices can be provided on the walls at all heights from close to the floor (about 400mm above) to close to the ceiling. Indeed, some of the ceiling joists can have additional lengths added, with narrow gaps, similar to that described for the roof. Narrow 'boxes' constructed of rough soft wood measuring 300mm deep and 450 - 600mm long with a narrow space about 30mm wide can be attached to the walls. The top and sides should be closed and, for longer boxes, some of the base. Such sites are used for hibernation by various species.

Ground floors
It is desirable to achieve higher humidity in the ground floor especially in winter if bats are to hibernate. The choice of floor is dependent upon the prevailing ground conditions of the site. In wet areas on clay, it may be necessary to have the usual hard core, blinded with sand, topped with a concrete screed with a damp proof membrane. Such buildings are inevitably dry internally. In well-drained sites, a soil or sand covered floor may be sufficient and this will have a higher humidity. It is important to be aware that moisture levels in timber must not be allowed to rise above 20% or rot could become a problem. Generally, most timber used in buildings will at least have some surface treatment to prevent surface moulds but also, roof timber should be treated with proprietary treatments against rot, such as CCA or 'Tanalisation®'. Before using treated wood in a roof where bats are expected to roost the wood should be placed on the ground in the open and vigorously brushed with a stiff yard broom. The purpose is to remove the loose deposits of copper, chrome and arsenic salts which remain on the surface and which are poisonous if ingested while a bat is grooming.

Entrances
Access can be both through crevice routes over walls and into the roof space as well as directly through a hole in the wall, similar to that provided for horseshoes. If hanging tiles and weather boarding are provided, small spaces should be created through the wall behind the coverings to give alternative routes into the cavity and building. Waney edge boarding usually warps thus providing access crevices to the battening attached to the wall.

Access for monitoring
A standard lockable door should be provided. If there is a risk of vandalism, it can be faced with galvanised steel sheeting.

All species

Heating
Although the provision of heating is not essential, it seems to increase the probability of bats moving into the new roost. Thermostatically controlled systems are the most efficient and these should be focussed in areas most suitable for nurseries i.e. a south-facing roof apex. The advantage for bats is that they can maximise their energy budgets from food intake without needing to expend energy keeping warm. However, when food is difficult to find the bats quickly return to the cool roosts and become torpid.

Electric heating can present a potential fire risk if a fault develops, so there must be a fail-safe system of controlling temperature. The preferred alternatives are either to use a remote heating system with appropriate heat transfer arrangement such as hot water fed by convection from the ground floor, or by using a passive heating installation with solar panels on the lower part of the southerly facing roof and partially insulated water reservoir hung in the upper part of the roof. This set up also works by convection and should run without maintenance for at least 40 years.

Seeding the roost with droppings recovered from the roost being replaced
Droppings and any other materials impregnated with odours from the existing roost can be added to the completed building as these may encourage rapid colonisation. It is best to place these to one side of the roof in a line on polythene sheet, away from where an observer is likely to walk and clear of the apex where most roosting will occur and new droppings should be produced.

Robert E. Stebbings
The Robert Stebbings Consultancy

8.7 Post-development site maintenance and population monitoring

8.7.1 Site maintenance

If the deployment of bat boxes or the construction of roosts forms part of a mitigation proposal, consideration should be given to the lifespan of the proposed roosts and the maintenance requirement during this lifespan. Wherever possible, maintenance requirements should be minimised through careful design and any outstanding requirements should be addressed through appropriate planning agreements or similar mechanisms.

For bat boxes, a design life, including essential maintenance, of about 10 years would be appropriate, as this would be comparable with the lifespan of the tree roosts that bat boxes mimic. This lifespan can be achieved with good quality wooden boxes and exceeded by woodcrete bat boxes or other types of construction that ensure any softwoods are protected from the weather and attack by squirrels.

For buildings, or parts of buildings, intended as replacement roosts, a design life of at least 50 years and preferably 100 years should be aimed for. Although this is shorter than the lifespan of many houses, it is more appropriate to the simplified construction methods used for bat houses. For example, it may be preferable to build bat houses without damp-proof membranes in order to provide a high humidity level in parts of the structure.

If sites used by bats require maintenance, remember that any disturbance of bats or alterations to roosts may need to be carried out under licence. If the derogation licence has expired, personnel may require a further NPWS licence in order to carry out any works legally.

8.7.2 Population and usage monitoring

A monitoring plan should be put in place to assess whether the bat population has responded favourably to the mitigation, and to inform ongoing roost management. If consistent methods are used pre- and post-development, it will be easier to compare trends. The level of monitoring required depends on the population assessment and the impact of development. For some small schemes, no monitoring is required, while for developments which will result in significant impacts, a considerable monitoring commitment is required. Figure 6 gives guidance on the minimum requirements, though developers and consultants are urged to arrange for longer monitoring periods for important or novel mitigation schemes as these can then inform future mitigation projects. The contribution of such case studies to publications such as this mitigation manual is welcomed.

Monitoring may be incorporated into (and used to inform the implementation of) the management and maintenance plan. It should clearly outline who is responsible for undertaking the monitoring, when and by what methods. The results should be sent to the National Parks and Wildlife Service through licence returns. The NPWS also welcomes the submission of post-licence monitoring data. These should be sent to the Licensing Section at 7 Ely Place, Dublin 2. It would be helpful if the original derogation licence reference could be included.

9 Model examples

9.1 Introduction

These examples are given to illustrate the main aspects of mitigation proposals. It is expected that actual mitigation plans will provide considerably more detail than is given here. These examples show a range of commonly encountered situations, varying from low impact through to total site loss. None of the examples relates to large impacts on sites of national importance, as such cases are likely to be so site specific that it might be misleading to provide very general guidance here.

Each example shows to varying degrees an outline of the site and key survey information, predicted impacts, and finally the mitigation required. This approach distils the main information expected in mitigation plans, for which consultants and developers are recommended to follow the structure given in the next section (see 10. Presenting mitigation plans).

As well as the examples presented here, readers are also referred to Briggs (2002) for further examples of mitigation, both successful and unsuccessful. A CD produced by the UK National Trust (Appleton, 2003) gives details of case studies at 10 National Trust properties. The studies cover a wide range of situations, with varying outcomes for the bats.

9.2 Case Study 1: Building roost restoration 1

Location	Thatched cottage, Affick, Co. Clare
Species involved	Lesser horseshoe bat
Type of work	Building restoration
Possible impacts	Disturbance, roost loss
Type of roost	Maternity
Size of colony before works	50 - 100
Size of colony after works	c 100

9.2.1 Background

The roost was discovered in this one-storey derelict cottage and shed (Figure 9.2.1) in July 1998 during a summer survey of buildings for the lesser horseshoe bat undertaken on behalf of The Vincent Wildlife Trust. The bats accessed the structure through open doors and mainly roosted beneath the underside of the thatch that was overlain with corrugated iron sheeting. There was a partial ceiling in place.

9.2.2 Description of works

Complete renovation of the cottage, new thatch roof installed, with a natural slate roof with felt fitted to the adjoining shed. A ceiling was also put in place in the shed, which was converted into a series of bedrooms, with a partition to section off the water tanks from the bat roosting section.

Figure 9.2.1 Affick cottage and shed before renovation

9.2.3 Timing of works

The old roof was removed when the bats had vacated the buildings for the winter. It was three years before a new roof was in place on the shed section but, within days of the felt being fitted to the roof in preparation for slating, a small number of lesser horseshoe bats returned.

9.2.4 Protection of access point and existing roost site

A small opening, of about 300 mm in size, was left in the gable wall as an access point. This opens directly into the previous roosting area.

9.2.5 Post-construction monitoring

Roost numbers have stabilised at c 100.

Figure 9.2.2 Affick cottage after renovation

9.3 Case Study 2: Building roost restoration 2

Location	Derelict cottage, Blackwater Bridge, Co. Kerry
Species involved	Lesser horseshoe bat
Type of work	Building restoration
Possible impacts	Disturbance, roost loss
Type of roost	Maternity
Size of colony before works	75 - 100
Size of colony after works	200+

9.3.1 Background
A maternity roost of c. 100 lesser horseshoe bats was discovered in a derelict cottage (Figure 9.3.1) in Co. Kerry in 1988. Enhancements to the roost were made in 1992/93 and in the intervening years to encourage its further use by the bats.

9.3.2 Description of works
In 1992/93 the original roof of corrugated iron was replaced and underlined with mineral felt. Secure doors with bat access were fitted. In the winter of 2005/06, a ceiling was provided beneath the bat roosting area and light baffles were fitted to further darken the access point and reduce drafts.

Figure 9.3.1 Blackwater Bridge lesser horseshoe roost after new roof was fitted.

9.3.3 Timing of works
The main renovation was undertaken during the winter of 1992/93 when the bats were absent. Further work was undertaken during the winter of 2005/06.

9.3.4 Post-construction monitoring

The original roost had a count of 77 bats in 1988, which was raised to 150+ in the summer of 1993 after renovation. Numbers stabilised around 150 until the fitting of a ceiling and light baffles in 2005/06 after which the colony increased to 200+ in the summer of 2006.

9.4 Case Study 3: Church roost restoration and repair

Location	Kylemore Gothic Church, Letterfrack, Co. Galway
Species involved	Natterer's, brown long-eared and pipistrelle bats
Type of work	Replacement of roofing lead and internal flooring timbers, underground heating installed
Possible impacts	Disturbance, roost loss
Type of roost	Maternity roost
Size of colony before works	Natterer's bat: c150, others unknown
Size of colony after works	Bat colony retained but no recent counts

9.4.1 Background

The neo-gothic church (Figure 9.4.1) in the grounds of Kylemore Abbey was built in 1870, along the lines of a miniature cathedral. Erosion caused by exposure to rain resulted in serious damage to the interior of the building and a major restoration project was begun in 1992. A conservation architectural company oversaw the project. A number of meetings were held on site between the architect, a wildlife ranger and the Vincent Wildlife Trust and guidelines were given primarily on the timing of major work on the roof and on the importance of always keeping a section of the roof available and free from disturbance for the bats.

9.4.2 Description of works

Works included: complete replacement of lead on the roof and capping stones. Replacement of rotten timbers in floor of main church and tower, minor works to the iron roof trusses, chemical cleaning of fungal/bacterial growth on the marble columns on the interior and of the stone work on the outside, under floor heating system installed, repairs to stained glass windows in-situ.

Figure 9.4.1 Kylemore Gothic Church

9.4.3 Timing of works
Sections of the roof were opened up completely to enable timbers and lead to be replaced. This had begun in the summer of 1992 before the presence of the bats was noted. Following meetings on site with the NPWS, this work was stopped and the roof boarded up again until the end of the breeding season. However, the bats did not use the roof for breeding the following year, as other works were still ongoing but returned thereafter.

9.4.4 Protection of access points and existing roost site
- The contractors were advised to leave gaps between the roof beams and the wall to allow access into the church wall.
- The contractors were advised to strip the roof carefully.

Guidance on the use of insecticides and fungicides was provided to the architect together with a list of products that are suitable for buildings with bat roosts.

9.4.5 Post construction monitoring
The church was reopened by President Mary Robinson in April 1995. The bat colony did return but numbers are currently unknown.

9.5 Case study 4: Replacement bat roost 1 – bat boxes

Location	Cahir, Co. Tipperary
Species	Daubenton’s bat
Type of work	Construction of new road
Possible impact	Roost loss through building demolition
Type of roost	Satellite
Size of colony before works	10
Size of colony after works	To be determined next season

9.5.1 Background
The realignment of the existing N8 between Mitchelstown to Cashel road required the demolition of a farm building (Figure 9.5.1) used by male Daubenton’s bats near Cahir. Because complete demolition of the building was required, the only possible mitigation was the erection of alternative roosting sites.

9.5.2 Description of works
Two ‘Schwegler’ woodcrete bat boxes (Figure 9.5.3) were erected on trees adjacent to the site one month prior to works commencing. The farm building was carefully dismantled during the winter months. One side of the roof being manually removed on the first day and the other side was left for 24 hours before removal to encourage any bats in the structure to leave. However, ten roosting Daubenton’s bats were discovered under a ridge tile during works. These were retained in a wooden box (Figure 9.5.2) until dusk and released on site.

Figure 9.5.1 Demolition of farm building.

Figure 9.5.2 Ten male Daubenton's bats in wooden box.

Figure 9.5.3 Woodcrete bat boxes erected as alternative roosting sites on nearby trees.

9.5.3 Post-project monitoring

The bat boxes will be monitored on an on-going basis over the first five years.

9.6 Case study 5: Replacement bat roost 2 – purpose built building

Location	Ruined mansion, Dunboy, Co. Cork
Species	Lesser horseshoe bat
Type of work	Construction of new hotel
Possible impact	Roost loss through restoration of mansion
Type of roost	Maternity
Size of colony before works	70+
Size of colony after works	First bat investigated new roosting site in August 2006, colony size be determined next season

9.6.1 Background
Renovation of a derelict mansion (Figure 9.6.1) used as a maternity roost by lesser horseshoe bats was required to develop the site into a six-star exclusive hotel complex. The site was sub-optimum for bats due to the deteriorating state of the ruin and the bats were occupying several chimneys. Refurbishment of the building presented an opportunity to design a purpose-built roost site providing suitable conditions for the long-term retention of the colony.

9.6.2 Description of work
In order to maximise the probability of the bats moving into the new building a site was chosen close to the original and near to woodland. The new bat house (Figure 9.6.2) was based on a design from the Vincent Wildlife Trust and was erected over a two month period.

An L-shaped design was chosen to provide the widest range of environmental conditions. The building is 6 m x 9 m with gable height of 5 m (Figure 9.6.3). The cut and pitch traditional roof construction gives a roof void height of 3 m. Walls are of cavity block and the roof covering is natural black slate on Tanalised softwood battens over felt, which should give good heat retention.

A cool room was included in the design to offer the bats a hibernation site. This consisted of a double block wall with insulation.

As a maternity roost was confirmed in the structure, it was necessary to allow the bats to remain in this location until the end of the breeding season. This was facilitated by sealing off all the other chimneys/fireplaces within the structure by packing the 64 openings with straw stuffed bin liners both at the top and bottom. Those with bats were done during the hours of darkness to ensure all individuals had vacated. This ensured that the lesser horseshoe bats were confined to a single known location. This final chimney was excluded after the breeding season once the bat house was in place and the bats had shown an interest in it.

9.6.3 Post-project monitoring
Bats showed an interest in the new building in August 2006 when was one present. The bat house will be monitored on an on-going basis.

Figure 9.6.1 Front view of the ruined mansion.

Figure 9.6.2 Photograph and elevation of the new bat house.

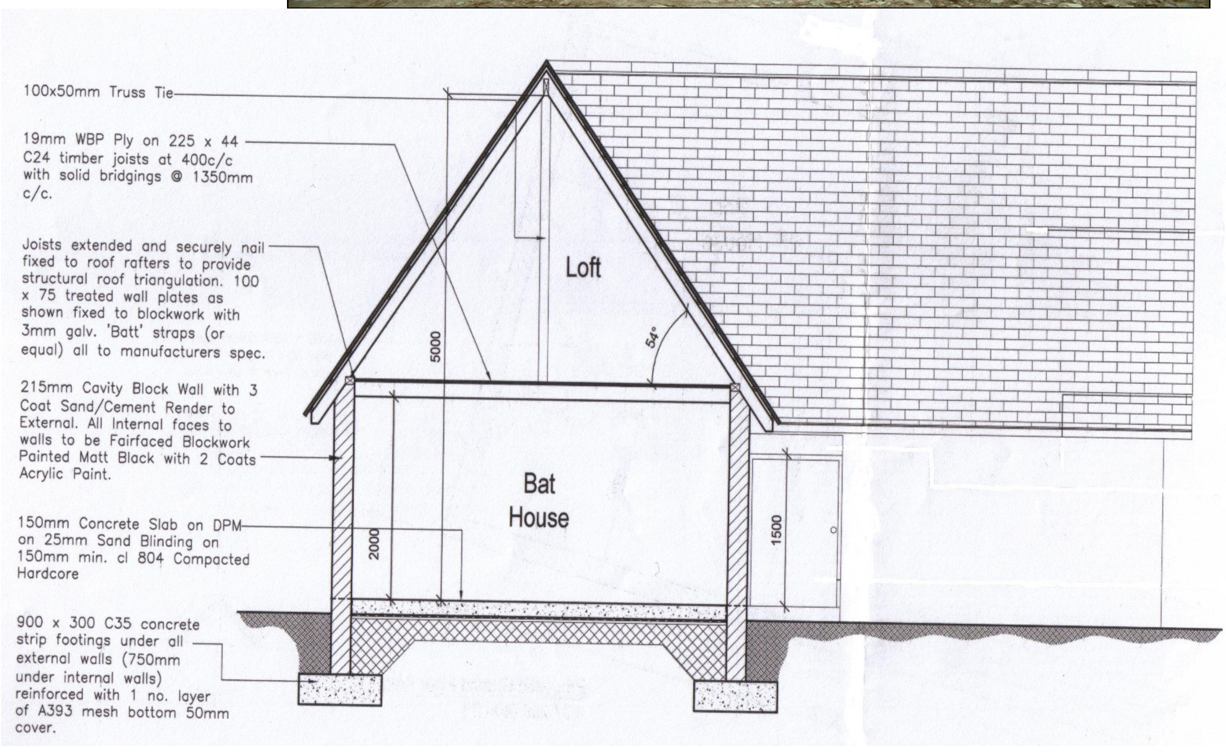


Figure 9.6.3 Construction drawing of the new bat house.

9.7 Case Study 6: Replacement bat roost 3 – existing building restoration

Location	Cottage and outbuilding, Glaninchiquin, Co. Kerry
Species involved	Lesser horseshoe bat
Type of work	Building restoration for translocation of nearby roost
Possible impacts	Disturbance, roost loss
Type of roost	Maternity
Size of colony before works	c 150
Size of colony after works	130+ to date

9.7.1 Background

A maternity roost of c. 150 lesser horseshoe bats was heavily disturbed in the summer of 2004 as a result of renovation works to an old cottage in Co. Kerry. Despite the high level of disturbance, the female bats (with young) remained in the gutted building until the autumn of 2004. Inclusion of a suitable roost in the renovated cottage was not feasible so it was decided to undertake works to an adjacent stone outbuilding (Figure 9.7.1) to accommodate the bats. The outbuilding, which is 12 metres x 5 metres and approximately 10 metres from the original cottage, was roofed with natural slate with an underlay of mineral felt.

9.7.2 Description of works

A loft was created in the building with two trap doors and an access point in one of the gables directly into the loft (the original roost had also had a direct gable entrance into its loft). The floor of the loft was insulated to help minimise disturbance as the owner planned to store materials in the outbuilding.

Figure 9.7.1 Glaninchiquin outbuilding during renovation. Bat access highlighted.

9.7.3 Timing of works
The renovation works were undertaken during the autumn/winter months of 2004/05.

9.7.4 Post-construction monitoring
The original roost had a count of 150+ bats in 2003, the year prior to disturbance, and c130 in 2004 after the roost had been gutted. The peak count for the new roost in 2005 was c120. Bats were not able to enter the original roost by this time as all access points had been sealed. Some small modifications were made in the winter of 2005/2006 when a baffle was inserted in the loft to further darken the interior and reduce drafts entering through the access point. A count of 130+ bats was made in June 2006. The surrounding coniferous woodland is to be cleared in 2007 and replaced by broadleaves, including some larger saplings near the roost which may further benefit the roost.

9.8 Case study 7: Altering an existing roost for public access

Location	Underground servants' tunnels, Lough Key Forest Park, Co. Roscommon
Species	Natterer's, Daubenton's, whiskered, brown long-eared, soprano pipistrelle and lesser horseshoe bats
Type of work	Refurbishment and building alteration to allow for public access
Possible impact	Roost loss, disturbance
Type of roost	Hibernation
Size of colony before works	Single specimens of each species
Size of colony after works	Currently being monitored

9.8.1 Background
Lough Key Forest Park is a public amenity site. The grounds consist of mixed woodland and conifer plantations with open parkland and riparian vegetation associated with the lake. Plans were proposed to enhance the public access to the area and, as part of the development, the underground servants' tunnels were to be opened to the public for exploration as part of the 'Lough Key Experience'. A survey of the tunnels revealed that six bat species were using the site as a refuge during the winter months.

9.8.2 Description of works
Planned works included: Lighting along the length of the tunnels, power washing of tunnel walls, pointing of crevices where necessary, lowering of floor at entrance of tunnel and grilling of entrances to underground rooms leading from the tunnels.

9.8.3 Foreseen impacts on bats
Lighting would increase the temperature within the tunnels. This effect would impact on the potential use of the tunnels by hibernating bats. Lighting may also impact on bat usage of the tunnels outside the hibernation period. Lighting during the daytime would limit the number of suitable crevices to roosting bats. Only deep crevices within the roofs of the tunnels may be used by the bats in order to remain in darkened conditions.

Lesser horseshoe bats prefer to roost in quiet and darkened areas. Increased tourist activity and increased lighting would discourage this species especially from continuing to roost within the tunnels as this bat hangs freely.

Power washing and re-pointing of crevices within the tunnels would decrease roosting sites for bats.

9.8.4 Mitigation measures

To allow bats to continue to use the tunnels, a minimum amount of lighting was installed (Figures 9.8.1 & 9.8.2). Also, lighting was installed following the criteria below to reduce the negative impacts:

- Low level lighting – avoiding bright lights.
- Directional lighting – light emitted was directed downwards towards the ground rather than upwards towards crevices.
- Low heat lighting – avoiding light bulbs with high heat levels.
- Incorporating lighting only in areas along the tunnels where lighting was previously installed.
- Avoiding lighting up rooms adjacent to the tunnels.

Power washing of the tunnel walls was undertaken according to the following criteria:

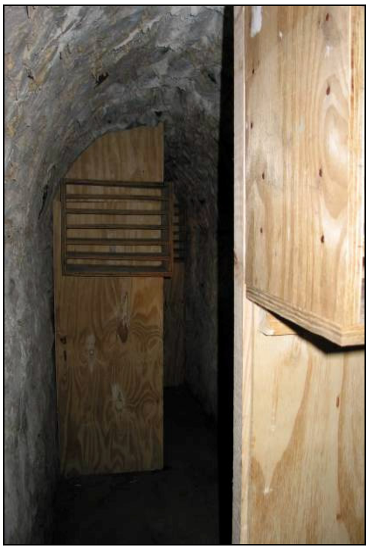
- Crevices recorded as sites used by bats in previous surveys were avoided.
- Tunnels were power washed in phases.
- No more than 1/4 of tunnel length was power washed at any one time. The washed area was left to completely dry before starting washing of the next section of tunnel. This was to ensure that bats were not excluded from using tunnels during works at any time.
- Power washing was not undertaken in areas zoned for bats (e.g. bat tunnel and bat shaft).
- Works were undertaken during the months of April, September and October.

To provide replacement roosting sites as a result of the loss of the two main tunnels, it was proposed to designate one small tunnel as a ‘bat tunnel’ for exclusive use. This required the following works:

One entrance was sealed with a solid wooden door (Figure 9.8.3). The other was sealed with stone but with an opening of 125mm x 500mm to allow for bat access. Four wooden partitions (Figure 9.8.4) (constructed from untreated 3cm thick rough wood) were installed within the tunnel from ceiling to floor, approximately ¾ the width of the tunnel to reduce air flow thereby creating areas within the tunnel with different ambient temperatures. A series of wooden baffles (boxes) (Figure 9.8.5) were constructed on two of the partitions to increase the available roosting potential for crevice roosting bats. Within one tunnel, a small room to one side (approximately 4m high, 3m long and 1m wide) (Figures 9.8.6 & 9.8.7) was enhanced for by similar means for roosting bats, especially lesser horseshoe bats. This was grilled (Figure 9.8.8) to prevent disturbance.

Repointing of crevices in stonework was avoided where possible. Where re-pointing was required, it was manually applied, not pressure grouted. Works were undertaken during the months of April, September and October.

Figures 9.8.1 & 9.8.2 Lighting installed within tunnels.



Figures 9.8.3, 9.8.4 & 9.8.5 Bat Tunnel, depicting door, length of tunnel with partitions and close-up of bat boxes. Bat access point highlighted.

Figures 9.8.6 & 9.8.7 Bat Room, depicting door and close up of bat boxes installed. Arrow indicates lesser horseshoe bat entrance point to interior of room.

Figure 9.8.8 Sample of grilled gate on room adjoining tunnel.

9.8.5 Post construction monitoring

Works carried out in 2006 and initial monitoring is on-going.

10 Presenting mitigation plans

Mitigation plans will often need to be understood, and commented on, by several organisations or individuals. As mitigation can be complex, it is important that the proposals are clear and allow the reader to quickly understand the key points. This will facilitate the processing of licence applications. The section below proposes a structure with section headings which would be appropriate for most typical schemes. Comments on content are given in square brackets. Further details on the kind of information required are given in the appropriate section in these guidelines. Note that a mitigation plan based on this structure can form the basis of a Method Statement for use in a NPWS derogation licence. Colour photographs, maps and diagrams can be very useful but bear in mind that several colour copies may be required since monochrome photocopies of colour images can make it very difficult to pick out detail. The front cover of the plan should show the author and revision history (the latter being useful for assessing how previous consultation comments have been incorporated).

10.1 Recommended mitigation plan structure

This plan structure is based on that included with the derogation licence application form. Not all sections will be applicable in all cases. It is important to provide clear plans and diagrams' showing the current situation and what is proposed. Plans and diagrams should be no larger than A3. Because derogation forms are updated periodically, you are recommended to check on the National Parks and Wildlife Service website that the form you are using is the current version.

A Contents

B Introduction

- B1 Background to activity [location, ownership, type of and need for the proposed development, planning history, land allocation in Local Plan (or equivalent), etc]
- B2 Full details of proposed works on site that are to be covered by the licence (including a site plan at Section E7). The site may be inspected by an NPWS representative, so the details given should clearly reflect the extent of the project and leave no room for doubt. This information will be used to compare site conditions with the Method Statement.

C Survey and site assessment

- C1 Pre-existing information on species at survey site
- C2 Status of the species in the local/regional area
- C3 Objective(s) of survey
- C4 Survey area
- C5 Habitat description [based on daytime visit(s); to include the roost and surrounding area for context]
- C6 Field survey
  - C6.1 Methods
  - C6.2 Timing
  - C6.3 Weather conditions
  - C6.4 Personnel
- C7 Results (to include raw data, any processed or aggregated data, and negative results as appropriate)

C8 Interpretation and evaluation
  C8.1 Presence/absence
  C8.2 Population size class assessment
  C8.3 Site status assessment (combining quantitative, qualitative, functional and contextual factors)
  C8.4 Constraints (factors influencing survey results)
C9 Map(s) of survey area (with habitat description, marking structures or features examined; summary of survey results marked on map if appropriate. Map should show area on an Ordnance Survey (or similar) base-map)
C10 Cross-referenced photographs of key features (if appropriate)

D Impact assessment
D1 Pre- and mid-activity impacts
D2 Long-term impacts [roost or habitat loss, modification, fragmentation, etc.]
D3 Post-activity interference impacts [disturbance etc.]
D4 Other impacts
D5 Summary of impacts at the site level
D6 Summary of impacts in a wider context
D7 Plans or maps to show impacts (clear indication of which areas would be affected and how)

E Mitigation and compensation
E1 Mitigation strategy (overview of how the impacts will be addressed in order to ensure no detriment to the maintenance of the population at a favourable conservation status)
E2 Replacement roost site selection
  E2.1 Existing species status (give survey data)
  E2.2 Location, ownership and status
  E2.3 Habitat description, size, boundaries
E3 Habitat creation, restoration and/or enhancement (as appropriate)
  E3.1 Terrestrial habitats
  E3.2 Integration with roads and other hard landscapes
  E3.3 Integration with other species/habitat requirements
E4 Capture and exclusion
  E4.1 Timing, effort, methods, capture/exclusion methods
E5 Post-development site safeguard
  E5.1 Roost management and maintenance (either set out details here, or if complex then give outline here and give details as an annexed stand-alone plan)
  E5.2 Population monitoring
  E5.3 Mechanism for ensuring delivery (who will undertake the work and reporting details)
E6 Timetable of works (phasing diagram to include all works associated within section E, and to indicate construction works timing)
E7 Site plan to show all work covered by the licence
E8 Map to show the extent of each parties interest on site (if appropriate)
E9 Map to show location of receptor site in relation to development site
E10 Map to show habitat creation, restoration and/or enhancement
E11 Map to show post activity management (if appropriate)
E12 Diagram to show exclusion apparatus (only required if non-standard techniques are proposed)

F Summary

F1 Summary of development and mitigation (NB to include overall consideration of the three main licensing criteria: effect on conservation status, purpose, and alternatives) [see 2.2 Exceptions and licensing for details]

G References

H Annexes

H1 Management and maintenance plan

H2 Pre-existing survey report(s)

11 Acknowledgements

Thanks are due to Peter Carvill and Enda Mullen for advice and comments on aspects of the legislation in relation to bats. For supplying details and photographs of case studies, Drs Tina Aughney and Kate McAney were major contributors, as were Clare Heardman and Michael O'Sullivan, Conservation Rangers. Additional photos were provided by Julie Fossitt and Mark Masterson. Many thanks also to Dr Vincent O'Malley, of the *National Roads Authority*, for permission to reproduce the Bat Species and Habitats Survey Timetable as given in the NRA's *Bat Conservation Guidelines for the Planning and Construction of National Road Schemes* and to Austin Hopkirk for supplying the cover photograph.

12 Further reading

12.1 Literature on bat ecology, conservation and mitigation

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13 Document information

13.1 Production notes

This manual draws very heavily on English Nature's *Bat Mitigation Guidelines* prepared by A.J. Mitchell-Jones, both for the overall structure and approach and for the text of some sections. The contributions of the many people who have helped to improve earlier drafts or contributed material for the case studies are gratefully acknowledged.

If you have comments on this document or wish to make suggestions for future versions please send them to the co-author at The National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, 7 Ely Place, Dublin 2; Email: ferdia_marnell@environ.ie . These guidelines may be updated periodically to take account of new findings and changes in policy, practice and legislation, so please ensure you have the current version by checking with the NPWS. The latest version is available as a hyperlinked PDF (Adobe® Acrobat®) file on the National Parks and Wildlife Service website: www.npws.ie . Paper copies are available from Head Office at (Tel: 01-8882000).

13.2 Revision history

Version 1, published December 2006.

14 Appendix 1: Bat Species and Habitat Survey Timetable

Habitat → / Species ↓	Woodland and Parkland			Scrub		Individual trees	Recently felled woodland	Grassland	Tall herb and fern Bracken		Heath	Mire
	Broadleaved	Coniferous	Mixed	Dense/continuous	Scattered				Continuous	Scattered		
Common pipistrelle	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 All year	2 Mar (June-Aug) Sept		2 Mar (June-Aug) Sept			2 Mar (June-Aug) Sept
Soprano pipistrelle	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 All year	2 Mar (June-Aug) Sept		2 Mar (June-Aug) Sept			2 Mar (June-Aug) Sept
Nathusius' pipistrelle	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	2 All year	2 Mar (June-Aug) Sept		2 Mar (June-Aug) Sept			2 Mar (June-Aug) Sept
Brown long-eared	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year		2 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		
Leisler's	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	4 All year	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept			1 Mar (June-Aug) Sept	
Daubenton's	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year						
Natterer's	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year		2 Mar (June-Aug) Sept				
Whiskered	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year						
Brandt's	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	4 All year						
Lesser horseshoe	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept	3 Mar (June-Aug) Sept				4 Mar (June-Aug) Sept			
Method →	Detector/harp/netting/lures/radio-telemetry			Detector/trapping/lures/telemetry		Fibrescope/binoculars		Detector	Detector/trapping		Detector	Detector

Annex II species

All season survey to locate/determine roost use

Spring/Summer/Autumn survey to confirm mating/lekking sites and foraging areas

Summer/Winter survey to locate maternity, transitional and hibernation roosting sites

Winter survey to locate/assess hibernation sites

4 Number of survey rounds per season required to confirm species presence and activity

Mar (Apr-Sept) Oct Survey season with optimum months in brackets

Swamp	Wetland	Open water		Coastland				Exposed rock and bare ground					Cultivated land
								Natural		Artificial			
		Standing water	Running water	Intertidal	Saltmarsh	Sand dune	Cliff and slope	Cliff	Cave	Quarry	Mine	Refuse-tip	
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 Oct (Jan-Feb) Mar	2 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar		
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 Oct (Jan-Feb) Mar	2 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar		
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 Oct (Jan-Feb) Mar	2 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar		
									4 Oct (Jan-Feb) Mar				
	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		2 Mar (June-Aug) Sept								2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept
	4 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar		
		2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept					4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar		
								4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar		
								4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar		
								4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar	4 Mar (June-Aug) Sept	4 Oct (Jan-Feb) Mar		
Detector	Detector	Detector		Detector				Detector	Torch	Detector	Torch	Detector	Detector

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Boundary			Structures								Bat & bird boxes	← Habitat	Notes
			Overground							Underground			
Treeline/ Hedgerow/fence	Wall	Ditch	Barn/ House	Grotto	Folly	Aquaduct	Culvert	Bridge	Castle	Various		↓ Species	
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 All year (Apr-Sept)		4 All year	4 All year (Apr-Sept)			4 All year	4 Within light zone (Apr-Sept)	2 All year (Feb & Aug)	Common pipistrelle	**Mating activity apparent in Aug-Sept Lure (Apr-Sept)**
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 All year (Apr-Sept)		4 All year	4 All year (Apr-Sept)			4 All year	4 Within light zone (Apr-Sept)	2 All year (Feb & Aug)	Soprano pipistrelle	**Mating activity apparent in Aug-Sept Lure (Apr-Sept)**
2 Mar (June-Aug) Sept	2 Mar (June-Aug) Sept		4 All year (Apr-Sept)		4 All year	4 All year (Apr-Sept)			4 All year		2 All year (Feb & Aug)	Nathusius' pipistrelle	**Mating activity apparent in Aug-Sept Lure (Apr-Sept)**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept	4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar	2 All year (Feb & Aug)	Brown long-eared	**Mating activity apparent in April as well as Aug-Sept**
			4 All year (Apr-Sept)		4 All year	4 All year (Apr-Sept)			4 All year		2 All year (Feb & Aug)	Leisler's	**Lekking behaviour in Aug-Sept**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar		Daubenton's	**Mating activity apparent in Aug-Sept**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar	2 All year (Feb & Aug)	Natterer's	**Mating activity apparent in Aug-Sept Swarming (Sept-Nov)**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar	2 All year (Feb & Aug)	Whiskered	**Mating activity apparent in July-Aug**
4 Mar (June-Aug) Sept	4 Mar (June-Aug) Sept		4 All year (Apr-Sept)	4 All year	4 All year	4 All year (Apr-Sept)	4 All year	4 All year	4 All year	4 Oct (Jan-Feb) Mar	2 All year (Feb & Aug)	Brandt's	**Mating activity apparent in July-Aug**
4 Mar (June-Aug) Sept		4 Mar (June-Aug) Sept	4 All year (Apr-Sept)	4 All year (Apr-Sept)	4 All year (Apr-Sept)		4 All year	4 All year	4 All year	4 Apr (May-Sept) Oct Nov (Jan-Feb) Mar		Lesser horseshoe	**Mating activity apparent in April as well as Aug-Oct**
Detector/Torch/Fibrescope/Trapping			Detector/Torch/Fibrescope/Trapping							Visual	Visual	← Method	

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