

# A study of bats at Birkhill Fireclay Mines on the River Avon, Scotland

Authors: Neil E Middleton\*, Christopher Gould and Kirsty Morrison

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Correspondence Address: 25 Killin Drive, Polmont, Falkirk, Scotland, UK, FK2 0QQ  
email: middleneil@msn.com

## Abstract

During 2003 and 2004 a small number of bat surveys were carried out at Birkhill Fireclay Mines (near Bo'ness, Scotland), in order to establish activity and diversity of species present. We adopted a number of methods (i.e. harp trapping and bat detector surveys) resulting in us establishing that the site was being used for roosting and/or foraging purposes by at least three species of bat (*Myotis daubentonii*, *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus*). This paper provides an overview of the site, the methods adopted and the results obtained.

Key words: bat, harp trapping, detector, *Myotis daubentonii*, *pipistrellus*, *pygmaeus*

## Introduction

This paper provides a summary of bat work carried out at Birkhill Fireclay Mines (near Bo'ness, Falkirk, Scotland) during 2003 and 2004. The project work pertaining to this site was never intended to be long term and as such our methods were more geared towards finding out as much as possible about the bat activity at the site in a short period of time. The site was surveyed twice in 2003 (August and October) and once in 2004 (May).

## Background information about the site

The site lies not far to the south west of Bo'ness in the Falkirk Council area (OS Grid Ref: NS963789) and is a popular tourist attraction served by a local steam railway (Bo'ness Steam Railway). During the period April to October, annually, the mines themselves attract circa 8/10,000 visitors. The area is managed by Falkirk Council and our bat survey work here has also, conveniently, contributed towards the Falkirk Local Biodiversity Action Plan (LBAP).

The site, although small, has a number of interesting features that make it of particular value to wildlife generally and bats in particular. The River Avon runs through the gorge where the mine entrances are present, this area being surrounded by semi natural ancient woodland. In addition to this there is a natural meadow above the gorge, old mine buildings and three mine entrances to which bats could gain access (only one entrance, Mine 3, is open to the public). The other two entrances relate to Mine 1 and were blocked off circa 10 years

ago, albeit in a manner that still allowed bats to gain access. The River Avon travels through the site creating a natural wildlife corridor connecting the area to other valuable sites locally (i.e. the Union Canal and Muiravonside Country Park). To the north of the site there is an area designated SSSI. The site also has a number of less common flowers present and has been noted as a place of interest with regards to butterflies. Roe deer and otters have also been recorded in the locality.

Having assessed the site, we concluded that the area would be an ideal location for such a project for the following reasons:

- A wide diversity of habitat and features in a concentrated area.
- The River Avon passed directly through the site.
- A local tourist attraction.
- Accessibility to the site.
- Availability and enthusiasm towards such a project displayed by site management and staff.

## Details about the mines

Geologically the area consists of a sandstone surface layer, beneath which lies a bed of fireclay, underneath this, limestone (not exposed). Fireclay is formed through seat earth clay being compressed and dehydrated into mud stone. As such solid rock is formed (albeit a relatively soft stone compared to others).

Birkhill Fireclay Mines were opened up to production initially in 1916 when Mine 1 was worked until circa 1928. Mine 3 opened up later and was worked until the 1940s. For a map of the

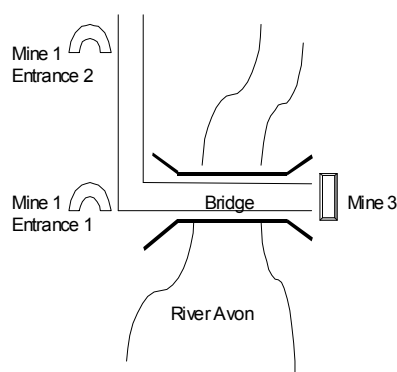
site please refer to Figure 1. A second mine (Mine 2) also existed, however this has now been totally sealed over and did not form part of our study.

In Mine 3 there is approximately 6 miles of tunnels, most of which are flooded to roof level. There is however probably about 1.5 miles of accessible area beneath the surface.

In Mine 1 the total tunnel area is only circa 2 miles, again with a good percentage of this not being accessible due to flooding. Mine 1 however is more level and does not drop away to the same extent as Mine 3. It should be noted that both entrances to Mine 1 are connected by a tunnel only a matter of metres behind the blocked area. The internal distance between these entrances is therefore only about 75 m. Note also, that although technically speaking it would be possible to access this mine, it is blocked up in such a way that special equipment would be required along with extensive Health & Safety Risk Assessments and the presence of expert advice relating to this type of site. For the purposes of our survey work we decided that access to this mine would not be required, albeit at some stage in the future this could prove a useful exercise.

The structure of the tunnels within all of these mine areas is a system known in Scotland as 'Stoop and Room' (in England 'Pillar and Stall'). In effect the tunnels are in grid/honeycomb type order. Away from the entrances and the areas to which fresh air is able to circulate the temperature remains fairly constant at 11 °C.

Figure 1: Map of survey site (not to scale)



## Overview of survey methods adopted

In view of the short period of time in which we wished to gather as much detail as possible it was decided to simultaneously adopt a variety of techniques at the site during each of the three survey evenings. The study site was divided into

two main areas of activity, namely the 'Meadow' and the 'Gorge'.

## Survey dates and environmental conditions

The site was surveyed on three occasions between August 2003 and May 2004. During each of these evenings we recorded some basic weather information along with some other useful points as summarised in Table 1 below.

Table 1: Environmental conditions recorded during each survey evening

	Survey 1	Survey 2	Survey 3
Date	12.08.03	02.10.03	24.05.04
Sunset	21.01	18.49	21.40
Start Time	21.31	19.19	22.10
End Time	23.05	21.30	23.30
Temperature	14.9 °C	12.6 °C	9.6 °C
Rain	Dry	Light / Dry	Dry
Wind	Light	Calm	Light
Cloud Cover	100%	100%	0% (nil)

## Meadow: heterodyne methods

For the Meadow area we adopted a transect methodology, starting our surveys at sunset + 30 mins on each occasion, finishing approximately 50 mins later. Designated points were selected (N=10) in order to produce a route covering a variety of features in the area.

In order to maximise bat encounters, two heterodyne detectors were used during these surveys. One detector was tuned to 45 kHz and the other tuned to 55 kHz. These frequencies were chosen as they usually concur with the peak frequencies of maximum energy used by the two species of pipistrelle bat found in Scotland (Haddow and Herman, 2000). In addition we would also be in a position to listen for bats belonging to the genus *Myotis* (i.e. Daubenton's bat and Natterer's bat). Bat passes were counted during these surveys, both at the designated survey points (point reference) and in between (during the walk between each point reference). Table 2 shows the position of each of our designated survey point references. At each point the surveyors stopped for four minutes and noted bat passes, allocating these to bat species/family/genus where possible.

Table 2: Position of designated survey points relating to transect surveys of the Meadow area

Point ref'	Description	Point ref'	Description
1	Foot of steps next to Entrance 2, Mine 1	6	Bench at foot of slope, under trees
2	Top of steps, outside old buildings	7	Clearing where power lines pass overhead
3	10 m beyond toilet block sign	8	Bench at corner on upward slop
4	Where path at start of meadow forks	9	On path with Silver Birch on either side
5	50 m further along path	10	Oak tree on right, at edge of wooded area

## Meadow: heterodyne results

During this aspect of our studies we only ever encountered pipistrelle bats, mostly relating to *Pipistrellus pygmaeus* (Soprano pipistrelle), but with a small number of *Pipistrellus pipistrellus* (Bandit or Common pipistrelle) also being present. In addition to these records a small number of pipistrelle bats were encountered that could not be allocated to species level as their frequency of maximum energy fell between the diagnostic ranges of the two potential species of pipistrelle occurring in the area. These bats will belong to one of the two previously mentioned species but cannot be safely allocated to either. As such we described them as '*Pipistrellus* spp. (unallocated)'. Table 3 below summarises the results obtained during this part of our study.

Table 3: Heterodyne bat detector survey results (Meadow)

Survey Time Log				<i>Pipistrellus pipistrellus</i>			<i>Pipistrellus pygmaeus</i>			<i>Pipistrellus</i> spp. (unallocated)		
				Number of bat passes recorded								
Survey Number	1	2	3	1	2	3	1	2	3	1	2	3
Point 1	21.32	19.20	22.10	1			8		10		1	
Walk									3		2	
Point 2	21.39	19.30	22.16				1	12	1			
Walk							2					
Point 3	21.45	19.35	22.21						2	1		
Walk										1		
Point 4	21.51	19.40	22.27									
Walk										1		
Point 5	21.57	19.46	22.32					1	2			
Walk												
Point 6	22.02	19.50	22.37			1			1			
Walk								1				
Point 7	22.08	19.55	22.42					1				
Walk								1				
Point 8	22.13	20.01	22.47				2	1				
Walk												
Point 9	22.19	20.06	22.52	1								
Walk												
Point 10	22.25	20.11	22.57	1								
Totals				3	0	1	13	17	20	2	3	0

## Meadow: time expansion methods

In addition to the heterodyne detectors, a time expansion detector (Courtpan, EcoTranquility) was also used during the transect surveys of the Meadow area with bats being recorded on to a mini disc recorder (Sony, MZ-R30). The detector was set to record with a time expansion of X10, capturing real time sequences of 640 ms. All recorded data was later analysed using sound analysis software (Pettersson Elektronik A B, Batsound, V3.0). For analysis purposes we used a sampling frequency of 22.05 kHz (16 bits, mono), and a 512 point FFT with a Hanning window.

## Meadow: time expansion results

Figure 2 shows the results for each survey with the bats allocated to their frequency of maximum energy. Table 4 allocates the total number of bats for all surveys to species level. Note, that due to the operational differences that exist between heterodyne and time expansion bat detector systems (Ahlen, 2004) the bats that contribute towards these results do not necessarily tie in with those recorded during the heterodyne surveys that were being carried out simultaneously.

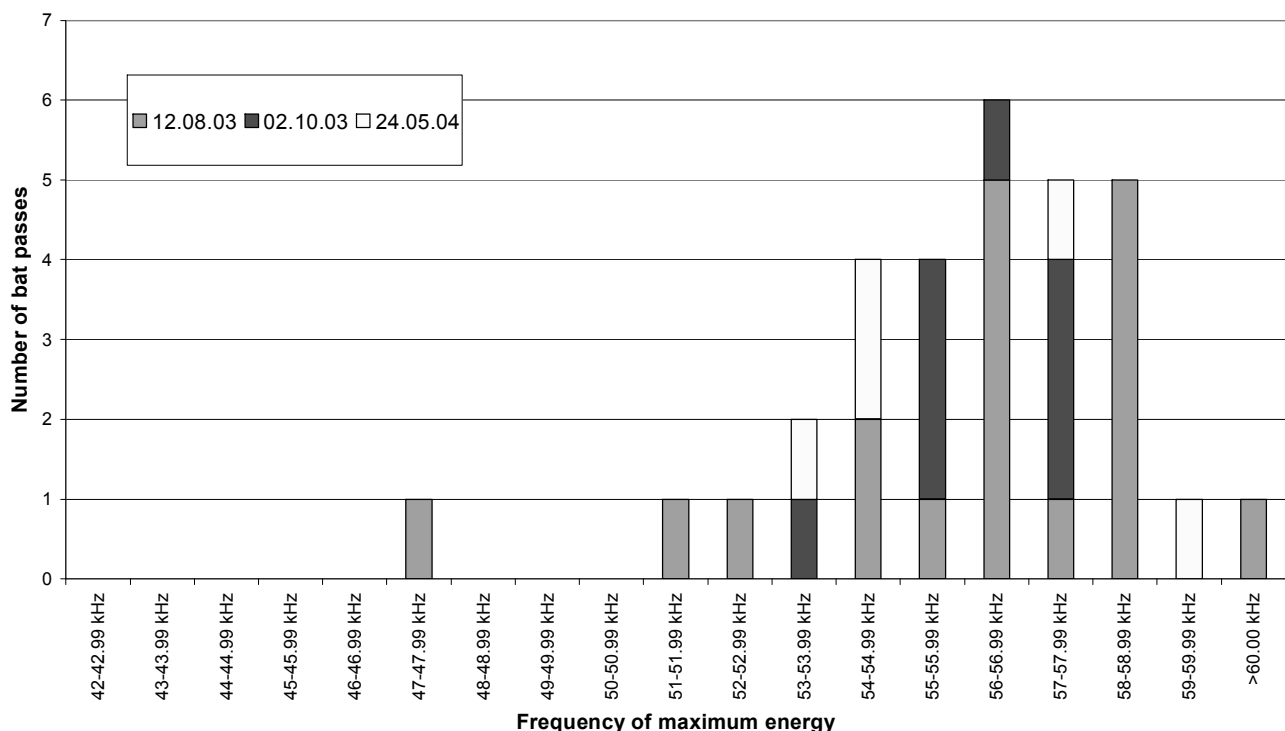
Table 4: Time expansion results (Meadow). Total of all bats encountered allocated to species

Species	<i>Pipistrellus pipistrellus</i> (<48.00 kHz)	Unallocated <i>Pipistrellus</i> spp. (48-51.99 kHz)	<i>Pipistrellus pygmaeus</i> (>52.00 kHz)
Bat Passes	1	1	29

## Meadow: new *Pipistrellus pygmaeus* maternity roost discovered

In addition to the bats encountered during the transect surveys we were also alerted to the possibility of a bat roost in a nearby holiday cottage (S Smith, Lothians Bat Group, pers. comm.). During our survey activity in May 2004 we visited the location (with the owners permission) and were able to confirm the presence of a *Pipistrellus pygmaeus* (Soprano pipistrelle) maternity roost which was in the process of an evening emergence at 21.27 on the date in question. The exact details of this roost have been omitted from this report as it is within a private dwelling, however it is contained within OS Grid Ref: NS9678.

Figure 2: Time expansion survey results (Meadow), pipistrelle bats allocated by recorded frequency of maximum energy



## Gorge: heterodyne methods

This survey only took place on two of the evenings (12.08.03 and 24.05.04). In order to establish use by bats relative to various strategic points within the Gorge we set up four heterodyne bat detectors each linked, simultaneously, to its own channel on a four track recorder (Fostex Corporation, model X24). This methodology was similar to that developed by BATS & The Millennium Link (BaTML) to monitor *Myotis daubentonii* (Daubenton's bat) on the canal corridors in the Central Belt of Scotland (Middleton *et al.*, 2004). The precise location of each of these detectors is described in Table 5 below.

Detectors 1, 2 and 4 were all set to 50 kHz. This frequency was a compromise whereby both species of pipistrelle bats could be heard, but not specifically identified, as well as being within a range whereby the presence of *Myotis* spp. could also be ascertained.

Detector 3, which was focussed on an area of calmer water on the River Avon, was tuned to 40 kHz in order to maximise the chances of it picking up *Myotis daubentonii* foraging along the river below.

Table 5: Position of heterodyne detectors in the Gorge area

Detector 1 (50Khz)	Pointing directly into Mine 1 (Entrance 2)
Detector 2 (50Khz)	Pointing directly into Mine 1 (Entrance 1)
Detector 3 (40Khz)	Positioned on the bridge pointing north (downstream) over the River Avon
Detector 4 (50Khz)	Pointing directly into Mine 3 (the mine to which tourists have access)

## Gorge: heterodyne results

All bat activity recorded for each location is shown in Table 6 below. As a result of our analysis we would make comment upon a number of interesting observations. On the first survey date bats were heard to be present inside both entrances to Mine 1 from approximately 15 mins before sunset (i.e. 20.45). This activity had died down considerably by the time our bat detector surveys commenced some 45 mins later.

Feeding buzzes were evident throughout the first survey from the area covered by Detector 3. This

activity mostly belonged to *Pipistrellus pygmaeus* flying above the river, as well as *Myotis daubentonii*. Good levels of social calls, again belonging to *Pipistrellus pygmaeus*, were also recorded during the first survey from the area covered by Detector 3. These calls were particularly regular from about 75 mins after sunset.

Although during the first survey not much activity could be placed from coming within the mine to which tourists have access (Mine 3), the second survey produced a considerable amount of activity here and we are fairly certain that bats were exiting and/or entering this mine entrance throughout the evening.

Activity at Mine 1, Entrance 1 (Detector 2) will have been affected to some extent as a result of a harp trap positioned there on each of the two survey evenings.

Table 6: All bat activity (passes), split by genus, recorded using heterodyne methods in the Gorge area

Detector Number Genus	12.08.03	24.05.04
Detector 1 <i>Pipistrellus</i> spp.	40	Constant
Detector 1 <i>Myotis</i> spp.	30	101
Detector 2 <i>Pipistrellus</i> spp.	NIL	NIL
Detector 2 <i>Myotis</i> spp.	20	7
Detector 3 <i>Pipistrellus</i> spp.	73	Not Recorded
Detector 3 <i>Myotis</i> spp.	159	Not Recorded
Detector 4 <i>Pipistrellus</i> spp.	12	79
Detector 4 <i>Myotis</i> spp.	NIL	13

## Gorge: time expansion methods and results

This survey took place on all three evenings. The time expansion detector was positioned on the bridge next to heterodyne Detector 3 and was also

directed over the River Avon facing north. The settings and analysis followed that of the time expansion methods for the Meadow area (refer to earlier section).

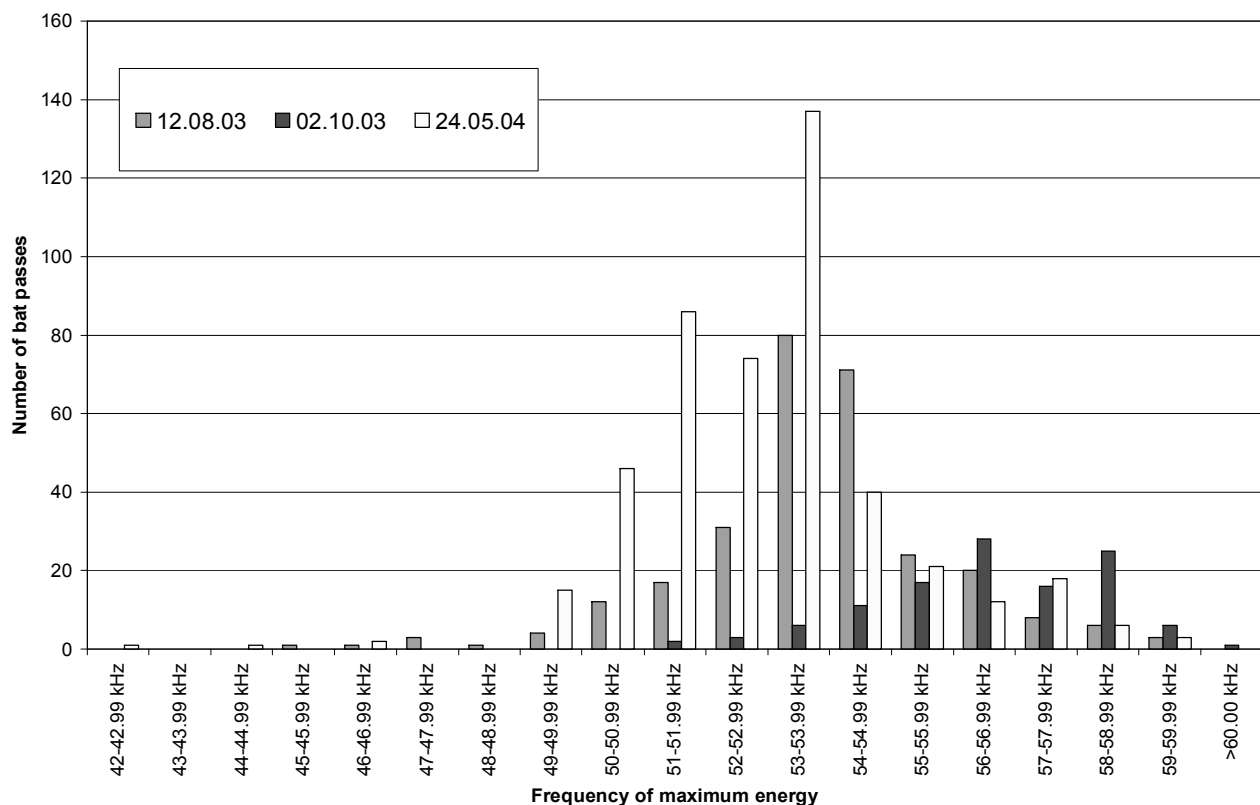
Table 7 shows the total pipistrelle spp. results collected over the three survey nights. In addition to pipistrelle spp. being present, *Myotis* bats were also recorded regularly during the surveys. These bats were difficult to see, however in all likelihood they were almost certainly *Myotis daubentonii* as we were able to witness the typical behaviour of this species with a red spotlight as they flew past, very close above the water surface (Altringham, 2003; Vaughan *et al.*, 1997). Figure 3 shows the pipistrelle spp. results for each survey with the bats

allocated to their recorded frequency of maximum energy.

Table 7: Time expansion results (Gorge) overall total of all bat passes recorded from the three survey evenings

	<i>Pipistrellus pipistrellus</i> (<48.00 kHz)	<i>Pipistrellus</i> spp. (unallocated) (48-51.99 kHz)	<i>Pipistrellus pygmaeus</i> (>52.00 kHz)
Bat Passes	9	183	667
%age	1.1%	21.3%	77.6%

Figure 3: Time expansion survey results (Gorge), pipistrelle bats allocated by recorded frequency of maximum energy



## Gorge: harp trapping methods and results

During each of the three survey evenings a harp trap was placed at one of the entrances to Mine 1. The trap was in position from approximately sunset for two hours thereafter. To assist with capture rates, heavy duty scaffolding netting was also used to block off most of the area surrounding the trap as positioned centrally within the mine entrance. On each occasion, however, we did leave a small area around the trap open in order to allow bats, aware of its existence, an escape route.

Although we did not capture many bats at the site using this technique, we were able to show beyond doubt the presence of *Myotis daubentonii* in the area. All of the captured bats belonged to one species, *Myotis daubentonii*. Table 8 summarises our results in this respect. All bats were identified and processed quickly with details of sex, weight, tragus length, calcar shape, forearm length, ossification and the presence of a dark chin spot (Richardson, 1994) all being noted. The latter of these features can be of particular assistance in determining whether or not a bat of this species is an immature.

Table 8: *Myotis daubentonii* captures. Results of harp trapping (Gorge) at entrances to Mine 1

Date	Entrance Number	Age/Sex	Weight (g)	Forearm (mm)
12.08.03	1	Adult/Male	8.0	35.6
02.10.03	2	Imm/Male	11.0	36.7
24.05.04	1	Imm/Male	8.0	36.8
24.05.04	1	Adult/Female	9.5	38.1
24.05.04	1	Adult/Male	8.0	37.2

## Discussion

In total we were able to visit the site only three times, however our visits were geared to different seasonal activity (i.e. May, August and October).

As a result of our work we are able to make certain conclusions about bat activity in the immediate area as follows.

*Pipistrellus pygmaeus* (Soprano pipistrelle) is present in good numbers both within the Gorge and around the Meadow area. In addition to foraging in the area, a maternity roost has been found and social calls (presumably belonging to male bats advertising for females) have been recorded later in the summer. Of the two pipistrelle species, Soprano pipistrelle is by far the most regularly occurring.

*Pipistrellus pipistrellus* (Bandit or Common pipistrelle) although present in the locality appears to be fairly scarce.

*Myotis daubentonii* (Daubenton's bat) forages over the river at this point and also uses the mine entrances in some capacity during the evening. It is quite likely that small numbers of these bats are roosting within Mine 1 as the levels of activity heard by us occurred very early in the evening. In addition to this, it is possible that other *Myotis* spp. may be present in the area (i.e. *Myotis nattereri*).

Mine 1 (Entrances 1 and 2) and Mine 3 are used by bats (*Pipistrellus* and *Myotis* species) early evening during emergence time and during the hours of darkness. Although we cannot be certain to what extent and specifically for what reason.

The combination of features and access to a large number of potentially interested visitors not only meant that we could conduct a valuable study, but we could do this in such a way that helped bats generally. The site already had an interpretation board outside one of the entrances to Mine 1 where

bats were highlighted (pipistrelle) and as a matter of course the tourist guides always mentioned bats during their public tours. By involving a number of these guides with our work we have helped to improve their knowledge about the bats that they so regularly talk about. To support this activity a factsheet has also been produced for the site guides to refer to.

## Acknowledgements

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