11th Meeting of the Advisory Committee

City of Luxembourg, Luxembourg, 8 – 10 May 2006

Report of the IWG on Protection of Overground Roosts

This draft report for discussion at AC11 deals in particular with protection of overground roosts in buildings of cultural heritage importance.

Contents

1. Introduction

MOP4 in 2003 asked the Eurobats Advisory Committee to gather information on methods used to protect sites other than underground sites, with roost sites in buildings that are part of the cultural heritage as a priority. The results to be disseminated by 2006.

An Intersessional Working Group [IWG] was established at AC 9 in 2004 to address this issue. The following terms of reference were agreed for that group:

- Establish types of overground sites used as roosts
- Identify methods used to protect these roosts
- Identify relevant issues with respect to cultural heritage buildings

A timetable was agreed for the work of the group, which would culminate in a final report to AC 11 in 2006. A questionnaire (see Appendix 2) was circulated to all Party and Non-party range states in December 2004. To date, responses have been received from the following 32 countries: Albania, Armenia, Austria, Azerbaijan, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Hungary, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Netherlands, Norway, Portugal, Romania, Russian Federation, Serbia & Montenegro, Slovakia, Slovenia, Sweden, Switzerland and the UK.

The questionnaire sought information on the types of overground sites used as roosts, on the administrative and practical protection of roosts and on the interactions between bats and buildings of cultural heritage. Responses were received from 30 countries by April 2005 and these were discussed by an expanded Working Group at AC 10. A further IWG meeting took place at EBRS X in Galway (August 2005).

This document summarises the results from the overground roost questionnaire; provides an overview of suitable protective measures and explores the interactions between bats and buildings of cultural heritage importance. A number of case studies are included to illustrate how conflicts between bats and cultural heritage have been successfully resolved in different parts of Europe.

2. Literature Review

A large volume of literature relevant to the work of this IWG has been published in the UK. It is these sources, and in particular English Nature's *Bat Mitigation Guidelines* (2004), JNCC's *Bat Workers Manual* (2004), The National Trust's *Wildlife and Buildings* (2001) and Bat Conservation Trust's *The Bats in Churches Project* (1995), which largely inform this report. Published and unpublished materials from Austria, Estonia, Ireland, Italy, Latvia, Lithuania and the Russian Federation were also examined in the preparation of this report.

Eurobats has already produced an advisory document on underground roosts – *Protecting and managing underground sites for bats* – which can be downloaded (?) from the Eurobats website [www.eurobats.org]. The report from this overground roost IWG aims to complement that underground roost document and where overlaps occur the reader will be referred to that earlier report.

3. Use of overground roosts by bats

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.

Man-made structures regularly used by bats across Europe include bridges, castles, churches, houses, blocks of flats, barns and stables. *Myotis daubentonii* is particularly associated with bridges and will form roosts in suitable cracks in both old and new structures. *Pipistrellus pipistrellus* and *Eptesicus serotinus* usually roost in houses. *Myotis blythii* can be found roosting in churches over much of its range. While *Plecotus auritus* has come to rely more and more on man-made roost sites in some countries due to the successive loss of suitable natural habitat.

Bats can be found in buildings all year round. 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 *Pipistrellus pipistrellus*, show a clear preference for confined roost sites, such as soffit boxes, eaves or under hanging tiles, whereas others, such as the *Rhinolophus* spp. 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 variety 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 such as cellars and basements. These latter are covered by the Eurobats report on underground roosts and are not considered further here.

The overground roost questionnaire asked national experts to estimate the dependence of individual bat species on specific roost types as high, medium, low, not important, not known or just as present when no detailed information was available. Table 1 provides a summary of the responses. [A more detailed breakdown can be found in Appendix 3.] An analysis was then conducted of the dependence of bats on different overground roost types in different countries. The main roost types identified were churches, castles/fortifications, houses/block of flats, barns/stables, bridges and trees. Respondents also added bat/bird boxes, rocky crevices, hunting stands, wooden cottages, log houses and piles of wood.

A number of caveats should be borne in mind when examining the data :
i) For a large proportion of bat species the degree of dependence on specific roost types in specific countries is unknown.
ii) It is not clear if all the answers dealing with castles/fortifications are only referring to overground roost types; some may include underground habitats (cellars, basements etc.).
iii) For the analyses presented below we have chosen only records where the dependence of bat species on specific roost types is estimated as high.
iv) Returns from further Party and non-Party range states are required to complete the picture for the region, particularly for the Mediterranean species.

3.1 Dependence of bat species on overground roost types

Because of the problems mentioned above we have to be extremely cautious when trying to interpret the questionnaire returns. Table 1 summarises the importance of the main overground roost types by species. A more detailed breakdown is given in Appendix 3.

Table 1. Percentage of Eurobats range countries with high bat species dependence on overground roost types. (High dependence in: 1–20% of countries (+); 21–40% (++); 41–60 % (+++); 61–80 % (++++); 81–100 % (+++++). Countries that could not specify a degree of dependence (answers "not known" or "bat species present") are excluded).

Overground roost type / Species	Church	Castle/ Fortification	House/ block of flats	Barn / Stables	Bridge	Tree
		+	+	+		+++
Barbastella leucomelas						
Eptesicus bottae			+++			+++
Eptesicus nilssonii	+	+	+++			+
Eptesicus serotinus	++	+	++++	+		
Hypsugo savii			+			
Miniopterus schreibersii	+	+				
Myotis alcathoe						++
Myotis aurascens			++	++	++	
Myotis bechsteinii						+++++
Myotis blythii	++	+	+	+	+	
Myotis brandtii		+	++			+++
Myotis capaccinii						
Myotis cf. *punicus*						
Myotis dasycneme	++	++	+++	+		+
Myotis daubentonii	+	++			++	+++++
Myotis emarginatus	++	++		+		
Myotis hajastanicus						
Myotis myotis	++++	++	++			
Myotis mystacinus	+	+	+++	+	+	++
Myotis nattereri	+	+	++		+	+++
Myotis nipalensis						
Myotis schaubi						
Nyctalus lasiopterus						+++++
Nyctalus leisleri			+			+++++
Nyctalus noctula	+	+	++	+	+	+++++
Otonycteris hemprichii						
Pipistrellus kuhlii	+	+	++++	++	+	+
Pipistrellus nathusii	+		+++	+	+	+++++
Pipistrellus pipistrellus	++	++	++++	++	+	++
Pipistrellus pygmaeus	+	+	+++	++	+	+++
Plecotus auritus	+++	++	++	+		+++
Plecotus austriacus	+++	++	+++	+		+
Plecotus kolombatovici						
Plecotus macrobullaris	++		+	+		
Plecotus sardus						
Rhinolophus blasii						
Rhinolophus euryale	+	+				
Rhinolophus ferrumequinum	++	+	+	+	+	
Rhinolophus hipposideros	++	++	++	+	+	
Rhinolophus mehelyi						
Rousettus aegyptiacus						
Tadarida teniotis					+	+
Taphozous nudiventris						
Vespertilio murinus	+	+	++++	+		+

3.2 General geographic pattern of dependence of bat species on overground roost type

This section merits further analysis which is largely beyond the scope of this IWG, however, for the purpose of this report we have prepared some maps. Figs. 1-6 present the absolute number and percentage of bat species highly dependent on specific overground roost types in each country. Fig 7 shows the percentage of bats across Europe which are highly dependant on overground roosts in potential cultural heritage buildings (churches, castles, houses and barns combined).

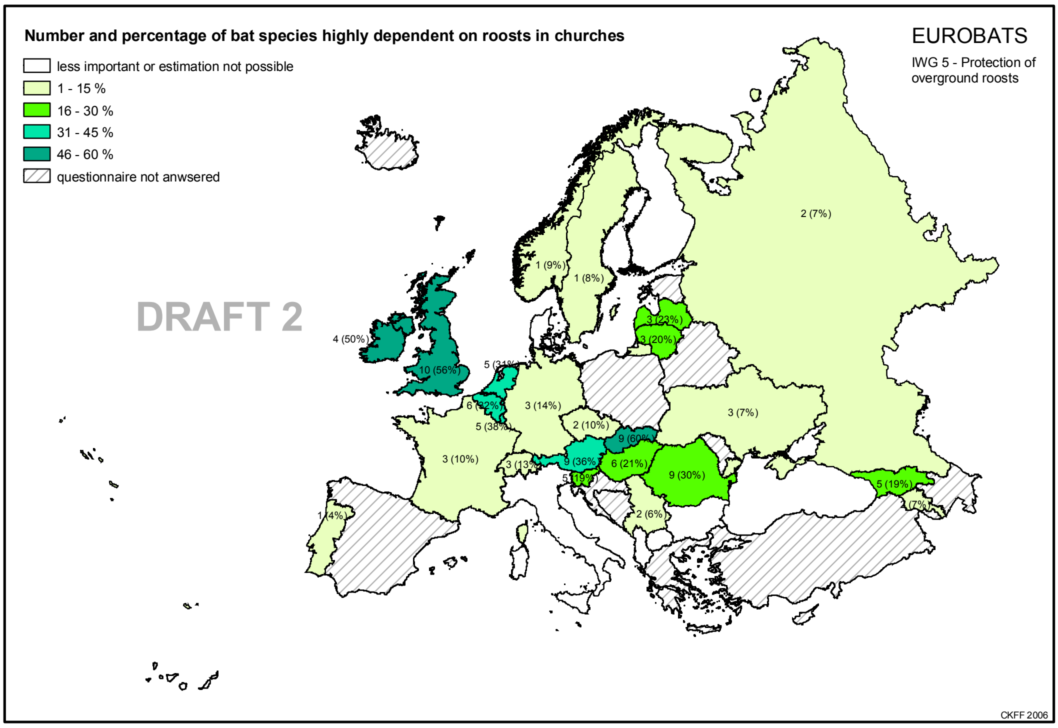


Fig. 1. Absolute number and percentage of bat species highly dependent on roosts in **churches** in Eurobats range countries.

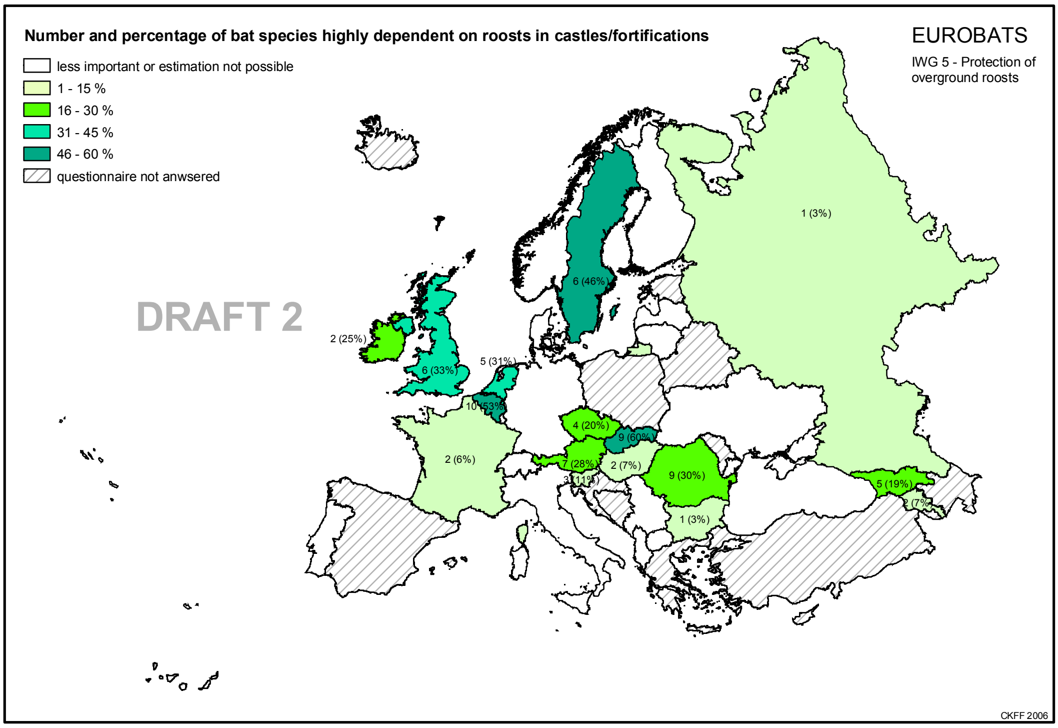


Fig. 2. Absolute number and percentage of bat species highly dependent on roosts in **castles/fortifications** in Eurobats range countries.

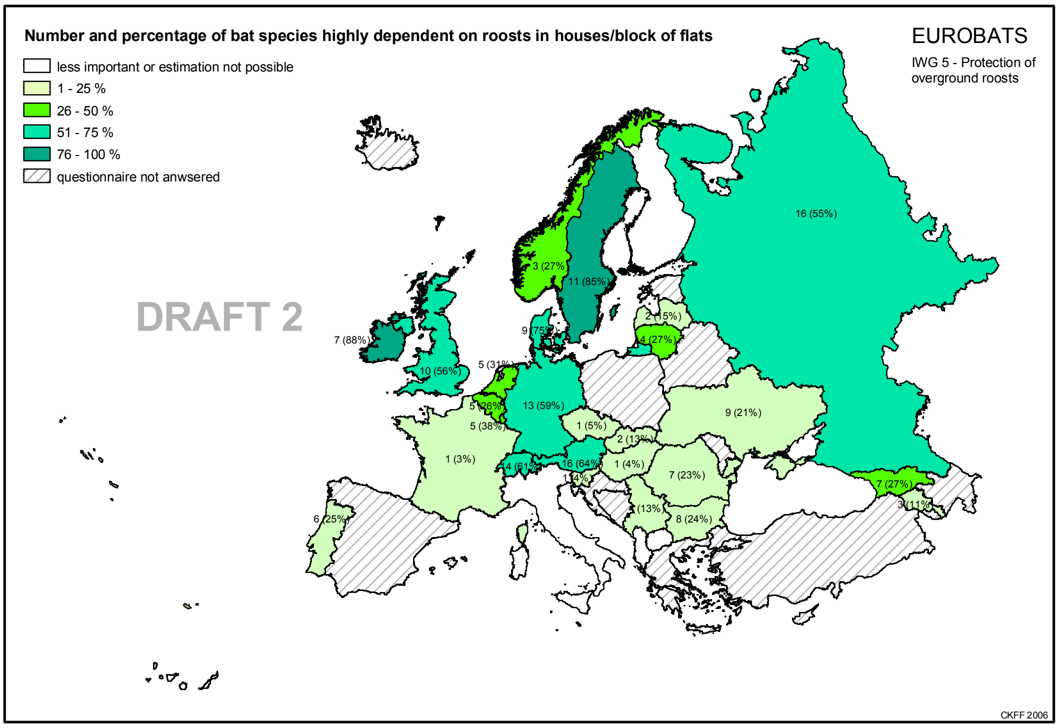


Fig. 3. Absolute number and percentage of bat species highly dependent on roosts in **houses/block of flats** in Eurobats range countries.

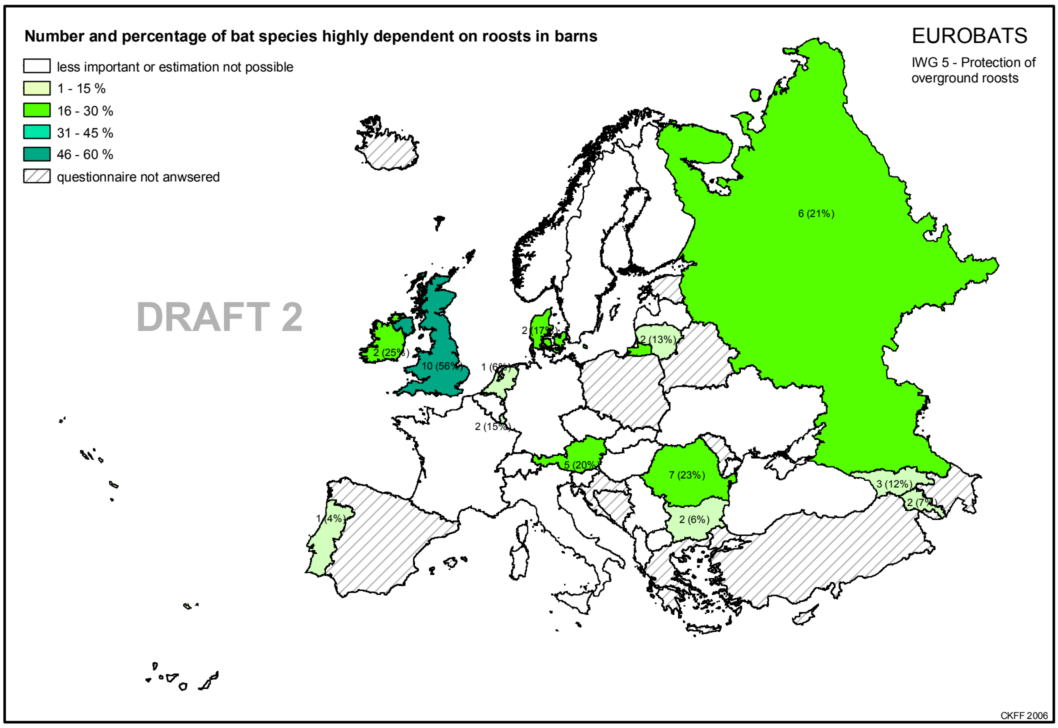


Fig. 4. Absolute number and percentage of bat species highly dependent on roosts in **barns/stables** in Eurobats range countries.

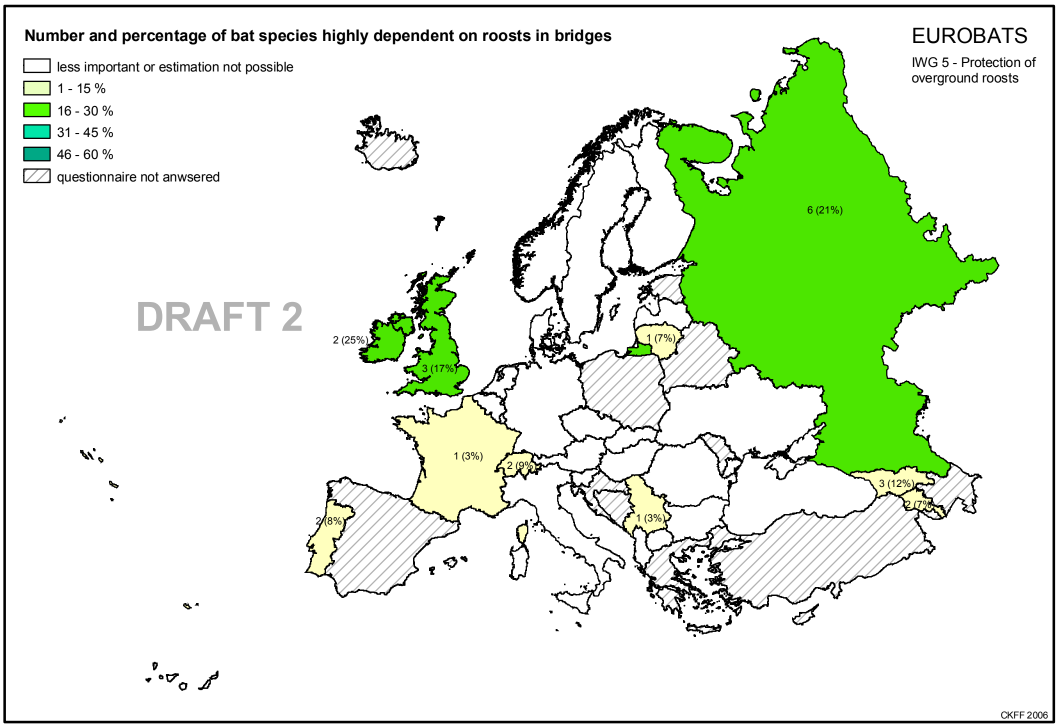


Fig 5. Absolute number and percentage of bat species highly dependent on roosts in **bridges** in Eurobats range countries.

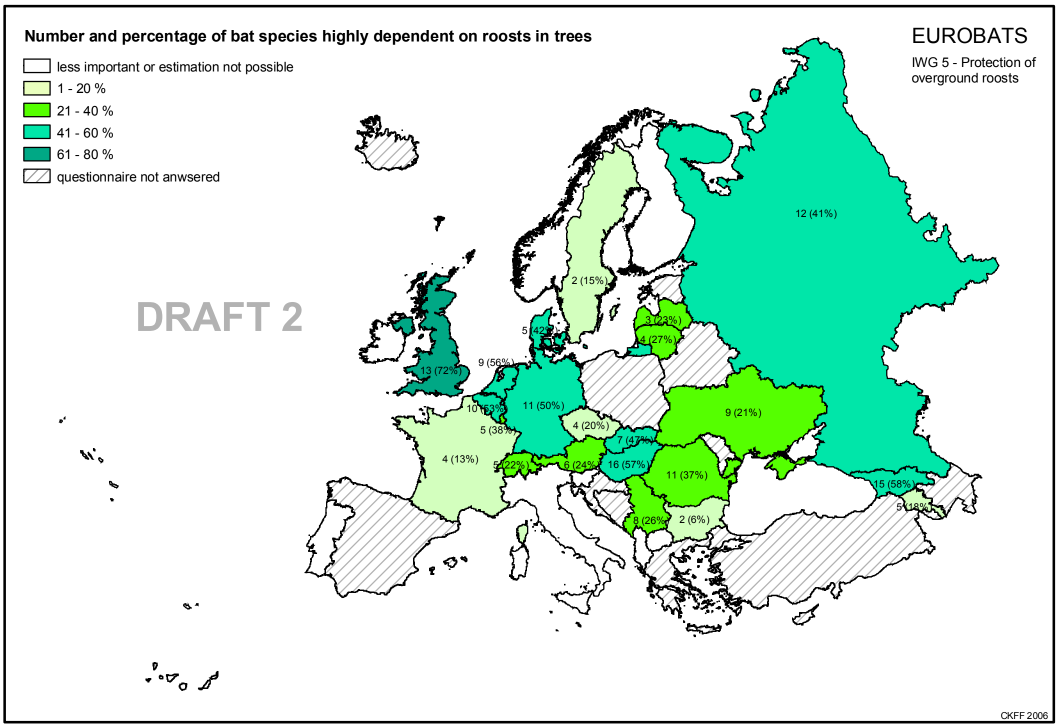


Fig. 6. Absolute number and percentage of bat species highly dependent on roosts in **trees** in Eurobats range countries.

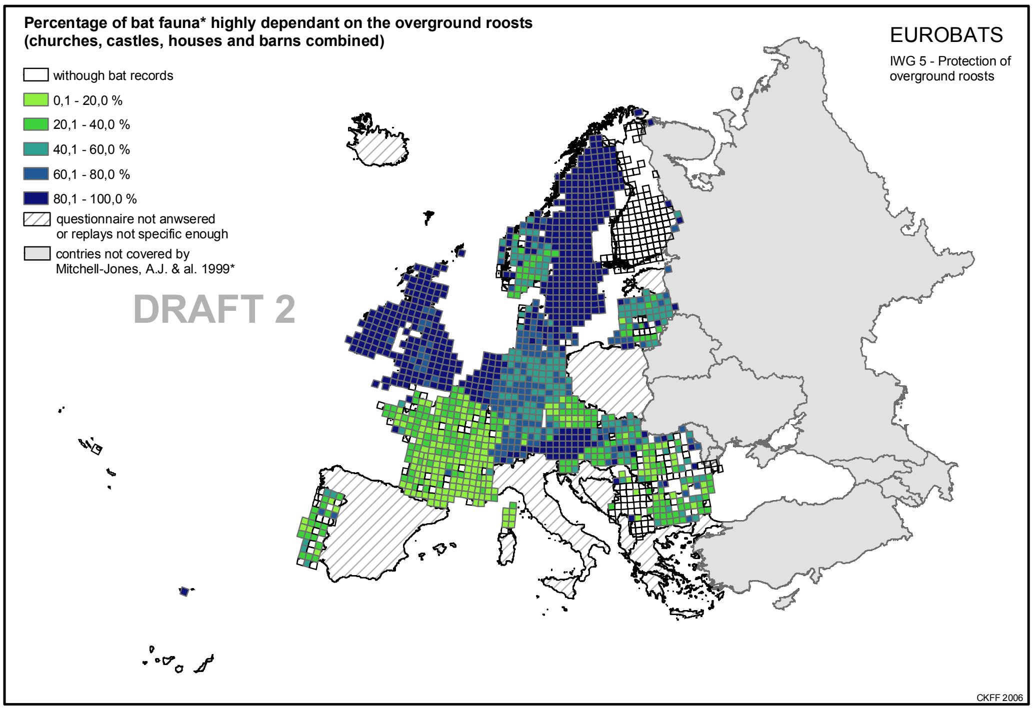
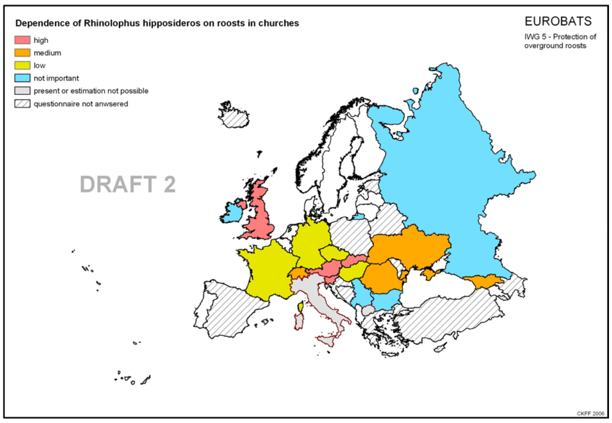


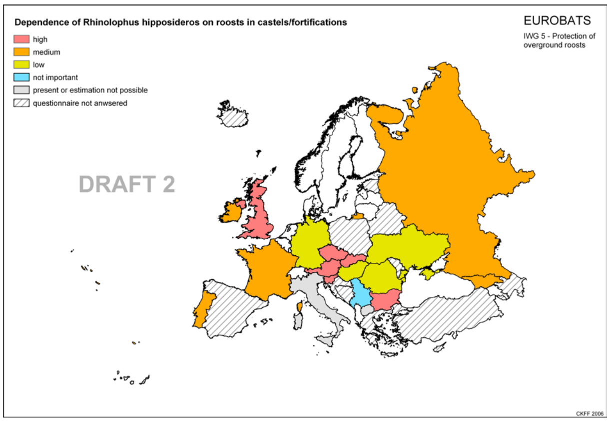
Fig 7. Percentage of bat fauna* highly dependant on the overground roosts in potential cultural heritage buildings (churches, castles, houses and barns combined)
(* Only species mentioned by Mitchell-Jones *et al.*1999 are considered)

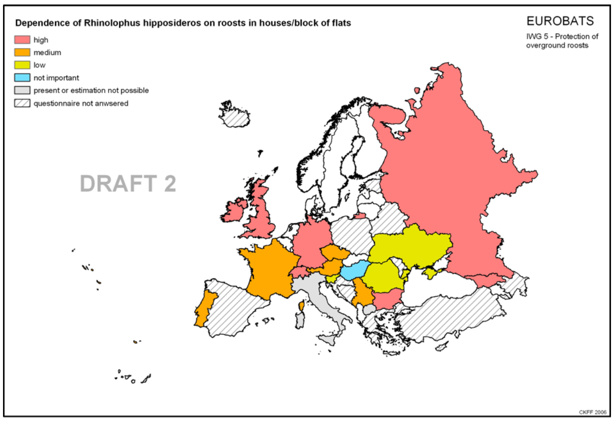
3.3 Variation across the European range

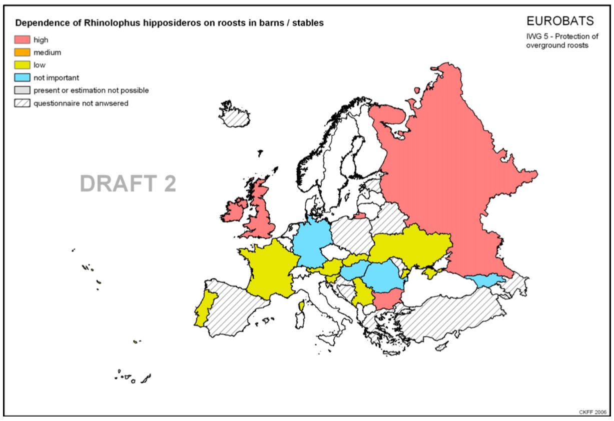
It is clear from the responses to the questionnaire that while certain bat species can be found in the same type of overground roosts across their range, other bats show marked variation in their roost choices across their European range.

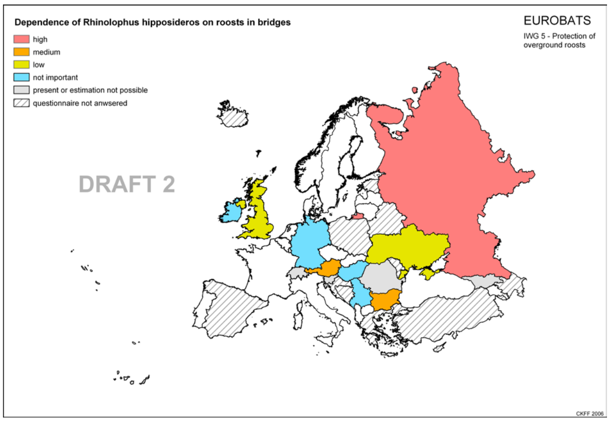
Rhinolophus hipposideros provides a good example of this. Churches are highly important for this species in Austria, Slovenia and Slovakia and are of medium importance in neighbouring Hungary, Czech Republic, Germany and France. Further south and east, in Serbia and Montenegro, Bulgaria, Ukraine, Russia and Georgia, churches are less important for *R. hipposideros*. Much of this variation can probably be attributed to religion (!). More specifically, differences in church construction. In general, catholic/evangelic churches, which predominate in western and central Europe, have large accessible attics, while large attics are not so common in the orthodox churches further east. In contrast to this general trend, the churches in Ireland tend not to have attic spaces, and when they are present they usually do not have openings large enough for *R. hipposideros* to use. Consequently, this species is seldom found roosting in churches in Ireland, but uses houses and barns instead. In general, houses and barns are often very important for *R. hipposideros* where churches and castles are not. The Figures below illustrate this further.











4. *Roost protection*

Three main forms of protection for overground roosts can be recognised: legal protection, physical protection and education / information.

4.1 Legal protection

According to the questionnaire returns, most Eurobats range states have some form of national legislation protecting bat roosts, although a small number do not. Furthermore, specific legislation applies to the 25 EU Member States [MS] – in particular all microchiroptera species are listed on Annex IV of the EU Habitats Directive [92/43/EEC]. Article 12(1) of this Directive requires MS to implement a system of strict protection. 12 (1) b) and 12 (1) d) are particularly relevant, they prohibit:

> “b) deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration; …….
>
> d) deterioration or destruction of breeding sites or resting places. “

The full text of this Directive can be found at: http://europa.eu.int/comm/environment/nature/nature_conservation/eu_nature_legislation/habitats_directive.
It is worth noting that the transposition of this Directive into National Law can lead to some variation in implementation between countries.

The Bern Convention lists all bat species on Appendix II, except *P. pipistrellus*, which is listed on Appendix III.

In more than half of the countries which responded, overground bat roosts were also afforded legal protection through NGO or State ownership.

4.2 Physical protection

Overground roosts can be protected from disturbance by a number of means, including grilling, fencing and blocking off. In all cases it is important that these protective measures should not have any accidental adverse impact on the bats themselves e.g. the necessary works should be timed to avoid disturbing the bats and the SNCO should always be consulted. All in effect restrict public access and extensive details on these methods can be found in the Eurobats report *Protecting and Managing Underground Sites for Bats*.

4.3 Education / Information

The availability of readily accessible and practical information was identified by many Eurobats countries as key to the protection of bat roosts. This can include web-based resources as well as published materials. For maximum effect, information should be as focussed as possible e.g. information on bat friendly bridge repairs for local authorities; information on bats in churches for church authorities.

4.3.1 Web sites

Web based information sources are becoming more common. They allow easy and free access to the latest information on best building practise as well as bat ecology and biology from a wide range of countries, although most of it is in English. The availability of this information can be particularly useful in countries wit limited working knowledge of bats. It should always be borne in mind, however, that situations will vary between countries and even the same species can have different requirements in distant parts of its range.

NGOs and academic research groups play an important role in the area of bat education and the provision of related information throughout Europe. See for example the websites of:
the Dutch Mammal Society [www.vzz.nl];
the Italian Chiroptera Research Group [http://fauna.dipbsf.unisubria.it/chiroptera];
the Russian Bat Research Group [http://zmmu.msu.ru/bats];
Bat Conservation Ireland [www.batconservationireland.org]

The Eurobats website provides an extensive list of links to bat conservation organisations across Europe.

Further work on this area is underway. An INTERREG project in the Alpine / Adriatic area is looking in detail at the effects of renovation works in buildings of all sorts on bats. A report is in press - *Reiter G. & Zahn A. (in press): Leitfanden zur sanierung von fledermausquartieren im Alpenraum. Koordinationsstelle für Fledermausschutz und -forschung in Österreich (KFFÖ) and Koordinationsstelle für Fledermausschutz*

Südbayern, 150 pp. - which includes, on a species by species basis, an examination of the critical factors that have to be considered before, during and after renovation works. The website for this project is: www.fleddermausschutz.at/INTERREG

Some useful general resources available on the web include:
English Nature's 2004 *Bat Mitigation Guidelines*
JNCC's 2004 *Bat Worker's Manual*

4.3.2 Site notices

Although bat conservationists often prefer to keep the location of important, unprotected sites secret, sensible use of site notices can be an effective way of alerting developers to the importance of a building or bridge for bats. The notice might usefully state the legal provisions under which bats are protected and provide contact details for the relevant SNCO or NGO as appropriate. If the site is only important for bats for part of the year, the notice could explain this as well.

Once again the value of education and information in the protection of bat roosts has been covered in detail in the Eurobats report *Protecting and Managing Underground Sites for Bats*.

5. Focus on buildings of cultural heritage

5.1 Introduction

As a general principle, older structures have a greater variety of bat species than newer ones. Thus, buildings of cultural heritage importance such as castles and churches can play a key role in providing roost sites for many of Europe's bat species. General features of older buildings that make them attractive to bats include the greater use of natural stone and large hardwood timbers, a wide range of constructional features, limited human disturbance and a certain amount of weathering (A. Hutson, 1995). It is also a notable feature that bats show a greater degree of site fidelity in old buildings than they do in modern structures.

Frequently the management of the areas around heritage buildings is based on a traditional form of land management that would retain features suitable for bats and their insect food (such as trees, permanent pasture and water bodies).

When conflict arises between bats and buildings of cultural heritage importance it is usually in one of two ways: either restoration/renovation works are planned for the building that will impact on the bats, or the bats themselves are causing a disturbance or damage within the building. In some cases these conflicts may be supported by opposing legislation, with the bats being protected under wildlife law and the building and / or its contents protected under other heritage legislation. However, such conflicts can normally be resolved to the satisfaction of both the built heritage and the natural heritage.

Conflict between bats and the built heritage was recognised as a genuine concern in almost all countries that responded to the questionnaire. Most countries had examples of bats being disturbed during conservation works on buildings of heritage importance and 25 countries cited instances of bats being excluded as a result of such works. The disturbance of humans by bats is also a concern in most countries, with noise, smell and the build up of guano being the most common causes. Actual damage to property by bats was identified in 15 countries.

There are many examples from throughout Europe to show how bats need not be impacted during building works. Indeed, with some careful planning, the status of bats in a building of cultural heritage can often be enhanced during such operations. Equally, it has been shown that if bat expertise is involved from the early planning stages of a restoration project, and a flexible approach is taken to the scheduling of the works, the bats can be satisfactorily accommodated throughout the project, at little or no additional cost, and without compromising the aims of the works.

5.2 Avoidance *[adapted from* Bat Mitigation Guidelines *2004]*

The most common and effective method of minimising the impact of renovation or restoration works on bats is to carry out the work at an appropriate time of the year. More than half of respondent countries to the overground roost questionnaire had employed this approach. 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 (which is taken from English Nature's 2004 *Bat Mitigation Guidelines*) should be modified in the light of site-specific species information. For example, some species, most notably *Plecotus auritus* and *R. hipposideros*, 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.

Table 2: Optimum season for works in different types of roosts. 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

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 by bats 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.

Case Study 1: St Cadoc's Church, Wales

Three species of bat roost in St. Cadoc's church in Wales - *Rhinolophus hipposideros*, *Plecotus auritus* and *Myotis nattereri*. The church dates back to the early 1200s and is of considerable historical importance. In 2002 it was discovered that essential repairs to the roof were required and scaffolding was immediately erected to stop it from collapsing. No further works were carried out, however, until the bats had left the church in the autumn. At that stage a polythene tent was constructed over the roof to allow the restoration works to be carried out over the winter months with a view to having the building ready for occupation by bats again the following spring.

The work took longer than expected, however, and the builders were still onsite when the bats returned. Through agreement with the local SNCO [Countryside Council for Wales], work was able to continue on the main roof, but the tower where the bats roosted was left untouched during the breeding season. The bats successfully reared their young, despite the ongoing restoration works nearby, and the remaining works were completed over the autumn.

An interesting, unexpected benefit of the restoration works was the discovery of a medieval wall painting, thought to have been covered up since the Reformation.

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.

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.

5.3 Incorporating existing roosts into renovated buildings *[adapted from* Bat Mitigation Guidelines *2004]*

The renovation of heritage buildings used by bats can provide opportunities to incorporate existing roosts into the final structure. Apart from the timing of the works, 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.

5.3.1 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, some species may require light-sampling areas where they can fly in and out before finally emerging. Hibernation roosts in buildings are normally underground. The table below (which is adapted from BMG, 2004) gives an indication of summer roost preferences for some species, though there is a great deal of variation; the overall objective should be to maintain the roost size as close to the original as possible.

Table 3. Species-specific roost types and sizes.

Species	**Summer/maternity roosts**
Greater horseshoe bat *Rhinolophus ferrumequinum*	Horseshoe bats require large roost areas with flight access into them, where they hang free. Normally require associated sheltered light-sampling areas.
Lesser horseshoe bat *Rhinolophus hipposideros*	
Bechstein's bat *Myotis bechsteinii*	Rarely found in buildings. Little information about requirements.
Brandt's bat *Myotis brandtii*	Crevice dweller, but may enter roof voids and fly around.
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.
Whiskered bat *Myotis mystacinus*	Crevice dweller, but may enter roof voids and fly around
Natterer's bat *Myotis nattereri*	Crevice/hole dweller; may require light-sampling areas. Frequent in crevices in timbers in old barns.
Nathusius' pipistrelle *Pipistrellus nathusii*	Crevice dweller.
Common pipistrelle *Pipistrellus pipistrellus*	Crevice dweller, but sometimes enters roof voids. Does not normally require light-sampling areas.
Soprano pipistrelle *Pipistrellus pygmaeus*	
Leisler's bat *Nyctalus leisleri*	Crevice/hole dweller. Sometimes in buildings, but unlikely to fly inside.
Noctule *Nyctalus noctula*	Hole dweller. Rarely in buildings and unlikely to fly inside.
Serotine *Eptesicus serotinus*	Crevice dweller. Depends heavily on buildings. Does not generally fly in roof voids.
Barbastelle *Barbastella barbastellus*	Crevice dweller; may require light-sampling areas.
Brown long-eared bat *Plecotus auritus*	Hole dwellers. Readily fly within roof voids. Often in crevices by day, although sometimes in the open.
Grey long-eared bat *Plecotus austriacus*	

For species that fly within roof voids, notably both species of horseshoe bats and 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 UK 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).

5.3.2 Roost entrances

Horseshoe bats generally prefer entrances they can fly through (see the Batworker's 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 should be avoided.

5.4 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 horseshoe and long-eared bats, careful attention must be paid to the design in order to provide a suitable roof void. See above 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 soffits boxes and eaves via a small gap (15-20 mm) between soffits 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 SNH 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.

Case Study 2: Glaninchiquin, Kerry, Ireland

When an old cottage with a colony of *R. hipposideros* was being renovated in south-west Ireland an adjacent outbuilding was modified to provide an alternative roost.

A maternity roost of c. 150 *R. hipposideros* was heavily disturbed in the summer of 2004 as a result of renovation works to an old cottage in Kerry in south-west Ireland. 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 to accommodate the bats. The outbuilding, which was 12m by 5m and approximately 10m from the original cottage, was roofed with slate, with an underlay of mineral felt.

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 a loft). The floor of the loft was insulated to help minimise disturbance as the owner planned to store materials in the outbuilding.

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 new roost was constructed at the end of 2004 and by May 2005, the bats had moved in. 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.

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Outbuilding at Glaninchinquin renovated to allow lesser horseshoe bats roost in the attic. Arrow indicates access point made for bats into attic space.

5.1 Timber treatment and pest control

Repair and restoration of old buildings often requires timber treatment against infestations of wood-boring insects. *In situ* remedial timber treatment with organochlorine insecticides and some fungicides is thought to be a significant cause of bat mortality across Europe. In recent years, the widespread replacement of certain toxic chemicals, such as lindane, with relatively harmless alternatives (e.g. synthetic pyrethroids) has improved the situation for bats. Nonetheless, the guiding principle is that treatment should take place at a time when no bats are present. In most situations, where bats are only present seasonally, this is fairly straightforward. Certain species, however, may be present in buildings all year round and there is no ideal solution in these cases. Advice should be sought from the SNCO.

The control of pest insects or rodents need not lead to any disturbance of bats providing it is done sensitively. Ideally any treatments would be applied while bats are not using the roost, but localised applications of insecticide powder or rodent poison is unlikely to harm bats. If the control work must be done while the bats are present and needs to be more extensive then advice should be sought from the SNCO. Extensive guidance on best practise in the areas of timber treatment and pest control is given in the JNCC's Bat Worker's Manual [www.jncc.gov.uk/pdf/batwork_manualpt4.pdf].

6. *Bridges and barns*

6.1 Bridges

Bridges are not technically buildings. However, bridges were identified by this working group as being of particular importance for 13 species of bats (see Table 1) across Europe, and old bridges, normally made of stone, regularly form part of our cultural heritage. These are subject to different types of disturbance and require different forms of maintenance to other man-made structures which might host bat roosts. Some general guidelines on the protection of bats in these structures are given here.

Bats are commonly found under bridges in small numbers. A survey of 200 known roosts of *Myotis daubentonii* in Ireland showed that 75% were occupied by 1-5 bats and only 5% held 20 or more bats. Individual bats will use crevices as small as 50mm deep and 12mm wide, but larger groups require bigger, deeper roosting sites.

6.1.1 Bridge surveys

Bat surveys of bridges require a certain degree of expertise. Likely roosts can be identified quite readily, providing there is convenient access to the underside of the bridge, but determining whether they are used by bats is not always easy. The presence of bat droppings may provide a clue, but a fibrescope may be necessary to investigate some cracks. If there is evidence that a bridge is used by bats then the national nature conservation organisation should be contacted and measures should be taken to ensure that any impact on bats is avoided, or, where this is not possible, minimised.

6.1.2 Mitigation measures

In general the bridge should be as suitable for bats after the required works as it was before. In some cases it may be possible to improve conditions for bats by incorporating specific bat roosts into the structure. As with restoration work of other structures of cultural heritage importance, timing the works to coincide with the period when bats are absent may be sufficient to avoid any impact.

In most cases, the implementation of the following mitigation measures should ensure that bridge renovation works do not negatively impact on bats:

- Careful timing of the works, especially if breeding or hibernating bats roost in the bridge
- Preserving individual roosting spaces wherever possible
- Hand pointing in sensitive areas, e.g. around crevices to be retained
- Creation of new roosts – bat bricks or boxes can be incorporated into a bridge to replace lost crevices.

Case Study 3. Bridge

6.2 Barns

Old barns play an important role as roosts for some bat species in certain countries. A study in the UK has shown that many old timber-framed barns, some dating back several centuries, are now being converted into dwellings. Briggs (2002 and 2004) found that the vast majority (77%) of converted barns have not maintained their bat species and she questions whether barns with bats should ever be converted. She looked at how bats could best be accommodated in these conversions and provides details of mitigation measures that should be built into future barn conversion designs. The features covered include :

- Species specific design
- Roost site retention
- Light pollution
- Access
- Conservation and enhancement of adjacent habitats
- Timing of the works

The reader is referred to those documents for further details.

Case Study 4. Paston Barn, England

The barn was built in 1581 and is home to a breeding colony of *Barbastella barbastellus* as well as *Pipistrellus pipistrellus* and *Myotis nattereri*. The building is owned by the North Norfolk Historic Buildings Trust, which had initially planned to turn the barn into a visitor centre for the nearby gas works before the bats were discovered. English Nature has now taken a 50-year lease on the building.

The barn has been subject to massive renovation over the last few years, including complete re-thatching, re-pointing, replacement of doors, and restoration of its associated buildings. A steering group, including BCT, English Nature, the local bat group and the buildings trust, has controlled restoration work at the site. Measures to minimise the disturbance to the bats have included timing of works out of the breeding season (though due to delays work sometimes overran), replacing doors with temporary structures while work was done off site, use of traditional materials and carrying out work by hand where possible. The roost spaces above the lintels, which were favoured by the Barbastelles, were maintained and the new doors were constructed to give continued access for the bats.

The collaboration of all parties and the sensitive nature of the works to date have ensured the continued use of this historic barn by the bats.

7. Damage and disturbance by bats in buildings of cultural heritage

Bats flying around within an occupied building can sometimes be a cause of disturbance or concern. Furthermore, bat excreta may cause damage to vulnerable objects and furnishings in buildings.

7.1 Damage by bats

Droppings, over a protracted period of time, may cause pitting, long-term staining and etching to porous materials such as painted wall surfaces, wooden monuments and stone sculptures. Bat urine (which is 70% urea) is chemically more aggressive and therefore of even greater conservation concern. It can cause spotting and etching of wooden, metal and painted surfaces.

Before any management of these situations begins it is essential to assess bat activity and its effects on the building's contents. In most cases, there are practical steps that can be taken to manage these problems without compromising the status of the bats or the cultural heritage.

In each individual case information will need to be gathered on the bats themselves, the rate of deposition and the seasons when it occurs, the area / articles being damaged and the extent of the damage. Once these assessments have been carried out an informed decision can be made on which of the following management techniques [adapted from advice prepared by the UK's National Trust] may be most usefully implemented:

- **Do nothing –** Bats may not be a problem if they occur in very small numbers or only use parts of a building without vulnerable or significant objects.
- **Moving objects –** If an object being exposed to bat excreta is freestanding, it may be possible to move it to a location with a lower rate of deposition.
- **Covers –** Covers may be appropriate when deposition is localised or if there are a few vulnerable objects. They are not suitable if deposition occurs throughout a room, as there would be a great aesthetic impact. Porous materials such as linen or natural carpet are suitable covers, however, polythene should not be used as this may create a moist microclimate around the object.
- **Coatings –** Synthetic lacquers offer some protection against bat damage and may be acceptable on historically and artistically insignificant metal and wooden objects. Natural organic coatings (such as beeswax) offer little protection against bat urine.
- **Deflector boards –** A wooden board 100-150mm wide and 1-2m long can be positioned at an angle beneath a roost or access point to deflect and/or catch any droppings. This can be useful to reduce rates of deposition in specific areas. The board can be erected during the summer and removed at other times of the year for cleaning.
- **Relocation of roosts or access points –** This has been used with some success in the past. Excluding bats from one roost site will reduce the impact in the immediate area, but may cause them to move to another part of the building and have an undesirable effect there. This can be avoided by blocking off potential roost sites first. Relocation should be considered carefully, with the relevant SNCO and local bat group being contacted for advice and permission.
- **Exclusion –** This decision, only to be taken by the SNCO, will depend upon a variety of criteria, including the value of the object at risk and the rarity of the bat species. Advice and permission should be sought from both the relevant SNCO and those responsible for the conservation of the historic artefacts. Exclusion may be difficult and expensive. The provision of an alternative roost may be required.

7.2 Disturbance by flying bats

To be developed…. !

8. *Further reading*

http://www.nationaltrust.org.uk/wildbuildings/html/roof/bats/index.htm

http://www.npta.org.uk/bats.htm

http://www.bats.org.uk/helpline/helpline_roosts.asp

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Appendix 1: Working Group members

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Appendix 3: Summary of questions on dependence of bat species on overground roost types

Number of countries with estimated dependence of bat species on overground roost types.
(dependence: high (**H**)**,** medium (**M**), low (**L**), not important (**NI**), not known (**?**), just present (**P**); combination of categories are not included so far; CH categories valid for Switzerland; **bold** are marked values of H & M dependence which sum exceeds 4)

Overground roost type / Species	Church						Castle/ Fortification						House/ block of flats (CH Buildings)						Barn / Stables						Bridge (CH Bridge/Rock)						Tree					
	H	**M**	**L**	**NI**	**P**	**?**	**H**	**M**	**L**	**NI**	**P**	**?**	**H**	**M**	**L**	**NI**	**P**	**?**	**H**	**M**	**L**	**NI**	**P**	**?**	**H**	**M**	**L**	**NI**	**P**	**?**	**H**	**M**	**L**	**NI**	**P**	**?**
		1	4	9		2	**1**	**5**	1	6	1	3	**2**	**3**	5	5	1	5	3		4	4		5			2	7		7	9	1	3	1	1	5
Barbastella leucomelas			1	1								1						1						1						1			1	1		
Eptesicus bottae				1				1					1											1				1			1	1				
Eptesicus nilssonii	1	3	4	7	1	1	1	3	3	5		2	**7**	**4**	2	2	1	2		2	1	3		5				6		7	2	1	3	2		6
Eptesicus serotinus	**9**	**5**	4	2	1		**3**	**4**	2	5	1	1	**16**	**3**	1		2	1	2	2	4	2		3		2	2	8		2		1	4	6		3
Hypsugo savii		2		7	1	2		2	1	5	1	2	**2**	**4**		3	1	2		1		3	1	5		1		4		5		1		4		4
Miniopterus schreibersii	1	1	2	4		2	1		2	5		2			3	6	1	2			1	5		3				6	1	3				7	1	2
Myotis alcathoe				4						3		1		1		3		1				3		1				3		1	1			2		2
Myotis aurascens				4						3		1	1			2		1	1			2		1	1	1		2						3		1
Myotis bechsteinii		1		11		1		1	3	7		2		1	3	7	1	3		1		8		3		1		8		4	**15**				1	3
	6	**3**	2	2	1		**2**	**3**	3	3	1	1	3	1	2	3		2	1	1		4		3	1	1	1	4	1	3			1	5		3
Myotis brandtii		2	3	8		4	3	1		7		6	**5**	**8**		4		4		2	1	4		8		1		7		8	8	1		2		6
Myotis capaccinii			1	5					2	4					1	5					1	4		1				4	1	2				4		2
Myotis cf. *punicus*				1						1					1	1					1	1					1	1						1		
Myotis dasycneme	**5**	**1**		3		2	**3**	**2**	1	3		3	**6**	**2**	1			3	2			4		4				3		7	1	3	2			5
Myotis daubentonii	1	1	4	7		4	**5**	**2**	4	2		6	**2**	**7**	4	3		4		3	2	6		7	**5**	**3**	7	2	2	5	**19**	**2**			1	4
Myotis emarginatus	**8**	**4**	1	3			**6**	**5**	1	3	1		**3**	**5**	4	2	1	1	3	2	2	3	1	3			1	7	1	5				5		6
Myotis hajastanicus				1						1						1						1						1				1		1		
Myotis myotis	**11**	**3**		1	2		**5**	**4**	2	1	1	1	**4**	**3**	3	3	1			3		5		2		2	2	5		3		1		4	1	5
Myotis mystacinus	2	2	5	6		4	**4**	**2**	2	5		6	**11**	**5**	1	2	2	4	4	1	2	3		8	1	2	1	5		10	**7**	**2**	1	2		8
Myotis nattereri	2	2	3	6		5	**3**	**3**	2	3	1	7	**7**	**5**		2	1	7	2	4	1	2	1	8	1	2	2	6	1	8	**10**	**1**	1			10
Myotis nipalensis				1						1						1						1						1						1		
Myotis schaubi				1						1						1						1						1				1		1		
Nyctalus lasiopterus		1		6				1		5		1		1	1	4		1		1		4		2				4		3	**6**				1	2
Nyctalus leisleri		1		11		3		2		8		4	1	3	5	6	1	3		1	1	7		5			1	8		5	**17**				2	4
Nyctalus noctula	3	1	3	6		3	2	1		9		4	**9**	**4**	3	1	1	2	1		1	7		6	1	1	2	5		7	**21**				2	3
Otonycteris hemprichii				1						1						1						1						1						1		
Pipistrellus kuhlii	**3**	**2**	2	6	1	1	**2**	**3**		5	1	2	**12**	**2**		1	1		3	1	1	4	1	3	2	1		5	1	3	2			4	2	6
Pipistrellus nathusii	2	2	3	8		3		2	3	7		3	**11**	**5**	1	2	1	3	2	1	3	5		6	2	1		6	1	7	**17**	**2**	1			4
Pipistrellus pipistrellus	**8**	**3**	4	4	2	1	**5**	**3**	3	4	2	3	**18**	**4**		2	3	1	**5**	**2**	4	3	1	4	3	1	4	4	2	5	**8**	**2**	3	1		6
Pipistrellus pygmaeus	**4**	**1**	4	6		3	**3**	**2**		5		6	**8**	**4**		3		6	3	1	2	1		9	2	1		5		8	**8**	**3**	1	1		8
Plecotus auritus	**12**	**5**	4	3	2	2	**7**	**4**	3	1	1	5	**10**	**8**	2	1	2	2	**2**	**4**	6	2		7		2	1	6		10	**11**	**5**	1		1	6
Plecotus austriacus	**9**	**3**	3	1	1	2	**6**	**2**	3			4	**7**	**3**	3		1	3	2	2	3	2		4		2		5		7	2	2		3		7
Plecotus kolombatovici				1						1						1						1						1						1		
Plecotus macrobullaris	**2**	**3**	1	1	2			2		1		2	1	3		1		1	1		1	2		2				3		2		2	1	2		2
Plecotus sardus				1						1						1	1					1						1						1		
Rhinolophus blasii		1	1	3				1	1	3					1	3					1	3						3		1				3		1
Rhinolophus euryale	2		1	5			1		2	5					3	5					1	7						5	1	2				6		1
Rhinolophus	**6**	**2**	4	2	2	1	**4**	**5**	4		2	1	**3**	**7**	4	2	1		2	2	5	4		1	2		1	6	1	3				11		1
Rhinolophus hipposideros	**5**	**4**	4	4	2		**7**	**5**	4	1	2		**7**	**5**	3	1	2		4		7	4	1		1	2	2	4		4			1	10		2
Rhinolophus mehelyi		1	1	5		1				5		2				5		2				5		2				5		2				7		1
Rousettus aegyptiacus				1						1						1						1						1						1		
Tadarida teniotis			1	4	1					2		1		1	1	1	1	1				2		1	1		1	2		1	1			2		1
Taphozous nudiventris				1						1						1						1						1						1		
Vespertilio murinus	1		4	6		4	1		2	5		6	**14**	**5**		1		2	2		1	3		9			1	3		9	2	1	2	3		8