MENDIP HILLS BIG BAT SURVEY – ASSESSING BAT DISTRIBUTION ACROSS A LANDSCAPE

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Abstract

Somerset has 16 of the 17 bat species resident in the UK. Although a large amount is known about some roost sites, there is still much to be learnt about how bats use the landscape to commute between roosts and for foraging purposes. In 2007, the Somerset Wildlife Trust and Somerset Bat Group organised the first Mendip Hills Big Bat Survey. Results of the survey over the subsequent six years are summarised here, and the observed distribution of Greater and Lesser Horseshoe Bats are compared with Somerset County Council's 'Species Occurrence Mapping' for these species. The Big Bat Survey data are also used to explore the links between bat distribution of abundance and the occurrence of particular habitat types and landscape features. The survey is an excellent example of 'citizen science' in action; it enabled a large number of amateur naturalists to get involved in bats, increasing their awareness of these animals in the Mendip Hills and opening up a fairly specialist aspect of ecological monitoring to the wider community.

INTRODUCTION

Somerset has long been known as an excellent county for bat species, with all but one of the 17 species resident in the UK known to be present within the county. Many species have long been known to occur in Somerset, but the first Leisler's Bat (*Nyctalus leisleri*) in the hand was only recorded as recently as 2012 (from a location in Taunton). The newly identified Alcathoe Bat (*Myotis alcathoe*) (Jan *et al.* 2010) is similar in appearance to Whiskered Bat (*Myotis mystacinus*) and Brandt's Bat (*Myotis brandtii*), and its status in the county is as yet unconfirmed; a genetic study is ongoing to establish whether this species is indeed present in Somerset. During 2009-10 a trapping study identified that both female and male Bechstein's Bat (*Myotis bechsteinii*), a particularly rare species, were present and breeding in Somerset (Serjeant and Kennedy 2012). The Grey Long-eared Bat (*Plecotus austriacus*) is a decidedly local species but is known to be present in the south and east of the county, with individuals recorded near Yeovil, Hinkley Point and Williton.

Bats are protected under European and domestic legislation, and the safeguarding of bat maternity roosts, hibernacula and foraging habitat is viewed as a major UK nature conservation priority. Many bat species are listed under Section 41 of the Natural Environment and Rural Communities (NERC) Act as 'species of principal importance for the conservation of biodiversity in England', while in 2009 bats were added to the national statistics as an important indicator of biodiversity and the health of the environment (Defra 2013). Since 1996, monitoring of bats has been undertaken on a large scale through the National Bat Monitoring Programme, coordinated by the Bat Conservation Trust. Somerset Wildlife Trust (SWT) and Somerset Bat Group devised the Mendip Hills Big Bat Survey to sit alongside this national programme, providing quantitative data on bat distribution and activity at a landscape scale.

The Big Bat Survey began in 2007 and ran for six years; it formed part of the SWT's Mendip Hills Living Landscape work, which aims to restore, recreate and reconnect islands of wildlife habitat within the working countryside. The survey set out to improve our knowledge of bat distribution and their use of different habitats across the landscape, as well as identifying which landscape features may be significant in providing physical links between blocks of important habitat.

The targets for the project included community and volunteer engagement; from the start, it was intended that these surveys should seek to involve amateur naturalists, including both the Somerset Bat Group and members of the public having no specialist knowledge or previous experience of bats. The Big Bat Survey was particularly successful in attracting a wide range of volunteers to take part and stands as an excellent example of 'citizen science', generating much useful information whilst encouraging wide engagement and enjoyment by experts and beginners alike.

METHODS

Location

The Mendip Hills are formed from a ridge of limestone lying along the Somerset county boundary with North Somerset. The western hills are higher than those in the east and were designated an Area of Outstanding Natural Beauty in 1998. The area is characterised by an open landscape on the tops dominated by calcareous grassland with limestone walls and barns, and by steep-sided dry valleys with broadleaved woodland. There is little woodland on the plateau and very few watercourses, with dew ponds being a feature of the landscape and used as a water source prior to the arrival of 'mains' water. A few areas of heathland and peaty soils have developed on sandstone caps at Blackdown Common and Rowberrow Plantation, as well as at Priddy Mineries and Stockhill Plantation.

The karst landscape is dominated by extensive limestone caves, with the Cheddar and Wookey Hole complexes being presented as show caves and many more visited for recreation. The caves are known hibernacula and maternity roosts for many bat species, notably Lesser Horseshoe Bat (*Rhinolophus hipposideros*) and Greater Horseshoe Bat (*R. ferrumequinum*), and are designated under the EU Habitats Directive as a Special Area of Conservation for this reason (JNCC 2011).

Altitude within the study area ranges from 325 m on Blackdown Common to just 10 m above sea level on the adjoining Somerset Levels. The gradient is not as steep on the northern side, falling away to the Chew valley and Chew and Blagdon Lakes. Scarps are well wooded with two woodland National Nature Reserves at Rodney Stoke and Ebbor Gorge, as well as other woodland nature reserves such as Cheddar Woods. The limestone grasslands, such as at Draycott Sleights, are also recognised for their unique wildlife, whilst on the plateau there are wildflower meadows. Agriculturally, the hills are dominated by livestock farming with a mixture of sheep and cattle.

Transects

Fourteen transects were surveyed over the course of the six year survey, with one transect in eastern

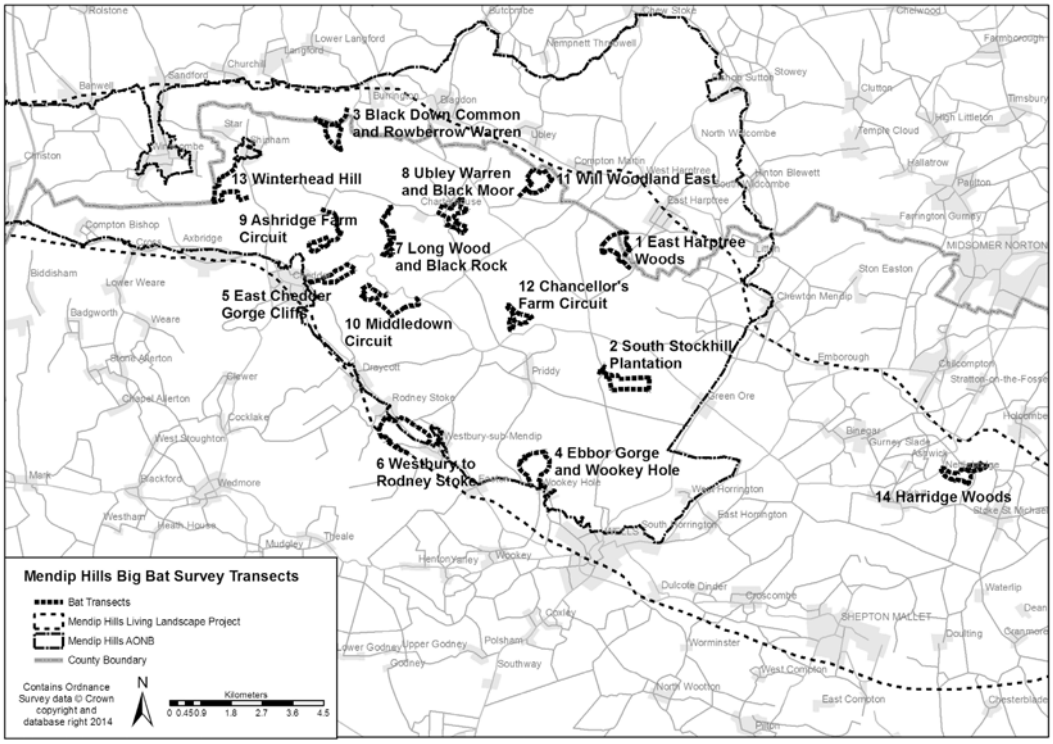

Fig. 1 Locations of the 14 transects undertaken for the Mendip Hills Big Bat Survey

Mendip being added in 2011 (Fig. 1). Each transect consisted of six stop sections of five minutes each, and six walked sections lasting an average of about ten minutes each. The stops were chosen to incorporate potentially significant landscape features. Transect routes were mainly along established footpaths for the comfort and safety of the volunteers. Each transect was checked to measure the timings of sections at a steady walking pace and to describe the habitats at each stop. Transects were walked in one direction one year and then reversed the following year so that bat distribution could be assessed at different times of night at both ends of the route. Each transect was therefore walked a total of three times in each direction over the six year period. All landowners along each transect were asked for permission to survey and none denied permission. Prior to the survey a health and safety briefing and risk assessment was provided to all volunteers.

A transect recording group consisted of 4-6 individuals with a mixture of bat experience from beginner to very experienced. One person monitored continuously for bat activity using a 'frequency division' bat detector connected to an MP3 recorder, minidisk recorder or wave recorder. Another member acted as scribe, while the rest of the group had 'heterodyne' bat detectors and noted what they heard on a form (for an explanation of the different bat detectors see Waters and Barlow 2013). Results from the 'heterodyne' detectors could not be objectively verified, but did provide a useful secondary source of information that could be used if the 'frequency division' recording failed. Transect surveys started 30 minutes after sunset and usually took 1½ hours to 2 hours to complete. All fieldwork was undertaken during August, usually on the first, second or third Friday of the month.

Sound Analysis

Recordings were analysed using BatSound (Pettersson Elektronik) and BatScan (Batbox Ltd) computer software to identify the bat species present. A bat pass was picked up by the bat detector as a continuous stream of clicks (echolocation calls), the number of bat passes made by each species providing a measure of bat activity along each transect. Except for bats within the genera *Myotis* (the mouse-eared bats) and *Plecotus* (the long-eared bats), each species has a sound spectrogram which is usually distinctive with a good enough recording (Vaughan *et al.* 1997; Russ 2012), meaning that bat passes could generally be ascribed to particular species. Faint Pipistrelle calls can be difficult to distinguish to species level and were grouped if an accurate identification could not be ascertained.

Selected transects (one on 2007 and two in 2008) were assessed by both of the two main analysers to check for any differences in their species identification and counts of bat passes. In both years there was a 6-7% difference in their counts of bat passes but no difference in the species identified (Shellswell 2008; Rush and Shellswell 2009).

Generally 'Batbox Duets' were used for the surveys, being the cheapest bat detector available with frequency division capabilities. In 2007 one group used an 'Anabat' detector, while 'Pettersson' detectors, some of which also have time expansion capability, were also used in some years. Although all these bat detectors record in frequency division, they have different sensitivities and cover different ranges of area around the surveyor. Even detectors of the same type can vary in range depending on factors such as local environmental conditions (e.g. weather) and battery strength. Attempts were made to minimise these differences by recording transects at the same time on the same night, and ensuring that new batteries were always used; but, when examining the results, the detection range (and therefore numbers of bat passes 'logged') always had to be borne in mind as it could have been affected to some extent by the different models of bat detector being used.

RESULTS

Over the course of the survey ten species of bats were recorded plus the '*Myotis* group' which may have comprised more than one species (Table 1). The distribution and numbers of recorded passes provide a good indication of which bat species are prevalent in Mendip. Common Pipistrelle (*Pipistrellus pipistrellus*) was the most frequently recorded species, followed by Serotine (*Eptesicus serotinus*) and Soprano Pipistrelle (*P. pygmaeus*). The species least recorded were: Nathusius' Pipistrelle (*P. nathusii*), a very rare bat only found near extensive water bodies; Barbastelle Bat (*Barbastella barbastellus*), which specialises in foraging in woodlands; and Greater and Lesser Horseshoe Bats, known to have maternity roosts and hibernacula in the Mendip Hills. Seven of the

TABLE 1: BAT PASSES AND PERCENTAGE OF PASSES RECORDED ANNUALLY FOR EACH SPECIES

Species / Species Group	**2007 Bat Passes** (10 transects)	**2007 Total (%)**	**2008 Bat Passes** (12 transects)	**2008 Total (%)**	**2009 Bat Passes** (12 transects)	**2009 Total (%)**	**2010 Bat Passes** (13 transects)	**2010 Total (%)**	**2011 Bat Passes** (13 transects)	**2011 Total (%)**	**2012 Bat Passes** (11 transects)	**2012 Total (%)**
Greater Horseshoe	8	2.5	20	3.3	24	2.5	19	1.2	37	3.3	5	0.6
Lesser Horseshoe	59	18.1	23	3.9	10	1.0	78	4.7	16	1.4	26	2.4
Common Pipistrelle	125	38.5	260	43.6	446	45.6	730	44.4	529	47.6	565	51.8
Soprano Pipistrelle	20	6.2	78	13.1	152	15.5	422	25.7	154	13.9	215	19.7
Nathusius Pipistrelle											1	<0.1
Pipistrelle sp							14	0.9	3	0.3	8	0.7
Serotine	55	16.9	161	27.0	191	19.5	200	12.2	224	20.2	142	13.0
Noctule			4	0.7	13	1.3	39	2.4	24	2.2	6	0.6
Noctule/ Leisler's							4	0.15				
Myotis sp	58	17.8	50	8.4	94	9.6	90	5.5	83	7.5	90	8.3
Long-Eared Bat							1	0.05				
Barbastelle							10	0.5	1	0.1	3	0.3
Unidentified					48	4.9	37	2.3	40	3.5	29	2.7
TOTAL	325	100	596	100	978	100	1644	100	1111	100	1090	100

species recorded are listed under Section 41 of the NERC Act: Barbastelle, Greater Horseshoe, Lesser Horseshoe, Soprano Pipistrelle, Brown Long-eared Bat (*Plecotius auritus*) and Noctule (*Nyctalus noctula*); plus Bechstein's Bat, one of the *Myotis* group, which was confirmed by trapping to be present in Rodney Stoke Woods in 2013, but which has a call almost indistinguishable from other *Myotis* species.

Ecological Networks and 'Species Occurrence Mapping'

The most recent publication about bat distribution in Somerset (Wells and Wells 1998) provided records at tetrad level for maternity roosts and hibernacula of all bat species known to be present at that time in the county. Although extremely useful, it is important, too, to know how bats are using and moving through the landscape, so that flight corridors and feeding locations can also be safeguarded.

SWT is working with landowners, farmers and volunteers to restore, recreate and link up remnant wildlife habitats in Mendip, including limestone grassland, lowland meadow, woodland and heathland. SWT's objective is to help create a resilient landscape for wildlife in the long term. As part of this, there is a need to establish how ecological networks function, and to better understand where to target conservation work to improve habitat connectivity. Over the past six years, SWT and partners have gathered habitat and species data across the Mendip Hills. The area includes many important ancient woodlands that support a range of associated fauna including Greater and Lesser Horseshoe Bats, as well as significant areas of species-rich grassland.

SWT has been working with partners to model 'ecological networks' across Mendip (and the whole of Somerset) using the least-cost network model developed by Forest Research (Watts *et al.* 2005, 2007, 2010), also known as BEETLE (Biological and Environmental Evaluation Tools for Landscape Ecology). SWT's existing Integrated Habitat System (IHS) (SERC 2014) data were used within BEETLE to produce a 'permeability map' of the Mendip landscape for a 'typical' woodland species – with 'permeability' being a measure of the degree to which the matrix of habitat and landscape features would be likely to facilitate or impede the movement of that species through the landscape. Such a map identifies where ecological networks are functioning well, and helps to target habitat restoration or creation at those areas where gaps in suitable habitat currently prevent the existence of larger ecological networks.

A planning tool, known as 'Species Occurrence Mapping', has been developed by Somerset County Council (SCC and SERC 2012), which ascribes a value to habitats used by a range of 'priority species' ranging from 1, the most suitable habitat, to 0.1, the least suitable habitat (and zero for habitat that is likely to be avoided altogether). Other information is also included, such as the location of bat roost sites and estimates of 'home range' from these roosts.

In the case of bats, the maps consist of 'principle-element occurrence zones' (EO) surrounding hibernacula and maternity roosts where the probability of the species being present is considered to be > 75%. Surrounding these are 'inferred extent zones' (IE) in which the probability of presence is estimated to be 25-75%.

Survey results for two species, Greater and Lesser Horseshoe Bats, are summarised below; these are included as examples of the information generated by the Big Bat Survey, and to show how such information can be superimposed on the 'Species Occurrence Maps' to identify further potentially important areas of bat habitat in the Mendip Hills.

Greater Horseshoe Bat (*Rhinolophus ferrumequinum*)

Within the western Mendip Hills, the Greater Horseshoe Bat is one of the best studied bat species, with well-recorded hibernacula and maternity roosts and a radio-tracking survey (Jones and Billington 1999). SCC's Species Occurrence Map for this species makes use of information from these sources, which was coincidence-mapped against SERC's IHS data to identify blocks of suitable foraging and 'linking' habitat. The results of the present survey further increase the information available to understand the movements and 'activity' of this species in the area (Fig. 2). For information on the population dynamics, distribution and ecology of the Greater Horseshoe Bat see Altringham (2003), Bat Conservation Trust (2014), Ransome (1997), Billington (2000) and Jones and Billington (1999).

Much of Cheddar Gorge is designated as a Special Area of Conservation (SAC) for its Greater and Lesser Horseshoe Bats, as it lies close to a

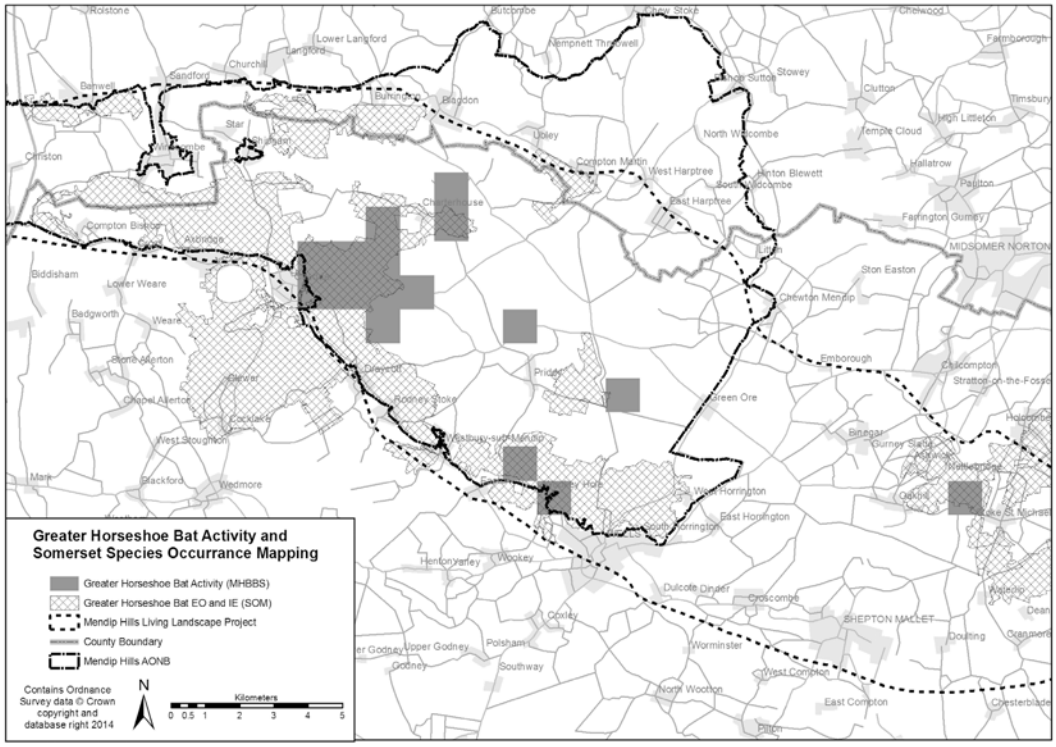

Fig. 2 Map showing Greater Horseshoe Bat activity recorded in the Mendip Hills Big Bat Survey and Somerset Occurrence Mapping (used with the kind permission of Somerset County Council)

maternity roost as well as its caves providing suitable hibernacula. However, the present study also located Greater Horseshoe Bat activity at Middle Down (ST4852) Nature Reserve, south-east of the main Gorge, and at Black Moor (ST5055) in the upper Gorge – both in areas not recognised as EOs or IEs in the Species Occurrence Map (Fig. 2).

Greater Horseshoe Bat activity at Wookey Hole (ST5348) and Ebbor Gorge (ST5248) is relatively well known – the former holds a large maternity roost – and the importance of this general area is reflected on the Species Occurrence Map (Fig. 2). It is not surprising that there was an absence of Greater Horseshoe Bat activity along the swallet line at Blackdown Common (ST4758) and Rowberrow Warren (ST4658); while this area has a known hibernaculum it has never been known to hold roost sites in summer. However, the presence of this species at Chancellor's Farm (ST5252) and Stockhill Plantation (ST5550) was unexpected. Greater Horseshoe Bats were also found to be present around Harridge Woods (ST6547 and ST6548) in eastern Mendip, especially at the eastern end of the broadleaved woodland where an old cottage has been turned into a bat roost.

Greater Horseshoe Bat activity identified through the present survey warrants further assessment to determine whether it could be used to refine the Species Occurrence Map for this species, in particular to extend the IEs to include additional areas over which this species appears to be active in summer. The results could also help to inform our understanding of which landscape features are of particular significance to commuting Greater Horseshoe Bats.

Lesser Horseshoe Bat (*Rhinolophus hipposideros*)

Fewer studies have been undertaken on Lesser Horseshoe Bats in the Mendip Hills. Most of the available information concerns known maternity roosts and hibernacula. There is much

less information on the activity of this species which, being smaller than the Greater Horseshoe Bat, is less amenable to radio-tracking studies. For information on the population dynamics, distribution and ecology of the Lesser Horseshoe Bat see Altringham (2003) and Bat Conservation Trust (2014).

There are three well-known maternity roosts for Lesser Horseshoe Bats in western Mendip: in caves at the bottom of Cheddar Gorge (ST4653), at Charterhouse (ST5055) in the upper Gorge, and at Bradley Cross (ST4653) to the east of the Gorge. It is thus not surprising that Lesser Horseshoe Bats were found in the present survey along transects in the vicinity of this area (Fig. 3). The lack of any other known large maternity roosts in western Mendip makes the presence of the species elsewhere of particular interest. Lesser Horseshoe Bats were heard in 2007, 2008 and 2009 at the entrances to swallets on Blackdown Common (ST4758) and Rowberrow Warren (ST4658). Activity was particularly high in 2007, indicating a substantial presence of Lesser Horseshoe Bats there. There were also regular passes detected during 2007 and 2009 over Stockhill Plantation (ST5550) suggesting that there may have been a roost nearby, possibly in the disused infrastructure associated with the Mineries at Priddy or in underground tunnels or caves in that area. A Lesser Horseshoe Bat pass was detected within East Harptree Plantation (ST5554) in 2007, while between 2008 and 2010 passes of this species were detected under a large hedgerow tree along a field boundary to the east of the woodland, suggesting a possible commuting route. The area around Hazel Farm (ST5356) also featured Lesser Horseshoe Bat passes in 2009, 2010 and 2012, possibly indicating that the species was using routes along the northern slopes of the Mendip Hills for commuting. The extensive broadleaved woodland planting on Will Woodland Estate, around Hazel Farm, may enhance the habitat for Lesser Horseshoe Bats in that area, and it will be interesting to see whether activity increases there in the future.

Roost data included in the Species Occurrence Map only covers the administrative county of

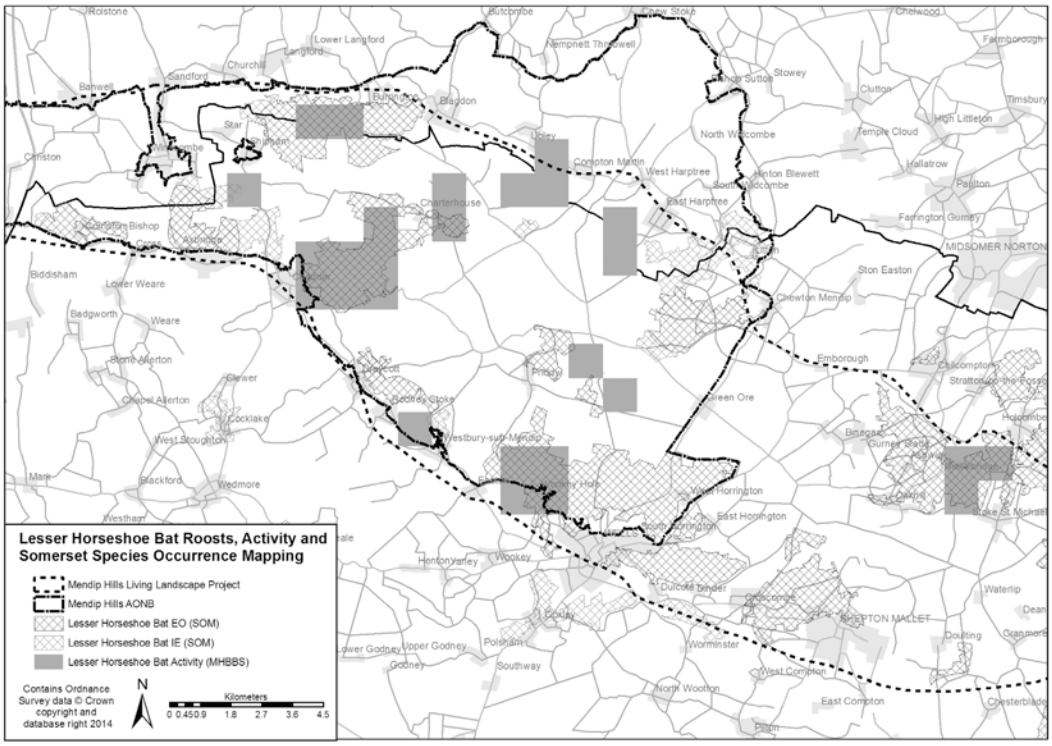

Fig. 3 Map showing Lesser Horseshoe Bat activity recorded in the Mendip Hills Big Bat Survey and Somerset Occurrence Mapping (used with the kind permission of Somerset County Council)

Somerset, and it is likely that there are roosts lying in adjoining North Somerset that use the northern fringes of the study area for foraging or commuting purposes. As such, Fig. 3 could be under-estimating the extent of EOs and IEs close to the county boundary. In eastern Mendip, Lesser Horseshoe Bats were present at the eastern end of Harridge Woods (ST6547 and ST6548) near the converted cottage and along the woodland edge adjoining the wet meadows there.

The results of the present survey could be used to modify and extend the IEs identified for this species; also, particularly high concentrations of bat activity in some areas may point to the existence of several (as yet undiscovered) roost sites, e.g. at Blackdown Common, Rowberrow Warren and Stockhill Plantation/Priddy Mineries.

Using habitat features to predict presence or abundance of bat species

The information presented below is summarised from Reid (2012) which used data from the first five years of Mendip Hills Big Bat Surveys 2007-2011 to investigate the extent to which habitat features/characteristics could be used to predict the presence of bats, or when present the abundance of bats. The study made use of data from transect stop points, but data from walked sections of transects were not used as they could not be allocated to specific habitat types or features. Difficulties in determining passes to species level meant that records of *Myotis* bats were grouped together, as were those of Noctule/Serotine/Leisler's Bats. Barbastelle, Brown Long-eared (*Plecotus auritus*) and some Pipistrelle Bat records (those that could not be distinguished as being either Common or Soprano) were excluded from the analysis due to low numbers of records.

Habitats at each transect stop point were described in various ways, as follows:

- Elevation above sea level (as an indication of likely levels of exposure);
- Percentage of different habitat types present within a 500 m radius of each stop point, comprising 'grassland', 'woodland and hedgerow', 'water body', and 'other';
- The two habitat features immediately adjacent to the stop point, ranked as **primary** and **secondary** key features, comprising 'water' (pond or stream). 'grassland' (including gardens), 'exposed upland' (areas of grassland with few if any trees or other forms of shelter), 'within woodland' (areas where any form of shelter was provided by vegetation, including steep-sided, vegetated gullies) and 'woodland edge' (including hedgerows and lone trees);
- Potential use being made of habitat/s by bats, classified into four non-mutually exclusive categories: 'maternity roost', 'night roost', 'foraging', 'commuting'.

The statistical method used in the analysis was saturated generalised linear modelling using binomial, negative binomial, poisson and quasi-poisson distributions. The analysis of various habitat categories against presence/absence and abundance data for each bat species allowed the identification of the habitat variables that may be important for particular species or species groups.

Analysis of presence/absence data suggested that no habitat attributes were statistically significant predictors of the presence of any bat species. In contrast, analysis of 'abundance' showed that several habitat types/attributes were statistically significant predictors of levels of activity in certain species or species groups (Table 2).

'Water body' was the habitat element most often correlated with levels of bat activity, with increased numbers of bat passes associated with transect stop points having higher percentages of water-body cover within a 500 m radius. This positive correlation was evident for Soprano Pipistrelle, Greater Horseshoe and *Myotis* bats. Interestingly, for Common Pipistrelles lower activity levels were predicted by the presence of water bodies. Until the early 1990s Common and Soprano Pipistrelles were thought to be one species (Jones and Parijs 1993), and it is only since then that studies have shown that Soprano Pipistrelles are often associated with water (Bat Conservation Trust 2014), whilst Common Pipistrelles are generalists foraging across a wide range of habitats (Altringham 2003; Bat Conservation Trust 2014).

'Woodland and hedgerows' are known to be important for a number of bat species, and yet unexpectedly they were not found to be positively associated with activity levels of any species. Lower levels of activity for the Noctule/Serotine/Leisler's group were associated with woodland and hedgerows, which is not surprising as these tend to forage on larger invertebrates associated with dung and so can often be detected foraging above pastures containing livestock. In addition, recorded activity levels of this group in wooded areas could

have been affected by overhead vegetation and 'clutter' making it harder to detect these higher flying species.

The 'other' habitat category was negatively associated with Soprano Pipistrelle and *Myotis* bat activity, one possible explanation being that it mainly consisted of built-up areas, roads and quarries which were often well lit and, hence, avoided by species particularly sensitive to light.

Categories relating to potential 'habitat use' by bats were statistically significant in just two cases. Common Pipistrelle activity levels were significantly lower at locations lying on potential 'commuting' routes, which often included linear habitat features such as hedgerows, gullies and woodland edges. Lesser Horseshoe Bat activity was significantly higher at locations close to habitat features having the potential to be useful as 'maternity roosts', which for this species included buildings and caves.

In summary, if bats were present the abundance of each species could be linked to at least two habitat categories, except for Greater Horseshoe and Lesser Horseshoe Bats which could only be linked to one (Table 2). 'Water bodies' clearly had the greatest predictive value, with the extent of water bodies within a 500 m radius being the most useful habitat attribute for predicting likely levels of bat activity. In contrast, several other habitat categories were found to have relatively little or no predictive value for most of the species or species groups investigated.

CITIZEN SCIENCE

The project started with very modest objectives for 'volunteer engagement'. On realising the extent of coverage required for a landscape-scale survey of this sort, these objectives were up-scaled and specialists from the Somerset Bat Group were contacted in the planning stages to develop the project as a joint initiative between SWT and the Bat Group. Bat surveying has generally been the province of specialists, not least because expensive equipment is involved, including bat detectors, recording equipment and sound analysis software. A certain amount of training is required to use bat detectors properly and novices can find the prospect of identifying bats from their echolocation calls rather daunting. Somerset is fortunate in that the local Bat Group has long provided walks and talks to make bats generally more 'accessible' to the general public.

TABLE 2: A SUMMARY OF WHICH HABITAT FEATURES WERE FOUND TO BE STATISTICALLY SIGNIFICANT PREDICTORS OF THE LEVELS OF ACTIVITY FOR EACH OF THE BAT SPECIES, OR SPECIES GROUPS. A DOUBLE ✓ DENOTES THAT THE CLASSIFICATION WAS A STATISTICALLY SIGNIFICANT PREDICTOR TO THE P=0.05 LEVEL; A ✓ DENOTES THAT IT WAS STATISTICALLY SIGNIFICANT TO THE P=0.1 LEVEL; × DENOTES THAT IT WAS NOT STATISTICALLY SIGNIFICANT; AND N/A DENOTES CATEGORIES THAT COULD NOT BE ANALYSED

Habitat category		**Common pipistrelle**	**Soprano pipistrelle**	**Greater horseshoe**	**Lesser horseshoe**	**Noctule, leisler's & serotine**	***Myotis* spp.**
Elevation		×	×	×	×	×	×
Percentage coverage within 500 m radius	Grassland	×	×	×	×	✓✓	×
	Woodland & hedgerow	×	×	×	×	✓✓	×
	Water bodies	✓	✓✓	✓✓	×	×	✓✓
	Other	×	✓	×	×	×	✓✓
Primary key feature		✓ grassland	×	×	×	✓✓ grassland	×
Secondary key feature		✓✓ exposed upland; within woodland	×	×	×	✓✓ woodland edge	×
Potential use by bats	Maternity roost	×	×	×	✓✓	×	×
	Night roost	×	×	×	×	×	×
	Foraging	×	×	×	×	N/A	×
	Commuting	✓	×	N/A	×	N/A	×

'Citizen Science' is all about the involvement of volunteers in science (Tweddle *et al*. 2012). Three approaches have been identified:

- Contributory approach, the project designed by scientists but involving volunteers;
- Collaborative projects, designed by scientists but with volunteers participating in more than one stage of the process (e.g. field recording, data analysis and communicating the results of the project);
- Co-created projects, designed collaboratively as a full partnership between scientists and volunteers.

The Mendip Hills Big Bat Survey adopted the last approach. The roles of each lead body changed slightly during the course of the survey, but by the third year the responsibilities were as follows:

- SWT undertook volunteer recruitment and coordination, health and safety responsibility, communicated with landowners for access permission and hosted the report on their website. SWT also supported a student project in 2011 that statistically analysed the data, and applied for grants to cover aspects of the project requiring funding support, including staff time and a small amount of equipment.
- The Bat Group undertook the training of volunteers, provided specialist expertise to lead each of the survey groups, and was responsible for data collation, sound analysis and the majority of reporting writing and mapping of results.

Initial work to set up the transects was undertaken by SWT staff, but in more recent Big Bat surveys across the Blackdown Hills and Brue Valley this work has been done by the Bat Group. The survey method was devised by SWT staff with inputs from the Bat Conservation Trust and University of Bristol. As results of the National Bat Monitoring Programme (NBMP) are used by the UK Government for national statistics on biodiversity (Defra 2013), it was important not to add pressure onto existing volunteers to undertake further survey work during the busy summer months (May to end-July/early August). With the end of the most active time of year for bats being mid-September, it was decided that August would be the most opportune period for undertaking the Mendip Big Bat Survey. Less experienced volunteers attended a series of workshops based on the 'How to use your ears' training written by the Bat Conservation Trust for the NBMP. In addition, in the first two years of the project SWT trained six group leaders new to bat surveys in the use of bat detectors and recorders. Volunteers were also involved in analysing and writing up the results each year.

In total, 157 volunteers took part over the six years of the survey (Table 3). Seven participants, 4% of all volunteers and all of them members of the Bat Group, took part in five or six of the Big Bat Survey events; 103 (66%), took part in the survey once – some, of course, on account of the fact that they did not join the survey until the final year – while 29 (18%) took part twice. Feedback from volunteers was extremely positive, and no-one suggested that their failure to come back was because the experience had not lived up to expectation. Poor weather certainly affected the number of participants in 2012, and possibly in some other years as well. The survey was undertaken at a busy time of year, especially for those with children, and this may have been a factor limiting some people's involvement in the project. No formal record was kept of how far people had travelled to participate, but volunteers reported travelling from as far away as Bristol, Wiltshire and Dorset. A number of participants joined the Bat Group as result of their experience of the Big Bat Survey, and membership of the Group grew over the period of the survey.

TABLE 3: NUMBER OF PARTICIPANTS TAKING PART IN EACH SURVEY AND THE NUMBER OF SBG MEMBERS INVOLVED FOR 2010-2012

Survey Year	No. of participants	No. of SBG participants
2007	31	Not recorded
2008	53	Not recorded
2009	43	Not recorded
2010	47	14 (30%)
2011	52	20 (38%)
2012*	39	15 (38%)

* bad weather in 2012 led to many volunteers unable to attend and cancellation of two transects.

DISCUSSION AND CONCLUSION

The Mendip Big Bat Survey adopted a novel 'landscape-scale' approach to surveying for bats, making use of local specialists and volunteers to

investigate the distribution and abundance of bat species in the Mendip Hills. The surveys yielded much useful information, but the following limitations with regard to data quality and geographical coverage need to be borne in mind.

The surveys were all undertaken at the same time of year, meaning that seasonal variations in bat activity could not be investigated. The surveys coincided with the time that young bats 'fledge'; juvenile bats generally stay closer to maternity roosts compared with adults, which may result in higher bat activity in the vicinity of roosts at this time of year.

All transects were recorded at the same time of night. This meant that information was only captured on bat activity for one period of the night, activity at other times being unrecorded. (For example, there are observations that bats may be foraging on the open heath of Blackdown Common between 2-4 am, in areas where early-evening foraging was not observed.)

Transects were restricted to safe routes, generally footpaths, and amicable landowners, and this obviously limited the extent of the area (and sorts of terrain) surveyed; so there were doubtless potentially important foraging, commuting and/or roosting areas away from the transect routes that would have been missed.

The number of transects was obviously restricted by the number of volunteers and amounts of equipment available. With more resources it would have been possible to cover larger areas.

Gathering environmental data at each stop point would have been useful – including air temperature and wind speed, both of which may affect the availability of insects for bats. Recording land-use data, such as the presence or absence of livestock, would also have been worthwhile. The presence of livestock may be associated with larger numbers of invertebrates, particularly dung beetles and larger insects that are important prey items for Noctule, Serotine, Leisler's and Greater Horseshoe Bats.

Habitat factors may also have changed between years, including the structure (density and height) of vegetation, which may have been partly responsible for some of the observed increases or decreases in bat activity over the course of the survey. The transect at East Harptree Plantation was not recorded after 2010 as the vegetation along the footpath had become too dense to allow easy access, and this change in the vegetation could also have affected the bats frequenting this area.

The Mendip Hills Big Bat Survey achieved its objective of finding out more about the distribution and activity of bats in the Mendip Hills, while also engaging the local community and bat specialists in a challenging and interesting survey. Data from the project will hopefully be used to refine the woodland species models and SCC's Species Occurrence Maps, and in this way will help to ensure that planning decisions take full and proper account of those habitats and landscape features of particular importance to bat species, and that resources for habitat restoration and creation can be targeted in a way that enhances habitat connectivity and landscape 'permeability'.

Should the Mendip Big Bat Survey be repeated in the future, a comparison could be made with data collected between 2007-2012, to identify any apparent changes in the presence/absence, distribution and activity levels of the species involved. Ideally, future surveys would attempt to replicate the number, locations and timings of surveys undertaken in 2007-2012. Alternatively, or additionally, surveys in different locations could be undertaken to increase geographical coverage.

The partnership between SWT and the Bat Group has recently been expanded through the development of comparable Big Bat Surveys in the Blackdown Hills, and the Brue Valley between Wedmore and Glastonbury. Neither of these areas has been subject to intensive bat surveys before, and the data gathered will greatly improve our understanding of the distribution of bats across the county, while at the same time helping to raise awareness of bats amongst landowners and the general public.

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VASCULAR PLANT REPORT 2013

There are numerous reasons for making plant records and the focus of plant recording in Somerset can be as varied as the recorders. The Botanical Society of Britain and Ireland (BSBI) has announced its intention to produce a new atlas of the British and Irish flora in 2020: for this, records for all species are equally important and good coverage of the county is essential. Meanwhile, Somerset Rare Plants Group (SRPG) remains dedicated to the production of a Rare Plant Register (RPR) for Somerset: updating of records of rare and threatened native species is ongoing and many excellent records were made for the RPR in 2013. More general recording is also undertaken by SRPG members and others, with the long-term aim of one day producing a new 'Atlas Flora' for the whole county. This report attempts to highlight some of the more unusual and interesting records arising from all this recording activity in 2013.

As usual, the majority of new county or vice-county records were for neophytes (species introduced by man since AD 1500, wittingly or unwittingly, and now naturalised in the wild) or for casual aliens (those introduced species which fail to persist more than five years). Just two *native* taxa were recorded new for Somerset: a hybrid rose and a hybrid between Wild Radish and Sea Radish. There were, however, many important records of native taxa made during the year, and details of these are given in the third section of the list below.

It is difficult to know when to brand a species as locally extinct and indeed use of the term 'extinct' for species which cannot be found is often criticised. For the Somerset RPR, the term is used for species which, despite several searches, have not been found in the last twenty years or so. This is a bold approach, intended to provoke intense search and rediscovery; it certainly did in 2013! Early Gentian (*Gentianella anglica*) had been feared lost in VC6, and possibly Somerset, but in 2013 two plants were found in flower at Hatch Hill, the first record for the county for 14 years and the first for VC6 in 21 years. Greater Dodder (*Cuscuta europaea*), a parasitic annual entirely dependent on its host plant – usually Common Nettle (*Urtica dioica*), occasionally Hop (*Humulus lupulus*) – had been declared extinct in VC5, last seen in 1963. In 2013, after an apparent absence of half a century, this species was found on the roadside at Muchelney. Another species believed to have been lost from VC5 was Hoary Cinquefoil (*Potentilla argentea*), last seen in 1990 on waste ground by a chicken run at Perry Green; 23 years later it turned up again in a new location, on the outskirts of Taunton. In 2013, Heath Dog-violet (*Viola canina* subsp. *canina*) was recorded in Somerset for the first time in 18 years: it had never really been feared extinct, but had presumably been overlooked for a while. Serendipity can play its part in perceived plant distributions.

Ten RPR species were discovered in new hectads (10km x 10km squares) in 2013. This is particularly pleasing for three species which are GB Red-listed (Cheffings and Farrell 2005). Common Cudweed (*Filago vulgaris*), found alongside a car park at Ham Hill, is listed as Near Threatened in GB, while Henbane (*Hyoscyamus niger*), found at Porlock Weir, is listed as Vulnerable. Sea Barley (*Hordeum marinum)* is not only Vulnerable but also Nationally Scarce, occurring in fewer than 100 hectads in Britain. In 2013 this coastal species was found in a new 10km square, inland on the central reservation of the M5. Sea Barley was first found as a roadside halophyte in VC5 in 2012 (Crouch 2013), so may be spreading and is worth looking out for in this relatively new habitat. This species was also re-found in 2013 in a coastal hectad in which it had been feared lost, last seen in 1973. These are excellent records for a Nationally Scarce species; however, discovery of a rare plant in any new site is always thrilling, regardless of whether it is in a new 10km square. In 2013, the Vulnerable