

The distribution, relative abundance and emitted frequencies of maximum energy of *Pipistrellus* spp. along the canal corridors in the Central Belt of Scotland

Author: Neil E Middleton* and Kirsty Gourlay

Dated: 30th November 2006

*Correspondence Address: email: neil.middleton@echoesecology.co.uk

Abstract

The BATS & The Millennium Link (BaTML) project carried out Time Expansion bat detector surveys during the period 2001 to 2005 in order to record the distribution, relative abundance and frequencies of maximum energy of *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* along the canal corridors within the Central Belt of Scotland. This paper reports on the results of the data collected.

Key Words: Bats, Millennium Link, surveys, *pygmaeus*

Introduction

BATS & The Millennium Link (BaTML) was launched in 2000 to study the bat populations along and adjacent to the canal network in the Central Belt of Scotland (Middleton *et al.*, 2004). During our activities we conducted a survey programme, using Time Expansion bat detectors (TED), to map the distribution and establish the relative abundance of *Pipistrellus pipistrellus* (Common or Bandit pipistrelle) and *Pipistrellus pygmaeus* (Soprano pipistrelle).

Methods

An overview of the species being studied and the methods adopted by BaTML in the collection and analysis of data has already been reported upon (Middleton *et al.*, 2005).

In summary, during the period 2001 to 2005, BaTML carried out 101 TED surveys contributing towards this study. Each survey was undertaken at one of 22 randomly selected sites. Our surveys commenced at 30 minutes after sunset and lasted for 90 minutes thereafter. All surveys were carried out during the period April to September each year and in total we collected 151.5 hours of data.

Results

We have split our results into three sub sections, each of which tackles the separate aspects relating to this study. For a fuller account of the supporting data relating to these results please refer to Appendix I.

Frequencies of maximum energy recorded during our study programme

Whilst measuring the frequency of maximum energy (FmaxE), in order to help allocate bat echolocation calls to species, we noticed a large percentage (28.85%) of calls falling between the frequencies of 48 kHz and 52 kHz. When considering FmaxE in isolation, whilst trying to separate *Pipistrellus pipistrellus* from *Pipistrellus pygmaeus*, if any calls are encountered between these frequencies it is not safe to allocate them to a specific species. In such circumstances we have described these bats within our analysis overall as an Unallocated *Pipistrellus* sp.

Although it was never an initial aim of ours to specifically study the FmaxE relating to *Pipistrellus* spp. we felt it would be useful, due to the amount of unallocated calls we were encountering, to explore this area further. As such, for the period May 2001 to September 2004 we noted the precise FmaxE of the bats we were allocating to the three potential species groups we were interested in, namely: *P. pipistrellus*, Unallocated *Pipistrellus* spp., *P. pygmaeus*. During this exercise 4,814 calls were measured for FmaxE, the results of which are shown in Figure 1.

As a comparison against our canal study area we also decided to take a selection of results collected and measured in a similar way from other sites within the UK. These sites were purely selected on the basis that they happened to be areas where one of the authors (N Middleton) was visiting for other reasons anyway. 2,701 calls were recorded from these non Central Belt canal sites and the results relating to this UK wide sample are shown in Figure 2.

Figure 1: FmaxE relating to *Pipistrellus* spp. recorded during BaTML Surveys from May 2001 to September 2004 (4,814 data entries)

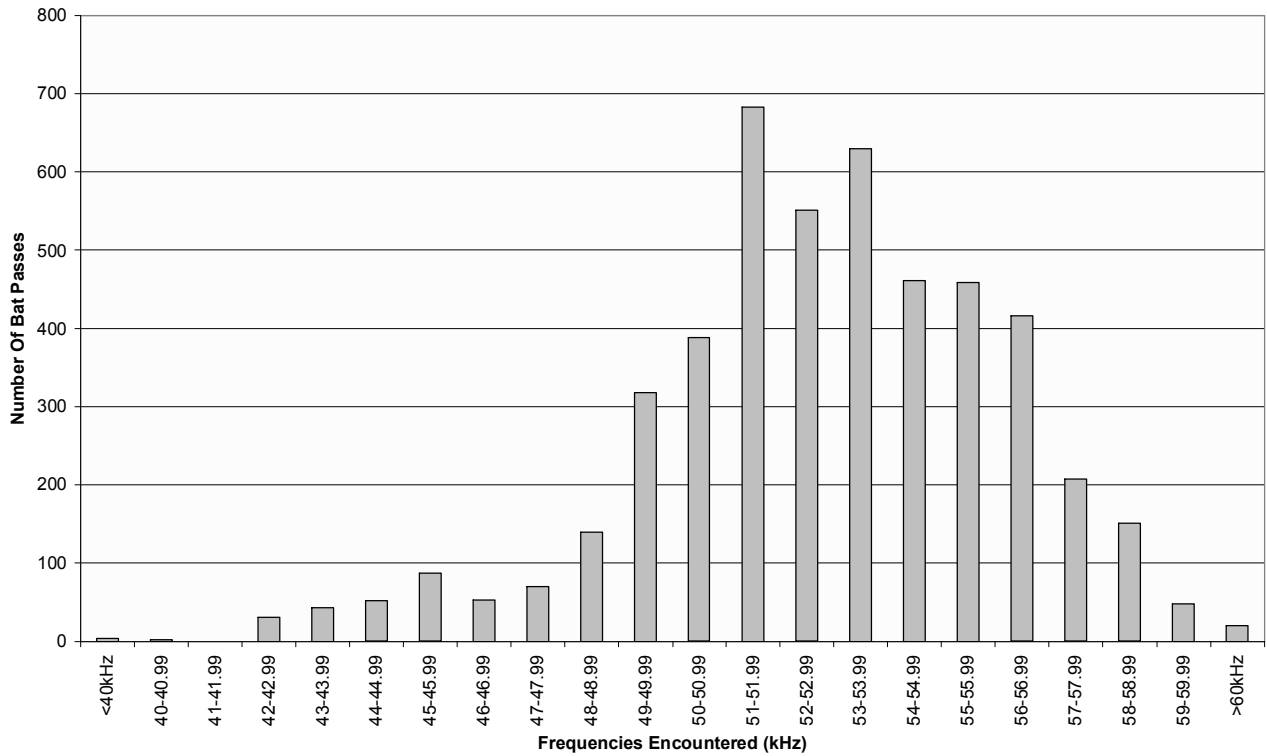
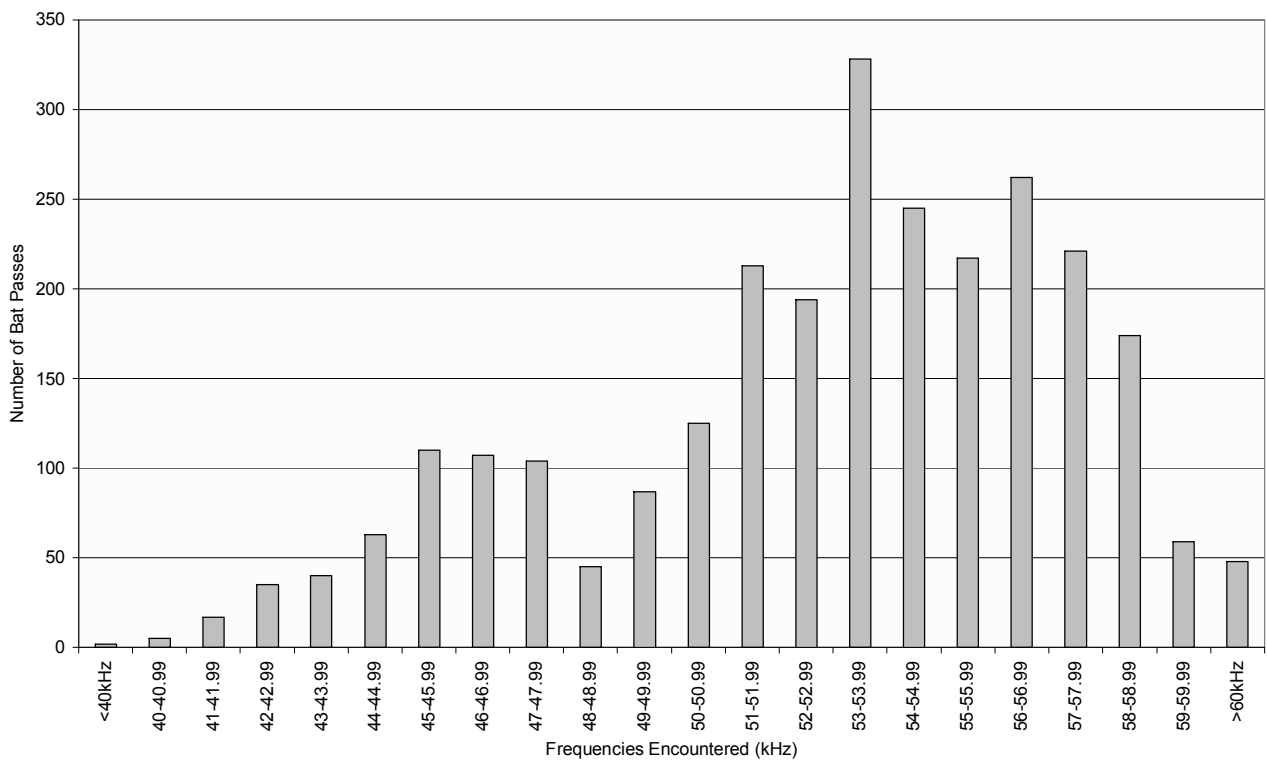


Figure 2: FmaxE relating to *Pipistrellus* spp. recorded elsewhere (UK) during the period May 2001 to September 2004 (2,701 data entries)



The results relating to Figure 1 (canal sites) show *P. pipistrellus* represented by 10.01% of the recordings, whilst *P. pygmaeus* sits at 61.13%. 28.85% fall into the grey area where bat calls measured in this way alone cannot be allocated safely to either species. The lower percentage of *P. pipistrellus* is probably a combination of this species not being as common within the locality compared to *P. pygmaeus* (Clear, 2005) and *P. pipistrellus* not showing the same affinity to riparian habitat as *P. pygmaeus* (Vaughan *et al.*, 1997; Russo & Jones, 2003; Davidson-Watts & Jones, 2006).

With regards to the non canal sites (Figure 2) we find a greater representation (19.55%) of *P. pipistrellus*. This is not surprising since many of the recordings relating to these results came from sites further south (England) and sites not necessarily associated with riparian habitat. *P. pygmaeus* is confirmed 64.72% of the time. However, the interesting result lies in the 'Unallocated' category, where these occur 15.73% of the time (almost half when compared against the canal sites in Scotland).

In both sets of data we have encountered echolocation close to or just below 40 kHz. It is feasible that these calls may relate to another species, *P. nathusii*, however because we only encountered brief echolocation passes and no accompanying social calls we are not in a position to categorically confirm that this species has been encountered. As such the few records we have encountered in this area have been lumped into the *P. pipistrellus* category.

There is not much published work relating to FmaxE in *Pipistrellus* spp. in the UK. The few studies that have measured this in the past have shown a strong clustering of FmaxE averaging at either 45/46kHz or 55kHz (Jones & Parijs, 1993; Russ, 1999) depending upon species. The recognised range for each species has been described as from 41.7kHz to 51.8kHz for *P. pipistrellus*, and 48.8kHz to 61.6kHz for *P. pygmaeus* (Russ, 1999). Therefore an overlap occurs between the frequencies of 48.8 kHz and 51.8 kHz whereby bats falling into this area cannot be safely allocated to one of either species. In one study (Barlow & Jones, 1997) no bats were found to emit a FmaxE between 49kHz and 52kHz, whilst in an earlier piece of research (Jones & van Parijs, 1993) it was estimated that only 5% of bats echolocated with a FmaxE between 49 kHz to 52 kHz.

A study carried out in mainland Europe (Mayer & von Helversen, 2001) measured the end frequencies alongside the length of call and

concluded that bats flying in edge/open habitat during search phase produced typical calls, whereas in cluttered habitat they produced calls at higher than the typical frequencies. As such, *P. pipistrellus* calls became higher and therefore more likely to encroach upon the frequency range of *P. pygmaeus* echolocating typically in open habitat. In this study however, they encountered only a few intermediate recordings close to 50 kHz.

Relative abundance of each species present

Our data relating to the relative abundance of the two species known to be present within the canal corridors of central Scotland is described as follows. Figure 3 shows the total percentage allocation in respect of the Forth & Clyde Canal corridor. Figure 4 provides the same data for the Union Canal. Finally, Figure 5 provides a total across both canals as measured over the five years of study (101 surveys, 7,400 data entries).

Figure 3: Forth & Clyde Canal (1,590 data entries)

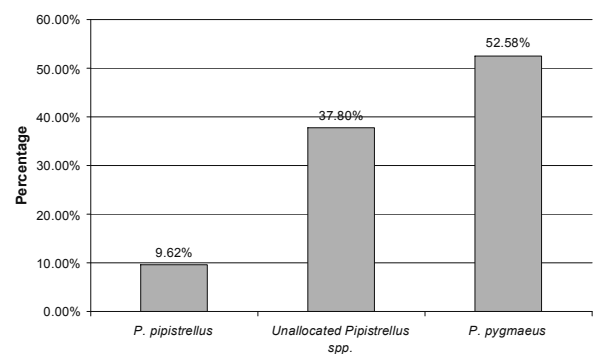


Figure 4: Union Canal (5,810 data entries)

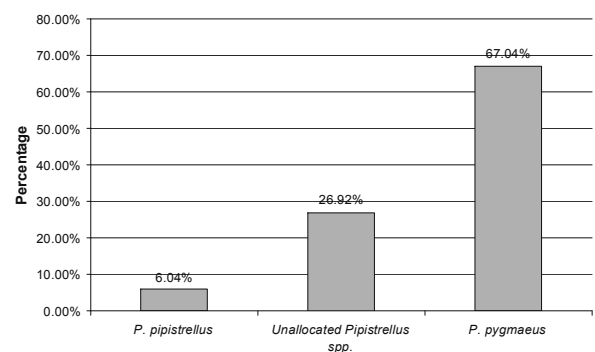
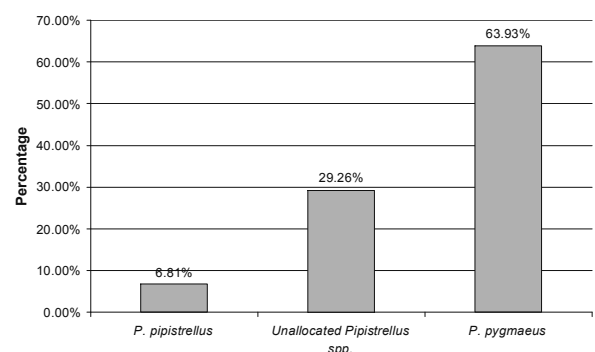


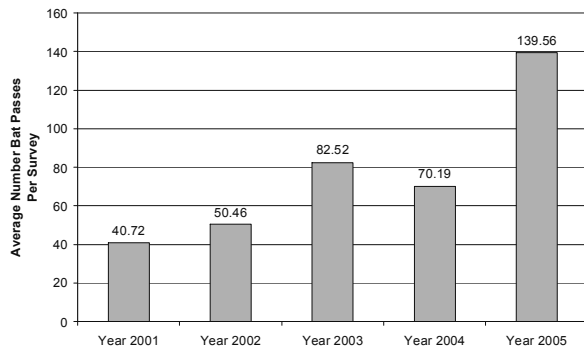
Figure 5: Total Canals (7,400 data entries)



An annual comparison of the abundance of *Pipistrellus* spp. during the study period

Figure 6, below, shows an annual comparison of the average number of bat passes recorded for all *Pipistrellus* spp. during the five years of the study.

Figure 6: Annual comparison of abundance of *Pipistrellus* spp.



Although it has not been possible to carry out further statistical analysis for this data, it does appear to show an upward trend throughout the period.

The distribution of *Pipistrellus* spp. along the canal corridors of central Scotland

The figures shown within this section (Figures 7 to 11) show the results regarding the distribution of *Pipistrellus* spp. across the entire canal corridor. Each figure shows a different local authority area, working from Figure 7 in the west through to Figure 11 in the east.

The BaTML site codes (including approximate OS Grid References) are described within Table 1 at the end of this section.

The results show clearly that *P. pipistrellus* is not commonly encountered across the canal network as a whole. Two exceptions to this appear to occur at UN10 (Falkirk Tunnel East) and UN22 (Harrison Park).

By far, the most common of the two *Pipistrellus* spp. is *P. pygmaeus*. Definitive records of these bats occur at every site and we would expect that a large percentage of the Unallocated *Pipistrellus* spp. would also fall into the *P. pygmaeus* category.

With regard to the distribution of Unallocated *Pipistrellus* spp., most of the sites follow a trend showing this category to be in the middle. However, it is interesting to note that some sites (FC1, FC6, UN13 and UN18) show this category to be more heavily represented than the other two categories totalled together.

Figure 7: East Dunbartonshire

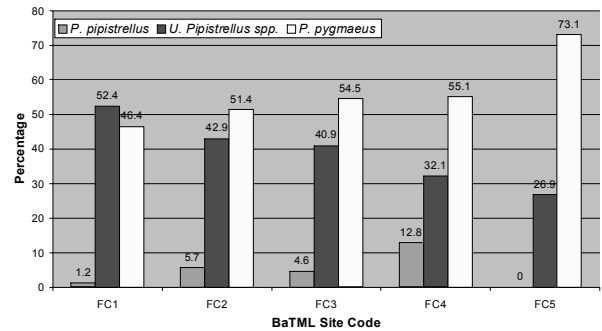


Figure 8: North Lanarkshire

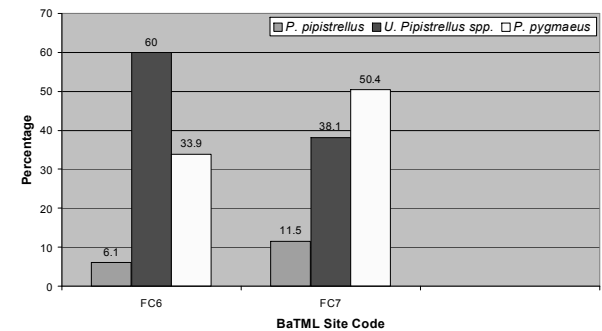


Figure 9: Falkirk

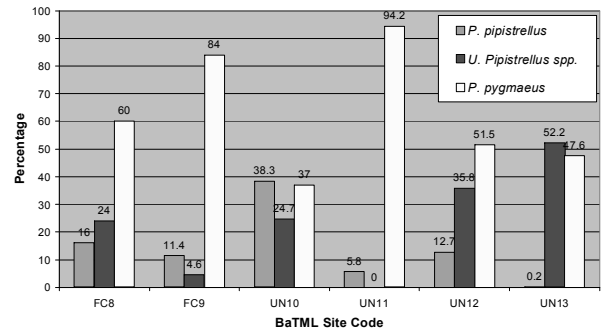


Figure 10: West Lothian

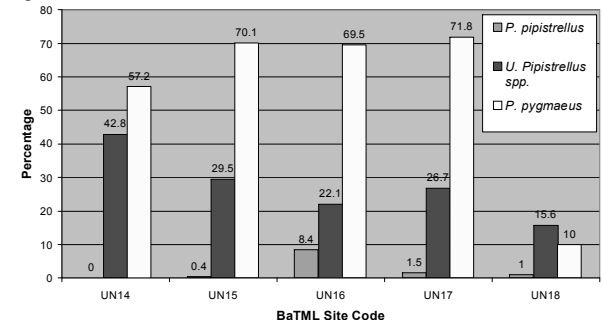


Figure 11: Edinburgh

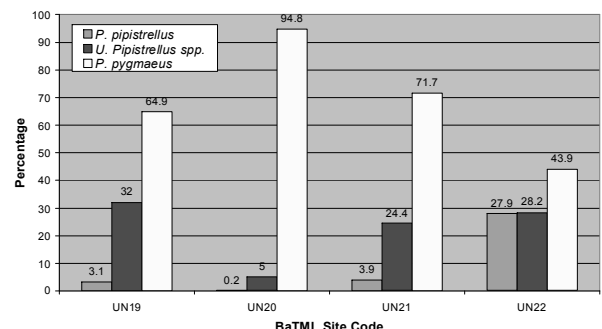


Table 1: Site names, site codes and grid references

Survey Site Name	Canal	BaTML Site Code	OS Grid Reference
Netherton	Forth & Clyde	FC1	NS5469
Possil Loch	Forth & Clyde	FC2	NS5870
Jellyhill	Forth & Clyde	FC3	NS6172
Kirkintilloch West	Forth & Clyde	FC4	NS6473
Tintock	Forth & Clyde	FC5	NS6874
Auchinstarry	Forth & Clyde	FC6	NS7276
Kelvinhead	Forth & Clyde	FC7	NS7578
Underwood East	Forth & Clyde	FC8	NS8079
Carmuir	Forth & Clyde	FC9	NS8580
Falkirk Tunnel East	Union	UN10	NS8878
Purliehill	Union	UN11	NS9078
A801	Union	UN12	NS9477
Causewayend	Union	UN13	NS9675
Avontoun	Union	UN14	NS9776
Wilcoxholm	Union	UN15	NT0177
Fawnspark	Union	UN16	NT0676
Winchburgh North	Union	UN17	NT0875
Learielaw	Union	UN18	NT0871
Wilkie Basin	Union	UN19	NT1171
Gogar Moor Bridge	Union	UN20	NT1570
Slateford	Union	UN21	NT2270
Harrison Park	Union	UN22	NT2371

Discussion

The results presented appear to show a number of interesting conclusions. Firstly, there appears to be a higher than expected percentage of bats falling within the 'Unallocated' FmaxE area, and for some reason, certain sites seem to show a far stronger bias towards this.

With regard to the overall abundance of *Pipistrellus* spp. during the first five years after the canal corridors re-opening, there is nothing to suggest that the numbers of *Pipistrellus* spp. have reduced and, indeed, an increase in use appears to be more likely. Whether this is as a result of changes to the local habitat or as part of a general trend anyway it is difficult to be certain. However the National Bat Monitoring Programme reported its

national (UK) field survey results for the period in question and for *P. pipistrellus* so far concludes an upward trend. For *P. pygmaeus* the trend reported by NBMP appears to be fairly level during the period 2001 to 2005 (NBMP, 2006).

Finally, with regard to the distribution of each of the two *Pipistrellus* spp. known to occur in the study area, we can certainly suggest that *P. pipistrellus* is by no means common (as one of its commonly used names, 'Common pipistrelle', infers) when compared against *P. pygmaeus*.

We recognise that for the raw data presented here we have not been able to carry out a more robust statistical analysis. The authors would be happy to consider sharing our data with others with a view to a fuller statistical analysis being carried out and reported upon.

Acknowledgements

We are greatly appreciative of the funding obtained from Scottish Natural Heritage, British Waterways, Falkirk Environment Trust and The Royal Bank of Scotland Group. We are also keen to acknowledge the support given to us by the following organisations: The Bat Conservation Trust, BTCV, Central Scotland Bat Group, Clyde Bat Group and Lothians Bat Group.

Finally we would like to thank all of the volunteers that have been associated with this project, unfortunately too many to name, and in particular the following people: Chris Gould (BaTML), David Dodds (BaTML), John Haddow (Central Scotland Bat Group), Olivia Lassiere (British Waterways), Kirsty Morrison (BaTML), Craig Macadam (BaTML), Stuart Smith (Lothians Bat Group) and Natalie Taylor (BaTML).

References

- Barlow, K. E. and Jones, G. (1997). Differences in songflight calls and social calls between two phonic types of the vespertilionid bat *Pipistrellus pipistrellus*. *J. Zool., Lond.* Vol 241, 315 - 324.
- Clear, S. (2005). Factors affecting the distribution of *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* in the Lothians region, Scotland. BaTML Publications, Vol 2, 23 - 33.
- Davidson-Watts, I. and Jones, G. (2006). Differences in foraging behaviour between *Pipistrellus pipistrellus* (Schreber, 1774) and *Pipistrellus pygmaeus* (Leach, 1825). *Journal of Zoology*, 268, 55 - 62.

- Jones, G. and van Parijs, S. M. (1993). Bimodal echolocation in pipistrelle bats: are cryptic species present? Proceedings of the Royal Society of London. Vol 251, 119 - 125.
- Mayer, F. and von Helversen, O. (2001). Sympatric distribution of two cryptic bat species across Europe. Biological Journal of The Linnean Society. Vol 74, 365 - 374.
- Middleton, N. E., Gould, C., Macadam, C. R., Mackenzie, S. and Morrison, K. (2004). Introducing BATS & The Millennium Link. A study of bats and their use of canal corridor habitat in the Central Belt of Scotland. BaTML Publications, Vol 1, 2 - 5.
- Middleton, N. E., Gourlay, K. and Macadam, C. R. (2005). The methods adopted by BaTML for recording the echolocation calls of *Pipistrellus* spp. using Time Expansion Detectors and the analysis thereafter. BaTML Publications, Vol 2, 9 - 14.
- NBMP. (2006). The National Bat Monitoring Programme Annual Report 2005. The Bat Conservation Trust, London.
- Russ, J. (1999). The Bats of Britain and Ireland. Alana Ecology Ltd, ISBN 095360490X.
- Russo, D. and Jones, G. (2003). Use of foraging habitats by bats in a Mediterranean area determined by acoustic surveys: conservation implications. Ecography. Vol 26, 197 - 209.
- Vaughan, N., Jones, G. and Harris, S. (1997). Habitat use by bats (Chiroptera) assessed by means of a broad-band acoustic method. J. Appl. Ecol. Vol 34, 716 - 730.

Appendix I: Summary of data collated during study period (2001 to 2005)

Pipistrellus pipistrellus

Site Code	No of Surveys	2001	2002	2003	2004	2005	Total
FC1	4				1		1
FC2	5				1	3	4
FC3	4			1	1		2
FC4	5	6	10	60	13		89
FC5	4						0
FC6	3	8		7			15
FC7	4	2		26		1	29
FC8	4	2		2		4	8
FC9	3		1		4		5
UN10	4	7	3	5	16		31
UN11	3		2			1	3
UN12	4	3	2	6		11	22
UN13	4	1					1
UN14	4						0
UN15	4		2			1	3
UN16	7				11	112	123
UN17	6	2			2		4
UN18	5		3	2			5
UN19	5		3	13		1	17
UN20	11					2	2
UN21	6	2				5	7
UN22	2	34		99			133
Total	101	67	26	221	49	141	504

Unallocated *Pipistrellus* spp.

Site Code	No of Surveys	2001	2002	2003	2004	2005	Total
FC1	4	2		40	0	2	44
FC2	5	8			3	19	30
FC3	4	5	7		6		18
FC4	5	4	94	95	31		224
FC5	4	7	3		2	16	28
FC6	3	13	1	133			147
FC7	4	39		46	8	3	96
FC8	4	7		3		2	12
FC9	3		1		1		2
UN10	4	9	5	3	3		20
UN11	3						0
UN12	4		9	1		52	62
UN13	4	39	177		23		239
UN14	4	68	7	24	11		110
UN15	4	7	14		74	166	261
UN16	7		25		110	188	323
UN17	6	13	21		25	13	72
UN18	5		65	11		2	78
UN19	5		7	172			179
UN20	11		1	1	30	9	41
UN21	6	5	33	5		1	44
UN22	2	15		120			135
Total	101	241	470	654	327	473	2165

Pipistrellus pygmaeus

Site Code	No of Surveys	2001	2002	2003	2004	2005	Total
FC1	4	2		23	2	12	39
FC2	5	12	2		9	13	36
FC3	4	6	3	9	6		24
FC4	5	6	46	288	44		384
FC5	4	5	4		16	51	76
FC6	3	32	1	50			83
FC7	4	79		32	9	7	127
FC8	4	9	8	2		11	30
FC9	3		5	27	5		37
UN10	4	6	6	8	10		30
UN11	3	7	25			17	49
UN12	4	7	36	12		34	89
UN13	4	47	140	5	26		218
UN14	4	102	9	17	19		147
UN15	4	27	11		27	555	620
UN16	7		393		207	418	1018
UN17	6	2	23		102	67	194
UN18	5		15	28		7	50
UN19	5		24	336		3	363
UN20	11		76	27	265	410	778
UN21	6	13	90	12		14	129
UN22	2	63		147			210
Total	101	425	917	1023	747	1619	4731

Total *Pipistrellus* spp.

Site Code	No of Surveys	2001	2002	2003	2004	2005	Total
FC1	4	4		63	3	14	84
FC2	5	20	2		13	35	70
FC3	4	11	10	10	13		44
FC4	5	16	150	443	88		697
FC5	4	12	7		18	67	104
FC6	3	53	2	190			245
FC7	4	120		104	17	11	252
FC8	4	18	8	7		17	50
FC9	3		7	27	10		44
UN10	4	22	14	16	29		81
UN11	3	7	27			18	52
UN12	4	10	47	19		97	173
UN13	4	87	317	5	49		458
UN14	4	170	16	41	30		257
UN15	4	34	27		101	722	884
UN16	7		418		328	718	1464
UN17	6	17	44		129	80	270
UN18	5		83	41		9	133
UN19	5		34	521		4	559
UN20	11		77	28	295	421	821
UN21	6	20	123	17		20	180
UN22	2	112		366			478
Total	101	733	1413	1898	1123	2233	7400
Surveys	101	18	28	23	16	16	