Bat Conservation Trust

JNCC
Joint Nature Conservation Committee

The National Bat Monitoring Programme

Annual Report 2009

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Acknowledgements

A huge thank you must go out to all of our hard-working NBMP volunteers who have collected bat data that have contributed to this report. The NBMP relies on the ongoing efforts of hundreds of volunteers whose dedication allows us to produce population trends for UK bats. Without our volunteers the NBMP would not exist. Many of our volunteers have received training from our volunteer Regional Bat Detector Workshop Leaders (RBDWLs) and we would like to thank them for their continuing dedication to helping us to train up volunteers to maintain the high standards of NBMP surveys. RBDWLs include Jules Agate, Ian Bond, Philip Briggs, Rebecca Collins, Ian Cornforth, Richard Crompton, Richard Dodd, Diana Hagues, Andrew Heath, Bill Landells, Claire Lippold, Louise Mapstone, John Martin, Dan Merrett, Shirley Pottie, Claire Rawcliffe, Ed Santry, Mandy Spry, Natalie Taylor, Nick Tomlinson, Michael Walker, Edward Wells and Anne Youngman.

The NBMP is a partnership project between the Bat Conservation Trust (BCT) and the Joint Nature Conservation Committee (JNCC). Between 2007 and 2009 funding was provided by JNCC, BCT, Natural England, Heritage Lottery Fund, Forestry Commission and the Environment Agency. The People's Trust for Endangered Species, Forestry Commission, Scottish Forestry Trust, WREN, Countryside Council for Wales and the BBC Wildlife Fund have all funded the Bechstein's Project. The iBats UK project is a partnership project with the Zoological Society of London. Members of the NBMP team at BCT were responsible for entering and processing the data used in this report, and Steve Langton completed all the statistical analyses.

This report was completed in September 2010.

The **Bat Conservation Trust** is the only national organisation in the UK solely devoted to the conservation of bats and their habitats. It works with a network of almost 100 local bat groups and over 1,000 bat workers who survey roosts and hibernation sites, and supports householders and a range of professional sectors including builders, farmers and foresters to protect bats. BCT operates the Bat Helpline on **0845 1300 228**, providing advice for all who come into contact with bats.
For more information visit **www.bats.org.uk**
For more details on the NBMP and to sign-up, visit our webpage: http://www.bats.org.uk/pages/nbmp.html
You can also contact the NBMP team by email: nbmp@bats.org.uk or by phone: 0207 501 3622.

Joint Nature Conservation Committee (JNCC) The JNCC is the statutory adviser to the UK Government and devolved administrations on UK and international nature conservation. Its work contributes to maintaining and enriching biological diversity, conserving geological features and sustaining natural systems.
For more information visit **www.jncc.gov.uk**

TRACKING Mammals PARTNERSHIP

The Bat Conservation Trust is a member of the Tracking Mammals Partnership, a collaborative initiative involving 25 organisations with a variety of interests in UK mammals, which aims to improve the quality, quantity and dissemination of information on the status of mammal species in the UK.

For more information visit **www.trackingmammals.org**

Cover photo: Sunset/Sunrise survey, BCT

Contents

Executive Summary

This report covers the period 1997 – 2009 of the National Bat Monitoring Programme (NBMP). The report focuses on updated trends for 2009 but also provides a summary of findings from the programme between 2007 and 2009. The primary aim of the programme is to produce statistically-defensible population trend data for resident UK bat species. Effective bat conservation relies on gathering information to identify changes in populations that are of conservation concern.

The main monitoring techniques employed by the programme are the Field, Waterway, and Hibernation Surveys and summer maternity Colony Counts. Newer monitoring techniques involve the use of broadband bat detectors to record a range of species along roadsides, woodland transects and around lakes. The total NBMP site network now stands at 4,678. In 2009 a total of 1,991 sites were monitored of which 77% were repeat sites.

At present sufficient data are collected by the programme to produce population trends for 11 of the UK's 17 resident bat species. In 2009, seven species showed statistically significant increases in at least one survey:

- Greater horseshoe bat (Colony Count)
- Lesser horseshoe bat (Hibernation Survey & Colony Count)
- Natterer's bat (Hibernation Survey)
- Common pipistrelle (Field Survey)
- Whiskered/Brandt's bat (Hibernation Survey)
- Noctule (Field Survey)

From these results we conclude that the lesser horseshoe population is increasing as both sources of data are indicating the same trend. We also conclude that the common pipistrelle population is increasing, as Field Survey data are considered to be more reliable that Colony Count data. It is less clear whether the increasing trend seen in Natterer's bat from the Hibernation survey is a real reflection of population increase or other factors as the Colony Counts count data do not support the increase. The greater horseshoe bat, whiskered/Brandt's bat and noctule trends should be treated with caution at present.

Significant negative trends were reported for common pipistrelle and soprano pipistrelle (Colony Counts), though these may be highly influenced by the mobility of these species. The Field Survey showed a significant increase for common pipistrelle and a stable trend for soprano pipistrelle and these trends are presently considered most robust.

The remaining species: Daubenton's bat and brown long-eared bat and serotine all showed no significant trend to 2009. Daubenton's bat has shown a fairly stable trend from both Hibernation and Waterway Survey data, although there has been a slight, but not significant decline since 2005. Brown long-eared bat had shown a slight increase since 2005, but lower counts in 2008 and 2009 have resulted in no overall significant trend from either the Hibernation Survey or Colony Count. No significant trend has been shown for serotines from either the Field Survey or Colony Counts. Sample sizes are small and confidence intervals large for this species however, as it is encountered infrequently and has a restricted range in the UK and it may be difficult to detect trends.

Trends results have remained fairly consistent over the period from 2007 to 2009 with four species showing significant increases throughout this time: greater horseshoe bat (Colony Counts), lesser horseshoe bat (Colony Counts and Hibernation survey), Natterer's bat (Hibernation survey) and common pipistrelle (Field survey). The majority of species surveyed therefore appear to be stable or increasing. Whilst these are positive results, it should also be taken into account that these trends reflect changes in bat populations from 1997 and it is likely that prior to this, in the second half of the twentieth century, there were significant historical declines in bat populations.

NBMP surveys and data contribute to UK government biodiversity monitoring and reporting obligations including UK Biodiversity Action Plan, the Habitats Directive and the national report to EUROBATS. In 2008, NBMP data were used to develop a composite index of widespread bat populations, which was incorporated into the UK biodiversity indicators which help measure progress towards the Government's target of halting biodiversity loss by 2010. NBMP contributes data to the National Biodiversity Network. Data are also used to support various research initiatives including the BICCO-Net project.

Bat monitoring in the UK

An introduction to the National Bat Monitoring Programme

The National Bat Monitoring Programme (NBMP) is a partnership between the Bat Conservation Trust (BCT) and the Joint Nature Conservation Committee (JNCC) which aims to deliver trends to assess the conservation status of the UK's bat species.

Effective conservation requires monitoring of underlying population trends to provide an 'early-warning' system for population declines; to ensure scarce conservation resources are targeted towards sustaining bat populations or the habitats on which they depend; and also to help to inform and influence policy. The NBMP aims to deliver this information and, through collection of data, aims to enables us to understand more about the drivers of any change in population trends. The NBMP also aims to deliver information needs for country biodiversity strategies, Habitats Directive obligations and the UK Biodiversity Action Plan (UK BAP). Bats are widely distributed through the range of landscapes and habitats in the UK. A combination of their reliance on insect prey, sensitivity to prevailing climatic conditions, dependence on a range of habitats and vulnerability to changed land and site management approaches, makes them likely to be valuable indicators of the 'health' of the UK environment. In May 2008 NBMP data enabled bats to contribute to the suite of UK biodiversity indicators which help measure progress towards the Government's target of halting biodiversity loss by 2010 (see http://www.defra.gov.uk/evidence/statistics/environment/wildlife/download/pdf/biyp2010.pdf).

Through continued development of new surveillance techniques, training approaches and volunteer recruitment, the NBMP has grown substantially in capacity since it was first established in 1996, now delivering statistically robust trends for 11 of the UK's 17 resident species. For a more detailed account of the background, aims, objectives and monitoring approach of the NBMP go to www.bats.org.uk/pages/nbmp_background_info.html

Aims of the report

This is one of a series of Annual Reports from the NBMP which aims to provide an annual update on the trends for each of the UK bat species included in the programme. In this report, we also provide an overview of the results of the last three years from 2007 to 2009, and information on some of the wider projects that have used or been based on NBMP data.

The report will be made available on our website to ensure that it will reach a wide audience including our volunteers who have generously given their time to contribute to the findings presented here.

Survey coverage 2009

The core surveys in the NBMP programme are as follows:

- Field Survey (surveying for noctule, serotine and pipistrelles)
- Waterways Survey (surveying for Daubenton's bats)
- Colony Counts (for common and soprano pipistrelles, brown long-eared bat, serotine, lesser horseshoe and greater horseshoe bats and Natterer's bat)
- Hibernation survey (providing data on greater horseshoe bat, lesser horseshoe bat, Daubenton's bat, Natterer's bat, whiskered / Brandt's bat and brown long-eared bat)

These surveys currently provide sufficient data to produce population trends for 11 of the UK's bat species: greater horseshoe bat, lesser horseshoe bat, Daubenton's bat, whiskered / Brandt's bat, Natterer's bat, noctule, serotine, common pipistrelle, soprano pipistrelle and brown long-eared bat. Some species are monitored by using more than one of the survey methods. As a general rule, trends from the Field Survey and Waterway survey are considered most robust at present, followed by the Hibernation Survey and then the Colony Counts. Further details of survey methods and their robustness are given in the 2006 NBMP Annual Report (BCT 2007).

In addition to the core surveys, the Woodland Survey aims to monitor the presence of barbastelle bats at protected sites designated for this species in particular, and a distribution survey for Nathusius' pipistrelle was piloted in September 2009. We also encourage new volunteers to get involved in the NBMP by participating in our Sunset / Sunrise survey which is run each summer. Additional projects are being undertaken on mapping the distribution of Bechstein's bat in the UK (Bechstein's Project) and monitoring bats using car transects as part of the iBats programme (iBats UK) and these are reported on in more detail separately to the core NBMP surveys.

The total site network for all surveys in 2009 totals 4,678 sites, a 0.8% increase on the 2008 site total. There was a 1.4% increase in the number of sites surveyed in 2009 compared with 2008. These figures are also expected to further increase very slightly as 2009 survey forms continue to be sent in belatedly during 2010. Of the sites surveyed in 2009, a high percentage, 77% (on average), had been surveyed at least once before, with the Greater horseshoe bat Colony Count, Hibernation Survey and Lesser horseshoe Colony Count showing the highest levels of repeat site monitoring (Table 1). The Sunset/Sunrise Survey is not included in the table below as this survey does not involve building up a site network for repeat site monitoring. The Nathusius' pipistrelle Survey is a pilot survey new in 2009, and therefore all the sites were new and it was not included in the overall calculation of new and repeat site averages this year.

Table 1. UK site coverage 2008-2009

Surveys	**Total number of sites in the network 2009**	**Total sites surveyed 2008**	**Total sites surveyed 2009**	**Sites surveyed percentage change 08-09**	**Percentage of new sites 2009**	**Percentage of repeat sites 2009**
Field	653	235	223	-5.1%	24.4%	75.6%
Waterway	1112	375	368	-1.9%	18.7%	81.3%
Hibernation	590	376	380	1.1%	6.3%	93.7%
Colony Counts:						
Lesser horseshoe	289	170	167	-1.8%	13.8%	86.2%
Natterer's	83	47	47	-	23.4%	76.6%
Serotine	131	50	45	-11.1%	37.8%	62.2%
Common pip	443	233	216	-7.2%	22.6%	77.4%
Soprano pip	334	166	157	-5.4%	22.9%	77.1%
Pipistrelle sp.	738	193	172	-10.8%	36.6%	63.4%
Brown long-eared	169	86	91	5.8%	25.2%	74.8%
Greater horseshoe	24	22	23	4.5%	4.3%	95.7%
Woodland	30	11	20	81.8%	40%	60%
Nathusius' pip (new survey)	82	-	82	-	100%	0%
All surveys	**4,678 (Total)**	**1,964 (Total)**	**1,991 (Total)**	**1.4%**	**23% (Mean excl Nathusius')**	**77% (Mean excl Nathusius')**

Table 2 shows the number of sites surveyed in 2009 by country and English Government Office Region (GOR). The table also shows the number of repeat sites which are included in the trend analysis, the minimum requirement being that a site needs to have been surveyed at least twice. The NBMP was originally designed to detect population trends at the UK level, but reporting at finer scales is possible, providing the sample size of sites exceeds certain thresholds. Power analysis completed in 2001 showed that a core of 30-40 sites need to be surveyed annually in order to enable trend estimates to be calculated (BCT 2001). From Table 2 it can be seen that there is sufficient coverage to look at trends in England for most surveys with the exception of the Greater horseshoe Colony Counts. In Wales, the Hibernation Survey and Lesser horseshoe Colony Counts meet the required target. In Scotland however, only the Waterway Survey begins to reach target sample size and no surveys reach the target in Northern Ireland. Very few English regions currently have sufficient survey coverage to allow regional trends to be investigated.

The way forward to achieving the long-term objective of producing trend data for each UK country and the English regions is for us to continue to encourage new volunteers to take part in areas where survey coverage is currently low.

Table 2. UK site coverage 2009 – summary table by country and English Government Office Regions.
Note: numbers in brackets are repeat sites which meet the minimum requirement for inclusion in trend analysis.

	Country				**Government Office Region**								
Survey	**England**	**Scotland**	**Wales**	**Northern Ireland**	**North East**	**North West**	**East Midlands**	**West Midlands**	**Yorkshire & The Humber**	**East of England**	**Greater London**	**South East**	**South West**
Field	182 (144)	27 (18)	17 (7)	2 (0)	14(10)	13 (10)	11 (7)	14 (10)	14 (12)	27 (26)	11 (8)	46 (40)	32 (21)
Waterway	268 (228)	44 (34)	16 (11)	35(25)	7 (4)	39 (32)	36 (31)	19 (15)	17 (15)	28 (25)	16 (13)	65 (57)	41 (36)
Hibernation	313 (296)	24 (19)	43 (41)	0 (0)	1 (1)	18 (18)	15(14)	10 (10)	5 (5)	36 (35)	9 (9)	148 (141)	71 (64)
Colony Counts:													
Lesser horseshoe bat	64 (57)	-	103(87)	-	0 (0)	0 (0)	0 (0)	11 (11)	0 (0)	0 (0)	0 (0)	1 (1)	52 (47)
Natterer's bat	40 (32)	4 (4)	3 (0)	0 (0)	2 (1)	1 (1)	11 (8)	0 (0)	7 (6)	2 (2)	0 (0)	10 (8)	7 (6)
Serotine	45 (38)	-	-	-	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (3)	0 (0)	29 (27)	12 (8)
Common pipistrelle	171 (130)	31 (25)	12 (10)	2 (2)	6 (3)	14 (11)	23 (15)	22 (17)	19 (12)	15 (13)	2 (2)	42 (33)	28 (24)
Soprano pipistrelle	105 (74)	29 (26)	20 (18)	3 (3)	3 (1)	10 (8)	24 (10)	7 (6)	7 (5)	13 (10)	6 (6)	19 (16)	16 (12)
Pipistrelle unsure	141 (92)	12 (6)	18 (10)	1 (1)	8 (4)	10 (5)	26 (16)	14 (11)	10 (5)	26 (17)	0 (0)	35 (27)	12 (7)
Brown long-eared bat	65 (51)	17 (12)	6 (3)	3(2)	2 (0)	6 (4)	14 (12)	8 (6)	2 (2)	2 (2)	0 (0)	20 (16)	11 (9)
Greater horseshoe bat	18 (17)	-	5 (5)	-	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	18 (17)
Total for all surveys	**1408 (1160)**	**188 (144)**	**238 (192)**	**46 (35)**	**41 (25)**	**111 (89)**	**159 (102)**	**159 (102)**	**81 (60)**	**153 (130)**	**44 (38)**	**408 (370)**	**301 (250)**

Population Trend Analysis

The purpose of analysis is to draw correct conclusions on population trends occurring in species of interest. Many factors can influence the appearance of trends (apart from true changes in population size) and the magnitude of their effect should be estimated, and methods for reducing their influence put into place to reduce the possibility of data misinterpretation.

In order to produce a clear picture of the long-term trend for each species, GAMs (General Additive Models) have been used to fit a smooth line to each dataset. These smoothed curves are quite robust against random variation between years, except at the ends of the series where annual fluctuations and extreme outliers can have an unacceptably large impact on the first and last years. To counteract this problem, it is best not to use the first year of a survey as the baseline year, where the index equals 100, and in this report the year 1999 has been taken as the baseline year wherever possible. On the graphs in each survey description, crosses represent the calculated means (converted to the index scale) and the solid line represents the estimated trend from the GAM. Dotted lines show 95% confidence limits. In all cases, the estimate for the most recent year should be regarded as provisional and a dotted line is used on the graphs to indicate this.

GAM models can include covariates for factors that could influence the means (e.g. bat detector make, temperature). Generalised Linear Mixed Models (GLMMs) were used to investigate these factors, with any variables that were statistically significant with a biologically plausible relationship included in subsequent GAMs. GAM models were then fitted with and without the covariates, to compare the results. In most cases the differences between the two models were minimal, but for some of the field survey results bat detector type had a marked impact on results, due to the gradual change in the detectors used over time. In this report the analysis with covariates is reported when this achieves a marked increase in precision compared to the unadjusted trend. A detailed explanation of GAMs can be found in Appendix 1.

The average annual percentage change is an approximation based on the assumption that the trend during the period considered is constant and linear. It is estimated by calculating the annual percentage change that would take the population from 100 in the base year to the index value in the current year.

Species coverage

Core surveys

Power analysis carried out in 2001 led to a recommendation that a core of 30-40 sites needed to be covered annually in order to enable UK estimates of trend (BCT 2001). Table 3 shows how close we are to meeting this target for each species in each survey (i.e. 40+ sites having been surveyed in all thirteen years of the programme since 1997 with the listed species occurring in at least one year).

Targets are being exceeded for Daubenton's bat, Natterer's bat and brown long-eared bat on the Hibernation Survey, with a core of 40+ sites with these species present having been surveyed every year since the NBMP began. Very high levels of regular repeat site monitoring also occur on the Hibernation Survey for whiskered/Brandt's bat and lesser horseshoe bat, on the Colony Counts for lesser horseshoe, common pipistrelle and soprano pipistrelle, on the Field Survey for common pipistrelle, soprano pipistrelle and noctule, and on the Waterway Survey for Daubenton's bat. The number of greater horseshoe colonies being monitored is comparatively small but the sample size is likely to be sufficient given that it represents a large proportion of known roosts.

Table 3. No. of repeat sites with species present in at least one year, categorised by number of years in which they have been surveyed

Note: Highlighting indicates the years represented by 40+ sites for each survey. Targets are being met where 40+ sites have been surveyed every year since the survey began. Repeat sites surveyed in fewer years represent additional survey site patterns which add value when combined with the 'core' sites

Survey/species	**No of years surveyed**											
	13	**12+**	**11+**	**10+**	**9+**	**8+**	**7+**	**6+**	**5+**	**4+**	**3+**	**2+**
	No of sites											
Colony Counts:												
Greater horseshoe	4	6	8	10	12	13	13	14	20	22	23	24
Lesser horseshoe	17	26	37	61	78	97	119	129	138	158	180	206
Natterer's bat	0	1	2	4	10	14	20	28	39	45	56	67
Common pipistrelle	9	21	35	47	66	88	112	144	168	215	273	344
Soprano pipistrelle	7	16	24	34	50	59	77	97	120	148	190	250
Serotine	8	13	18	21	22	25	25	32	40	45	55	70
Brown long-eared	1	1	2	4	13	22	36	46	63	79	97	121
Field Survey												
Common pipistrelle	N/A	4	17	33	50	67	97	137	190	242	311	404
Soprano pipistrelle	N/A	4	15	29	45	58	77	108	154	191	240	304
Serotine	N/A	3	8	15	22	28	40	54	77	94	117	146
Noctule	N/A	4	15	28	43	57	83	115	154	189	238	300
Waterway Survey:												
Daubenton's bat	0	4	23	41	53	93	132	194	256	346	469	643
Hibernation Survey:												
Greater horseshoe	3	5	11	15	24	36	39	43	47	49	57	68
Lesser horseshoe	4	9	17	25	40	58	64	79	94	103	127	143
Daubenton's bat	46	63	76	89	108	124	142	154	178	187	200	219
Whiskered/Brandt's	22	31	39	49	62	71	80	90	96	97	105	110
Natterer's bat	52	71	87	104	127	148	166	181	210	227	247	271
Brown long-eared	51	68	80	95	121	142	162	179	203	217	236	256

Barbastelle

The NBMP Woodland Survey is partly funded by Natural England with the primary aim of monitoring barbastelles at sites that have been designated as Special Areas of Conservation (SACs) due to this species' presence. In 2009 six SAC sites were monitored as part of this survey. The results are summarised in Table 4 below.

Table 4: SAC sites surveyed for barbastelle bats in 2009

Site	**County**	**Barbastelle recorded**		
		Period 1 (25 Jul - 8 Aug)	**Period 2 (9 Aug - 23 Aug)**	**Period 3 (24 Aug - 7 Sep)**
Briddlesford Copses*	Isle of Wight	No survey	No survey	Yes
Ebernoe Common	West Sussex	No survey	Yes	No
Eversden and Wimpole Woodlands	Cambridgeshire	Yes	Yes	Yes
Exmoor and Quantock Oakwoods	Somerset	No survey	No survey	Yes
Mottisfont	Hampshire	No survey	Yes	Yes
North Pembrokeshire Woodlands	Pembrokeshire	Yes	Yes	No

*Barbastelle is not a qualifying feature of this SAC, but due to this species' presence on the site it is included in the Woodland Survey SAC site monitoring at the request of Natural England.

Barbastelle presence was confirmed at all of the above SAC sites during at least one of the survey periods. Surveys were carried out in the third survey period only at two of these sites (Briddlesford Copses and Exmoor and Quantock Oakwoods). Previous information collected at Ebernoe Common and North Pembrokeshire Woodlands suggests that at some locations the earlier survey periods may be more productive than the third period as barbastelles may start to disperse by late August. At the two sites that were only surveyed during the final period this was not the case as barbastelle bats were still recorded at these sites. For 2010 however, it is proposed that all sites should be surveyed in at least one of survey periods 1 and 2 to maximise the likelihood of detecting barbastelles.

The Woodland Survey was also carried out at 13 further woodlands that are not designated as SAC sites for barbastelle. The distribution of sites is shown below (Figure 1). Sound analysis is still being carried out on the recordings from these sites and the results will be published at www.bats.org.uk later in 2010.

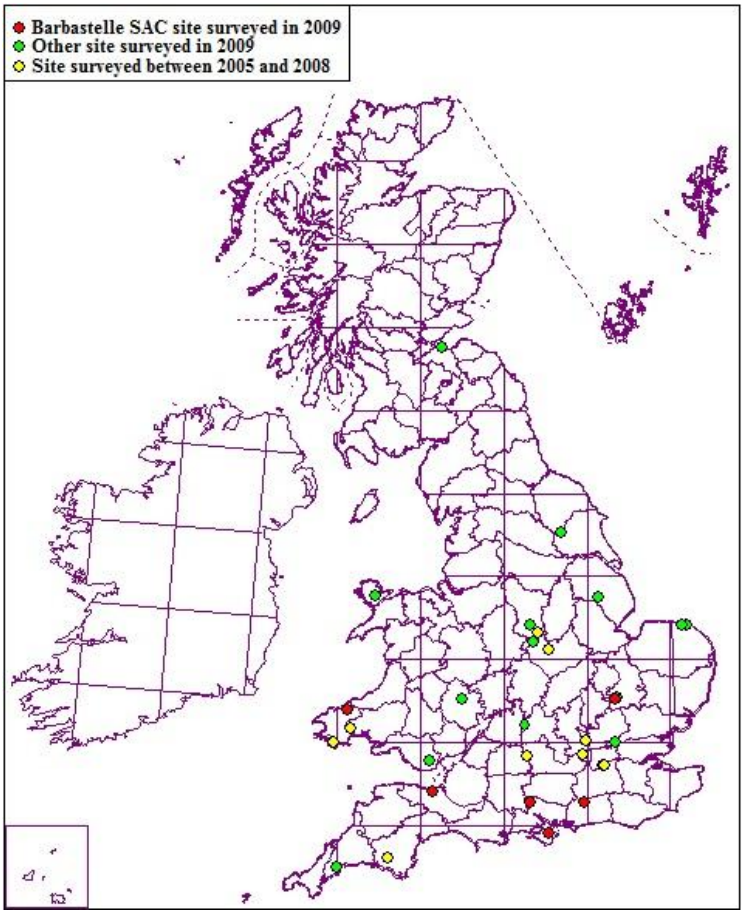

Figure 1. Distribution of Woodland Survey sites

Nathusius' pipistrelle

A Nathusius' pipistrelle survey was piloted in September 2009 at lakes and lochs across the UK. The aim of the survey is to collect systematic distribution data for this species for the first time. Other potential future outputs include investigating changes in Nathusius' distribution and/or activity levels, habitat associations and migratory patterns across the UK. The survey focuses on this species during its late summer/early autumn migration when it is most commonly recorded in the UK.

The survey method involves a walked 1km transect route around the edge of the lake or loch. The presence of Nathusius' pipistrelle is recorded at ten stopping points along the route and also while walking between stopping points. At each site one survey is carried out between 1st-15th September and a second survey between 16th-30th September. The standard equipment used is a combined heterodyne/frequency division bat detector attached to a digital recorder. This enables Nathusius' pipistrelle records to be verified and additional species of interest to be identified. An alternative Anabat protocol was also produced in response to volunteer requests and this method has proved effective in collecting and verifying the required data.

74 volunteers took part in September 2009 and data were received from 82 sites. Nathusius' pipistrelle was recorded at 24 of these sites (29%) with verified recordings from 14 sites (17%). Several volunteers simply used a heterodyne detector which generated a lot of useful data but did not allow for verification of records. The survey will be run again in September 2010 when more frequency division detectors and recording equipment will be available for loan to volunteers to enable verification of this species at a higher proportion of sites.

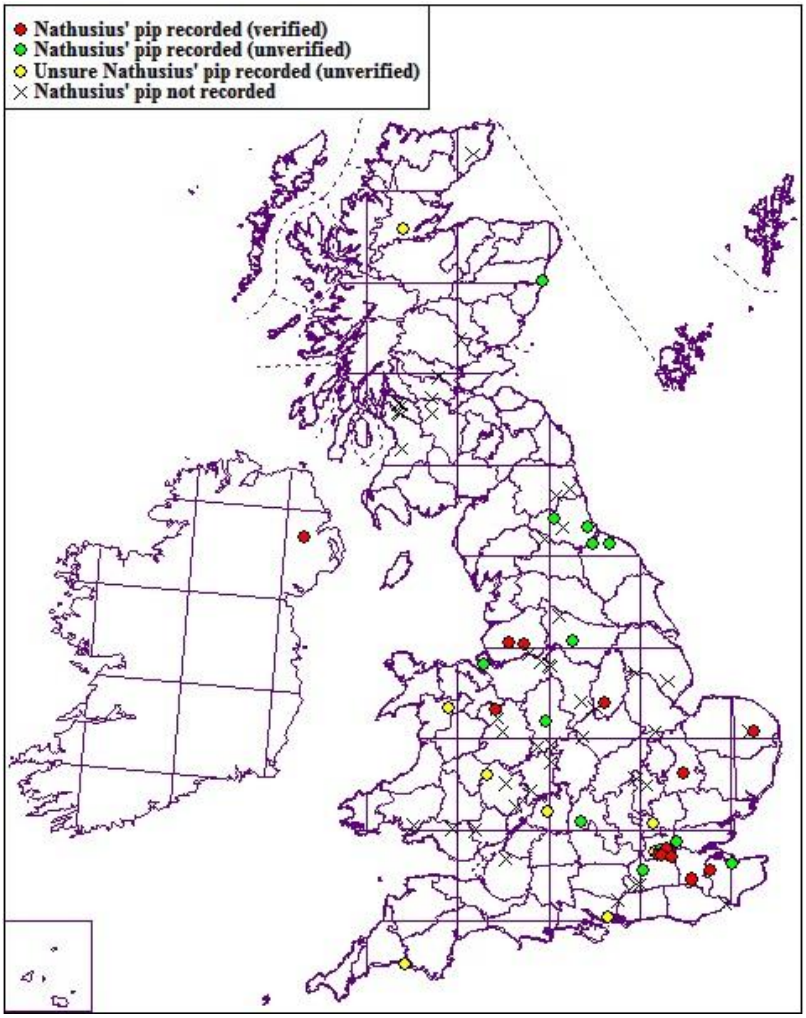

Figure 2. Distribution of the pilot Nathusius' Pipistrelle Survey sites, September 2009

Notes:
'Verified' records are from surveys where recordings were made and Nathusius' pipistrelle presence was confirmed through sonogram analysis.

'Unverified' records are from heterodyne detectors.

'Unsure' records could possibly be common pipistrelles calling at the lower end of their frequency range. A target for 2010 will be to make recordings at all sites with unverified records to enable verification to be carried out.

'Not recorded' are sites which were surveyed but where Nathusius' pipistrelle was not recorded.

Indicator Bats Program (iBats) UK

The Indicator Bats Program in the UK (iBatsUK) is a partnership project between BCT and The Zoological Society of London. It aims to develop national bat monitoring programs across the globe in order to generate long-term data on biodiversity indicator species, helping to assess the impact of national development and global change. The iBatsUK project started out in 2005 as The Bats & Roadside Mammals Survey, a partnership project between BCT and the People's Trust for Endangered Species. Now fully integrated into the global iBats project, the survey is carried out by a large number of groups throughout the UK. The main aims of the project are to increase the number of records of mammals (primarily bats) along roads, determine which roadside habitats are important for bats, and provide long-term monitoring at the national and regional level.

The survey involves volunteers driving up to 40 km of roads per survey using ultrasonic time expansion detectors attached to a car window to record bats. A GPS unit allows geo-referencing of all records. Data collected extends and complements existing NBMP projects and, in the longer term, will enable statistical monitoring of selected species at the regional level.

In total fifteen groups participated in the iBatsUK project in 2009 (Central Scotland, Cornwall, Essex, Exe, Isle of Man, Isle of Wight, Norwich, Norfolk, Valleys, Kent, Somerset Environmental Records Centre, South Lancashire,

Warwickshire, West Yorkshire and Perth). Data from fifty-five survey routes have been uploaded to the iBats website to date. Analysis of the sonogram data is still ongoing.

For more information on iBats visit the webpage: www.bats.org.uk/pages/ibats.html.

Survey site distribution

Figures 3, 4 and 5 below show the distribution of sites surveyed in 2009 for the Waterway, Field and Hibernation surveys respectively. For information on additional species for which trends are not yet available visit the website: www.bats.org.uk/pages/nbmp_background_info.html .

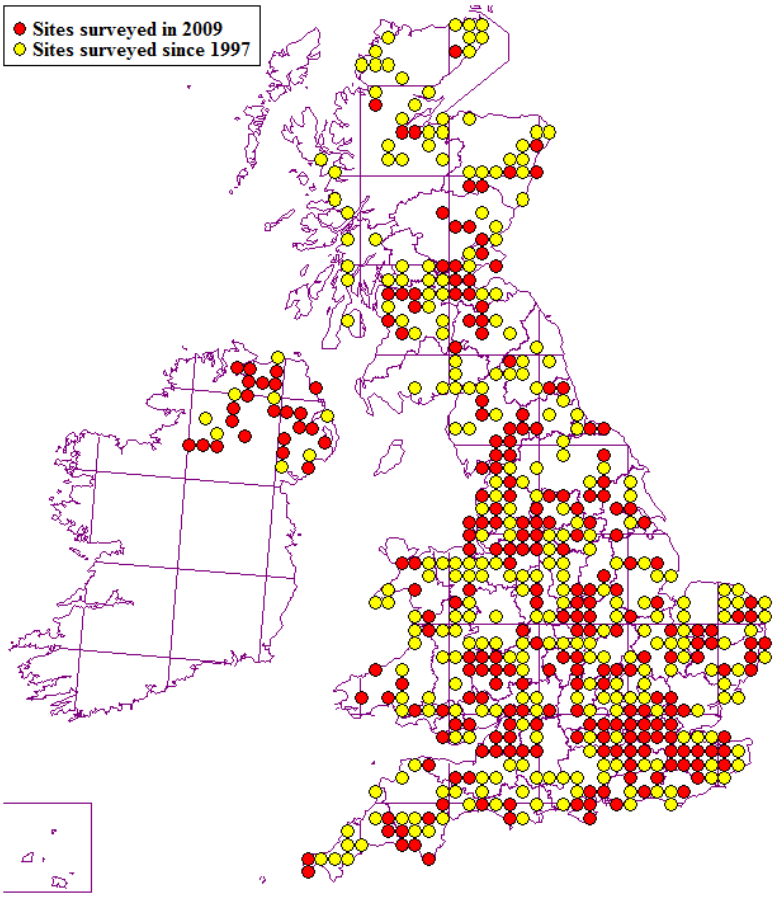

Figure 3. Distribution of Waterway Survey sites

Notes:
368 sites were surveyed in 2009 (shown in red), representing 33% of the total site network (other sites in the network shown in yellow).

Northern Ireland sites are from the All-Ireland Waterway Survey, run by Bat Conservation Ireland, and funded in NI by the Northern Ireland Environment Agency.

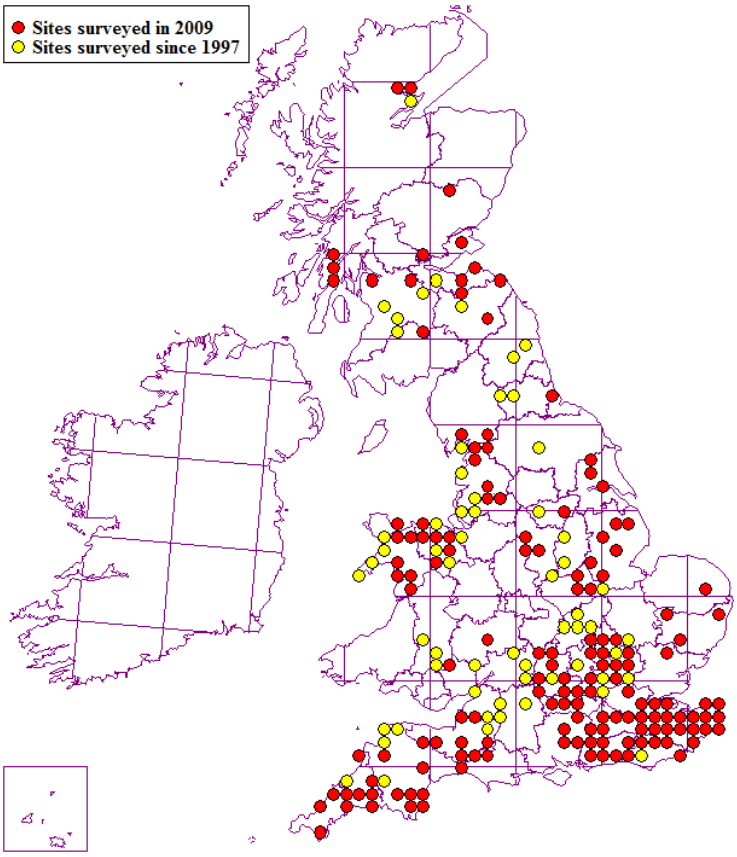

Figure 4. Distribution of Field Survey sites

Notes:
223 sites were surveyed in 2009 (shown in red), representing 34% of the total site network (other sites in the network are shown in yellow).

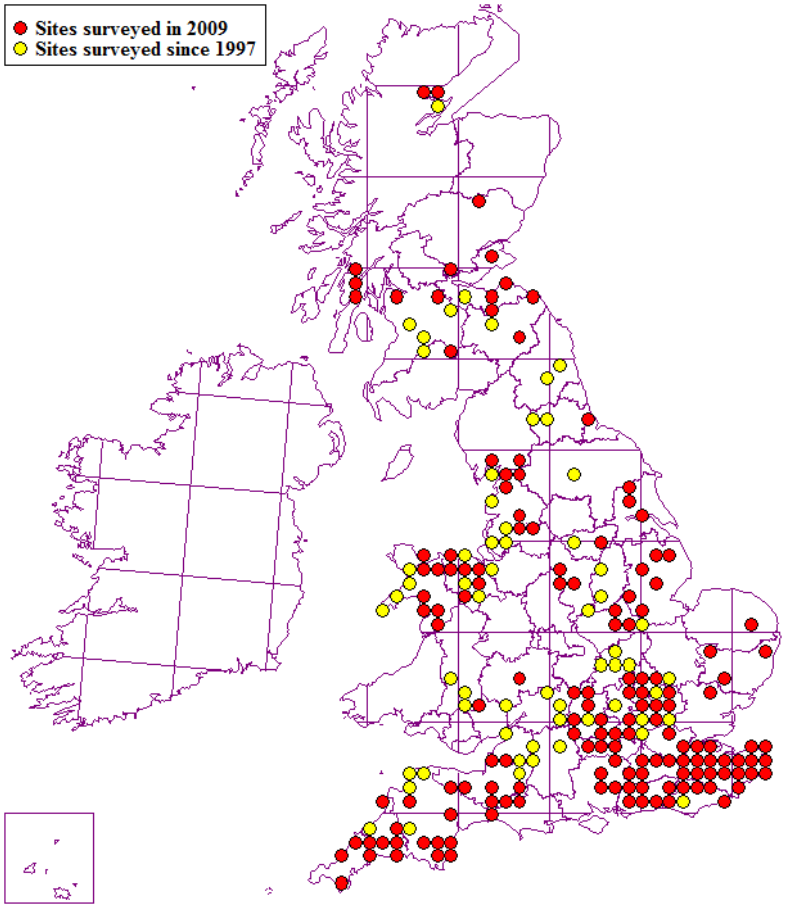

Figure 5. Distribution of Hibernation Survey sites

Notes:
380 sites were surveyed in 2009 (shown in red) representing 64% of the total site network (other sites in the network are shown in yellow).

Species Population Trends

Summary of Trends

Table 5 provides a summary of UK bat species trends including results up to 2009. The numbers of sites that contribute to the trend analysis are shown, as well as an approximation of the average annual percentage change since the set baseline year. The average annual percentage change since the base year has been shown in preference to the total percentage change in index value across the survey period, to facilitate easier comparison of species that have been surveyed over different periods. Note that although average annual percentage change values have been given for every species, the underlying assumptions of the analysis noted earlier means that they are genuinely appropriate only for those species for which the trend line appears linear. This table should therefore be cross-referenced with the individual species accounts below. Significant trends are highlighted in bold and where a species has significant trends from two or more surveys then an asterisk indicates the most statistically robust trend.

In 2009, seven species showed statistically significant increases in at least one survey. Significant positive trends were reported for the greater horseshoe bat (Colony Count), lesser horseshoe bat (Hibernation Survey & Colony Count), Natterer's bat (Hibernation Survey), common pipistrelle (Field Survey), whiskered/Brandt's bat (Hibernation Survey) and noctule (Field Survey). From these results we conclude that the lesser horseshoe population is increasing as both sources of data are indicating the same trend. We also conclude that the common pipistrelle population is increasing, as Field Survey data are considered to be more reliable that Colony Count data. It is less clear whether the increasing trend seen in Natterer's bat from the Hibernation survey is a real reflection of population increase or other factors as the Colony Counts count data does not support the increase. The greater horseshoe bat, whiskered/Brandt's bat and noctule trends should be treated with caution at present: further explanation for this caution can be found in the individual species accounts.

Significant negative trends were reported for common pipistrelle and soprano pipistrelle (Colony Counts), though these may be highly influenced by the mobility of these species. The Field Survey showed a significant increase for common pipistrelle and a stable trend for soprano pipistrelle and these trends are presently considered more robust than the Colony Count trends for these two species.

The remaining species: Daubenton's bat and brown long-eared bat and serotine all showed no significant trends in 2009. Daubenton's bat has shown a fairly stable trend from both Hibernation and Waterway Survey data, although there has been a slight, but not significant decline since 2005. Brown long-eared bat had shown a slight increase since 2005, but lower counts in 2008 and 2009 have resulted in no overall significant trend from either the Hibernation Survey or Colony Count. No significant trend has been shown for serotines from either the Field Survey or Colony Counts. Sample sizes are small and confidence intervals large for this species however, as it is encountered infrequently and has a restricted range in the UK and it may be difficult to detect trends.

The majority of species surveyed therefore appear to be stable or increasing. Whilst these are positive results, it should also be taken into account that these trends reflect what has happened to bat populations since the late 1990s. It is generally considered that prior to this in the period between the 1950s and the late 1980s /early 1990s there were significant historical declines in bat populations, although evidence is fragmented and few data were collected in a systematic way (e.g. Harris *et al.* 1995; Stebbings 1988). Finally, Table 5 also summarises the monitoring status of the remaining six UK species: for all these species, insufficient data are available at present to allow calculation of population trends.

Table 5: UK bat species population trends summary table.
Notes: *indicates most statistically robust trend**. Bold indicates significant result at 5% (p<0.05).** # indicates UK Biodiversity Action Plan priority species. **'S**ites' refers to the number of sites where bats are present that contribute to the trend analysis.

Species	Status	Survey	Trend time period	No. of sites	Long-term trend %	Average annual change %
Greater horseshoe bat #	Very rare, confined to southwest England and south Wales	Hibernation	1999-2009	71	34.9	3.0
		Colony	1999-2009	24	**89.5**	**6.6**
Lesser horseshoe bat #	Rare, confined to southwest England and Wales	Hibernation	1999-2009	152	**63.7**	**5.1***
		Colony	1999-2009	223	**57.6**	**4.7**
Whiskered/Brandt's bat	Common in N & W England, rare elsewhere	Hibernation	1999-2009	123	**52.7**	**4.3**
Natterer's bat	Common	Hibernation	1999-2009	291	**97.6**	**7.1**
		Colony	2000-2009	65	-23.9	-3.0
Daubenton's bat	Common	Hibernation	1999-2009	232	11.1	1.1
		Waterway	1999-2009	710	1.6	0.2
Serotine	Uncommon, restricted to Southern England	Field	1999-2009	313	20.1	1.9
		Colony	1999-2009	82	-0.6	-0.1
Noctule #	Uncommon, absent from Northern Ireland	Field	1999-2009	297	**50.4**	**4.2**
Common pipistrelle	Common	Field	1999-2009	434	**65.4***	**5.2***
		Colony	1999-2009	360	**-48.1**	**-6.4**
Soprano pipistrelle #	Common	Field	1999-2009	435	20.7	1.9
		Colony	1999-2009	279	**-40.5**	**-5.1**
Brown long-eared bat #	Common	Hibernation	1999-2009	264	-2	-0.2
		Colony	2001-2009	128	0.6	0.1
Bechstein's bat#	Very rare	No trend data available; baseline distribution survey in progress (Bechstein's Project)				
Leisler's bat	Scarce in GB, common in Ireland	Recorded on Roadside Survey but more data needed to detect trends				
Nathusius' pipistrelle	Rare	Recorded on Roadside Survey and pilot Nathusius' Survey but more data needed to detect trends				
Barbastelle#	Rare	Recorded on Woodland Survey but more data needed to detect trends				
Grey long-eared bat	Very rare	No trend data available				
(Greater mouse-eared bat)	Status unconfirmed	Only one individual known in UK at present				

The following species accounts provide current status information and a detailed interpretation of the population trends for each species covered by monitoring programme.

Greater horseshoe bat

Native, very rare and endangered. Distribution confined to southwest England and south Wales

Population estimate: UK >6,600 (Battersby *et al*. 2005), England ?, Scotland 0, Wales ?, N. Ireland 0

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Priority species in UK Biodiversity Action Plan; Natural Environment and Rural Communities Act (England & Wales); IUCN Red List; Habitats Directive Annexes II & IV; EUROBATS Agreement; Wild Mammals Act. Ten maternity roosts and 27 hibernation sites have been designated as SSSIs. Eleven SSSIs have been selected for designation as SACs. It is thought that most major roosts are known.

Importance/threats: At the edge of its range in the UK so vulnerable to changes in climate. Juveniles forage on dung beetles extensively so factors affecting dung quantity, i.e. cattle numbers, can impact on populations. Unimproved pasture and woodland are habitats important for sustaining dung and chafer beetle and large moth populations and reluctance to cross open spaces makes linear landscape features important. Majority of breeding roosts heavily protected but closure of disused mines may impact on autumn/winter populations.

Data on population trends of greater horseshoe bats is now collected from two surveys:

- Hibernation Survey (1997-2009)
- Greater Horseshoe Colony Counts (1997-2009). Colony data are kindly supplied by Natural England.

Hibernation Survey

UK level

Figure 6 shows trend analysis results calculated from the total hibernation network of 563 sites that were surveyed between 1997-2009 across the UK. During this time, greater horseshoe bats were recorded in 77 (14%) of these sites. In the winter of 2008-09 this species was found in 41 (11%) of the 372 sites surveyed. After a steady downward (but not statistically significant) trend from 1997-2003, the index rose for several years, but now looks to have stabilised. The 2009 index value is not significantly different from the 1999 value.

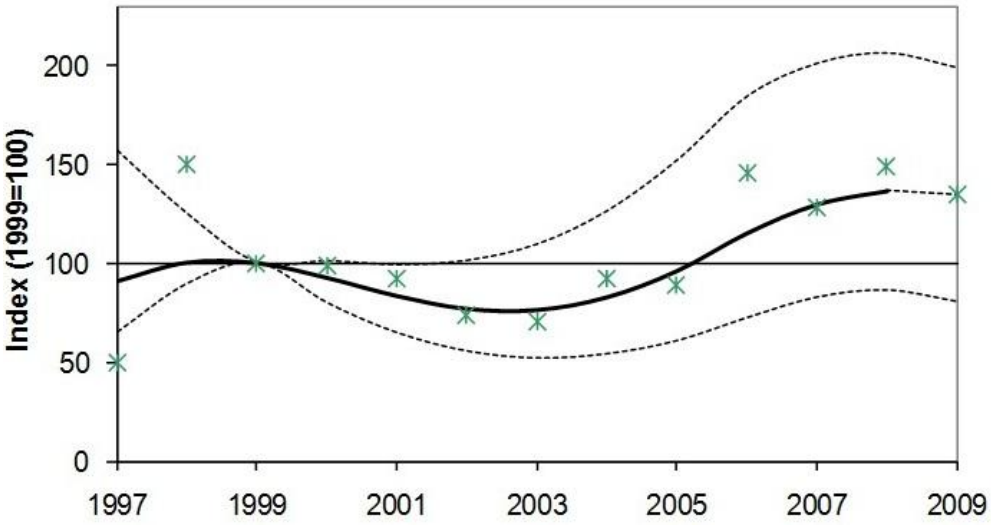

Figure 6: Greater horseshoe bat - UK Index of greater horseshoe bats from the Hibernation Survey (1997-2009). Results of GAM analysis with 95% confidence limits. No significant trend. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

Colony Counts

UK level

Figure 7 shows trend analysis based on a network of 24 colonies observed between 1997-2009. A gradual increase is apparent from 1999. This trend is statistically significant, but should be treated with caution (see interpretation of survey results). The index is currently 90% above the 1999 value (equivalent to an increase of 6.6% per annum).

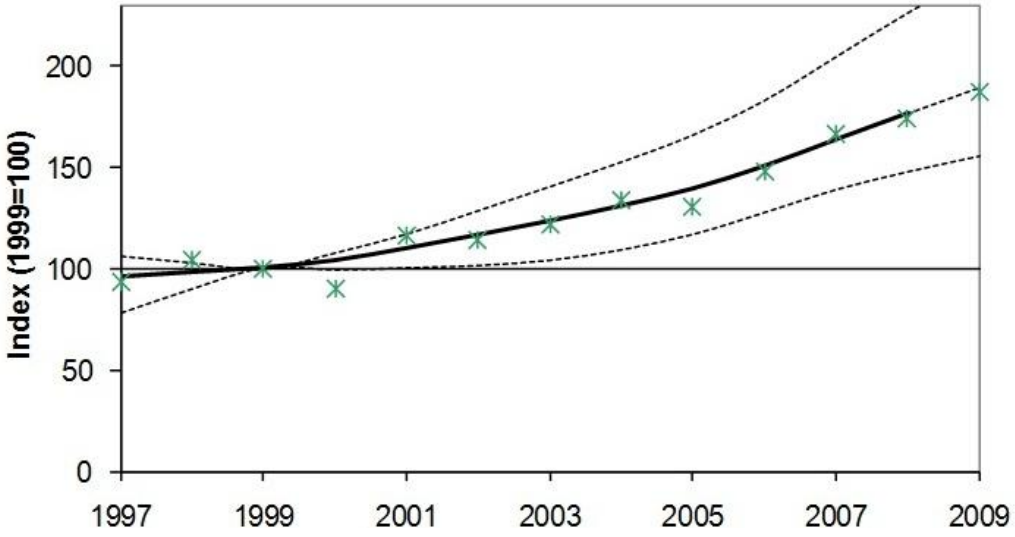

Figure 7: Greater horseshoe bat - UK Index of greater horseshoe bats from the Colony Counts (1997-2009). Results of GAM analysis with 95% confidence limits. Significant positive trend. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

Interpretation of survey results: The 2009 hibernation count is slightly lower than that observed in 2008 but remains an improvement on the 2002-2003 trough. The small number of hibernation sites in which greater horseshoe bats were recorded limits the degree to which these findings may be considered robust (although represents a high proportion of those sites that are known). The significant trend in the Colony Counts appears sustained, but should continue to be treated with caution because of the small number of colonies counted and the historical inconsistencies in counting approach (namely collection and submission of data on external counts, internal counts, or a combination of both, and wider variability in count date than observed in other species) that present challenges to data interpretation. Approaches to data collection in recent years have become more standardised and will lead to greater confidence in colony count trends. At present, trends based on hibernation data are considered to have greater reliability than those at summer colonies.

Lesser horseshoe bat

Native, rare and endangered. Distribution confined to southwest England and Wales

Population estimate: UK est. 50,000 (Henry Schofield, pers. comm. 2008), England ?, Scotland 0, Wales 28,000 (Matthews & Halliwell 2008), N. Ireland 0

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Priority species in UK Biodiversity Action Plan; Natural Environment and Rural Communities Act (England & Wales); IUCN Red List, Habitats Directive Annexes II & IV; EUROBATS Agreement; Wild Mammals Act. At least 12 roost sites have been notified as SSSIs, 70 other roosts are within SSSIs. Fourteen SSSIs have been selected for designation as SACs.

Importance/threats: At the edge of its range in the UK so vulnerable to changes in climate. Reliant on deciduous woodland and mature hedgerows for foraging. Sealing of disused mines could restrict hibernation sites.

Data on population trends of the lesser horseshoe bat are collected by two surveys:

- Hibernation Survey (1997-2009)
- Lesser horseshoe Colony Counts (1997-2009). Data from Wales are kindly supplied by the Countryside Council for Wales.

Hibernation Survey

UK level

Figure 8 shows trend analysis results calculated from the total hibernation network of 563 sites that were surveyed between 1997-2009 across the UK. During this time, lesser horseshoe bats were recorded in 185 (33%) of these sites. In the winter of 2008-09 this species was found in 105 (28%) of the 372 sites surveyed. The trend line showed a steady and significant increase from 1999 to 2005, before levelling off. The most recent results suggest that the species may again be increasing, but a further year's data will be needed to confirm this. The index is currently 64% above the 1999 value (equivalent to an increase of 5.0% per annum).

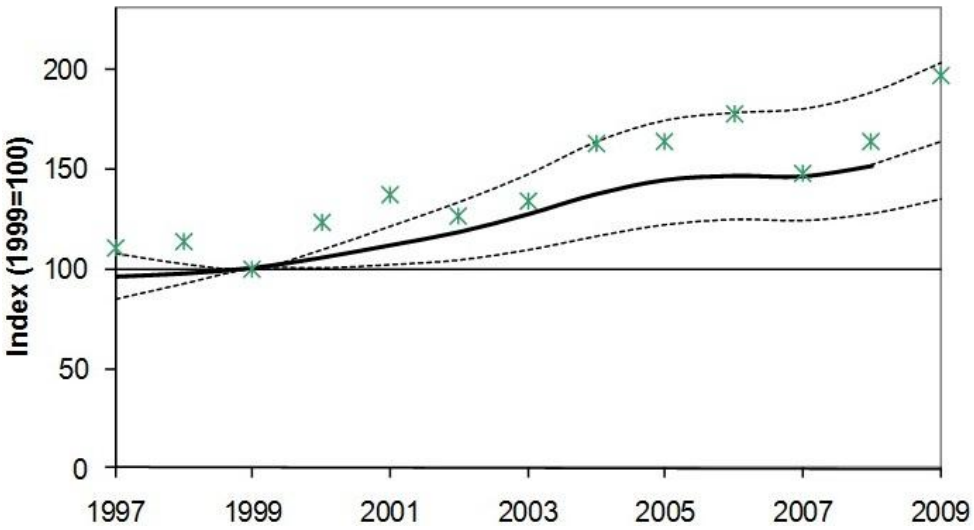

Figure 8: UK Index of lesser horseshoe bats from the Hibernation Survey (1997-2009). Results of GAM analysis with 95% confidence limits. Upward trend is significant. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

England and Wales

There was no statistically significant difference between English and Welsh hibernation count trends.

Colony Counts

UK level

Figure 9 shows survey results for 290 summer colonies surveyed between 1998-2009, of which the number of colonies contributing to the results in any single year ranged between 61 and 158. In 2009 151 roost sites, representing 52% of the total network, were visited, with lesser horseshoe bats being recorded at 97% of these. The 2009 colony counts were lower on average than those reported in 2008, but the smoothed trend estimate remains significantly upward overall, and the average annual increase in colony size is now estimated at 4.6%. In 2009, the average size of lesser horseshoe bat colonies was 120.

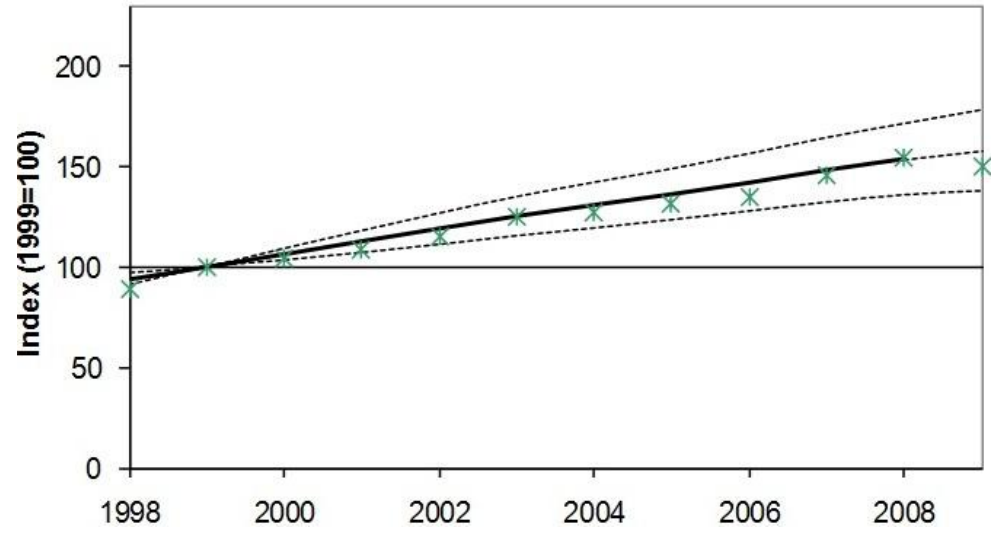

Figure 9: UK Index of lesser horseshoe bat colony size from the lesser horseshoe Colony Counts (1998-2009). Results of GAM analysis with 95% confidence limits. Upward trend is significant. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

England and Wales

Colonies in both countries have continued to show a steady increase, but the upwards trend is greater in England. This difference in trends is not statistically significant. The average annual rates of increase are now 7.6% in England and 4.6% in Wales.

Interpretation of survey results: There is a significant upward trend for both hibernation and colony surveys, indicating that the population has increased since 1999. The increase in lesser horseshoes is likely to have resulted from a succession of mild winters (enhancing winter survival) and direct conservation action stimulated by the species' BAP priority status.

Daubenton's bat

Native, commonly observed on waterbodies throughout much of the UK.

Population estimate: UK 560,000, England 95,000 (Harris *et al*. 1995), Scotland 40,000 (Harris *et al*. 1995), Wales 15,000 (Harris *et al*. 1995), Northern Ireland 410,000 (Russ 1999; estimate of Northern Ireland should be treated with caution and is likely to be lower).

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Habitats Directive Annex IV; EUROBATS Agreement; Wild Mammals Act.

Importance/threats: This species is widespread throughout Europe and the UK. Factors affecting water quality, riparian habitats (including the availability of roosts in trees and artificial structures) and underground hibernation roosts can all impact on Daubenton's bat populations.

Data on population trends of Daubenton's bat are collected by two surveys:

- Waterway Survey (1997-2009)
- Hibernation Survey (1997-2009)

Waterway Survey

UK level

Figure 10 shows survey results calculated from a total site network of 1107 1km stretches of waterway surveyed between 1997-2009 across the UK (however, this network includes a high proportion of sites that have been surveyed in only one year and, therefore, do not yet contribute to the estimation of trends). The number of sites contributing to the results in any single year varies between 147 and 363, apart from 2001 when few sites were visited due to the epidemic of foot and mouth disease. In 2009, 347 sites, representing 31% of the total site network, were surveyed.

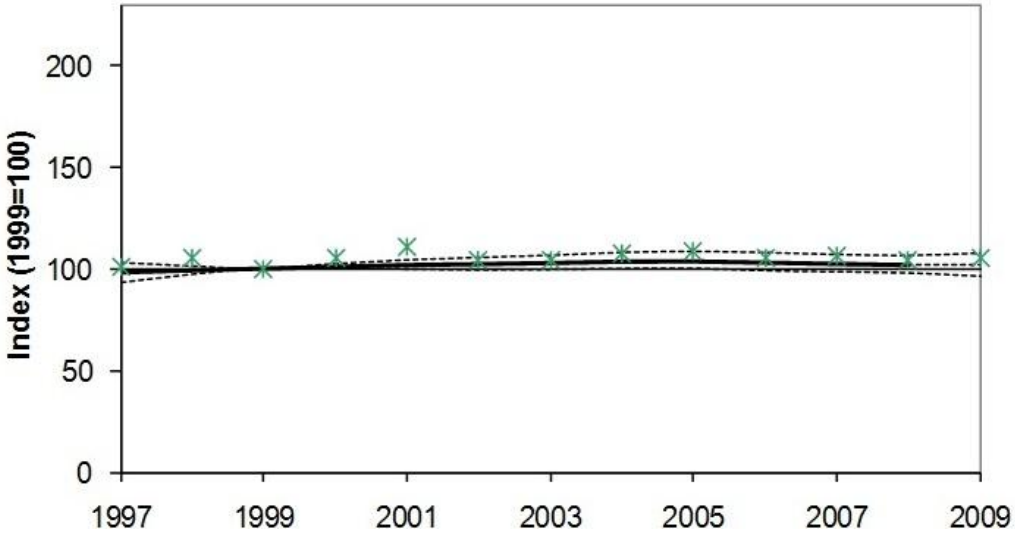

Figure 10: UK Index of the Daubenton's bat population from the Waterway Survey (1997-2009). Results of GAM analysis with 95% confidence limits. No significant trend. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

A new method of analysis, based on the proportion of survey points with bats, has been introduced in 2009. This approach avoids the risk of distortion from a few survey points with continuous bat activity. Using this approach the index remains very close to the baseline value, with a very slight peak around 2005. The 2009 index value is 2% above the 1999 baseline, equivalent to an increase of 0.2% per annum, which is not statistically significant at the 5% level. No significant differences were observed when trends calculated at country or regional level were compared

Hibernation Survey

UK level

Figure 11 shows survey results calculated from a total site network of 563 hibernation sites surveyed between 1997-2009 across the UK. Hibernating Daubenton's bats have been reported from 235 (42%) of these sites. In the winter of 2008-09 this species was found in 116 (31%) of the 372 sites surveyed. There is no significant trend, and although it now appears to be heading downwards, the index is still 11% higher than the baseline value.

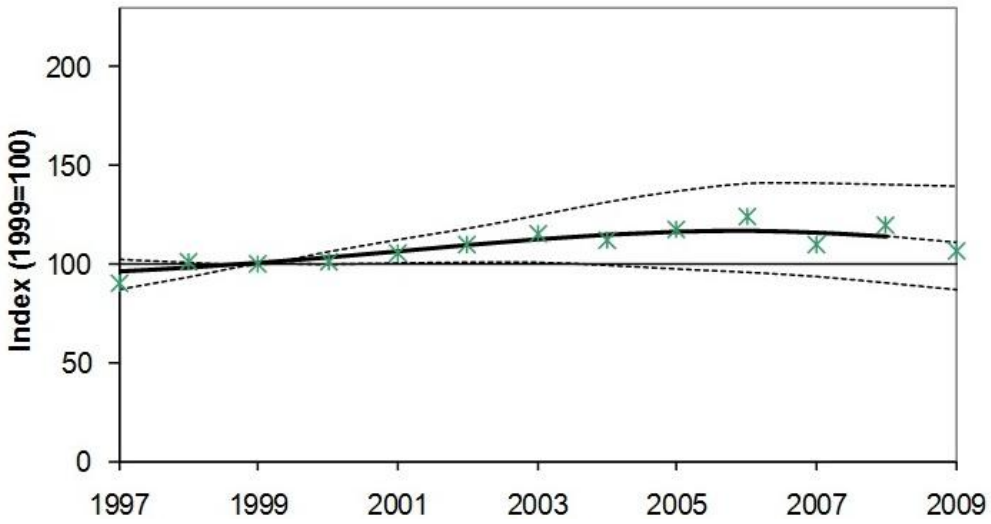

Figure 11**:** UK Index of the Daubenton's bat population from the Hibernation Survey (1997-2009). Results of GAM analysis with 95% confidence limits. No significant trend. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

Country and English GOR Regions Population Trends

Randomisation tests indicate no significant differences in hibernation trends between countries, regions or environmental zones.

Interpretation of survey results: Both the Waterway Survey and the Hibernation Survey suggest that the species increased slightly in numbers between 1999 and 2005, and may now be declining very gradually. Further years' of monitoring will be needed to confirm whether this will become a significant trend. Overall, there has been little change from the baseline value and there is no cause for concern at present.

Whiskered/Brandt's bat

Native and locally common

Population estimate: Whiskered – UK 64,000, England 30,500 (Harris *et al*. 1995), Scotland 1,500 (Harris *et al*. 1995), Wales 8,000 (Harris *et al*. 1995), Northern Ireland 24,000 (Russ 1999; estimate should be treated with caution and is likely to be lower)

Brandt's – UK 30,000, England 22,500, Scotland 500, Wales 7,000, N. Ireland 0 (Harris *et al*. 1995).

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Habitats Directive Annex IV; EUROBATS Agreement; Wild Mammals Act.

Importance/threats: Associated with trees/woodland so sensitive to current woodland management.

Data on the population trends of Whiskered/Brandt's are collected from the Hibernation Survey (1997-2009). Since these species are highly similar in appearance and the majority of hibernation records do not distinguish between them the analysis combined data for the two.

Hibernation Survey

UK level

Figure 12 shows survey results calculated from a total site network of 563 hibernation sites surveyed between 1997-2009 across the UK. Hibernating whiskered/Brandt's bats have been reported from 122 (22%) of these sites. In the winter of 2008-09 these species were found in 53 (14%) of the 372 sites surveyed. Numbers recorded in 2009 were again comparatively high, with the result that the curve is heading steeply upwards and is significantly higher than the baseline value. The index is currently 53% above the 1999 value (equivalent to an increase of 4.3% per annum).

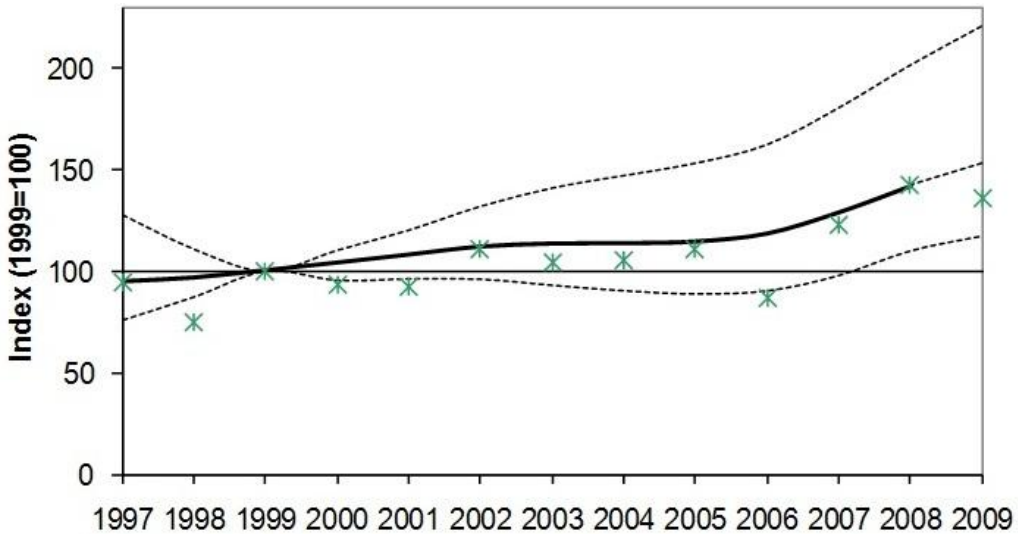

Figure 12: UK Index of whiskered/Brandt's bat from the Hibernation Survey (1997-2009). Results of GAM analysis with 95% confidence limits. Increase of borderline significance. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

Interpretation of survey results: Despite the high level of uncertainty associated with the trend line, it is now showing a statistically significant increase, caused by three successive years of relatively high counts. However, this particular index should be treated with even greater caution than others since it combines data for two species which, though morphologically very similar, are likely to have differing ecology, with the possibility that the population size of each may be influenced by different environmental variables. Current work to facilitate the reliable identification of these species and anticipated future work to better understand the degree to which their ecologies may overlap is likely to inform future population trend analysis approaches.

Natterer's bat

Native, widespread throughout much of the UK

Population estimate: UK 148,000; England 70,000 (Harris *et al*. 1995); Scotland 17,500 (Harris *et al*. 1995); Wales 12,500 (Harris *et al*. 1995); Northern Ireland 48,000 (Russ 1999; estimate of Northern Ireland should be treated with caution and is likely to be lower)

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Habitats Directive Annex IV; EUROBATS Agreement; Wild Mammals Act.

Importance/threats: this is a widespread species throughout Europe and the UK. It is the most common *Myotis* species encountered on the passive surveillance survey that involves members of the public and batworkers sending in dead bats to the Veterinary Laboratory Agency (VLA) for rabies testing. This species is commonly found roosting in barns and the recent surge in barn conversions is likely to have reduced roosting opportunities.

Data on population trends of Natterer's bat are collected on two surveys

- Hibernation Survey (1997-2009)
- Natterer's Colony Counts (2000-2009)

Hibernation Survey

UK level

Figure 13 shows survey results calculated from a total site network of 563 hibernation sites surveyed between 1997-2009 across the UK. Hibernating Natterer's bats have been reported from 296 (53%) of these sites. In the winter of 2008-09 this species was found in 173 (47%) of the 372 sites surveyed. Counts were high in 2008-09 and the data continue to show a statistically significant increase. The 2009 index is 98% above 1999 levels, which is equivalent to an increase of approximately 7.0% per annum.

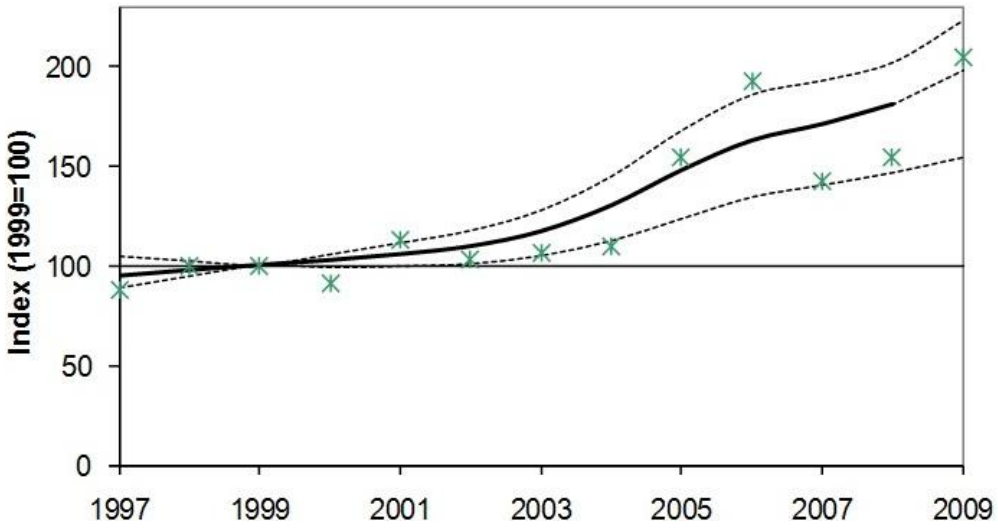

Figure 13: UK Index of Natterer's bat population trends from the Hibernation Survey (1997-2009). Results of GAM analysis with 95% confidence limits. Upward trend is significant. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

Colony Counts

UK level

Figure 14 shows survey results drawn from 81 summer colonies that were surveyed between 1997 and 2009 across the UK. The base year for calculation of the trend is 2000, as only a very small number of colonies were counted in earlier years. In 2009 32 colonies, representing 40% of the total network, were visited, with Natterer's bats being recorded at 72% of these. The number of colonies included in the trend analysis (which requires a colony to

be counted in two or more years) in any individual year varied between 25 and 41, with the exception of 2001 in which colony counts were almost completely prevented by the foot and mouth disease outbreak. No significant trend is evident. The average count of bats at Natterer's colonies was approximately 36 in 2009.

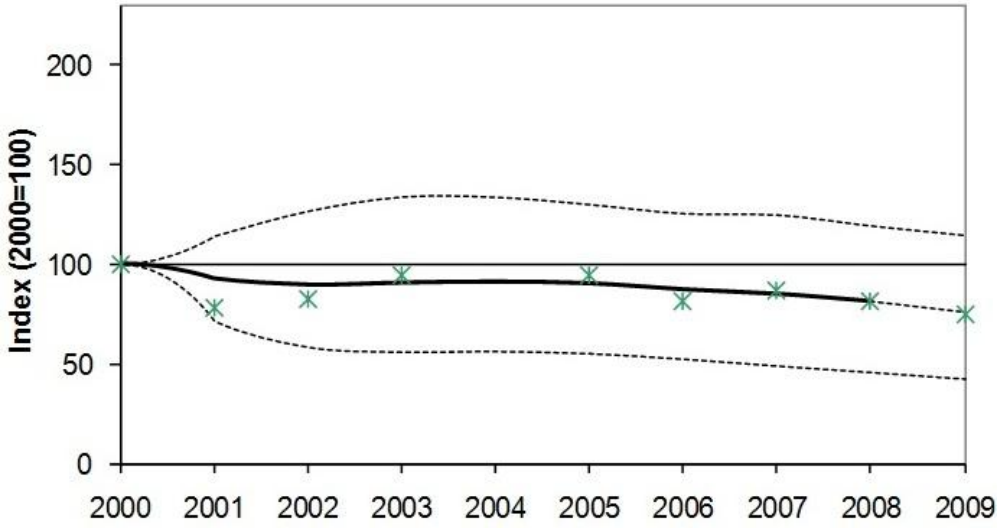

Figure 14 UK Index of Natterer's bat colony size from the Natterer's summer colony Count (2000-2009). Results of GAM analysis with 95% confidence limits. No significant trend was observed. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

Interpretation of survey results: The significant positive trend reported at hibernation sites has been sustained. Increased winter abundance at hibernation sites may infer an increase in the total UK population, but can also reflect other influences on the species' use of such locations. The power of colony counts to detect significant trends is currently impeded by the relatively short time-series and small sample size of the network. Recruitment of more summer colonies into the survey, in combination with retention of existing network sites remains an aim, in order to better understand the relationship between the two surveys and ultimately obtain a definitive answer on the nature of population changes.

Common pipistrelle

Native, widespread and common throughout the UK

Population estimate: UK 2,430,000, Northern Ireland 1,150,000 (Russ 1999; estimate of Northern Ireland should be treated with caution and is likely to be lower)

Legal and Conservation Status: Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5,6; Conservation (Natural Habitats , &c.) Regulations 1994 (as amended in each country); Habitats Directive Annex IV; EUROBATS Agreement; Wild Mammals Act.

Importance/threats: This species is widespread and common throughout Europe and the UK. Factors affecting general small insect abundance/distribution, availability and protection of roost sites in artificial structures, especially buildings, general public attitudes towards bats, and amount of hedgerows and woodlands can all impact on common pipistrelle populations.

Data on population trends of the common pipistrelle are collected on two surveys

- Field Survey (1998-2009)
- Common pipistrelle Colony Counts (1997-2009)

Field Survey

UK level

Figure 15 shows trend results derived from analysis of data drawn from a total network of 679 random 1 km squares that were surveyed between 1998 and 2009 across the UK. Common pipistrelles have been recorded at 84% of these sites during the survey period. In 2009, 253 sites (representing 37% of the total network) were

surveyed, with 66% of the sites surveyed in 2008 visited again in 2009. Common pipistrelles were recorded at 220 (87%) of the 2009 sites.

A new method of analysis, based on the proportion of survey points with bats, has been introduced in 2009. This approach avoids the risk of distortion from a few survey points with continuous bat activity. Using the new analysis, the 2009 value is approximately 65% above the 1999 baseline, with the positive trend equating to an average annual increase of 5.2%.

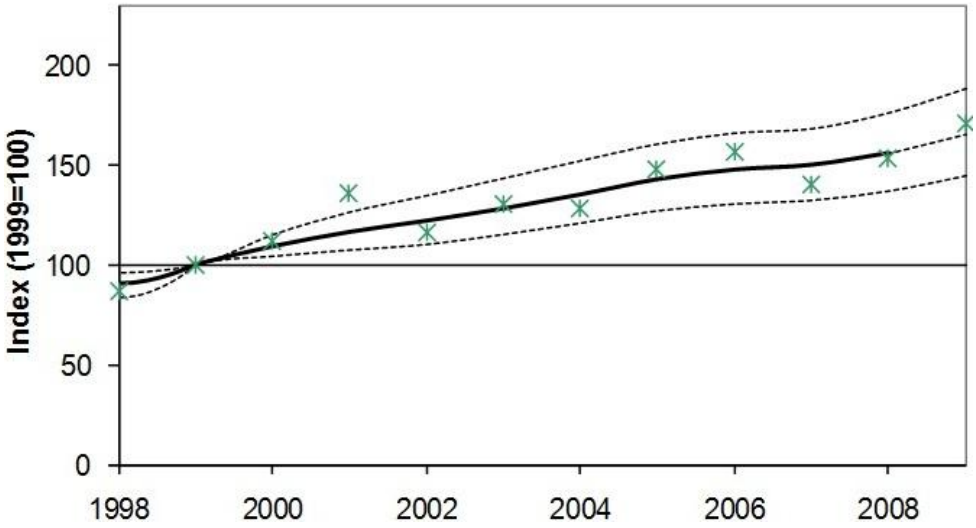

Figure 15: UK Index of common pipistrelle population trends from the Field Survey (1998-2009). Results of GAM analysis with 95% confidence limits. Upward trend is significant. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

Colony Counts

UK level

Figure 16 shows survey results derived from a network of 441 summer colonies across the UK that were surveyed between 1997 and 2009. The number of colonies included in the trend analysis (which requires a colony to be counted for two or more years) ranged between 76 and 219 for a particular year and has been consistently above 150 since 2002. In 2009 175 colonies, representing 40% of the total network, were visited, with common pipistrelles being recorded at 71% of these. The overall trend during the period has been a significant decline. The average count of bats at common pipistrelle colonies in the survey was 50 in 2009, and the trend line is continuing to decline. The 2009 value is approximately 48% below the 1999 baseline (equivalent to an average annual decrease of 6.4%).

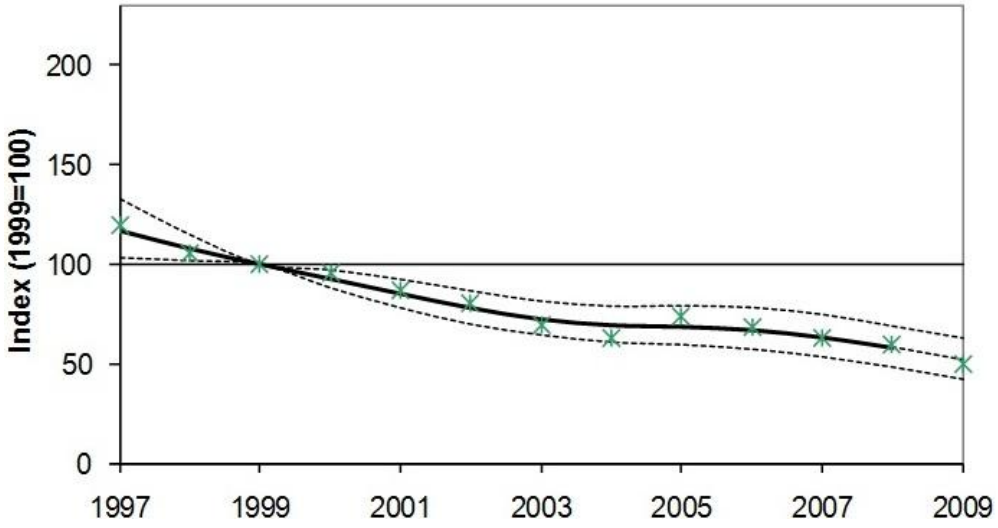

Figure 16: UK Index of common pipistrelle colony size from the summer Colony Counts (1998-2009). Results of GAM analysis with 95% confidence limits. The trend for 2009 is shown as a dashed line to indicate that it is provisional. The observed downward trend is significant.

Country and regional level trends

There is continuing evidence in both surveys of a regional difference in the results, with more positive results in the south and east of the country. In the case of the field survey, numbers seem to be increasing consistently in the south and east of England, whereas they have been relatively stable since around 2002 in the rest of Britain. For the colony counts, all regions show a decline, but there was some recovery between 2004 and 2006 in the south and east of England. Confidence limits are wide for regional results, however, and it will be interesting to see whether this difference is maintained in the future.

Interpretation of survey results: There remains a clear discrepancy between the results of the two surveys with the Field Survey showing a significant increase and the Colony Count survey showing a significant decrease over the survey period. There are also signs of regional differences, and these may distort the national trends due to the higher number of volunteers in some parts of the country. Studying a species that uses different roosts throughout the summer brings a number of challenges and the degree to which the colony count trends are likely to reflect the UK population of common pipistrelles has been discussed (BCT, 2001). Common pipistrelles are known to use multiple roosts throughout the summer and we assume this behaviour may result in an erroneous trend. For the present we rely on population trends derived from the Field Survey to reflect what is occurring in the wider common pipistrelle population and, therefore, conclude there has been a significant increase in the population.

In time, as understanding of colony dynamics and factors influencing the behaviour of this species improves, it would be desirable to examine the relationship between the trends derived from the two surveys in more detail. In-depth studies of colony behaviour and the consideration of additional population parameters would benefit both the conservation of this species and the more effective use of Colony Count data.

Soprano pipistrelle

Native, common and widespread throughout the UK

Population estimate: UK 1,300,000, Northern Ireland 580,000 (Russ, 1999; estimate for Northern Ireland should be treated with caution and is likely to be lower)

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Priority species in UK Biodiversity Action Plan; Natural Environment and Rural Communities Act (England & Wales); Nature Conservation (Scotland) Act 2004; Habitats Directive Annex IV; EUROBATS Agreement; Wild Mammals Act.

Importance/threats: This species is strongly associated with habitats that have a high abundance of small insects. Factors that influence the quality and quantity of waterbodies and wetland areas, availability and protection of roost sites in artificial structures, especially buildings, and general public attitudes towards bats can all impact on soprano pipistrelle populations.

Data on population trends of the soprano pipistrelle are collected on two surveys

- Field Survey (1998-2009)
- Soprano pipistrelle Colony Counts (1997-2009)

Field Survey

UK level

Figure 17 shows trend results derived from analysis of data drawn from a total network of 679 random 1 km squares that were surveyed between 1998 and 2009 across the UK. Soprano pipistrelles have been recorded at 61% of these sites during that survey period. In 2009, 253 sites (representing 37% of the total network) were surveyed, with 66% of the sites surveyed in 2008 visited again in 2009. Soprano pipistrelles were recorded at 150 (59%) of the 2009 sites.

A new method of analysis, based on the proportion of survey points with bats, has been introduced in 2009. This approach avoids the risk of distortion from a few survey points with continuous bat activity Using the new analysis,

the trend is again not statistically significant. Counts in 2009 were lower than in 2008, but still higher than the previous few years. The index is now 21% above the 1999 baseline.

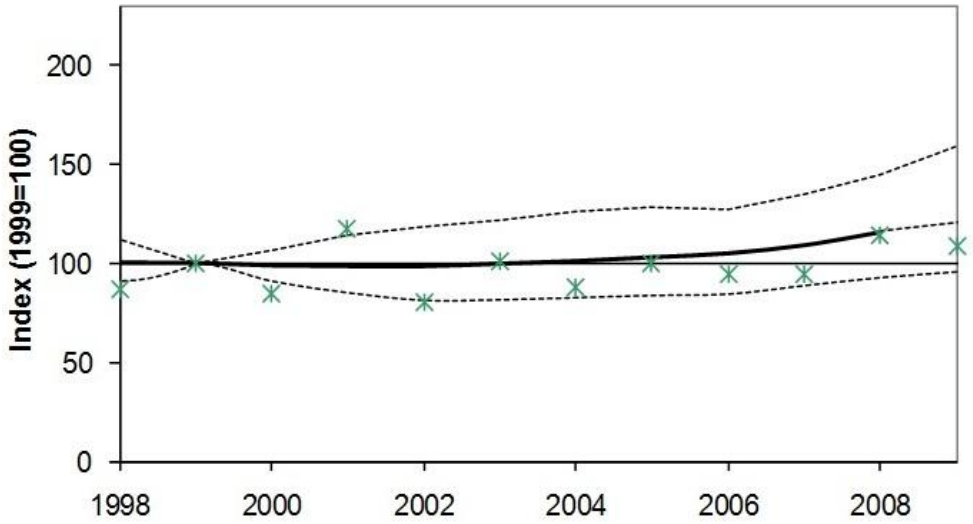

Figure 17: UK Index of soprano pipistrelle population trends from the Field Survey (1998-2009). Results of GAM analysis with 95% confidence limits. No significant trend. The trend for 2009 is shown as a dashed line to indicate that it is provisional.

Colony Counts

UK level

Figure 18 shows survey results derived from analysis of data from 334 summer colonies that were surveyed between 1998 and 2009 across the UK. The number of colonies included in the trend analysis (which requires a colony to be counted for two or more years) ranged between 69 and 140 for a particular year and has been at least 100 since 1999, with the exception of 2001 when the foot and mouth outbreak meant that fewer colonies were counted. In 2009, 142 colonies, representing 42% of the total network, were visited, with soprano pipistrelles being recorded at 73% of these. Whilst 2009 counts were, on average, slightly higher than those in 2008, the estimated value of the index has continued to fall and this decline is statistically significant. The 2009 index value is 40% below the 1999 baseline, equivalent to an annual decrease of 5.1%. The average number of bats counted at soprano pipistrelle colonies was 186 in 2009.

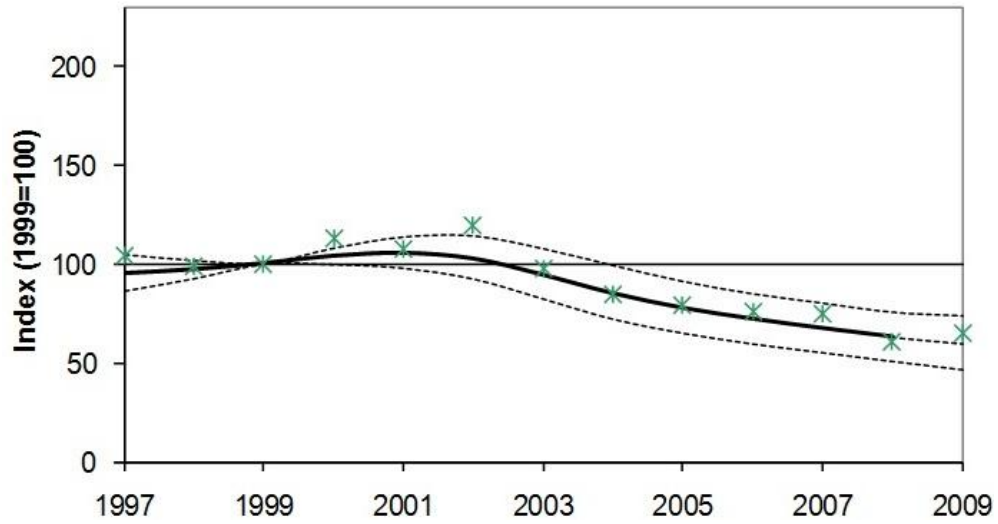

Figure 18: UK Index of soprano pipistrelle colony size from the summer Colony Counts (1998-2009). Results of GAM analysis with 95% confidence limits. The trend for 2009 is shown as a dashed line to indicate that it is provisional. The observed downward trend is significant.

Country and English GOR Regions Population Trends

Trends did not differ significantly among countries, regions or environmental zones.

Interpretation of survey results: The field survey results suggest that there has been no significant change in the population over the course of the survey, although there are signs of a recent increase and it will be interesting to

see if this is sustained. The significant decline in Colony Counts requires careful tracking. As with common pipistrelle, it will become desirable in future years to examine more closely the relationship between the trends provided by the two surveys. Although this species forms colonies that are more sedentary than those of common pipistrelle and hence data trends might be anticipated to be less affected by potential distortions due to colony mobility, the general cautions applying to the use of all types of colony focused data remain.

Serotine

Native, uncommon and restricted to southern England. Occasional records from Wales.

Population estimate: UK 15,000, England 15,000, Scotland 0, Wales 0, N. Ireland 0. (Harris *et al*. 1995)

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Habitats Directive Annex IV; EUROBATS Agreement; Wild Mammals Act.

Importance/threats: The serotine is reliant on artificial structures, usually buildings, for roosting and is therefore sensitive to building renovation and timber treatment. It is a beetle specialist and reliant on unimproved grassland that supports chafer beetles in early summer and cattle pasture in mid to late summer that supports dung beetles. Factors influencing cattle numbers and dung beetle populations, e.g. Avermectin insecticide use, will impact on this species' populations.

Data on population trends of the serotine bat are collected from two surveys:

- Field Survey (1998-2009)
- Serotine Colony Counts (1998-2009)

Field Survey

UK level

Figure 19 shows trend results derived from analysis of data drawn from a total network of 679 random 1 km squares that were surveyed between 1998 and 2009 across the UK. Serotines have been recorded at 182 (27%) of these sites. In 2009, 253 sites (representing 37% of the total network) were surveyed, with 66% of the sites surveyed in 2008 visited again in 2009. Serotines were recorded at 60 (24%) of these. Serotine distribution is restricted to the southern part of Britain, and only data from regions in which serotines are known were used to calculate the trend. The confidence intervals for this species are large, and there is no significant overall trend.

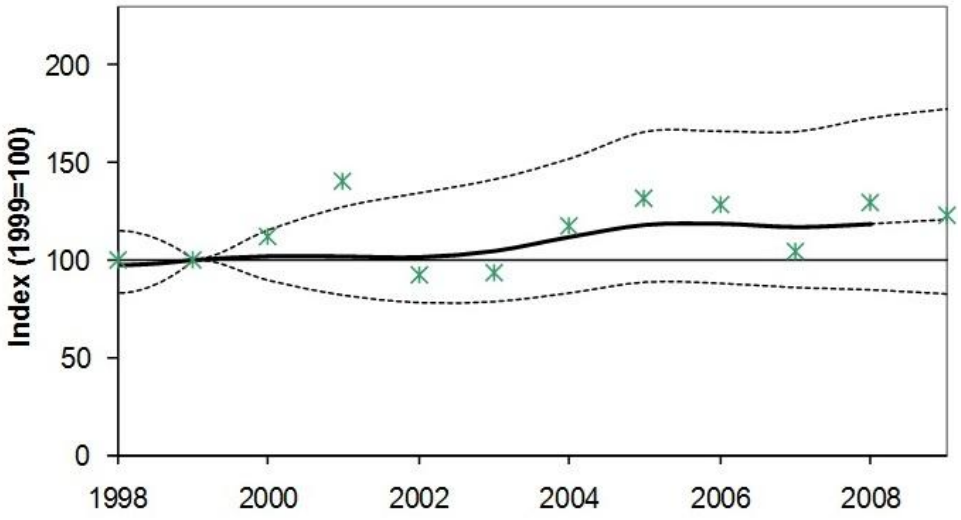

Figure 19: UK Index of serotine population trends from the Field Survey (1998-2009). Results of GAM analysis with 95% confidence limits. The trend for 2009 is shown as a dashed line to indicate that it is provisional. No significant trend.

Colony Counts

UK level

Figure 20 shows survey results calculated from the network of 131 summer colonies surveyed between 1998-2009. The number of colonies included in the trend analysis (which requires a colony to be counted for two or more years) ranged between 29 and 43 for a particular year. 41 sites in this network (31%) were counted in 2009, with serotine bats recorded at 85% of them. The index values have changed little during the course of the survey and no significant trend was observed.

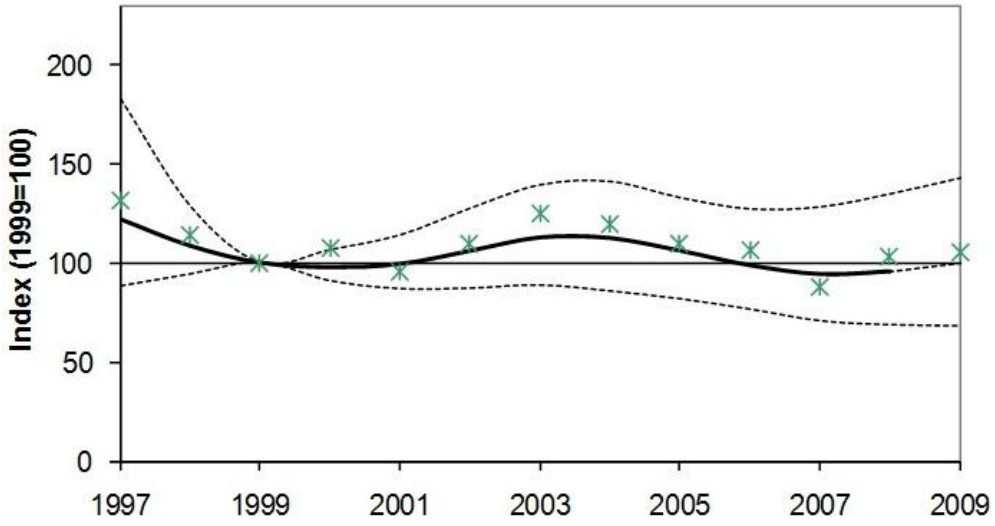

Figure 20: UK Index of serotine colony size from the Colony Counts (1998-2008). Results of GAM analysis with 95% confidence limits. The trend for 2009 is shown as a dashed line to indicate that it is provisional. No significant trend

Country and English GOR Regions Population Trends

The serotine bat is only found in three regions (East, South-East and South-West of England). There is evidence from the field survey of a significant regional difference in trends, with a steady increase in the south-west of England since 2004, in contrast to little change elsewhere. However, this result should be treated with caution due to the wide confidence limits for the south-west. Sample sizes in the south-west are even smaller in the colony counts survey, and so this cannot confirm this difference.

Interpretation of results: No significant trends were found at national level. However, it should be noted that because the species is encountered relatively infrequently and colony sizes are generally small, such trends may also be difficult to detect. It is important to retain existing locations where the species has been found within the surveying network, and where possible expand the number of sites surveyed, in order to maximise analytical sensitivity.

Noctule

Native, generally uncommon and found as far north as Central Scotland but absent from Northern Ireland

Population estimate: UK 50,000, England 45,000, Scotland 250, Wales 4,750, N. Ireland 0. (Harris *et al*. 1995)

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Priority species in UK Biodiversity Action Plan; Natural Environment and Rural Communities Act (England & Wales); Nature Conservation (Scotland) Act 2004; Habitats Directive Annex IV; EUROBATS Agreement; Wild Mammals Act.

Importance/threats: The noctule is mostly reliant on trees for roosting and is often recorded in limbs or trunks of dead trees. The number of dead or decaying trees in landscapes is important to provide roosting opportunities. Forages in areas of high insect abundance and often associated with large waterbodies or wetland areas, e.g. reservoirs, lakes, reedbeds. Also found foraging along white streetlamps and open sewage works.

Data on population trends of the noctule are collected using the Field Survey (1998-2009).

Field Survey

UK Level

Figure 21 shows trend results derived from analysis of data drawn from a total network of 679 random 1 km squares that were surveyed between 1998 and 2009 across the UK. Noctules have been recorded at 395 (59%) of these sites during that survey period. In 2009, 253 sites (representing 37% of the total network) were surveyed, with noctules recorded at 119 (47%) of them. Estimated counts in 2009 were below the very high levels observed in 2008, but the increase from the baseline remains statistically significant. The index is now 50% above the 1999 level, equivalent to an annual increase of 4.2%.

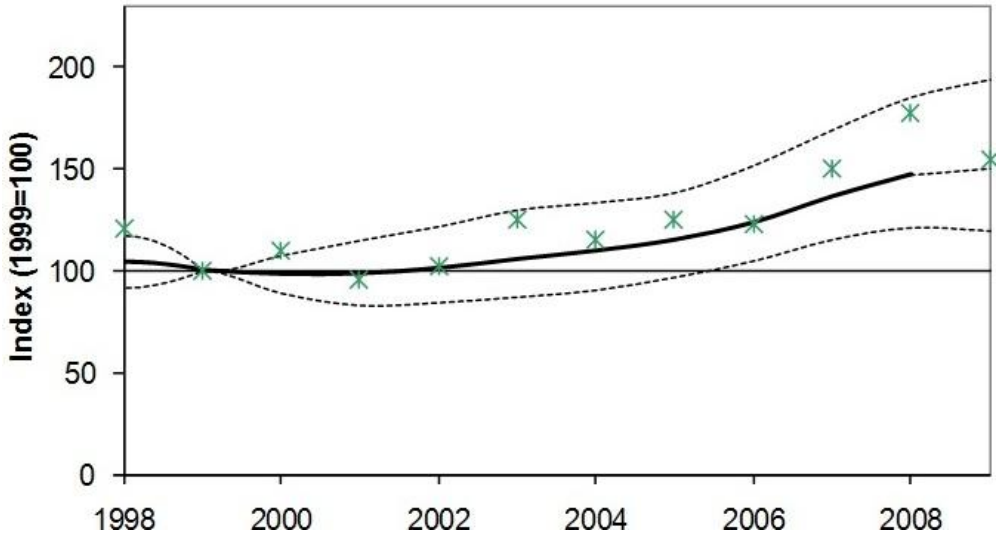

Figure 21: UK Index of noctule population trends from the Field Survey (1998-2009). Results of GAM analysis with 95% confidence limits. The trend for 2009 is shown as a dashed line to indicate that it is provisional. Significant upward trend.

Country and English GOR Regions Population Trends

This year analysis has been based on the number of transect walks with noctules present. This analysis is less sensitive to a few unusual observations than the previous analysis based on counts of passes and, as a result, the slight regional differences in trend previously observed no longer appear to be significant. There are however signs of a particularly large increase in noctule passes at some Scottish sites, and we will be monitoring this situation carefully over the coming years.

Interpretation of results: Numbers in 2009 were below the exceptionally high values observed in 2008, but were nevertheless well above the levels seen up to 2006. As a result the index is now showing a significant increase compared to the baseline value in 1999.

Brown long-eared bat

Native, widespread throughout UK and common.

Population estimate: UK 245,000, England 155,000 (Harris *et al*. 1995), Scotland 27,500 (Harris *et al*. 1995), Wales 17,500 (Harris *et al*. 1995), Northern Ireland 45,000 (Russ 1999; estimate should be treated with caution and is likely to be lower).

Legal and Conservation Status: Bern Convention Appendix II; Convention on Migratory Species Appendix II; Wildlife & Countryside Act Schedules 5, 6; Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in each country); Priority species in UK Biodiversity Action Plan; Natural Environment and Rural Communities Act (England & Wales); Habitats Directive Annex IV; EUROBATS Agreement; Wild Mammals Act.

Importance/threats: A woodland species that is commonly encountered roosting in houses with large loft spaces and barns. Sensitive to building renovation, especially barn conversions.

Data on population trends of brown long-eared bats are collected on two surveys:

- Hibernation Survey (1997-2009)
- Brown long-eared Colony Counts (2001-2009)

Hibernation Survey

UK Level

Figure 22 shows survey results calculated from a total site network of 563 hibernation sites surveyed between 1997-2009 across the UK. Hibernating brown long-eared bats have been reported from 272 (48%) of these sites. In the winter of 2008-09 it was found in 99 (27%) of the 372 sites surveyed. Average numbers in 2008-9 were similar to those in 2007-08, and there is no significant difference from the base year of 1999.

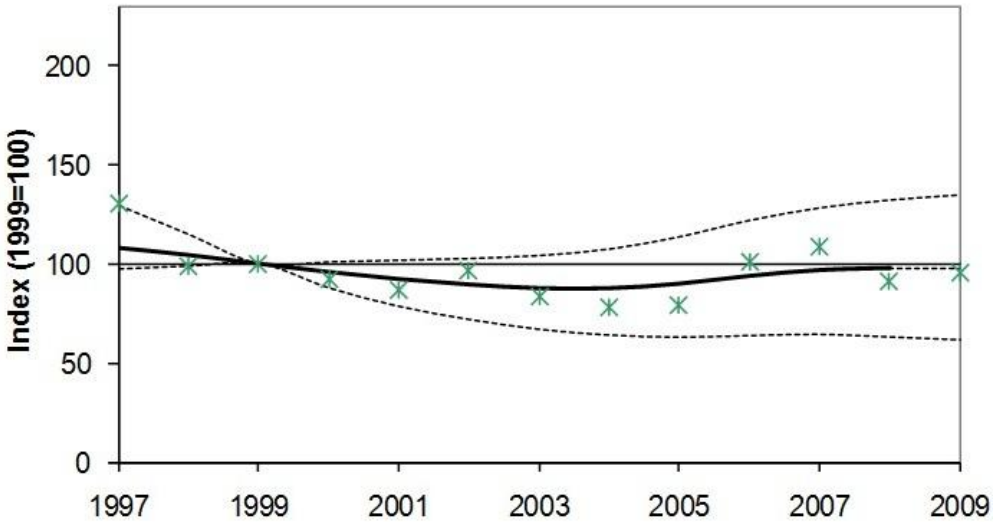

Figure 22: UK Index of brown long-eared bats from the Hibernation Survey (1997-2009). Results of GAM analysis with 95% confidence limits. The trend for 2009 is shown as a dashed line to indicate that it is provisional. No significant trend.

Colony Counts

UK Level

Figure 23 shows survey results calculated from the network of 168 summer colonies surveyed between 1998-2009. The number of sites incorporated in the trend model each year (i.e. sites that have been surveyed at least twice) has ranged between 13 and 73, and has been at least 50 every year since 2002. 69 sites in this network (41%) were counted in 2009, with long-eared bats recorded at 94% of them. Relatively few colonies were counted prior to 2001 and so 2001 is used as the base year for the trend, rather than 1999. Counts in 2009 were low for the second successive year, with the result that the index is very close to its baseline value and is heading downwards.

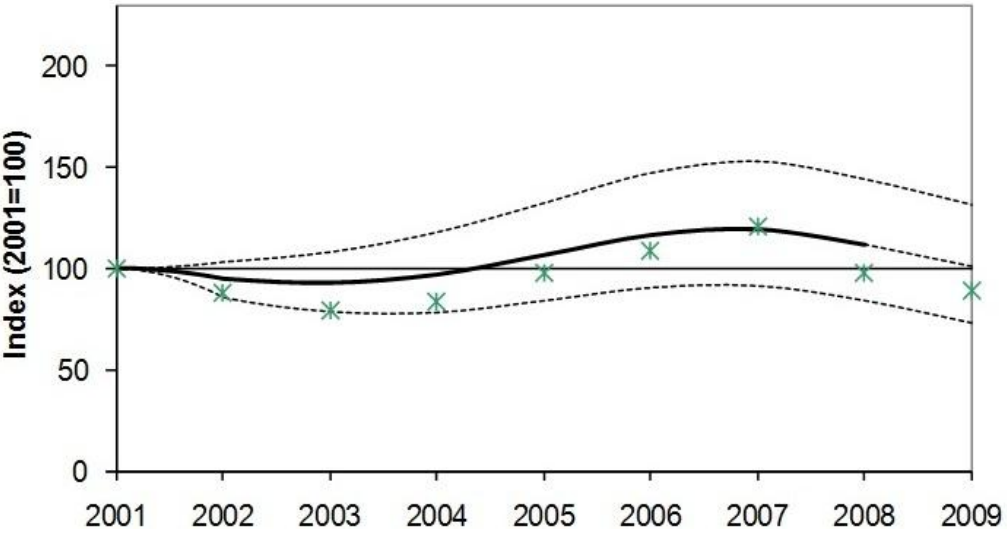

Figure 23: UK Index of brown long-eared colony size from the summer Colony Counts (2001-2009). Results of GAM analysis with 95% confidence limits. The trend for 2009 is shown as a dashed line to indicate that it is provisional. No significant trend.

Interpretation of survey results: After some high counts in 2006 and 2007, the population now appears to be close to the baseline level. The colony count smoothed trend is now declining and it is to be hoped that this stabilises in the coming year.

Species trends summary 2007-2009

UK level

Trends results have remained fairly consistent over the period from 2007 to 2009 with four species showing significant increases throughout this time. Significant positive trends have been reported in all years for the greater horseshoe bat (Colony Counts), lesser horseshoe bat (Colony Counts and Hibernation survey), Natterer's bat (Hibernation survey) and common pipistrelle (Field survey).

The lesser horseshoe bat has shown increases both in colony size and at hibernation sites and we are confident that the UK population is therefore increasing. The greater horseshoe bat trend should be treated with caution due historical inconsistencies in counting methods at colonies (which have now been standardised). Milder winters in recent years and targeted conservation work under the BAP have probably contributed to these trends.

Natterer's bat has shown significant increases at hibernation sites but no significant trend from colony counts. Data from the hibernation sites is likely to be more robust as it is the most commonly encountered species in the NBMP Hibernation survey, whereas the sample size for Colony counts is relatively low. However it is still unclear whether the increasing trend from the Hibernation Survey truly reflects an increasing population, or other factors affecting the bats during hibernation.

Common pipistrelle has shown an increase from the Field Survey since 2007, but this result conflicts with the significant decline shown in Colony counts over the same period. The soprano pipistrelle also shows a significant decline in Colony counts, but for this species there is no significant trend from Field surveys. The Field survey is considered to be the more reliable method for monitoring both pipistrelle species as pipistrelle colonies (particularly common pipistrelle but also soprano pipistrelle colonies as shown in a previous report (BCT 2009)) are mobile during the breeding season, potentially leading to an overestimation of negative changes when roosts move away from known sites within the network. The UK population of common pipistrelle is therefore thought to be increasing. It is the most widespread and adaptable species, and being primarily a species that roosts in houses, it may have benefited from conservation efforts to improve public attitudes to bats and from the legal protection afforded to bat roosts since 1981. In contrast there appears to be no change in the population of soprano pipistrelle. Its tendency to form larger maternity colonies may make it more vulnerable to the loss of roost sites. There are also differences in the foraging habitats of the two species with soprano pipistrelle being more selective of riparian habitat (Davidson-Watts *et al.* 2006) which could also affect the populations of these species.

Serotine (Colony Counts and Field Survey) and Daubenton's bat (Waterway and Hibernation Surveys) continue to show no significant trends in this period between 2007 and 2009. The Daubenton's bat appears to be relatively stable, whereas the counts for serotine are highly variable and detection of trends may be difficult. For the remaining species the picture is less clear. In 2008 a positive trend was reported for the first time from the Field survey data for noctule, which continued into 2009. Reasons for this increase are uncertain and we will continue to monitor the change over the next few years to see if it is sustained. A positive trend was also reported for the first time in 2008 for whiskered/Brandt's bat which was also supported by the 2009 data. This trend should be treated with extreme caution however, as it is based on information from more than one species whose populations may be affected by different factors. Furthermore, the recent discovery of Alcathoe bat in the UK (Jan *et al.* 2010), a species that closely resembles whiskered and Brandt's bat, renders the possibility that this survey may be tracking populations of three species. Further work on identification, distribution and ecological differences between these species is required to assist in better understanding this trend. Brown long-eared bat showed a short term increase to 2007 with a significant increase in Colony counts in that year. This has not been sustained since however, and counts are now starting to decline again, although overall there is no significant trend from either the Hibernation survey or Colony counts.

Country level

The NBMP was designed to detect population trends at the UK level, although if sample sizes are sufficient and exceed certain thresholds, reporting may be possible at a finer scale. Some improvements in country level survey coverage have been made since 2007. Survey coverage has been sufficient for England for most surveys since 2007. At this time the main exceptions were Natterer's bat, serotine and greater horseshoe colony counts. In 2009

the sample sizes for repeat sites for Natterer's bat and serotine colony counts increased and now almost meet the minimum threshold required for trend analysis in England. The coverage has remained similar in Wales over the same period, being adequate for lesser horseshoe bat colony counts and potentially for hibernation surveys for those species that are recorded at the majority of sites. Scotland had sufficient coverage for the Waterways survey in 2007, but numbers of sites surveyed has decreased since then and was below the threshold required for calculation of a country trend in 2009. We will be working towards reporting country level trends in the future.

Summary of NBMP projects 2007-2009

Several projects have been completed on NBMP data within the period from 2007 to 2009 and these are summarised in the following paragraphs.

The NBMP data now available on the NBN Gateway, the online search engine for the National Biodiversity Network, have been updated and expanded. Waterway Survey data were already available up to 2005, and these have been updated. In addition, data from the Colony Counts, Field Survey and Hibernation Survey have been added to a standard resolution of 1km (with some exceptions due to site sensitivity or confidentiality). These data complement other NBN datasets, adding to the information available on species distribution, although it is made clear that gaps in these datasets do not necessarily indicate species absence and that reference to the datasets should not be used as a substitute for other data searches and/or surveys for bats.

Following a considerable amount of work to develop a composite species index of 'populations of widespread bats', in May 2008 the Department for the Environment, Food and Rural Affairs (Defra) included bats in the set of 'indicator species' that contribute to the UK biodiversity indicators that measure progress towards the Government's target of halting biodiversity loss by 2010. The indicators show changes in aspects of biodiversity such as the population size of important species or the area of land managed for wildlife. They provide part of the evidence to assess whether the targets set out above have been achieved. The six species used as indicator species in the composite index are the noctule, lesser horseshoe bat, common pipistrelle, soprano pipistrelle, serotine and Daubenton's bat.

New analyses have been carried out to explore the power of the Field Survey to detect trends for four species: noctule, serotine, common and soprano pipistrelle. The analyses suggest that by analysing the proportion of survey points with the species present, in preference to counts of bat passes, using a binomial modification of the GAM analysis, greater power was achieved in the likelihood of detecting declines. Currently both the binomial and Poisson versions of the analyses are being carried out for comparison. The same approach has also been used for the Waterway Survey data and the Daubenton's bat trend analysis. In addition, where sample sizes allow, regional and/or country level analyses have also been completed to investigate whether trends vary across the UK.

In addition to the core NBMP surveys that provide trends for the 11 species which are described in the previous section of this report, additional priority species have been targeted using new survey methods. These include species that are challenging to study and may have a poor level of information known about their populations in the UK as follows:

- The four-year Bechstein's Project was set up in 2007 to study this rare species with the aim of establishing baseline distribution data across the entire species range in England and Wales and to gather information to inform future conservation policy and woodland management for this species. For more information on the Bechstein's Project visit www.bats.org.uk/pages/bechsteins_bat_project.html.

- The Woodland Survey, which is partly funded by Natural England, continues to monitor barbastelles at sites that have been designated as SACs (Special Area of Conservation) due to this species' presence by using broadband bat detector transects. It has also been extended to include other woodlands where barbastelles may be present, and to gather additional data on woodland species assemblages.

- A Nathusius' pipistrelle survey was piloted in September 2009 at lakes and lochs across the UK. The aim of the survey is to collect systematic distribution data for this species for the first time by using broadband bat detector transects focusing on the migration period for this species when it is most commonly recorded in the UK. The survey will continue into 2010.

- The iBats UK project started out in 2005 as The Bats & Roadside Mammals Survey as a partnership project between the BCT and the Mammals Trust UK and is now fully integrated into the iBats programme. The aims of iBats UK are to determine which roadside habitats are important for bats and to provide long-term monitoring at the national and regional level by using time expansion bat detectors along car survey transects.

A number of partnership projects have also been developed in the period from 2007-2009, some of which are summarised below:

A paper based on the Waterway Survey was published in *Aquatic Conservation: Marine and Freshwater Ecosystems* online in December 2009 (Langton *et al.* 2009). The paper described an Environment Agency-funded study carried out in 2008 that re-evaluated and tested a predictive model of Daubenton's bat distribution and abundance at waterway sites. The paper subsequently appeared in print in May 2010 in a special issue of the jounal with the theme 'Recent developments in classification, assessment and management strategies for freshwater habitats'.

A partnership with the University of East Anglia has been modelling the associations between bat observations in NBMP data and landscape variables. A PhD studentship has focused on integrating NBMP data with landscape datasets using GIS, including using these data to investigate habitat associations of species encountered during the Field survey. Another partnership with the Laboratoire Ecologie, Systématique & Evolution, Université Paris-Sud XI to examine the NBMP Colony Count dataset for potential Allée effects. The data are being analysed as part of a PhD studentship.

BCT is a partner in a consortium led by the Royal Society for the Protection of Birds and also incorporating Plantlife, Butterfly Conservation and Wildlife Trusts Wales which aims to establish whether the Welsh higher level agri-enviroment scheme, Tir Gofal, is benefiting selected taxa. This project, funded by Welsh Assembly Government, monitors species on matched pairs of farms (a Tir Gofal farm and a similar farm not in an agri-environment scheme). Summer 2009 was the first field season for this project and a team of BCT surveyors carried out the Field Survey at 40 farms and the Waterway Survey at 36 farms. This has greatly increased the sample sizes for these surveys in Wales. The field work in summer 2010 will focus on increasing the site network and resurveying some of the 2009 sites which will enable inclusion of the data in NBMP trends subject to the relevant agreements on use of the data being put into place.

BCT is a data-providing partner in the BICCO-Net project (see www.bicco-net.org/), an online collaborative project providing the latest information on the impacts of Climate Change on UK biodiversity. It is a Joint Research Initiative sponsored by Defra, Countryside Council for Wales and Scottish Natural Heritage, and managed by JNCC. This consortium project is led by the British Trust for Ornithology and includes partner organizations Centre for Ecology and Hydrology, University of Durham, Plantlife, Forest Research, BCT and Rothamsted Research. In 2009, NBMP staff contributed to this project by attending meetings, supplying data and providing guidance on the selection and interpretation of climate change variables likely to influence bat activity and population levels.

Future Directions

The NBMP will continue to build on its strong foundation of reporting on population change. In the longer term aspirations for the programme's expansion include:

- delivery of data on additional species and enhancement of the quality of information available on species distribution;
- development of online reporting and data entry systems to improve efficiency and decrease delays in annual reporting of trends
- enhancement of dissemination of information online;
- increasing survey coverage, for example, to aim towards delivering country level trends; and
- development towards an improved understanding of the factors affecting populations of bats.

In order to improve delivery on additional species, the study on Nathusius' pipistrelle, which was piloted in 2009, will continue with the aim of expanding it to a greater number of sites across the UK. In addition, the role of new technologies and their potential incorporation into the NBMP will be explored further. For example it may be possible to extend the use of broadband detector systems further within the programme, or to use geo-referenced data for spatial analysis. The NBMP team will also work to improve surveillance coverage of other priority species.

Work will be undertaken over the next four years to try to improve our understanding of factors that may be affecting changes in bat populations. This will be through the continuation and development of collaborative working and partnership projects. For example, work will continue with the BICCO-net Project which is investigating relationships between population trends of a number of taxa, including bats, with changes in key climate variables. Ecological interpretation of trends will also be extended to include an assessment of potential drivers that may affect bat populations, and an attempt to provide an account of what is happening to bats in the countryside, within the limitations of the data and research available.

Work will continue to provide and develop indicators using bat data from the NBMP to address the needs of government and other public stakeholder groups, for example to provide indicators at a country level or relating to particular habitats. The team will also prepare and submit at least two papers for publication in peer-reviewed scientific journals in the next three years.

Conclusions

In 2009, seven species showed statistically significant increases in at least one survey. Lesser horseshoe bat (a UK BAP species) continues to show a significant positive trend at both summer roosts and hibernation sites. Greater horseshoe bat (a UK BAP species) is also showing an increase at summer roosts, although this result should be treated with some caution as discussed in this report. Natterer's bat is showing a consistent increase at hibernation sites, and whiskered/Brandt's bat also showed a positive trend for the second year running. The trend for this species group however should be treated with caution as it includes data from more than one species which may be affected by different factors and may not be a reliable reflection of actual changes in populations. Common pipistrelle also continues to show a significant increase from the Field survey data, although this conflicts with the decrease seen in the Colony counts. The Field survey is considered to provide more reliable data however, due to the mobile nature of pipistrelle breeding colonies which may affect colony count trends. Finally, the noctule (a UK BAP species) has also shown a significant positive trend for the second year running. Three of these species (whiskered/Brandt's bat and noctule) have shown a statistically significant increase for only a short period and therefore these results need to be treated with caution until it becomes clearer whether these are sustained trends or short term fluctuations. The remaining four species monitored by the core programme, Daubenton's bat, serotine, soprano pipistrelle (a UK BAP species) and brown long-eared bat (a UK BAP species) are currently considered to be stable, although further years of monitoring are required to better understand some of the fluctuations and discrepancies in the trends for these species.

It is expected that longer term monitoring will reveal clearer trends for all species. The structure of the NBMP programme has been built around preliminary power analysis carried out in 2001 that suggested that after 25 years of monitoring all surveys should detect Amber (1.14% per year) and Red (2.73% per year) alert changes (BCT 2001). Thus the NBMP is designed to meet the current JNCC recommendation that monitoring schemes should be sensitive to moderate change. These power analyses are reassessed at intervals. NBMP data deliver the information required to measure the impact of government policies designed to protect the UK's biodiversity. This includes informing the conservation of the seven bat species on the UK BAP priority list and determining whether policy, legislation and conservation commitments are working. NBMP data continue to allow bats to be included in the suite of UK biodiversity indicators that help measure progress towards the Government's target of halting biodiversity loss by 2010.

Other potential applications of NBMP data include delivering trends for selected habitats, an approach that has been explored as part of the work that successfully established bats as indicator species; and identifying possible impacts of climate change. The latter is being explored as part of BICCO-Net (the biodiversity impacts of climate change observation network).

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Appendix 1: Detailed explanation of GAMs

The GAM models are based on the method described by Fewster *et al.* (2000). These involve fitting a log-linear generalised linear model (i.e. a regression model with a logarithmic relationship to the explanatory variables and a Poisson error distribution) to the counts on each survey. A site term is fitted in the model to allow for differences in abundance between sites and the time trend is modelled using the GAM framework to fit a smoothed curve. These GAM models are essentially a more sophisticated version of a polynomial curve, and are less likely to display misleading trends at the extremes of the data than a polynomial. The degree of smoothing is controlled by specifying the degrees of freedom for the smoothing process; this may vary between 1 (equivalent to a simple linear trend) and one less than the number of years (a 'saturated model' equivalent to fitting individual annual means). The degrees of freedom used for the results presented here were determined by examining the goodness-of-fit of curves with increasing degrees of freedom, and selecting the first model which provided a good fit to the annual means without being unduly influenced by individual outlying years. The index values are derived from the fitted curve, taking the base year to be 100.

The other feature of the models is that confidence limits based on standard theory will not be valid due to temporal correlations. This is probably not very important for bat data where the temporal correlations are not strong, but the bat data does suffer from other complications not present in the data of the Fewster paper which will also invalidate the usual confidence limits. These are the extreme over dispersion of the data (i.e. bat data is much more variable than a Poisson distribution) and the repeat counts in each year (which have previously been accounted for by using REML/GLMM models). All these problems are avoided by using a bootstrap approach in which the model is fitted to a large number of new datasets created by resampling sites with replacements from the original sites. Thus if a dataset contained five sites numbered 1, 2, 3, 4 and 5, a bootstrap sample might contain sites 2, 3 and 5, plus two copies of site 4, or two copies of site 2, three of site 5 and none of 1, 3 and 4. The distribution of the fitted curves from all these bootstrap samples is used to produce confidence limits. One thousand bootstrap samples are used for each model to ensure robust 95% confidence limits.

The models fitted use two modifications to the published approach. The first, which does not affect the results in any way, is that the graphs include annual means from the saturated model in order to give a visual impression of any deviations from the smoothed curve. The second is designed to make the models easier to fit with large numbers of sites. Because the models involve a term for each site they get impossible to fit with large numbers of sites. To address this, models are fitted as a two step process, first fitting the saturated model (which is much quicker to fit in packages such as Genstat) and then fitting the GAM to the annual means, appropriately weighted to reflect the different numbers of sites contributing to each value. Simulations indicate that this modification has negligible impact on the precision of the method but allows the model to be fitted to almost any size of dataset.

Data from all the surveys are much more variable than would be expected from a Poisson distribution. This phenomenon, known as 'overdispersion', is very common in biological data, but is particularly extreme in these datasets. The bootstrapping method ensures that the confidence limits shown in the graphs reflect this high level of variability, and simulations have confirmed that the models perform reasonably well. Fewster *et al.* (2000) suggest a negative binomial distribution might be an alternative, but simulations suggest that, whilst it sometimes produces more precise results, this is not always the case. We have therefore kept with the Poisson distribution for all the graphs presented here. With some of the datasets, particularly colony counts of the more mobile species, the overdispersion results partially from an excess of zeroes compared to the Poisson distribution. In these cases a Zero Inflated Poisson (ZIP, Lambert 1992) model may be a better alternative and we will examine this possibility in the future.

In order to test whether the smoothed curves differed between different countries or regions Fewster *et al.* (2000) suggest a deviance test. However, simulations have suggested that this test can produce too many significant results, and so the results presented here use a randomisation approach to obtain a probability value from the change in deviance.

Bats are difficult to count, and even using the best available sampling methods, there will be uncertainties inherent in population estimates and estimates of trend. In trend estimation, however, repeatable counts do not have to be

accurate in the sense that the population estimate is close to the actual population figure. If the counts are consistently wrong for any reason the changes from year to year can still be measured accurately using repeatable methods to achieve high precision. Thus the ability to count bats with the same detectability each year remains an essential attribute of a successful bat population monitoring scheme. However, the effects of small sources of bias are often over-emphasised in comparison with a lack of precision (Toms *et al*. 1999). For this reason, it is important to measure or justifiably estimate the magnitude of bias and to take this into consideration when balancing bias and precision in monitoring schemes.

There are a number of factors that influence the encounter rate of bats on field surveys or numbers of bats counted from summer roosts. These can be divided into two categories:

1. Factors that influence bat encounters and are likely to change over time resulting in potentially erroneous trends
2. Factors that influence bat encounters but are likely to remain stable over time

Detailed analyses of the potential biases in the data have been conducted. A Residual Maximum Likelihood (REML) model has been used to explore the effects of covariates, in order to allow for the complex structure of the data. Factors evaluated have included the influence of bat detector model, survey duration and temperature.