5.0 ROOST CONSERVATION

5.1 Constructional methods that may affect roosts

In the past bat roosting sites (crevices/holes) have been lost during maintenance/strengthening works. Engineers have been hesitant to retain voids for fear of creating weaknesses or water entry points.

Holes in stonework and concrete are infilled by pointing (with concrete mortar), spraying (with gunite or shotcrete concrete) or pressure injection (with cementous grout). Any of these processes may fill roost crevices and prevent access to other cavities within the bridge - this may entomb any bats roosting in deeper crevices. Roberts (1989) stated that roosts were in most danger from major strengthening works.

High pressure water can be used to clean out stonework prior to pointing/grouting - this may crush or drown roosting bats. Spandrel walls can drift apart requiring deep grouting, rebuilding or bolting together.

Steel girder bridges (which support wood, steel or concrete spans) have to be regularly painted to avoid corrosion. This often entails shot blasting to remove old paintwork and bats roosting in abutments, steelwork, or woodwork are at risk from disturbance or being killed if they are not using very deep crevices.

Some bridges have to be 'saddled' - the entire bridge is excavated down to the arch stones from the road surface and then infilled with reinforced concrete. This is likely to affect most roosting holes - especially the deeper ones. Bats present may be crushed or made to quit their roosting site.

Bridges that are beyond viable repair may have to be demolished, or reinforced by infilling beneath the bridge, ending up with sloping embankments on either side, up to approximately deck level. This method has been used on several road bridges over disused railways in Cumbria. All crevices will be lost with the exception of the parapet walls above deck level.

5.2 Roosts threatened and destroyed

In Cumbria we know of eleven bridge roosting sites that have been destroyed - Barth (Dent), Barley (Staveley), Blackpool Gate (Bewcastle), Crooklands (Crooklands), Croglin (Kirkby Stephen), Crow Park (Natland), Dent Church (Dent), Millness (Crooklands), Petteril Crook (Wreay), Rawthey (Sedbergh) and Stock (Appleby) Bridges. The only roosting site that has been recreated is at Kirkby Stephen Station/Croglin Bridge Cumbria, which was used by small numbers of two or three species of bat and one species of bird. Infilling has been carried out and roosting crevices have being lost. As a mitigating measure crevices have been recreated (see 6.4.1 and Appendix VII). Barth Bridge was an unusual case as a detailed works plan was drawn up to ensure bat roosting crevices were retained and any bats present were excluded prior to the repair works starting. A survey was carried out from scaffolding with a number of bat holes being

clearly marked for retention and agreed with an engineer. A dusk exclusion of one bat was made just before works started at the beginning of June 1995. A follow up survey revealed that most of the holes had been filled in.

A number of roosting sites in abutment stonework beneath steel or wood spans are threatened by the requirement for frequent maintenance works.

Briggs (pers. comm.) reported the accidental poisoning of pipistrelles roosting in the steelwork of a railway bridge over a canal in Hertfordshire. The bridge was sprayed with herbicide from a train, and 24 dying bats landed on canal boats beneath.

In Angus (Smith and Altringham, 1988) the roads department contacted the bat group when a large colony of bats was found during repair work. Nature Conservancy Council employees were on the spot quickly to find many of the bats had already been killed.

Cefn Coed y Cymmer Bridge, Glamorgan, which was a pipistrelle hibernation site had to be demolished (McOwat, unpub.).

5.3 Survey requirement

In Cumbria 23.5% of suitable bridges surveyed (grades four and five) were confirmed to be bat roosts, and roosts occurred up to 450m a.s.l.. Roberts (1989) reporting on the North Yorkshire bridge survey concluded that any bridge over a clean river in favourable habitat will be used by bats. Bridge surveys before maintenance and strengthening works are therefore of great importance for bat conservation in the U.K..

5.3.1 Baseline surveys

To conserve roosting sites ideally a full survey of all potential bridges should be undertaken by suitably trained and equipped surveyors. Individual site records should be copied to the relevant statutory nature conservation organisations (SNCO's) (see Appendix I, section 5) and maintenance bodies (listed in Table 5), who should also be issued with guidelines and training. Difficulties are experienced in surveying some sites properly either because of the height of the structure, or the presence of deep or fast moving water or deep mud - some bridges are affected by tides. Bats can be found in any type as well as virtually anywhere on a bridge.

In Texas, USA, bridges housing bats are often large modern concrete structures spanning water, roads and/or railway lines. Large colonies have been found roosting in culverts. Congress Avenue Bridge houses an estimated 1.5 million Mexican free-tailed bats (*Tadarida brasiliensii*) and Mcneil Bridge has 600,000. The Bat Conservation International (BCI) Bats and Bridges Project has surveyed over 1060 bridges with principle roosting sites occurring in expansion joints, blocked drain pipes and on the walls of culverts (Keeley, pers. comm.). Cave bats (*Myotis velifer*) are also found in bridges, particularly in culverts and drain pipes (Childs, 1996).

5.3.2 Future survey requirements before works start

Before any works commence on a site that has suitable holes for bats (as determined by a trained surveyor) a detailed survey should be conducted. If crevices are very deep a fibrescope will be required to ensure all possible sites are checked. Ladders, scaffolding or a hoist may be required to gain access to all parts of the bridge. These are often necessary for contractors to carry out the works. In some cases bridges cannot be surveyed fully until scaffolding is erected to start works. If there may be a bat roost present then request it is put up in advance (*eg.* two weeks before) to allow for surveying the site properly - **but if bats are found then works may have to be postponed if young are present (June - August) or hibernating bats are found in winter (November - April).** This demonstrates the need for a baseline survey to indicate the likely season of use by bats.

5.3.3 Recommended action to ensure procedures run smoothly

Bridges have to be regularly inspected (every two years) and to carry out these engineers sometimes have to use access equipment to get close enough to be able to touch stonework. Assessments are made of their weight carrying capacities. Bat surveys could be usefully combined with inspection programmes.

All holes that need retaining should be clearly marked, and a site meeting held with the engineer and contractor to discuss requirements and resolve problems arising between engineering constraints and accommodating the bats. Problems can arise in retaining holes that lie in straight lines, clusters, or around critical stones, *eg.* outer arch voussoir ring stones, as these may create unacceptable lines of weakness. In such cases alternative bat access into areas of the bridge where it causes no problems should be created.

5.4 Maintenance and strengthening works

5.4.1 Planning

By identifying sites at an early stage discussions can be conducted with the contract organiser to determine the best timing of works to minimise disturbance to any bats or birds using the site. This should help to prevent contractors having to be laid off if bats or nesting birds are found. With contract agreements this could be very costly, *eg.* at Rash bridge (Sedbergh) Cumbria, contractors were put off for several days until the bat situation had been resolved. The more that is known about how bats use a site the easier planning of works becomes. Forward planning will often result in little or no extra cost to the contract to enable bat roosts to be retained. Any proposals should always be included in contracts to ensure the contractors are under an obligation to carry out instructions. Any opportunities that arise to improve sites for bats and birds should also be considered (see section 6).

Selecting the timing of works will vary depending on how the bats use the site. Some sites can be used throughout the year by bats, but only a small percentage are suitable for year round

occupation. A number of bridges are swamped by flood water and are only suitable for habitation from May to September.

It is believed that few sites offer sufficient depth of crevices to give bats the temperature stability they require for mid-winter hibernation (see 1.3.1), but further study is required to confirm this.

Nursery colonies either require sites that sustain high enough temperatures or there are crevices of sufficient size for the bats to cluster together. Only a few sites have been confirmed to be maternity colonies. It is important to ensure that maintenance bodies know where these are.

During night surveys of two bridges in Cumbria - Bouthray (June 1996) and Beckfoot (August 1994), Natterer's bats entered at dawn roosting in deep crevices. There were no visible signs of the bats after they had entered except for staining on the stonework at Bouthray Bridge (the number of bats and time of year suggest this is a nursery roost). Natterer's bat colonies appear to seek deeper crevices making it difficult to identify the sites they use and to determine their importance.

A number of bridges are used as male mating stations discernable by the low frequency calls (see 1.3.1 and Appendix III). Mating groups of bats may be present in September or October (and possibly in April, May, August, or November).

Bird nesting sites (of at least ten species) were encountered in about 12% of Cumbria's surveyed bridges. As all occupied bird nests are protected this may preclude works being carried out for several weeks anytime between February and August, depending on the species present (see Appendix I).

5.4.2 Bat (and bird) occupation in bridges for guidance in planning works

April - May
Limited work in Cumbria has suggested this could be a significant bat occupation period in bridges. Richardson (pers. comm., quoted in Richards, 1992) observed that bat activity on canals in Northamptonshire peaked in May/June and again in September. These periods of peak bat activity are when the highest abundance of insects occurred.

April - July
Main period when nesting birds may be present - advance surveys will identify most sites.

June, July and August
Nursery colonies of bats may be present and birds may still be nesting.

September and October
Greatest bat occupation of bridges found within the COBIB survey period (June - December). Dispersed maternity colonies, non-breeding groups, and harems may be present with widely dispersed males using sites as mating stations. In two bridges bats were found to take up residence in the same holes in which birds had nested during the same season.

November - March
Small numbers of mainly Natterer's bats were found in November. Very few surveys have been carried between early December and March. A number of bridges and culverts appear to be suitable as hibernation sites. Some bird species begin to nest in February.

5.4.3 Timing of works

General guidelines for timings of works are shown in Figure 1. The suggested acceptable periods of work discussed here should only be considered as a guide, weather conditions and different habitation patterns will influence the final optimum timing.

If a site has very deep holes and cannot be surveyed properly in advance of works (due to access problems) it should be considered to be used the year round by bats. So works should take place during **October**. Scaffolding should be erected two weeks in advance of works being started in case bats need to be excluded (see 5.4.1). If birds are not present then works could also be carried out in **April** and **May.**

Prior knowledge of how bats (and birds) are using sites will in most cases greatly extend the potential safe working periods.

5.5 Repairs to bridges that contain bat roosts

5.5.1 Bat exclusions

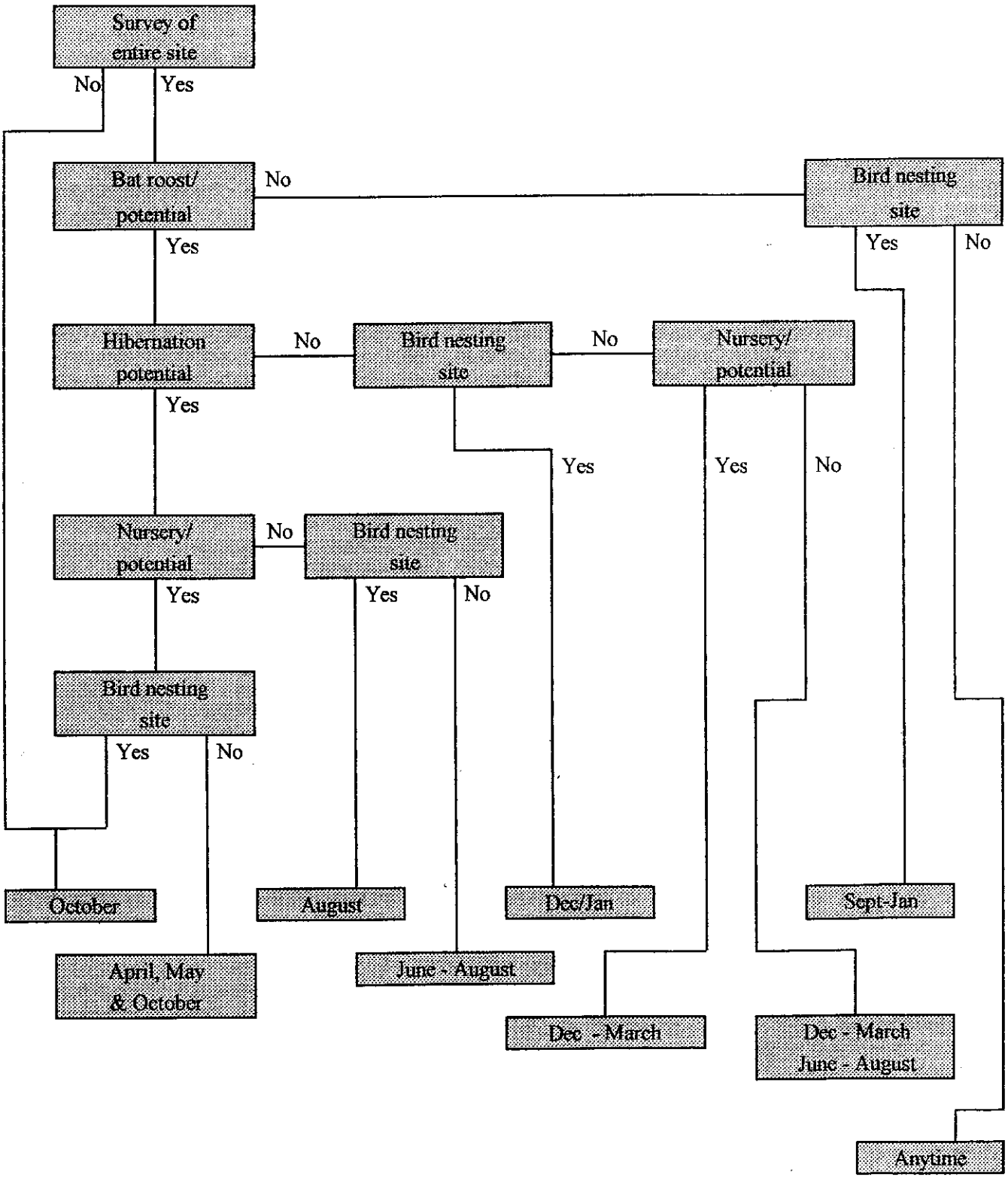
Even with the best pre-planning bats can still be present when works are due to start. Exclusions may have to be carried out to ensure the bats are out of harms way. This involves temporarily blocking them out of their roosts. This is usually acheived by stuffing newspaper into holes after they have emerged at dusk. Tubes and polythene funnels have been used (outside of Cumbria) to allow bats to emerge but not return (see 5.5.2.2). Noise caused by repair works or preparations may actually drive bats deeper into holes making them more difficult to notice.

If bats have to be excluded from a complete structure then a temporary roost could be constructed as close to the site as possible, duplicating the dimensions of the original crevices (this has never been tried and is suggested as an added precaution in case there is no other roosting site nearby). This would need to be put in place as soon as possible to allow bats sufficient time to find it. A shelf fitted beneath the artificial roost would indicate if bats had started to use it. The roost may need protecting from interference from the public or predators with temporary fencing or screening (see section 6).

In conclusion bats may need careful exclusion by licensed specialists. The timing of work is critical seasonally and time taken to effect exclusion will be variable depending on circumstances.

To be able to visit bat roosts, handle or exclude bats a licence is required from the relevant statutory nature conservation organisation (see Appendix I, section 5).

Figure 1; Flow chart to determine timing of works



5.5.2 Case histories and procedures

5.5.2.1 Examples in Cumbria

Barth Bridge
A single arch stone bridge with low flood inverts. Major re-pointing and pressure grouting was scheduled for May 1995. Bat signs were discovered in September 1994. Scaffolding was erected two weeks ahead of works to take account of any bats present. A detailed survey was carried out using a fibrescope and several bat holes were identified and marked. A site meeting was held with the engineer. A further survey and exclusion (by stuffing holes with newspaper after emergence and removing one Daubenton's bat), was carried out at the beginning of June, but due to contractors not following instructions most of the holes were lost (Billington, 1996).

Calthwaite Bridge
A single arch stone bridge. Re-pointing works had started when residents contacted the bat group over a bat roost that was present, and at least 12 Daubenton's bats were found (Hewitt, pers. comm.). Several holes were retained and bats were noted at the site again in 1996.

Lorton Low Bridge
Double arch stone bridge hand pointed in September 1996 (up to 6 Daubenton's bats recorded here). A fibrescope survey was carried out, holes were marked with waterproof crayon with the contractor present, and an exclusion was carried out from scaffolding on 18th September 1996. Bat holes were retained.

Low Fields Bridge
This low single arch bridge was hand pointed in 1996. A number of crevices that droppings had been found under and a selection of others were retained.

Mill Beck Stock Bridge
In 1996 it was necessary to remove a concrete slab bridge that was built alongside a stone arch. Bats used crevices in the stone bridge close to the joint with the concrete slab. A fibrescope survey confirmed that no bats were present so holes near the joint were blocked with newspaper for the duration of the works. All bat holes were preserved.

Rash bridge
Double arch stone bridge in which the main roosts of Daubenton's (12) and Natterer's (3) bats are situated in the northern arch. Major re-pointing and pressure grouting works were carried out in 1994 and 1995. Works were delayed after bats were found. A fibrescope survey was carried out on the southern arch from scaffolding. Several bat holes were marked and successfully retained (October 1994), some more than 700mm deep. Works were delayed on the northern arch until May 1995 (in case hibernating bats were present). Holes were surveyed with a fibrescope and marked. Problems arose as some of the bat holes extended upwards for almost one metre. English Nature contracted an independent engineer to produce a report on retaining deep crevices (Turner, 1995 - see Appendix VII). Two methods were discussed:

1. To excavate a section of the arch from underneath (whilst supporting the bridge on acrow props), set stainless steel anchors into the stonework, then spray seal the rear of the hole with shotcrete (mortar with carbon reinforcing particles), coating it with a plain mix to cover up the sharp protruding reinforcing particles. The stones could be reset with a combination of anchors and `spot' pointing (alternate sections of mortar and gaps) - retaining the structural integrity of the bridge and full depth crevices leading back into a narrow void.

2. To excavate down from the road surface to the arch and fit a concrete `tray' over the arch crevices.

A different method was actually chosen by the engineers. They decided to carry out restricted grouting of areas where there were bat holes. This was done by `ring grouting' where the area around the holes to be kept was only grouted at three bar pressure (up to nine bar may normally be used), and when any grout emerged from bat holes pumping was stopped. Once the bat holes area was completely grouted standard pressures could be resumed elsewhere. This was successful in retaining the full depth of holes (confirmed with a fibrescope afterwards). Before works were carried out on the northern arch several bats had to be excluded. After the bats had emerged at least 180 holes were blocked up with newspaper and the deeper holes were opened and reblocked over the next three nights in case any bats were trapped inside (none were). Daubenton's bats were observed at the bridge in 1995 but the Natterer's bats do not seem to have returned (Billington, 1996).

Rosgill Bridge
A triple arch stone bridge that had major hand pointing works carried out in September 1996. The contract had been delayed because bats were found in the bridge in early summer. As works progressed across the bridge a fibrescope survey identified the bat holes which were marked and retained along with a selection of others. Bats were excluded by blocking up holes with newspaper after they had emerged.

5.5.2.2 Outside Cumbria

Angus
In Angus, in 1989, two large bat holes over one metre deep were retained during repairs to a bridge. The following year bats were found to be using the site again (Pritchard, pers. comm.).

Ardachy Bridge, Inverness
This stone arch bridge was found to have at least 12 Daubenton's bats in July 1994 (a maternity roost). Extensive re-pointing and staying works to a spandrel wall were scheduled to start in early September and end in mid October. Three cavities were identified for retention, two of which were used by bats, and one additional one which was large enough to accommodate a maternity colony. All cavity entrances were reduced in size to help keep water out. This was accomplished by stuffing paper into crevices, pushing a short length of plastic pipe into the crevice and filling with mortar around the pipe. Once the mortar had set the plastic pipes and paper were removed. Bats started to re-use holes before repair works had finished (Whitaker, unpub.).

Brynich Aqueduct, Powys
This multi-arched stone aqueduct had extensive repair works carried out in 1996. Bottomless socks were attached over short lengths of plastic drainpipe which were then inserted into bat crevices, allowing the bats to escape but not return (Smith, pers. comm.).

Mucomir Bridge, North Lochaber
This triple arch stone bridge underwent major re-pointing and saddling works in 1990. The Nature Conservancy Council were informed by local residents that the bridge had a bat roost (maternity colony). Dr Bob Stebbings was contracted as a consultant and several visits were made in early May and at the end of July. The eastern arch was stripped down and reinforced with concrete (saddling) from 8th-22nd May (as originally planned). The re-pointing of the western and central arches was brought ahead to be completed by 20th June to prevent disturbance to the bat colony (Whitaker, unpub.). The final re-pointing of the eastern arch was carried out after 1st August when the young had started to fly (*op. cit.*).

In North Lancashire two bridge roosts were successfully preserved in 1996. Several others have been preserved in the past (Bradley, pers. comm.) through close cooperation between engineers and the local bat group.

In South Lancashire roosting holes were preserved in a long culvert under Rochdale by liaison between the bat group and engineers (Armstrong, pers. comm.).

California USA
In the USA bats have been deliberately blocked into deep expansion joints of concrete bridges with polystyrene foam to protect them from excessive disturbance or harm during works - the foam is removed once works are complete (McCabe, 1996).

5.5.2.3 Lessons learnt

Surveying a site fully before any works start is of vital importance to determine which places are used by bats and when. Where close co-operation takes place between the bridge maintainers, contractors and persons supplying information about the bats, roosts can be preserved and disturbance kept to a minimum. Pre-planning for the most appropiate timing of works is essential to avoid the sensitive periods (see 5.4).

Stuffing paper into crevices to preserve holes during grouting works has been tried a number of times in Cumbria with the intention of removing the paper afterwards. This has had limited success and cannot be recommended as in most cases the paper cannot be removed, or only inadequate shallow crevices are preserved. Stebbings (pers. comm.) stated that using paper to retain crevices was not to be recommended.

The 'ring grouting' method carried out at Rash Bridge was very successful - but in cases of very deep roosting sites, or crevices which stretch horizontally as well as vertically into the structure, areas of stonework may have to be removed and rebuilt to retain the full extent of the roosting cavities during grouting works. Stebbings (pers. comm.) stated that deep crevices had been

successfully preserved in a number of sites by carefully isolating areas of holes to be retained before proceding with the remaining works.

Hand pointing presents few problems for retaining roosts as long as crevices are clearly marked and agreements made with engineers and contractors over what is required.

5.5.3 Training and guidelines

5.5.3.1 Cumbria

In Cumbria liaison was initiated over the bats in bridges issue in 1992 and since then several meetings and training sessions have been held, leading up to the commencement of this project.

During the COBIB Project nine training seminars were run for the six highway areas (three sessions), the four Lake District National Park regions (four sessions), British Waterways, East Cumbria Countryside Project, and volunteers. These were an integral part of the project to ensure maintenance engineers were aware of the importance of bridges to bats.

Bat biology, the law, the places used by bats in bridges and the periods during the year that they inhabit sites were discussed. Also the threats from maintenance works and methods of retaining roosts and minimising disturbance were covered, and site visits were arranged to see bat roosts in bridges.

A new bridge recording form was produced for the beginning of the project (expanding the data fields previously recorded), and a new revised version for future use has been designed (see Appendix II).

Guidelines for maintenance and procedures for preserving bat roosts have been compiled during the project and distributed to engineers and maintainers (see Appendix I). Guidelines for carrying out surveys and batworker training have been compiled (see Appendix III). Designs for creating roosts have been produced (see Appendix VII) and slides have been compiled of bridge roosts and works being carried out.

5.5.3.2 Outside Cumbria

Roberts (1989) reported taking North Yorkshire engineers to visit bat roosts and McAney (1992) produced a report on the importance of bridges to bats including maintenance guidelines. Hinchcliffe (Vincent Wildlife Trust) gave training and assisted engineers and bat groups in several northern counties in 1992 and 1993, and produced guidance notes on bats in bridges (Hinchcliffe, unpub.) Stebbings (pers. comm.) has been involved nationwide with bridge works and has run training sessions for Highways engineers *eg.* in Northern Ireland.

A number of other batworkers/groups/SNCO's have been involved with individual bridge works and in making engineers more aware of bats, mainly on a case by case basis on request.

In Cornwall and Lancashire the Environment Agency has produced guidance notes on carrying out work on bridges, and the threats to bats (Anon., unpub.(a); Anon., unpub.(b)).

5.5.4 Future training

It is proposed as a follow up to the project to produce a slide pack of the types of bridges and locations in them that bats use (see Appendix VI). A 'user friendly' colour leaflet illustrating the importance of bridges to bats and the procedures to follow during maintenance works (to be aimed at engineers) is also proposed. A new section in the revised Bat Workers Manual (in prep.) on bridge maintenance and surveys will assist bat workers involved with bats in bridges.

As a result of the project discussions are taking place with bridge maintainers such as the Highways Authority and British Waterways to include extra information about bats in bridges in their maintenance and construction guidelines (*eg.* Design Manual for Roads and Bridges).