THE CONSERVATION OF BATS IN BRIDGES PROJECT

A report on the survey and conservation of bat roosts in bridges in Cumbria

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March 1997

Cumbria

ENGLISH NATURE

PEOPLE'S TRUST FOR ENDANGERED SPECIES

Species recovery programme

Lake District National Park

1.0 INTRODUCTION

1.1 The Conservation of Bats in Bridges Project

The first bat roosts in bridges in Cumbria were found in the mid-1980's, but little survey work was done to find additional roosts until 1993 when the Westmorland and Furness Bat Group and the Cumberland Bat Group initiated a bridge survey in conjunction with English Nature. The survey was started in response to the increased threat to bridge roosts resulting from a major programme of bridge strengthening by Cumbria County Council's (CCC) Highways Department (see 1.3.4).

The bat groups' survey targeted bridges on CCC's annual work list, and the results were passed on to the council via English Nature (who also funded surveyors' travelling costs). Advice was given on retaining roosts and carrying out works in a sensitive manner. Training sessions for engineers were held by Erica Donnison (English Nature), Geoff Billington (Westmorland and Furness Bat Group), and Gill Hinchcliffe (Vincent Wildlife Trust). By the end of 1995, 585 bridges had been surveyed and a total of 58 bridge roosts had been recorded in the county (Table 1)(Norman, 1995; Marshall, 1996).

In spite of these efforts to conserve roosts 11 identified bridge roosts were made unsuitable for bats by maintenance works in Cumbria, either by the County Council Highways Department or British Waterways. Provisions for bats were only considered in one case. Several problems contributed to these losses, the most important being the poor liaison between the various parties. The bat groups had been unable to survey all of the bridges on the work lists, work lists did not include all bridges that would be worked on, and some bridges that were surveyed and reported to the Highways Department were still damaged. The crevices in one bridge were filled in despite several site visits by bat workers and an English Nature representative (Billington, 1996). After discussions between CCC, English Nature, and the bat groups, the following requirements were agreed:

> Training should be provided for highways engineers in how to deal with bridges with potential or confirmed bat roosts.
>
> All bridges should be surveyed before works are carried out.
>
> Liaison between the Highways Department and the other parties should be improved.

The best way to carry forward these objectives was to fund a short-term project, with two bat workers employed to conduct a survey of all county road bridges and to train appropriate council staff. Grant applications were made in early 1996 and grants were received from Cumbria County Council, English Nature (Species Recovery Programme), English Nature (Cumbria), The Lake District National Park, and The Peoples Trust for Endangered Species. The Conservation of Bats in Bridges (COBIB) Project started on the 24th June 1996 and ran for seven months.

Publicity for the project was achieved through a local BBC television news item, which later appeared on the national news and Newsround, local newspaper articles (*eg*. Kermode, 1996), and a poster at the National Bat Conference. A press release was prepared at the end of the project.

1.2 Bats in Britain

There are 15 resident species of bat in Britain. They are all members of the sub-order Microchiroptera and are strictly insectivorous. Despite a lack of historical documentation it is known that there has been a decline in the numbers and distribution of some species (Stebbings, 1991). This decline has been attributed to habitat degradation (largely through agricultural intensification), the widespread use of pesticides, persecution, and the incidental destruction of roosts (*op. cit.*). Due to the apparent decline and numerous threats that they face, bats and their roosts received legal protection in the United Kingdom under the **1981 Wildlife and Countryside Act** (as amended). A summary of the protection they receive under this act is given in Appendix I, section 1. Bats receive protection under the following international agreements:-

> **The Bern Convention** - all bat species except pipistrelle (*Pipistrellus pipistrellus*) appear on Appendix Two (which requires special protection for all listed species).
>
> **The Bonn Convention** - all bats are listed on Appendix Two, and agreements are set up between member states to protect Appendix Two species. The agreement on the Conservation of Bats in Europe came into force in 1994 and aims to protect bats and their habitats, co-ordinate research, and increase public awareness.
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> **The Habitats and Species Directive 92/43/EEC** - gives all bat species strict legal protection but specific sites, known as Special Areas of Conservation, will only be designated for the four rarest species.
>
> **The Convention on Biological Diversity - The UK Action Plan** - Individual action plans have been drawn up for the conservation of three bat species: greater horseshoe bat (*Rhinolophus ferrumequinum*), greater mouse-eared bat (*Myotis myotis*), and pipistrelle.

1.2.1 Bats in Cumbria

Bat species diversity in Britain declines with rising latitude and Cumbria has only seven resident species, all of which are members of the family Vespertilionidae. Their status in Cumbria has been summarised by Hewitt (1996(a)) as follows:

Pipistrelle (*Pipistrellus pipistrellus*) and brown long-eared bat (*Plecotus auritus*) - common and widespread.
Whiskered bat (*Myotis mystacinus*) and Daubenton's bat (*M. daubentonii*) - widespread
Natterer's bat (*M. nattereri*) and noctule (*Nyctalus noctula*) - widespread but local.
Brandt's bat (*Myotis brandtii*) - probably widespread but very local.

1.2.2 Bat lifestyles

In high latitudes bats' lifestyles are governed by seasonal weather conditions. Bats are nocturnal and their insectivorous diet means that there is little or no food available when night-time temperatures drop below the level needed for insects to fly (although species which glean prey may still be able to feed). Bats cope with these unfavourable conditions by going into a state of torpor, slowing their heartbeat and dropping their body temperature to that of their surroundings (ambient). In this condition they can survive for long periods without feeding, provided they have sufficient fat reserves. The extended period of torpor during winter is referred to as hibernation. Low air movement and stable temperatures, generally in the range 0-10° C, are required for hibernation (Stebbings, 1991). In the spring bats arouse more frequently as night-time temperatures rise and their insect prey becomes more abundant.

Mating can occur from autumn through to spring, and in late spring the females ovulate and become pregnant using stored sperm. For rapid development of the foetus and growth of the young bat high roost temperatures are required. The female bats gather together into large groups known as nursery or maternity colonies where the combined heat of the bats and roost characteristics such as aspect and material of construction provide the necessary conditions. Most males roost separately from the nursery colonies at this time, either singly or in small bachelor groups (Stebbings, 1991; Swift, 1996). These male roosts are often found in cooler sites where the bats can enter torpor and thereby reduce the need to feed.

The gestation period varies according to weather and feeding conditions. The young bats are usually born in late June or early July and are weaned in about five weeks. In the greater horseshoe bat a second wave of births can occur in August, possibly as a result of spring matings (McOwat, pers. comm.).

When the nursery colonies disperse the males set up mating territories which some species, *eg.* pipistrelle and noctule, advertise with loud social calls. They attract harems of females, and mating continues into the winter as the bats seek suitable sites for hibernation with the onset of cooler temperatures.

Bats require different roost conditions with the changing seasons. Although these varying conditions may occasionally be found in one site, they often make local movements, or sometimes even short migrations, between summer roosts, hibernacula and transition roosts (Stebbings, 1991).

1.3 Bats and bridges

1.3.1 Roosts

Many bridges have suitable roost crevices for bats and offer safety, stable temperature conditions, high humidity, nearby drinking water and feeding areas, and access to linear habitat features used for commuting. A large number have been recorded as roost sites in Britain and Ireland (see Table 1), and bats also roost in bridges in Texas (Keeley, pers. comm.; Childs, 1996) and California (McCabe, 1996).

The cool, stable conditions found in many bridge crevices are ideal for bats roosting in spring and autumn, and males in summer, when bats may wish to enter daily torpor. Nursery roosts in bridges are presumably heated by the sun due to a southerly aspect or close proximity to the road surface, by the clustering of large numbers of females, or a combination of the two. Bridges with deep crevices may also offer good hibernation sites if they are sufficiently isolated from external temperature fluctuations. Partially blocked arches appear to be particularly suitable as hibernacula.

All bridges can provide suitable night roosts for resting, eating large prey, or socialising and male pipistrelles use bridges as mating stations (Rydell *et al.*, 1994; Russ, 1995). Male bats defending a territory around a bridge have access to large numbers of bats feeding along the linear features and to bats that are using these features as commuting routes (*op. cit.*).

1.3.2 Associated habitat

Foraging Vespertilionid bats have been shown to strongly select all fresh water habitats and woodland edges and openings (Walsh *et al.*, 1995). This is supported by many observations and is attributed to the high insect densities found in these habitats.

While feeding and commuting to and from roosting and feeding sites bats often choose to fly along linear landscape features such as woodland edges, hedges, and watercourses (Limpens & Kapteyn, 1991). These features are believed to provide protection from predation, good feeding opportunities, and an aid to navigation (*op. cit.*). The National Bat Habitat Survey (Walsh *et al.*, 1995) also emphasised the importance of linear habitats. It was suggested that feeding opportunities and cover were the most important factors influencing this choice of habitat, based on the avoidance by bats of linear features without one or both of these characteristics *i.e.* stone walls and fragmented hedges (*op. cit.*).

The importance of the riparian environment to bats has been reviewed by Racey (1996). In this review he concluded that bat roosts are concentrated in buildings and bridges in river valleys; Daubenton's bat, pipistrelle, noctule, and whiskered bat have a strong association with water bodies when feeding; and pipistrelles use bridges as mating stations.

Many features that bats find attractive are concentrated in river valleys, including broad-leaved woodlands, buildings and watercourses. As the majority of bridges are located in river valleys and all are found at the intersection of two linear features, it is likely that they are a key feature in the landscape for bats; especially if they also provide roosting crevices.

1.3.3 The occurrence of bridge roosts in Britain and Ireland

In order to determine the frequency of bridge roosting in bats in Britain a literature search was carried out and a letter requesting records was sent to the group contact of all 90 local bat groups. Responses were received from 44 groups.

In many counties, where extensive surveys have not been conducted, small numbers of bridge roosts are known. These have been discovered in the course of other bat surveys, by following up reports from the public and bridge engineers, or during ad hoc bridge surveys which are often in response to threats such as bridge strengthening.

Large scale surveys have been carried out in North Yorkshire (Roberts, 1989), Eire (Smiddy, 1991; McAney, 1992), Fife (Smith & Altringham, 1988), Angus (Swift, 1990), NE Scotland (Pritchard, pers. comm.; Speakman *et al.*, 1991), Durham (Durham Bat Group, unpub.), and Northern Ireland (Rendell, pers. comm.), and on a number of canals in England and Wales (Richards, 1992). The number of roosts found in these surveys is shown in Table 1, and compared to the results from the voluntary bridge survey in Cumbria carried out prior to this project.

Table 1: Large scale bridge surveys in Britain and Ireland

Area of survey	Number of bridges surveyed	Number of roosts	Percentage of bridges occupied
North Yorks	306	25	8%
Canals in England,Wales	315	11	3.5%
Angus	73	1	1.4%
SW Ireland	364	51	14%
Nthn Ireland	200-300	not known	3%
Fife	90	0	0%
Durham	48	8	16.7%
Cumbria	585	58	10%
NE Scotland	67	1	1.5%
NE Scotland	72	2	2.8%

NB Data from tunnels (>50m long) excluded from canals results.

Accuracy is likely to vary widely between and within surveys due to variations in equipment and techniques used, survey effort, and the experience of the surveyors themselves. Some survey data includes bridges confirmed as roosts by evening visits. These results do however suggest a wide variation in bridge occupation rates between different geographical areas.

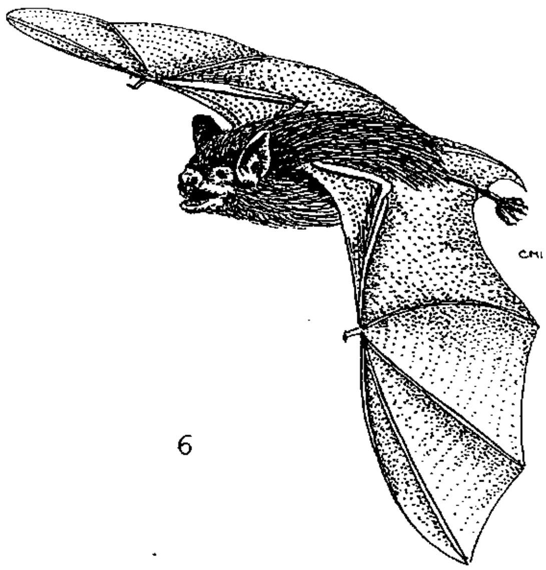
1.3.3.1 Daubenton's bat

The majority of bats identified to species in bridge roosts have been Daubenton's bats and several authors have suggested that bridge roosts are of great importance to this species. Roberts (1989) considered that bridges were the most important roost site for Daubenton's bats in North Yorkshire, and McAney (1992) states that in Eire, where over 200 Daubenton's roosts are known, this species roosts almost exclusively under bridges. In Cumberland ten of the 18 Daubenton's roosts known at the end of 1995 were in bridges (Norman, 1996).

Most bridge roosts appear to have very small numbers of bats but some support large numbers of Daubenton's bats (bat group responses). 12 records of between 20 and 100 Daubenton's bats using bridges were reported, and one bridge in North Yorkshire has a maximum count of 132 (Oxford *et al.*, 1996). In addition McAney (1992) stated that 5% of bridge roosts in Eire held over 20 bats.

Roosts of this size may be nursery roosts or roosts where female bats gather before moving on to a nursery roost, but Daubenton's bats are known to form large associations of male bats in summer and autumn (Swift, 1990; Swift 1996). The bats occupying a roost should therefore be closely examined before recording the roost type. Swift (1996) stated that male Daubenton's bats in her study area in Perthshire were found roosting in bridges and lade (millstream) tunnels, and Schober and Grimmberger (1989) state that small groups of males are often found in cracks under bridges in summer. Most bats caught on emergence from bridge roosts in Cumbria have been males, and at one bridge roost used by females the bats are not present during the nursery period.

Two intensive studies of Daubenton's bats have found that nursery roosts occur predominantly in trees (Nyholm, 1965 quoted by Speakman, 1991; Childs, pers. comm.), and Schober and Grimmberger (1989) also state that nurseries are principally in trees. Buildings are also frequently used as nurseries, and Swift (1996) found two nursery colonies in buildings and one in a tree. Norman (1996) reported that of 15 known summer roosts in Cumberland four were in buildings (at least two nurseries), one in a tree (nursery), and ten in bridges (status unknown). Although a small number of nursery roosts are known from bridges both in Cumbria and from other parts of the country, it would appear that for Daubenton's bats bridges are most important as transitional roosts and male summer roosts, probably due to the cool temperatures likely to be found in bridge crevices.



1.3.3.2 Natterer's bat

Natterer's bats have been frequently recorded in bridge roosts in previous surveys in Cumbria, and other counties with records include; Cork, Waterford, North Yorkshire, Perthshire, Oxfordshire, and the Isle of Wight. Two of these counties only have records of hibernating bats in bridges. Swift (1996) reported that male Natterer's bats in Perthshire chose bridges and tunnels for roosting, and nursery colonies occurred in warmer sites, particularly buildings. Schober and Grimmberger (1989) state that both individuals and nurseries are found in cracks under bridges. Two bridge roosts in Cumbria have had large numbers (40 and 100) of Natterer's bats but it is not known how the bats are using these sites, and most roosts are of much smaller numbers.

1.3.3.3 Other species

The following species have also been identified using bridges as day roosts (bat group responses; previous survey data from Cumbria): whiskered bat, pipistrelle (three records of over 20 bats), noctule, brown long-eared bat, and lesser horseshoe bat (*Rhinolophus hipposideros*). Most reported roosts are in the arches of stone bridges although brick, concrete, and even steel bridges can have roosting bats. Bats have been found roosting in bridges in all seasons.

Unusual roosting situations have included up to 21 pipistrelles hibernating in hollow concrete beams in a large road bridge (McOwat, unpub.), 17 lesser horseshoe bats also hibernating in a hollow in a concrete bridge (Richards, 1992), and pipistrelles roosting between the steel track bed and steel stress plates of a railway bridge (Briggs, pers. comm.).

1.3.4 Threats to bridge roosts

Bridge roosts are threatened by unsympathetic bridge repair, maintenance, strengthening, and demolition (see 5.1). Most roads and their associated bridges are owned and maintained by the appropriate county council, but the Department of Transport (DoT) owns all motorways and trunk roads. These roads are generally maintained by the local county councils, but the maintenance contracts for some trunk roads (*eg.* A69) have been awarded to private organisations and more are set to follow.

In 1987 the DoT announced a 15 year rehabilitation programme to bring all of its structures up to current standards (DoT, 1995). Bridges are being strengthened to carry lorries up to the European Community limit of 40 tonnes by the end of 1998, and upgrading will be completed by 2002/03 (*op. cit.*). However, in Cumbria at least, this programme is underfunded and without an additional injection of funds from the government the work will continue well beyond the deadline. County Highways departments generally follow DoT guidelines for trunk roads in the maintenance of county roads, and this means that many county roads are also being strengthened. Bat roosts in bridges are therefore at increased risk of disturbance and destruction for the duration of these strengthening works. The information gathered during this project is intended to minimise this risk, and encourage cooperation between engineers and conservationists to conserve the bats that roost in bridges.

2.0 METHODS OF SURVEY

2.1 Bridge location and targeting

Road bridges were located using County Council lists and maps (bridges, culverts, and tunnels are jointly referred to as bridges throughout this report). Other bridge types were located using 1:50,000 Ordnance Survey maps by looking for bridge symbols and points where railways, tracks, and footpaths crossed watercourses. Many extra bridges were found adjacent to targeted bridges and in the course of travelling between bridges. Initially only road bridges and examples of other bridge types that were adjacent to road bridges were surveyed, but as the project progressed the following types were also targeted; stone footbridges, private tracks, disused railways, and a sample of live railways. The following bridge types were excluded from the survey; most piped culverts, bridges over live railways, bridges over motorways, and bridges carrying motorways whose construction types were quickly found to have no potential for day-roosting bats *i.e.* concrete box.

Bridges appearing on the 1996 works list were prioritised for survey to enable appropriate advice to be given before works were carried out.

2.2 Survey method

The whole bridge structure was inspected with a strong narrow-beamed rechargeable torch to locate any crevices and constructional joints and assess their suitability for bats. Where necessary wellingtons, thigh waders, or chest waders were used. Automatically inflating life jackets were worn in deep or fast-flowing water, and fluorescent jackets were worn on highways. Survey forms were completed for each bridge, an example of which is shown in Appendix II. The survey and recording methods are adapted from those recommended by various workers including Mitchell-Jones (1989), Hinchcliffe (unpub.), and McAney (1992). Where bridges required close inspection before works the Highways Department arranged for scaffolding to gain access to the bridge surface, and a fibrescope to examine deep crevices. These methods, and dusk surveys, are described in more detail in Appendix III.

2.2.1 Bridge grading

Bridges were graded according to the presence or absence of crevices considered suitable for bats to use as day roosts:

- 0 No crevices with potential for day roosting
- 2 Possibly suitable for day roosting (indicates uncertainty about suitability of crevices)
- 4 Crevices suitable for day roosting
- 5 Evidence of bats using the site for day roosting

Grade two was used in cases where it was impossible to predict with certainty whether a crevice would be suitable for bats to use. Previous survey work in Cumbria suggests that any crevice greater than 100mm deep and sheltered from the elements should be regarded as a potential bat roost. This is supported by studies on bats in bridges in Texas (Brian Keeley, pers. comm.).

During the voluntary survey bridges were graded zero, one, two, three, four, or five, with a zero indicating no potential for bats and five indicating evidence of bats using the bridge. This grading was felt to be over-complicated and was simplified for this survey (see above). A more simple grading of zero, one, two, or three was not used in this project because the Highways Department was accustomed to a six point grading, and based its management of bridges, with respect to bats, on these grades. Future surveys should use zero to three as grades.

The survey forms included recommendations for bridge engineers (see Appendix II), which were based on the bridge grading and other details on the form. Where bats were confirmed or felt likely to use crevices engineers were recommended to arrange a bat survey before works, and if crevices were only possibly suitable for bats the engineers were recommended to retain the crevices, and contact English Nature if crevices could be affected by works. Bridges graded zero could be worked on without a further survey.

2.2.1.1 Evidence of bat presence

If evidence of bats was found full details were entered onto the survey form. The following were considered to be evidence:

1. Bats visible - number and species recorded where possible.
2. Bats audible
3. Staining - where sites are heavily used by bats the stonework around the roost entrance may become stained with oil from the bats fur. Scratches on the stonework and stonework worn smooth by the passage of bodies were also used as evidence where this was attributable to bats rather than roosting or nesting birds.
4. Droppings - bat droppings in crevices, stuck to walls below suitable crevices, and on the ground below suitable crevices, were taken as evidence of bat roosts. Number and location of droppings and, if possible, species were recorded. Where small numbers of droppings were found scattered on the ground under spans and not underneath crevices the bridge was recorded as a flight route. Night roosts were recorded where concentrations of droppings and/or feeding remains were found (indicating stationary bats) and no suitable day roosting crevices were visible above the droppings.
5. Bat-fly *(Nycteribiidae)* pupae - these flies are parasitic on bats. Three species have been recorded in Britain and they are virtually host specific (Mitchell-Jones, 1987). Daubenton's bats are the host of *Nycteribia kolenatii* (Speakman, 1991). The other bat-fly species recorded in Britain are found on horseshoe bats (*Rhinolophus*) and Bechstein's bat (*Myotis bechsteinii*) (Stebbings, 1991; Ransome, 1991), neither of which occur in Cumbria. The presence of bat-fly pupae can therefore be regarded as evidence of a Daubenton's bat roost. The pupae are found attached to the stonework where the bats roost and are fairly distinctive if seen. Previous workers have searched for these during bridge surveys (Roberts, 1989; Mitchell-Jones, 1989).

2.2.2 Bridge details

Bridge name, owner, maintainer, road number, and highways area were obtained from council lists for council owned bridges, and a variety of other sources for bridges not owned or maintained by the council. National Grid References, vice-county, altitude, and watercourse name were taken from 1:50,000 Ordnance Survey maps. Other bridge details (see Appendix II) were recorded from field observation. Measurements, *eg.* arch height, watercourse width, were estimated. Arch height was recorded as the maximum height, from water level, of the highest arch on the bridge. All survey forms include a diagram which gives a general impression of the bridge structure, and highlights positions of bat roosts, suitable crevices, areas of damage, etc. The terminology for the various parts of a bridge are summarised in Appendix IV.

2.2.3 Habitats

The presence or absence of 12 habitat types (see Appendix II) was recorded for 50 metres upstream and downstream of the bridge and ten metres from each edge of the bridged feature. Up to two habitats could be highlighted as dominant habitats. Habitats were recorded to enable conclusions to be drawn about the selection of bridges by bats based on the presence of feeding grounds, commuting routes, and alternative roosts.

2.2.4 Other species

Other species associated with bridges were recorded. These include bird species which nest in or on bridges *eg.* dipper (*Cinclus cinclus*), mammals which use bridge structures to leave territorial signs *eg.* otter (*Lutra lutra*), and invertebrates which spend at least part of the year in bridge cavities *eg.* drone fly (*Eristalis tenax*). Many invertebrates can be found sheltering in bridge structures, notably moths, snails, slugs, woodlice, caddis flies, spiders, and harvestmen, but only those that were readily identifiable by the surveyors were recorded systematically. Many plants can be found growing on bridges but these were not recorded in a systematic fashion.

2.3 Data handling

Completed survey forms were copied and sent to bridge owners and/or managers. One complete set was retained by the surveyors and handed to English Nature (Cumbria) at the end of the project. Data from the forms were entered onto a database written on Microsoft Access for Windows 95, at the Lake District National Park Headquarters, Murley Moss, Kendal.

Records of bats and all other species recorded on the survey were also forwarded to the Tullie House Museum and Art Gallery, Carlisle, for entry onto their RECORDER database.