



COMMISSIONED REPORT

Commissioned Report No. 160

A review of the success of bat boxes in houses

(ROAME No. F01AC310)

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This report should be quoted as:

Bat Conservation Trust (2006). A review of the success of bat boxes in houses. Scottish Natural Heritage Commissioned Report No. 160 (ROAME No. F01AC310).

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A review of the success of bat boxes in houses

Commissioned Report No. 160 (ROAME No. F01AC310)

Contractor: Bat Conservation Trust

Year of publication: 2006

Background

One of the management options available to Scottish Natural Heritage (SNH) when advising on the management of bat colonies in buildings is to promote the use of alternative artificial roosting areas for the bats within the building, but in a contained, manageable space. The overall aim of this form of species management is to address the problems caused by the bats, while maintaining the colony in the property. This option is usually only appropriate in specific circumstances where there is a particularly important colony and where the roost owner is supportive and prepared to retain the colony on the premises. In most cases, SNH has provided financial support and staff resources to help implement the work. Local voluntary bat groups have also played a vital role in most of these cases.

The aim of the present study was to assess the success of all of these structures (custom-built *in situ* bat boxes). The success of each structure was assessed both in terms of:

- resolving the bat-related problems experienced by the roost owners and;
- ensuring the continued long-term viability of the bat roost.

Main findings

Nine bat roost boxes (or functionally similar structures) constructed within roofs were visited and assessed. Seven of these were provided for soprano pipistrelles *Pipistrellus pygmaeus*, and one was for brown long-eared bats *Plecotus auritus*. This latter box has never been occupied by roosting bats. The remaining box, which was designed for pipistrelles, has also never been occupied by bats. (The species of pipistrelle was not identified, but may be the common pipistrelle *P. pipistrellus*).

Of the seven boxes for *Pipistrellus pygmaeus*, all have been occupied by roosting bats with varying degrees of success. Six key requirements of design and construction which, if addressed, would improve the rate of successful occupation by bats, are included.

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FOREWORD

This report constitutes the second part of a more extensive contract that was let to the Bat Conservation Trust in 2001¹ to review the outcome of SNH statutory advice on the management of bat colonies. (Contract No. BAT/AC306/01/02/28). The full report on this contract is primarily intended for SNH internal use. However, the information on bat boxes is considered to be of wider interest amongst the bat worker community, hence the publication of this report.

Since the publication in 1996 of the SNH booklet *The Design and Construction of Bat Boxes in Houses*, there appears to have been an increased level of interest in the construction of *in situ* bat boxes within the roof spaces of houses harbouring significant colonies of bats. This publication provides detailed drawings of the various designs considered to be appropriate for the three species that are most commonly encountered in the roof spaces of Scottish houses – common and soprano pipistrelles and the brown long-eared bat. In developing these designs, the authors of the booklet paid particular attention to the roosting requirements of these species and the most common forms of construction used in Scottish houses.

Most of the nine boxes reviewed in this report are based on designs recommended in the above publication, although each box was necessarily customised according to the particular set of circumstances present in each case. Each of these boxes, although intended to be solution to the problems experienced by the individual roost-owner, should perhaps be considered as experimental and was designed according to the best information that was available at the time. With further refinements and an increased understanding of the specific roosting requirements of the different bat species, the success rate of future *in situ* bat boxes may perhaps be increased, but for the short-medium term, this approach must realistically be regarded as an experimental one, where success cannot be guaranteed. Since this review was undertaken, at least one other bat box has been constructed in South Ayrshire in a council-owned property, apparently with some success.

In compiling this report, it has been necessary to include some additional introductory remarks in the summary, to re-format the text to form a stand-alone document and to remove any references to individuals and private estates. Some amendments to the original scoring system for rating the relative success of each box have been included and agreed with the original author. The conclusions and recommendations are those of the contractor and do not necessarily reflect current SNH thinking.

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April 2006

¹ Final report received in February 2002.

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Introduction and overview

All the bat roost boxes reviewed as part of the study were constructed between 1994 and 2001 in order to provide an area within the roof for the bats to roost in. In most cases this was because of problems associated with the numbers of bats roosting in the roof spaces.

The costs involved in these projects were not assessed since this was outside the scope of the study. However, it is known that they range from SNH staff time to grants for design, construction and remedial work, to payments to owners or householders for ongoing management of the boxes. In one case rent and council tax have been reduced, indicating a cost to the owner and a benefit to the occupant.

Seven of the bat roost boxes were intended for soprano pipistrelles *Pipistrellus pygmaeus* and one was for brown long-eared bats *Plecotus auritus*. This latter box has never been occupied by roosting bats. The remaining box, which was designed for pipistrelles, has also never been occupied by bats. (The species of pipistrelle was not identified, but may be the common pipistrelle *P. pipistrellus*).

Of the seven boxes for *Pipistrellus pygmaeus*, all have been occupied by roosting bats with varying degrees of success. Two of the less successful, in terms of retaining the bat colony were the Gariob bat box, built in 2001 and Seafield. A small number of droppings were found during an inspection in July. Wasps, however, occupied this box for the critical part of the summer and the bats did not appear to be using it at that time. The Seafield box, has now been closed and the bats prevented from using the box.

A full description of each bat house is given, including detailed drawings. Note that many of the bat roost boxes have required alteration following initial construction, thus their present status, rather than the initial design, has been assessed.

Bat roost box details

The information on bat roost boxes was obtained from the following sources: visits to the sites; examination of the roost boxes and observation of bats roosting in them; texts, plans and photographs held in SNH offices; the owners or occupants of the buildings; and from SNH staff and bat workers involved in the design or construction of the boxes or monitoring the bat colonies. Nine bat roost boxes constructed within house roofs were visited and full descriptions are given below. All the boxes were located in properties in Scotland, as follows (the SNH Area is given in brackets).

- Aden Country Park (Grampian)
- Dalreoch Lodge (Strathclyde & Ayrshire)
- Keithfield Cottage (Grampian)
- Battleby (Tayside & Clackmannanshire)
- Gariob (Argyll & Stirling)
- Formakin (Strathclyde & Ayrshire)
- Seafield Farm, (Argyll & Stirling)
- Laigh Raws (Argyll & Stirling)
- Burnhead Farmhouse (Strathclyde & Ayrshire)

A summary of the success rating for each box is given, followed by details of each roost box according to the following subject areas:

- general description, including site description, bat numbers;
- history of the bat roost;
- description of the bat roost box in detail;
- history since construction of the roof box;
- reasons for success or failure of the design;
- recommendations.

The maximum number of bats using the roost is indicated for periods before and after the box was constructed, wherever figures are available.

Scoring system used for assessing success or failure

Each bat box was awarded (a) an overall success rating from 0–8. This is the sum of (b) a success rating from 0–4 in terms of maintaining the bat colony, and (c) a success rating from 0–4 in terms of reducing problems to householders *while satisfying their underlying wish to retain the bats in the property*.

It is accepted that there is an element of subjectivity associated with these scores, especially with regard to the latter householder ‘satisfaction’ rating. This is because when making a judgement here, the assessor was required to acknowledge that one of the fundamental reasons for constructing any of these boxes in the first place, was *to retain the bat colony at the site*. Thus, in cases where a ‘satisfaction’ rating of less than 4 was given for a site, where no bats were present after a roost box had been installed, the score takes account of the total failure of the structure to accommodate any of bats, even though there could no longer be any bat-related problems. If complete exclusion of the colony had been the householder’s declared objective and they could not be persuaded otherwise, no effort would have been directed at constructing a bat box.

An assessment of this type is further complicated by the fact that the original *primary* management objectives for the various bat roosts reviewed here differed. In some cases, conservation of the bat colony was the primary objective, even if some of the original bat-related ‘nuisances’ remained. At other sites, the primary objective was to reduce or eliminate the problems experienced by the householder, whilst trying to retain the bat colony, even if a reduction in the size of the colony was the result.

Each of the two 0–4 scoring systems are defined thus:–

Maintaining the bat colony (b)

| Score | Definition |
|--------------|--|
| 4 | The bat colony has been retained and post-construction counts are within the range of previous counts. Colony size appears to be stable (or increasing). |
| 3 | The bat colony has been retained, but post-construction counts suggest that the colony is slightly reduced in size. The population trend is unclear. |
| 2 | The colony is considered to be of a reasonable size but it is clearly reduced in size. |
| 1 | Bats are still present, but the colony that is now present is only a small fraction of the size of the original. |
| 0 | The roost has been abandoned, (or the bats have been excluded.) |

Reducing problems for the householder (c)

| Score | Definition |
|--------------|--|
| 4 | The problems caused by the bats have been completely solved and the householder is totally happy with the outcome. |
| 3 | The problems have generally been solved, but some minor concerns remain. |
| 2 | Some improvement, but not a satisfactory solution. More work may be required. |
| 1 | Very limited improvement. More work is required. |
| 0 | The problems have not been solved at all (and may be even worse than before). More work is required. |

1 THE COACH HOUSE, ADEN COUNTRY PARK, ABERDEENSHIRE

Summary

| Score category | Score | Comments |
|---|-------|--|
| Overall success rating Score (a); rated between 0 and 8 | 0 | No bats were present after the works as the colony had moved elsewhere, creating the possibility of a problem at a new site within the nearby buildings. |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 0 | |
| Reducing problems to householders Score (c); rated between 0 and 4 | 0 | Roost has not been occupied since construction. |
| Maximum number of bats before bat box | 44 | |
| Maximum number of bats after bat box construction | 0 | |

The bat box is built into the roof of a building which is the office of the Aberdeenshire Farming Museum, part of Aberdeenshire Heritage, Aberdeenshire Council. The building is the former coach house, built in 1801 as part of a set of buildings that make up Aden Farm, for the Aden Estate. The unusual outer buildings are curved, since they form a circular outline. The Coach House sits in the middle of the circle.

1.1 History of the bat roost

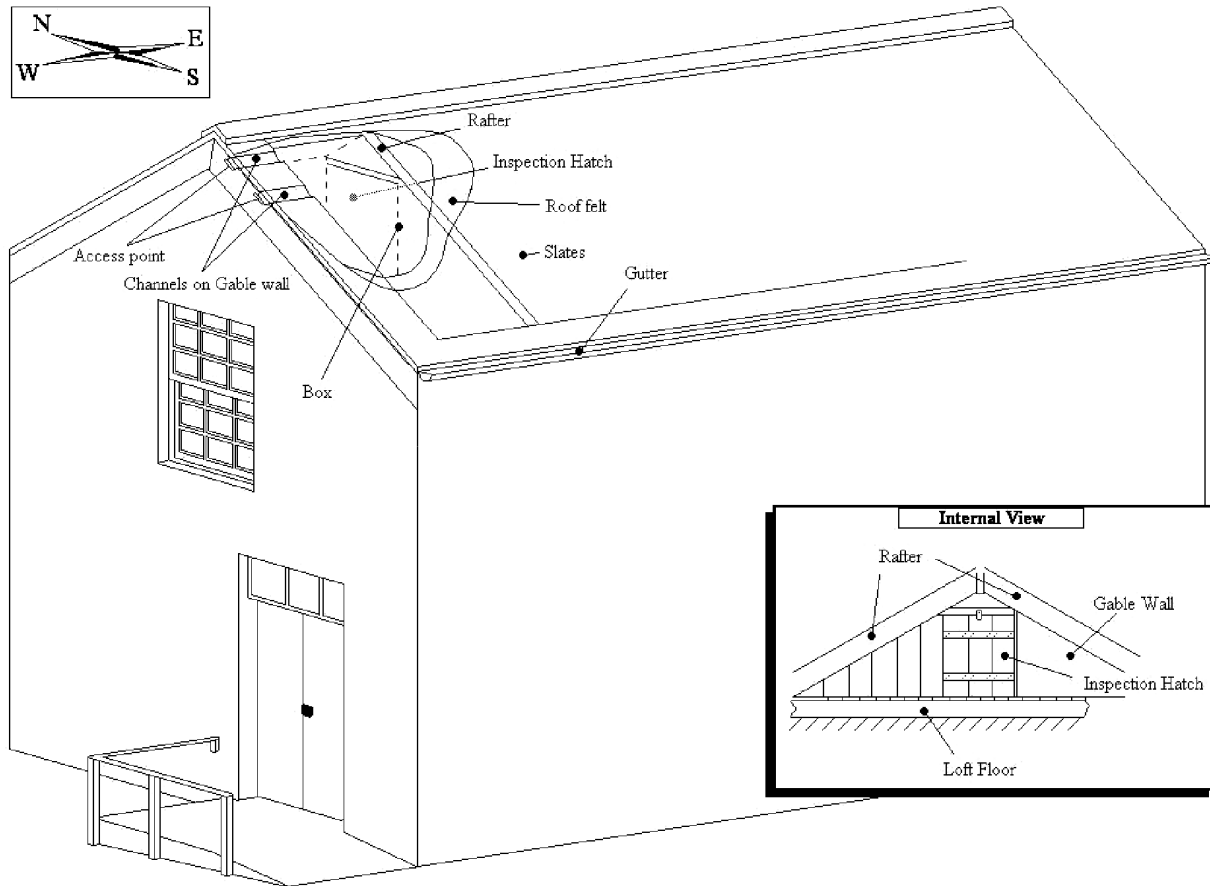
These semi-derelict farm buildings were renovated in 1981 when Aden Country Park was formed. Pipistrelle bats have been known to use the roof of the coach house at least since the summer of 1992. The largest count was in the summer of 1995 when 44 pipistrelle bats were counted emerging from the roof. The exact date of this count is not recorded, but it is likely this was a count of adult females.

In November 1995 emergency repairs were made to the roof of the coach house. The slates and sarking boards were removed from the western end of the roof and the existing roof timbers strengthened, before replacement of the roof. After consultation between Aberdeenshire Council and Scottish Natural Heritage, it was decided that a bat box should be constructed to provide roosting space in the renovated roof. The bat box was based on a design in a draft version of a booklet published by SNH in 1996: "The Design and Construction of Bat Boxes in Houses". Access by the bats was under the barge board on the southern side and the bats roosted between the wall head and the sarking. The layer of droppings indicated they also used part of the roof space.

The species of pipistrelle has not been determined here. The numbers using the roost might indicate it is *Pipistrellus pipistrellus*, rather than *P. pygmaeus*, which often forms much larger nursery roosts.

1.2 Description of the bat roost box

The box extends across the southern half of the gable end and part-way across the northern half. Its dimensions are approximately 120cm high by 90cm deep. Access is by a small channel in the surface of the wall head. The remainder of the wall head was tightly sealed. The entrance to the channel is through two slots cut into the upper part of the barge board. These slots are approximately 10cm wide by 2cm high. Heating for the box is provided by the sun and by the office below, there is no additional heat source.



The Coach House, Aden Country Park, Aberdeenshire

1.3 History since construction of the roof box

The roost box was completed in November 1995 and was then ready to be occupied by pipistrelle bats in the summer of 1996. Some of the droppings found in the roof were scattered on the floor of the box to give a "familiar smell".

No bats have occupied the box since its construction. None have been observed, and no fresh droppings have been noted.

The roof and box was examined on 29/07/2001. The box was occupied by a large and active wasps' nest (byke). Because of this it was not possible to open the box from the roof space.

Two torpid pipistrelles were found when the roofing was removed in November 1995. They were near a valley, under slates, although it is unclear whether they had also been using the site as a summer roost.

1.4 Reasons for success or failure of the design and suggested improvements

The entrance to the roost box is unsuitable for pipistrelles to gain entry. Pipistrelle bats normally land on a rough surface below the roost entrance and crawl into the entrance. Frequently the entrance is in the angle

between an overhanging roof and the top of the wall. Before the box was constructed, the roost was entered under the lower edge of the barge board, a typical pipistrelle entrance type. When seeking for roost sites, pipistrelles search for narrow crevices, the type of gap provided by the roughness of stone behind a fascia board, or the gaps in mortar at the top of a stone or brick wall behind the fascia. A roughened wood "landing board" was designed for attachment below the roost entrances, but was never attached. As a result the bats would have to land on the smooth painted surface of the board and crawl into a slot entrance cut through the board.

Other possible reasons for bats not roosting here are:

- the availability of alternative roosts in nearby buildings;
- use of the box by wasps.

1.5 Recommendations

- The entrance should be redesigned to allow bats to have access under the lower edge of the bargeboard as they did before 1996.
- The wasps nest should be removed.

2 MAINS OF KEITHFIELD COTTAGE, ABERDEENSHIRE

Summary

| Score category | Score | Comments |
|---|-------|---|
| Overall success rating Score (a); rated between 0 and 8 | 5 | |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 3 | |
| Reducing problems to householders Score (c); rated between 0 and 4 | 2 | Some improvement, ie the bats have a box and use it, but there are still problems with smell and bats gaining access to the living space. |
| Maximum number of bats before bat box | 546 | |
| Maximum number of bats after bat box construction | 455 | |

This bat roost box was built into the corner of a single storey cottage roof where it connects with the flat roof of a kitchen extension. It has been constructed within a cupboard enclosing a hot water tank. The bats involved are soprano pipistrelles *Pipistrellus pygmaeus*.

2.1 History of the bat roost

Bats had been known to roost in this cottage since 1993. By 1998 the roost was well-known to staff and research students at Aberdeen University, and was included in some of their research.

A new occupier moved into the cottage in October 1997, and in September 1998 asked SNH for advice. An estimated 500 bats emerged from the roost in the summer. The bats were known to enter at the southeast corner of the flat roof extension over the kitchen and crawl along the south edge to reach the hot water tank which is situated in an airing cupboard at the southeast corner of the main, pitched roof. Before 1998 bats appeared to roost mainly at the corner of the flat roof and also above a window on the east side. A number of bats had entered the living areas of the cottage. There was a noticeable smell from the roost site and there had been electrical faults associated with the bats – since their entrance is via the edge of the flat roof, where some of the electric wiring is routed.

The initial advice visit was on 7/10/1998 resulting in the proposal to provide a roost box to contain the bats and reduce the nuisance caused by them within the cottage.

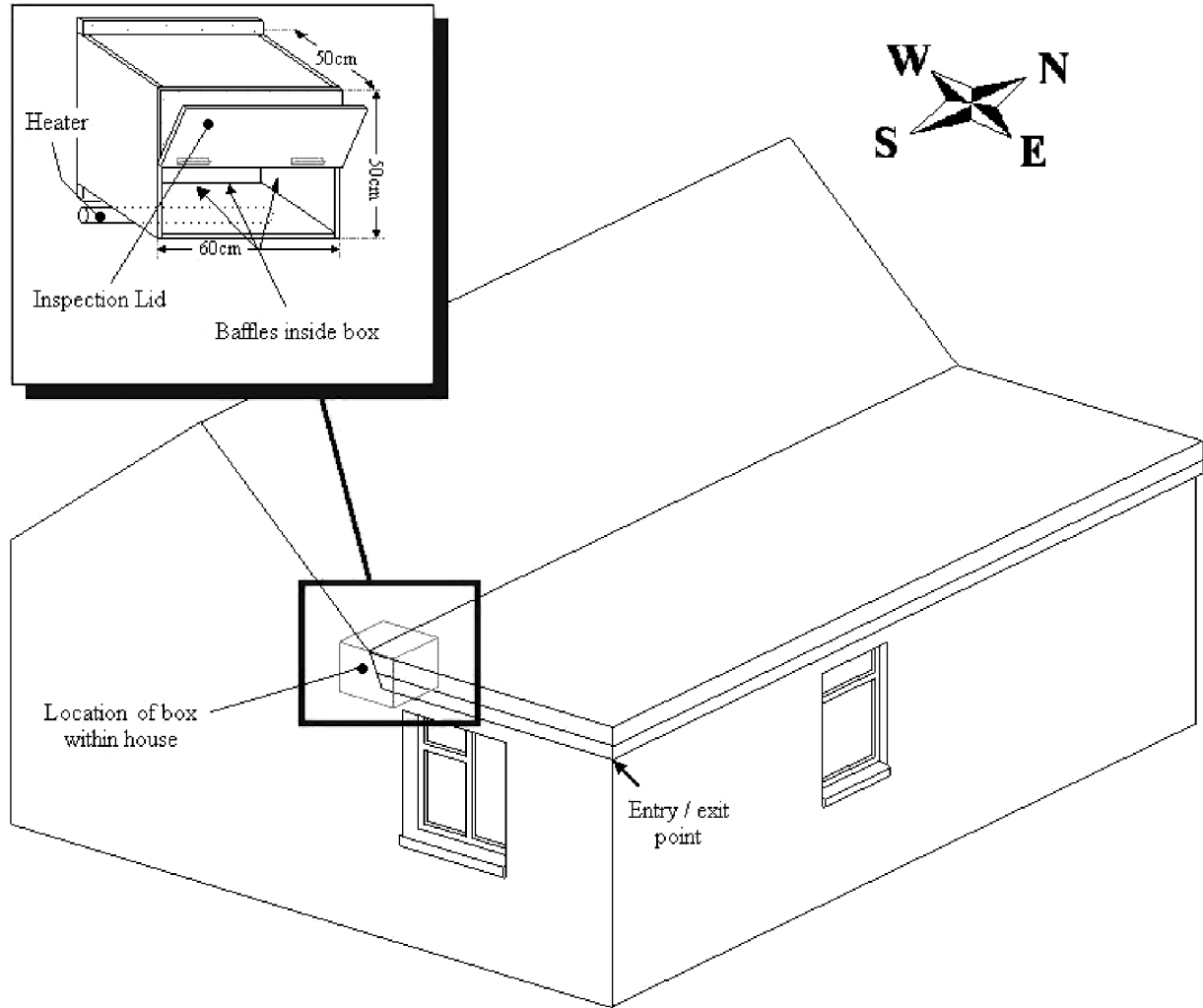
Two positions were considered for the site of the box; (a) at the southeast corner close to the entrance and (b) above the hot water tank. Option (a) had the advantage of being close to the entrance, so keeping the bats away from the electrical wiring. Its disadvantages were that the box would project into the kitchen and that the position was cooler than (b). Option (b) had the disadvantage of being a distance from the entrance, but was well heated by the hot water tank. Option (b) was chosen.

2.2 Description of construction work

During March–April 1999 the roost box was constructed in the airing cupboard above the hot water tank. The design had been produced after consultation between staff at SNH and Aberdeen University.

The construction was of plywood, 60cm wide x 30cm high x 30cm deep. The upper section was divided into four compartments by wooden separators. The lower half of the front is removable for inspection and cleaning. A hole at one top corner allows access by bats from the flat kitchen roof edge.

A low-wattage heater was attached below the box to provide heat when the hot water system was not in use.



Mains of Keithfield Cottage, Aberdeenshire

2.3 History since construction

Bats returned to the roost in April 1999. Emergence counts showed a maximum of 257 on 22/6/1999.

During the summer of 1999 over 100 bats were returned to the cupboard by the occupier after making their way into the rooms. It was discovered that the cupboard had not been provided with a ceiling, as planned in the design. Bats were able enter the airing cupboard space from their entrance route. It was recommended that a ceiling should be fitted to the airing cupboard and additional roost surfaces should be provided inside the box.

In the summer of 2000 bats continued to enter the rooms of the house, and there was still concern about the bats being in contact with electrical wiring.

A ceiling for the airing cupboard was again proposed, (although this was never actually constructed.) Plastic mesh was to be attached to the inside surface of the box. Cardboard egg boxes placed inside the box are intended to increase the surfaces for bats to crawl or roost on, as well as being absorbent. These are replaced when the droppings are cleaned out. A hinged front opening to the box was fitted to enable easier access for cleaning, and also returning any stray bats.

Numbers of bats using the roost in 2001 were similar to the first summer after the box construction. The numbers of bats roosting here following the bat box construction were lower than before 1999, however numbers in *P. pygmaeus* roosts often fluctuate naturally. Emergence counts did not fall significantly after the construction of the box.

2.4 Summary of emergence counts

| Date | Count |
|-------------|--------------|
| 1993 | 23 |
| 15/06/96 | 195 |
| 10/06/97 | 460 |
| 16/06/97 | 482 |
| 11/06/98 | 78 |
| 23/06/98 | 546 |
| 13/06/99 | 140 |
| 22/06/99 | 257 |
| 29/08/99 | 100 |
| 09/06/00 | 455 |
| 25/06/00 | 393 |
| 22/05/01 | 331 |
| 13/06/01 | 161 |
| 28/06/01 | 215 |
| 18/07/01 | 268 |

2.5 Reasons for success or failure of the design

In terms of maintaining the size of the colony the design and installation of this bat box has been a success. However, bats continued to enter the rooms of the house in 2000, and there was concern about the bats' contact with electrical wiring.

2.6 Recommendations

The problem of bats entering the rooms should be solved when the ceiling has been fitted to the airing cupboard and the structure adequately isolated from the living space. This may also require improvement to the entrance route, for example providing a duct or pipe for the bats to crawl along. Before that is attempted, a second exit could be constructed close to the roost box. If the second exit proves to be used, then the first exit can be closed off.

An alternative to opening the hinged front, to prevent escape of bats or droppings, would be to build in a small "return" hatch or one-way opening.

3 GARIOB, ARGYLL

Summary

| Score category | Score | Comments |
|---|-------|--|
| Overall success rating Score (a); rated between 0 and 8 | 2 | |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 0 | |
| Reducing problems to householders Score (c); rated between 0 and 4 | 2 | Difficult to judge success, as this assessment was made in the first season following completion of the work. The bats could not use their original roosting site, but it was too early to know whether the box would be used by them. |
| Maximum number of bats before bat box | 950 | Estimate of adult total. |
| Maximum number of bats after bat box construction | 0 | Some may have used the box before it was blocked by the wasps nest. |

This bat roost box has been constructed in the coom space of the southeast facing side of a cottage roof. The bats are soprano pipistrelles *Pipistrellus pygmaeus*.

3.1 History of the bat roost

The cottage was completely renovated in February 1991 in the knowledge that bats were known to roost in the roof. There was no attempt to exclude the bats, as the owners were keen to encourage the roost. Bat entrance points were purposely left at the top of the northeast-facing gable.

In July 1991, 365 bats were counted as they emerged. Subsequently a count was made every year, and the numbers peaked at 1,930 (including newly-flying young) in 1995. The upper storey rooms have been built into the roof of the cottage, so that there is a triangular coom space alongside the lower walls, and above the narrow flat central section of ceiling there is a very small loft space. The bats roosted at the apex, and were known to spread to positions along the whole length of the roof. When the numbers were high, bats were noticeable from the sounds made while they were active, particularly when the juvenile bats were in the roof during July.

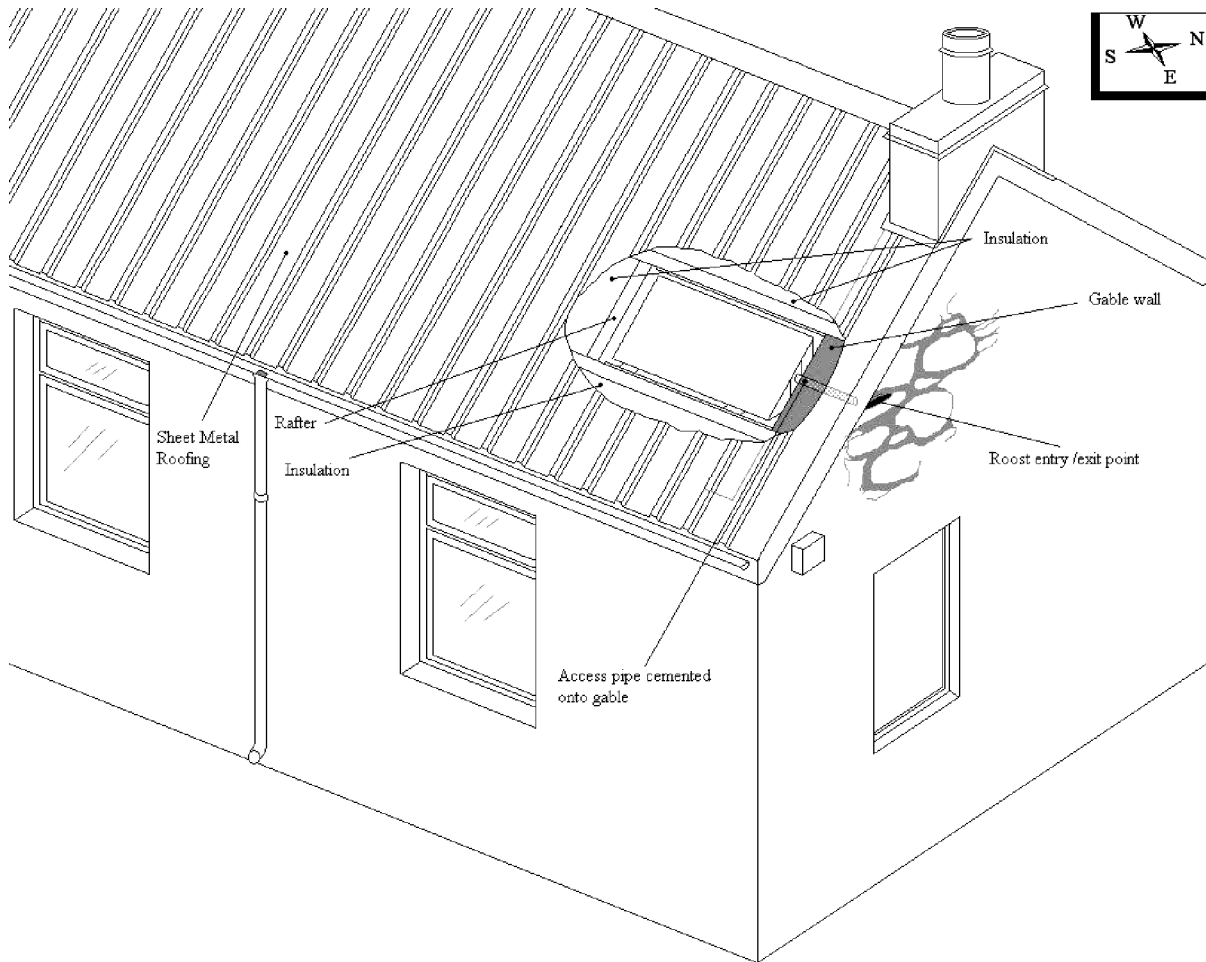
In 1996 and 1997 the numbers were not counted accurately, but the owners estimated that they were similar to 1995. Numbers counted between 1997 and 1999 showed a downward trend.

In 1999 the owners contacted SNH for advice, since there was a noticeable increase in the smell from the roost, in the upper rooms of the cottage. In August 2000 it was agreed that work should be done on the roof to remove soiled insulation materials and wallboard. At the same time a box would be constructed to provide a roost for the bats.

3.2 Description of construction work

The bat box was designed by the owner with advice from SNH. In March 2001 the roof was stripped back to the rafters and the box was then built in to the southeast facing coom space. It is 2m long x 0.8m wide x 0.8m high, triangular in section. Inside the box lengths of wood were attached in such a way as to provide internal crevice sites for roosting bats. The outer, pitched side of the box was covered with roofing felt, and a layer of sound deadening material was placed between the inner wall of the box and the wall board of the upper room. A horizontal entrance tube, a piece of plastic pipe 60cm long and 40mm diameter, was built into the gable wall head. A wider entrance "porch" shaped in mortar leads to a space under the barge board. The opposite end can be removed to provide access from within the coom space, which in turn can be entered from an upper room.

Bat droppings were cleaned out of the roof apex and the insulation material and the roof was replaced.



Gariob, Argyll

3.3 History since construction

On 25/7/2001 the box was examined but no bats were using the roost box, though there were some bat droppings in it. A wasps nest (byke) was found just inside the entrance and the wasps were entering and leaving via the tube. The fresh wooden surfaces had provided the raw material for the wasps to construct their nest. This nest was removed but the bats did not return in the 2001 season. Some pipistrelles did use a nearby holiday cottage.

3.4 Summary of emergence counts (all in July)

| Date | Count |
|-------------|----------------------------|
| 1991 | 365 |
| 1992 | 560 |
| 1993 | No count |
| 1994 | 1,560 |
| 1995 | 1,930 |
| 1996 | Estimate 1,900 |
| 1997 | Estimate 1,900 |
| 1998 | 700 |
| 1999 | 650 |
| 2000 | Bats present, but no count |
| 2001 | 0 |

3.5 Reasons for success or failure of the design

Although no bats roosted in the box in its first summer, it is too early to comment on its success or otherwise². It is likely that the wasps prevented the bats from occupying the box in its first summer. Until 2001 the bats roosted in the apex of the roof, which is likely to be warmer than the position of the box.

3.6 Recommendations

1. Additional heating may improve the roost. A small electric heater could be provided during the summer months.
2. The plastic entrance pipe, though it was re-used material, may be too smooth for the bats to crawl along easily. If possible the inside surface should be roughened, eg with coarse grade sandpaper.
3. Preventing wasps from occupying the box will be difficult. Regular internal checks of the box early in the season should prevent a recurrence.

² No bats have occupied the Gariob box since this review was undertaken.

4 SEAFIELD FARM, ARGYLL

Summary

| Score category | Score | Comments |
|---|-------|---|
| Overall success rating Score (a); rated between 0 and 8 | 0 | |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 0 | Bat box failed to contain the bats, although some may have used it. There was still noise and bats continued to enter the living space. This resulted in a request to exclude the colony. |
| Reducing problems to householders Score (c); rated between 0 and 4 | 0 | See above comment. |
| Maximum number of bats before bat box | 769 | |
| Maximum number of bats after bat box construction | 277 | April, so numbers likely to have increased by June. |

This bat roost box was built into the coom space on the southeast side of the roof of a converted stable and byre. The building was converted to a holiday cottage, its owners live in the farmhouse nearby. The bats roosting here are soprano pipistrelles *Pipistrellus pygmaeus*.

4.1 History of the bat roost

SNH were asked to advise on this large pipistrelle roost which was affecting the owners' holiday letting business, since the main holiday season coincided with the summer nursery season for the bats. Bats were noticeable through noise, smell and entering the living space. The roost position was in the southern end of a southeast facing roof slope. Entry was from the southwest facing gable, through a gap under the bargeboard near its lower end.

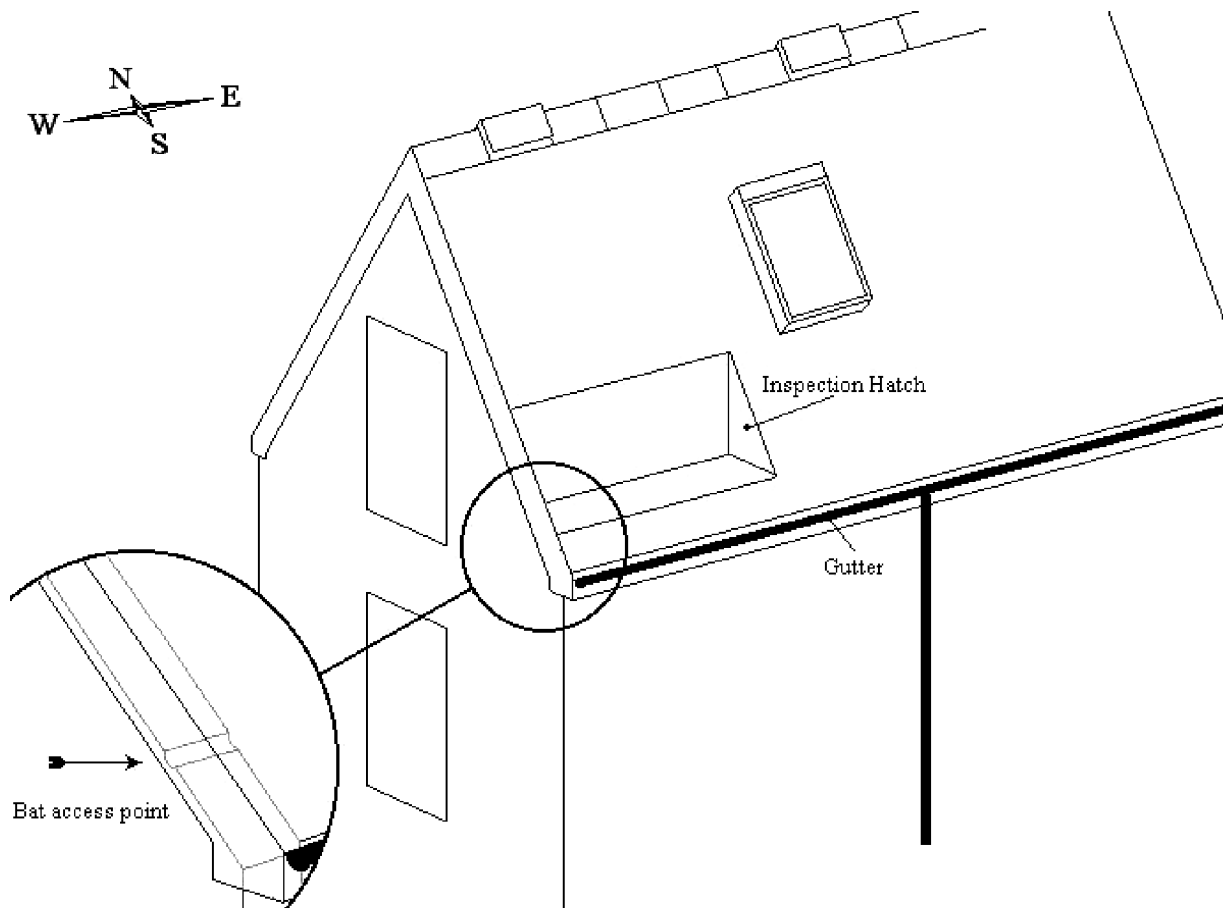
A total of 769 emerging bats was counted on 13/7/1998.

Simpson and Brown Architects³ were asked by SNH to assess the building and its roost and to design a suitable bat roost box to contain the bats and reduce the associated problems. The report was produced in November 1998. Construction of the bat roost box was planned early in 1999.

4.2 Description of construction work

Work on the construction of the box took place in February 1999. The lower half of the roof was stripped back to expose the rafters. Soiled insulation material and a large quantity of droppings were removed. The walls are of rough stone and approximately 60cm thick with numerous gaps inside the wall. The roof is constructed of traditional slate over sarking boards and modern bituminous roofing felt. The box was built of softwood boarding, 2m in length x 0.9m x 0.9m and triangular in section to fit into the coom space. The entrance for the bats was designed to follow the bats existing route into the roof. It was constructed by leaving an unblocked section of the gable between the bargeboard and the southwest end of the box. The route across the wall top was between 20cm and 40cm wide. All other possible roof edge entry was sealed off. A hatch with a door was provided at the northeast end of the box, to enable inspection and cleaning. Access to this door is from the remaining coom space.

³ The architects firm which compiled and edited *The Design and Construction of Bat Boxes in Houses*.



Seafield Farm, Argyll

4.3 History since construction

Bats were seen using the roost entrance on 1/4/1999. The owner counted 277 bats emerging in an evening.

The numbers of bats using the roost during the summer are not recorded, but a considerable number used the box and it seemed to work well. However during the following summer, 2000, holiday guests complained of noise from the bats continuing through the day and night. No complaints about smell had come from guests, but the owner had noticed an odour.

Early in 2001 the Robert Stebbings Consultancy was asked by SNH to provide a report on the management of this roost in order to reduce or eliminate its problems. The report identified that bats had entered the space amongst insulation material between rafters, sarking boards and plasterboard outside of the roost box. Bats were crawling through a small gap between the top of the gable wall and sarking boards. The report made a number of recommendations to reduce or eliminate these problems, however, the owners requested total exclusion of the bats.

A roost visit on 3/5/01 confirmed that no bats were occupying the roost at that time. Following the letter of advice to the owners, the entrance was blocked to exclude the bats.

4.4 Reasons for success or failure of the design

This bat roost box was effective in its first season but subsequently failed to prevent bats from causing noise disturbance to guests in this holiday cottage. Clearly the position of the roost in a building providing holiday accommodation was the key to the intolerance of the owners to further alterations.

Had someone with specialist knowledge of bats and building bat roost boxes closely supervised the original construction work, it may have been possible to prevent the recurrence of the problem.

4.5 Recommendations

A report by the Robert Stebbings Consultancy recommended:

- blocking the access to the area around the box;
- adding a layer of sound deadening material and a layer of heavy polythene between the bat box and the bedroom wall;
- fitting a slate vent;
- reducing the entrance to 10cm wide.

There is a high probability that the additional measures proposed would have eliminated problems arising from bats entering the area around the box.

5 BURNHEAD FARMHOUSE, AYRSHIRE

Summary

| Score category | Score | Comments |
|---|-------|--|
| Overall success rating Score (a); rated between 0 and 8 | 3 | |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 1 | Based on the maximum adult count of 3,500. |
| Reducing problems to householders Score (c); rated between 0 and 4 | 2 | |
| Maximum number of bats before bat box | 3,500 | |
| Maximum number of bats after bat box construction | 740 | |

This roost site is in the roof space of the main, two storey section of Burnhead farmhouse. This is not a roost box in the sense of the other roosts described here. The intention was to provide the whole roof space for the bats to roost in. A "roost board" has been provided on the west gable end wall. This is a 25mm thick board covering much of the end wall area, supported on battens and approximately (due to the unevenness of the stone) 30mm away from the wall.

5.1 History of the bat roost

The first contact between the owner of the house and SNH was 27/05/1998. Bats had been known to use the roof since 1993 or earlier. The initial visit by SNH on 03/06/1998, revealed a very large pipistrelle roost (*P. pygmaeus*). The occupants (tenants) experienced problems with an ammonia smell in the house, contamination of the hot water storage tank and bats entering upper rooms.

A count of emerging bats made on 10/06/1998 reached 3,500, the largest number of adult bats recorded from a pipistrelle roost in the UK. A further count on 30th June totalled 1,573, roughly equally divided between the north and south sides of the roof. This indicates that the colony of bats used more than one roost site, since approx. 2,000 bats must by then be roosting elsewhere. Pipistrelle roost numbers often fluctuate in this way during the nursery season. By 22/07/1998 the number emerging was 4,750, indicating that, assuming up to 50% were newly flying juveniles, the number of adult females had increased to around 2,500.

The Robert Stebbings Consultancy was contracted by SNH to provide a roost site for the bats but contain them and their attendant problems (Stebbing 1998).

5.2 Description of construction work

Work started in March 1999 and prior to that droppings and roof insulation were removed. It was discovered that numbers of bats were hibernating within the dry-lined walls, using gaps in the stonework. These had to be displaced before and during the work.

The loft was floored on top of new insulation and the edge of the flooring sealed.

The ends of the spaces between the roof joists were sealed to prevent access to the insulation.

The hot water tank in the bathroom below the roost was boxed in.

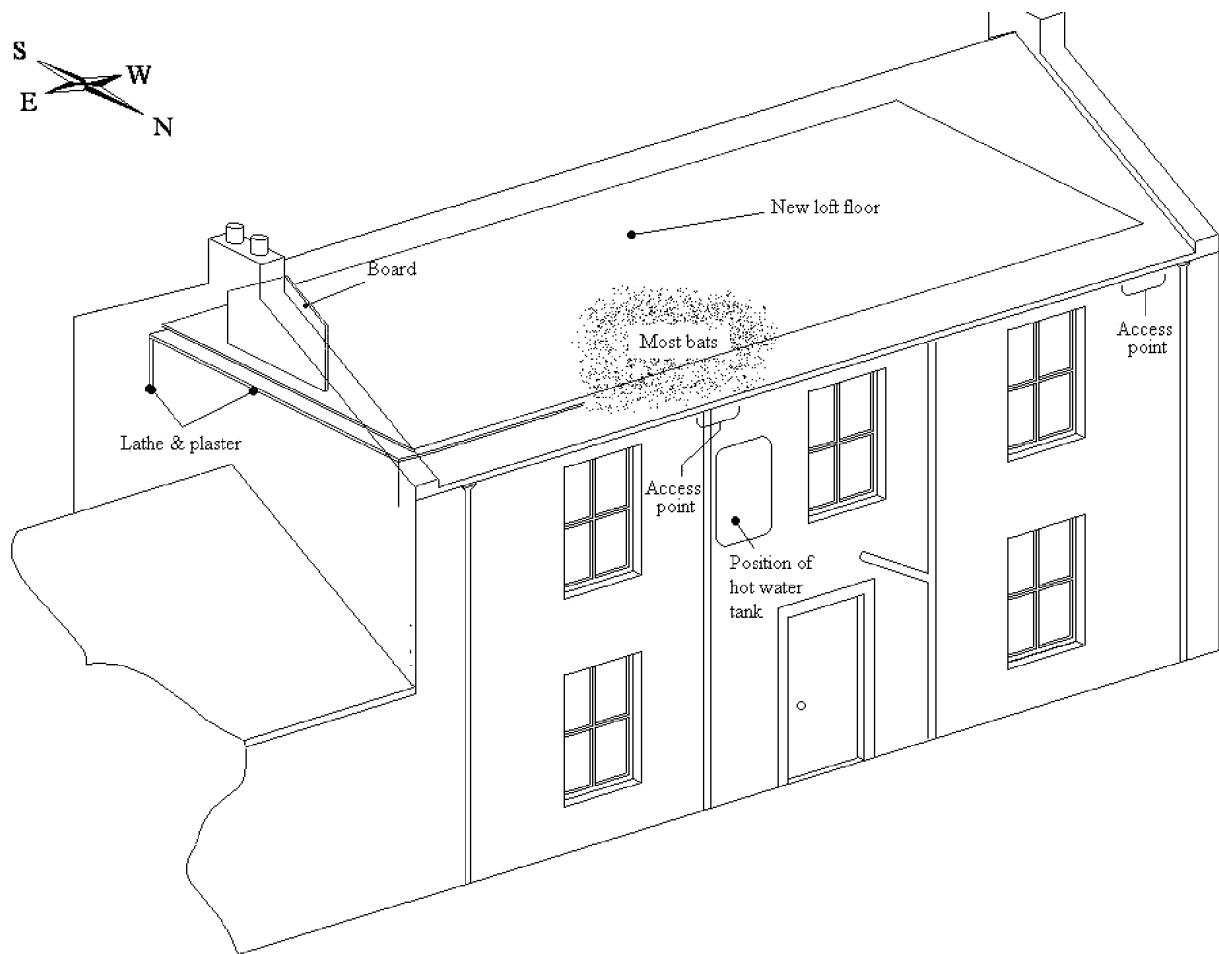
Gaps in the stonework around the wall head were re-pointed.

Internal excluders were fitted to direct any bats from the wall-head space into the roof space.

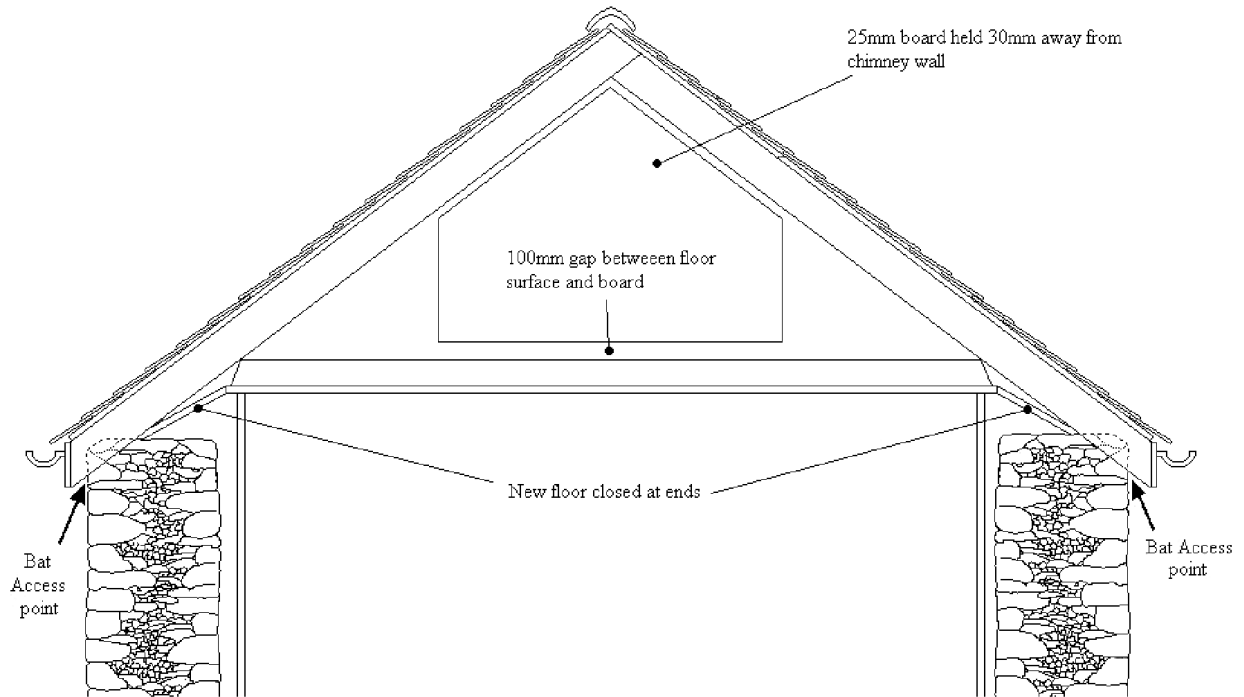
The edge of the roof was sealed to limit access to slots provided for entry and emergence on both sides of the roof – two on the south side and three on the north side.

A roost board was attached to the west gable, where heat from the chimney provided warmth. This provides a roost space behind the board of 30mm or more (due to the roughness of the stone wall).

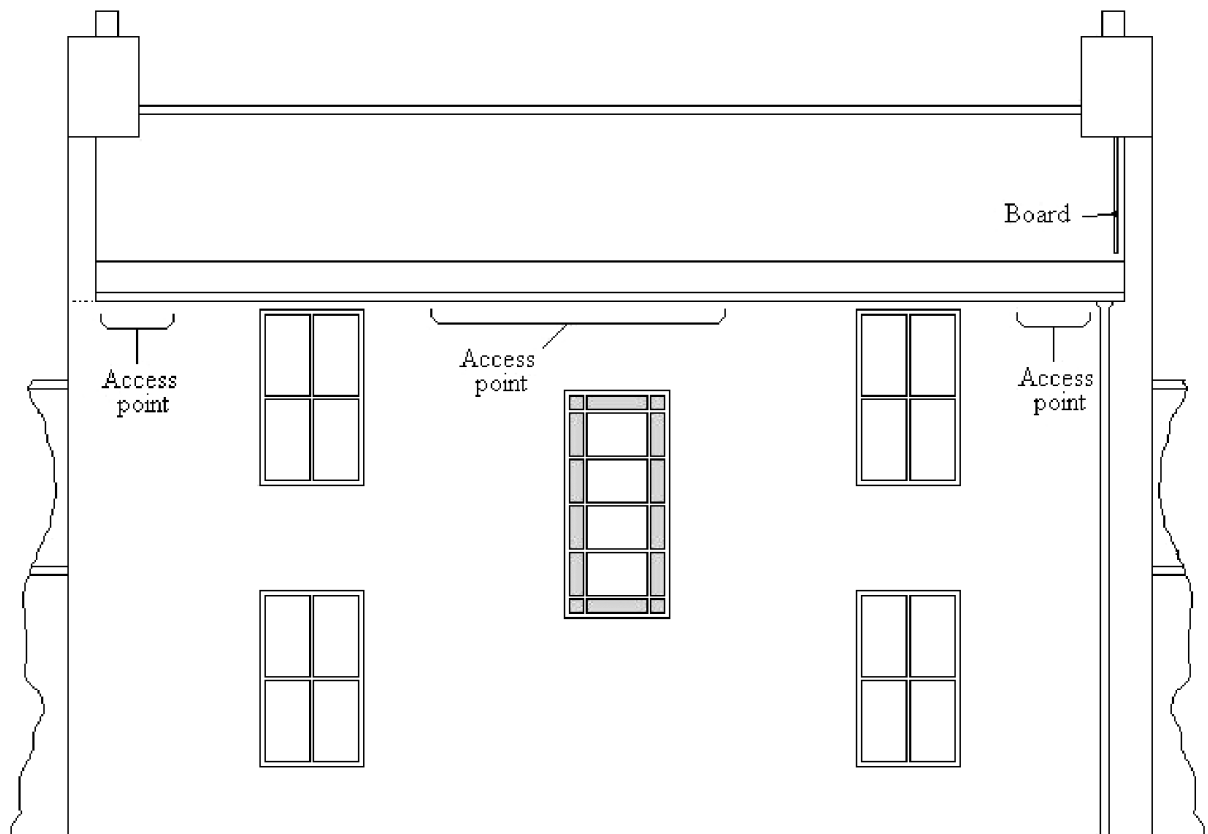
Work was completed by the end of April, but some additional sealing of the roof edge was carried out during 18–20/05/1999.



Burnhead Farmhouse, Ayrshire

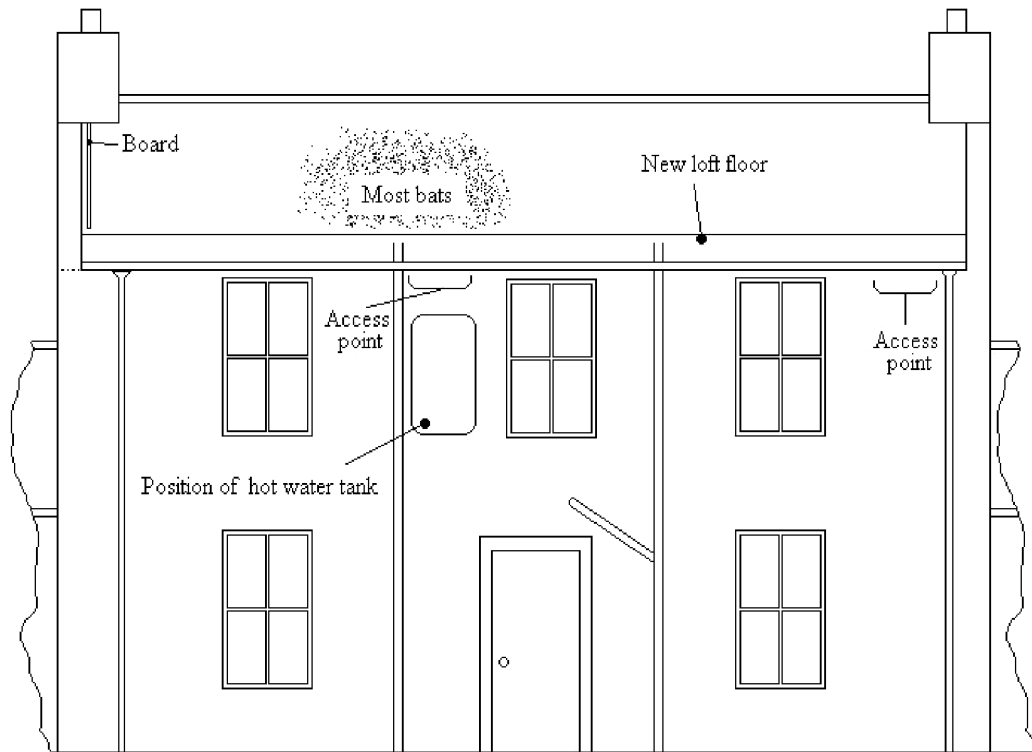


Burnhead Farmhouse, Ayrshire (Redrawn by J A McQueen from Stebbings 1998)



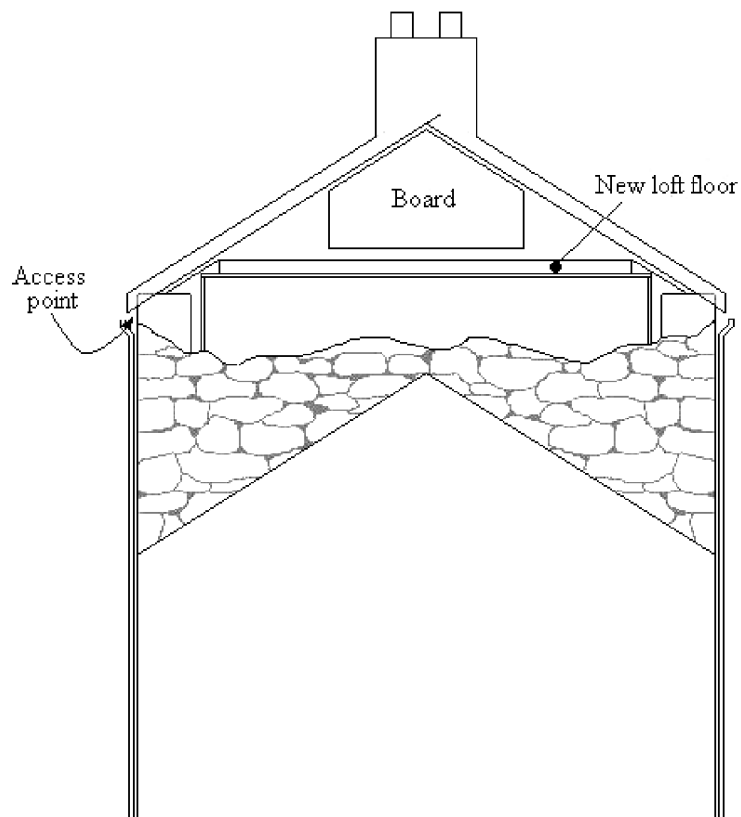
1. Burnhead – South wall

Burnhead Farmhouse, Ayrshire



3. North wall – (roadside)

Burnhead Farmhouse, Ayrshire



2. East Gable wall

Burnhead Farmhouse, Ayrshire

5.3 History since construction

During the first summer following construction (1999) few bats roosted in the roof, indicating that they had moved to another site (or sites). In early July 2000, 740 bats were counted and 900 on 22/08/2001 (including adults and juveniles). This partial recovery of the numbers is promising, however the bats are roosting mainly in the area around the hot water tank, within the insulated space between the ceiling and the flooring of the loft. Droppings have accumulated within the space around the hot water tank and its enclosing box. Little use is made of the enclosed roof space, indicated by the small quantity of droppings present in October 2001. Bats still gain access to the space between the stone and the dry lining of the walls and have occasionally appeared in the bathroom. The roost board is not used as a roost site. Instead, the bats have made use of the space under the new floor which is similar to the area used before its construction.

5.4 Summary of emergence counts

| Date | Count |
|-------------|------------------------|
| 10/06/98 | 3,500 |
| 30/06/98 | 1,573 |
| 22/07/98 | 4,750 (includes young) |
| 28/08/98 | 1,500 |
| 18/05/99 | 120 |
| 15/06/99 | 12 |
| 30/06/99 | 17 |
| 07/07/99 | 49 |
| 27/07/99 | 36 |
| Early 07/00 | 740 |
| 22/08/01 | 900 |

5.5 Reasons for success or failure of the design

Firstly, it appears that the blocked ends of the insulated spaces between the joists did not exclude the bats. Secondly, the roost was probably not warm enough. Pipistrelles require an additional source of heat for their nursery roost if solar heat is insufficient or unreliable. Lastly, bats prefer to crawl into the roost space and avoid having to travel through an exposed area within the roost. The bats therefore showed preference for the area heated by the water tank rather than to crawl or fly to the gable end, where the heat is probably intermittent, depending on the summer weather.

5.6 Recommendations

1. The area at the blocked ends of the insulated spaces between the joists could be turned into bat roost boxes by removing sections of the flooring adjacent to the entrance slots, flooring these spaces with plywood, providing a section for the bats to roost in while tightly sealing off the rest of the joist spaces. These boxes will require access for cleaning.
2. Ventilation holes are needed in the lids/loft floor.

6 DALREOCH LODGE, AYRSHIRE

Summary

| Score category | Score | Comments |
|---|-------|----------|
| Overall success rating Score (a); rated between 0 and 8 | 6 | |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 2 | |
| Reducing problems to householders Score (c); rated between 0 and 4 | 4 | |
| Maximum number of bats before bat box | 1,963 | |
| Maximum number of bats after bat box construction | 1,174 | |

This roost box is in a lodge house at a gateway into a country estate. A roost box has been constructed to contain the pipistrelles *P. pygmaeus* within one area of the roof space.

6.1 History of the bat roost

This roost was described in Tanner 1995 as the largest pipistrelle roost in Britain.

The first contact with SNH was 11/09/1992, when concerns were expressed by the occupier about the large size of the bat roost and the smell experienced during the summer of that year.

On 25/05/1993 a roost visit was undertaken to assess its scale and advise on solutions to any problems. Their count made on 25 May showed that the majority of the bats (1,256) emerged from the northeast corner of the roof. A smaller number (455) emerged from the southeast corner, and more (175) from the east side, midway between these exits. On 8 June the bats emergence pattern had changed to: northeast 485; southeast 1303; midway 175. Clearly there was movement of bats to different parts of the roof at different times. Observations inside the roof indicated that the majority roosted at the southern end of the roof.

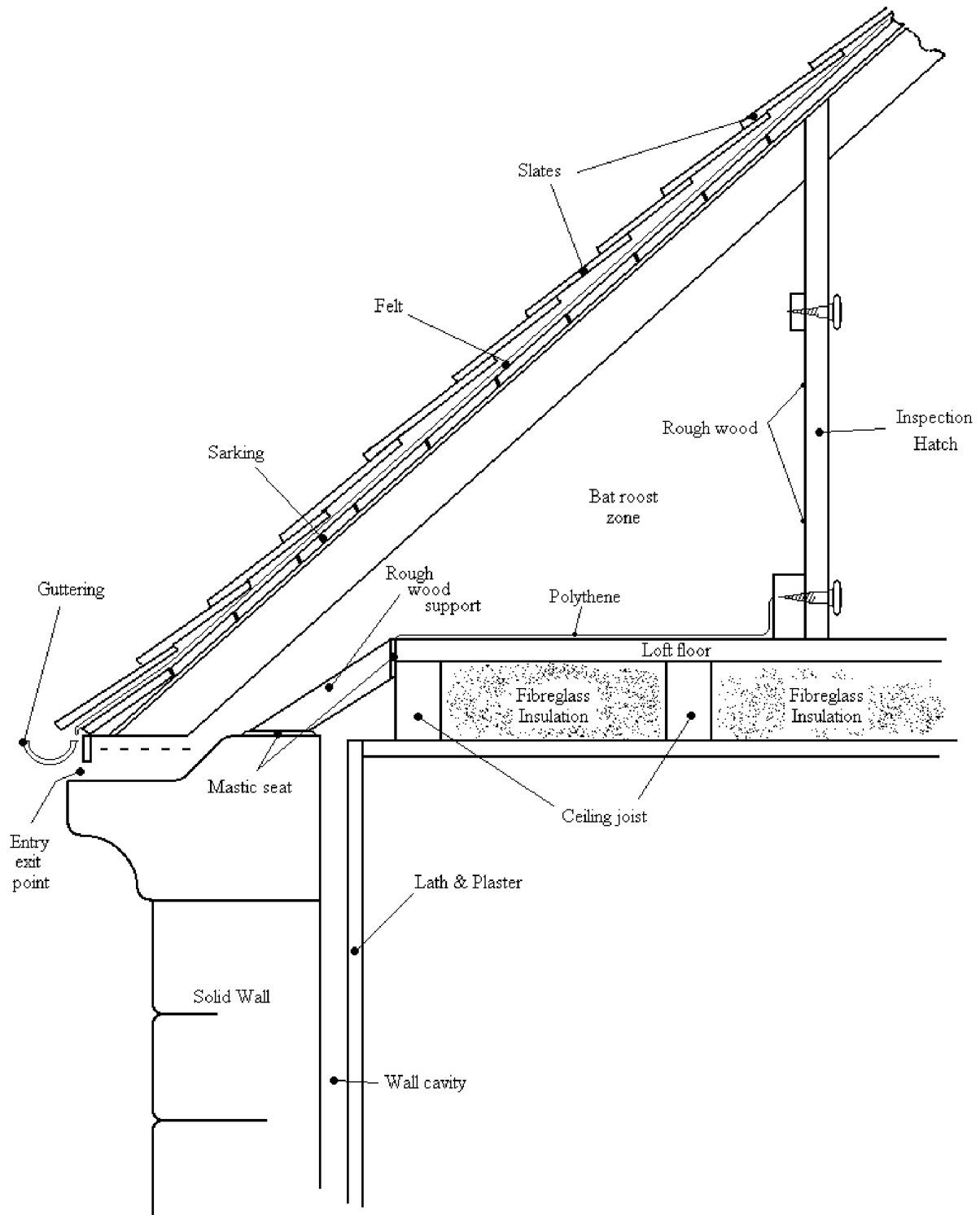
The main problem was the strong ammonia smell from the roof space during the roosting season. Noise from roosting bats was also noticeable when they occupied a site over the main bedroom, but this was an unusual occurrence, probably only during spells of hot weather.

In June 1993 droppings and old loft insulation material were removed. Plastic sheeting was laid in the roof space to catch further droppings for easy removal. The hatch from the loft was sealed tightly to prevent smells from passing into the bedroom to the west of the roost area.

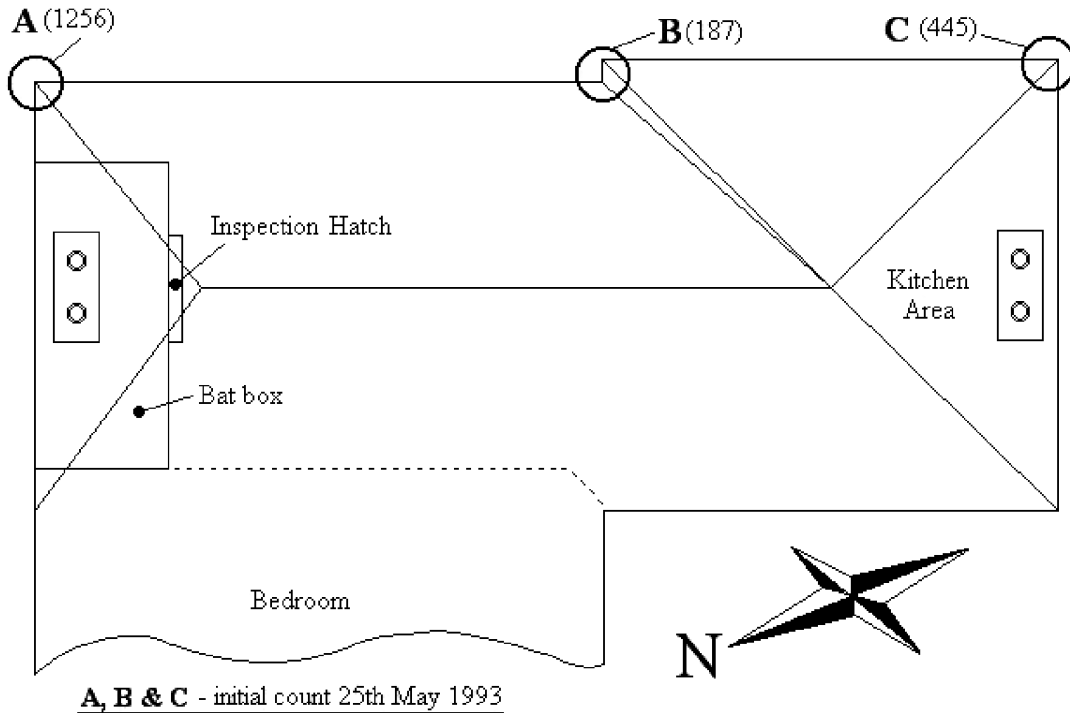
The roost continued to be monitored over the next two years. In 1995 The Robert Stebbings Consultancy was contracted by SNH to design and construct a roost area within the roof to contain the bats and eliminate any smell nuisance (Stebbing 1995).

6.2 Description of construction work

Work started late in 1995. The first phase involved replacing insulation and flooring the roof space. Phase two was completed by the beginning of March and involved the construction of an internal bat roost box around and to the west of the chimney at the north end of the roof. The design of the box followed the recommendations given in Simpson & Brown 1996.



Dalreoch Lodge, Ayrshire (Redrawn by J A McQueen from Stebbings 1995)



Dalreoch Lodge, Ayrshire

6.3 History since construction

In the summer of 1996 it was clear that bats were roosting in areas other than the roost box. On 29/05/1996 340 emerged from the north side of the house (the roost box end), 330 from the south side and 12 from the east side (a total of 682). The following evening 782 bats emerged, all from the north side and none from the south or east.

In September 1996 further work was done to improve the box and to ensure that there was no access possible by bats around the roof except at the entrance to the bat roost box in the north end. An electric socket was provided for a heater to provide additional heat within the roost box.

On 20/05/1997 approximately 100 bats were present in the roof space, around the kitchen chimney on the south side. On 03/07/1997 there were approximately 300 bats visible at the north end, adjacent to the box, and about 30 inside the box. Several young bats, dead or dying, were seen on the floor of the roof space. It was noticed that the roof space was hotter than the inside of the bat box. Seven hundred and eighty three bats were subsequently counted emerging from the roof.

A heater was installed in the roof box on 08/07/1997. In May 1998 some bats found their way into a bedroom and the stairwell. Some bats were observed roosting outside the roost box but 300–350 were seen in the roost box. A fan was installed to cool the roof space in areas away from the box in order to discourage roosting there. On 09/07/1998 1,174 bats were counted emerging from the roost. Other bats were still audible inside the roof after the emergence was complete.

There are no counts recorded in 1999 or 2000. In 2001 the count on 12/06/2001 is the only record of a total for adult bats only.

6.4 Summary of emergence counts

| Date | Count |
|-------------|--------------|
| 25/05/93 | 1,898 |
| 08/06/93 | 1,963 |
| 26/05/94 | 750 |
| 16/06/94 | 1,589 |
| 09/06/95 | 1,275 |
| 29/05/96 | 682 |
| 30/05/96 | 782 |
| 06/06/96 | 1,007 |
| 03/07/97 | 783 |
| 09/07/98 | 1,174 |
| 12/06/01 | 480 |
| 22/08/01 | 623 |

6.5 Reasons for success or failure of the design and suggested improvements

This roost box has been fairly successful. It has contained most of the bats using the roost within the bat roost box. Bats have been prevented from entering via the eaves in most of the roof except at the entrance to the roost box. Some bats still manage to reach the roof space outside the roost box. The smell has been reduced and is no longer evident within the house.

The total number of bats roosting in the summer has been reduced, but it can be seen from the summary that numbers fluctuate greatly. The number of bats roosting in the roof is likely to remain smaller than before construction since bats have been excluded from the southern end of the roof. This will have been warmer than the north end due to solar heat and the proximity of the kitchen and its chimney. The largest number of bats counted emerging from the north end before the box construction was 1,256. At that time (1993) bats were able to use more than one site within the roof, and were known to move between positions. Such a large colony of pipistrelles requires a variety of sites within the roof to suit changes in season, temperature and numbers of bats.

6.6 Recommendations

1. The roost could be improved by providing a roost box in the southern end of the roof in addition to the north end box. This proposal appeared in Stebbings 1995, but after discussions involving SNH and the owner only one box was constructed.
2. Assess the advantage to the colony of roosting in one large concentration versus spread over two or more roosts with a more detailed long-term monitoring of this and other roosts.

7 BATTLEBY, PERTSHIRE

Summary

| Score category | Score | Comments |
|---|-------|--|
| Overall success rating Score (a); rated between 0 and 8 | 5 | This box did not work as originally envisaged as the bats could gain access to other parts of the roof. Subsequent work (2003) appears to have successfully prevented access to these other areas. |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 3 | |
| Reducing problems to householders Score (c); rated between 0 and 4 | 2 | |
| Maximum number of bats before bat box | 280 | |
| Maximum number of bats after bat box construction | 682 | |

This bat roost box was constructed in the southeast facing edge of the roof of the converted coach house wing of Battleby, one of the headquarters offices of Scottish Natural Heritage.

7.1 History of the bat roost

A summary of the history of Battleby's bat box has been described in Pritchard 1993 and 1995.

After the merger of the Countryside Commission for Scotland (CCS) and the Nature Conservancy Council for Scotland (NCCS) in 1992, the newly formed Scottish Natural Heritage (SNH) occupied Battleby House, a 19th Century mansion set in 36ha of landscaped surroundings. Included in the house was a sizeable pipistrelle summer colony. The Nature Conservancy Council was originally asked for advice concerning bats flying inside the building in 1983. At that time the colony was dispersed around the old building. A count of emerging bats was made in 1987, but there was difficulty including all the exit points during counts. It is not known whether or not bats used the newer Battleby Centre before 1991, but in that year an apparently new roost, in the roof above the foyer, made them much more noticeable.

The new site was located along the wall-head on the south side of the building. Occupancy was seasonal with bats arriving in April/May and staying until late autumn. An emergence count in 1992 recorded 280 bats.

The colony however had access through gaps between the ceiling and the rough stone walls into the large foyer areas. On warm days during summer, the bats were active for much of the day, and crawled upwards through the ceiling, frequently emerged and flew around the inside of the building. At night many more entered the building and flew through the corridors.

As well as the roost in the reception area, several other sites in the building continued to be used. A survey of the many lofts was carried out in August 1992 and bat droppings were found in a further seven locations – pipistrelle droppings were in five of these areas, brown long-eared bats *Plecotus auritus* (probably) in two.

The problems caused by bats have been summarised as:

1. The bat roost in the reception area is in close proximity to a catering area and the foyer itself is used frequently as a dining area.
2. Bats regularly entered the building and flew around the foyer and reception offices.
3. Droppings and urine from the roost were evident on the large picture windows and collected on the carpet and tables in the foyer. With bats flying inside the building further droppings could be found almost anywhere in the connecting rooms (including the kitchens). There was a noticeable odour of bats from the roost.
4. Battleby House required extensive maintenance work, involving the stripping of the roof, replacement of timbers, repointing of the stonework and remedial timber treatment.
5. Bats entering the inside of the building were often unable to escape, and small numbers of dead bats were found around the foyer in the mornings.

However there were positive aspects to retaining this roost: an opportunity to promote bat conservation by the provision of interpretative material focused on the Battleby roost; and the provision of bat worker and SNH staff training.

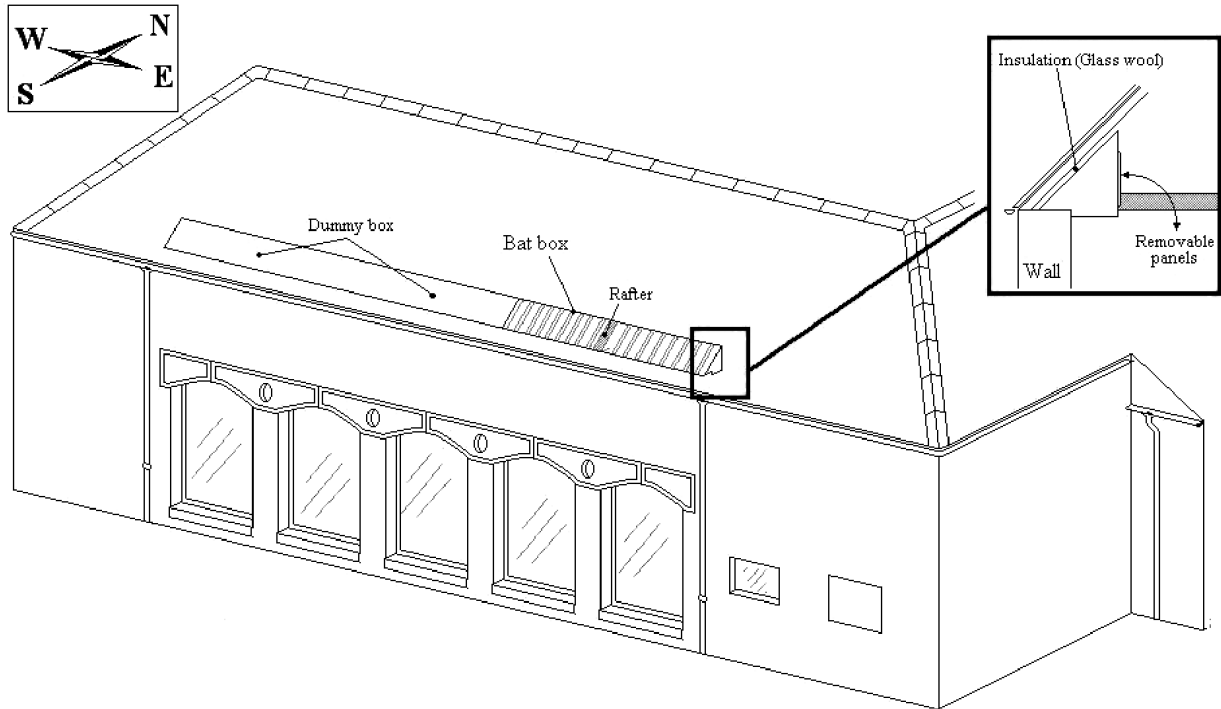
7.2 Description of the bat roost box and its construction

Almost the entire roof of the building was removed, in stages, between November 1993 and March 1994, for timber repairs, and stonework re-pointing. Several hibernating pipistrelles were uncovered in the course of this work.

Prior to re-pointing, those crevices and gaps known to be used by bats or which looked like they could be of value to bats were marked and subsequently left open.

The bat roost box was designed and fitted into the roof during the renovation work. It measured over 6m in length and in two parts each weighing more than 50kg.

With the exception of the floor, the box was made of untreated, rough-sawn, softwood timber. The floor of the box is melamine surfaced for ease of cleaning and to help resist warping from the effect of the wall mounted heaters located a short distance below. Inside, the box is partially divided with boards every 15–20cm to provide numerous surfaces and corners for roosting. Access for the bats is via specially prepared routes across or through the stonework of the wall at its top. There is access for inspection via hinged doors on the inner side.



Battleby, Perthshire

7.3 History since construction of the roof box

In June 1985 a count of bats emerging from this section of roof totalled 682, greater than previous years. However an examination of the box showed that the bats roosted in the space between the box and the roof covering but not inside the box. Some bats were still getting through into the building. Bats were also using roost sites elsewhere around the building.

In March 1995 work was done to prevent roosting around the box, by widening the access routes from the bat holes at the wall head into the box, and by sealing up routes around the box.

No further work has been carried out to the bat roost box. Pipistrelles (and brown long-eared bats) continue to roost in a number of sites around the buildings at Battleby. An examination of the box in October 2001 indicated that bats have not roosted inside the box, but continue to use the space between the box and the roof.

7.4 Reasons for success or failure of the design

1. Gaps exist allowing bats to move into the space around the box. Sealing of entrances identified elsewhere in the building is unlikely to be effective in persuading the bats to roost in the box. In such a large and complex roof they are likely to find new sites. Also care will be required to prevent sealing the entrances to brown long-eared roost sites.
2. Crevices provided inside the box are too large.
3. It is possible that the higher temperatures immediately below the roof surface are preferable to the bats, and the temperature within the box is not high enough.

7.5 Recommendations

1. In order to prevent pipistrelles from using the space around the box and only within the box, it is necessary to seal up all possible gaps (over 5mm) around the box. This will require stripping of the lower edge of the roof to obtain access to any gaps, and to ensure that the existing roost box entrances only lead to the box.
2. Improvement could be made to the inside of the box by providing the type of roost position preferred by this species, ie narrow crevices. This will require some re-designing, eg addition of internal boards to provide narrow crevices.
3. It may also be necessary to provide additional heating during the nursery season (particularly June–July). An investigation of the comparative temperatures between the inside of the box and the positions actually used by the bats would be valuable. It is possible that the higher temperatures immediately below the roof surface are preferable to the bats, and the temperature within the box is not high enough.

8 FORMAKIN, RENFREWSHIRE

Summary

| Score category | Score | Comments |
|---|-------|--|
| Overall success rating Score (a); rated between 0 and 8 | 0 | |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 0 | |
| Reducing problems to householders Score (c); rated between 0 and 4 | 0 | |
| Maximum number of bats before bat box | 20 | |
| Maximum number of bats after bat box construction | 0 | But maximum of 22 adults from adjacent loft (see 8.4). |

A bat roost box has been built in the roof of the East Wing to the mansion house on the Formakin Estate. It was constructed during the renovation of the whole building which now comprises three separate homes. The species roosting in this roof is the brown long-eared bat, *Plecotus auritus*.

8.1 History of the bat roost

The presence of brown long-eared bats was first recorded on 25/07/1995 when advice was sought from SNH on bats observed in the roof. Redevelopment of the property was then being planned. On 01/08/1995 an evening visit established that the bats emerged from windows in the upper floor – through gaps where the windows were damaged or partly open. It was then agreed that a bat roost box would be built into the roof, and alternative access enabled.

About 12–20 bats were observed in July 1998.

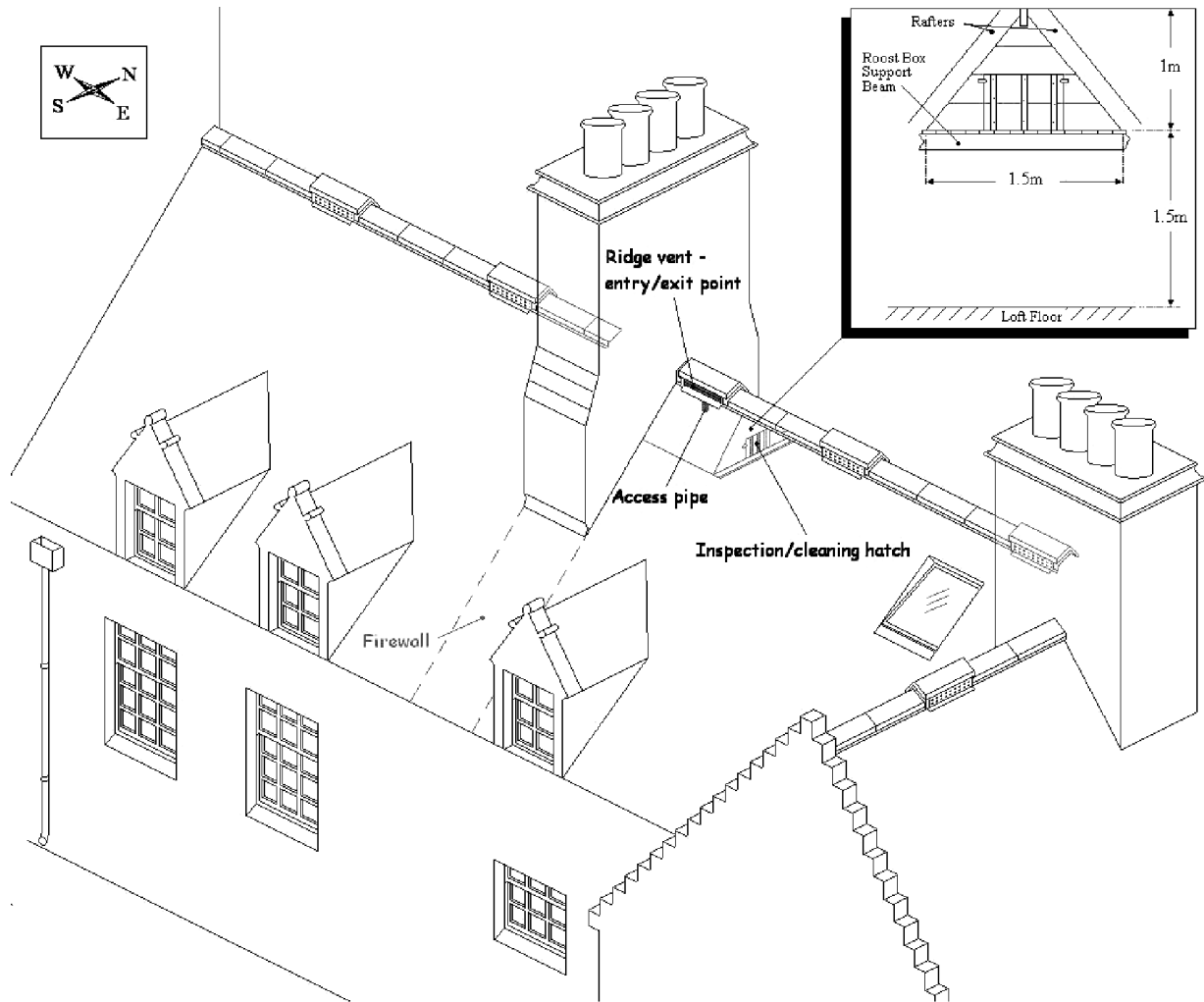
The developers were provided with a copy of “The Design and Construction of Bat Boxes in Houses” and the roost box was constructed in the winter of 1997–1998.

8.2 Description of construction work

The bat box was constructed to the design for the “The Ridge Bat Box” (pages 19–29). At the beginning of this section (4.1.1) it is stated “This is suitable for use at various points along a ridge, eg at a gable or hip, or at an internal chimney. It may be more attractive than an eaves box to brown long-eared and Natterer’s bats.”

An entry point was provided via a ridge ventilator tile with a short length of lead pipe (internal diameter approximately 30mm) attached to the ridge board to provide a route into the box. The floor of the box is 1.5m above the loft floor, and the box is 1m high x 1.5m wide and 1.5m long.

Construction was completed by 05/02/1999.



Formakin, Renfrewshire

8.3 History since construction

Bats were counted while emerging on 02/07/2001 (22 emerged) and 24/07/2001 (36). This was undertaken as part of the National Bat Monitoring Programme (BCT/JNCC). No bats emerged from the bat box, all exited from the ridge ventilators on the western half of the roof. This is separated from the eastern half by a chimney and a fire wall.

The roof section including the roost box was examined on 09/10/2001. There were no signs of bats having used that part of the roof since the redevelopment was completed, and there was no evidence of bats using the bat box.

8.4 Reasons for success or failure of the design

This box has clearly failed to fulfil its intended function, for straightforward reasons: the design of the entrance and the size of the roost box.

The roost of brown long-eared bats still exists in the roof, but only in the western half. There they enter and leave via the ridge vents, which lead to the roof space. The vent intended to provide entrance to the box leads to a narrow lead pipe (though it has been carefully shaped). Long-eared bats are very unlikely to crawl through this vertical tube. Even if they did, traces of the soft metal would be ingested on grooming and possibly lead to toxic levels in the blood.

The main cause of failure is the size of the roost box. In Scotland this species typically roosts in larger attic spaces where they enter at one point but fly through the attic space to find roost positions. Entwistle *et al.* (1997) found that 73% of attics used as roosts by this species had more than one compartment, which gave bats a range of roost sites, and thus a range of temperatures to select a site (Swift 1998). The architect who designed the box clearly followed the design in the SNH booklet, on the recommendation quoted above. In fact the box extends along the roof across four rafters, giving a length of approx. 1.5m. The sketch in "The Design and Construction of Bat Boxes in Houses" (Fig 51, p19) indicates a length equal to the gap between two rafters, ie 45cm.

Natterer's bat *Myotis nattereri* use similar roof spaces to brown long-eared bats. Frequently Natterer's bat will be found in a roost also used by the other species. They do also use confined roosts, but like the long-eared bat, where there is a choice they will opt for a large attic space.

8.5 Recommendations

1. To succeed in containing brown long-eared bats within a roof it will be necessary to provide a large roof space and prevent the bats from entering any other part of the building. In such a large mansion as that at Formakin, this would be a large (and expensive) task. Fortunately this species normally roosts in much smaller numbers than *Pipistrellus pygmaeus*, and rarely causes any nuisance in respect of smells or noisiness.
2. Removal of the lead tube would provide a better entrance.

9 LAIGH RAWES, STIRLINGSHIRE

Summary

| Score category | Score | Comments |
|---|-------|--|
| Overall success rating Score (a); rated between 0 and 8 | 3 | |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 1 | Reflects situation at 2001. |
| Reducing problems to householders Score (c); rated between 0 and 4 | 2 | |
| Maximum number of bats before bat box | 950 | Estimate of adults. |
| Maximum number of bats after bat box construction | 1,331 | The majority of these bats used the box in the year of construction, but not thereafter. |

This roost box was built into the coom space of a large, traditional stone-built house. The house has two full storeys, and a third storey has been constructed from the large attic space. The box is at the north end of the west-facing roof slope. The bats using the roost are pipistrelles, *Pipistrellus pygmaeus*.

9.1 History of the bat roost

Recorded information on the bats in this roost began on 30/08/1991, when the owner asked the Nature Conservancy Council for Scotland for advice, since timber treatment in the roof was planned. At that time only five bats were seen in the roof space – brown long-eared bats, *Plecotus auritus*. On 09/07/1993 a second advice visit recorded 30–40 long-eared bats and a large number of pipistrelles visible in the roof spaces.

In 1994, Laigh Rawes was sold to new owners. The pipistrelles were particularly noticeable that summer, since they were concentrated at the north gable end, where the attic room was used as an office by the owners. Numbers of bats also used the lower edge of the roof's west side. Another roost area was at the south end, close to the hot water storage tank.

In December 1994 droppings were cleared from the roof space to reduce any smell problem. Unfortunately during part of the cleaning process use of a vacuum cleaner in the northwest coom space caused damage to the ceiling below. The vibration from the cleaner loosened a piece of the already cracked ceiling and it fell into the room below. SNH accepted responsibility for the damage and compensated the owners for the cost of repairs.

On 25/07/1999 the number of bats counted on emergence was 1,880. Since bats emerged from the north, west and south sides, several local bat workers were required to make an accurate count. At this date in the summer, juvenile bats were flying, so it can be estimated that the number of adult females will be 950–1000.

In July 1999 the Robert Stebbings Consultancy was asked by SNH to provide a report on the management of this roost. The report proposed the construction of a bat roost box to limit roosting to the north-west corner of the roof (Stebbing 2000).

9.2 Description of construction work

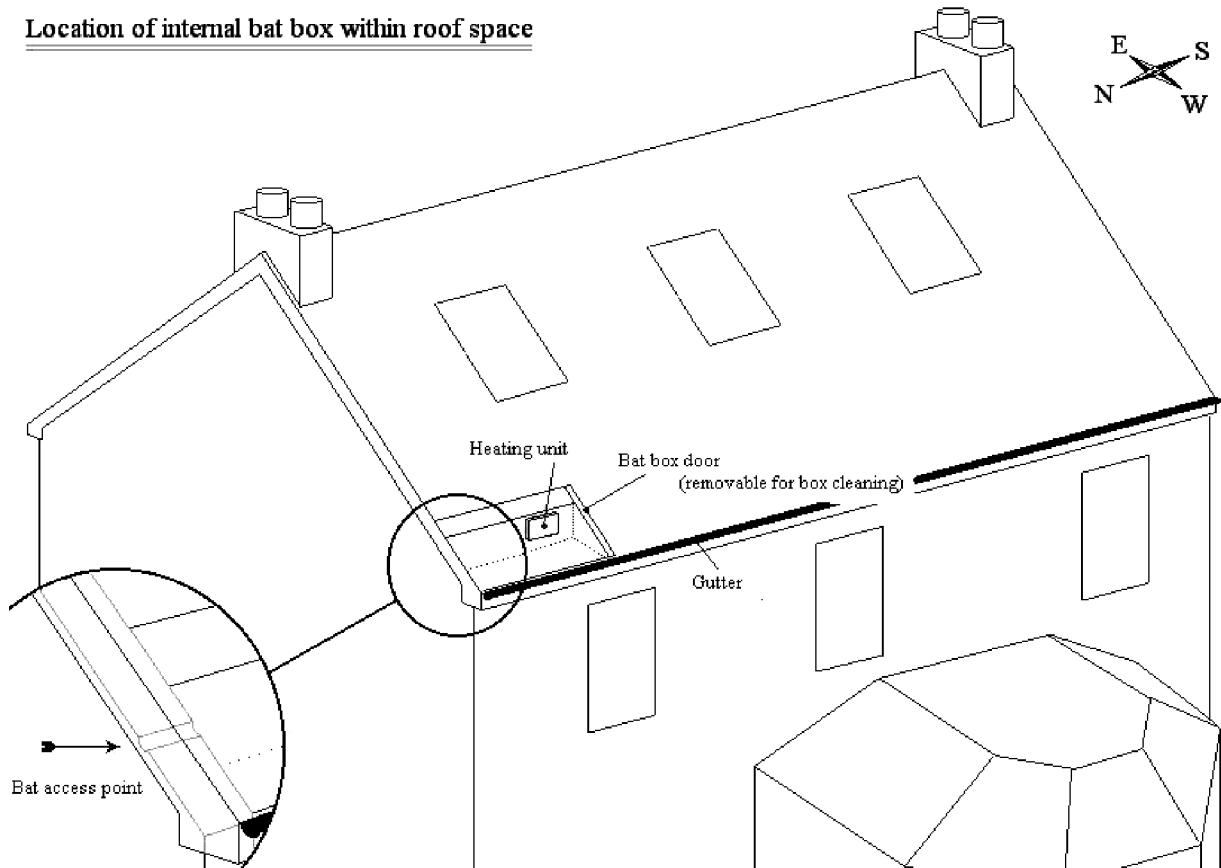
Construction of the bat box took place in the spring of 2000. It was built from within the coom space, by constructing a floor across 7 joist spaces, nailing rough sawn timber to the back of the stud wall, then attaching a door to the south end. This door has a bat excluder fitted into it – a one-way opening which enables stray bats to enter the box from the roof space but not escape from the box. A small heater, connected to the house heating system, was mounted on the internal wall to provide additional heat during the nursery season.

An entrance was constructed at the top of the north gable wall to allow bats to enter and leave.

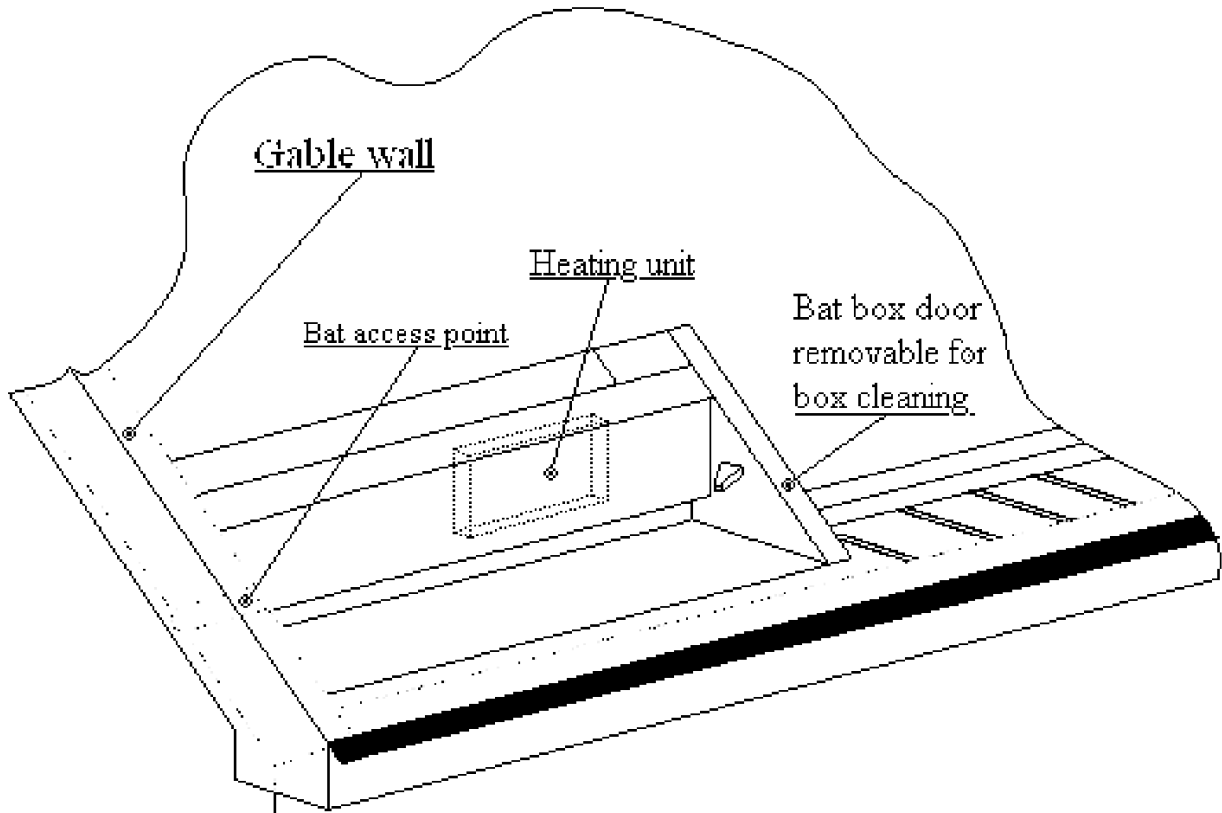
The lower edges of the roof on the east and west sides were sealed by removing the fascia boards and dealing any gaps with polyurethane foam. Five plastic pipe excluders were fitted to allow bats to escape but not re-enter.

Work on the roof was completed in April 2000.

Location of internal bat box within roof space



Laigh Raws, Stirlingshire



Laigh Raws, Stirlingshire

9.3 History since construction

In the summer following construction the roost box was occupied by bats, but there was still a proportion of them roosting outside the roost box, at positions around the roof as before. It was apparent that bats were gaining entry via several places not sealed up during construction. The maximum number of adult bats counted was 1,331 on 23/6/00.

Later in the year it was decided that the condition of the roof was such that the bats' points of entry could not be limited to one position. Complete re-felting and re-slating was proposed. This was done in April 2001. At the same time some additional work was done to ensure that access by bats was restricted to the roost box entrance only. The work on the roof continued later than was planned, and as a result ran into the start of the roosting season.

During the summer of 2001 the roost box was not occupied, apart from a small number in May and early June. In an emergence count on 09/08/2001 only 5 bats were observed leaving the roof – from the apex on the north side of the south gable chimney. On the same evening 63 emerged from the garage roof in the house grounds.

9.4 Summary of emergence counts

| Date | Count |
|-------------|--------------------------------|
| 09/07/93 | "Large number" |
| 25/07/99 | 1,880 |
| 10/06/00 | 60 |
| 23/06/00 | 1,331 |
| 2001 | "Small" number of bats present |

9.5 Reasons for success or failure of the design

It is too early to consider this roost box a success or a failure, since the latest work on the roof overlapped with the beginning of the nursery roost season in 2001, and possibly resulting in them moving to another site.

Exclusion of the bats from the roof, other than the bat roost box, was unsuccessful in the first year because of the number of possible access points. Re-roofing has greatly improved this, but it is likely that some bats will always gain access to crevices in and around the roof. The roost box accommodated the majority of the bats in the first season (2000). In the summer of 2001 the bats moved to another nursery roost. Another roost is known to exist within 1km of Laigh Raws, and since it is common for pipistrelles to change roosts without any apparent disturbance, it remains to be seen whether the bats will return.

Discussion

A number of problems were identified with the design and construction of the boxes. These included:

- inappropriate design of the entrance to the box (5 boxes);
- insufficient temperature within the box (3 boxes);
- inappropriate size of box (2 boxes);
- unsuccessful exclusion from other sites within the property (8 boxes);
- unsuitable position within the roof (4 boxes);
- inappropriate timing of construction (1 box).

These problems and deficiencies are summarised by property in Table 1.

Table 1 Elements of roost box design and installation procedure limiting the use of the box by bats

| Site | Aden | Keithfield | Gariob | Seafield | Burnhead | Dalreoch | Battleby | Formakin | Laigh Raws |
|--------------------------------|------------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|---------------|
| Species | <i>P. pip.</i> ? | <i>P.pyg.</i> | <i>P.pyg.</i> | <i>P.pyg.</i> | <i>P.pyg.</i> | <i>P.pyg.</i> | <i>P.pyg.</i> | <i>Pl. auritus</i> | <i>P.pyg.</i> |
| Problems or deficiencies | | | | | | | | | |
| Entrance | + | + | + | | | | + | + | |
| Temperature in box | | | + | | + | | + | | |
| Size of box | | | | | | + | | + | |
| Exclusion from other positions | + | + | | + | + | + | + | + | + |
| Position in roof | | | + | | + | + | + | | |
| Timing of construction | | | | | | | | | + |
| Success rating (0–8) | 0 | 5 | 2 | 0 | 3 | 6 | 5 | 0 | 3 |

Table 2 Use of the roost following installation of bat box together with a score of ‘success’ (a balance between maintaining the colony and reducing the nuisance to the householder).

| Site | Aden | Keithfield | Gariob | Seafield | Burnhead | Dalreoch | Battleby | Formakin | Laigh Raws |
|--|----------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|---------------|
| Species | <i>P. pip?</i> | <i>P. pyg</i> | <i>P. pyg</i> | <i>P. pyg</i> | <i>P. pyg</i> | <i>P. pyg</i> | <i>P. pyg</i> | <i>Pl. auritus</i> | <i>P. pyg</i> |
| Overall success rating: Score (a); rated between 0 and 8 | 0 | 5 | 2 | 0 | 3 | 6 | 5 | 0 | 3 |
| Maintaining the bat colony Score (b); rated between 0 and 4 | 0 | 3 | 0 | 0 | 1 | 2 | 3 | 0 | 1 |
| Reducing problems to householders Score (c); rated between 0 and 4 | 0 | 2 | 2 | 0 | 2 | 4 | 2 | 0 | 2 |
| Maximum number of bats before bat box | 44 | 548 | 950 | 769 | 3,500 | 1,963 | 280 | 20 | 950 |
| Maximum number of bats after bat box construction | 0 | 455 | 0 | 277 | 740 | 1,174 | 682 | 0 | 1,331 |

Conclusions and recommendations

This study has identified six key requirements of bat boxes, the absence of which appears to limit their use by bats:

1. It must be possible to prevent access to any other part of the roof. All gaps of 6mm or over must be blocked, since it has been shown that bats can gain entry through any gap of this size. It is important, however, to ensure that measures taken do not conflict with the ventilation requirements of the roof.
2. The temperature within the box should be at least that within the existing roost spaces. An additional source of heat may be required.
3. The entrance should be designed to be similar to the existing one, and should be composed of suitable rough(ened) material.
4. The size of the box should be adequate to accommodate the species and the number of bats roosting.
5. Construction of the box should be done outside the season in which bats normally occupy the roost (ie usually from November to March).
6. The position of the box should be within part of the roof already used for roosting.

Two further recommendations, to improve use of bat boxes by bats and to increase their potential contribution to bat conservation, arise from this study:

1. An interim revision of *The Design and Construction of Bat Boxes in Houses* (Simpson & Brown (Architects), 1996) published by Scottish Natural Heritage (out of print) should be produced, taking the above recommendations into account.
2. To improve the rate of occupation by bats and ensure that the problems highlighted during this study are addressed, a bat box research programme should fine tune and test new designs for bat boxes, and the conditions they provide. The results from this study should feed into a subsequent revision of *The Design and Construction of Bat Boxes in Houses*. This programme should include a grant scheme for bat boxes in order to accelerate the process of testing and fine-tuning designs from *The Design and Construction of Bat Boxes in Houses*.

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