TRACKING Mammals PARTNERSHIP

UK Mammals

Species Status and Population Trends

First Report by the Tracking Mammals Partnership

UK Mammals: Species Status and Population Trends

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Executive summary

- The **Tracking Mammals Partnership** (TMP) is a collaborative initiative, involving 24 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. Many sections of the mammal community, as well as Government at UK and country levels, require good quality data on the distribution and population trends of all UK mammals to guide conservation and wildlife management policy. Joint working by organisations within the partnership seeks a coordinated approach to standardising survey design, assessing where information is missing, exchanging data and expertise, sharing best practice, sharing information on new technology and data collected, as well as cooperating to recruit, train and support the networks of volunteers who carry out the surveys. This is the first of a projected series of annual reports on the work carried out by the Partnership, hereafter termed the TMP First Report, bringing together in one place the wealth of available information. Publication of the report has been guided by a Steering Group comprising members of the 24 organisations in the TMP.

- The 24 organisations cooperate on surveillance and monitoring activities, while working independently in other areas. Individual groups within the partnership have each devised and carried out surveys in the past employing different methods, whose results cannot be compared. As a result, population trends for the majority of mammal species in the UK have been based on limited and sometimes unreliable data.

- Several reports and two scoping studies, *Proposals for future monitoring of British mammals* (Macdonald *et al.*, 1998) and *Developing a mammal monitoring programme for the UK* (Toms *et al.*, 1999), have highlighted the need for a comprehensive national mammal monitoring network to provide robust data on population trends. It has been recognised that the provision of population trend information is a long-term and complex activity and could only be achieved with the joint co-operation of all existing mammal organisations. Hence, the TMP was launched in July 2003, with the aim of producing population trend information for all resident terrestrial UK mammal species.

- The TMP aims to provide both surveillance and monitoring data and to develop best practice surveillance and monitoring methods. Surveillance consists of repeated and standardised observations of abundance over time, using methods that enable changes in numbers to be detected. Monitoring requires that targets are set, management recommendations made and carried out, the effectiveness of the management assessed and responses made to the changes observed. The TMP First Report is mainly concerned with surveillance of mammal populations, but it is hoped that over time it will be possible to improve the breadth of data collection and provide monitoring information as well.

- The main purposes of surveillance and monitoring include: detecting changes in distribution and abundance over time, influencing national policy and setting of conservation priorities, assessing the effects of conservation and other types of wildlife management, fulfilling national and international obligations and educating people about conserving and managing mammal populations.

- The TMP First Report comprises five chapters and four Appendices. Chapter one provides an introduction to the work of the TMP and some historical background. Chapter two provides a detailed overview of the TMP Surveillance and Monitoring Programme including information on all the schemes currently running or planned in the near future. Chapter three provides detailed information on the work of the volunteers and the support provided to volunteers by the organisations in the TMP. Chapter four provides accounts of individual species including information on distribution and population change that is available from the various schemes in the TMP. Chapter five provides a synthesis of current knowledge on mammal populations and considers the future for mammal surveillance and monitoring, including the potential funding implications of providing a comprehensive network. A list of the organisations in the TMP appears in Appendix I with a short summary from each organisation on their involvement in the Partnership. Appendix II contains information on legislation and conservation initiatives pertaining to mammals in the UK and internationally. Appendix III provides a glossary of terms used in the report and Appendix IV a list of acronyms.

- The TMP has taken the approach of coordinating a diverse programme of surveillance and monitoring schemes, some that collect data on a range of species and others covering individual species that require more specialist survey methods. Historic survey information already existed for some species and has been included where appropriate. Where possible the surveys were either incorporated into the programme (*e.g.* national otter surveys, National Dormouse Monitoring Programme), the methods adapted for use in new surveillance schemes (*e.g.* brown hare surveys), or the results used to inform the setting up of new schemes (*e.g.* badger and water vole surveys).

- The TMP has produced a set of guidelines for surveillance and monitoring that consider: area coverage,

survey stratification and spatial scale, assessment of population change, assessment of appropriate methods, statistical power, survey frequency, time and species coverage and data collection, quality and management. These are available from the TMP website (*www.trackingmammals.org*).

- There are 17 surveillance schemes operating within the TMP with nine delivering information on a range of species in the wider countryside including: The National Gamebag Census; The Breeding Bird Survey – Mammals; the National Bat Monitoring Programme; the Waterways Breeding Bird Survey – Mammals; Mammals on Roads; Winter Mammal Monitoring; Vincent Wildlife Trust Polecat and Mink Abundance Monitoring; Deer Surveys; and a pilot Tracking Elusive Mustelids survey. There are four multi-species schemes providing information on species in the urban environment including: the English House Condition Survey; Living with Mammals; Garden BirdWatch – Mammals; and Mammals in Your Garden? Finally, there are four single species schemes including: the series of national otter surveys; the National Dormouse Monitoring Programme; Monitoring Water Voles at National Key Sites; and The Mammal Society's Water Shrew Survey.
- The TMP is operating a very diverse range of schemes in order to collect robust data on mammal population trends. This has involved the organisations within the TMP engaging large numbers of volunteers to collect the data. The non-governmental orgainisations (NGOs) that run the surveillance schemes invest a great deal of time and money in providing support and appropriate training to the volunteers to build the volunteer network and ensure that they collect good quality data, as well as continuing to develop their skills and confidence. The TMP has facilitated the development of best practice in engaging volunteers and managing volunteer networks. It has jointly held, with the National Biodiversity Network Trust, workshops addressing volunteer co-ordination and health and safety issues, with a published manual as a result.
- The TMP owes a tremendous amount to all the organisations and their volunteers who have participated in surveys and the TMP could not operate without their support. We are very fortunate in the UK to have such a resource and we should recognise its value. Over 14,000 volunteers take part in mammal surveillance every year, carrying out over 140,000 hours of survey work, covering more than 16,500 survey sites across the UK. Some of the volunteers are primarily collecting data on birds, but are also providing good data on mammal populations.
- Two detailed case studies on volunteer engagement, the National Dormouse Monitoring Programme and the National Bat Monitoring Programme, highlight the skills required by the volunteers in the various schemes and the value of their survey effort.
- In total the TMP surveillance and monitoring programme is providing information on 37 mammals, representing 57% of the UK terrestrial mammal fauna. For 33 species and one subspecies there are sufficient data to make some assessment of population change and for 29 species, 45% of UK terrestrial mammals, it has been possible to carry out population trend analysis.
- Of the 33 species and one subspecies for which some assessment of change is possible, 25 are natives.
- Ten native species including greater horseshoe bat, lesser horseshoe bat, Natterer's bat, Daubenton's bat, common pipistrelle, polecat, badger, otter, red deer and roe deer have increasing populations, with common pipistrelle, otter and roe deer showing increases of more than 50%. Four native species, mole, whiskered bat, Brandt's bat and soprano pipistrelle show stable populations at present.
- Three native species including mountain hare, water vole and common dormouse, have shown significant declines, with water vole showing declines of more than 50%. For eight natives including hedgehog, serotine, noctule, brown long-eared bat, Irish hare (a subspecies of the mountain hare), fox, stoat and weasel, the information on population change is not clear. There is evidence of a long-term decline in UK hedgehog populations, with regional declines in parts of eastern England and a significant decline in riparian habitats. Other evidence suggests stable or increasing populations. There are some indications of declines for serotine, noctule and brown long-eared bat, and long-term and possible current declines in weasel populations. The time series for Irish hare is too short at present to provide robust trend information, although the population has increased significantly from 2002–2004.
- Of the nine introduced species, representing the remaining 26.5% of species for which some assessment is possible, rabbit has shown a significant decline. Six introduced species populations – grey squirrel, common rat, sika deer, fallow deer, muntjac and water deer – have probably increased and two species, brown hare and mink, have stable or declining populations, but the trends are less clear than for the other species.
- To summarise, 40% of natives appear to be increasing, 12% appear to be declining, 16% appear to have stable populations at present, and for 32% the trends are unclear. Of the introduced species 66% are increasing, 11% appear to be declining and 22% are stable.
- In all cases the trend information taken from the 1995 baseline provides a short time series, but future years of surveillance will provide increasingly robust information. However, there may be some difficulties interpreting overall trends where results differ between surveys.
- The report has highlighted the breadth of species covered by the TMP, but also the gaps in the programme. There are still insufficient data for approximately 50% of terrestrial mammals and this situation needs to be addressed. Some of the species are already covered by existing schemes, and as the datasets expand population

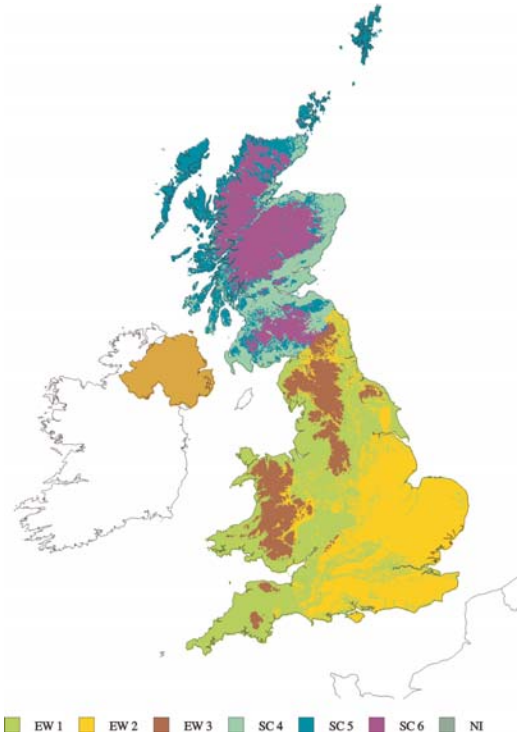
trend information will be available for them. The main groups in need of new schemes are small mammals, riparian species and those for which single species schemes are likely to be most appropriate, such as wildcat, red squirrel, Bechstein's bat and pine marten.

- The TMP First Report has also highlighted some of the other important issues, such as providing information at different spatial scales and the cost of providing a comprehensive programme. The majority of existing surveys are generating good data at a UK level. However, coverage in Scotland, Wales and Northern Ireland for some species is quite poor and regional analyses in England are only possible at present for a very limited number of widespread and common species. On average approximately 75% of survey sites are in England, 13% in Scotland, 11% in Wales and 1% in Northern Ireland and compared with the land area breakdown for the UK, there is a bias towards England and Wales in terms of survey coverage, with Scotland and Northern Ireland being under-represented in surveys.
- An attempt has been made to assess the cost of running the current programme of schemes and the overall cost of providing a comprehensive network. The current programme is estimated to cost approximately £500,000 annually, with a substantial amount of funding being provided by non-governmental organisations. It is estimated that it would cost an additional £350,000 to complete species coverage, bringing the total to £850,000. The figure of £850,000 is a substantial sum of money. However, it has to be balanced against the considerable value of the data already being collected. The total value of volunteer time is estimated to be approximately £4.5 million annually, which is donated free by the recorders. On the basis of these estimates, the ratio of the cost of running schemes to the value of volunteer time contributed is currently about 1:7, which represents very effective gearing. Taken with the good quality and extent of the data already obtained on mammal abundance, the TMP surveillance programme is seen as extremely good value.

Contents

Figures and tables

Figure 2.1 Map of England Government Office Regions



EW 1 Easterly lowlands (England/Wales)
EW 2 Westerly lowlands (England/Wales)
EW 3 Uplands (England/Wales)
SC 4 Lowlands (Scotland)
SC 5 Intermediate uplands and islands (Scotland)
SC 6 True uplands (Scotland)
NI Northern Ireland

Figure 2.2 Map of Environmental Zones in the UK. Northern Ireland has its own set of Environmental Zones that have been devised on a different basis to those used for Great Britain. In this report the Zones have been combined and Northern Ireland treated as a single unit, so as to facilitate presentation at the UK scale.

Reproduced from Haines-Young *et al.*, 2000 © Defra/ NERC

Figure 2.3 Volunteers taking part in the Winter Mammal Monitoring Survey

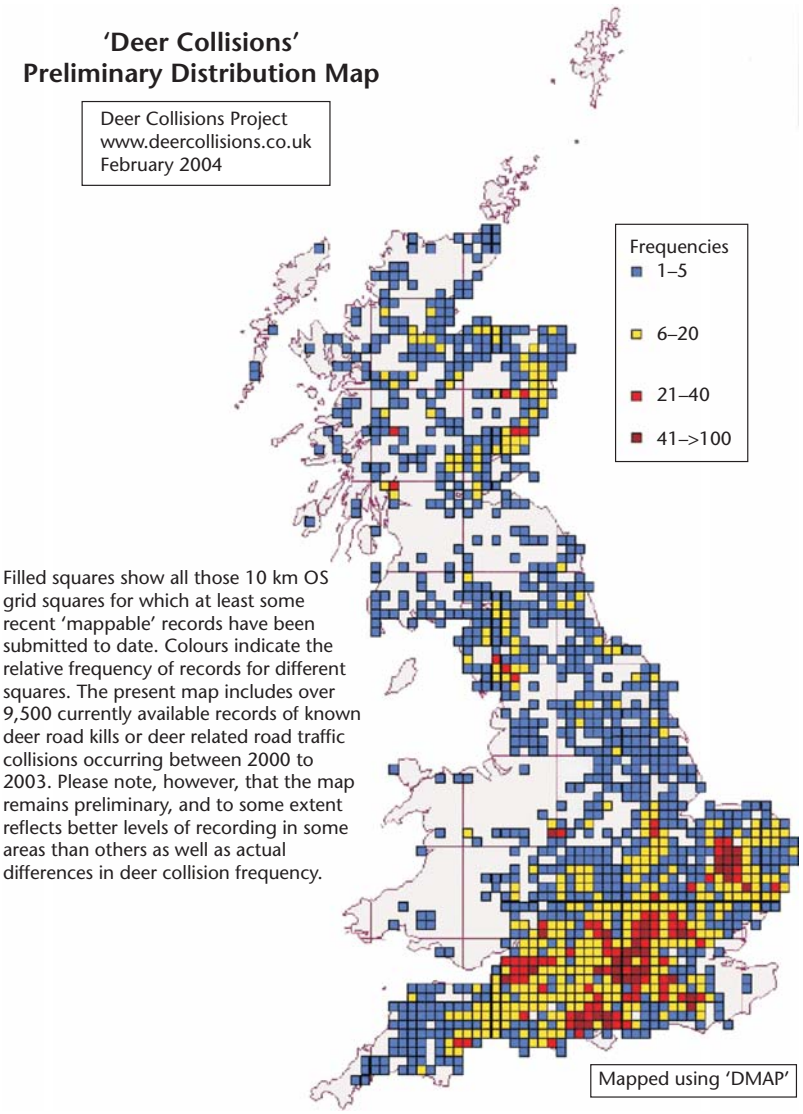


Figure 2.4 Preliminary results from the Deer Collisions Project

Figure 2.6 Volunteers looking for signs of water shrew

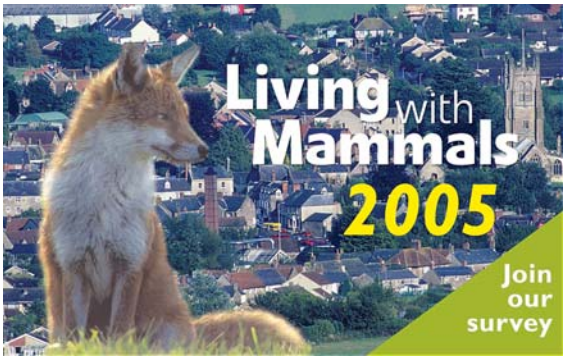


Figure 3.1 Living with Mammals flier – an example of advertising to recruit volunteers

PROTECTING OUR NATIVE ANIMALS AND THEIR HABITATS
Mammals Trust UK

JOINT NATURE CONSERVATION COMMITTEE

Mammals on Roads Survey

Incorporating the National Hedgehog Survey

Part of the Tracking Mammals network

Name:				
Address:			E-mail:	
			Postcode:	
Please circle the type of vehicle that you are driving:	Car	Van	Lorry	Other (specify)
We will send you a free copy of the survey results early next year. Please enclose a 19p stamp with your survey form, if you are able.				

Figure 3.2a Mammals on Roads survey form, front cover

SECTION A SITE REGISTRATION FORM

Xxxxx xx xxxxxx xxxxxxx xxxxxx xxxxx xxxxx xxx xxx xx x xxxxxxx xxxxxx xxxxx xxxxx xxx xxx xxxxx xxxxx xxxxxx xxxxx xxxxx xxx xxx.
BLOCK CAPITALS PLEASE

1. YOUR DETAILS

YOUR NAME

ADDRESS

Postcode

SITE ID NUMBER X X X X X X

2. YOUR CHOSEN SURVEY SITE

i) Location

ADDRESS

Postcode

SITE GRID REF

ii) Type of site Do not record on nature reserves

Private garden	☐	Golf course	☐
Community garden	☐	Sports pitch	☐
Urban park	☐	Urban farm	☐
Country park	☐	Churchyard	☐
Commons	☐	Cemetery	☐
Wasteland	☐	Road or rail corridor	☐
School playing fields	☐	River bank	☐
Allotment	☐	Other *(Please specify)*	☐
Village Green	☐		
Children's recreation area	☐		

iii) Aproximate age of site

In what decade was your site created?

iv) Size of your site

You can estimate the size of the site by pacing it out – one large pace equals about 1m

SITE LENGTH (in m)

SITE WIDTH (in m)

3. DESCRIPTION OF YOUR SITE

Indicate the percentage of your survey area that consists of the following: • 0% • 1-25% • 26-50% • 51-75% • 76-100%
Please ensure that your figures add up to 100%.

Grass	%	Barren surfaces	%
Shrubs	%	Shed / hut / building	%
Trees	%	Wild, untended area	%

Do any domestic animals use the survey site?

Dogs ☐ Cats ☐ Other *(Please specify)*

Please indicate the presence of the following on your site:

Garden shed	☐	Piles of dead wood	☐
Garden pond	☐	Bird table	☐
Bat box	☐	Bird bath	☐
Hedgehog box	☐	Other animal feeder	☐
Bird feeder	☐	Bird box	☐
Compost heap	☐		

Do any of the trees or shrubs on the site produce

Fruit	☐	Nuts	☐
Seed	☐	Bulbs	☐
Cones	☐	Veget	☐
Berries	☐		

4. BOUNDARY DESCRIPTION

What type of boundary surrounds your survey area?

None, it's all open	☐	Partially walled	☐
All fenced	☐	All trees	☐
Partially fenced	☐	Partially trees	☐
All hedged	☐	Other *(Please specify)*	☐
Partially hedged	☐		
All walled	☐		

Please indicate the height of the boundary

0-1m ☐ 1-2m ☐ 2m+ ☐

If your boundary is fenced, is the bottom of the fence:

Touching the ground ☐

Clear of the ground, enough to let mammals as large as cats to pass through ☐

Buried in the ground, not allowing any sized mammal to pass through ☐

5. DETAILS OF THE SURROUNDING AREA

Which of the following occur within 100 metres of your survey area?

Woodland	☐	Main road	
Coniferous forest	☐	(A Road upwards)	☐
Scrubland	☐	Park / recreation area	☐
Grassland	☐	Active railway	☐
Marsh / bog	☐	Refuse tip	☐
Moorland / heath	☐	Water body	☐
Farmland	☐	Stream / river	☐
Other gardens	☐	Seashore	☐

Xxxxx xx xxxxxx xxxxxxx xxxxxx xxxxx xxxxx xxx xxx xx x xxxxxxx xxxxxx xxxxx xxxxx xxx xxx xxxxx xxxxx xxxxxx xxxxx xxxxx xxx xxx.

Figure 3.2b Living with Mammals survey form

Winter Mammal Monitoring Sightings Transect Form

Obs. code	Transect section	Species code	Number seen	Time seen
e.g.	1	BRH	1	0730
A				
B				
C				
D				
E				
F				
G				
H				
J				
K				
L				
M				
N				
P				
Q				
R				
S				
T				
U				
V				
W				
X				
Y				
Z				
AA				
BB				
CC				
DD				
EE				
FF				
GG				
HH				
JJ				
KK				
LL				
MM				
NN				
PP				
QQ				
RR				
SS				

Species codes	
Hedgehog	HED
Mole	MOL
Common Shrew	COS
Pygmy Shrew	PYS
Water Shrew	WAS
Rabbit	RAB
Brown Hare	BRH
Mountain Hare	MOH
Red Squirrel	RSQ
Grey Squirrel	GSQ
Bank Vole	BAV
Field Vole	FIV
Water Vole	WAV
Wood Mouse	WOM
Harvest Mouse	HAM
House Mouse	HOM
Brown Rat	BRR
Common Dormouse	COD
Red Fox	FOX
Pine Marten	PIM
Stoat/Weasel	STW
Stoat	STO
Weasel	WEA
Polecat/Ferret	POF
Polecat	POL
Ferret	FER
American Mink	MIN
Badger	BAD
Otter	OTT
Wildcat/Domestic Cat	WDC
Wildcat	WIC
Free-roaming Cat	CAT
Free-roaming Dog	DOG
Red/Sika Deer	RSD
Red Deer	RED
Sika Deer	SID
Fallow Deer	FAD
Roe Deer	ROD
Muntjac	MUN
Wild Swine	WIS
Vole	*YYV*
Shrew	*YYS*
Mouse	*YYM*
Hare	*YYH*
Deer	*YYD*

Please return this form to The Mammal Society, 15 Cloisters House, 8 Battersea Park Road, London SW8 4BG by **Monday 17 February 2003**. For queries please telephone 0207 498 4358 or e-mail enquiries@mammal.org.uk.

Figure 3.2c Winter Mammal Monitoring survey form

Figure 3.3a A team helps to prepare Longworth traps ready for small mammal surveys

Figure 3.3b A team checking traps the next day and examining the mice and voles caught for data-collection, prior to release back

Figure 3.3c A Daubenton's bat survey volunteer using a heterodyne detector

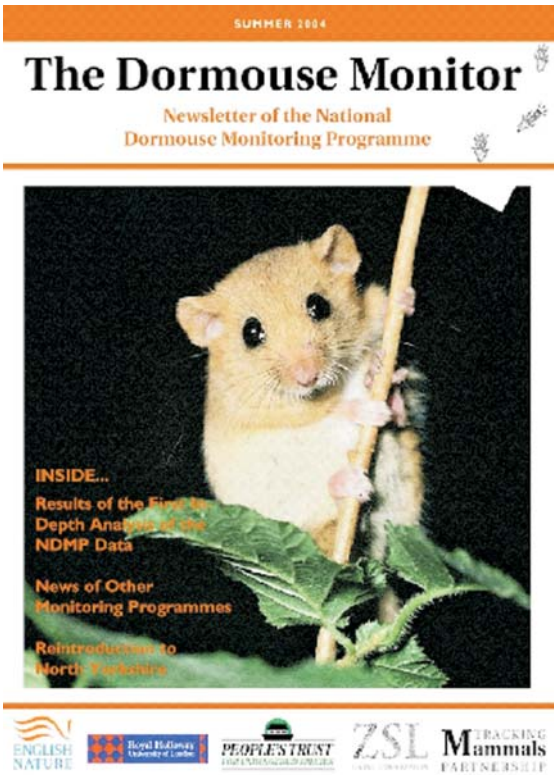


Figure 3.4a The Dormouse Monitor

Figure 3.4b Mammals on Roads Newsletter

Figure 3.4c Bird Table Magazine

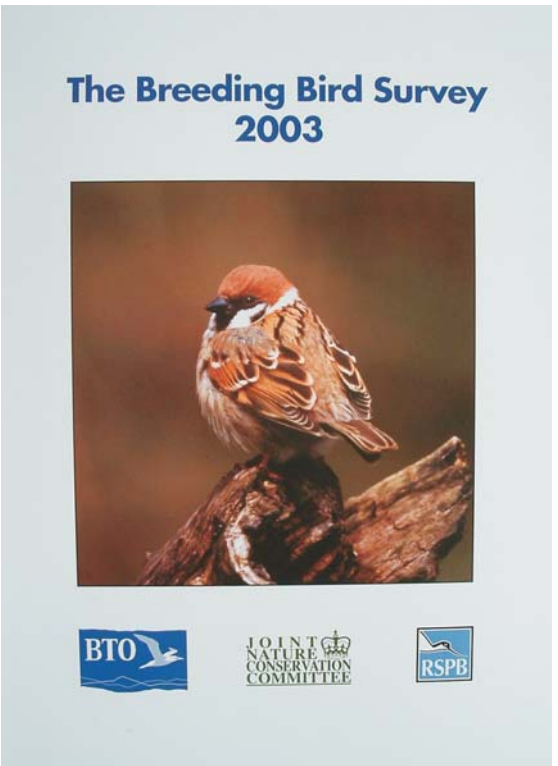
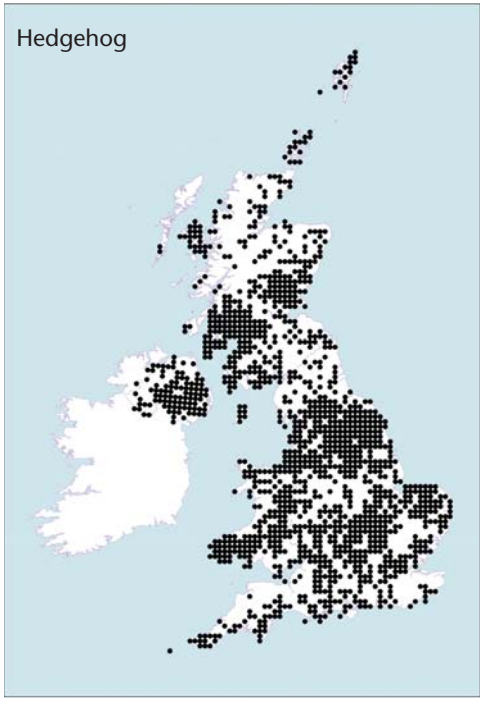


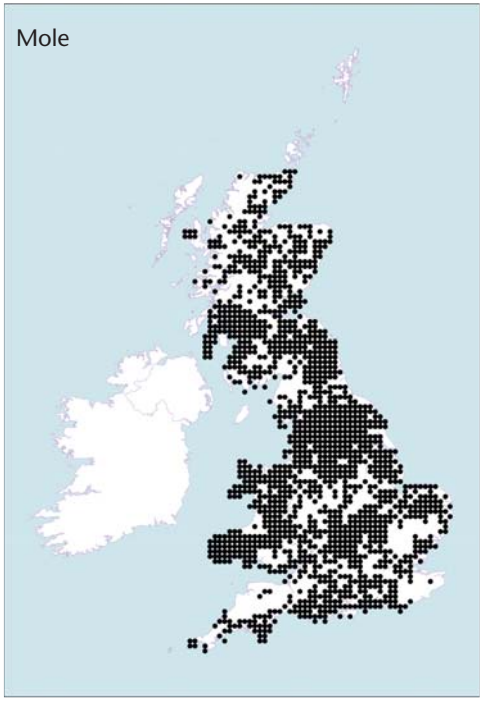
Figure 3.4d The Breeding Bird Survey Report

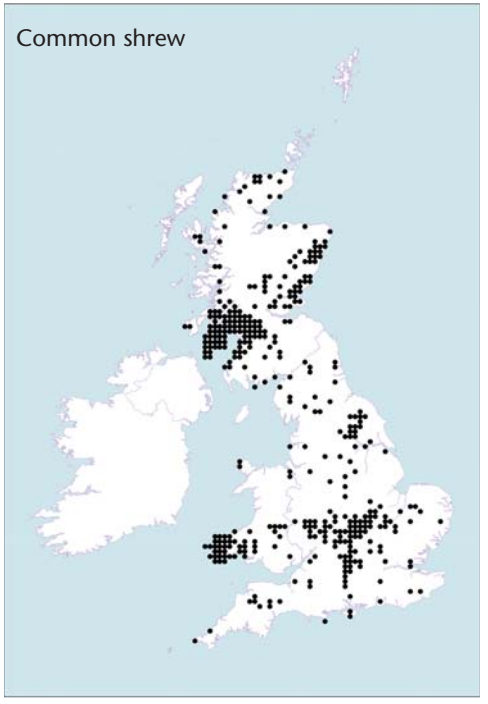

Hedgehog © Nida al Fulaij, PTES


Mole © Pat Morris


Common shrew © Pat Morris



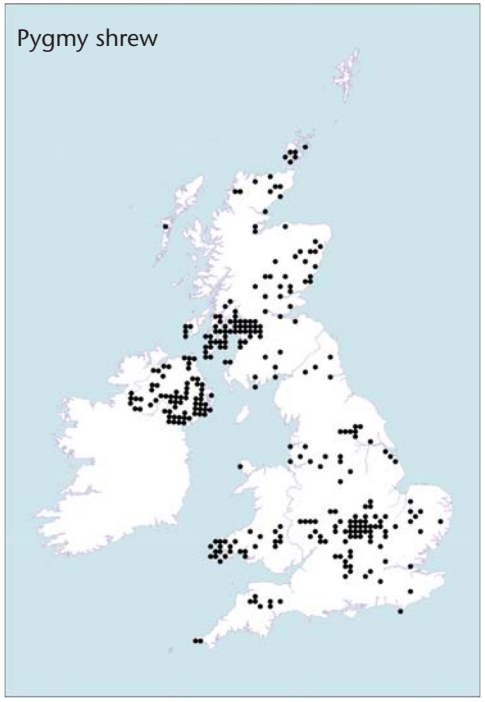


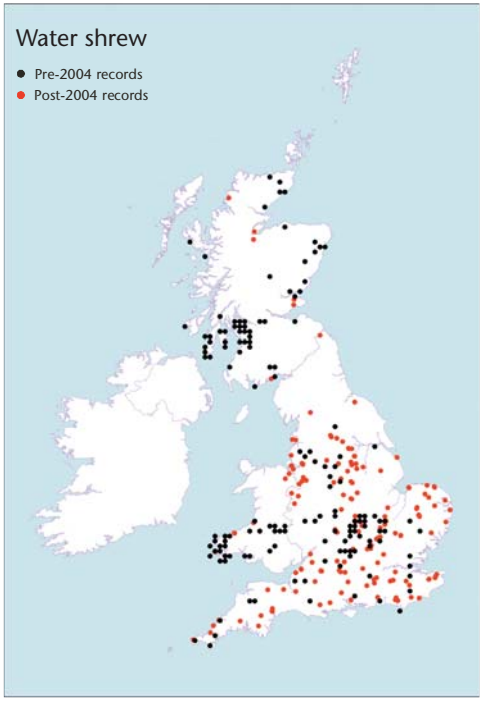


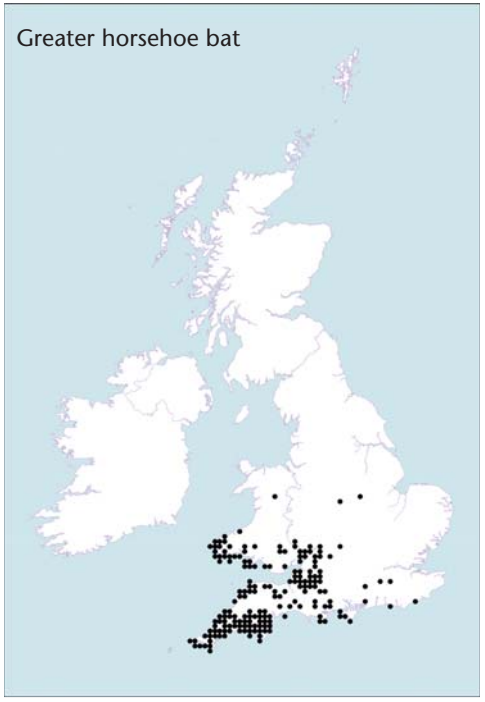

Pygmy shrew © Pat Morris

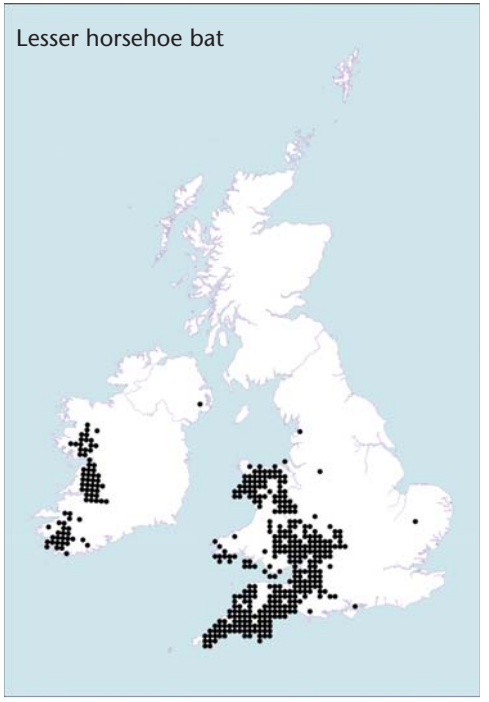

Water shrew © Pat Morris

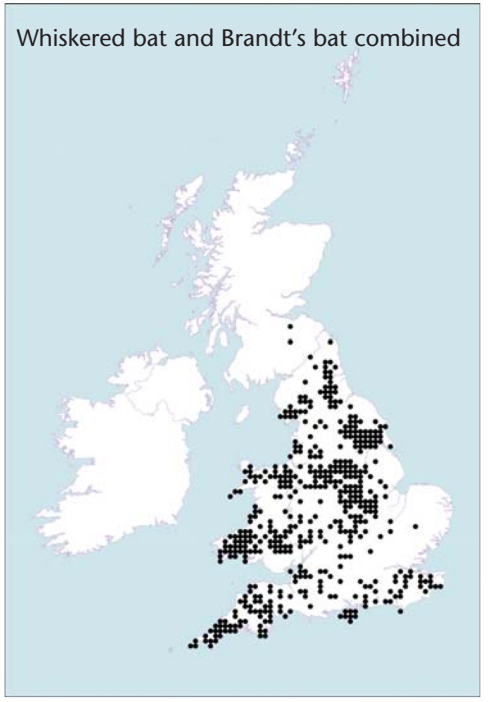

Lesser white-toothed shrew © Pat Morris






Greater horsehoe bat


Lesser horsehoe bat


Whiskered bat and Brandt's bat combined


Greater horsehoe bat © J J Kaczanow/BCT


Lesser horsehoe bat © J J Kaczanow/BCT

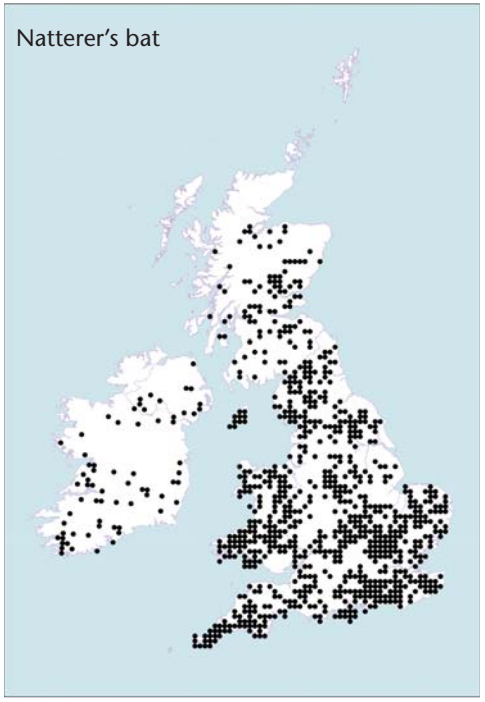

Whiskered bat © BCT

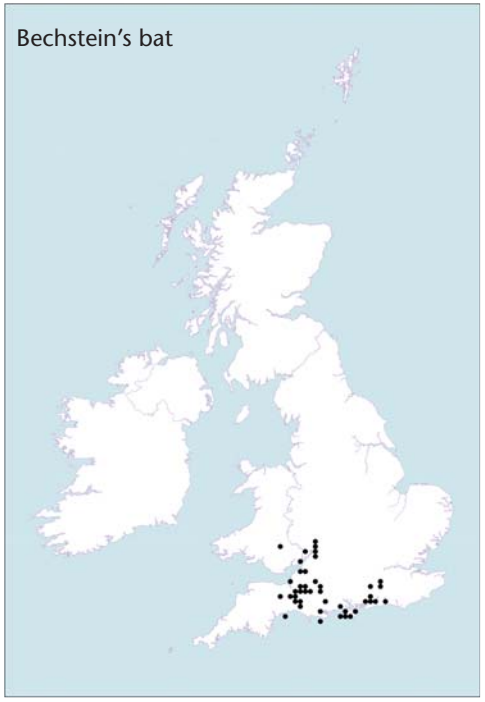

Natterer's bat © BCT


Bechstein's bat © Hugh Clark/BCT


Brandt's bat © R E Stebbings/BCT

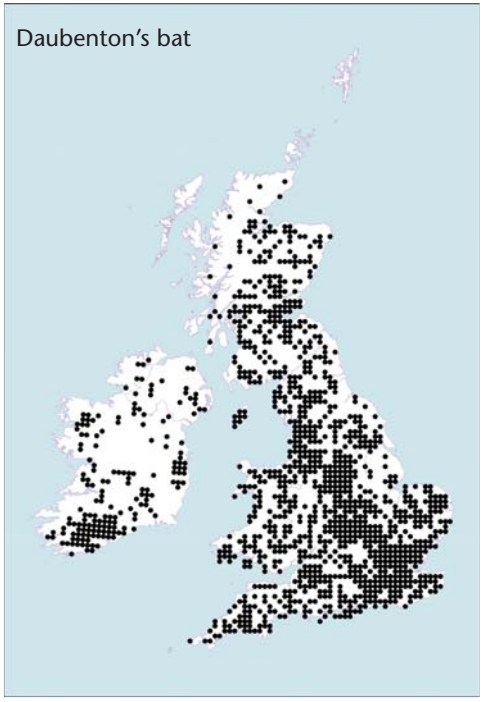
Whiskered and Brandt's bat are very difficult to tell apart and so they are generally not recorded separately. See Plate IX for species distribution.

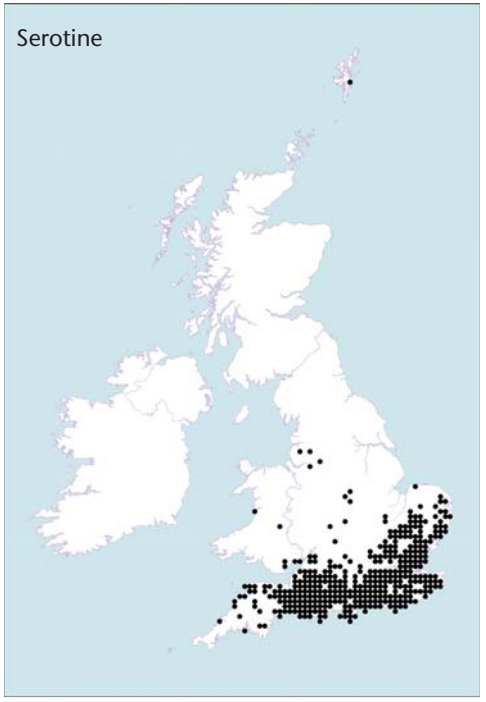


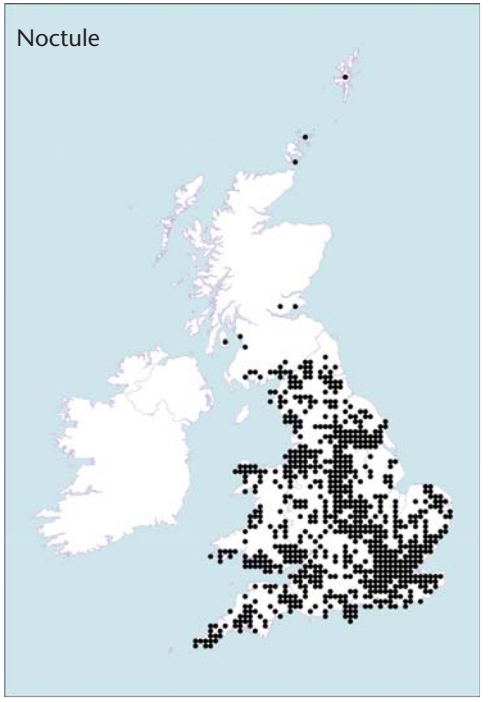



Soprano pipistrelle © Hugh Clark/BCT

The soprano pipistrelle was only recently identified as a separate species from the common pipistrelle; hence the majority of existing records do not differentiate between the two species. See Plate XII for a combined distribution map.








Daubenton's bat © J J Kaczanow/BCT

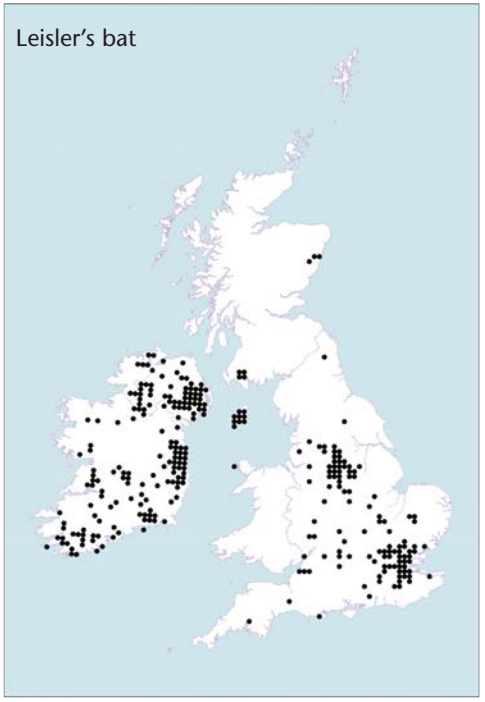

Serotine © Hugh Clark/BCT

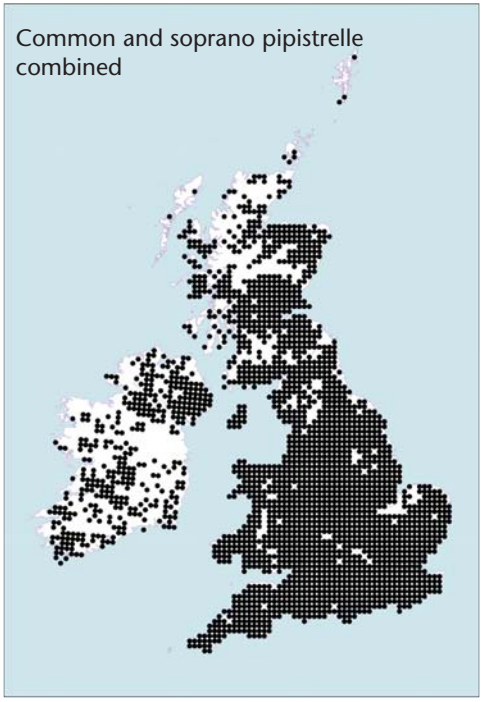

Noctule © R E Stebbings/BCT

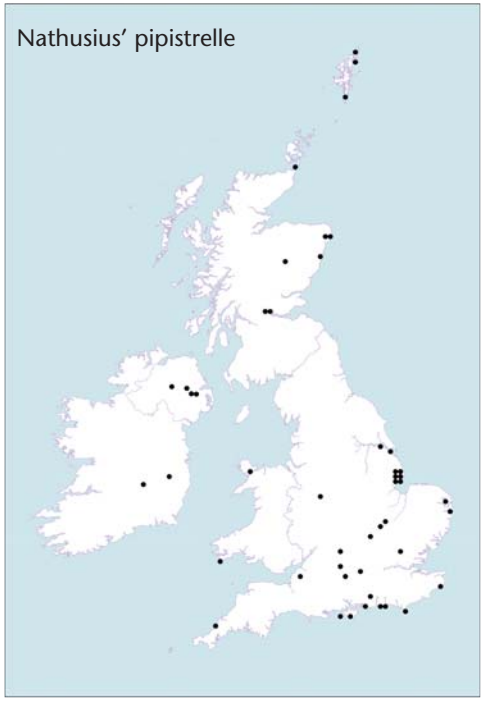

Leisler's bat © J J Kaczanow/BCT

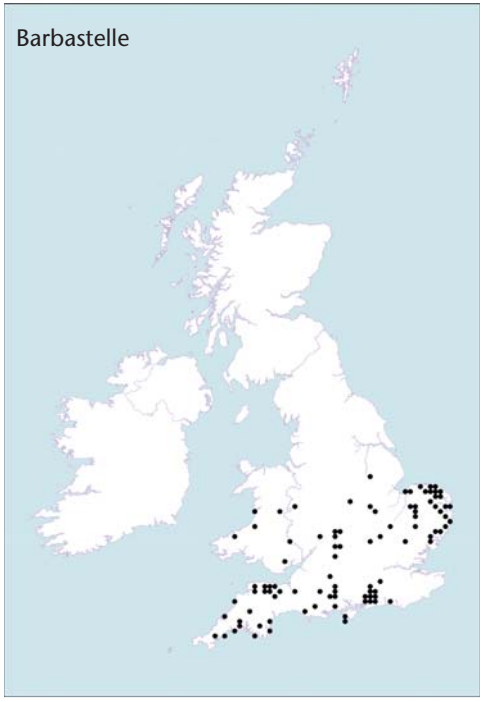

Common pipistrelle © Hugh Clark/BCT

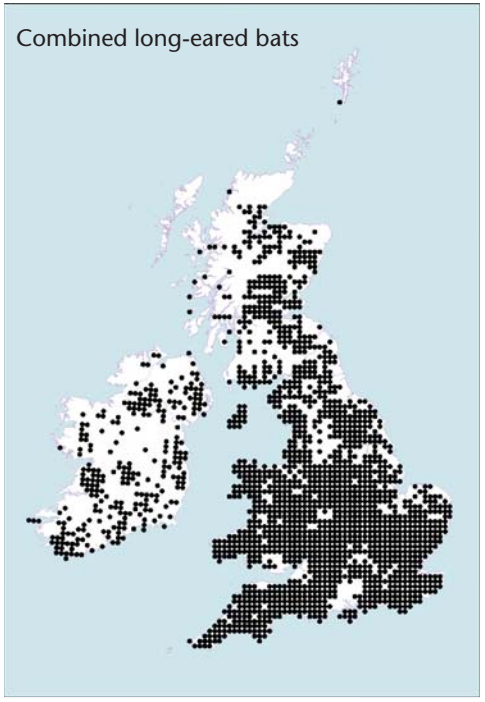

Nathusius' pipistrelle © Shirley Thompson/BCT












Barbastelle © Frank Greenway/VWT

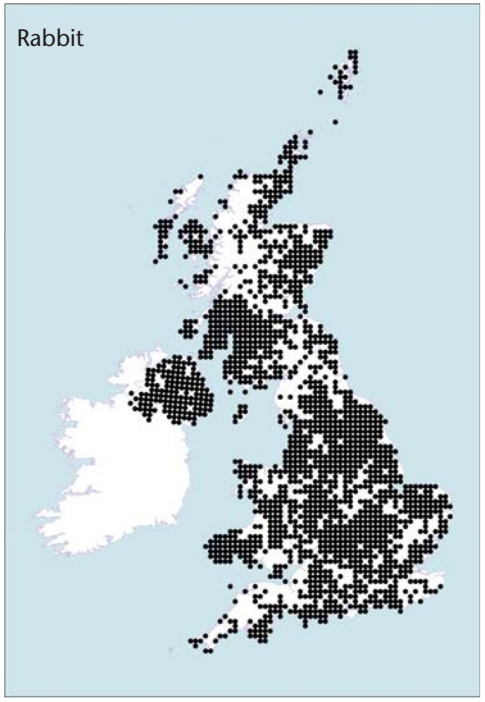

Brown long-eared bat © J J Kaczanow/BCT

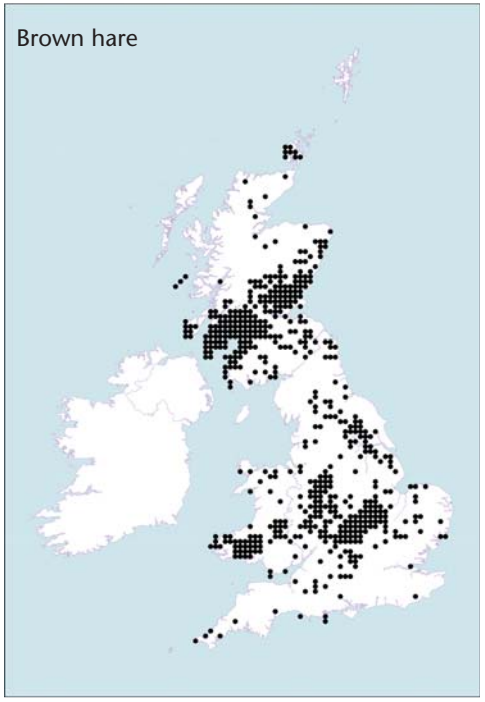

Grey long-eared bat © Hugh Clark/BCT

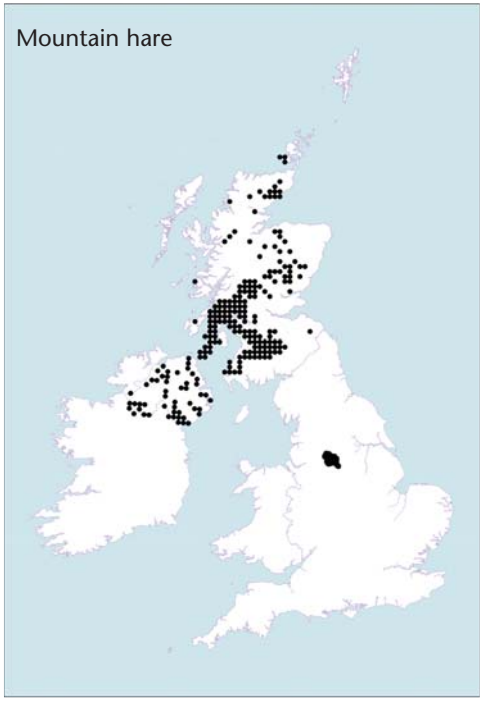

Rabbit © Pat Morris


Brown hare © Pat Morris


Mountain hare © Pat Morris



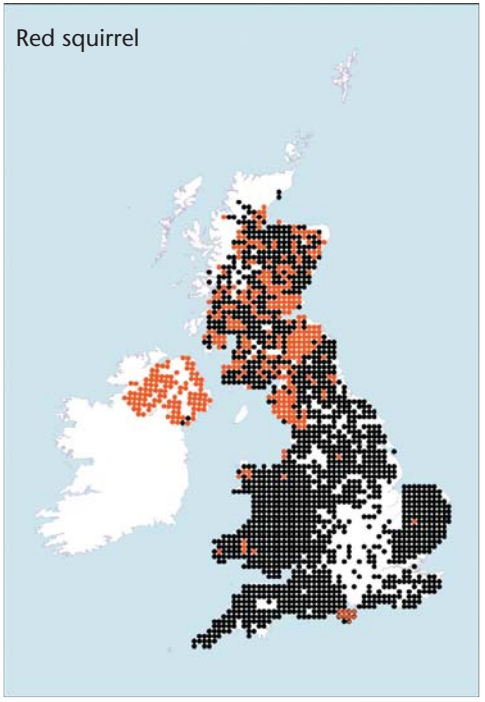


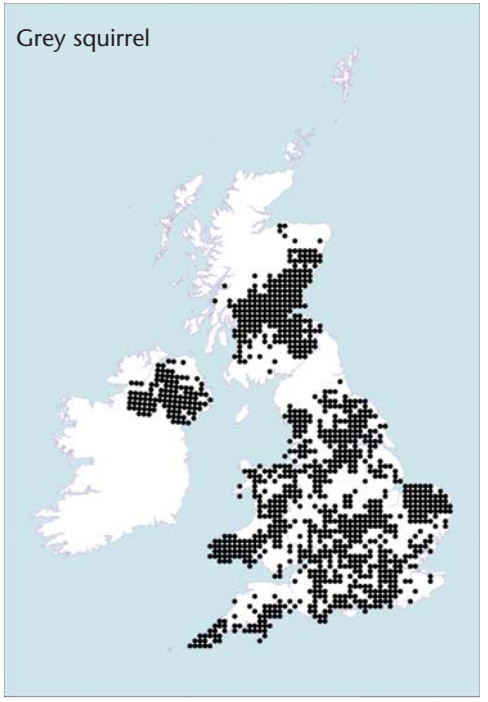


Irish hare distribution is included in the map for mountain hare (Plate XIV)

No distribution map currently available

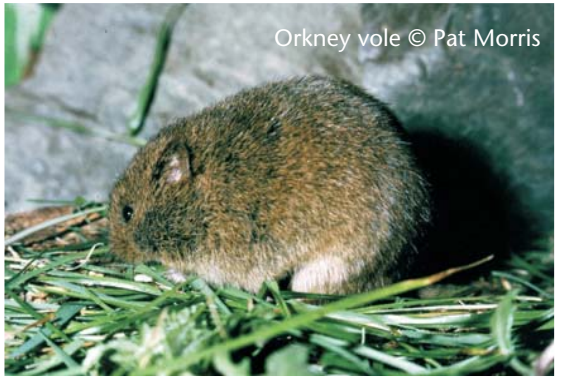
Red squirrel distribution has been contracting across the UK throughout the last century as a result of grey squirrel population expansion. The map shows historic and current UK distribution for the species. Black dots indicate red squirrel distribution prior to 1985 and brown dots indicate where squirrels were present prior to 1985 and are currently still present.

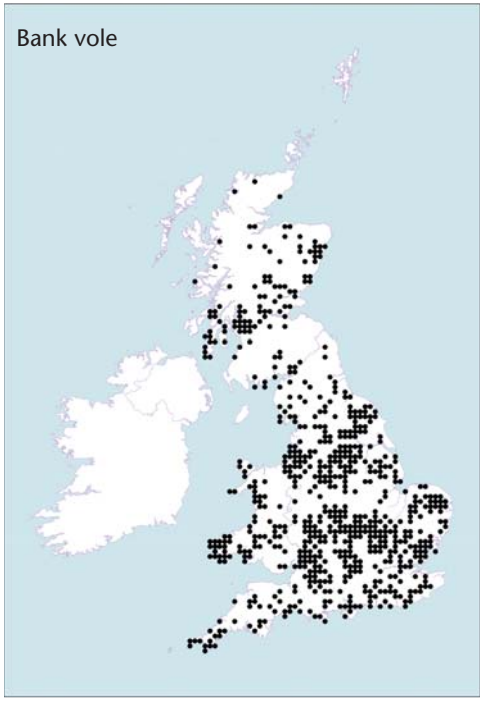


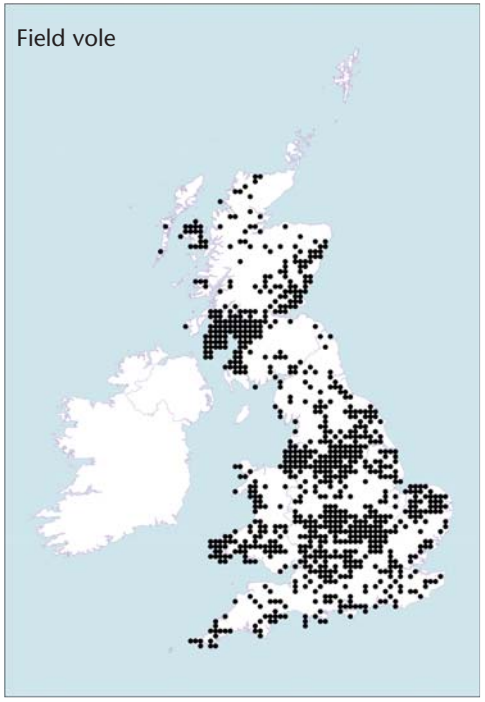



Bank vole © Pat Morris


Field vole © Pat Morris


Orkney vole © Pat Morris

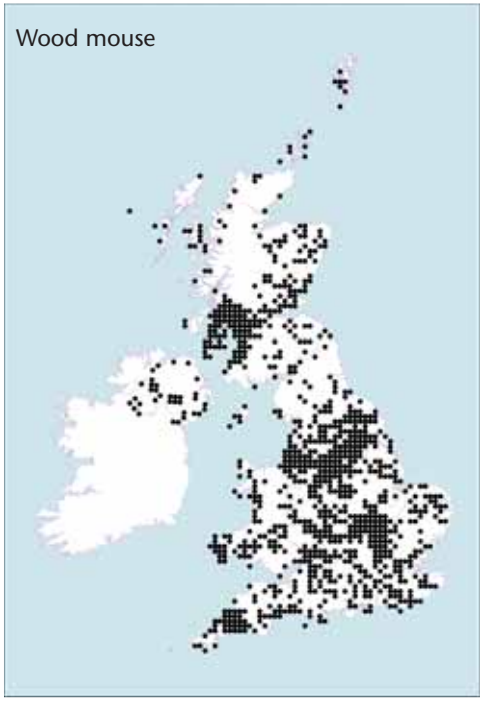


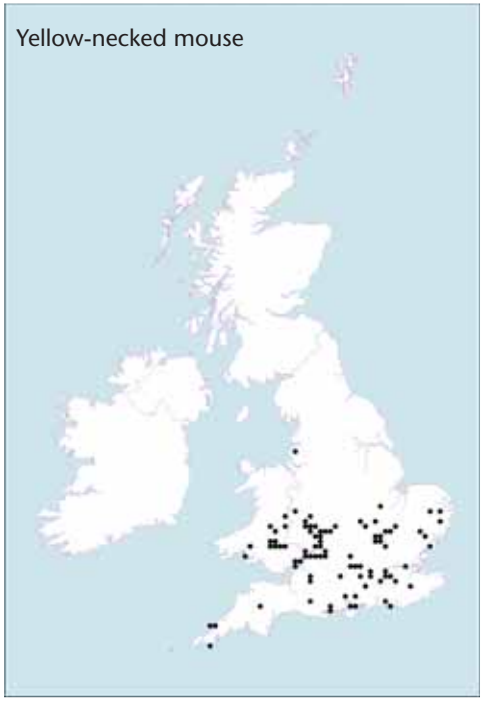



Water vole © Pat Morris

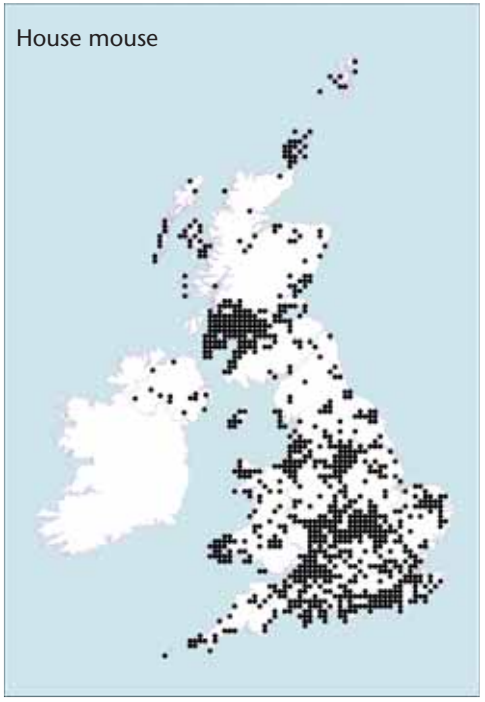

Wood mouse © Pat Morris

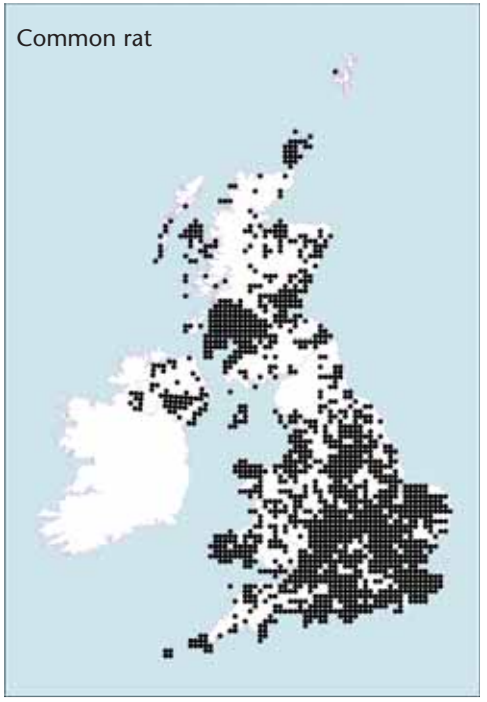

Yellow-necked mouse © Pat Morris






Harvest mouse


House mouse


Common rat

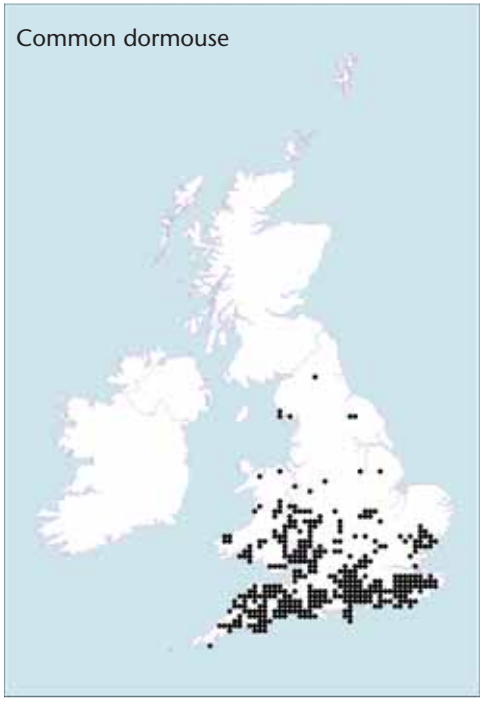

Harvest mouse © Pat Morris


House mouse © Pat Morris


Common rat © Pat Morris


Ship rat © Pat Morris

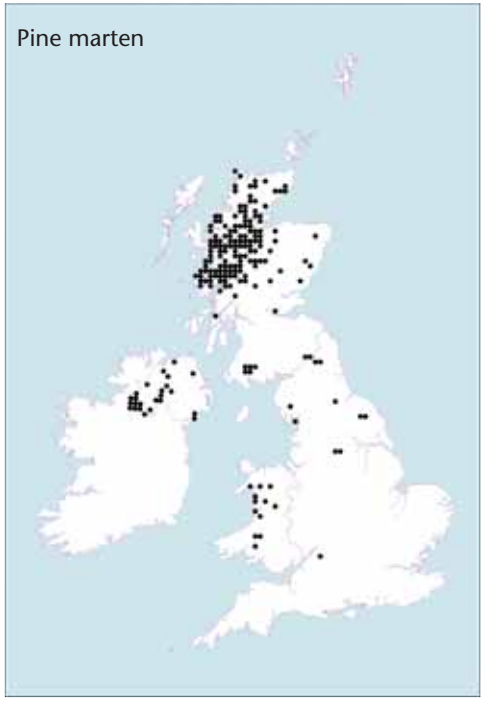

Common dormouse © Paul Bright

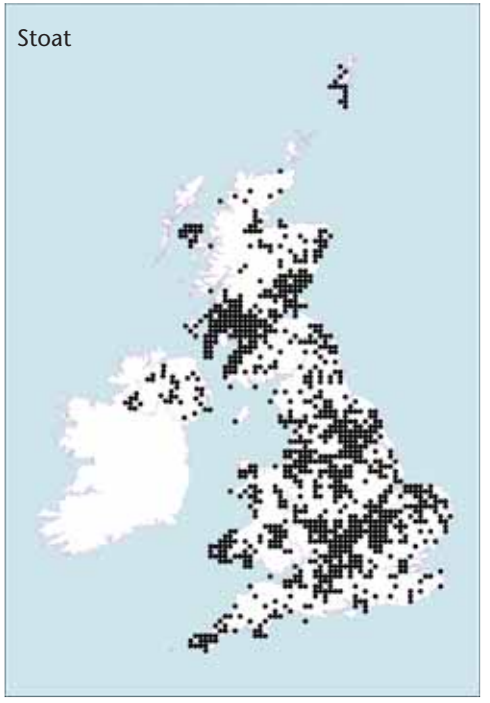



Fat dormouse © Pat Morris

No distribution map currently available


Fox


Pine marten


Stoat


Fox © Nida al Fulaij/PTES

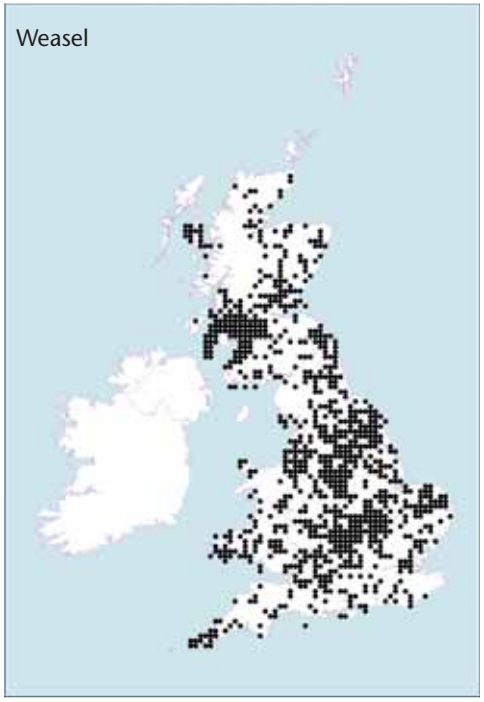

Pine marten © Frank Greenway/VWT

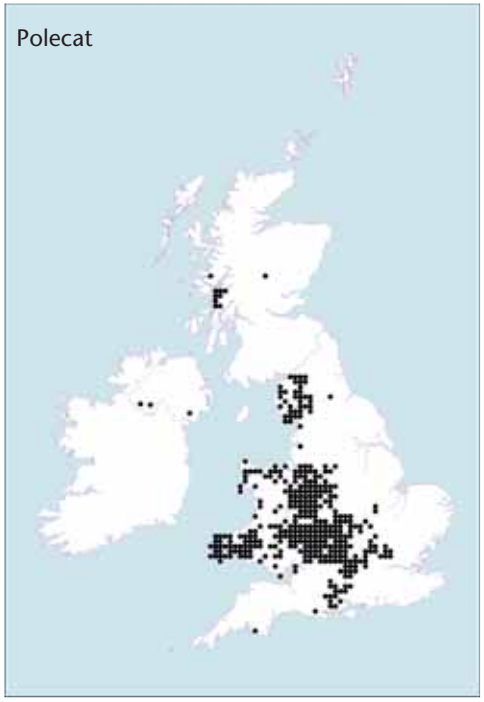

Stoat © Pat Morris

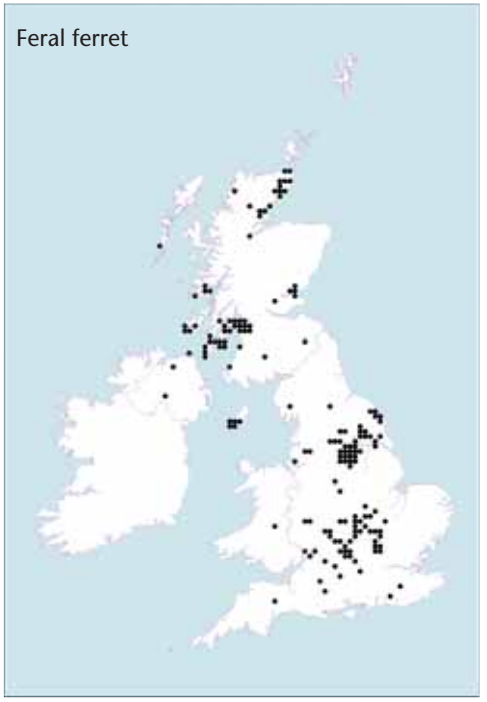

Weasel © Pat Morris

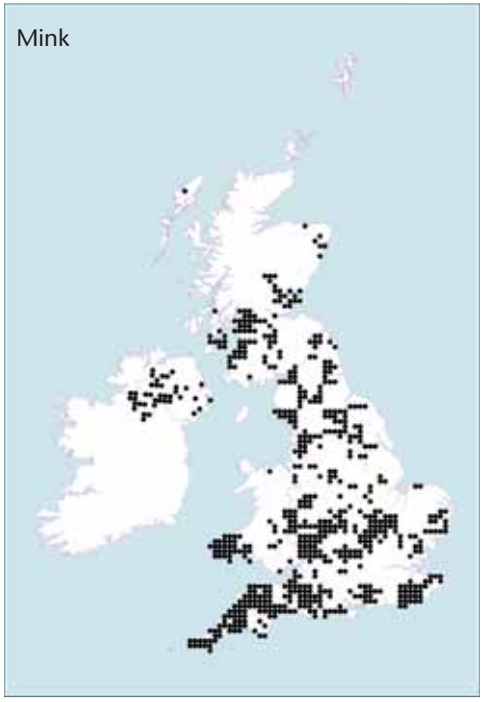

Polecat © Susan Sharafi/PTES


Feral ferret © Pat Morris








Mink

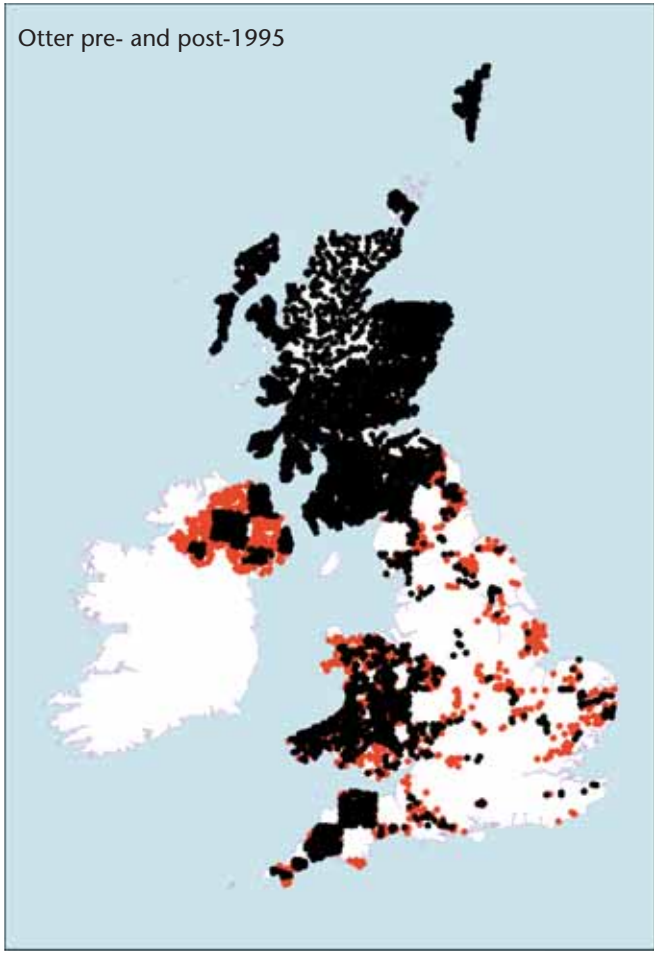

Badger


Wildcat


Mink © Pat Morris


Badger © Nida al Fulaij/PTES

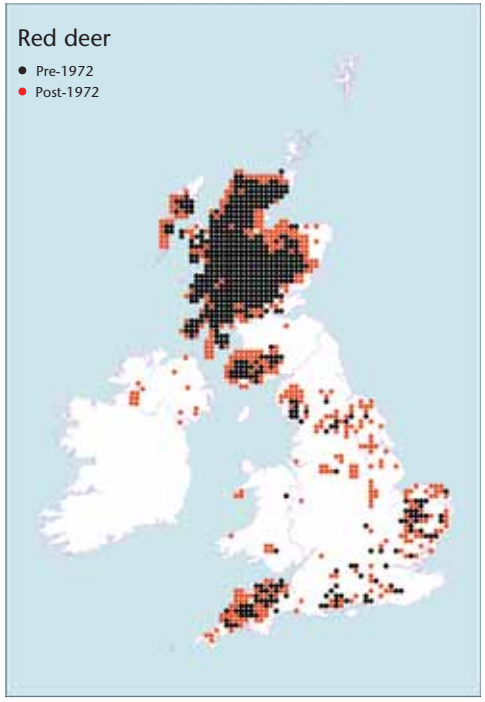

Wildcat © Ewan A Macdonald

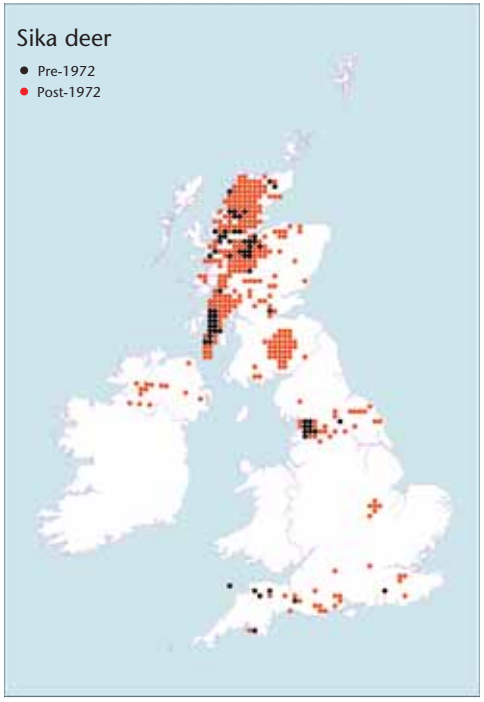


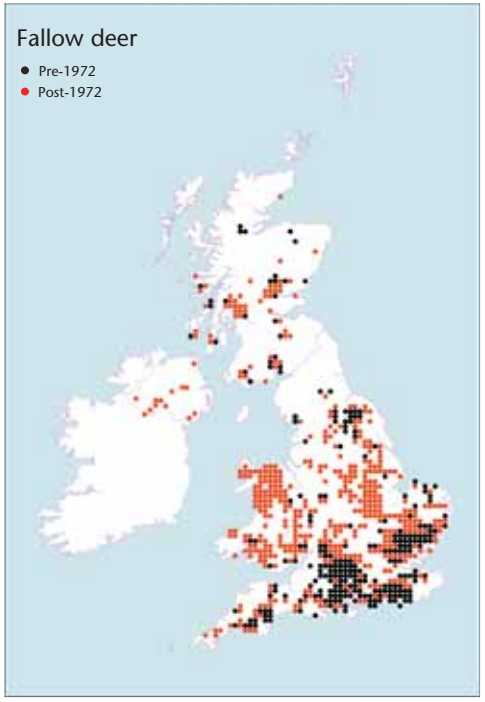
The otter distribution map has been collated from the National Otter Survey results from each of the four countries. Black dots represent the known otter distribution to 1995 and brown dots represent the increase in range recorded in the most recent series of surveys.

The initial National Otter Surveys of England and Northern Ireland used an alternate 50 km^2 sampling method; hence the blocks of distribution. Subsequent surveys have revisited these original sites and in some cases sampled additional areas. The most recent data for Scotland are not available and so Scotland shows the pre-1995 distribution only.

All deer distribution maps are compiled from the British Deer Society's pre-1972 survey data (black dots) and post-1972 records, including the BDS 2000 survey results (brown dots), which highlight the expansion of range for all six deer species.

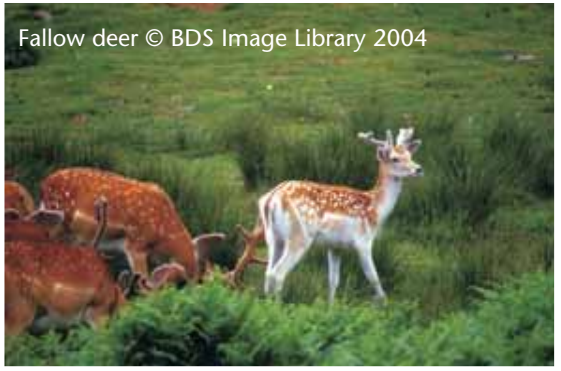

Red deer
Pre-1972
Post-1972


Sika deer
Pre-1972
Post-1972


Fallow deer
Pre-1972
Post-1972


Red deer © BDS Image Library 2004

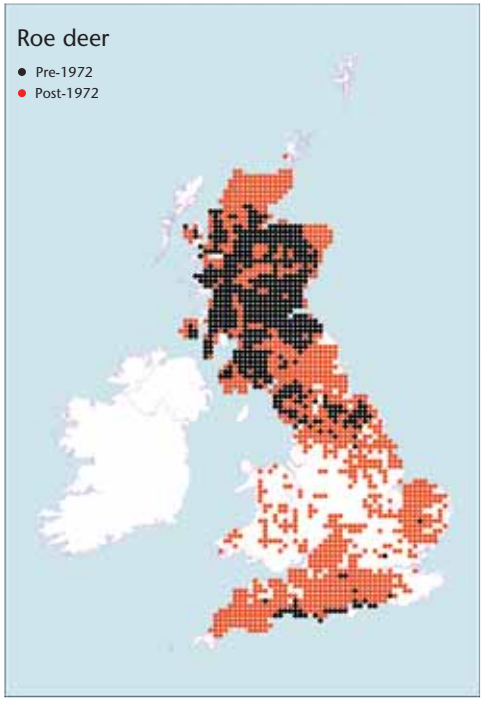

Sika deer © BDS Image Library 2004

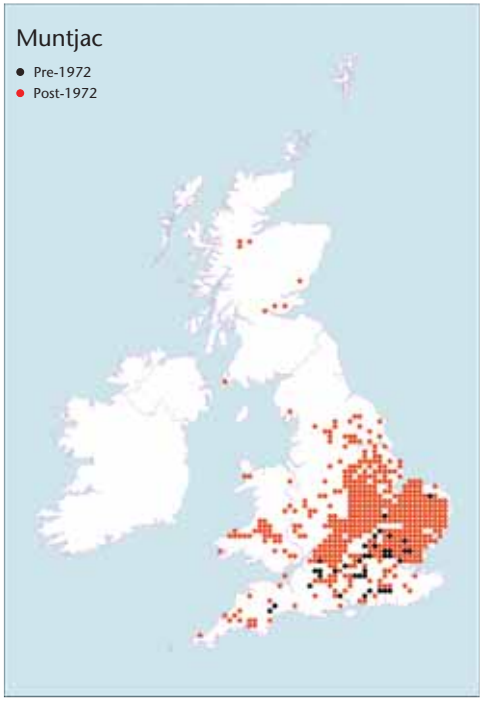

Fallow deer © BDS Image Library 2004


Roe deer © BDS Image Library 2004


Muntjac © BDS Image Library 2004


Water deer © BDS Image Library 2004


Roe deer
Pre-1972
Post-1972


Muntjac
Pre-1972
Post-1972


Water deer
Pre-1972
Post-1972

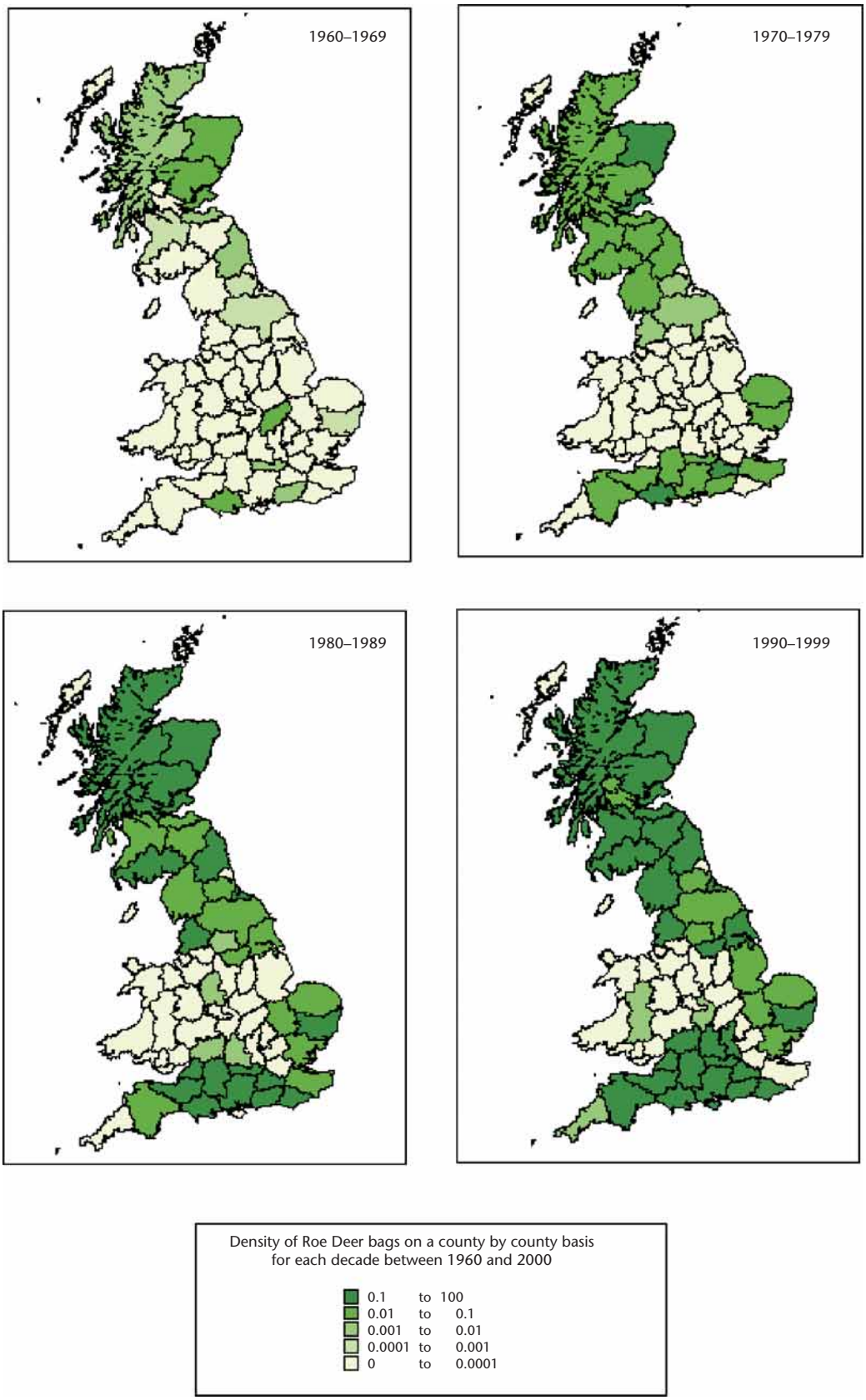


Fig 4.59a Roe deer density from NGC data

Wild boar © Ewan A Macdonald
No distribution map currently available

Feral goat © National Trust
No distribution map currently available

Soay sheep © National Trust
No distribution map currently available

Red necked wallaby © Pat Morrris
No distribution map currently available

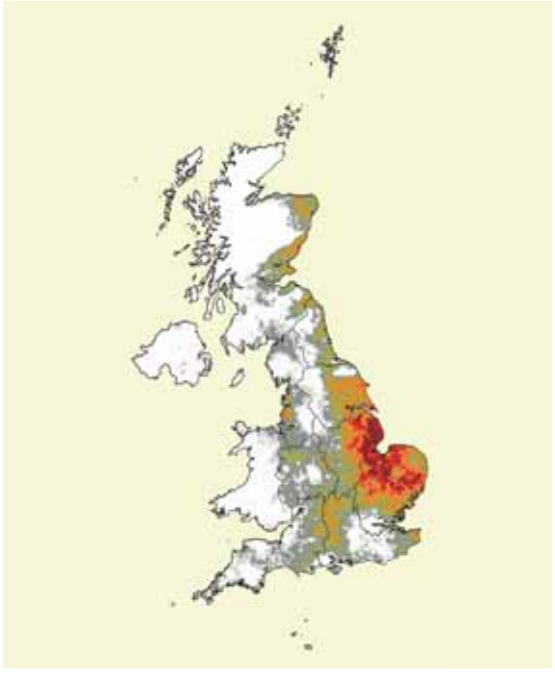


Figure 5.1a Interpolated abundance of brown hare from BBS mammal data (1995). Relative abundance increases from green to dark red.

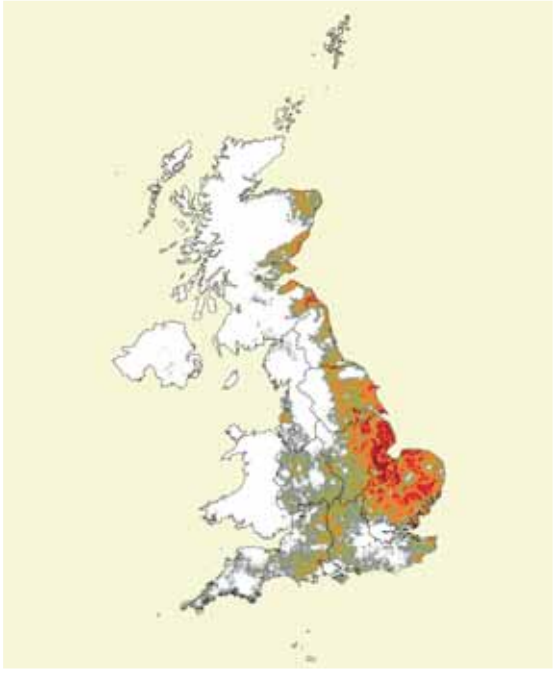


Figure 5.1b Interpolated abundance of brown hare from BBS mammal data (2002). Relative abundance increases from green to dark red.

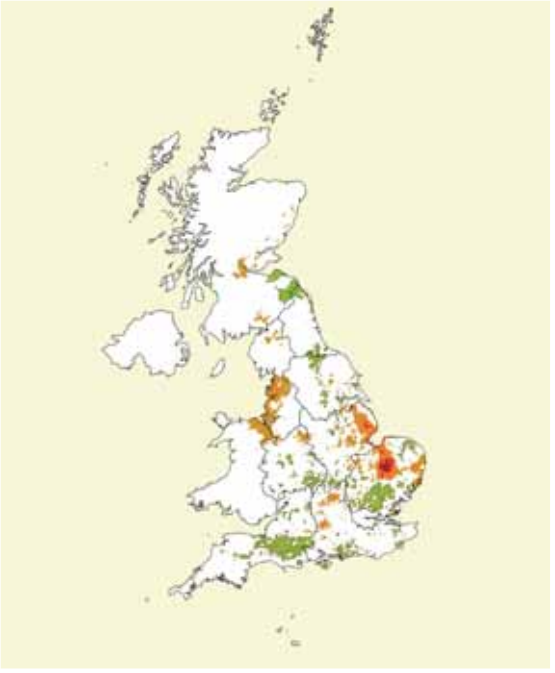


Figure 5.1c Change in the relative abundance of brown hare (1995–2002). Declines are shown in orange (small to large decline, yellow–dark red) and increases shown in green (small to large increases, light–dark green).

Table 5.1a Summary of species population trends (excluding bats) in TMP surveillance schemes

Species		Historic Trends (pre 1995)	Trends in individual schemes 1995 onwards with significant percentage changes										Overall Trends (post 1995)	Comments on Trend information
			NGC	BBS	WBBS	WMM	MoR	P&M	DS	EHCS	GBW	LWM	SS	
Insectivora														
Hedgehog *Erinaceus europaeus*	N	⇩ ↕		▲	▼		■				■	■		—↕	BBS data may be affected by change in recording methods in 2000. More data are required from all schemes to provide robust trends.
Mole *Talpa europaea*	N	?		▲	—	■					■	■		—?	Stable or increasing. BBS data may be affected by change in recording methods in 2000. Longer time series required to provide robust information.
Water shrew *Neomys fodiens*	N	⇩ ?											■		Insufficient data to carry out trend analysis.
Lagomorpha															
Rabbit *Oryctolagus cuniculus*	Int	⬆ ⇩ ⬆	▼ –47.7%	▼ –23%	▼	■	■				■	■		▼	Significant: continuous decline.
Brown hare *Lepus europaeus*	Int	⇩ —	▼ –49.4%	—↕	—	■								—↕?	Stable or declining with regional variations. Probable declines in Scotland, south-east England, Welsh and English uplands. Increases in south-west England and Welsh lowlands.
Mountain hare *Lepus timidus*	N	⬆ —		▼ –14%										▼	Significant decline but fluctuates between years – probably represents populations in Scotland. English Peak District population may be increasing.
Irish hare *Lepus timidus hibernicus*	N	⇩											▲	▲	Significant increase in the population from 2002–2004. Longer time series required to confirm long-term trends.
Rodentia															
Grey squirrel *Sciurus carolinensis*	Int	⬆	—	▲ 28%	—	■	■				■	■		▲?	Stable or increasing populations with regional variations. Longer time series from more surveys are required to provide robust trends.
Field vole *Microtus agrestis*	N	⬆ ⇩				■					■				Insufficient data to carry out trend analysis.
Water vole *Arvicola terrestris*	N	⇩			—								▼	▼—	88% decline in occupied sites in national surveys 1989–1990 and 1996–1998. WBBS suggests stable population since 1998. Annual riparian survey in the wider countryside required as well as longer time series in existing surveys.
House mouse *Mus domesticus*	Int	⇩ —								■	■				Insufficient data to carry out trend analysis.
Common rat *Rattus norvegicus*	Int	⇩ —	—	▲	—	■				■	■	■		▲?	Stable or increasing populations, with wide between year variations. Longer time series from existing surveys required to provide robust trends.
Common dormouse *Muscardinus avellanarius*	N	⇩											▼↕ –23%	▼↕	Significant decline in all regions where the species occurs, except southern England, where populations appear to be stable.

Table 5.1a *(continued)*

Species		Historic Trends (pre 1995)	Trends in individual schemes 1995 onwards with significant percentage changes										Overall Trends (post 1995)	Comments on Trend information
			NGC	BBS	WBBS	WMM	MoR	P&M	DS	EHCS	GBW	LWM	SS	
Carnivora														
Fox *Vulpes vulpes*	N	↑ — ↕	—	▼↕ –19%	—	■	■				■	■		—↕?	Stable or declining populations with regional variations showing increases in Wales. Large fluctuations between years. Longer time series required from more schemes to provide robust trends.
Stoat *Mustela erminea*	N	↓	—	—	▼									—	Stable populations. Longer time series required from more schemes to provide robust trends.
Weasel *Mustela nivalis*	N	↑ ↓	—↕	—	▼									—	Stable populations after longer term decline.
Polecat *Mustela putorius*	N	↓ ↑						■					▲	▲	National polecat survey showed 93% increase in occupied 10km squares between 1991–1997. Probable 70% explained by previous under recording.
Mink *Mustela vison*	Int	↑ —	—↕		—			■						—	Stable at UK level but significant decline of 49.7% in Scotland.
Badger *Meles meles*	N	↑		▲	—	■	■				■	■	▲	▲	Increasing populations. National badger surveys 1988–1997 detected a 77% increase. BBS detected a significant increase since 1995. Longer time series from more surveys are required to provide robust trends.
Otter *Lutra lutra*	N	↓ ↑			—								▲	▲↕	Large percentage increase in occupied sites across GB from 1978–2002, but a slight decline detected in Northern Ireland. Relationship with actual population change is not known but likely to indicate real population change.
Artiodactyla														
Red deer *Cervus elaphus*	N	↑		▼ –58%					▲					▲	BBS downward trend due to steep decline in 1996, resulting from a small number of sites recording large herds in 1995 and none or few in 1996. BDS survey shows increasing disrtibution.
Sika deer *Cervus nippon*	Int	↑							▲					▲	BDS surveys show increasing distribution.
Fallow deer *Dama dama*	Int	↑		▼ –55%					▲					▲	Same as Red deer.
Roe deer *Capreolus capreolus*	N	↑		▲ 56%		■			▲					▲	BBS Significant: continuous increase over the entire period. BDS surveys show increasing distribution.
Muntjac *Muntiacus reevesi*	Int	↑		▲ 46%					▲					▲	Same as roe deer.
Water deer *Hydropotes inermis*	Int	↑							▲					▲	BDS surveys show increasing distribution.

Table 5.1b Summary of NBMP population trends for UK resident bats

Species		Survey			Overall Trend		Significant % change		Comments
		Field	Hiber-nation	Colony	Historic (pre 1995)	Current (post 1995)	Annual	Total	
Greater horseshoe bat *Rhinolophus ferrumequinum*	N		—	▲	⇩	▲	6.3	36.0	Significant upward trend detected in colony counts. Large between year variation, small sample sizes. More years of data required.
Lesser horseshoe bat *Rhinolophus hipposideros*	N		—	▲	⇩	▲	6.7	79.0	Significant upward trend in colony counts. More years of data required to confirm trends.
Whiskered bat *Myotis mystacinus*	N		—		⇩	—			No significant trend. More years of data required.
Brandt's bat *Myotis brandtii*	N		—		⇩	—			
Natterer's bat *Myotis nattereri*	N		▲	■	⇩	▲	6.0	41.9	Significant upward trends in hibernation survey. More years of data required to confirm trends.
Daubenton's bat *Myotis daubentonii*	N	—	▲		⇩	▲	4.4	30.0	
Serotine *Eptesicus serotinus*	N	—		—	⇩	—			No significant trend. Small sample sizes. More years of data required.
Noctule *Nyctalus noctula*	N	—			⇩	—			
Common pipistrelle *Pipistrellus pipistrellus*	N	▲		—	⇩	▲	14.6	87.8	Significant upward trend in field survey. More years of data required to confirm trends.
Soprano pipistrelle *Pipistrellus pygmaeus*	N	—		—	⇩	—			No significant trend. Variation in the data. More years required.
Brown long-eared bat *Plecotus auritus*	N		—	■	⇩	—			No significant trend. Variation in the data. More years required.

Key to Tables 5.1a, 5.1b, 5.1c

⇧	Historic increase
⇩	Historic decline
▲	Significant increase
—	No significant change
▼	Significant decline
■	Data collected but trend analysis not possible
↕	Regional differences in trends
N	Native species
Int	Introduced species
•	No historic trend information
?	Trends unclear

NGC	National Gamebag Census, 1961 onwards (historic) and 1995 onwards (current).
BBS	Breeding Bird Survey – Mammals, 1995 onwards.
WBBS	Waterways Breeding Bird Survey – Mammals, 1998 onwards.
WMM	Winter Mammal Monitoring pilot, 2000 onwards.
MOR	Mammals on Roads pilot, 2001 onwards.
P&M	VWT Polecat and Mink Abundance Monitoring, 2002 onwards.
DS	Deer surveys. Distribution surveys 1969, 2000, 2005 and every five years. Density and Trends survey 2006 onwards.
EHCS	English House Condition Survey.
GBW	Garden BirdWatch, 2003 onwards.
LWM	Living with Mammals, 2003 onwards.
SS	Single Species Schemes: National otter surveys; National Dormouse Monitoring Programme, 1993 onwards; The Mammal Society's Water Shrew Survey, 2004 onwards; Irish hare surveys; National water vole surveys; the National polecat survey; the National badger surveys.

Table 5.1c Summary of species not currently covered by TMP surveillance schemes

Species		Historic trends	Potential methods and comments
Insectivora			
Common shrew *Sorex araneus*	N	●	Establish long-term trends in abundance across a range of habitats. A 4 or 5 year pilot study using volunteers is required, with attention given to the value of live-trapping, pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment.
French shrew *Sorex coronatus*	Int	●	
Pygmy shrew *Sorex minutus*	N	●	
Greater white-toothed shrew *Crocidura russula*	Int	●	
Lesser white-toothed shrew *Crocidura suaveolens*	Int	●	
Chiroptera			
Bechstein's bat *Myotis bechsteinii*	N	⇩	Research into locating roosts and assessing species distribution underway. Surveillance methods being developed.
Leisler's bat *Nyctalus leisleri*	N	⇩	Pilot survey being planned in Northern Ireland.
Nathusius' pipistrelle *Pipistrellus nathusii*	N	⇩	Potential to add to field surveys if broad band detectors used.
Barbastelle *Barbastella barbastellus*	N	⇩	Survey methods under development. Pilot survey of woodland bats planned.
Grey long-eared bat *Plecotus austriacus*	N	⇩	Collation of existing and new records.
Rodentia			
Red squirrel *Sciurus vulgaris*	N	⇩	Two year pilot study under way to set up a monitoring scheme.
Bank vole *Clethrionomys glareolus* (including Skomer vole *Clethrionomys glareolus skomerensis)*	N	●	Establish long-term trends in abundance across a range of habitats. A 4 or 5 year pilot study using volunteers is required, with attention given to the value of live-trapping, owl-pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment.
Orkney vole *Microtus arvalis orcadensis* and Guernsey vole *Microtus arvalis sarnius*	Int	⇩	
Wood mouse *Apodemus sylvaticus*	N	—	
Yellow-necked mouse *Apodemus flavicollis*	N	⇩	
Harvest mouse *Micromys minutus*	Int	⇩	Search for signs of this species in The Mammal Society's Water Shrew Survey.
Ship rat *Rattus rattus*	Int	⇩	Collect records of any sightings.
Fat dormouse *Glis glis*	Int	⇧	Surveillance required to assess potential for population increase and spread.
Carnivora			
Pine marten *Martes martes*	N	⇩	Single species surveillance required.
Feral ferret *Mustela furo*	Int	●	Some data on distribution collected in the VWT Polecat and Mink Abundance monitoring.
Wildcat *Felis silvestris*	N	⇩	Single species surveillance required.
Cat/feral cat *Felis catus*	Int	⇧	Some schemes collecting data, particularly on domestic cats. Insufficient data to carry out trend analysis.
Artiodactyla			
Wild boar *Sus scrofa*	N/Int	●	Potential information from the NGC. Added to the list of species in 2004.
Feral goat *Capra hircus*	Int	●	Regular local surveys to assess size of known populations.
Feral sheep *Ovis aries*	Int	●	
Diprotodontia			
Wallaby *Macropus rufogriseus*	Int	?	Regular local surveys to assess size of known populations.

1. Introduction

1.1 The UK mammal fauna

The 65 mammals in this report comprise a very important group of animals in the UK, given the range of conservation and management issues that affect them. Some of our native species, notably red squirrel, water vole, common dormouse and many of our bat species have suffered serious declines. The genetic integrity of others is seriously threatened through hybridisation with non-native species such as sika deer with native red deer, feral cats with native wildcats and feral ferrets with native polecats. Some are considered as problem species for a variety of reasons, mole as an agricultural pest, fox for predation on poultry and livestock, badger because of possible TB transmission to livestock, deer because of damage to forestry, agriculture and biodiversity. Non-native species are also important, some because they are invasive and have detrimental effects on our native fauna and flora, such as mink affecting water vole and water bird populations, the spread of the grey squirrel causing the decline of the native red squirrel as a result of competition and disease transmission, and muntjac, which is having a detrimental effect on woodland flora. Conversely, other non-natives have important populations here, such as water deer, which is increasingly threatened in its native habitat.

Many mammals, such as bats, otter and common dormouse, are indicators of the quality of the environment. Some mammals are carriers of disease that can be transmitted to humans; European Bat Lyssavirus (EBLV) in bats, Lyme disease transmitted by deer ticks, and *Leptospirosis* carried by common rats. Many small mammals are ecologically important because they provide the prey base for mammalian carnivores and avian raptors. Some mammals such as the otter and wildcat act as flagship species and capture the public imagination, highlighting important issues for their own populations and those of less charismatic species. Finally some species are afforded international protection because of worldwide declines, including otter and all UK bat species.

The importance of the UK mammal fauna is widely recognised, resulting in a desire for knowledge and a great deal of speculation about population increases and declines, because, paradoxically, there is a lack of robust information on population trends and why the trends are occurring. The aim of the TMP First Report is to provide the detailed information on mammal populations that has been sadly lacking in the past, to recognise what has been achieved so far and create a vision for what could be achieved in the future, if mammals are given a sufficiently high profile and funding is available to carry out the necessary work.

1.2 Historical background

The paucity of data on changes in mammal populations has been highlighted by several reports, including a review of population estimates and conservation status of British mammals (Harris *et al.*, 1995), which showed that for the majority of mammal species in the UK, population trends were based on limited and sometimes unreliable data. A more recent report on Britain's mammals reiterated the need for a comprehensive national mammal monitoring network to provide robust data on population trends (Macdonald & Tattersall, 2001).

Past work should not be ignored in this context, because much of it has provided the sound basis on which to build a comprehensive surveillance and monitoring network. Over the past 30 years a large number of surveys have been carried out to assess the distribution and abundance of individual mammal species (**Otter**: Andrews & Crawford, 1986; Andrews *et al.*, 1993; Crawford, 2003; Crawford *et al.*, 1979; Green & Green, 1980, 1987, 1997; Jones & Jones, 2004; Lenton *et al.*, 1980; Strachan & Jefferies,1996; **Badger**: Cresswell *et al.*, 1990; Wilson *et al.*, 1997; **Brown Hare**: Hutchings & Harris, 1996; **Dormouse**: Bright *et al.*, 1996; Hurrell & McIntosh, 1984; **Water Vole**: Strachan & Jefferies, 1993; Strachan *et al.*, 2000; **Pine Marten**: Balharry *et al.*, 1996; Strachan *et al.*, 1996; Velander, 1983; **Polecat**: Birks & Kitchener, 1999). Some surveys, for example the series of national otter surveys, water vole, brown hare and badger surveys, have been repeated periodically to try to ascertain changes in distribution and abundance over time.

There are many organisations, working at both national and local levels, collecting information on mammals, sometimes focusing on one species, and providing advice on mammal issues. This has produced a diverse group of organisations, carrying out essential work in their own area of concern. However, assessing mammal population trends has until now been rather uncoordinated, without standardised methods that would allow comparison between the various surveys, and not repeated frequently enough to separate real population trends from natural between year fluctuations.

To address the issue of assessing the changing abundance of mammals over time, in 1996 the then DoE and the Joint Nature Conservation Committee (JNCC) initiated a scoping study to investigate the ways in which a mammal surveillance and monitoring network might be set up and run, which resulted in the report *Proposals for future monitoring of British mammals* (Macdonald *et al.*, 1998). A further study, *Developing a mammal monitoring programme for the UK* (Toms *et al.*, 1999), built on and developed some of the proposals of the first report. Both reports

looked at the feasibility and costs of setting up a network and the survey methods that could be used for different species.

A very important recommendation from both scoping studies was to bring all the existing information and organisations together and provide a coordinated structure for future monitoring and surveillance work. It was recognised that the provision of population trend information is a long-term and complex activity and could only be achieved with the joint co-operation of all existing mammal organisations. With this fact in mind the Tracking Mammals Partnership (TMP) was launched in July 2003, with the aim of producing population trend information for all resident terrestrial UK mammal species.

In supporting a coordinated approach to mammal surveillance and monitoring, the UK government, devolved administrations and other organisations in the UK are recognising the importance of mammal biodiversity. The bird world has shown what can be achieved with a coordinated approach. For over 40 years information on changes in bird populations has been collected by bird conservation and research organisations, providing essential data to inform government and the public on the effects of agricultural and other changes to the landscape and habitats of the UK. The information collected has helped to inform government policy and to ensure that the conservation of birds has a high profile. However, it is important that other species groups are used to guide policy decisions and to provide a wider framework of information to aid the decision making process. The variety of issues affecting mammals means that they are an essential group to consider for this purpose.

1.3 Surveillance and monitoring

The TMP aims to provide both surveillance and monitoring data and to develop best practice surveillance and monitoring methods. Surveillance consists of repeated and standardised observations of abundance over time, using methods that enable changes in numbers to be detected (Hellawell, 1991). Monitoring requires that targets are set, management recommendations made and carried out, the effectiveness of the management assessed and changes made to improve the process. Surveillance is a means of assessing what is happening to populations of a particular species over time. Monitoring involves surveillance not only of the species in question but of, so far as possible, the other factors likely to affect populations of that species, such as climate, other species, habitat and food. Research is an important part of any comprehensive monitoring system because of the importance of understanding what is driving population change and causing targets not to be achieved.

Surveillance and monitoring information are used by different sectors to plan their activities and to take appropriate action. Some examples of sectors that require mammal abundance information are biodiversity conservation, agriculture, forestry and hunting or game interests. The main purposes of surveillance and monitoring are as follows:

Detecting changes in distribution and abundance over time. This is necessary in order to have an informed understanding of what is happening to mammal populations in the UK.

Influencing national policy and setting of conservation priorities. The UK government and the devolved administrations require good quality information on the status and changing fortunes of different elements of biodiversity in order to produce effective conservation and wildlife management policy.

Assessing the effects of conservation and other types of wildlife management. There is a great deal of habitat and species management in operation and being recommended across the UK for conservation and sustainable use. It is extremely important to know whether such management is achieving the intended goals and the main ways of assessing this are through monitoring changes in habitat structure and species abundance and distribution.

Fulfilling national and international obligations. The UK is party to several International and European Conventions and Directives, including the Convention on Biological Diversity (CBD), the Bern Convention, the Bonn Convention on Migratory Species (CMS) and the Habitats Directive. These are implemented in the UK through national law and conservation policy, including the Wildlife and Countryside Act (1981 as amended), the Conservation (Natural Habitats, etc.) Regulations, 1994, the CRoW Act, Natura 2000 and the UK Biodiversity Action Plan (for a summary of the relevance of these Conventions and Directives to mammal surveillance see Battersby & Greenwood (2004); more information can be found at the websites listed in Appendix II).

Educating people about conserving and managing mammal populations. Education is an important part of any conservation or wildlife management initiative. Informing the general public about issues affecting wildlife in urban environments and in the wider countryside, and obtaining public support and involvement in these areas are the keys to success. This can partly be achieved through organisations in the TMP encouraging volunteer participation in surveys, which at present happens widely. Volunteers are an extremely important part of many surveillance schemes and often it would be impossible to collect the necessary data without them. Many volunteers attend training courses to improve their survey and identification skills and receive newsletters about the results of the work they have done and thereby improve their knowledge and understanding. It is also important to inform and engage the general public more widely through mass participation surveys, easy to access websites, and annual reports and newsletters. Surveillance and monitoring schemes are ideal for achieving these interactions and assisting the information dissemination process.

1.4 Volunteer involvement

There is a great tradition of amateur naturalists in the UK and this interest in wildlife and the natural world has been a

very important resource for organisations wishing to collect information on UK flora and fauna. Mammals are no exception and there are large numbers of volunteers eager to go out into the British countryside to record mammals, resulting in a broad volunteer base of experienced and trained surveyors that organisations are able to call upon for surveying and monitoring mammals.

There are many advantages and some disadvantages to engaging volunteers in surveying and these are discussed in chapter 3 of the TMP First Report. A great deal of investigation was carried out in the scoping studies, comparing volunteer input with that of professional surveyors. The planned increase in the number and frequency of surveys in the TMP Surveillance and Monitoring Programme raised interesting questions about volunteer involvement. Is there a limit to the pool of volunteers available? Will they be prepared to repeat the surveys year after year? Are there limits to their abilities and to the quality of the data they collect? What are the health and safety obligations of organisations towards their volunteers? Again the TMP drew on the experience of the bird world, and has been facilitating the development of best practice in engaging volunteers and managing volunteer networks and has jointly held, with the National Biodiversity Network Trust (NBN), workshops addressing volunteer co-ordination, and health and safety issues, with a published manual as a result.

The decision taken, after much careful consideration, has been to engage volunteers and to design surveys with them in mind. The TMP owes a tremendous amount to all the volunteers who have participated in surveys and it is not unreasonable to say that the TMP could not operate without their support. We are very lucky in the UK to have such a resource and we should recognise its value and continue to support its growth and development.

1.5 Future directions

The TMP is a very young Partnership and the quality and quantity of data will improve and increase over time. Much of the information contained in the TMP First Report is incomplete and there are still many issues regarding coordination and data compatibility. The process of collecting together all the existing information on mammal population trends has highlighted where the gaps exist in species coverage and also where improvements need to be made in order to provide trend information at different geographical levels. At present there are UK trends for many species, but very few trends at country or regional level. However, the very fact of working together has enabled the TMP to identify the priority areas for future work and to collectively agree on the best way to address the problems.

Collating all the information in the TMP First Report has shown the achievements of mammal organisations in a relatively short time. It has provided an impetus for considering future uses of data, particularly combining and comparing datasets from different sources, assessing different ways of analysing data and applying the results for a variety of purposes. These issues are examined in detail in chapter 5.

2. The TMP Surveillance and Monitoring programme

2.1 Introduction

Mammals are very diverse ecologically, in terms of their spatial distribution, habitat use and reproductive behaviour. Some are very common and widespread, others are rare or have very restricted distributions. Some use a wide variety of habitats, others have more restricted habitat use. The times of mating and giving birth differ between species and will affect behaviour and also the numbers available to be seen and counted. Mammals are also very different in their level of visibility – some are very visible, *e.g.* rabbits, foxes and in certain circumstances, deer, while many of the rarer and smaller species are hardly ever seen, *e.g.* red squirrel, dormouse, wildcat. It is, therefore, not possible to use one survey method for all species.

Designing a programme of surveys to take all these factors into account and translating the information collected into meaningful results has required a great deal of discussion among experts. The TMP has taken the approach of coordinating a diverse programme of surveillance and monitoring schemes, some that collect data on a range of species and others covering individual species that require more specialist survey methods. Generally it is better to assess prebreeding populations because of the variability between years in juvenile recruitment to the population (Macdonald *et al.*, 1998) and this has meant designing surveys to target specific times of the year, depending on the species being surveyed. Historic survey information already existed for some species and has been included where appropriate. Where possible the surveys were either incorporated into the programme (*e.g.* national otter surveys, National Dormouse Monitoring Programme), the methods adapted for use in new surveillance schemes (*e.g.* brown hare surveys), or the results used to inform the setting up of new schemes (*e.g.* badger and water vole surveys).

Setting up such an ambitious programme has required a great degree of planning and the realisation that it could not be initiated at one time and would require several stages for development. Decisions had to be taken on which species were priorities for surveillance and with such a variety of organisations involved it was difficult to decide on the species that should take precedence. In the end a pragmatic approach was taken, which involved establishing surveys for the more common and widespread species that would be easier to recognise and where sample sizes would be good. Once these surveys were set up and running then the gaps in the surveillance programme could be identified and the lessons learned used to develop methods for the more difficult species.

2.2 Surveillance and monitoring approach

2.2.1 Surveillance and monitoring guidelines

Mammal surveys are often carried out in particular areas of the UK, with a variety of objectives, using different methods and timescales and operating at different geographical scales. Many surveys are also carried out locally and look at presence, or population size of a species in a given area at a particular point in time. The consequent differences in survey design mean that survey results cannot be compared very easily between regions, countries and species and, hence, opportunities to set the results in a wider context have been lost.

The TMP has recognised that an important part of coordinating a UK wide surveillance and monitoring programme for mammals involves standardising, where possible, the methods used, and data collection and management, and has developed a set of guidelines for designing surveillance schemes that are outlined below.

Area coverage. The TMP surveillance and monitoring programme aims to detect changes in population size and extent over time. Generally, it is better to cover as wide an area as possible, preferably collecting data across the whole of the UK. However, the distribution of some species is restricted to particular countries (*e.g.* fat dormouse and serotine restricted to England), some species are very rare (*e.g.* Bechstein's bat), while others have disjunct distributions (*e.g.* red squirrel, pine marten). For such species, targeted surveys at country or more local levels would be appropriate.

Geographical area and stratification. The collection of data at the UK level is designed to provide UK population trends. However, it is also desirable to provide information at regional levels and to be able to compare regional trends if possible. Regional divisions should, therefore, be standardised across surveys, but there should also be realistic expectations about the level of regional information that it is possible to obtain from a UK surveillance scheme. The TMP has agreed to provide trends for as many species as possible at a country level (England, Northern Ireland, Scotland and Wales), and for England at the level of Government Office Regions (GORs), which are now the primary classification for the presentation of regional statistics (see Figure 2.1 Plate I and *www.statistics.gov.uk/geography/gor.asp* for more information on GORs). However, it is unlikely that a survey designed to provide UK level trends would be able to provide individual county level information, because of the costs and logistical issues involved in obtaining large enough sample sizes.

Environmental Zones are an alternative, and more biologically meaningful, regional division that the TMP has also agreed to use (see Figure 2.2 Plate I). These cover the range of environmental conditions that are found in the UK, from the lowlands of the south and east, through to the uplands and mountains of the north and west and are based on combinations of the underlying sampling units, or land classes, used for Countryside Survey 2000 (CS2000) (Haines-Young *et al.*, 2000). The series of Countryside Surveys have been based upon the approach of taking a stratified sample of 1 km squares so that different types of countryside (derived from an extensive suite of physical attributes for each 1 km square in Britain to generate the classification) are represented proportionally within the survey. Use of Environmental Zones enables representative samples to be taken and increases the predictive power of the results obtained.

What is being measured? Surveillance schemes should provide data on changes in mammal distribution and abundance over time, rather than attempt the more difficult, and often impossible task, of assessing total population size at any point in time. Indirect methods should be used to provide indices of relative abundance and population change in place of direct counts. A stratified random sampling design should be used where possible. The TMP has agreed to adopt the Amber (25% over 25 years) and Red Alert (50% over 25 years) levels, used for UK birds as significant levels of decline (Gregory *et al*., 2002). Surveys should aim to detect at least Red Alert declines, but preferably Amber as well. Conversely, surveys should be able to detect the same levels of population increase, which is particularly important for producing effective management policies for problem species.

Assessing the methods. Surveys should have a pilot phase, where surveillance and monitoring methods are being tested and developed and should include features such as testing for survey bias and assessing survey power etc., before they become part of the established surveillance and monitoring programme.

Statistical power of the survey. The power of a surveillance scheme is the ability of the scheme to identify correctly an ongoing population trend and is expressed as the percentage chance that a particular design will detect a trend of the specified magnitude. Power is influenced by many factors, including the size of the population trend, between year population variation, the number of years of data, frequency of surveillance, the number of sites surveyed, proportion of samples with the species present and sampling error. The power of surveillance schemes should be analysed in the pilot phase to assess the level of information and degree of certainty that a scheme can deliver. Sample sizes and, therefore, the level of certainty of the results will vary for different species in the same surveillance scheme (because of differences in detectability). However, it will be important to know the power of a scheme to deliver the results at any point in time. The power of a scheme will be increased if the design includes repeating data collection at sample sites, and this should be a priority.

Survey frequency. Surveillance schemes should run annually where possible, because population change will be detected more quickly and with greater certainty, and because volunteer networks collecting the data are more likely to be maintained if engaged annually. However, for some species less frequent surveillance may be reasonably effective.

Time coverage. Surveillance schemes should run on a long-term basis, *i.e.* for decades. It is only through the collection of data over long periods of time that real declines or increases in populations can be observed and separated from the natural fluctuations that are often observed in mammal populations from year to year.

Species coverage. Schemes should provide information on as many species as possible and this particularly applies to the common, widespread and more visible species. However, some species require species specific surveys because of the degree of difficulty in obtaining surveillance data for them.

Comparison of results across years. A measure of the effort involved in data collection should be incorporated. This will either require standardising the effort used in terms of time taken, distance travelled etc. or incorporating a means of assessing the effects of different levels of effort on data collection. Standardising effort means that the results of surveys can be compared across years.

Data collection and quality. It is anticipated that the majority of schemes will involve engaging volunteers to collect data and it is important to have some way of verifying the data they provide. As a minimum, the information collected should include: species (sightings or signs), spatial reference (*e.g.* grid reference at 1 km square level or more detailed if possible), date, a measure of survey effort and the recorder's name. It is also important that schemes include some form of training and feedback of results to volunteers, as well as consideration of health and safety issues.

Data management. Data should be stored in a format that is accessible and can be maintained in perpetuity and made available to as wide an audience as possible. This will usually involve electronic data storage and access that comply with the principles of the NBN. Organisers of surveillance and monitoring schemes should have long-term (*i.e.* over decades) organisational, financial, data archiving and data supply structures in place, as far as practically possible. In particular, procedures should exist to safeguard the forgoing, irrespective of changes in personnel.

2.2.2 Research projects

Research projects are an integral part of the TMP surveillance and monitoring programme. Surveys in the pilot phase can be considered research projects because methods are being tested and refined. Research is also required to provide additional information on factors affecting the accuracy and validity of data, such as the validation and calibration of data collected by volunteers, or to design new survey methods to cover the more difficult species.

The full document on surveillance guidelines can be found on the TMP website (*www.trackingmammals.org*).

2.3 The Schemes

There are several multi-species and single species schemes operating within the TMP surveillance and monitoring programme. Some schemes have been running for five or more years and are beginning to provide information on population change, while others are still in the development phase, with methods being tested and costs, species coverage and volunteer engagement being assessed.

Survey schemes are grouped below according to species and area coverage, beginning with wider countryside multi-species schemes, followed by urban multi-species and then single species schemes. Within the groupings, schemes are in chronological order with the longest running scheme listed first.

2.3.1 Wider countryside multi-species schemes

The National Gamebag Census (NGC)

Participating organisations: the Game Conservancy Trust (GCT) and the JNCC. The NGC was set up in 1961 by GCT as a central repository of records from shooting estates across the UK, comprising numbers of game animals and predators killed annually. In 2003, the JNCC entered into a Partnership with GCT to develop the surveillance potential of the NGC, which was recognised as having some valuable data, particularly for mustelids (*e.g.* stoat and weasel). The NGC was assessed for biases in the data collection and with some planned modifications has been accepted as an established scheme. For further details on the NGC assessment see the full report (Whitlock *et al*., 2003) on the GCT website (*www.gct.org.uk/text01.asp?PageId=163*).

Methods: the GCT operates the census via postal questionnaires, mailed to members annually. Each estate contributing data has a unique identifier, based on its region and county within that region, with location recorded in six-digit British National Grid format.

Site coverage: UK wide. Between 1961 and 2001, the total number of estates contributing data to the NGC was 1,602 for game species and 1,222 for predatory species, with annual averages of 636 and 364, respectively. In comparison with other monitoring schemes, the sample sizes are large for species that are difficult to detect by conventional survey methods. Geographical coverage of the NGC is wide. Data can be extracted at country, regional or county scales, or mapped using British National Grid references. Coverage was highest in south-east England (14% of estates), north-east England (11%), East Anglia (15%) and Scotland (25%); it was lowest in Northern Ireland (1%) and Wales (5%). By area, NGC estates cover 5% of the UK, varying regionally from 15% in eastern Scotland to under 1% in the Midlands and Northern Ireland.

Species coverage: species assessed in the NGC report: rabbit, grey squirrel, common rat, fox, stoat and weasel. Other species potentially covered by the NGC: mountain/Irish hare, brown hare, mink, red deer, sika deer, roe deer, fallow deer and muntjac.

Survey power: the statistical power of the NGC to detect temporal change was estimated for notional declines over 25 years of 10%, 25% and 50% in weasel bags from south-east England. The power to detect a 50% decline was over 98% from sample sizes of 40 estates or more. For a 25% decline, power exceeded 80% for sample sizes greater than 130. There was no power to detect a decline of 10% within the range of sample sizes considered (1–133). This compares favourably with the power of other mammal monitoring schemes.

The Breeding Bird Survey (BBS) – Mammal data

Participating organisations: British Trust for Ornithology (BTO), Royal Society for the Protection of Birds (RSPB) and the JNCC. The BBS is a national survey that monitors the populations of common and widespread bird species in the UK. The BBS started in 1994 after two pilot years in 1992 and 1993. Between 1994 and 2000 the BBS ran alongside the Common Bird Census (CBC), until replacing it in 2001. In 1995, observers were also asked to record mammals (voluntarily). The BBS surveys over 2,000 randomly selected 1 km survey squares across the UK, from the Channel and Scilly Isles in the south to Shetland in the north.

Methods: stratified random sampling. 1 km survey squares are randomly selected within BTO regions by computer. Volunteers are asked to make two visits to their survey square each year, generally between early April and the end of June. Each visit involves walking a 2 km transect and recording all the birds heard or seen in three distance categories from the transect line. Volunteers also record habitat details on the first bird count visit, or if it is the first year a site has been surveyed, on a separate visit. On the two bird count visits, mammal species seen are also counted. Additional mammal species are also noted if:

- Field signs are seen during the two visits (*e.g.* badger setts, droppings/scats, hair, etc.)
- Dead animals are seen on the two bird count visits
- Other species are seen or heard on additional visits to that square during that fieldwork season
- Additional local knowledge suggests the species is present, *e.g.* from farmers or gamekeepers, etc.

Site coverage: UK wide. Mammal data have been collected from a mean of 1,791 1 km BBS squares between 1995 and 2002.

Species coverage: a total of 52 mammal species were recorded on BBS squares from 1995–2002. Population trend indices from sightings of animals can be obtained for nine species including: rabbit, brown hare, mountain/Irish hare, grey squirrel, fox, red deer, fallow deer, roe deer and muntjac. Changes made to the survey form in 2000 mean that it should be possible in the future to obtain population trend information for an additional six species using presence/absence data from signs including: hedgehog, mole, common rat, stoat, weasel and badger.

Survey power: data are sufficient to produce population trends at UK and country levels for all listed species and at Government Office Regions and Environmental Zones for five species: rabbit, brown hare, grey squirrel, fox and roe deer. Power analyses indicated that changes of 25% or more could be detected for mole, rabbit, brown hare, grey squirrel, fox and roe deer. Changes of 50% or more could be detected for hedgehog, mountain hare, common rat, stoat, weasel, badger, red deer, fallow deer and muntjac. Two full BBS reports (Newson & Noble, 2003; 2004) are available in pdf format on the TMP and BTO websites (*www.trackingmammals.org; www.bto.org*).

The National Bat Monitoring Programme (NBMP)

Participating organisations: The Bat Conservation Trust (BCT) and JNCC. Additional funding received from the People's Trust for Endangered Species (PTES) and the Environment Agency (EA). The NBMP pilot was established in 1996 by BCT, with funding from the then DoE, and was aimed at developing a volunteer network-based strategy to monitor bat population trends at a UK level. The NBMP has been operating as an established surveillance programme since 2000, with core funding provided by JNCC, and aims to eventually provide population trend information for all UK resident bat species.

Methods: the NBMP currently uses three methods to monitor bat populations, but is always investigating new surveillance methods in order to incorporate the more difficult and rarer species into the programme.

Field transect surveys. All UK resident bat species exclusively feed on a variety of insect prey. They navigate through the open countryside and detect their prey by emitting high frequency sounds, known as echolocation. These sounds can be made audible to the human ear using electronic bat detectors and in some cases the calls are very characteristic and the species can be easily identified. In the field surveys, trained volunteers are asked to visit randomly selected 1 km squares across the UK with a bat detector, and record when, where, how many times and which species they hear. For Daubenton's bat, a species known to forage predominantly over water, 1 km transects are selected along water courses and torches as well as bat detectors are used for species identification. This is the most statistically robust of the three methods, because the sites are randomly selected and because there has been some testing of the data that have been collected, using different types of detector to validate the results. It is also the most difficult of the three surveys and requires a high degree of skill. For these reasons, sample sizes are smaller than for the other two methods and the turnover of volunteers participating is quite high. However, the results from this survey are very encouraging and sample sizes are large enough to detect population changes.

Hibernation survey. Bats hibernate during the winter months and skilled volunteers are asked to count the bats in known hibernation sites across the UK on two occasions between December and February. This is a non-random survey and may not be representative of the total population, but the survey is easy to carry out and sample sizes are relatively high. Furthermore, hibernation site data have been collected for many years, before the NBMP was set up, and there is great value in collating and analysing the data and comparing the results with the other methods being used.

Colony survey. Bats (mainly groups of females) tend to form maternity colonies during the summer months in order to give birth and raise their young. Many of the known roost sites are in occupied buildings and volunteers are asked to count the bats during evening emergence from these sites across the UK in May and June. The intention is to obtain a maximum count of adults in the colony before the females give birth. It is not a random selection of sites and may present similar problems to those of the hibernation survey.

Site coverage: UK wide. Table 2.1 gives full details of the surveys run by the NBMP across years and countries, including start date for the survey, total number of sites covered in each survey, the mean annual coverage across all years and the number that have been surveyed in more than one year. Sites that have been surveyed in more than one year can be used in the statistical analyses for population trends, so effectively provide the real sample sizes.

Species coverage: the NBMP is collecting data on 11 of the 16 UK resident species and has good population trend data for 9 species. Population trends, where available, are reported in the species status section. Table 2.2 gives details of species coverage by scheme.

Survey power: power analysis of the survey results indicated that in the majority of surveys a minimum sample of 40 sites, with presence of the species in question, was required annually to provide the required monitoring sensitivity at the UK level, *i.e.* the ability to detect declines of 25% over 25 years. This sample size would also be required at each level of stratification, *i.e.* 40 sites in each country, GOR and Environmental Zone. At present, all surveys have sample sizes large enough to provide UK level Red and Amber Alert declines. The majority of surveys have large enough sample sizes to provide Red Alerts at the country level for England, but most surveys do not have the required samples sizes for Northern Ireland, Scotland or Wales. At present, sample sizes are generally too small to provide GOR and Environmental Zone analyses. This situation should improve as more years of data are added to the time series dataset.

More detail on the NBMP is provided in two reports (BCT, 2001; 2004), which are available to download from the BCT or TMP websites (*www.bats.org.uk; www.trackingmammals.org*).

Waterways Breeding Bird Survey (WBBS)

Participating organisations: BTO and the Environment Agency (EA). The WBBS commenced in 1998 as a pilot scheme designed to assess trends in bird populations in riparian habitats. As with the BBS, observers were asked to record other species, including mammals, on a voluntary basis.

Table 2.1 NBMP Survey Schemes – Summary information

		SITES											
		UK				England		Northern Ireland		Scotland		Wales	
SURVEYS	**Start year**	**Total network**	**More than 1 year**	**Mean annual**	**Mean annual % turnover**	**Total**	**Mean annual**	**Total**	**Mean annual**	**Total**	**Mean annual**	**Total**	**Mean annual**
Field surveys													
Noctule, Serotine and Pipistrelle (NSP)	1998	479	196	155.5	30.4	343	120.0	3	0.5	99	25.8	34	8.8
Daubenton's	1997	863	301	205.3	41.9	627	157.3	7	1.3	147	31.9	82	14.7
Hibernation	1997	379	310	218.7	15.2	310	185.7	0	0	17	5.3	52	27.7
Total		**1721**	**807**	**579.5**	**29.2**	**1280**	**463.0**	**10**	**1.8**	**263**	**63.0**	**168**	**51.2**
Colony counts													
Lesser horseshoe	1997	187	131	88.1	25.9	85	26.1	NP	NP	NP	NP	102	62.0
Natterer's	2000	54	36	38.3	25.5	49	32.7	0	0	5	2.7	3	3.0
Serotine	1997	98	59	40.7	30.2	98	40.9	NP	NP	NP	NP	NP	NP
Common pipistrelle	1997	240	186	116.4	24.7	186	87.4	2	1.6	42	21.1	9	6.3
Soprano pipistrelle	1997	169	147	84.3	22.6	93	46.0	6	3.7	53	26.4	17	8.1
Brown long-eared	2000	74	46	47.0	39.6	50	29.3	3	2.7	18	12.7	3	2.3
All colonies		**822**	**605**	**414.8**	**28.0**	**561**	**262.4**	**11**	**8.0**	**118**	**62.9**	**134**	**81.7**
All surveys		**2543**	**1412**	**994.2**	**28.6**	**1841**	**725.4**	**21**	**9.8**	**381**	**125.9**	**302**	**132.9**

NP = Not Present

Table 2.2 Surveillance methods used for UK resident bat species

	NBMP Survey methods			
Bat species	**H**	**NSP**	**D**	**CC**
Greater horseshoe	X			
Lesser horseshoe	X			X
Daubenton's	X		X	
Brandt's	X			
Whiskered	X			
Bechstein's				
Natterer's	X			X
Common pipistrelle		X		X
Soprano pipistrelle		X		X
Nathusius' pipistrelle				
Serotine		X		X
Noctule		X		
Leisler's				
Brown long-eared	X			X
Barbastelle				
Grey long-eared				

Key: H = hibernation sites; NSP = Noctule, Serotine and Pipistrelle survey; D = Daubenton's field survey; CC = colony counts

Methods: the WBBS uses a random sampling design, allowing WBBS results to be treated as representative of waterways across the UK. For this, 2 × 2 km squares (tetrads) were initially selected at random from all 2 × 2 km squares that make up the National Grid, discarding squares with no waterway running through them. The term 'waterways' here includes rivers, canals, stretches that could be defined as both river and canal, and various ditches and drains of 6.5 metres wide or more. For each randomly selected waterway, a map is prepared showing the boundaries of the random tetrad and the selected waterway is identified on the map with a highlighter. The survey is coordinated at BTO headquarters through a network of volunteer Regional Organisers who are responsible for the volunteer observers in their region and whose job it is to match each site to an observer. The start and end points of the survey within the highlighted length of waterway are not pre-set, but are left up to the observer to determine, although it is required that a whole number of 500 m transects is surveyed. The WBBS method is derived from that of the BBS, in which two bird/mammal recording visits are made between April and June (Noble *et al.*, in prep.). WBBS visits are timed to start between 06.00 and 07.00 hours. Visits during heavy rain, strong winds or poor visibility are discouraged. The transect route is divided into ten sections of fixed length (500 m). During each visit, all mammals detected from the transect line (*i.e.* following the waterway) during the two bird counts are counted and recorded. Records included sightings of mammals and presence of species from dead animals, field signs *e.g.* tracks, scats, mole-hills, local knowledge of presence for that year from a gamekeeper or landowner or live animals seen on additional visits to the stretch during that season.

Site coverage: GB since 1998. Mammal data were collected from a mean of 181 stretches of waterway from 1998–2003.

Species coverage: observers recorded sightings of 28 mammal species. Sample sizes, based on counts, were large enough to produce temporal trends in abundance for four species: rabbit, brown hare, grey squirrel and roe deer. Data were only sufficient to produce regional/country trends for England for three of these species: rabbit, brown hare and grey squirrel. Observers recorded the presence of 34 mammal species. Ten species had large enough sample sizes to model the change in presence on WBBS stretches: hedgehog, mole, water vole, common rat, fox, stoat, weasel, mink, badger and otter.

Survey power: survey power varied between species, depending on sample sizes. Rabbit was recorded on about 70% of stretches surveyed, and with these sample sizes a 16% change between two years should be detectable. Mole, brown hare, grey squirrel and fox were recorded on 30–50% of stretches, with the power to detect a 23–33% change. Roe deer was recorded on about 25% of stretches, giving power to detect a change of about 37%. Hedgehog, common rat, stoat, weasel, badger and red deer were recorded on 10–15% of stretches, and only large declines of about 48–58% would be detected.

More detail on the results of this survey scheme are available in a report by Newson *et al.* (2005), which can be viewed on the BTO and TMP websites (*www.bto.org; www.trackingmammals.org*).

Winter Mammal Monitoring (WMM)

Participating organisations: BTO and The Mammal Society with funding from Defra. A pilot survey from 2001–2004, including three field seasons. The remit of the pilot was to design and test a volunteer-based winter transect survey of mammals in the UK. The two components, a sightings survey and a signs survey, were both tested to assess the value of winter surveillance of mammals, because at this time they are more visible and, therefore, more likely to be seen. Assessment included: sample sizes obtained, species coverage, regional differences in species distribution, survey power and volunteer involvement.

Methods: volunteers were asked to make two visits during the winter months, to randomly selected 1 km squares in the countryside and walk a 2 km line transect recording sightings (first visit) and signs (second visit) of mammals. Volunteers were also asked to record broad habitat features so that relationships between mammal presence and habitat type could be assessed (Figure 2.3 Plate II).

Site coverage: UK wide. From 2001–2003 sample sizes were as follows: 803/490/301 for sightings, 455/402/240 for signs. If both components are combined then there were 880/537/323 sites surveyed across the three years.

Species coverage: *sightings survey*. Forty three species/groups of which 32 identified species were recorded. The sample sizes achieved in this survey indicate that for three species (feral cat, roe deer and grey squirrel) a halving or

doubling could be detected with a high degree of confidence. For another two species (brown hare and rabbit) a 25% increase or decrease could be detected with a high degree of confidence.

Species coverage: *Field signs survey*. Eight signs were recorded belonging to seven species. The sample sizes achieved in this survey indicate that a halving or doubling in signs of badger, common rat or foxes, and a change of 25% in signs of mole, rabbit, harvest mouse and field vole could be detected with confidence. Sightings and signs surveys are largely complementary in terms of species coverage, with six species being recorded in both, and only one (harvest mouse) being recorded solely in the field signs survey. Comparison with single species national surveys revealed higher detection rates in dedicated surveys but overall patterns of abundance were similar.

Survey power: this is being assessed at present.

Mammals on Roads (MOR)

Participating organisations: the People's Trust for Endangered Species (PTES), Royal Holloway, University of London (RHUL) and JNCC. Mammals on Roads is a pilot project running from 2000–2005, to assess the power of the survey method to detect population change for a number of target species. The pilot is also assessing the relationship between numbers of particular species killed on the roads, the abundance of those species in various habitats and the effects of species behaviour and microhabitat features on road kill numbers.

Methods: volunteers were asked to count mammals seen on at least 20 mile stretches of road during July, August and September. For safety and accuracy reasons, volunteers were asked not to carry out the survey on motorways, dual carriageways or at night time. Urban areas were also not included because of the requirements of the survey method, but also because urban mammal populations may behave differently with regard to roads than those in the wider countryside. Location was recorded at the start and the end of each journey and at every junction. Volunteers were also asked to take a milometer reading every 10 miles. Several calibration exercises were carried out to assess the rate of decay of corpses of various species; the time lapse required before repeat journeys along the same stretches of road could be included in the dataset; and the relationship between abundance of species in the wild (*e.g.* rabbits) and road kill numbers.

Site coverage: Great Britain. A mean of 469 volunteers took part in the survey from 2001–2003. A mean of 1,774 valid journeys and a mean total of 108,050 valid km were driven each year during that period.

Species coverage: 39 species were recorded during three field seasons, 2001–2003, with a mean total of 9,983 mammals seen each year. However, only five species were seen frequently enough to provide sample sizes for population trend analysis: hedgehog, rabbit, grey squirrel, fox and badger.

Survey power: this is currently being assessed.

VWT Polecat and Mink Abundance Monitoring

Participating organisations: The Vincent Wildlife Trust (VWT). There is evidence that the status of the polecat in Britain is changing as the species spreads from its western stronghold (Birks & Kitchener, 1999). Polecats are vulnerable to road traffic accidents, and these are a potential source of abundance data. In 2001, the VWT carried out a pilot road kill study in Wales and north-west England, during which volunteers recorded 44 polecats from a total of over 64,500 km driven [the total of km driven, with a strong bias towards Wales, is much higher in 2002 & 2003]. The present study, which is intended to run annually, has grown from the pilot exercise and now includes mink.

Methods: recording of polecat and mink road casualties during September and October. Volunteers are asked to record their name, home six-figure grid reference, mileage driven (with a breakdown by region in England), and where and when they see polecat and mink road casualties while out driving. Negative returns are as important as positive ones. Clear survey guidelines are provided, with some information on corpse identification and how to distinguish between polecat, feral ferret and mink.

Site coverage: Great Britain. 186 recorders are registered for the scheme with 116 returning data in 2002 and 117 in 2003. Recorders covered 501,754 km in 2002 and 449,248 km in 2003 over the two target months, with a strong bias towards Wales, but with some coverage in other areas of GB.

Species coverage: the three target species were recorded in both 2002 and 2003, with a mean of 150 polecats and 26 mink across both years. Three feral ferrets were recorded in 2002, with none in 2003.

Tracking Elusive Mustelids (TEM)

Participating organisations: PTES, RHUL and JNCC. There is no comprehensive monitoring scheme for the smaller mustelid species, especially the rarer protected species such as polecat and pine marten, but data are also patchy and variable for stoat, weasel and mink. This short pilot scheme ran for one field season in 2004 with the aim of trialling the use of footprint tracking and hair sampling tunnels as a monitoring method for this group of species.

Objectives: to modify the tracking tunnel design developed by the Game Conservancy Trust to produce inexpensive equipment for use by volunteers; to develop a protocol for digital capture of track images; to develop and test field sampling methods using tracking tunnels; and to develop digital biometric and statistical methods to automate the identification of tracks.

Site coverage: trials in southern England and Scotland.

Species coverage: potentially, pine marten, stoat, weasel, polecat and mink.

Deer Surveys

Participating organisations: British Deer Society (BDS), Central Science Laboratory (CSL), The Deer Initiative

(DI), British Association for Shooting & Conservation (BASC), Forestry Commission (FC) and Deer Commission for Scotland (DCS). The British Deer Society (BDS) is a registered charity dedicated to the welfare and humane treatment of deer in Britain and it conducts research and educational programmes to further the aims of the Society. In order to promote the welfare and humane treatment of deer species it is important to know the distribution and abundance of each species. The BDS plans to collect this information during the Great British Deer Survey 2005, which is being undertaken in close cooperation with CSL and the other members of the TMP. Two previous national deer surveys have been carried out by the BDS, in 1969 and 1998–2000, assessing the distribution of deer species across the UK at a 10 km square level. However, apart from these surveys, there have been no other systematic surveys of deer distribution, densities or population trends. The Great British Deer Survey 2005 has been designed to provide important information about wild deer populations in the UK. However, unlike previous surveys, BDS would like to collect a lot more information than simply the presence of animals within 10 km squares, including identifying trends in age-class and sex ratio distributions within the ranges of British deer and determining whether each observation represents a resident population, an occasional route used by some species or a one-off escapee or release of a single animal. This information will help in the understanding of how and why British deer are distributed in the way that they are. In order to achieve these aims it is proposed to carry out a national Great British Deer Survey every five years, with the intervening period being given over to an annual surveillance scheme, the Deer Density and Trends Survey, which will assess population density and trends.

Objectives: to establish presence or absence at a 10 km square level, of each of the six species of deer living wild in the UK; to qualify the status and quantify age-class distribution and sex ratio of observations; and to assess population trends of all deer species at different geographical levels.

Methods: the Great British Deer Survey 2005 will use trained and practised observers of deer, and to a limited extent, members of the general public, to record presence or absence of each of the 6 species of deer in each 10 km square within the UK. The 2006–2009 Deer Density and Trend Survey will use only trained and practised deer observers to record, over a period of years, numbers of each species and the changes that occur to those numbers within defined areas. This will provide the basis of modelling work by CSL to give accurate estimates of numbers and trends within the deer population of the UK.

Site coverage: UK. Also country level; England, Northern Ireland, Scotland and Wales. Every 10 km square searched for presence/absence of deer species.

Species coverage: Red deer, sika deer, fallow deer, roe deer, muntjac and water deer.

Survey power: the Great British Deer Survey 2005 will provide data across the UK at the 10 km square level. The Deer Density and Trends Survey, which is still in the development phase, will be designed to provide adequate data for accurate modelling of total population size and positive or negative population trends.

In addition to the planned deer surveys, there is the **Deer Collisions Project**, which is a research project, overseen by the Deer Initiative, looking into deer related Road Traffic Accidents (RTAs). The research is being funded by the Highways Agency and the Scottish Executive, together with the Woodland Trust, the National Forest Company, and the Deer Study & Resource. The research intends to develop for the first time a well stratified, nation-wide system for collection of standardised information on deer related RTAs from all relevant sources throughout Great Britain. The **objectives** include: ascertaining the level of deer related RTAs in differing regions and land classes in Britain; and exploring any underlying differences in frequency of accidents. The project is acting as a pilot and evaluation for a longer-term deer RTA monitoring program, and its possible extension to encompass RTAs with other wildlife. The latest distribution map is shown in Figure 2.4 (Plate II). The project has received over 12,000 records of deer and vehicle collisions or deer found dead at the roadside since January 2000. The map identifies UK 'hot spots' for deer collisions, but the lack of data in Wales could be due to low recording effort (Wales Deer Initiative, 2004).

2.3.2 Urban multi-species schemes

English House Condition Survey (EHCS)

Participating organisations: CSL and Department for Environment, Food and Rural Affairs (Defra). The English House Condition Survey (EHCS) is the only dwelling-based survey undertaken in England. Data on the infestation of dwellings by commensal rodents were collected for the first time during the 1996 EHCS and analysed by CSL. The rodents concerned were the house mouse and the common rat. House mouse infestations inside properties and common rat infestations both inside and outside were considered. A repeat survey was carried out in 2001.

Methods: the practical aspects of the commensal rodent element of the overall survey were undertaken during a 10 week period between April and July 1996. A physical survey of dwellings was carried out by approximately 100 professional surveyors, trained in detecting signs of rodent infestation.

Site coverage: England only. Approximately 12,000 properties surveyed.

Species coverage: house mouse and common rat. The analyses of the 2001 EHCS commensal rodent data are completed and the report will be placed in the public domain by Defra. This will offer the first objective view of recent trends for commensal rodent populations. The EHCS was re-organised as a continuous survey from financial year 2002/3. First results from this survey will be available from end 2004 and will be based on data from the

period 2002 and 2003. In future years, annual results will be available based on rolling combinations of two year data sets (*i.e.* next results will be available by end 2005 based on the period 2004 and 2005). This approach will provide a robust base for analysis and monitoring of change. Further information can be found in MAFF (1999) and Langton *et al.* (2001).

Garden BirdWatch (GBW)

Participating organisations: BTO and CJ WildBird Foods. The BTO/CJ Garden BirdWatch was expanded in 2003 to trial the collection of information on presence-absence of a range of mammals, butterflies, amphibians and reptiles.

Methods: volunteers are asked to record the presence of birds, mammals and other species in their garden throughout the summer months.

Site coverage: UK wide. In the pilot survey of 2003 over 8,000 survey forms were returned. In 2004 over 4,000 were returned by post and over 2,000 were recorded online. It is expected that this survey will have a sample size of approximately 6,000 sites per annum in the future.

Species coverage: 23 species were recorded, 19 of which have sufficient information for monitoring purposes. These include hedgehog, mole, common shrew, pygmy shrew, rabbit, brown hare, red squirrel, grey squirrel, bank vole, field vole, wood mouse, yellow-necked mouse, house mouse, common rat, fox, badger, roe deer, muntjac and cat. There was some variation in the confidence of observers to identify different species. Observers felt most confident to identify hedgehog, mole, rabbit, brown hare, red squirrel, grey squirrel, common rat, fox, badger and cat. They were least confident in identifying common and pygmy shrew, bank and field vole and yellow-necked mouse. Therefore, while this survey has the potential to provide information on small mammals, the ability of observers to identify correctly individual small mammal species may affect the results.

Survey power: a formal analysis was carried out to examine the level of statistical power to detect specified levels of change in the occurrence of non-avian species recorded by GBW. This was used to identify which species could be monitored adequately by this survey, to identify 'important' levels of population change and to determine the level of change that could be detected in these species at national and regional scales. Two approaches were used (one 'matched' and one 'unmatched') to examine the relationship between the power to detect a specified decline, the starting proportion of occupied gardens and sample size. The results of the 'unmatched' analysis show that GBW has adequate power to detect a decline in presence of 5–40% at a national level for nine of the 23 target mammal species (hedgehog, mole, rabbit, grey squirrel, wood mouse, house mouse, common rat, fox and cat). There were just four mammal species (otter, pine marten, water shrew and fat dormouse) for which there was not adequate power to detect a 'useful' decline in presence at the national level (defined here to be a decline of 50% or more). Examining power at a regional/country level, suggests that it should be possible to detect a 'useful' level of decline in presence for a large proportion of the species that can be monitored at the national level. The results from the 'matched' analysis are very similar to the 'unmatched' design at the national level.

Living with Mammals (LWM)

Participating organisations: PTES/Mammals Trust UK (MTUK) with scientific input from RHUL. A pilot scheme, launched in 2003, aimed at producing indices of mammal abundance near built land (not only in gardens), mainly in towns but also in the countryside.

Methods: volunteer surveyors were asked to record the maximum number of each mammal species seen together at a site each week between April and June. Volunteers were provided with a small booklet of information on UK mammals to aid identification.

Site coverage: Great Britain. In 2003, data from 808 survey forms were analysed. Of these, 792 (98%) recorded the presence of at least one wild mammal species.

Species coverage: 24 species or groups of species (*e.g.* bats) were recorded, including a number of protected species and some of high conservation concern such as water vole (see Figure 2.5). Results suggest that population trend information could be obtained for at least eight species including: hedgehog, mole, rabbit, grey squirrel, common rat, feral cat, fox and badger.

Survey power: the power of the survey to deliver population trend information has not been fully assessed and will require several more years of data. A full report on the first year of *Living with Mammals* is available on the TMP website (Carter *et al.*, 2003. *www.trackingmammals.org*).

Mammals in Your Garden? (MIYG?)

Participating organisations: The Mammal Society. A questionnaire based survey, first carried out by The Mammal Society in 2002, with the aim of assessing the use of gardens by mammals. Over 4,000 volunteers took part and were requested to return their forms by the end of 2002. The data from this pilot year are currently being analysed. The Mammal Society is planning on running this project again and volunteers will be asked to fill in the short questionnaire twice a year. The questionnaire has been adapted to enable the monitoring of numbers of mammals in gardens across the UK. Participants will also be asked for information regarding the occurrence of house mouse and common rat in their homes and gardens.

2.3.3 Single-species schemes

National Otter Surveys

A series of national otter surveys was initiated in 1977–78 in response to a growing concern for the status of the otter in the UK (O'Connor *et al.*, 1977). The surveys have been carried out at approximately seven year intervals at a country level, with four surveys now completed in England and Wales. The fourth survey is underway in Scotland and two

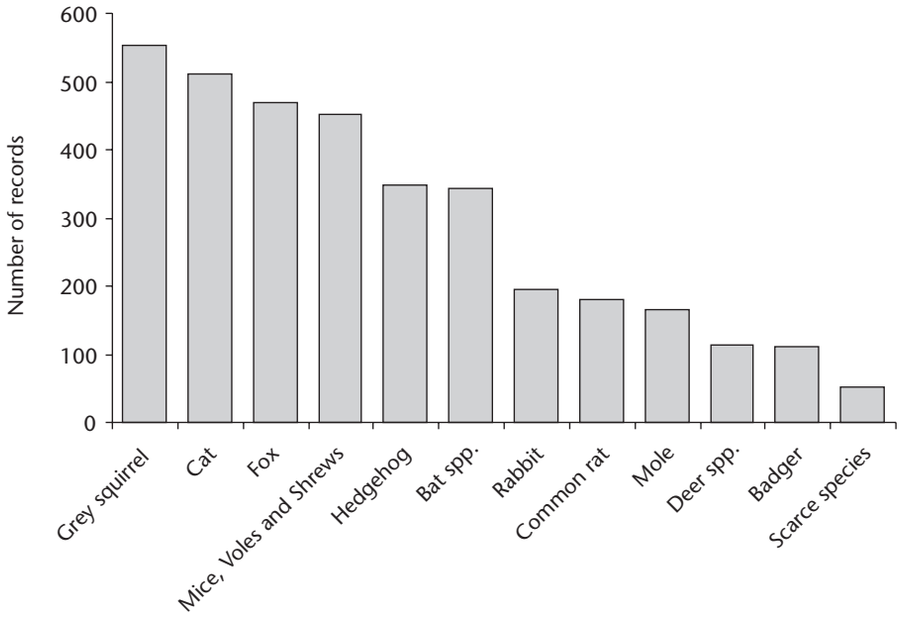


Figure 2.5 Species recorded in the Living with Mammals survey

surveys have also been carried out in Northern Ireland during that time. The aim of the surveys was to monitor changes in otter distribution over time. A further aim, since 1995, has been to assess whether otter Biodiversity Action Plan (BAP) targets on population spread were being achieved. These surveys have predominantly used paid and fully-trained surveyors to carry out the work, with the surveys usually taking two years to complete. This set of repeated surveys provides the best historical data set for any mammal species in the UK and provides a clear illustration of changes in the distribution of otters across the UK.

Participating organisations: The surveys have been run and funded by a variety of organisations, listed here under the respective countries.

England: the fourth survey (2000-02) was run by the Environment Agency (EA) and the Wildlife Trusts and funded by the EA, English Nature (EN), Water UK, Biffaward and local water companies. The third survey (1991–94) was run and funded by the VWT. The first and second surveys (1977–79 and 1984–86) were run and funded by the former Nature Conservancy Council (NCC).

Scotland: the fourth otter survey of Scotland is completed and a report should be available in 2005. It was run and funded by Scottish Natural Heritage (SNH), with a funding contribution from Scottish Water. The first (1977–79), second (1984–85) and third (1991–94) surveys were run and funded by the VWT.

Wales: the fourth survey (2002) has been completed. The survey was run by the EA and the Wildlife Trusts and was funded by the EA, Countryside Council for Wales (CCW) and Welsh Water. The second and third surveys (1984–85 and 1991, respectively), were run and funded by the VWT. The first survey (1977–78) was run and funded by the NCC.

Northern Ireland: the second otter survey of Northern Ireland was completed in 2003 and was funded by the Environment and Heritage Service (EHS). The first otter survey of Ireland (1980–81) was run and funded by the VWT.

Methods: the standard otter survey method was used, following that adopted by Lenton *et al*. (1980). The method involves walking 600 m transects along river banks in each 1 km square site, situated at 5–8 km intervals, along main rivers and coast or lake shores. Surveyors look for otter spraints (droppings) and also for signs of mink. The method adopted varied slightly between surveys; surveyors were required to walk the full 600 m in some surveys, whereas in others they were asked to stop as soon as otter spraints were found. This means that mink data were only collected in some surveys, resulting in rather patchy and not necessarily reliable information.

Site coverage: UK wide, carried out separately in the four countries, using a stratified sample of sites across the UK, following a stratification of the National Grid. Surveys were conducted at the 10 km square level, and sites were not randomly selected, so the surveys are best regarded as providing information about distribution at the 10 km square level. Within each 10 km square, sites to be visited were selected as being accessible and likely places to find signs of otter activity, typically road bridges and the confluences of watercourses. In England, every 10 km square in alternate 50 km squares was surveyed. In Scotland every 10 km square was covered in the first survey, with a reduced sample in the second and third surveys. The fourth survey covered a subset of the original sites, rather than the whole country, based on recommendations for reducing site coverage while retaining survey power (Brewer *et al.,* 2002). In Wales every 10 km square has been covered in all four surveys. In the most recent surveys, 3,327 sites were covered in England, approximately 1,363 sites in Scotland (exact figures will be available in the survey report to be published in 2005), 1,097 sites in Wales and 622 sites in Northern Ireland.

Survey power: this series of national level surveys was not originally designed to provide population trend information, but to provide presence/absence data and measure the rate of change in the distribution of the species over time. The report by Brewer *et al.* (2002) recommended a stratified sampling approach for the fourth survey of Scotland that would detect a 25% decline in otter distribution with 90% power. A *Life in UK Rivers* report (Chanin, 2003) on monitoring otters in protected sites made recommendations for assessing population trends rather than distribution change and was produced for monitoring otter populations in Special Areas of Conservation (Natura 2000 sites).

Details of the fourth English survey (Crawford, 2003) and the fourth Welsh survey (Jones & Jones, 2004) can be found on the EA website (*www.environment-agency.gov.uk/subjects/conservation/483249/?version=1&lang=_e*). Details of the most recent survey of Northern Ireland (Preston *et al.,* 2004) can be found at the EHS website (*www.ehsni.gov.uk/pubs/publications/otterreportNov2004.pdf*). The data from the surveys are available through the NBN Gateway at: *www.searchnbn.net.* A full list of otter survey reports can be found in the References (p. 102) and on the TMP website (*www.trackingmammals.org*).

National Dormouse Monitoring Programme (NDMP)

Participating organisations: PTES, RHUL and EN. The distributional range of the common dormouse declined by about 50% in Britain during the 20th Century (Morris, 1993). The NDMP was set-up in 1991 with the aim of monitoring changes in dormouse abundance. The survey covers a wide range of sites where the species is known to exist.

Methods: annual surveillance of dormouse sites across the known range of the species in GB since 1991. Trained and licensed volunteers are asked to check at least 50 nest boxes in each site during a 10 day period each month, commencing in May and ending in October. As a minimum, nest boxes are checked in June and October. Volunteers collect information on number of dormice seen in each nest box and body weight, sex, breeding condition and whether individuals are active or torpid. Volunteers and data are coordinated centrally by PTES. The survey assesses annual variation in breeding success and changes in population density across habitats and regions.

Site coverage: England and Wales. There are now 243 sites registered in the NDMP and approximately 477 volunteers participating each year, covering about 25% of known dormouse sites in Britain. In 2003, 159 sites returned data. The network will be increased to around 300 sites in the near future to include sites in Forest Enterprise conifer plantations.

Survey power: the sample sizes are large enough to detect Amber Alert changes (25% over 25 years) nationally and Red Alert (50% over 25 years) regionally (Sanderson, 2004). Volunteers are also being asked to record all other small mammal species seen in the nest boxes and if possible count, sex and weigh the specimens, as for the dormouse. Data from this additional survey are currently being assessed.

Monitoring Water Voles at National Key Sites

Participating organisations: PTES, RSPB, EA and EN. This project aims to select a number of nationally important areas for water voles (many are National Nature Reserves – NNRs), make sure they are being managed correctly and institute long-term monitoring. Associated scientific studies will look at why the water voles in these areas do not appear to fall 'victim' to mink and also look at ways of extending the water vole populations into the surrounding areas.

Methods: at each site a minimum of 12 and a maximum of 24 100 m transects have been selected, distributed as evenly as possible across the site. Each transect begins or ends at a recognisable landmark, so it is possible to monitor the same transects each year to obtain an index of water vole abundance based on latrine counts. A transect covers one bank/edge only of a water body and is searched metre by metre for latrines and other signs of water vole activity, which are recorded on a standard data sheet. Evidence of mink and otter are also recorded. A water vole latrine is defined as an area that has been used to deposit droppings on more than one occasion (*i.e.* consisting of old and fresh droppings). Latrines are also categorised as "trampled" or "untrampled". Droppings, latrines and feeding remains are classed as active signs; burrows alone are classed as non-active signs, because empty burrows may persist for some years after they cease to be occupied. Surveyors are also asked to record any significant changes in management between years. Comparisons of water vole abundance between years at each site are based on percentage site or transect occupancy and indices of abundance. Indices of abundance are calculated using the widely used regression equation $y = 1.48 + 0.638x$, where y = number of water voles and x = number of latrines (Morris *et al.*, 1998).

Site coverage: there are currently 14 National Key Sites throughout England and Wales. All sites fulfil the following four criteria: they are a known and probably sustainable refuge from mink; are likely to be major sources of water voles to recolonise surrounding areas; currently have habitat quality that is near optimal for water voles or where management could quickly be adjusted to make it so; and have long term secure land tenure, habitat management and (if needed) mink control.

Survey power: Not assessed at present.

The Mammal Society's Water Shrew Survey (WSS)

Participating organisations: The Mammal Society, with funding from EA. This pilot study (2004–2006) now has over 1,000 volunteers involved. The main aim of the survey is to increase knowledge of water shrew distribution with the ultimate aim of establishing a monitoring scheme for this species. Further aims include establishing habitat requirements and preferences of water shrews, with the intention of producing habitat management guidelines and producing a database of records to assess the

conservation needs of the species. Volunteers are also being asked to search their chosen sites for harvest mouse nests during the winter survey season.

Methods: volunteers are asked to go to sites of their choice during the summer (July–September) and during the winter (December–April). Baited tubes (20 cm lengths of waste pipe baited with casters) are placed among bankside vegetation. The tubes are collected after two weeks and any scats found are collected and returned to The Mammal Society for identification. Volunteers are asked to survey four or more sites within each survey period, recording habitat information at each site. Negative sites are being noted as well, but are not being treated as 'confirmed absence', and survey effort is being noted (Figure 2.6 Plate III).

Site coverage: results from the first two survey seasons are encouraging. Over 1,000 sites have been surveyed, with water shrews being recorded at 16% of these sites.

2.3.4 Supporting project

DNA library

Participating organisations: the Forensic Science Service (FSS) (mammals other than bats), University of Bristol (bats), JNCC, EHS and the Veterinary Laboratories Agency (VLA). The organisations involved are collaborating to produce a reference library of DNA information for all terrestrial mammals. The DNA reference library is being compiled to provide a resource for potential future use in national hair tube surveys for a variety of mammal species. Hair tubes have been used as a survey method in the past to establish species distribution and there is potential for using this method to estimate population trends. However, morphological methods of hair identification can be time consuming and require considerable expertise and regular practice. Hair tube surveys, with subsequent species identification using DNA sequencing, could be a useful method for small mammal species that are difficult to survey using other methods, once a cheap automated method for sequencing DNA has been devised. They also have the potential to involve large numbers of volunteers who need not necessarily have mammal identification experience.

Site coverage: not applicable as yet.

Species coverage: to date DNA sequencing of the cytochrome b gene has been completed for 28 mammal species. Work is underway at the University of Bristol to provide similar information for the 16 resident bat species and this should be completed in 2005. A detailed report has been produced by the FSS (Wetton *et al.,* 2002) and can be viewed on the TMP website (*www.trackingmammals.org*).

3. Volunteer engagement in the TMP

3.1 Introduction

The previous chapter on the Surveillance and Monitoring programme has shown that the TMP is operating a very diverse range of schemes in order to collect robust data on mammal population trends. This has involved the organisations in the TMP engaging large numbers of volunteers on a scale not normally seen for mammal surveys. This chapter examines many aspects of volunteer involvement, including some of the main reasons for engaging them to carry out surveillance work. It also looks at the various approaches being adopted by organisations in the TMP in managing volunteer networks to ensure that the valuable volunteer resource is maintained, and that the volunteers receive support and feedback in view of the time and effort that they freely give to the programme.

3.2 Volunteer participation in the surveillance and monitoring programme

3.2.1 Assessing the value of volunteers

The majority of schemes operating within the TMP engage volunteers to collect the data. Volunteers participate in surveillance work for many reasons and it is very important for the organisations managing their volunteer networks to understand what motivates volunteers and to provide volunteers with the service they expect. This is particularly true for annual surveillance schemes that are rigorously designed, with standardised methods, involving randomly selected survey sites. In these schemes there is an expectation that the methods outlined will be carried out to ensure confidence in the data that are returned. It is exacting work with a high level of commitment required from volunteers and an equally high level of service and management required from the organisations running the schemes.

The advantages and disadvantages of engaging volunteers compared with professionals has been widely discussed (Battersby & Greenwood, 2004; Macdonald *et al.*, 1998; Toms *et al.*, 1999; TMP, 2005) and one of the main reasons stated for engaging volunteers to collect surveillance data is that it is more cost effective than engaging professional surveyors to do the work. A detailed case study of the NBMP (see section 3.2.2) indicates that this is the case, but there are many other very good reasons for engaging volunteers in surveillance work and an examination of the factors involved shows that the issue is much more complex than simple economics.

Table 3.1 lists all the TMP surveillance schemes that engage volunteers. The table shows the number of volunteers participating in each scheme annually; the number of volunteers joining and leaving schemes each year, and the number of hours it takes for volunteers to complete each survey. The latter figures include all visits to a site where multiple visits are involved, and an estimate of the total hours given annually by volunteers in each survey. These figures are approximate, because it is difficult to assess individual volunteer time input accurately. However, in many cases guidance is given to surveyors on the length of time that should be spent on a particular survey, and in others, volunteers are asked to state the length of time spent surveying and this information has then been used to quantify survey effort.

Area and time coverage Table 3.1 shows that over 14,000 volunteers take part in mammal surveillance every year, carrying out over 140,000 hours of survey work, covering over 16,500 survey sites across the UK. Some of the volunteers are primarily collecting data on birds (BBS, WBBS, GBW), but are also providing good data on mammal populations. By any standards this level of input shows impressive dedication and involvement. Some of the surveys are fairly easy to conduct, but others require several hours, sometimes every week or month at certain times of year, in the evening, at night, in the early morning, across the whole of the UK. It is hard to envisage how such a structure could be organised that would use professional surveyors to such good effect.

Expanding the network The organisations running the schemes continue to recruit volunteers and in most cases, therefore, these schemes are continuing to grow in terms of numbers of people available to do the work. This is offset by the annual dropout of volunteers, which is often quite high in the pilot years of a survey, before the potential problems in the methods have been fully explored and before the core of volunteers who will continue to participate over a long period of time has become established. Once schemes are established (BBS, NBMP, NDMP), the turnover rate of volunteers tends to reduce and stabilise, with the loss of volunteers being more than offset by the recruitment of new ones. This means that schemes should have the capacity to grow over time, but it should be acknowledged that there is probably a limit to the time and resources that voluntary organisations can allocate to this recruitment process. These schemes are leading to the development of a knowledgeable and dedicated band of volunteers who know both the sites that they are surveying each year, and their local area. In addition, being on the ground and aware of land ownership issues they can often ensure that permission to survey on private land is easier and quicker to obtain.

Education considerations All the people who give so freely of their time are, we hope, gaining something personally from the experience. They will be increasing their knowledge of local wildlife and countryside, their

Table 3.1 Volunteer involvement in the TMP Surveillance and Monitoring Programme

	Volunteer participation				SITES Total/ Annual mean[1]					Volunteer input[2]		
SURVEY SCHEME	Start year	Annual mean	Annual Recruitment	Annual % turnover	UK	England	Northern Ireland	Scotland	Wales	Survey time (in hours)	Total hours	Annual mean hours
NGC	1961	636	low	low	1603/636	1096/409	16/5	408/197	83/25	n/a	n/a	n/a
BBS	1995	1,471	252	17	3116/1806	2224/1353	134/66	461/239	287/141	7	113,778	12,649
NBMP	1997	738	350	29	7606/994	1841/725	21/10	381/126	302/133	59	94,592	14,148
WBBS	1998	160	27	16	375/160	256/113	5/1	77/31	35/15	9	8,640	1,440
WMM sightings	2001	449	102	39	1043/531	821	4	125	91	4	6,372	2,124
WMM signs	2001	306	93	26	690/366	537	0	95	57	4	4,392	1,464
MOR	2001	500	n/a	~50	1,762	n/a	0	n/a	n/a	1	5,286	1,762
P&M	2002	117	30	n/a	117	75	0	2	40	60	14,040	7,020
GBW	2003	4,385	n/a	n/a	4,385	3,962	19	229	175	16	70,160	70,160
LWM	2003	830	n/a	~50	830	692	5	83	50	10	8,300	8,300
NDMP	1991	477	66	4	244/159	n/a	0	0	n/a	23	142,623	10,971
WSS	2004	190	n/a	n/a	1,020	n/a	0	n/a	n/a	8	8,160	8,160
MIYG? Pilot	2002	4,000	n/a	n/a	4,000	n/a	n/a	n/a	n/a	1	4,000	4,000
Total		**14,259**			**16,766**					**202**	**480,343**	**142,198**

[1]Annual mean sites is often more than annual mean volunteers because many volunteers cover more than one site.
[2]Calculation of volunteer input is based on an estimate of the time it takes to carry out the survey × the mean number of sites covered annually. Total input is based on this calculation × the number of years the survey has been operating. In the case of the NBMP the figure of 59 hours covers all surveys operating in that scheme and Table 3.2 explains the breakdown of figures for the total scheme. In the case of the VWT P&M survey, time taken to do the survey is based on an average of 1 hour per day for two months. In the case of the NDMP, an average of three surveyors per site has been included in the calculation. In the MOR survey the estimated average speed of all drivers was 40 mph.
This table has been compiled to give a general overview of all the surveillance schemes in the Tracking Mammals Partnership. Each scheme was devised to survey a different species or group of species, using different techniques and analytical methods and requiring varying levels of volunteer input both in terms of numbers and degree of training necessary. It would, therefore, be inappropriate to attempt to make any comparisons between them. BBS and GBW were set up primarily to collect bird data, but are now both providing useful and welcome data on mammals, too.

understanding of conservation and wildlife management issues, their natural history skills and their general understanding of science. They may also be participating in order to make a contribution to conservation themselves, which gives many volunteers much satisfaction. In carrying out surveillance in this way, a large network of well-informed individuals is being created, which can help to raise the profile of conservation and wildlife management among other members of the general public, and also assist in carrying out Local Biodiversity Action Plans, thereby helping local wildlife. In addition, they will be assisting the UK to carry out its international obligations, and inform future government policy decisions. These are important considerations, and a fundamental and significant part of the work being carried out by the TMP. These wider benefits could not be achieved by employing professional surveyors.

Financial considerations In the world of conservation, money is always a limited resource and it is often quite difficult to obtain sufficient funding to carry out important conservation management. Attaching a financial value to the work carried out by the TMP volunteers provides a useful illustration of the full value of the time contribution that volunteers make in carrying out survey work. The estimated value is not intended as a comparison of the costs involved in engaging volunteers or professionals. A detailed and considered comparison would include many other factors. However, it is worth mentioning that in most cases engaging professional surveyors to do the same kind of work would be more costly.

The NBMP case study (section 3.2.2) has involved quite a detailed assessment of volunteer value, because the NBMP core costs are covered by government funding and it is important to know the value of the overall programme. If this approach were to be generally applied to volunteers in all schemes, then based on hourly rates used to assess the value of NBMP volunteers (see 3.2.2) the time given by TMP volunteers (Table 3.1) would be estimated to be worth over £4.5 million annually and over £16.5 million since the programme of work began. The value of volunteer input is therefore considerable.

3.2.2 Assessing volunteer effort

Case study 1 – the National Dormouse Monitoring Programme (NDMP)

The National Dormouse Monitoring Programme (NDMP) began in 1991 and is the longest running single species surveillance programme in the UK. Dormice had been getting progressively scarcer over the previous century but it was only in the mid-1980s that conservation scientists were able to begin studying this species in earnest when it was discovered that they would use wooden boxes for breeding and shelter during the summer months. This led the way to the development of the National Key Sites for Dormice programme whose sites now form the nucleus of the NDMP. At each of the current 200 sites volunteers put up at least fifty boxes in a grid system (so that they may be located easily) in suitable woodlands, and return monthly from April to October inclusive to open the boxes, count, weigh and sex all the dormice that they find.

Engaging, training and maintaining volunteers are ongoing tasks. The common dormouse is a protected species and handling specimens requires a licence from EN or the CCW. In order to obtain a licence, volunteers assist with dormouse checks carried out by licensed fieldworkers in order to gain the necessary experience and confidence in handling these small mammals. Once they are considered sufficiently competent, their trainer must support their licence application in writing. Additional training can be obtained by attending one of a number of training courses held by PTES and by The Mammal Society. Volunteers, of course, need to be recruited in areas where the species occurs and where it is being monitored and also in areas close to reintroduction sites. Additional training courses have been held around potential reintroduction sites to encourage people to volunteer.

The nature of the work means that it is very difficult for one person alone to carry out dormouse checks successfully and therefore, a team of volunteers has been recruited at each site. Teams vary in size from two or three people to a dozen and it is only necessary for one person in each to hold a licence. Checks can take anything from several hours to several days, depending on the number of boxes to be checked and the number of dormice found. Having a team of volunteers ensures that not all the responsibility necessarily falls upon one or two people, and consequently, there are almost always enough people available to carry out the work at the appropriate times.

Table 3.1 gives a detailed summary of all the relevant information on volunteer input into the NDMP. The table shows the average number of volunteers participating annually and the % turnover. It also shows the total number of hours of volunteer input since the scheme began, and the number of hours of volunteer input on an annual basis.

Since the programme began, 732 people have become volunteers on the programme, with approximately 477 working each year. During 2003, 22 new sites came into the scheme with around 66 new volunteers recruited. The annual turnover is therefore approximately 4%, which is low, possibly because the people who come forward for training already have a great interest in the species and have invested considerable time and effort in training. Many are working at sites over which they feel they have an element of ‘ownership’. It is estimated that since the programme began, a total of 142,623 hours of voluntary work have gone into collecting surveillance data with approximately, 10,971 hours annually.

The turnover rate of volunteers experienced in the NDMP does not support the often held view that turnover rates increase with increasing difficulty of the survey, although there are higher turnover rates in some of the newer more difficult surveys within the TMP. Volunteers often travel considerable distances to carry out the work, sometimes in difficult terrain. Handling the dormice successfully requires considerable skill and manual dexterity.

Nevertheless, the turnover rate of volunteers in this particular scheme is low.

The NDMP is now run by PTES, which currently receives £8,000 per annum from English Nature to run both this programme and the annual reintroduction programme. This grant is matched by a similar sum from PTES itself. While PTES makes every effort to provide training, support and feedback for volunteers, the volunteers themselves are expected, at present, to provide their own boxes, pay for necessary equipment such as balances for weighing the dormice and cover the costs of their travel to and from their chosen site. PTES provides grants from its general funds to help groups that would otherwise face financial difficulty in supporting the programme.

The cost of detailed data analysis is not included in the above budget. The first ten years of the monitoring data were analysed recently at RHUL under a three year contract commissioned and funded by PTES at a cost of £36,000.

It is clear from the above that the NDMP both runs effectively on a relatively small budget and benefits from nearly 11,000 hours of trained volunteer time, freely given, every year.

It is to be hoped that in future, more funding may be forthcoming to enable this programme both to continue to grow to take in other woodlands in areas where we suspect the species is not doing well at the current time and to continue detailed data analysis in future.

Case study 2 – the National Bat Monitoring Programme (NBMP)

The National Bat Monitoring Programme (NBMP) commenced in 1995 and is the longest running multi-species surveillance programme designed to collect data on mammals, specifically bats. It is also dealing with a particularly problematic group of species, the bats; flying, nocturnal mammals that are difficult to see and can usually only be heard with the aid of ultrasonic detector equipment. Engaging, training and maintaining a volunteer workforce and designing surveys that will provide population trend information for all UK resident bats has been a challenging task and provides an interesting case study on the problems that have been encountered and the results that have been obtained.

Table 3.2 gives a detailed summary of all the relevant information on volunteer input into the NBMP surveys. The table shows the total number of volunteers that have participated in each survey scheme since the programme began and the total volunteer participation when adding all the years of volunteer input together. It also shows the number of volunteers participating in each scheme annually and the percentage turnover of volunteers for each scheme. It shows the number of hours estimated to complete each survey, the total number of site visits across all years in each survey, the total hours of volunteer input during that time and the number of hours of volunteer input annually. Finally there is an estimate of the total value of volunteer input across all years for each survey and the estimated annual value of that input.

Table 3.2 shows that over 1,900 volunteers have participated in the NBMP since the programme began and total volunteer participation across all years and surveys has been over 4,850. On average over 730 volunteers participate in the programme each year, but this is continuing to rise, with 801 participating in 2003. It takes an estimated 59 hours to complete all surveys once in a year and over 7,600 site visits have been made since the programme began, taking over 94,500 hours of volunteer time.

The rates of volunteers joining and leaving particular schemes are quite variable, with the lowest turnover in the hibernation survey, 15.8%, the highest in the NSP field survey, over 41%, and the average rate being around 30%. These differences confirm the generally held belief that turnover of volunteers increases with increasing survey difficulty, although in the case of the NBMP, the hibernation survey is quite difficult to carry out. The low turnover rate of the hibernation survey can probably be attributed to the fact that it is a long-running, well established survey and data were collated before the NBMP was set up. Hibernation site surveyors must have a licence to carry out the work and are therefore already experienced and dedicated volunteers with knowledge of what is required of them. By contrast the NSP field survey has only been operating since 1998, so it is still a very new survey. It is also the most difficult to conduct and requires a great deal of dedication and time input from surveyors. The turnover rate for this survey is, therefore, not surprising, but it is likely that it will reduce in future years as a core of dedicated surveyors is established.

Each year volunteers give over 14,000 hours of survey time. If hourly rates for professional surveyors are used as an estimate, then NBMP volunteers contribute over £495,000 of effort annually, and the total financial value of their input since the programme began would be £3.3 million. Additional effort is required in the field surveys, where for health and safety reasons the NBMP advises volunteers not to go to field sites at night unaccompanied and this fact has been included in the calculation for field survey volunteer participation. Companions have been valued at the same rate as the registered volunteers.

The overall costs of running the TMP surveillance and monitoring programme are discussed in chapter 5. However, it is worth noting that the average annual running costs of the NBMP have been approximately £107,500 since the programme began in 1996. This is the cost of maintaining staff to set up the programme, develop survey methods, run the surveys, manage and train the volunteer networks, input and analyse the data and report on the results. If this figure were added to the potential cost of paying for data collection, based on the value of volunteer input, the overall annual cost of the NBMP would be over £600,000.

The cost of running the coordinating centre might well be less if professional surveyors were employed in place of engaging volunteers, because the professionals would not require the level of training or management required for

Table 3.2 Volunteer involvement in the National Bat Monitoring Programme

SURVEYS	Volunteer participation					Value of volunteer input					
	Start year	Total volunteers participating	Total volunteer participation across all years	Mean annual participation	Mean annual % turnover	Hours to complete survey	Total site visits across all years	Total volunteer hours[1]	Mean annual volunteer hours[1]	Total value of volunteer input (£)[2]	Mean value of volunteer input (£ per annum)
Field surveys											
Noctule, Serotine and Pipistrelle	1998	355	764	110.0	41.7	12	933	22,392	3,732.0	783,825	130,620
Daubenton's	1997	528	1,209	172.7	28.2	11	1,436	31,592	4,514.0	1,105,720	157,990
Hibernation	1997	87	338	39.7	15.8	6	1,531	18,372	2,624.0	643,020	91,854
Total		**970**	**2,311**	**322.4**	**28.6**	**29**	**3,900**	**72,356**	**10,870.0**	**2,532,565**	**380,464**
Colony counts											
Lesser horseshoe	1997	48	117	23.4	29.0	6	616	3,696	528.0	129,360	18,480
Natterer's	2000	49	101	33.7	24.8	6	115	690	229.8	24,150	8,043
Serotine	1997	78	203	29.0	26.6	6	286	1,716	254.4	60,060	8,904
Pipistrelle spp (includes unidentified roosts)	1997	711	2,005	286.4	28.0	6	2,548	15,288	2,184.0	535,080	76,440
Brown long-eared	2000	68	129	43.0	39.9	6	141	846	282.0	29,610	9,870
All colonies		**954**	**2,555**	**415.5**	**29.7**	**30**	**3,706**	**22,236**	**3,278.3**	**778,260**	**114,741**
All surveys		**1,924**	**4,866**	**737.9**	**29.2**	**59**	**7,606**	**94,592**	**14,148.3**	**3,310,825**	**495,205**

[1]Volunteer hours estimated at twice 'total hours to complete survey X total sites' in the field surveys because the NBMP health and safety recommendations for night time field surveys are that volunteers should operate the 'buddy' system and always be accompanied by another person.
[2]Professional rates estimated at £35.00 per hour.

large networks of volunteers. This could result in a reduction in the number of coordinating staff to run the programme. However, even if the cost of the coordinating centre were reduced by 30% (the approximate amount of the current budget devoted to training) to approximately £80,000 per annum, it would still cost in excess of £570,000 to collect a similar level of data to that collected by the volunteers, and the costs would increase considerably if the programme were to be extended to provide larger sample sizes or cover additional species. The figure of £570,000 is more than five times the current cost of the NBMP and gives an illustration of the great contribution volunteers are making to the collection of biodiversity data in the UK.

A further consideration for engaging volunteers in the NBMP is that most surveys operate within a short time window, to provide an element of standardisation across survey sites. The colony counts must be carried out within a three week period in June, when maximum numbers of females are present in the colonies, but before they give birth. The NSP is carried out in July and the Daubenton's survey in August. It would be logistically very difficult, if not impossible, for a small number of professional surveyors to cover the required number of sites within the required time frame for each survey and a great deal of expense would be incurred by surveyors travelling around the country to different site locations.

3.3 Professional involvement

There are situations when engaging professional surveyors can be very beneficial. Table 3.1 shows a breakdown of annual site coverage by country and shows that on average across all surveys that are UK wide, 75% of sites surveyed are in England, 13% in Scotland, 11% in Wales and only 1% in Northern Ireland. It is not unexpected that the majority of volunteers are in England, being the largest country in the UK with the highest density population. However, the imbalance is perhaps greater than one would expect and, although efforts have been and continue to be made by organisations in the TMP to recruit more volunteers in the other three countries, the numbers are still not high enough to provide country level trends for most species. The issue of obtaining regional population trend data is examined in chapter 5. The organisations in the TMP hope to address this issue by targeting training and publicity for surveys in the respective countries, but it may be that this is an area where professionals could help to fill the gaps in data collection in the absence of volunteers. In such circumstances the TMP could benefit from pooling resources and engaging professionals to carry out several surveys simultaneously. However, it is worth noting that both options, employing professionals or targeting recruitment in areas of poor coverage, require greater financial investment in survey schemes.

3.4 Volunteer management

Having shown the superb work being done by volunteers and the great value of their contribution to the TMP Surveillance and Monitoring Programme, it is important to note that developing volunteer networks is a costly business and, in terms of managing them, it is both more costly and more complicated than employing professionals to do the same work, as mentioned already in the NBMP case study. Volunteers, rightly, have expectations when they become involved in a surveillance scheme. They may wish to learn new skills, meet like-minded people, learn more about the natural world, and they will almost certainly want to know how the information they collect contributes to the overall aims of the surveillance scheme. This means that they must be provided with regular information as the scheme progresses, including clear instructions on the methods to be used, how to receive appropriate training and how to contact survey co-ordinators if they have problems in conducting the survey and, very importantly, they need frequent and timely feedback on survey results.

3.4.1 Survey information

The majority of organisations provide detailed information on how to carry out their survey schemes. Each year volunteers are sent survey forms with clear instructions and in some cases mammal identification leaflets. Some examples are included in Figure 3.1 and Figures 3.2a (Plate III), 3.2b & 3.2c (Plate IV).

3.4.2 Training

Training is an essential part of providing volunteers with the necessary skills to carry out the survey work. Some surveys are quite specialised and require a certain level of knowledge before volunteers can effectively carry out the survey. Below are some examples of training provided by organisations in the TMP.

The NBMP runs an average of 16 training workshops annually across the UK, training approx 400 people a year in the use of bat detectors and species identification. Training workshops in survey methods, bat detector use and species identification skills are also run at the BCT annual Bat Conference.

The Mammal Society, which jointly runs the Winter Mammal Monitoring pilot with the BTO, has developed a training course specifically for this project, using funding from the Endangered British Mammals Fund (now MTUK). Training courses provide details on how to take part in the project (*e.g.* deciding on transects, collecting habitat data, how to search for signs and also cover identification of species that look very similar such as deer species, stoats and weasels). The workshops are being run by The Mammal Society's experienced and enthusiastic tutors and each workshop involves up to 20 participants. Similarly, The Mammal Society has created training workshops for its Water Shrew Survey. These courses teach volunteers about the ecology of the water shrew and teach scat identification to enable volunteers to identify the scat samples that they collect during the survey.

The Mammal Society runs a programme of Training Courses in subjects relating to British Mammals, from identification to conservation to survey techniques. The longest running course is *Mammal Identification*, which is

a residential course that covers identification of all British terrestrial mammals by sighting or sign, as well as live-trapping skills and owl pellet analysis. The course ends with an independently marked assessment, which can lead to attendees gaining their certificate in *Basic Mammal Identification*, accredited by The Mammal Society and the Field Studies Council (FSC). The Mammal Society also produces a series of identification aids that have been specially designed to be taken into the field when carrying out surveys.

PTES/MTUK, which runs the NDMP and MOR, in partnership with other organisations, and LWM, holds an annual training day, 'how to manage woodlands for dormice', aimed at woodland owners and managers. As new volunteers wish to join the NDMP, PTES advised individuals on how they may train to obtain a dormouse handler's licence and tries to pair them up with experienced workers close to where they live. As new sites are brought into the scheme, especially as a result of reintroductions, PTES runs local courses on dormouse monitoring to facilitate the formation of new monitoring groups.

Training in monitoring techniques is an essential element of the Water Vole Key Sites programme set up by PTES/EN/EA/CCW/RSPB. Trained groups of water vole surveyors are now established at 14 sites across England and Wales.

MTUK also provides a free identification booklet on UK mammals to all participants of the LWM survey.

3.4.3 Assessing volunteer input

Volunteers are very variable in their ability to carry out survey work. Some will be very experienced while others will be doing surveys for the first time. Under these circumstances it is important to have some idea of the quality of the information collected by volunteer surveyors and to assess factors such as their ability to collect the required data, the percentage of field signs they miss or identify incorrectly, and their rate of improvement over time. All these factors are likely to bias the survey data and must be considered when interpreting the reliability of the results.

The methods that can be used to assess volunteers are covered in the TMP volunteer management manual (TMP, 2005). Here we will look at a few examples of validation exercises carried out by TMP organisations.

Mammal monitoring in Wytham Woods

The Wildlife Conservation Research Unit (WildCRU) at Oxford University, with early funding from PTES, has been running a project at Wytham Woods, Oxfordshire, for a number of years, collecting data on the ecology, behaviour and changing abundance of a number of species, including several mammals. The extensive knowledge of the area has provided a very good backdrop against which to test the abilities of volunteers under various conditions and in April 2000 WildCRU and the Earthwatch Institute began a collaborative project to monitor the populations of mammals and the involvement of volunteers at Wytham Woods.

As well as integrating and co-ordinating ongoing mammal studies, the programme's long-term objectives extend beyond the site's 1,000 acres, by developing, calibrating and validating easy-to-use, yet accurate mammal monitoring techniques that could be used by volunteers nationwide.

The mammal communities in Wytham have been monitored by professional scientists and students since the 1940s and extensive data exist on the population trends there. However, multi-species monitoring is a demanding task, and this project relies upon the commitment, time and effort of keen volunteers to get the work done. Teams of volunteers are recruited by the Earthwatch Institute and assist the project for 6–10 days at a time. To date over 400 Earthwatch volunteers have helped with the study. By comparing the results of more sophisticated methods used by experienced scientists with those from surveys by volunteers it has been possible to establish which techniques are most reliable and appropriate for volunteers to use.

The stated objectives of the project include:

- Developing methodologies which will benefit from the work of volunteers to collect important monitoring data, and which will provide training in appropriate monitoring techniques.
- Providing an opportunity to calibrate and test the validity of specific survey methods.

More information on the project can be found at the WildCRU website (*www.wildcru.org/research/other/mammalmon.htm*).

Information gained from the experiments carried out at Wytham Woods shows that volunteers have high quality standards and their abilities should not be underestimated (Figures 3.3a & 3.3b show volunteers at work; Plate V). They can provide detailed data, particularly in terms of presence/absence information and their abilities improve with experience and/or training. There is an optimum amount of training that is needed in order to do the task effectively.

The quality of the data collected by volunteers and the amount of information they miss varies greatly and depends on: the nature of the task; the species (the skill level required); the motivation of the volunteers and the training required; and the output of the survey required (*e.g.* presence/absence or abundance).

In a comparison between volunteers and professionals, volunteers took more time and were reasonably accurate, but the professionals were much quicker and more consistent (reliable). However, volunteers are very willing to undergo training and to follow guidance in order to provide the information required, sometimes more so than professionals (Newman *et al.,* 2003).

The NBMP – assessing echolocation identification

The NBMP carried out a small survey to assess the level of correct identification of echolocation calls for two bat species, the common pipistrelle and the soprano pipistrelle.

These two species are very closely related and their echolocation calls are very similar, with the possibility of volunteers making mistakes in identification. Most volunteers use a heterodyne bat detector in the field surveys, which picks up the calls of bats when tuned to set frequencies by the surveyor (Figure 3.3c Plate V). Identification depends on surveyor knowledge and cannot be checked at a later date. Frequency division detectors pick up bat calls across a wide range of frequencies and can record the calls, replay them, and sonograms can be produced so that the bat identification can be confirmed. A small number of surveyors were asked to take both types of detector with them while carrying out a field survey and record all the pipistrelle calls they encountered. The results are shown in Table 3.3.

The results showed that volunteers were accurately identifying calls and not mistaking common pipistrelles for soprano pipistrelles or *vice versa*. The Frequency Division calibration exercise suggested some differences in recording and identification between the two methods, but also suggested that overall identification of the two pipistrelles, using volunteers with heterodyne detectors, was quite robust.

Garden BirdWatch

The Garden BirdWatch survey produces distribution maps from the survey results and assesses the results to highlight species that volunteers may have problems identifying. If the distribution of survey results for a particular species is very different from the known distribution of the species in question, then the results are considered to be less reliable than for other species. GBW also ask their surveyors to note which species they are confident in identifying and which are more problematic, which is another way of assessing the accuracy of the data.

3.4.4 Providing Feedback

Providing good and timely feedback to volunteers is absolutely essential if they are going to continue to engage with the survey and to feel that their contribution is valued. Within the TMP the organisations running the schemes provide very good feedback to volunteers and the methods of doing so are constantly reviewed and improved wherever possible. Feedback is provided in the form of postcards acknowledging receipt of the data or sending back verified data, newsletters and magazines, circulated to individual volunteers and/or placed on the relevant organisation's website. Websites are also used to provide news updates and reminders of surveys during the field season and in some cases, where online data entry systems have been developed, to provide detailed almost instantaneous updates of survey results at various levels. Table 3.4 gives a summary of volunteer feedback provided by TMP organisations and Figures 3.4a, 3.4b, 3.4c & 3.4d illustrate some examples (Plate VI).

3.4.5 Health and Safety issues

Health and safety factors have become increasingly important in recent years and although volunteers in this context cannot be regarded in any way as employees of the organisations engaging them to carry out survey work, there is an expectation that organisations have a 'duty of care' to their volunteers and should provide good health and safety advice, relevant to the survey they are being asked to conduct. There is also an expectation that volunteers should themselves observe high standards of health and safety and not carry out any survey if they do not feel competent to do so. The TMP has held workshops, in conjunction with NBN, on health and safety and the wider issue of how to engage volunteers and manage volunteer networks. The workshop on health and safety was attended by several experts from the legal profession, environmental health and areas of the voluntary sector with long expertise in engaging volunteers. The proceedings of both workshops have been published in a manual, which is available in downloadable format on the TMP website (TMP, 2005).

3.5 Conclusions

The TMP could not operate without its participant organisations' volunteer networks that collect the data. The value of the time that they freely give is enormous, the geographical area that they cover is very large and the species information they provide is of a very high quality. At current levels of available funding, it is unlikely that this level of

Table 3.3 NBMP data validation exercise for pipistrelle species identification

Detector type		Analysis with Frequency division detector				
	Species (Sample size)	Soprano	Common	Unidentified pipistrelle	Not recorded	Other species
Heterodyne detector	Soprano (12)	11	0	1	0	0
	Common (42)	0	30	5	6	1
	Unidentified pipistrelle (33)	3	7	14	5	4
	Not recorded (50)	5	6	23	–	16
	Other species (0)	0	0	0	0	0

Table 3.4 Summary of feedback provided by organisations in the TMP to their respective volunteers

Survey scheme	Organisation	Title of publication	Description
NGC	GCT	NGC Annual Newsletter	An annual newsletter circulated in February based on survey results.
		GCT Annual Review	The Annual Review, circulated in June, including an article based on the NGC results from the previous year. Web based information on the results for each species, updated regularly.
BBS	BTO	BBS News	Annual magazine on BBS results for the previous year. Contains all the information on the bird survey plus summary of mammal data.
		BBS online	Provide online access to individual data.
NBMP	BCT	Bat Monitoring Post	Annual newsletter on BCT website in downloadable pdf format
NDMP	PTES	Dormouse Monitor	Biannual newsletter sent out to all volunteers and on the MTUK website with survey information for the NDMP and other TMP surveys
MoR	PTES	MoR Newsletter	Annual newsletter on survey results
LWM	PTES	LWM Newsletter	Annual newsletter on survey results
Various	MTUK	Mammals UK	Quarterly magazine with varied information on mammals, including information on surveillance schemes run by MTUK and other organisations in the TMP.
GBW	BTO	Bird Table	Quarterly magazine with lots of garden bird information, plus a small section on mammals. Also provides online access to individual data.
WMM	TMS & BTO	WMM Newsletter	Annual newsletter on both BTO and TMS websites
WSS	TMS	Shrew News	Bi-annual newsletter sent out after each survey season. Includes survey updates and information.
Deer Surveys	BDS	Deer	Quarterly publication sent to members with lots of deer news and information
	DI		Web based information and regional newsletters

information could be collected by professionals. In addition, there are many other benefits in engaging volunteers, both to the organisations that ask for their help and to the volunteers themselves.

Engaging volunteers is, of course, not a cost free business even though it may be more cost-effective than employing professionals. Engaging and managing volunteer networks requires considerable time, expertise and financial input from the organisation(s) running the schemes. There are problems in relation to sample sizes, and with engaging volunteers in low population density areas. There are also problems in ensuring the quality and reliability of the data and maintaining volunteer interest over long periods of time. In all these areas professionals could provide invaluable input, surveying areas where few volunteers come forward and at sites where it is expected that little of interest may be found, and testing, assessing and improving volunteer capabilities.

4. Species status and population trends

4.1 Introduction

This chapter provides summary results from the TMP surveillance and monitoring programme. An individual account is provided for each species including: brief information on population estimates; legal status; a summary of the most important economic and ecological factors affecting the species; historic information on population trends where available; and a section on current population trends. This is followed by an interpretation of the results using existing, and where appropriate, historic information. Finally, there is an indication of the future requirements for each species in order to provide comprehensive monitoring. Trends are reported at different spatial scales where available, including UK, country (England, Scotland, Wales and Northern Ireland), English Government Office Region and Environmental Zones (see the paragraph under section 2.2.1 on p. 20 for an explanation). For the majority of species, analysis of population trends is not possible below the country level because sample sizes are too small or the survey has not been operating long enough to provide sufficient annual data.

4.2 Information in the species accounts

Background information on species status, population estimates and historic population trends for Great Britain is taken from Harris *et al.* (1995) unless otherwise stated. The review by Harris *et al.* (1995) covered GB only and there are few published estimates for mammals in Northern Ireland. Where population estimates have been published they are quoted with references. Generally, numbers are quoted where they are known; a "0" indicates the species is not present and a "?" indicates that the species is present but there is no population estimate.

In Harris *et al.* (1995) population estimates were given a reliability score of 1–5, 1 being the most reliable and 5 the least reliable. Of the 65 species and sub-species listed, 44 of the population estimates had a reliability score of 3–5. The majority of population estimates should, therefore, be viewed with caution and are presented here to provide comparative information on general population size for each species.

More detail on factors affecting individual species populations and a full explanation of the reliability scores is provided in Harris *et al.* (1995), and, for Northern Ireland populations, in the references for Northern Ireland. Detailed summaries of individual species ecology, legal status and threats can be found in Corbet & Harris (1991) and Macdonald & Tattersall (2001). The species names follow Corbet & Harris (1991), with the exception of the following additional taxa: pipistrelle (*Pipistrellus pipistrellus*) has now been split into two species, common pipistrelle (*Pipistrellus pipistrellus*) and soprano pipistrelle (*Pipistrellus pygmaeus*); the recognition of Irish hare (*Lepus timidus hibernicus*) as a subspecies and the recognition of Skomer vole (*Clethrionomys glareolus skomerensis*) as a subspecies. Feral sheep are here assigned to *Ovis aries*.

Distribution maps for most species have been reproduced using data from the NBN (*www.searchnbn.net*), mainly sourced from Arnold (1993), but where data have been provided from other sources, they are acknowledged. The distribution maps provide an indication of the range of each species, but as the records have generally not been collected in a structured way they do not necessarily provide reliable or extensive information on the real distribution of most species. Distribution maps and species' photos are located in colour plates VII–XXVII.

International Conventions, Agreements under those Conventions, European Directives, national legislation and other relevant information on conservation status are listed in an abbreviated form in each species account, where they pertain to that species. A list of the relevant legislation and website addresses where more detailed information can be obtained is provided in Appendix II.

The results from the individual TMP surveillance schemes are listed in chronological order in each species account where they provide information for that species. A full list of acronyms is given in Appendix IV.

4.3 Population trend analysis – historic and current

Several schemes have sufficiently long time-series to carry out population trend analysis, namely the NGC, NBMP, BBS, WBBS and NDMP. Below is a summary of the analysis methods used in each of the schemes. More detailed explanations can be found in the individual reports for the schemes, listed in the References section.

Where sufficient data are available to provide information on population trends for individual species, the trends have been analysed as historic or current, to enable the results of current conservation and wildlife management actions to be assessed against a suitable baseline. The TMP has decided to take 1995 as the division point, with historic information on trends being pre-1995 and current trends from 1995 onwards, a division similar to that used for Birds of Conservation Concern (Gregory *et al.*, 2002).

The decision to use 1995 as the point at which species population information ceases to be regarded as historic and becomes current was taken for several reasons. First, 1995 was the year that the UK BAP process was initiated and has

involved the drawing up of habitat and species Action Plans, which list targets to be achieved and actions required to achieve them. The year 1995 is therefore a baseline year, which is suitable to assess the success of conservation policies. Secondly, the Habitats Directive came into force in 1992 and was implemented in the UK under the Conservation (Natural Habitats, etc.) Regulations in 1994. The Habitats Directive has the fundamental purpose of establishing a network of protected sites throughout the European Community to maintain the distribution and abundance of threatened species and habitats and to maintain and restore 'favourable conservation status' of species listed in Annexes II, IV and V. Thirdly, several of the schemes, the BBS-mammal data, the NBMP and the NDMP commenced data collection either in 1995, shortly before (NDMP in 1991, with data analysed from 1993 onwards) or shortly afterwards (NBMP in 1996) and the majority of other schemes have commenced since then. Post-1995 is, therefore, a time period when systematic, structured mammal surveillance commenced at a national level.

For more detail on the rationale for assessing population trends see Macdonald *et al.* (1998) and Toms *et al.* (1999).

4.3.1 NGC bag indices for eight mammal species from 1961 to 2003 and from 1995 to 2003

The NGC bag indices have been analysed twice in the TMP First Report, once including the whole dataset from 1961–2002 to provide historic trends and then using a subset of data from 1995–2002 to provide current trends. For the period 1961–2002, 1,603 estates provided returns covering rabbit and hare and 1,222 estates provided returns covering the six non-game species, grey squirrel, common rat, fox, mink, stoat and weasel. The corresponding numbers for the period 1995–2002 were 638 and 616 respectively. Too few estates contributed to the NGC during this period to analyse data separately for Wales or Northern Ireland. The data from each estate were first converted to bag densities by dividing the number killed by estate area, then annual means calculated for the UK as a whole, and for England and Scotland separately. These were converted to bag indices by dividing the mean annual bags for 1961–2002 (full series) and 1996–2002 (short series) by that for 1995. In this way the index value for 1995 was one and the index values for other years were relative to 1995. The percentage change between 1995 and 2002 was calculated by subtracting one from the 2002 index and multiplying by 100.

4.3.2 BBS and WBBS population trend analyses

Temporal trends in abundance

For the species for which counts are made in these two schemes, the maximum number of each species of mammal sighted was determined for each site in each year during the survey period. Survey work was severely affected by foot-and-mouth disease restrictions in 2001, resulting in a heavy bias towards particular areas of the country. For this reason, survey data for 2001 were excluded from all analyses and an index was interpolated for that year. This value and the associated variance is the mean of the two surrounding years and, as such, should be interpreted with caution.

Log-linear Poisson regression was used to model site counts, with site and year effects (ter Braak *et al.*, 1994) for the UK, where the year effect is an index of the change in numbers relative to 1995 (1998 for WBBS), the first year of the survey. This year (1995/1998) is set to an arbitrary index value of one from which all other years are measured. Counts of animals can violate the assumption of a Poisson distribution, so corrections for over-dispersion are made using the 'dscale' option in SAS/STAT software (SAS, 1996).

As with many long-term surveys these data include many missing values, where a particular site was not surveyed in a particular year. The model uses the observed counts to predict the missing counts and calculate the indices from a full data set, including the observed and predicted counts. The model requires that two points in the time series are available to estimate parameters, so squares counted in one year only have been excluded from the analysis. For the BBS, results are only presented for species occurring on a mean of 40 or more squares in two or more years over the seven years for which survey data are available, because of the low precision associated with small sample sizes (Joys *et al.*, 2003).

The WBBS is not comparable with the BBS in that the stretches are on average longer (average of 7 × 500 m transect sections), compared with 10 × 200 m transect sections of the BBS, so the power to detect population change is likely to be greater for the WBBS for the same number of sites surveyed. For this reason the 40 sites cut-off point has been changed to present all trends based on about 20 or more stretches. To examine the significance of the trends a comparison was made between the first and last years of the survey. Because non-overlapping of 95% confidence intervals highlights significance at the 5% level or more, separate formal analyses to examine differences between indices were not performed.

Temporal trends in presence

For several species that are not counted in sufficient numbers for trend analysis, but which leave obvious field signs or which are known to be present within a BBS/WBBS site, change in presence/absence on surveyed squares was examined. Species presence is defined here as information demonstrating that the species was present on a BBS/WBBS site in a particular year. This included counts of live animals as used in the above analyses, dead animals, field signs (*e.g.* tracks, scats, mole-hills), local knowledge of presence for that year from a gamekeeper or landowner or live animals seen on additional visits to the square during that season. In response to recommendations made in preliminary analyses of BBS mammal data (Newson & Noble, 2003), a change in the survey form in 2002 asked observers to indicate the primary method or methods used to record species presence.

To examine whether there has been a significant change in the presence of these species on BBS/WBBS sites, presence/absence was modelled as a function of site and year using logistic regression. The year effect in this case is the relative odds ratio, which is the odds of being present on a particular BBS square in a particular year relative to the odds of being present on that square in the first year in the time series. In these analyses for BBS 1996 is treated as the first year in the series, because most species of interest appeared for the first time on the survey form in this year. For WBBS it is 1998.

To illustrate the concept of the odds ratio, if in the first year, the probability of being present is 0.2, the probability of being absent is 0.8. The odds of being present would therefore be 0.8/0.2 = 0.25. If, five years later, the probability of being present was 0.8 and the probability of being absent was 0.2, the odds of being present would be 4, and the odds ratio relative to the first year would be 4/0.25 = 16. Unlike the analyses of count data, the change in odds ratio described above is not intuitive. For this reason, simple figures are presented showing percentage change in the presence of species on BBS/WBBS squares, although logistic regression has been used to test the significance of the change.

Once again survey work was severely affected by foot-and-mouth disease restrictions in 2001 and survey data for that year were excluded from the analyses. The year 2001 has been omitted from all graphs showing percentage presence of species on BBS and WBBS survey sites.

4.3.3 NBMP – population trend analysis

In all surveys in the NBMP, annual means were calculated for each project from a log-linear generalised model. The model includes terms for factors that could influence the means *e.g.* bat detector make, temperature etc. so their effect can be measured. For easier interpretation the means are then converted to an Index that starts at 100 for the first reliable year of data.

Generalised additive models (GAM) were used to calculate individual trends over time for each site surveyed. 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.

On the NBMP graphs, crosses represent the calculated means (converted to Index) and the line represents the estimated trend from the GAM. Dotted lines represent 95% confidence limits. The actual trend occurring can be described from either the GAM (line) or the log-linear generalised model (crosses) although in many cases the interpretation is similar.

The confidence limits for the GAM trend are obtained by a bootstrapping process, in which a large number of artificial datasets are generated by sampling sites at random from the full dataset. These confidence limits for a particular year are designed so that they will include the true index value in that year, relative to the base year, approximately 95% of the time. Because of the relatively small number of years currently available for analysis and the high variability of bat data, the confidence limits for several species diverge on the NBMP graphs presented, reflecting the growing uncertainty in the index further from the base year.

The annual percentage change assumes the annual trend direction is constant. 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 2003.

The benchmark for monitoring sensitivity is that sufficient sites are monitored to identify magnitudes of decline of 50% and 25% over 25 years.

4.3.4 NDMP – population trend analysis

Population indices were derived from GAMs, using procedures outlined by Goedhart & ter Braak (1998). Indices for all sites from 1993–2002 were generated and indices were also stratified by land class group (LCG) using the land classification system developed by Bunce *et al.* (1996) and the LCG system developed by Haines-Young *et al.* (2000). Further detail on the methods used can be found in Sanderson (2004).

4.4 Species Accounts

4.4.1 Insectivora

1. Hedgehog *Erinaceus europaeus*

Native, locally common.

Population estimate: UK ?; England 1,100,000; Scotland 310,000; Wales 145,000; Northern Ireland ?

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 6; WMA.

Importance/threats: the hedgehog is a good indicator of the abundance of ground-dwelling invertebrates and of varied habitat features, such as hedges and copses (Reeve, 1994). Loss of grazing habitat in the 20th Century, the use of pesticides and the regeneration of urban wasteland areas are all likely to have had detrimental effects on hedgehog populations. However, the species has become a problem on offshore islands where it has been introduced and has been implicated in the decline of ground nesting birds (Jackson & Green, 2000). It is a popular species and draws the attention of the public to wildlife.

Historic trends: hedgehogs are thought to have been plentiful throughout GB in the early 20th Century with an estimate of 36,500,000 in the 1950s (Burton, 1969), although this may have been a substantial over-estimate (Pat Morris, *pers. comm.*). Numbers on the mainland are thought to have declined considerably since then, but introduced island populations have generally increased. The population size of the Outer Hebrides is estimated to

be 7,000 on South Uist, Benbecula and North Uist (Macdonald & Tattersall, 2001).

Survey schemes providing information on this species: wider countryside NGC, BBS, MOR, WBBS; urban GBW, LWM.

Information on population trends

NGC. Results suggested a steady reduction in numbers from 1960–1980 (Tapper, 1992), when partial protection for the hedgehog under the Wildlife and Countryside Act (1981 as amended) may have reduced subsequent data collection in this scheme.

BBS. Hedgehogs were present in 9.8% of survey squares on average across all years. Results indicate a significant upward trend for this species (Figure 4.1a). These data should be interpreted with great care because in 2000 the method of data collection was modified to make the results more robust, and this may have caused an increase in the number of records for this species in subsequent years.

WBBS. Hedgehogs were present in 16.2% of survey stretches on average across all years (Figure 4.1b). Preliminary results from this survey suggest a significant decline in hedgehog presence on sites from 1998–2003.

MOR. Hedgehog was the second most frequently seen mammal in this survey with a mean of 19% of total sightings from 2001–2003. Numbers seen per 100 km driven ranged from 2 in 2001, to 1.8 in 2002 and 1.7 in 2003. Overall the results suggest that UK and country numbers have remained relatively stable across the three years of data collection (Figure 4.1c). There are insufficient annual data at present to provide trend analyses.

LWM. In the first year of this survey in 2003, 25% of urban area surveyed (204 of 808 survey forms returned) showed presence of hedgehogs.

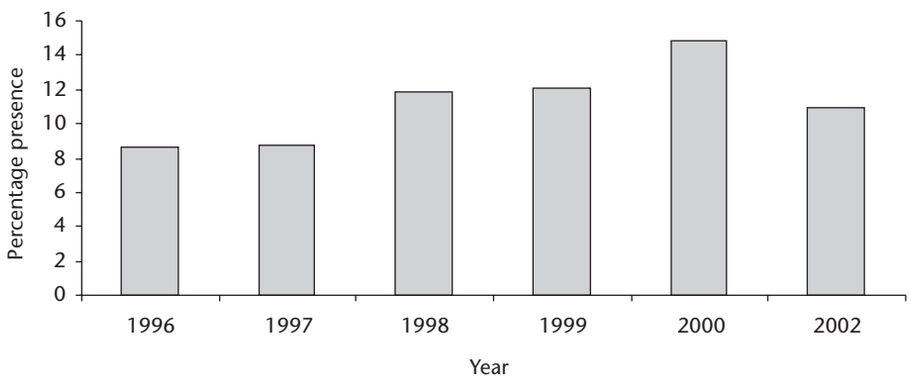


Figure 4.1a UK hedgehog presence (% of occupied squares) in the BBS (1996–2002)

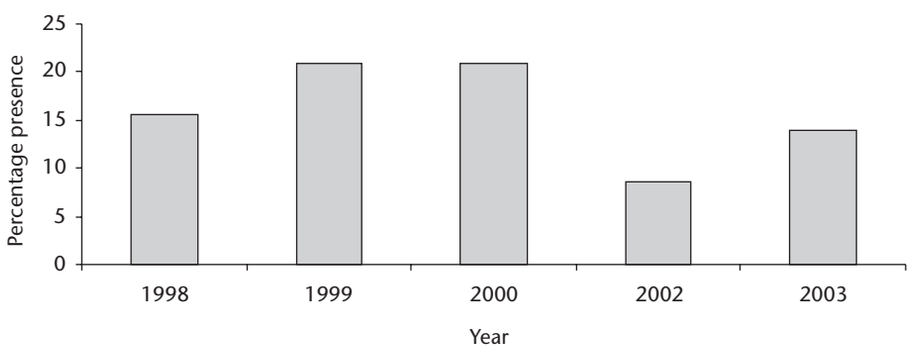


Figure 4.1b UK hedgehog presence (% of occupied stretches) in the WBBS (1998–2003)

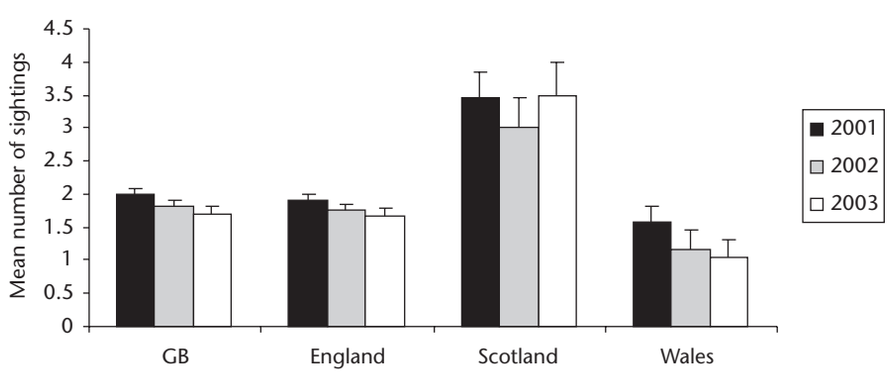


Figure 4.1c Observations of hedgehog road kills at GB and country level, from the MOR survey (2001–2003)

GBW. In this survey 1,935 gardens had records of hedgehogs in 2003, representing 44.1% of gardens surveyed.

LWM and GBW do not have sufficient annual data as yet to carry out trend analyses. However, if the current level of recording continues then it should be possible to detect population change in the urban environment through these surveys.

Interpretation of survey results: historic data from the NGC suggest a decline in numbers of hedgehogs in some regions. The WBBS shows a downward trend for this species since 1998, but the WBBS is restricted to riparian habitats and may only provide representative data for riparian species. The BBS suggests an upward trend in hedgehog populations and the MOR survey has insufficient data for trend analysis.

The varied results from the surveys make overall interpretation quite difficult. This species can exhibit large between year fluctuations in population size that are not related to long-term trends, but it is likely that there has been a real long-term decline. There is a noticeable difference in percentage of sites with hedgehogs present between wider countryside surveys (BBS 9.8%, WBBS 16.2%) and those in the urban environment (LWM 25%, GBW 44.1%). This may suggest differences in behaviour and population density between the two environments and there may be future differences in population trends. The differences in survey results highlight the importance of collecting annual data using standardised methods and having a number of different schemes to provide cross calibration of results.

Future requirements: longer time series of data are required, at least another 5 years, before robust conclusions can be drawn about current hedgehog population trends.

2. Mole *Talpa europaea*

Native, common.

Population estimate: UK 31,000,000; England 19,750,000; Scotland 8,000,000; Wales 3,250,000; Northern Ireland 0.

Legal and conservation status: WMA.

Importance/threats: a good indicator of soil invertebrate abundance, mainly earthworms. The species is perceived as a problem in agricultural habitats, particularly pastures and recreational grasslands.

Historic trends: there is no real information on historic populations. The effects of control on populations through poisoning and the effects of hedgerow removal, deep ploughing and the use of pesticides are not known.

Survey schemes providing information on this species: wider countryside BBS, WBBS, WMM; urban LWM, GBW.

Information on population trends

BBS. Results show a significant upward trend for this species (Figure 4.2a). On average across all survey years 21.4% (min 7.2, max 33.7) of survey squares showed signs of moles. These data should be interpreted with great care because in 2000 the method of data collection was modified to make the results more robust, and this may have

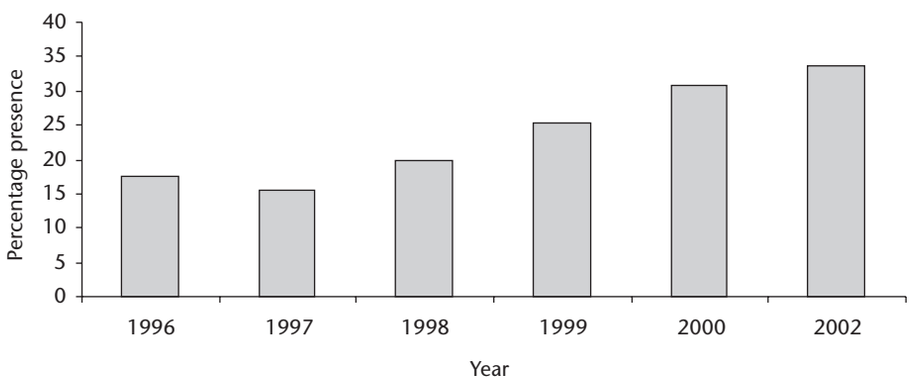


Figure 4.2a UK mole presence (% of occupied squares) in the BBS (1996–2002)

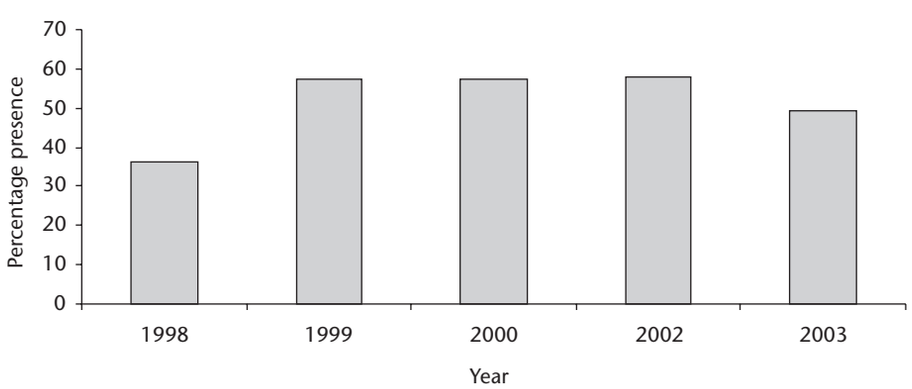


Figure 4.2b UK mole presence (% of occupied stretches) in the WBBS (1998–2003)

caused an increase in the number of records for this species in subsequent years.

WBBS. Results show no significant trend for this species (Figure 4.2b). On average moles were present on 49.9% of sites.

WMM. In the survey 98.3% of squares surveyed were searched for mole signs. Of those a mean of 72.5% were positive. With only three years of data the time series is too short to carry out trend analysis.

LWM. In the first year of this survey mole signs were recorded in 24.7% of urban area surveyed (200 of 808 survey forms returned).

GBW. There were 848 gardens with signs of this species in 2003, representing 19.4% of gardens surveyed.

LWM and GBW do not have sufficient annual data to carry out trend analyses.

Interpretation of survey results: the significant upward trend in the BBS and no trend in the WBBS suggest that mole populations are stable or increasing slightly, but the available data are very limited at present. The difference in the percentage of survey squares with mole signs between the BBS and WMM surveys may be due to observer effort. BBS observers are noting what they happen to see while collecting bird data, while WMM observers are specifically looking for mammal signs. Over time this difference may be unimportant in terms of detecting population trends, but a comparison of the results of these two surveys will be necessary for several years in order to ascertain the effects of the different methods of data collection on survey results. This also highlights the importance of having surveys specifically designed to collect mammal date if more complete information is required and the WMM survey may be an important survey for providing population information on this species in the future.

Future requirements: annual data are required for at least another five years from a variety of schemes before robust conclusions can be made about mole population trends.

3. Common shrew *Sorex araneus*

Native, common.

Population estimate: UK 41,700,000; England 26,000,000; Scotland 11,500,000; Wales 4,200,000; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 6; WMA.

Importance/threats: forms part of the prey base for mammalian carnivores and avian raptors.

Historic trends: unknown, but possible decline through loss of their natural habitat, such as ancient grassland and meadows. This may have been reversed through an increase in long-term set-aside (Brockless & Tapper, 1993).

Survey schemes providing information on this species: none. Population trends are unknown.

Additional species information: since 1993, The Mammal Society has been collecting information on small mammal abundance and distribution as part of its ongoing National Owl Pellet Survey. Pellet analysis can be used to investigate changes in the diet of owls and, therefore, changes in the availability of small mammal species. Annual data (annual % contribution of prey items) is available for common shrews, allowing changes in the availability of this prey species to be assessed (see Love *et al*., 2000). Across all regions and land classes, the percentage of common shrew found in owl pellets showed a decline of 9.1% between 1974 (data collected by the BTO) and 1997 (data collected by The Mammal Society 1993–97) surveys. This gives an indication of the changes that may have occurred to this species during the 20th Century. However, interpretation of the results is complicated by the changes in behaviour of the barn owl in terms of prey selection.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance.

4. French shrew *Sorex coronatus*

Introduced to Jersey. Localised population, but widely distributed in Europe.

Population estimate: not known.

Legal and conservation status: Bern Convention Appendix III; WMA.

Survey schemes providing information on this species: none. Population trends are unknown.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the common shrew (see above p. 44).

5. Pygmy shrew *Sorex minutus*

Native, common.

Population estimate: UK ?; England 4,800,000; Scotland 2,300,000; Wales 1,500,000; Northern Ireland ?

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 6; WMA.

Importance/threats: forms part of the prey base for mammalian carnivores and avian raptors.

Historic trends: unknown, but possible decline through loss of their natural habitat, such as ancient grassland and meadows. This may have been reversed through an increase in long-term set-aside (Brockless & Tapper, 1993).

Survey schemes providing information on this species: none. Population trends are unknown.

Additional species information: the Mammal Society Owl Pellet Survey includes over 10 years data on the pygmy shrew. Love *et al.* (2000) found that pygmy shrews comprised 7.5% of the diet of barn owls in 1997; an increase of 3.2% since 1974.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the common shrew (see above p. 44).

6. Water shrew *Neomys fodiens*

Native, locally common.

Population estimate: UK 1,900,000; England 1,200,000; Scotland 400,000; Wales 300,000; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 6; WMA.

Importance/threats: potential indicator of water and habitat quality, although the effect of water quality on water shrew populations in unknown (Churchfield, 1991).

Historic trends: unknown, but thought to be locally common in the past and possibly declining.

Survey schemes providing information on this species: The Mammal Society's Water Shrew Survey.

Information on population trends

The results from The Mammal Society's Water Shrew Survey have revealed, at the end of the second of four survey seasons, 163 positive records of water shrews from a total of 1016 sites surveyed across the UK. In addition, volunteers have provided other records from 1993 to the present, comprising sightings, live trapping, cat kills and owl pellet analyses. The distribution map shows the known distribution of the species from these records (Plate VIII).

Future requirements: continue the pilot survey and assess the methods used and the power of the survey to detect population trends.

7. Greater white-toothed shrew *Crocidura russula*

Found in the Channel Islands (Alderney, Guernsey and the Herm islands). Localised population.

Population estimate: not known.

Legal and conservation status: Bern Convention Appendix III; WMA.

Survey schemes providing information on this species: none. Population trends are unknown.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the common shrew (see above p. 44).

8. Lesser white-toothed shrew *Crocidura suaveolens*

Introduced to the Isles of Scilly probably in the Iron Age. Localised population, not found in the rest of the UK.

Population estimate: total pre-breeding population of 40,000 (Temple & Morris, 1997).

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 6; WMA.

Survey schemes providing information on this species: none. Population trends are unknown.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the common shrew (see above p. 44).

4.4.2 Chiroptera

The graphs and data for bat species are taken from the NBMP report (BCT, 2004) unless otherwise stated. Bat population estimates for Northern Ireland have been taken from Russ (1999) and are mean population estimates based on flying individuals.

9. Greater horseshoe bat *Rhinolophus ferrumequinum*

Native, very rare and endangered.

Population estimate: UK >6,600 (Tony Mitchell-Jones, *pers. comm.*); England ?; Scotland 0; Wales ?; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix II; CMS Appendix II; W&CA Schedules 5, 6; HD Annexes II, IV; SAP; IUCN Red List; EUROBATS Agreement; WMA. There are 10 maternity roosts and 27

hibernation sites designated as SSSIs. Eleven SSSIs have been selected for designation as SACs. It is thought that most major roosts are known.

Importance/threats: the UK has an internationally important population because of severe declines in populations across Europe. The species is under threat because of life history factors including a low reproductive rate and late onset of breeding (the average age for first breeding in females in Britain is 5.7 years) and the need for relatively warm hibernacula compared with other bat species (Ransome, 1990). The major factors affecting populations are unfavourable climatic conditions (cold and wet summers), the loss of summer and winter roost sites, particularly the closure of disused mines, and the loss of suitable foraging habitat and insect prey (Ransome, 1991). This species is a good indicator of the effects of climate change.

Historic trends: there was a substantial decline in populations of greater horseshoe bats across Europe in the 20th Century, resulting in the disappearance of the species from half of its former range in Great Britain. Knowledge of historic population trends is patchy, but Ransome (1989) monitoring greater horseshoe bats around Bristol found that the minimum number of bats alive in 1987/1988 was only 42% of the number alive in 1968/1969. Following the strict protection of roosts and favourable management of the surrounding foraging habitat, coupled with the absence of cold winters, the species appears to be making a slow recovery.

Survey schemes providing information on this species: NBMP and English Nature (EN) monitoring. The NBMP collects hibernation site data for the UK. EN has been collating colony counts in England since 1986.

Information on population trends

Hibernation survey. The NBMP has been collecting hibernation data for this species since 1997. Greater horseshoe bats have been found in 32 of the site network of 379 sites, with a mean number of 5.73 bats per site (max 60). Figure 4.9a shows the graphical representation of the GAM analysis. Although the graphs suggests a downward drift, estimated at 6.81% annually, the confidence limits are very wide and there are no significant year to year differences ($\chi^2 = 7.93$, 6 df, $P = 0.24$) and no significant population trend. Although there was a sufficiently large sample of sites, many of them had zero or very small counts making the analysis sensitive to a small number of extreme values and this is reflected in the graph.

Colony survey. There are some data for greater horseshoe colonies going back to 1986 (collected by NCC and then EN) and these data show a mean of 6.9 colonies counted annually from 1986–2004, and a mean of 125.3 bats per colony. Sample sizes for pre-1999 counts are generally small and the data are very variable. Therefore, trend analysis has been carried out by EN on a subset of the data, from 1999–2004. This dataset includes a mean of 9.5 colonies counted and a mean of 147.3 bats per colony annually during that period. The trend analysis shows a significant overall increase of 36%, representing a mean annual increase of 6.34% (Figure 4.9b).

Interpretation of survey results: the evidence suggests that greater horseshoe bat populations are increasing. However, although colony counts have been carried out for a number of years, the sample size for trend analysis is very small and counts at more roosts over a longer period of time are required to provide robust population trends.

Future requirements: in order to assess the effect of habitat management measures under the SAP, research is required to assess colony dispersal rates/new colony formation, to estimate population increase as well as decline. Co-ordination and standardisation of colony and

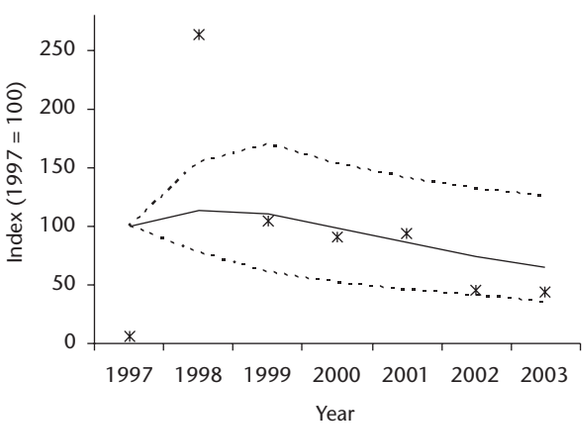


Figure 4.9a Greater horseshoe bat hibernation survey (1997–2003). Results of GAM analysis with 95% confidence limits

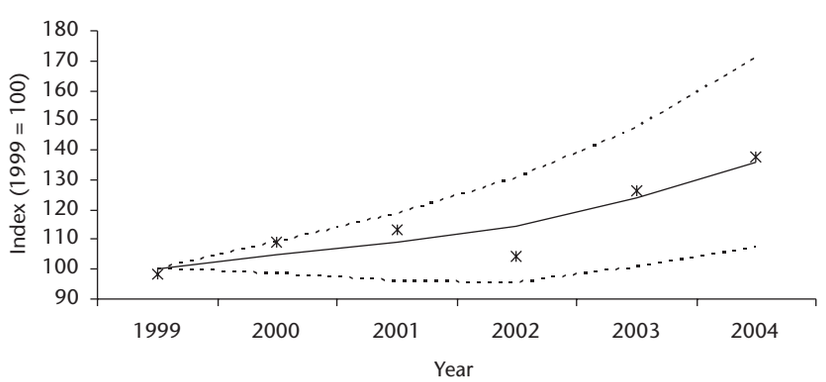


Figure 4.9b Greater horseshoe bat colony counts (1999–2004). Results of GAM analysis with 95% confidence limits

hibernation surveys is required to ensure all available data are used to assess population change and provide the best information possible for conserving this species.

10. Lesser horseshoe bat *Rhinolophus hipposideros*

Native, rare and endangered.

Population estimate: UK 18,000; England 9,000; Scotland 0; Wales 9,000; Northern Ireland 0. (UK BAP reporting 2002: *www.ukbap.org.uk/2002onlinereport/mainframe.htm*).

Legal and conservation status: Bern Convention Appendix II; CMS Appendix II; W&CA Schedules 5, 6; HD Annexes II, IV; SAP; IUCN Red List; EUROBATS Agreement; WMA. At least 12 sites notified as SSSIs, 70 other sites within SSSIs. There are 13 SSSIs that have been selected for designation as SACs.

Importance/threats: the UK has an internationally important population because of severe declines across Europe. The decline may be associated with the loss of summer and winter roost sites, foraging habitat and insect prey. The species is a good indicator of woodland quality and effective conservation management of the wider countryside.

Historic trends: there have been large declines in populations across Europe in the last 50 years and the species has disappeared from northern England. However, the existing English and Welsh populations form one of the European strongholds for this species and following strict protection of roosts sites there is evidence of population increases in both countries.

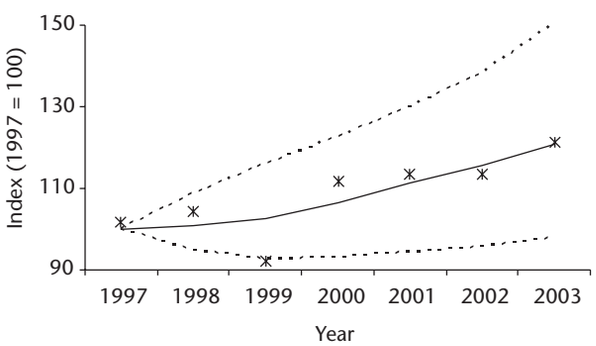


Figure 4.10a Lesser horseshoe bat hibernation survey for the UK (1997–2003). Results of GAM analysis with 95% confidence limits

Survey schemes providing information on this species: NBMP and Countryside Council for Wales (CCW) monitoring. The NBMP collects hibernation site data for the UK and carries out colony counts in England. CCW has been carrying out colony counts in Wales since 1993 and provides data to the NBMP for analysis.

Information on population trends

Hibernation survey. Lesser horseshoe bats were seen in a mean of 52 sites from 1997–2003, representing 13.7% of the total site network (379 sites). Of those 70% are located in England and 30% in Wales. Mean number of bats per site across all years is 17.34 (max 273). Trend analyses showed no significant trend for the UK (Figure 4.10a) and separate country analyses showed no significant trends for either England or Wales.

Colony survey. The total number of colonies counted from 1994–2002 is 187, with 85 of those colonies in England and 102 in Wales. The mean number of colonies counted annually in the UK is 93, in England 30.5 (minimum 6, maximum 45) and in Wales 62.5 (minimum 31, maximum 68). The mean number of bats per colony is 101 (minimum 1, maximum 680). The results of this survey show that within the species range in England and Wales, the size of colonies has increased significantly by 79% from 1994–2002 with a 6.7% increase annually (Figure 4.10b). A country breakdown shows that there has been a significant 84% overall increase in England, representing 7.9% annually and in Wales there has been a significant 75.5% increase, representing a 6.5% annual increase (Figures 4.10c & 4.10d). Sample sizes are not large enough to assess population trends at the level of English GOR or Environmental Zones. These analyses may be possible in future years.

Interpretation of survey results: the survey results suggest steady upward trends for this species. More time is required to see if the hibernation survey results confirm this trend.

Future requirements: more years of surveillance data are required to confirm trends. In order to assess the effect of habitat management measures under the SAP, research is required to assess colony dispersal rates/new colony formation, to estimate population increase as well as decline.

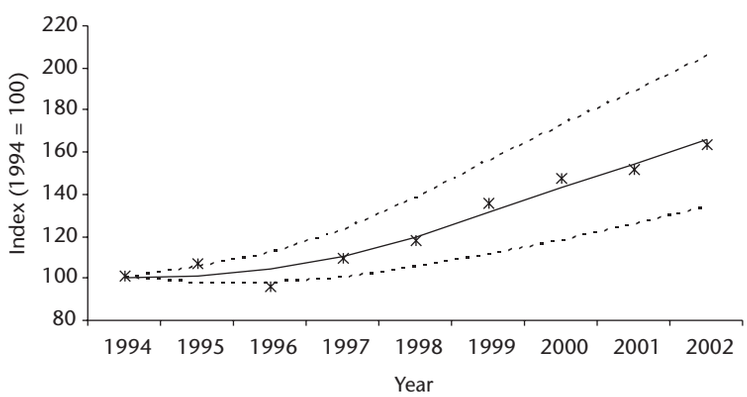


Figure 4.10b Lesser horseshoe bat colony counts for the UK (1994–2002). Results of GAM analysis with 95% confidence limits

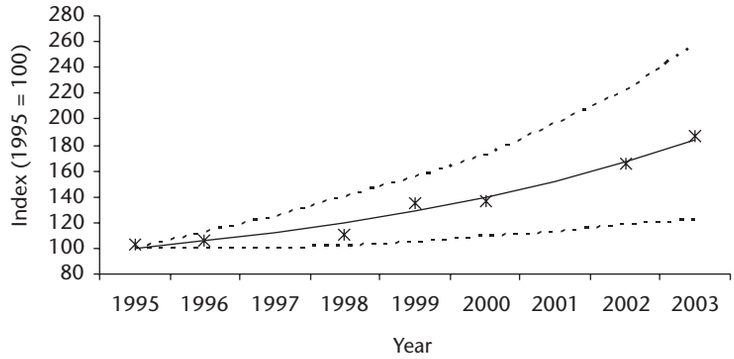


Figure 4.10c Lesser horseshoe bat colony counts for England (1995–2003). Results of GAM analysis with 95% confidence limits

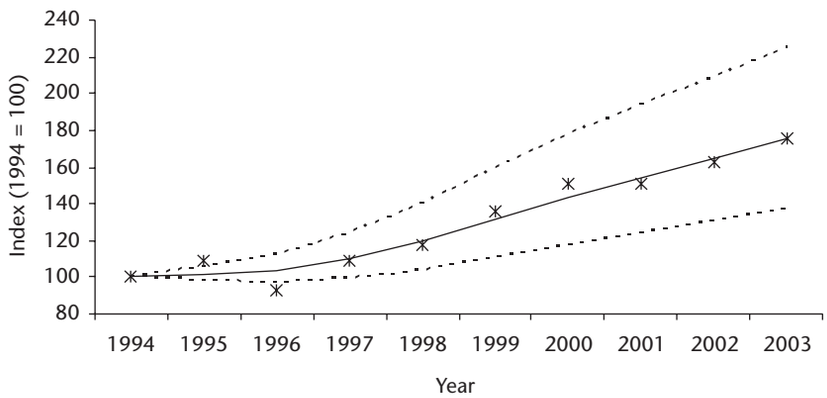


Figure 4.10d Lesser horseshoe bat colony counts for Wales (1994–2003). Results of GAM analysis with 95% confidence limits

11. Whiskered bat *Myotis mystacinus*

Native, locally distributed.

Population estimate: UK 64,000; England 30,500; Scotland 1,500; Wales 8,000; Northern Ireland 24,000 (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; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: requirements of this species are largely unknown, but it is probably subject to the same threats as other bat species, *i.e.* the loss of roost sites, foraging habitats and insect prey.

Historic trends: considered by some to be relatively abundant in the 20th Century and before, although the species was often overlooked or mistaken for pipistrelles, so the real status of the species is unclear. It may have declined significantly in recent years.

Survey schemes providing information on this species: NBMP.

Information on population trends

Hibernation survey. It is very difficult to separate this species from Brandt's bats in hibernation sites, because they are morphologically very alike and positive identification would require disturbance of the bats. Therefore, whiskered and Brandt's bats have been treated as one species for the purpose of data analysis. An annual mean of 52 hibernation sites had counts of these species since 1997. Figure 4.11 indicates a stable population for this/these species. Year to year differences are not significant ($\chi^2 = 3.60$ with 7 d.f., $P = 0.825$) and the confidence limits are very wide.

Interpretation of survey results: the hibernation survey is the only survey collecting data on whiskered/Brandt's bats at present and results suggest that the populations are stable, although it is not possible to detect individual species trends and this should be an important consideration in any future surveys developed with these species in mind.

Future requirements: *Myotis* bats are difficult to survey because of similarities between species in their ecology, morphology and echolocation. Methods that distinguish between species are being developed by the NBMP, including the use of frequency division bat detectors. It should then be possible to develop survey techniques to assess population distribution and changes in relative abundance.

12. Brandt's bat *Myotis brandtii*

Native, common in west and north England, rare or absent elsewhere.

Population estimate: UK 30,000; England 22,500; Scotland 500; Wales 7,000; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix II; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

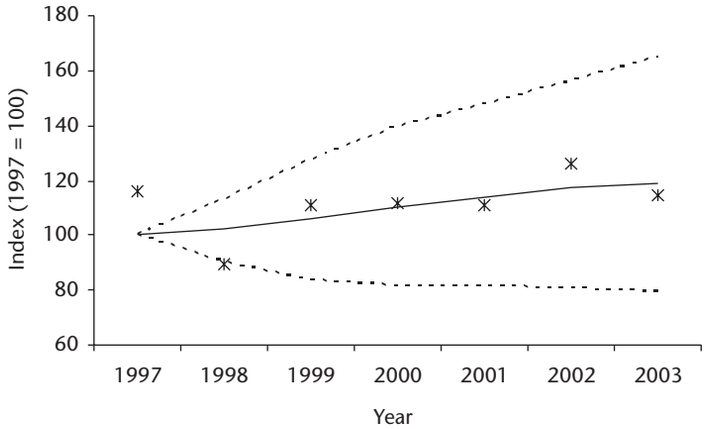


Figure 4.11 Whiskered/Brandt's bat hibernation survey for the UK (1997–2003). Results of GAM analysis with 95% confidence limits

Importance/threats: requirements of this species are largely unknown, but it is probably subject to the same threats as other bat species, *i.e.* the loss of roost sites, foraging habitats and insect prey.

Historic trends: not distinguished from whiskered bat until 1970 and many records do not separate the two species. It may have declined significantly in recent years.

Survey schemes providing information on this species: NBMP.

Information on population trends

Hibernation survey. It is very difficult to separate this species from whiskered bats in hibernation sites, because they are morphologically very alike and positive identification would require disturbance of the bats. Therefore, whiskered and Brandt's bats have been treated as one species for the purpose of data analysis. An annual mean of 52 hibernation sites had counts of these species since 1997. Figure 4.11 indicates a stable population for this/these species. Year to year differences are not significant ($\chi^2 = 3.60$ with 7 d.f., $P = 0.825$) and the confidence limits are very wide.

Future requirements: *Myotis* bats are difficult to survey because of similarities between species in their ecology, morphology and echolocation. Methods that distinguish between species are being developed by the NBMP, including the use of frequency division bat detectors. It should then be possible to develop survey techniques to assess population distribution and changes in relative abundance.

13. Natterer's bat *Myotis nattereri*

Native, fairly common throughout much of the UK.

Population estimate: UK 148,000; England 70,000; Scotland 17,500; Wales 12,500; Northern Ireland 48,000 (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; CMS Appendix II, W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: requirements of this species are largely unknown, but it is probably subject to the same threats as other bat species, *i.e.* the loss of roost sites, foraging habitats and insect prey. Possibly particularly associated with old large stone buildings with large timbers, where renovation could be a threat. The UK population may be of international importance (Hutson, 1993).

Historic trends: unknown because of the difficulties in distinguishing between *Myotis* species and developing effective survey methods.

Survey schemes providing information on this species: NBMP

Information on population trends

Hibernation survey. A mean of 124 sites has been counted annually from 1997–2003. Trend analysis indicates a significant overall increase of 42%, representing a mean annual increase of 6% (Figure 4.13).

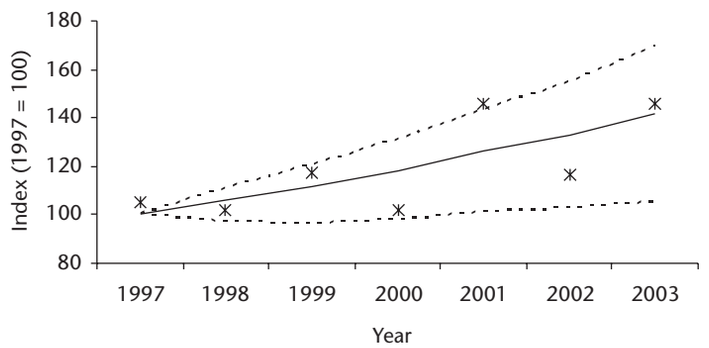


Figure 4.13 Natterer's bat hibernation survey for the UK (1997–2003). Results of GAM analysis with 95% confidence limits

Colony survey. Counts of Natterer's colonies only commenced in 2000, so there is a very limited data set available. A total of 58 colonies have been counted, with an annual mean of 39 roosts counted across the UK. Mean number of bats per colony is 35, with slightly larger colonies in Scotland (mean 38 bats) than in England and Wales. Sample sizes are too small at this stage to carry out trend analyses.

Interpretation of survey results: the results of the hibernation survey suggest that there has been a significant increase in UK populations of this species. In four or five years it should be possible to produce more robust information when both the hibernation and colony surveys have sufficient data for trend analysis.

Future requirements: continued surveillance using current methods is required for at least five years to assess trends. Natterer's bat tends to forage in woodland and has relatively quiet echolocation calls, so it has been difficult to develop field survey methods for this species. The use of frequency division detectors may produce survey techniques that will enable population distribution to be properly assessed.

14. Bechstein's bat *Myotis bechsteinii*

Native, very rare.

Population estimate: UK ?; England 1,500; Scotland 0; Wales ?; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix II; CMS Appendix II; W&CA Schedules 5, 6; HD Annexes II, IV; EUROBATS Agreement; WMA; SAP; IUCN Red List. There are nine SSSIs that have been selected for designation as SACs.

Importance/threats: probably one of the UK's rarest resident mammals, its rarity may make it vulnerable to the loss of individual roost sites and foraging areas. A good indicator of the quality of ancient woodlands.

Historic trends: there is evidence that this species may have been more common over 2,000 years ago and that as a woodland foliage gleaner, it has suffered from the fragmentation and loss of ancient deciduous woodlands (Yalden, 1992). In more recent times the species populations may have stabilised at very low levels and may not have undergone recent declines.

Survey schemes providing information on this species: none at present.

Additional species information: this species has a close association with semi-natural woodland but is very difficult to monitor as the echolocation call is too quiet to pick up with ultrasonic detectors. Colonies roost mainly in trees and are very mobile and the species is only rarely encountered in the NBMP hibernation survey. A recent survey development using artificially produced social calls to attract Bechstein's bat into mist nets has proved successful (Figure 4.14). Work on locating roosts and identifying the habitat used by the species is being continued by David Hill and Frank Greenaway at the University of Sussex with funding from MTUK and the Forestry Commission (Hill & Greenaway, 2005).

Figure 4.14 Bechstein's bats are attracted by the simulated social calls produced by the Autobat. This greatly increases the chances of catching them, and so makes it feasible to survey woodlands for their presence. © Frank Greenaway

The NBMP's approach is to use non-invasive monitoring protocols that are suitable for widespread use by volunteers and thus there are no plans for widespread mist net use for bats at present. Bechstein's bat is caught in sufficient numbers for monitoring at mating 'swarming' sites in late summer and this could offer a potential for monitoring. However, bats need to be caught and handled to identify them. The only other possible non-invasive technique is to monitor Bechstein's use of bat boxes. Bat box research in southern England has demonstrated some success in attracting Bechstein's bat. However, Frank Greenaway (*pers. comm.*) has raised the issue of potential disruption to Bechstein's communities through placing large numbers of bat boxes in semi-natural woodland. This issue needs to be investigated before pursuing the use of bat boxes as a possible monitoring strategy.

Future requirements: continue to develop knowledge of the species distribution, habitat preferences and the location of maternity colonies, using existing methods and develop and test non-intrusive monitoring and surveillance methods.

15. Daubenton's bat *Myotis daubentonii*

Native, common throughout much of the UK.

Population estimate: UK 560,000; England 95,000; Scotland 40,000; Wales 15,000; Northern Ireland 410,000 (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; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: this species is a good indicator of riparian habitat management and water quality. European Bat Lyssavirus (EBLV) type II has been detected in Daubenton's bats in the UK on several occasions in recent years and it is likely that EBLV is endemic in UK populations.

Historic trends: considered abundant in England and Wales at the turn of 20th Century and widespread in Scotland, the species subsequently declined in the north. More recently there have been population increases across

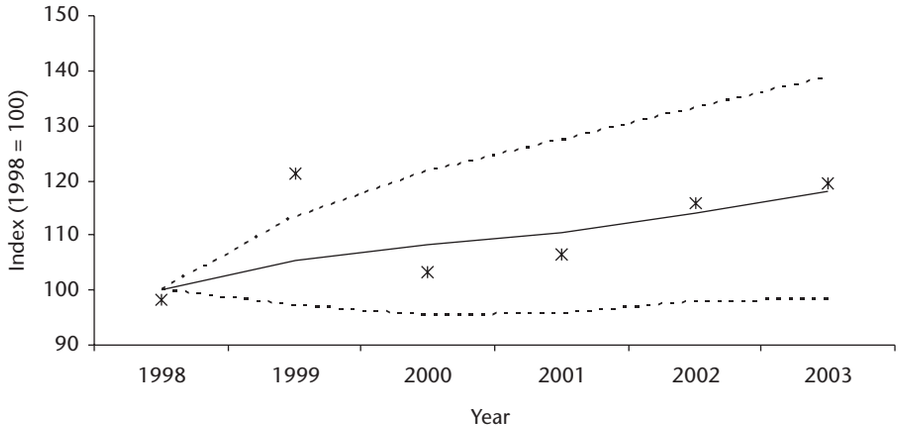


Figure 4.15a Daubenton's bat field survey for the UK (1998–2003). Results of GAM analysis with 95% confidence limits

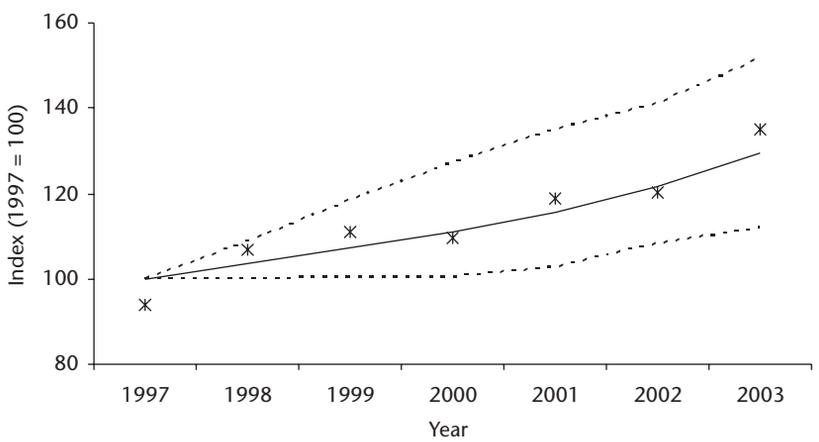


Figure 4.15b Daubenton's bat hibernation survey for the UK (1997–2003). Results of GAM analysis with 95% confidence limits

Europe, possibly because of changing abundance of aquatic insects (Daan, 1980; Warren *et al.*, 2000).

Survey schemes providing information on this species: NBMP.

Information on population trends

Field survey. The analysis of survey results showed no significant trend at the UK level (Figure 4.15a), although there appears to be an upward trend from the graph. Separate analyses carried out for England and Scotland also showed no significant trends. Sample sizes for Wales and Northern Ireland were too small for separate analyses.

Hibernation survey. Analysis of results from this survey showed highly significant year to year differences (χ^2 = 23.53 with 10 d.f., P = 0.009) with an estimated overall increase of 30%, representing a mean annual increase of 4.4% across the UK from 1997–2003 (Figure 4.15b). There is evidence from historic data sent to the NBMP of a continued increase from 1993, but as the number of sites surveyed pre-1997 was small, results have been presented from 1997 onwards.

Interpretation of survey results: the indications are that populations of this species are increasing across the UK, although further data are required, particularly from the field survey, to confirm this result.

Future requirements: continue existing surveillance of this species to confirm population trends.

16. Serotine *Eptesicus serotinus*

Native, widespread in southern Britain.

Population estimate: UK 15,000; England 15,000; Scotland 0; Wales 0; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix II; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: this species roosts almost exclusively in buildings so is particularly vulnerable to anthropogenic factors, such as building renovation and timber treatment. May also rely on cattle pastures for insect prey at certain times of the reproductive cycle and so management of agricultural land is an important consideration. EBLV is present in European populations, but there are no indications of EBLV presence in UK populations at present.

Historic trends: the species has always had a restricted distribution and been considered a rare bat. However, it is a crevice dwelling bat that generally forms small colonies within its UK range and may have been under-recorded in the past. There is no clear consensus on historic trends for

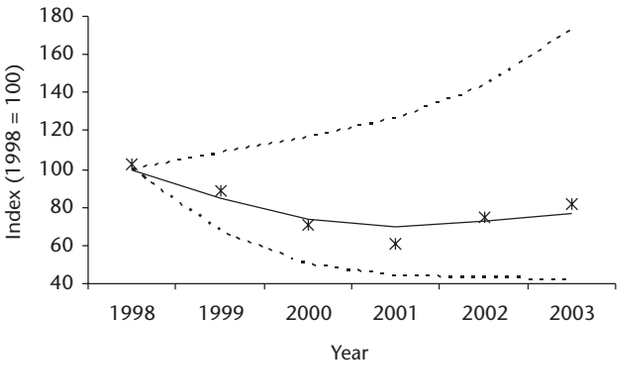


Figure 4.16a Serotine field survey (1998–2003). Results of GAM analysis with 95% confidence limits

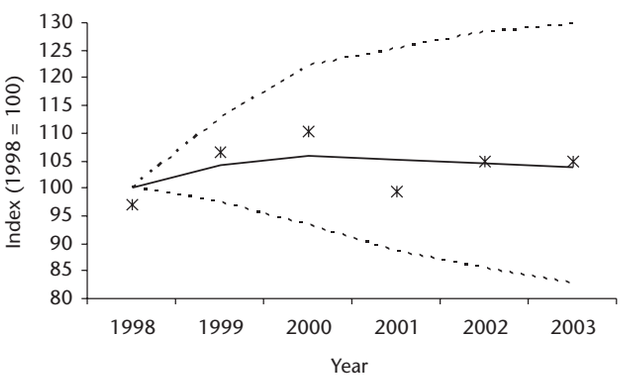


Figure 4.16b Serotine colony counts (1998–2003). Results of GAM analysis with 95% confidence limits

this species, but some evidence exists for serious declines in the population (Battersby, 2000; Stebbings & Griffith, 1986).

Survey schemes providing information on this species: NBMP.

Information on population trends
This species has a restricted distribution with records mainly from southern England.

Field survey. Serotines were detected on a mean of 31.5 survey squares from 1998–2003, representing 20.2% of squares surveyed annually. The data analysis showed no significant trend across years (Figure 4.16a).

Colony survey. A total of 98 colonies has been counted since 1997, with 60 counted more than once. Mean number of colonies counted each year is 41, with a mean colony size of 19.6 bats and a maximum of 295 bats in a very large roost in Somerset. Figure 4.16b shows no significant trend across years for this species.

Interpretation of survey results: the time series dataset and the sample sizes for both surveys are quite small, but at present the information suggest that the population is stable.

Future requirements: longer time series and larger sample sizes are required to provide robust results. New methods are required to locate roosts and assess population distribution, abundance and range change as a possible result of climate change.

17. Noctule *Nyctalus noctula*

Native, generally uncommon, but more numerous in well-wooded areas.

Population estimate: UK 50,000; England 45,000; Scotland 250; Wales 4,750; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix II; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: the noctule is a tree-dwelling species, often roosting in large colonies in the hollow trunks or branches of old or dead trees. The loss of suitable roost sites through woodland management is, therefore, a problem.

Historic trends: in the early 20th Century the species was considered common and widespread in most of England and Wales, although rarer in Scotland. More recent observations suggest a substantial decline in this species, particularly after the 1940s, but there are insufficient data to substantiate this (Stebbings & Griffith, 1986).

Survey schemes providing information on this species: NBMP.

Information on population trends
Field survey. The NSP is the only survey collecting data on this species. Noctules were detected on a mean of 67 survey squares from 1998–2003, representing 43% of squares surveyed annually. Trend analysis showed no significant change, suggesting that the population is stable (Figure 4.17).

Interpretation of survey results: the ecology of this species makes it a difficult subject for surveillance schemes. Very few maternity roosts are known and it is not found in known hibernation sites. However, the sample size in the field survey is sufficient to deliver UK level trends and at present the population appears to be stable, although the time series dataset is relatively short and longer datasets are required to provide robust trends.

Future requirements: continue existing surveillance of this species to confirm population trends. Consider developing new methods to locate roosts and assess population distribution and abundance.

18. Leisler's bat *Nyctalus leisleri*

Native, widespread, scarce in GB, common in Northern Ireland.

Population estimate: UK 28,000; England 9,750; Scotland 250; Wales 0; Northern Ireland 18,000 (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; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA; IUCN Red List; SAP (Northern Ireland).

Importance/threats: Ireland has an internationally important population of this species and the Northern Ireland population is therefore important.

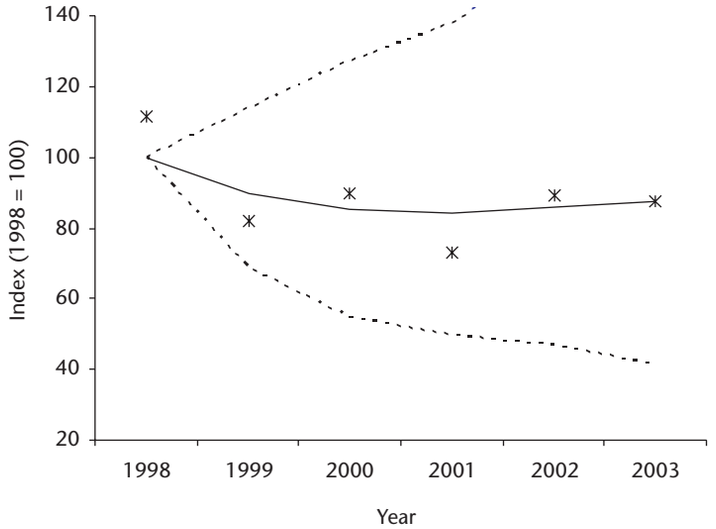


Figure 4.17 Noctule field survey (1998–2003). Results of GAM analysis with 95% confidence limits

Historic trends: not known, but may be increasing in the UK.

Survey schemes providing information on this species: none at present.

Additional species information: although widespread in the UK, Leisler's bat appears to be at low density with few breeding colonies recorded in GB, but in Northern Ireland it is a common species that is encountered roosting in houses. Its echolocation call is intermediate between noctules and serotines, the exact type of call dependant on the environment where it is found. Identification of this species with reasonable confidence requires surveyors who have some previous experience. However, once broadband detectors are used as standard equipment in field surveys it will be possible to monitor this species.

Future requirements: develop and pilot survey methods, particularly in Northern Ireland where the species is relatively common.

19. Common pipistrelle *Pipistrellus pipistrellus*

Native, common across the UK.

Population estimate: UK 2,430,000; GB 1,280,000 (Colin Catto *pers. comm.*) country breakdowns not available; Northern Ireland, 1,150,000 (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; CMS Appendix II; W&CA Schedules 5, 6; SAP; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: the most common bat across the UK, it is considered that widespread habitat management at a landscape scale to benefit this species through the SAP, will also help to conserve some of the rarer species with more restricted distributions. A high proportion of colonies are found in buildings and so the species is particularly vulnerable to anthropogenic factors, such as disturbance, timber treatment and building renovation.

Historic trends: numerous and widespread across the UK in the early 20th Century, this species is thought have undergone substantial population declines of around 55% since the 1960s (Stebbings & Griffith, 1986). However, the recent division of this species into two species, the common and soprano pipistrelle, makes it difficult to interpret historic trends.

Survey schemes providing information on this species: NBMP.

Information on population trends

Field survey. Common pipistrelles were the most frequently recorded species in this survey, detected on a mean of 77 survey sites from 1998–2003, representing 49.5% of sites surveyed annually. The trend analysis indicated a significant upward trend of 98%, representing a mean annual increase of 14.6% across the UK. The annual pattern does not vary significantly between countries ($\chi^2 = 3.33$ with 10 d.f., $P = 0.972$) (Figure 4.19a).

Colony survey. Counts have been carried out at a total of 222 roosts throughout the UK since 1997, with an annual mean of 99 roosts. Mean colony size across the UK was 70.9 bats and this varied significantly between countries with England having the smallest colonies (mean 60.5) compared with Scotland (mean 85.2) and Wales (mean 103.4). The sample for Northern Ireland was too small for comparison. The trend analysis for the colony survey showed no significant change (Figure 4.19b) and there was no difference in annual patterns between countries.

Interpretation of survey results: initial results from the field survey suggest a substantial increase in common pipistrelle populations. However, this is a relatively short time-series dataset and the trend is not supported by the colony count data, which suggests that populations are currently stable. The biases associated with colony surveys mean that the colony count data are less robust than the field survey data and therefore the field survey is more likely to be correct. Further investigation and longer time series are required to confirm and explain trends.

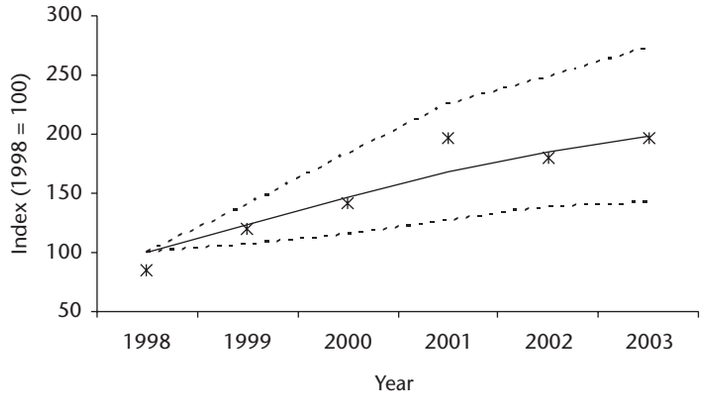


Figure 4.19a Common pipistrelle field survey for the UK (1998–2003). Results of GAM analysis with 95% confidence limits

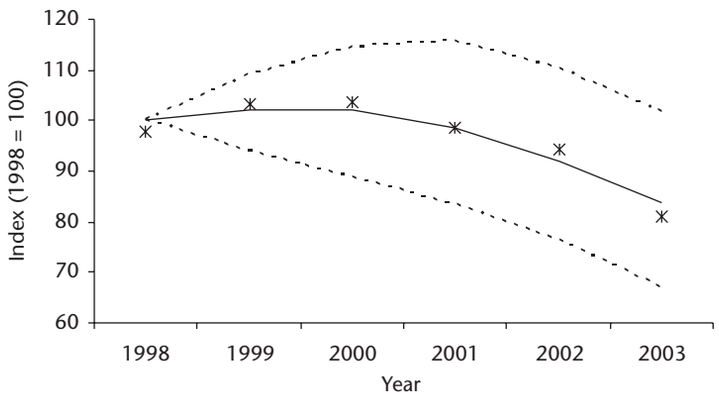


Figure 4.19b Common pipistrelle colony counts for the UK (1998–2003). GAM results plus 95% confidence limits

Future requirements: continue field and colony surveillance of this species in the NBMP to confirm trends. There are a number of 'unidentified species' colony counts being returned to the NBMP each year and it is probable that the majority of these are common or soprano pipistrelle colonies. Positive identification of these colonies by an expert is a priority, in order to increase the colony count datasets for both these species.

20. Soprano pipistrelle *Pipistrellus pygmaeus*

Native, common across the UK.

Population estimate: UK 1,300,000; GB 720,000 (Colin Catto *pers. comm.*) country breakdowns not available; 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; CMS Appendix II; W&CA Schedules 5, 6; SAP; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: a recently discovered species, the soprano pipistrelle can be distinguished from the common pipistrelle by its higher echolocation frequency (55kHz as opposed to 45kHz for the common pipistrelle). The species appears to be more reliant on aquatic habitats than the common pipistrelle. The soprano pipistrelle also roosts preferentially in buildings, but tends to form larger colonies than the common pipistrelle. This may increase the threat from human interactions, because of potential conflicts with occupants of dwellings.

Historic trends: the fact that this species was only recently discovered in the UK (Barrett *et al.*, 1997) means that historic information on populations is not available.

Survey schemes providing information on this species: NBMP.

Information on population trends

Field survey. Soprano pipistrelles were detected on a mean of 70.5 survey squares from 1998–2003 across the UK, representing 45% of squares surveyed annually. The GAM analysis showed no significant trend for this species (Figure 4.20a). In England, which is the only country with sufficient data to carry out a separate analysis, the species was detected on a mean of 53.5 survey squares and the trend analysis also showed no significant change.

Colony counts. Counts have been carried out at a total of 166 roosts across the UK since 1998 with an annual mean of 61.6 colonies counted. Mean colony size across the UK was 295.5 bats and this varied significantly between countries, with England having the smallest colonies (mean 240.3 bats) compared with Scotland (mean 332.9 bats) and Wales (mean 449.1 bats). The sample for Northern Ireland was too small for comparison. The trend analysis showed no significant change from 1998–2003, although there appears to be an upward trend from the graph (Figure 4.20b).

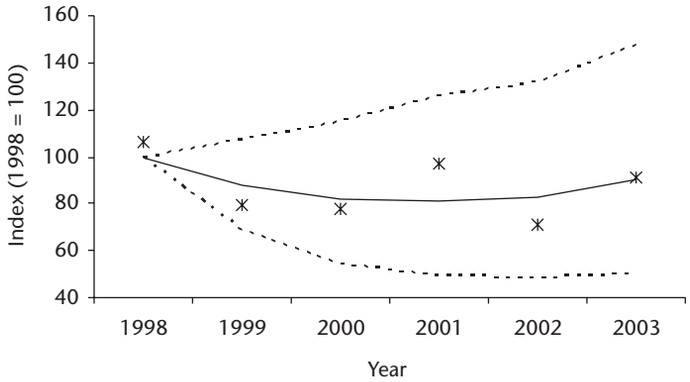


Figure 4.20a Soprano pipistrelle field survey for the UK (1998–2003). Results of GAM analysis with 95% confidence limits

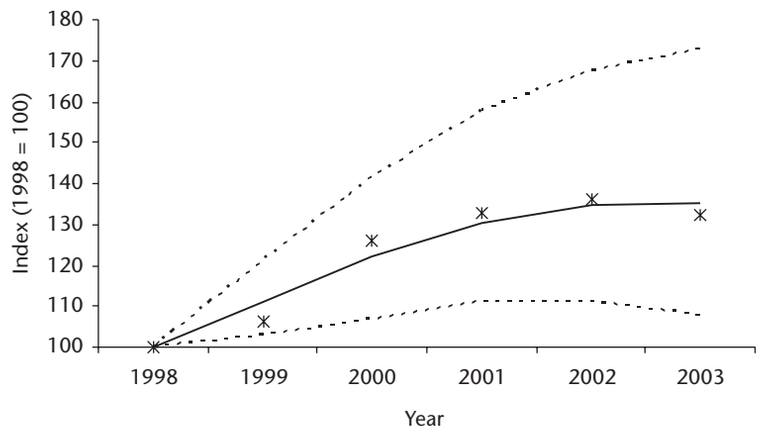


Figure 4.20b Soprano pipistrelle colony counts for the UK (1998–2003). Results of GAM analysis with 95% confidence limits

Interpretation of survey results: at present this species appears to have stable UK populations, although the sample sizes for the field survey are quite small and variable, producing wide confidence limits. The difference in colony size between the two pipistrelle species, which has been detected in the colony survey, supports previous findings that soprano pipistrelles have substantially larger colonies than common pipistrelles.

Future requirements: further investigation, longer time series and larger sample sizes are required to provide robust information and produce country level trends.

21. Nathusius' pipistrelle *Pipistrellus nathusii*

Native, rare.

Population estimate: UK 16,000; GB 4,000 (Colin Catto, *pers. comm.*); Northern Ireland 12,000 (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; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: a relatively recent discovery as a resident species in the UK, little is known about populations of this species. Under the EUROBATS Agreement it is a priority species for autecological research and there are obligations to locate migration routes.

Historic trends: unknown across the UK.

Survey schemes providing information on this species: none at present.

Additional species information: this species had long been considered as a vagrant in the UK but the discovery of a breeding colony in Northern Ireland in 1998 and subsequently in England and Wales confirm that this is a resident UK species. Although there are few known colonies, this species has a distinctive echolocation call (and a unique social call) that can be relatively easily recognised by trained surveyors. In mainland Europe, where it is relatively common, it is often found foraging over water bodies. The long term aim of the NBMP is to use broadband detectors on field surveys and to identify species post-survey through sonogram analysis. When resources are available and broadband detectors are used on field surveys it will be possible to incorporate this species on the existing Daubenton's and NSP projects.

Future requirements: develop the use of frequency division detectors and include this species in the NSP and Daubenton's field surveys.

22. Barbastelle *Barbastella barbastellus*

Native, widespread but rare.

Population estimate: UK 5,000; England 4,500; Scotland 0; Wales 500, Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix II; CMS Appendix II; W&CA Schedules 5, 6; HD Annexes II, IV; EUROBATS Agreement; WMA; SAP; IUCN Red List. Nine SSSIs have been selected for designation as SACs.

Importance/threats: the species is rare and threatened throughout its range, including the UK. It roosts in old buildings, so is susceptible to potential conflicts with dwelling owners. It also roosts and forages in woodland, roosting under tree bark and frequently changing roosts, so loss of woodland and felling of dead trees is likely to have a negative effect on populations.

Historic trends: the species was known to be widely distributed, but in small numbers in southern England and parts of Wales at the beginning of the 20th Century. The number of records for this species declined after a peak in the 1950s and 1960s, suggesting a population decline, but there are no data to confirm this.

Survey schemes providing information on this species: none at present.

Additional species information: it is now possible to identify barbastelle bats from their echolocation calls with reasonable confidence. The NBMP will be piloting a detector-based sample survey, stratified by woodland, using broadband detectors combined with post-survey sonogram analysis. The project will focus on four known barbastelle roosts and surveyors will be asked to walk a 3–4 km transect in the general area throughout June, July and early August. Analysis of the encounter rate of barbastelle bats will determine the optimum time to implement survey transects and identify the minimum number of transects required for robust monitoring. If results are encouraging then funding can be sought for a larger scale, volunteer-based, monitoring project.

Future requirements: pilot a detector-based sample survey, using broadband detectors combined with post-survey sonogram analysis.

23. Brown long-eared bat *Plecotus auritus*

Native, common.

Population estimate: UK 245,000; England 155,000; Scotland 27,500; Wales 17,500; Northern Ireland 45,000 (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; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: a woodland species, but also roosts preferentially in large loft spaces. The species is a slow flying foliage gleaner and does not like to cross open spaces. It is therefore susceptible to woodland loss and fragmentation and potential conflicts with owners of dwellings.

Historic trends: one of the most widely distributed and common species at the beginning of the 20th Century, but has undergone a long-term decline in relative abundance and distribution.

Survey schemes providing information on this species: NBMP.

Information on population trends

Hibernation survey. This species has been counted at a mean of 118.7 sites annually since 1997, with a mean of 1.17 bats per site across all years. Trend analysis showed no significant change (Figure 4.23).

Colony survey. A total of 74 colonies have been counted across the UK since 2001. Mean colony size across the UK was 22 bats and this varied between countries with significantly larger colonies in Scotland (mean 30.7 bats) than in England (20.5 bats) and Wales (mean 8.8 bats). There are only three years of data for this species 2001–2003, so trend analysis is not possible at this stage.

Future requirements: existing surveillance for this species should be continued to obtain more robust information on population trends. The species should be included in the woodland bat survey, when developed.

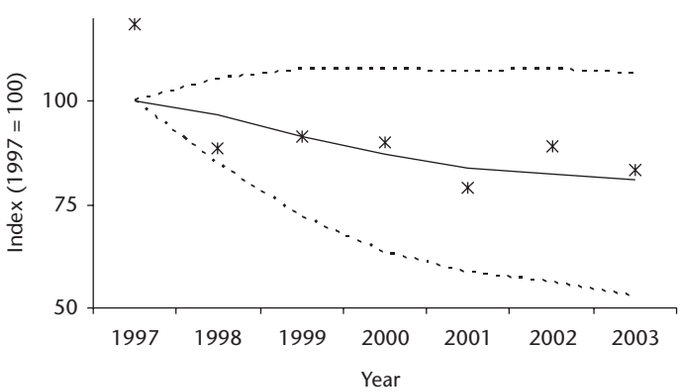


Figure 4.23 Brown long-eared bat hibernation survey for the UK (1997–2003). Results of GAM analysis with 95% confidence limits

24. Grey long-eared bat *Plecotus austriacus*

Native, very rare.

Population estimate: UK 1,000; England 1,000; Scotland 0; Wales 0; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix II; CMS Appendix II; W&CA Schedules 5, 6; HD Annex IV; EUROBATS Agreement; WMA.

Importance/threats: the extreme southerly restricted range of this species in the UK is an indication of its intolerance to harsh winters, so it is likely to be affected by climate change. In other respects it is very similar to the brown long-eared bat, although more associated with cultivated landscapes, and the threats are likely to be the same.

Historic trends: not known, but has probably always been rare in the UK.

Survey schemes providing information on this species: none at present.

Additional species information: this is one of the rarest mammals in the UK, whose distribution is confined to the south of England. It is morphologically very similar to the brown long-eared bat and requires an expert to confirm species identity. Like the brown long-eared, the echolocation call is too quiet to allow bat detector surveyors a monitoring option. At present no population monitoring options appear feasible although collation of existing and new records should be implemented.

Future requirements: compile a database of existing and new records of this species to assess possible distribution changes as a result of climate change.

4.4.3 Lagomorpha

25. Rabbit *Oryctolagus cuniculus*

Introduced, common in most areas.

Population estimate: UK ?; England 24,500,000; Scotland 9,500,000; Wales 3,500,000; Northern Ireland ?

Legal and conservation status: WMA.

Importance/threats: regarded as a pest species in agriculture and forestry and a conservation threat to the machair habitats of the Outer Hebrides and other sensitive habitats (Macdonald & Tattersall, 2001), the rabbit is an important prey species for mammalian and avian predators and is also considered useful in preventing secondary succession in some calcareous grassland, dune and heathland habitats.

Historic trends: substantial increase in wild populations from the mid-18th century gave an estimate of 100 million in GB at the turn of the 20th Century, but the introduction of myxomatosis in 1953 destroyed 99% of the population (Thompson, 1956). By the early 1990s the population had recovered and was estimated to be about 37.5 million. There are now concerns that populations could decline again following the possible spread of rabbit haemorrhagic disease (RHD) (Macdonald & Tattersall, 2001).

Survey schemes providing information on this species: wider countryside NGC, BBS, WBBS, MOR, WMM; urban LWM, GBW.

Information on population trends

NGC historic. This scheme has been collecting data since 1961 from a total of 1,603 estates. Figure 4.25a Shows historic population trends from 1961–2002, with a steadily increasing population until 1997, followed by a steady decline until 2002.

NGC current. Figure 4.25b shows current trends for NGC data from 638 estates from 1995–2002. The analysis indicated a significant decline of 47.7% in the species populations during that period across the UK. Separate analyses of English and Scottish estates showed that the decline was significant in both countries, but greater in Scotland, 42% and 57.3% respectively (see Table 4.1).

BBS. Results of this survey suggest a significant continuous decline across the UK from 1997–2002 of 23% (Figure 4.25c). The largest declines have been in Scotland, 40% and to a lesser extent in England, 17% where East and West Midlands have shown the greatest detectable declines. Significant declines were detected in Environmental Zones 1, 2 & 4, the westerly and easterly lowlands of England and Wales and the lowlands of Scotland (Table 4.2).

WBBS. Rabbits were counted in a mean of 52% of sites from 1998–2003, and showed a significant decline (Figure

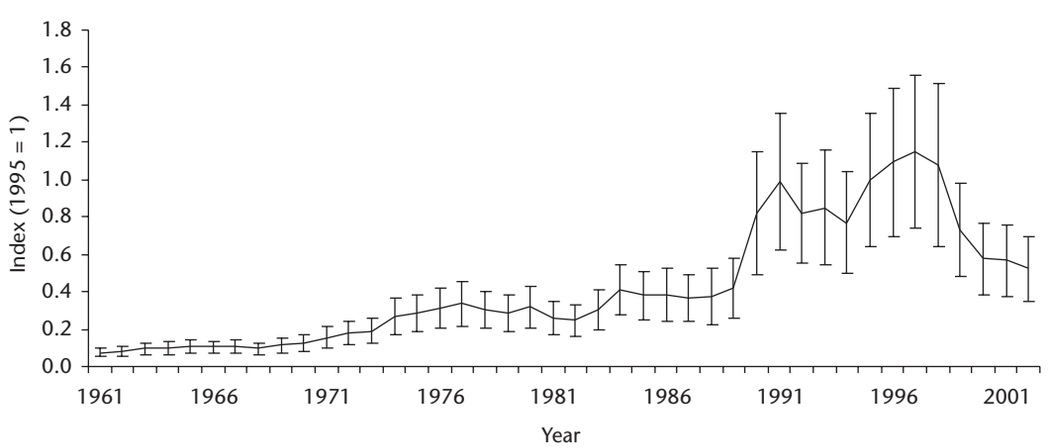


Figure 4.25a UK index of rabbit bags from the NGC (1961–2002)

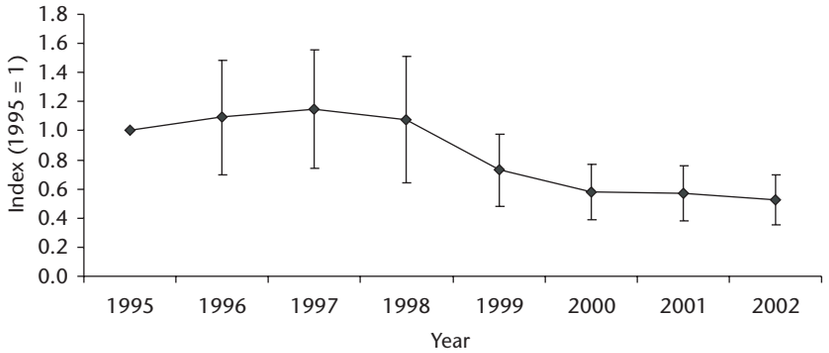


Figure 4.25b UK index of rabbit bags with 95% confidence limits from the NGC (1995–2002)

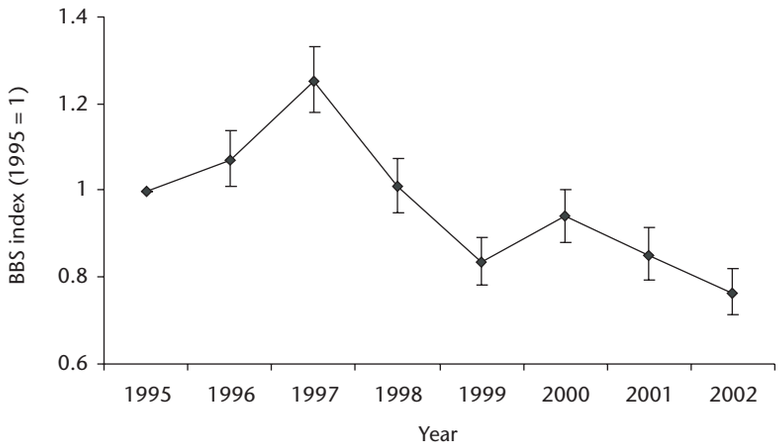


Figure 4.25c UK rabbit population indices with 95% confidence limits from the BBS (1995–2002)

Table 4.1 Summary of NGC gamebag results (1995–2002)

Species	UK		England		Scotland	
	Estates	% change (±SE)	Estates	% change (±SE)	Estates	% change (±SE)
Rabbit	638	–47.7±8.5 ***	366	–42.0±11.3 ***	246	–57.3±13.1 ***
Brown hare	638	–49.4±10.9 ***	366	–42.3±13.0 **	246	–38.8±20.8
Grey squirrel	616	–0.8±18.6	354	12.0±22.0	239	–46.7±30.2
Common rat	616	57.5±40.9	354	64.6±48.9	239	23.4±67.6
Fox	616	–1.0±10.1	354	1.0±11.5	239	0.1±18.8
Stoat	616	–6.1±10.7	354	–9.9±12.4	239	–2.8±19.4
Weasel	616	6.8±14.3	354	15.0±18.8	239	0.2±22.2
Mink	616	–11.1±17.6	354	28.3±33.5	239	–49.7±15.7 **

**$P < 0.01$; ***$P < 0.001$

4.25d), particularly in Environmental Zones 1 & 2, the westerly and easterly lowlands of England and Wales.

MOR. Rabbit was the most frequently seen mammal in this survey, with a mean of 53.5% of total sightings from 2001–2003. Mean number of rabbits seen per 100 km across GB increased from 3.77 in 2002, to 4.92 in 2003 and 7.13 in 2004 (Figure 4.25e). The increase appears to be mainly in England, although there are insufficient years of data to carry out trend analysis.

WMM. The sightings and signs components both recorded sample sizes large enough to monitor this species. Rabbits were seen on a mean of 224 squares from 2001–2003, representing 43.6% of sites surveyed. In the signs survey, rabbit presence was recorded on 62.2% of survey squares. With only three years of data the time series was too short to carry out trend analysis.

LWM. Rabbits were recorded in 154 of 808 urban sites representing 19% of sites. If this level of recording continues

Table 4.2 Rabbit presence in BBS squares (1995–2002)

Country	Mean squares present	Percent change (sig at $P \leq 0.05$)
UK	**1090**	**–23**
England	873	–17
Scotland	104	–40
Wales	75	NS
Government Office Regions		
North West England	90	–30
Yorkshire & The Humber	76	NS
East Midlands	71	–57
East of England	163	29
West Midlands	93	–41
South East England	208	–24
South West England	139	NS
Environmental Zones		
(1) Easterly lowlands (England/Wales)	479	–16
(2) Westerly lowlands (England/Wales)	367	–14
(3) Uplands (England/Wales)	105	NS
(4) Lowlands (Scotland)	60	–41

NS = Not significant

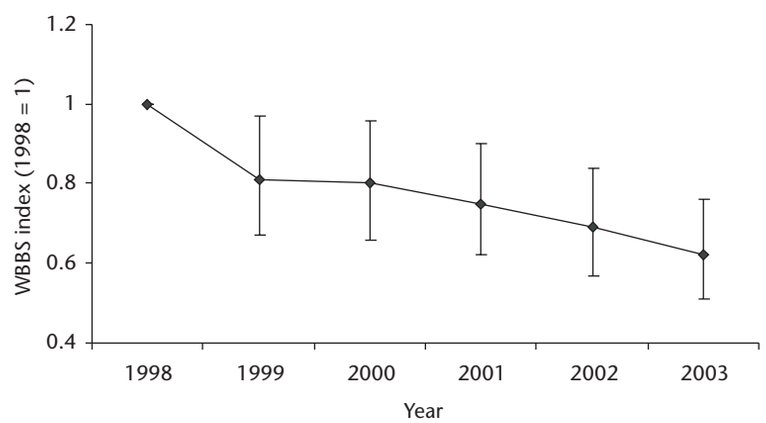


Figure 4.25d UK rabbit population indices with 95% confidence limits from the WBBS (1998–2003)

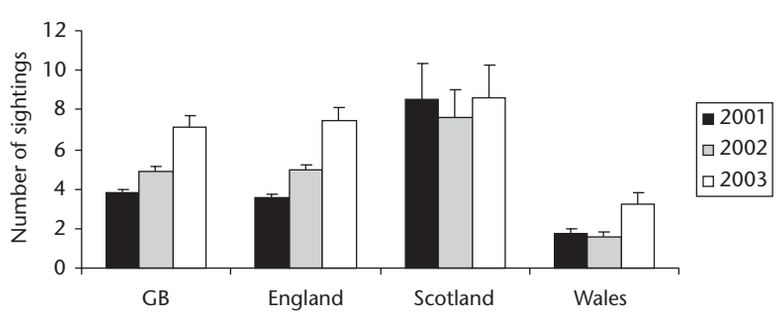


Figure 4.25e Observations of rabbit road kills at GB and country level, from the MOR survey (2001–2003)

then it should be possible to detect population change in the urban environment through this survey.

GBW. Rabbits were seen in 817 gardens during 2003, representing 18.7% of gardens in the survey.

Interpretation of survey results: evidence from three independent schemes, NGC, BBS and WBBS suggests that this species has been in decline since the mid-1990s, following a long term increase since the 1960s (from NGC historic data).

Future requirements: this species has the potential to be covered in the majority of wider countryside and urban multi-species schemes and could be used to cross calibrate the results for all surveys. Continued monitoring across a wide range of surveys is, therefore, essential.

26. Brown hare *Lepus europaeus*

Introduced, common and widespread.

Population estimate: UK 817,500; England 572,250; Scotland 187,250; Wales 58,000; Northern Ireland very few.

Legal and conservation status: Bern Convention, Appendix III; WMA; SAP.

Importance/threats: hares can cause damage to cereal crops, young trees and shrubs and so they are regularly shot for game and as a pest. However, this does not seem to have a long-term effect on population levels. The species is the subject of a SAP, which aims to maintain and expand existing populations, doubling spring numbers in GB by 2010.

Historic trends: probably introduced to GB by the Romans, the brown hare seems to have been abundant throughout GB at the turn of the 20th Century, but declines were already beginning. The reversion to traditional farming methods during the Second World War, and the decline in rabbit numbers following the introduction of myxomatosis in 1953, led to an increase in hare numbers, but populations declined again from the early 1960s, possibly stabilising in the early 1980s. Population changes have shown regional variation. Two National Hare Surveys have been carried out, the first in 1991–1993 and the second in 1997–1999, to establish effective survey methods and to provide a baseline of monitoring information. Volunteers were engaged and line transect sampling was used. The results of the surveys showed no significant decline in the overall population, but detected regional differences in trends, with hare densities highest in eastern Britain and declines apparent in southern England and coastal Scotland (Hutchings & Harris, 1996; Temple, Clark & Harris, 2000). Extrapolation of data from the surveys suggested that the population in the 1990s represented about 20% of the population in the 1890s.

Survey schemes providing information on this species: wider countryside NGC, BBS, WBBS, WMM; urban GBW.

Information on population trends

NGC historic. Figure 4.26a shows historic population trends from 1961 for 1,603 estates returning information on this species. The number of brown hares shot each year per unit area has declined steadily from 1961 to the end of the 1980s, at an average rate of 6% per year.

NGC current. Figure 4.26b shows current trends for NGC data from 638 estates from 1995–2002. Analysis of the results shows a significant 49.4% decline across the UK during that period. Country level analyses show the decline has been significant in both England, 42.3% and Scotland 38.8% (Table 4.1). Sample sizes were too small to provide separate analyses for Wales or Northern Ireland.

BBS. Brown hare sightings were recorded in a mean of 546 squares from 1995–2002, representing 30.5% of squares surveyed. There was no significant change in abundance overall in the UK between 1995 and 2002, but regional differences suggest that abundance has fallen in Scotland and South East England and in the uplands of England/Wales, while abundance has increased in South West England and in the westerly lowlands of England/Wales. See Table 4.3 and Figure 4.26c for details of trend information.

WBBS. Brown hare sightings were recorded in a mean of 21.8% of sites from 1998–2003. There was no significant change in relative abundance across GB during that period (Figure 4.26d). Data were only sufficient for regional trend analysis in Environmental Zone 1, the easterly lowlands of England and Wales and there was no significant trend.

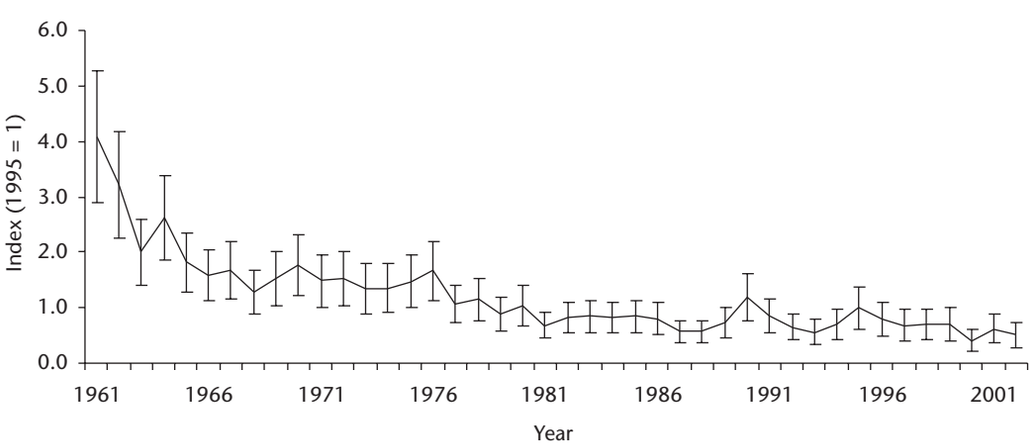


Figure 4.26a UK index of brown hare bags with 95% confidence limits from the NGC (1961–2002)

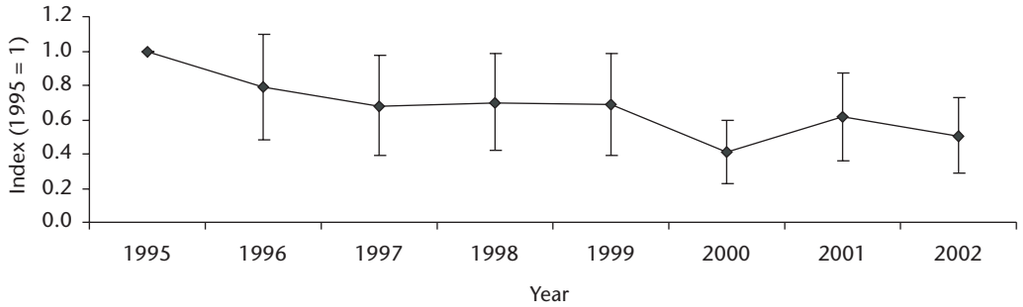


Figure 4.26b UK index of brown hare bags with 95% confidence limits from the NGC (1995–2002)

Table 4.3 Brown hare presence in BBS squares (1995–2002)

Country	Mean squares present	Percent change (sig at $P \leq 0.05$)
UK	546	NS
England	467	NS
Scotland	56	–43
Government Office Regions		
North West England	54	–19
Yorkshire & The Humber	46	NS
East Midlands	60	NS
East of England	130	NS
South East England	72	–25
South West England	51	27
Environmental Zones		
(1) Easterly lowlands (England/Wales)	292	NS
(2) Westerly lowlands (England/Wales)	145	16
(3) Uplands (England/Wales)	53	–20

NS = Not significant

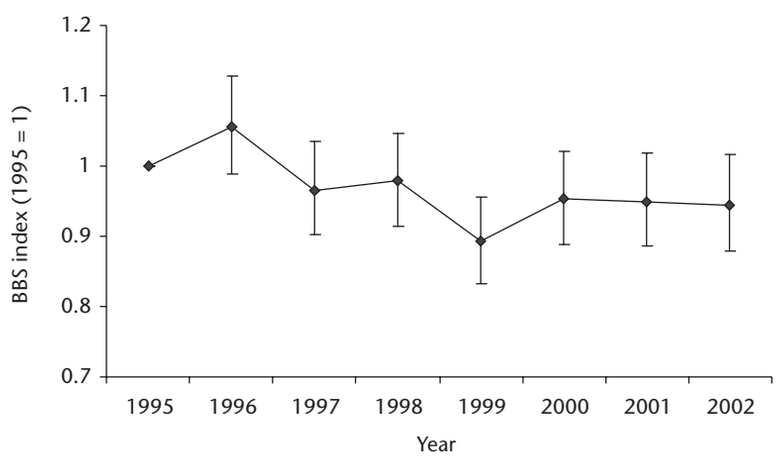


Figure 4.26c UK brown hare population indices with 95% confidence limits from the BBS (1995–2002)

WMM. In the sightings component brown hares were seen on a mean of 81.3 squares from 2001–2003, representing 16.4% of squares surveyed. With only three years of data the time series was too short to carry out trend analysis.

GBW. Brown hares were recorded in 113 gardens in 2003, representing 2.6% of gardens surveyed.

Interpretation of survey results: data from the NGC support historic reports of long-term declines in brown hare populations since the beginning of the 20th Century (Harris & McLaren, 1998; Tapper, 1992) and suggest that the long-term decline is continuing. Evidence from the BBS and WBBS suggests that populations may have stabilised since the 1990s at a relatively low level, but there are

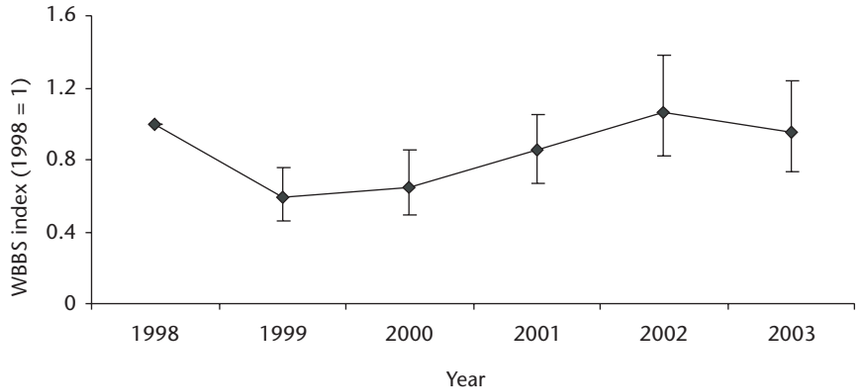


Figure 4.26d UK brown hare population indices with 95% confidence limits from the WBBS (1998–2003)

indications of regional trends in abundance, which may require further research and investigation.

Future requirements: continued monitoring of this species will lead to a better understanding of UK and regional population change.

27. Mountain hare *Lepus timidus*

Native, but widely introduced outside its natural range, locally common in some upland areas.

Population estimate: UK 360,000; England most recent estimate suggests the Peak District population could be as high as 10,000; Scotland 350,000; Wales 0; Northern Ireland – see Irish hare (page 63).

Legal and conservation status: Bern Convention Appendix III; HD, Annex V; WMA.

Importance/threats: mountain hares rely on heather moorland and benefit from traditional management for grouse shooting. However, they are a reservoir for louping ill, a tick borne disease that affects sheep and grouse, and can sometimes be regarded as pest species. They are hunted for sport and in order to control populations. The existing populations, particularly the English population in the Peak District, are under threat from isolation and possible local extinction.

Historic trends: a questionnaire survey carried out by GCT in 1995 on the distribution and trends of mountain hares in Scotland received information on 5,785 1 km squares from shooting estates. Approximately 66% of squares were located in upland habitat and mountain hares were found in 69% of those squares and 14% of the remaining lowland squares. Trend analysis on mountain hare bags from 1850–1995 suggested large fluctuations in mountain hare populations, with downward trends in the late 1970s and early 1990s. Numbers appeared to have been generally higher pre-1940 (Tapper, 1996). Populations may show a weak tendency towards population cycles with a periodicity of about 9.5 years (Tapper, 1987). The English population is restricted to the Peak District and two extensive surveys of the population have been carried out by Yalden (1984) who estimated the population contained a minimum of 735 individuals, and Mallon (2001) who suggested there were at least 994. These were both based on the maximum number of individuals seen during sighting surveys, and they may be underestimates (Wheeler, 2002). A further survey carried out over the winter of 2001–2002, based on sightings on transect walks, suggests that the population may currently be as large as 10,000 individuals (P. Wheeler, unpublished data, in Wheeler, 2002).

Survey schemes providing information on this species: wider countryside NGC, BBS.

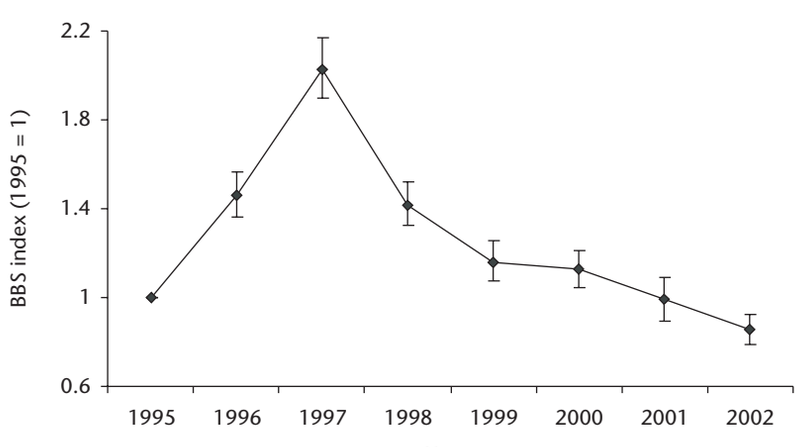


Figure 4.27 GB mountain hare population indices with 95% confidence limits from the BBS (1995–2002)

Information on population trends
NGC. This survey has the potential to provide information on mountain hare populations and future analyses of trends in game bags should be possible to assess trends in Scottish populations.

BBS. Mountain hares were recorded on a mean of 48 squares from 1995–2002, representing 2.7% of squares surveyed. Results from this survey indicate a significant overall decline in abundance of 14% in the UK (Figure 4.27). However, large fluctuations in abundance between years suggest that this may not be an underlying trend.

Interpretation of survey results: the best available evidence suggests that mountain hares in GB may be declining, but small sample sizes and large between year fluctuations make these data very difficult to interpret. As far as the English population is concerned, walks to count mountain hares in the Peak District have been organised by Sorby Natural History Society for the last thirty years, and the counts from these walks have provided an invaluable long-term population index of the Peak District mountain hare population. Recent years have shown a sustained increase in numbers, with the highest count (184 hares) in 2002 (Wheeler, 2002). It may be that the Scottish and English populations are undergoing different trends and because of the small size and local nature of the English population it is important to consider it separately.

Future requirements: continued monitoring at both a national level for the Scottish population and a local level for the English population in the Peak District to provide information on long-term trends.

28. Irish hare *Lepus timidus hibernicus*

Endemic subspecies of the mountain hare which is native to Ireland and considered to be genetically distinct from the Scottish population and more closely related to European mainland populations (Hamill, 2001).

Population estimate: Northern Ireland 82,000 (Tosh *et al.*, 2004).

Legal and conservation status: Bern Convention Appendix III; HD, Annex V; Wildlife (Northern Ireland) Order, Schedule 6 – cannot be taken by netting or snaring; SAP (Northern Ireland). Normally it would be legal to hunt by shooting or with dogs, but in early 2004 the species was subject to a temporary protection order for one year, preventing hunting by any means (John Milburne, *pers. comm*.).

Importance/threats: vulnerable to habitat changes caused by agricultural intensification. Forms part of the prey base for mammalian carnivores.

Historic trends: the evidence suggests a major decline in hare numbers throughout the 20th Century (Preston *et al.*, 2003), which has been linked to environmental change as a result of agricultural intensification. A survey conducted in the 1990s found hares to be widespread across Northern Ireland, but at low densities, 1–2 per km^2 (Dingerkus & Montgomery, 1997, 2002) and this prompted the setting up of a SAP by EHS (Biodiversity in Northern Ireland, 2000).

Survey schemes providing information on this species: Northern Ireland Irish Hare Surveys.

Information on population trends
Three Irish hare surveys have been carried out, in the mid-1990s, 2002 and 2004. The 1990s survey used transect walking methods, recording sightings of hares flushed from cover. The 2002 survey used a combination of daytime transect walks and night driven transects using spotlights to locate hares. The 2004 survey used only the night driven transect method. In the 1990s survey, hare density was estimated to be 1 hare per km^2 (Dingerkus, 1997) and this was supported in the 2002 survey, which estimated the same density and gave a population estimate of between 7,000 and 25,200 hares (Preston *et al.,* 2003). The repeat survey in 2004 gave an estimate of 5.87 hares per km^2, showing a marked increase in hare numbers during that time and a population estimate of 82,000 (Tosh *et al.,* 2004).

Interpretation of survey results: such a large population increase in a short space of time is indicative of the ability of hare populations to undergo rapid increases when conditions are favourable. However, this does not indicate long-term or lasting population change.

Future requirements: periodic surveys should be continued to assess population trends over a longer period of time.

4.4.4 Rodentia

29. Red squirrel *Sciurus vulgaris*

Native, but with multiple introductions from continental Europe. Near Threatened in England, Wales and Northern Ireland; locally common in Scotland.

Population estimate: UK ?; England 30,000; Scotland 121,000; Wales 10,000; Northern Ireland ?

Legal and conservation status: Bern Convention Appendix III; W&CA Schedules 5 & 6; WMA; SAP.

Importance/threats: this species is in serious decline, initially because of habitat fragmentation and loss, but also because of the spread of grey squirrel populations, which displace red squirrels through better exploitation of deciduous woodland habitat and potentially through transfer of squirrel poxvirus, a disease that is fatal in red squirrels but not in greys. A flagship species that is popular with the general public. Habitat management measures are required to conserve the species, which involve selection and protection of large coniferous woodlands that have no grey squirrels and that can be defended from their encroachment. However, this may conflict with the strategy being adopted for woodland HAPs, to plant mixed and deciduous woodland in place of conifer monocultures.

Historic trends: the species has shown a steady decline in England and Wales in both range and numbers since the grey squirrel was introduced and now only exists in a few isolated low density populations that are quite vulnerable. In Scotland there has been a slight range expansion, due to

increased afforestation (Gurnell & Pepper 1993), but the continued northward spread of grey squirrel populations is a major concern for the future. The current and historic distribution of red squirrels in the UK is shown in the distribution map for the species (Plate XV). Black dots indicate red squirrel distribution prior to 1985 and brown dots indicate where squirrels were present prior to 1985 and are currently still present.

Survey schemes providing information on this species: Northern Ireland red squirrel surveys. None at present in Britain.

Information on population trends

Northern Ireland surveys. Two surveys have been carried out in Northern Ireland to assess the change in distribution of red and grey squirrels. The first in 1995–1996 was an extensive survey of woodlands in Northern Ireland, which found that grey squirrels had dispersed to occupy all suitable habitat throughout the region (O'Teangana, 1999; O'Teangana *et al.*, 2000). The second survey was carried out in 2002 to assess the presence of red squirrels in areas considered to be preferred by them (McGhie & Milburne, 2000) and the areas of interface between the two species. A total of 80 sites were surveyed, including a proportion of the original survey sites that were at the interface of the two species. The results showed that grey squirrels had continued to spread across the region, and had displaced red squirrels completely in four sites where red squirrels had been recorded in the 1995 survey. A further four sites where only red squirrels had been recorded previously showed presence of grey squirrels as well (O'Neill & Montgomery, 2003).

Additional species information: a practice note has been produced by the Forestry Commission (Gurnell *et al.*, 2001) on the potential methods for monitoring squirrels, including sightings transects, drey counts, cone counts, hair tubes and mark–recapture. However, all the methods have problems (Gurnell *et al.*, 2003), some because they cannot distinguish between red and grey squirrels, others because the sample sizes obtained would be too small to assess population change over time (*e.g.* transect counts). The UK Red Squirrel Group (UKRSG), the lead partner for the red squirrel SAP, which has representatives from the country red squirrel groups, Forestry Commission and the Wildlife Trusts, has produced criteria for selecting priority areas for red squirrel conservation in each country. Using the criteria, several priority areas have been selected in England and management plans to favour red squirrels are being produced. The process of selection using the criteria is underway in Scotland and Wales (Scottish Squirrel Strategy, 2004. *www.snh.gov.uk/pdfs/scottish/squirrel.pdf. www.ukredsquirrel.co.uk*).

Future requirements: there is an urgent need to assess population trends in core red squirrel areas and in areas of red/grey interface and to monitor the rate of grey squirrel incursion into red only areas. A pilot study is commencing in 2005, funded by JNCC and PTES, to develop a surveillance scheme for red squirrels, which it is hoped will be operational in 3–4 years time.

30. Grey squirrel *Sciurus carolinensis*

Introduced, common and increasing.

Population estimate: UK ?; England 2,000,000; Scotland 200,000; Wales 320,000; Northern Ireland ?

Legal and conservation status: DIA; W&CA Schedule 9; WMA.

Importance/threats: a major invasive species, the grey squirrel has been the primary cause of red squirrel population declines across the UK. It is also known to have an effect on other native woodland birds and mammals and causes significant damage to market gardens, orchards, arable crops and commercial forests, particularly at high population densities (Gurnell, 1996, 1999; Hewson *et al.,* 2004; Macdonald & Tattersall, 2001; Pepper & Currie, 1998).

Historic trends: this species was introduced to England in various places from the late 19th Century until 1938, when it became illegal to import grey squirrels, or keep them in captivity (Lever, 1977). Since then the species has spread rapidly across England and Wales and is now spreading into parts of Scotland and is well established and spreading in Northern Ireland.

Survey schemes providing information on this species: wider countryside NGC, BBS, WBBS, MOR, WMM; urban LWM, GBW.

Information on population trends

NGC historic. The analysis of gamebag returns from 1961 from 1,222 estates across the UK shows large fluctuations with wide confidence limits in the early years and a relatively stable population for this species from 1979 onwards (Figure 4.30a). An analysis of regional trends carried out on the NGC data from 1975–2000 found significant increases in bags of grey squirrels in south-west England, East Anglia, east Midlands, north-east England, north-west England, east Scotland and west Scotland, with the greatest percentage increases occurring in East Anglia, northern England and Scotland. There was no detectable change in squirrel bags in south-east England or Wales. With the exception of East Anglia, increases in squirrel bags were thus predominantly located in the north of England and Scotland (Whitlock *et al*., 2003).

NGC current. Analysis of gamebag returns from 1995–2002 from 616 estates across the UK indicates no significant trend at the UK level (Figure 4.30b). Separate analyses for England and Scotland also showed no significant trends at the country level, although there were indications of a decline in Scotland, but confidence limits were very wide (Table 4.1, p. 58). Sample sizes were too small to provide separate analyses for Wales or Northern Ireland.

BBS. Grey squirrels were seen on a mean of 485 squares from 1995–2002, representing 27% of squares surveyed. Trend analysis suggests a significant 28% increase in abundance overall in the UK, with a large peak in 1996, perhaps related to high productivity in that year (Figure 4.30c). Increases were significant at the country level, with the largest increase in Wales, 77%, and to a lesser extent in

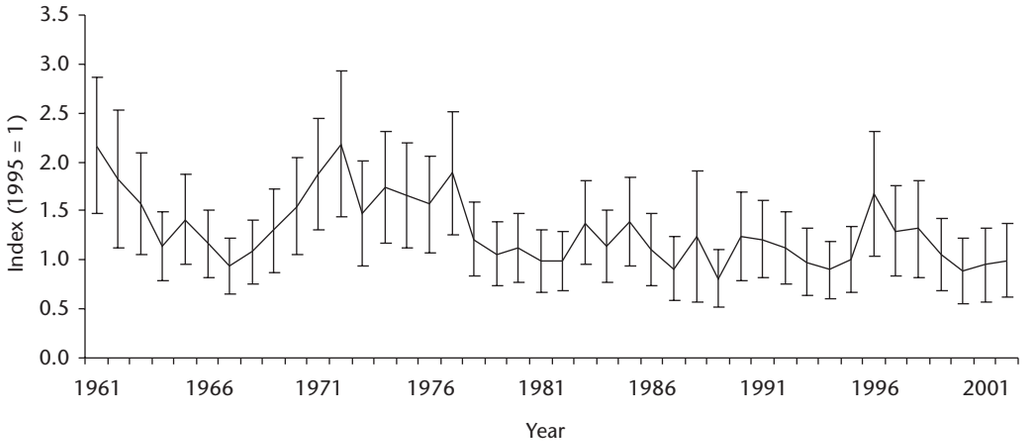


Figure 4.30a UK index of grey squirrel bags with 95% confidence limits from the NGC (1961–2002)

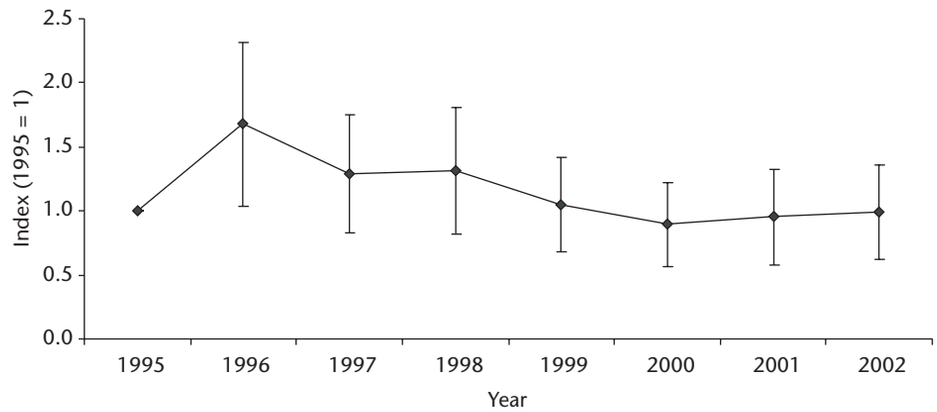


Figure 4.30b UK index of grey squirrel bags with 95% confidence limits from the NGC (1995–2002)

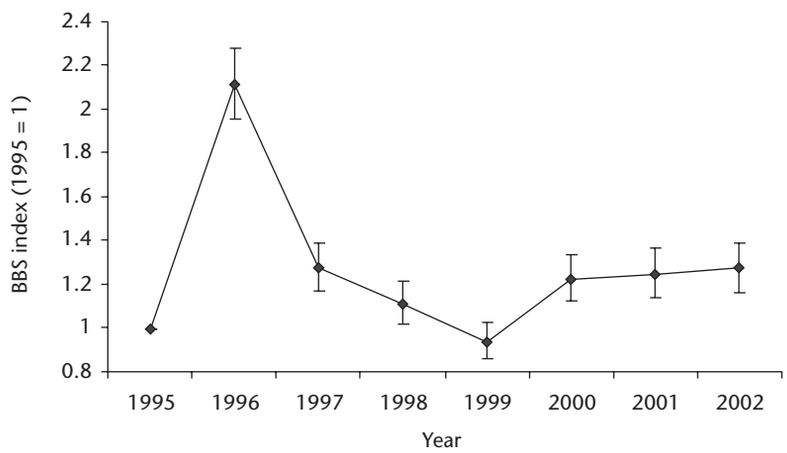


Figure 4.30c UK grey squirrel population indices with 95% confidence limits from the BBS (1995–2002)

England, 17% (Table 4.4). Sample sizes were too small to provide separate trends for Scotland. There were regional differences in trends, with significant increases in South West England, 81%, and Environmental Zone 2, the westerly lowlands of England/Wales.

WBBS. Grey squirrel was found on a mean of 44.2% of sites in this survey from 1998–2003, but the results showed no significant trend in populations during that time (Figure 4.30d).

MOR. Grey squirrel was the third most frequently seen mammal in this survey, with a mean of 5.11% of total sightings from 2001–2003. Mean number of sightings per 100 km across GB were greater in 2003 than 2001 and 2002 and this was also the case when looking at the countries separately (Figure 4.30e). There are insufficient years of data to carry out trend analysis.

WMM. Grey squirrels were seen on a mean of 160.7 sites from 2001–2003, representing 30.5% of squares surveyed.

Table 4.4 Grey squirrel presence in BBS squares (1995–2002)

Country	Mean squares present	Percent change (sig at $P \leq 0.05$)
UK	485	28
England	435	17
Wales	39	77
Government Office Regions		
East of England	77	NS
West Midlands	60	NS
South East England	128	NS
South West England	66	81
Environmental Zones		
(1) Easterly lowlands (England/Wales)	243	NS
(2) Westerly lowlands (England/Wales)	197	42

NS = Not significant

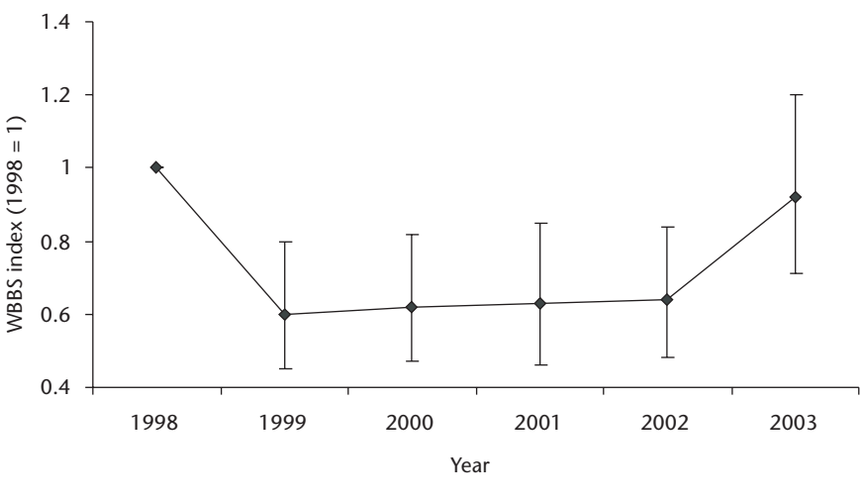


Figure 4.30d UK grey squirrel population indices with 95% confidence limits from the WBBS (1998–2003)

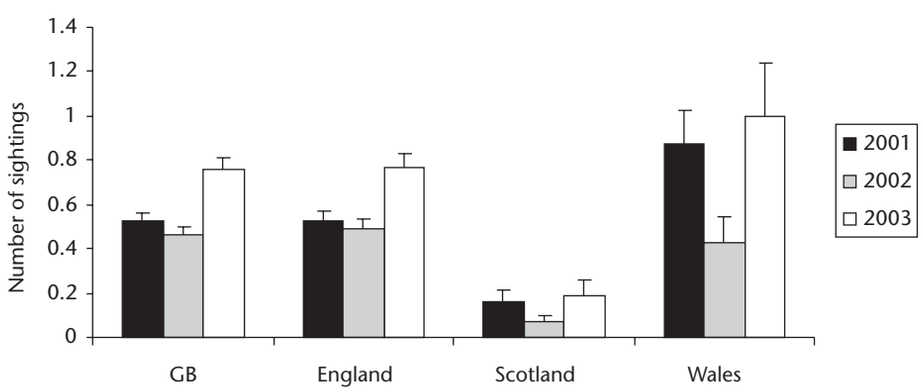


Figure 4.30e Observations of grey squirrel road kills at GB and country level, from the MOR survey (2001–2003)

Trend analysis was not possible with only three years of data.

LWM. Grey squirrels were seen in 487 of 808 sites surveyed, representing 60.3% of all sites. If this level of recording continues then it should be possible to detect population change in the urban environment through this survey.

GBW. This species was recorded in 3,365 gardens in 2003, representing 77.1% of gardens surveyed, indicating that this survey should be able to provide population trend information for grey squirrels in the future.

Interpretation of survey results: the results from the surveys carrying out trend analysis suggest stable or increasing populations for this species, with regional differences

and large between year variations. More years of data are required to confirm these results.

Future requirements: the majority of multi-species monitoring schemes contribute data on grey squirrels. However, important areas of overlap with red squirrel populations are difficult to monitor with existing techniques. This should be addressed in the pilot red squirrel monitoring scheme.

31. Bank vole *Clethrionomys glareolus*

Native, very common.

Population estimate: UK 23,000,000; England 17,750,000; Scotland 3,500,000; Wales 1,750,000; Northern Ireland 0.

Legal and conservation status: WMA.

Importance/threats: forms part of the prey base for mammalian carnivores and avian predators. This species could be vulnerable to lead exposure from roads and pesticide drift into field margins (Macdonald & Tattersall, 2001).

Historic trends: unknown.

Survey schemes providing information on this species: none.

Additional species information: as part of the ongoing National Owl Pellet Survey, The Mammal Society has been collecting data on this species for over 10 years.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, owl pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance.

32. Skomer vole *Clethrionomys glareolus skomerensis*

Native, locally common – confined to the island of Skomer, south-west Wales.

Population estimate: 7,000.

Legal and conservation status: WMA.

Importance/threats: endemic subspecies with an isolated population.

Historic trends: unknown.

Survey schemes: none.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, owl pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the bank vole (see above p. 67), but with local application.

33. Field Vole *Microtus agrestis*

Native, locally common.

Population estimate: UK 75,000,000; England 17,500,000; Scotland 41,000,000; Wales 16,500,000; Northern Ireland, 0.

Legal and conservation status: WMA.

Importance/threats: thought to be the most abundant mammal in the UK with a widespread but patchy distribution, field voles are a major prey item for several predators. The species may be threatened by increased grazing pressure, loss of rough grassland, removal of linear features and loss of 'marginal land' due to development.

Historic trends: probably declined since the 1970s due to grazing pressure from increasing rabbit numbers and loss of favoured habitat.

Survey schemes providing information on this species: WMM.

Information on population trends

WMM. In the signs component a mean of 84.7% of squares were searched for field voles from 2001–2003 and presence was detected on a mean of 64.5% of squares. With only three years of data the time series was too short to carry out trend analysis.

Additional species information: as a major component of the barn owl diet, The Mammal Society's National Owl Pellet Survey has over 10 years information on the distribution of this species and on annual variations in the percentage of this species caught and consumed by owls.

Interpretation of survey results: the WMM survey is the only scheme providing information on this species and the dataset is too short at present to provide information on population change.

Future requirements: continue surveillance in the WMM for at least another five years to assess population trends. Establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, owl pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. The same as for the bank vole (see above p. 67).

34a. Orkney vole *Microtus arvalis orcadensis*

Introduced to Orkney; common where it occurs.

Population estimate: Scotland, 1,000,000.

Legal and conservation status: WMA.

Importance/threats: confined to six of the Orkney Islands, it is an endemic subspecies and is vulnerable to habitat loss and fragmentation through agricultural development (Harris *et al.*, 1995). Important as a vital source of food for short-eared owls, hen harriers and kestrels.

Historic trends: probable substantial population declines from the mid-20th Century because of agricultural pressures resulting in the loss of suitable habitat. This may have slowed or halted as loss of habitat to agriculture has decreased.

Survey schemes providing information on this species: none.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, owl pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the bank vole (see above p. 67).

34b. Guernsey vole *Microtus arvalis sarnius*

Occurs only on Guernsey – possibly introduced.

Population estimate: not known

Legal and conservation status: WMA.

Importance/threats: an endemic subspecies with an isolated population.

Historic trends: not known

Survey schemes providing information on this species: none.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, owl pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the bank vole (see above p. 67).

35. Water vole *Arvicola terrestris*

Native, moderately common, although declining.

Population estimate: UK 875,000; England 486,000; Scotland 354,000; Wales 35,000, Northern Ireland 0 (Jefferies *et al.*, 2003).

Legal and conservation status: W&CA Schedule 5; WMA; SAP. The species has been recommended for full protection under Schedule 5 of the W&CA and it is now possible to designate SSSIs for water voles.

Importance/threats: the water vole is found throughout England, Scotland and Wales except most Scottish islands. The population had been declining throughout the 20th Century, due to habitat destruction and change with intensification of agriculture. This has been greatly exacerbated in the last 20–25 years by the spread of the introduced mink, a predator against which the water vole has little defence. The species is also threatened by water pollution, increased cattle grazing, human disturbance and climatic change (Macdonald & Tattersall, 2001).

Historic trends: Two national surveys, carried out by The Vincent Wildlife Trust (VWT) in 1989–1990 and 1996–1998, showed a loss of two thirds (67.5%) of the occupied sites and nine tenths (88%) of the remaining population in only seven years (Jefferies, 2003; Strachan *et al.,* 2000). As a result they are now patchily distributed and sparse or absent from many areas, leading to isolation of small populations.

Survey schemes providing information on this species: Monitoring Water Voles at National Key Sites; WBBS.

Information on population trends

Monitoring Water Voles at National Key Sites. In England and Wales the best known water vole populations have been selected for special management at Key Sites (Figure 4.35a). Monitoring methods have been developed for these sites and annual monitoring is underway. Figure 4.35b shows the results across 14 water vole Key Sites in England and Wales from 2001–2003. The proportion of transects occupied each year is roughly equivalent to distribution/spread of animals across the site. Initial indications are that populations are stable, but the time series is too short to carry out trend analysis.

WBBS. Water vole presence was recorded on about 15% of WBBS sites from 1998–2003 and analysis detected no significant change in presence during that time (Figure 4.35c).

Interpretation of survey results: water vole populations declined substantially during the 1990s, but more recent data suggest that the decline may have stabilised. However, the WBBS is the only wider countryside survey for this species and only has the power to detect a 50% decline in water voles populations, so a smaller level of decline might go undetected. The water vole has a high reproductive rate with large between year variation in population size and, environmental conditions permitting, populations should be able to recover relatively quickly. These factors mean that frequent surveillance, preferably annual, is essential to improve understanding of population fluctuations.

Future requirements: there are no plans to repeat a national survey for this species. Therefore, a pilot annual surveillance scheme dedicated to riparian mammals, including water vole, otter and mink should be developed. The scheme could possibly be linked to the existing WBBS, with the aim of improving water vole detection levels and increasing the sample size of the survey.

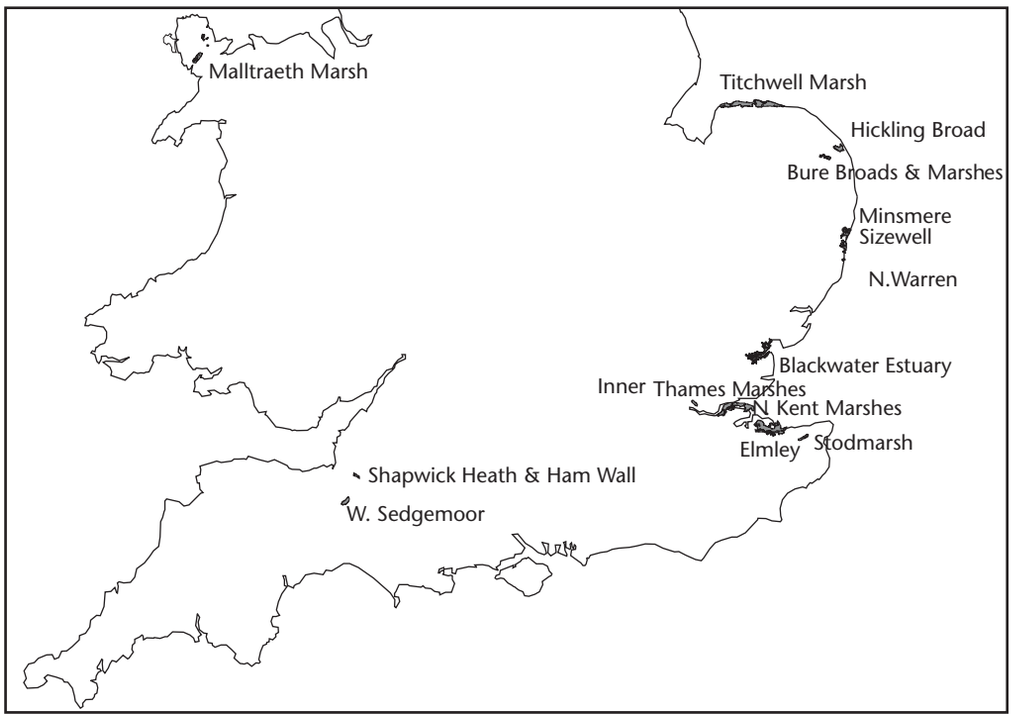


Figure 4.35a Location of water vole Key Sites in England and Wales

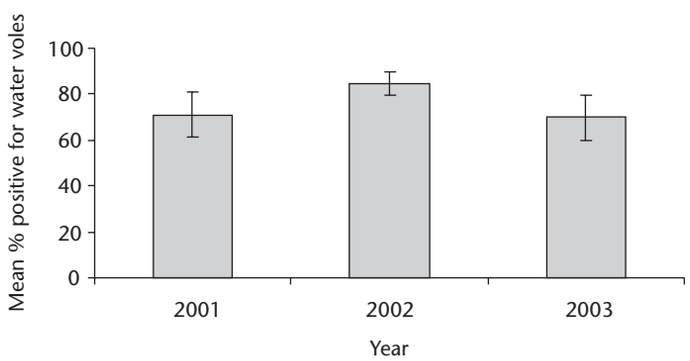


Figure 4.35b Percentage occupancy of transects in water vole Key Sites (2001–2003)

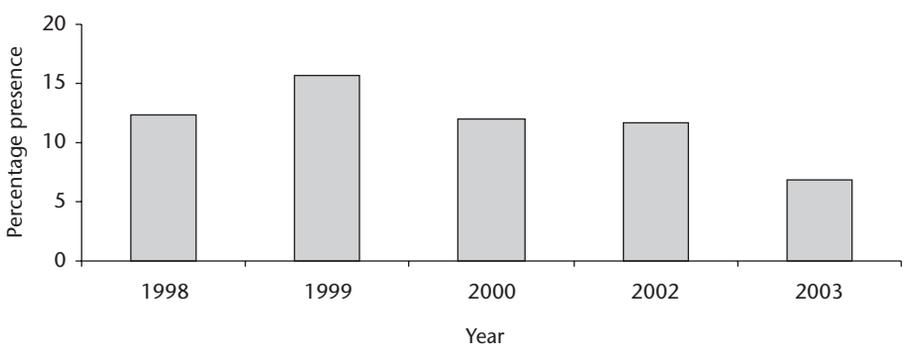


Figure 4.35c UK water vole presence (% of occupied stretches) in the WBBS (1998–2003)

Monitoring Water Voles at National Key Sites will provide a good indication of the status of water vole populations in optimal habitats.

36. Wood mouse *Apodemus sylvaticus*

Native, widespread and very common.

Population estimate: UK ?; England 19,500,000; Scotland 15,000,000; Wales 3,500,000; Northern Ireland ?.

Legal and conservation status: WMA.

Importance/threats: forms part of the prey base for mammalian and avian predators. The species is susceptible to poisoning on arable land by insecticides, herbicides and molluscicide pellets, because of the attractiveness of seeds as food (Tarrant & Westlake, 1988; Tarrant *et al.*, 1990).

Historic trends: Populations are assumed to be stable. They have fluctuated in the past depending on the quality of seed crops.

Survey schemes providing information on this species: none at present.

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, owl pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance.

37. Yellow-necked mouse *Apodemus flavicollis*

Native, locally common.

Population estimate: UK 750,000; England 662,500; Scotland 0; Wales 87,500; Northern Ireland 0.

Legal and conservation status: WMA.

Importance/threats: a species with a fragmented and restricted distribution in the UK and its close association with ancient woodland makes it very vulnerable to habitat loss and fragmentation. May be a good indicator of the effects of climate change. The species is linked to the spread of Tick Borne Encephalitis (TBE) across continental Europe and there could be implications if warmer climates allow the species distribution to spread northwards across the UK.

Historic trends: the fossil record suggests that the species was more widespread in historic times and may be a relict of a formerly widespread woodland species (Yalden, 1992; 1999).

Survey schemes providing information on this species: none at present.

Additional species information: a national survey carried out by The Mammal Society in 1998, through live-trapping in 168 deciduous woodlands, increased the known distribution of the species and found that maximum summer temperature was the most significant variable explaining distribution (Marsh, 1999; Marsh *et al.*, 2001).

Future requirements: establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, owl pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the wood mouse (see above p. 69).

38. Harvest mouse *Micromys minutus*

Probably a post-glacial introduction, limited distribution, but locally can occur in large numbers.

Population estimate: UK 1,425,000; England 1,415,000; Scotland 0; Wales 10,000; Northern Ireland 0.

Legal and conservation status: WMA; IUCN Red List.

Importance/threats: the distribution of the harvest mouse is generally limited to southern England and coastal Wales, with scattered colonies further north. The species is likely to be sensitive to climate change and, with a preference for dry conditions, may be limited by summer rainfall. Under threat from agricultural practices including combine harvesting, stubble burning, pesticide use, hedge management and possibly the flooding of reedbeds (Macdonald & Tattersall, 2001).

Historic trends: numbers are thought to be declining. A recent national survey aimed to determine if there had been substantial changes in the distribution of harvest mice since a survey conducted by Steve Harris for The Mammal Society in 1979 (Harris, 1979a, 1979b). At the end of its first year, 300 of the original 800 sites had been resurveyed. Harvest mouse nests were only found in 29% of these sites and only 24% of these sites still had suitable habitat (Mammal Society, *pers. comm.*).

Survey schemes providing information on this species: WMM.

Information on population trends

WMM. In the signs component harvest mouse was searched for on a mean of 71.9% of squares surveyed from 2001–2003 and presence was recorded on 2.85% of squares.

Future requirements: assess the value of data collected on this species from The Mammal Society's Water Shrew Survey. Establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the wood mouse (see above p. 69).

39. House mouse *Mus domesticus*

Introduced, locally abundant.

Population estimate: UK ?; England 4,535,000; Scotland 657,000; Wales 206,000; Northern Ireland ?

Legal and conservation status: WMA.

Importance/threats: a potential problem species because of its commensal existence and potential to contaminate food and spread disease, including *Salmonella*, *Cryptosporidium* and *Leptospirosis* (Macdonald & Tattersall, 2001). The species is economically important in GB as a pest of stored products and because it can cause physical damage to building materials and wiring.

Historic trends: house mouse used to be the third most common small mammal (in arable land), after wood mice and bank voles, but changing farming practices have resulted in a considerable decline (Harris *et al.*, 1995). Populations underwent a decline in urban areas in the 1970s, but seem to have stabilised since then.

Survey schemes providing information on this species: wider countryside none; urban: EHCS, GBW.

Information on population trends
EHCS. The 1996 EHCS found that 1.8% of dwellings were infested with mice and the results of the 2001 survey when available, should indicate whether there has been a change during the period between the two surveys.

GBW. House mice were recorded in 909 gardens in 2003, representing 20.8% of gardens surveyed, indicating that this survey should be able to provide population trend information for house mice in the future.

Future requirements: as yet there is no information on population trends for this species. Annual surveillance in the EHCS will provide some data in the future on trends in England, but apart from GBW, which commenced in 2003, there are no schemes assessing house mouse trends across the rest of the UK. Establish long-term trends in abundance across a range of habitats. A four or five year pilot study using volunteers is required, with attention given to the value of live-trapping, owl pellet analysis, field signs and the use of hair tubes, assessing the number of sites/traps required to give statistically meaningful data. Volunteers will require professional support and a good supply of equipment. Simulations could be run on data collected by Mallorie & Flowerdew (1994) to assess the number of sites required for UK level surveillance. Same as for the wood mouse (see above p. 69).

40. Common rat *Rattus norvegicus*
Introduced, common.

Population estimate: UK ?; England 5,240,000; Scotland 870,000; Wales 680,000; Northern Ireland ?

Legal and conservation status: WMA.

Importance/threats: this species is a vector of some important zoonotic diseases, including toxoplasmosis, Q-fever, Hantaan fever, *Cryptosporidium*, *Salmonella* and *Leptospirosis*, made more problematic because of its commensal existence.

Historic trends: there appears to have been a widespread decline in common rat populations in the wider countryside over the last 50–100 years. One estimate in the early 1900s put the population at around 40 million (Boelter, 1909), which is considerably more than the current estimate. However, that decline may have changed in recent years. Results from the 1993 Ministry of Agriculture, Fisheries and Food (MAFF) survey found that 4.8% of urban premises were infested with rats, which was a significant increase on the previous survey 14 years earlier.

Survey schemes providing information on this species: wider countryside NGC, BBS, WBBS, WMM; urban EHCS, GBW.

Information on population trends
NGC historic. The results of the survey returns from 1,222 estates from 1961 onwards suggest a downward trend between 1961 and 1979 with fairly stable populations from 1979–2002 (Figure 4.40a). Regional analyses of data from 1975–2000 found a significant increase in common rat bags in south-east England and a significant decrease in the east Midlands. In the other regions, no significant change in common rat bags was detected. Confidence intervals for percentage changes in common rat bags were wide, although not to the extent seen with rabbit bags. There does not appear to be a strong regional pattern in the distribution of increases or decreases in common rat bags (Whitlock *et al*., 2003).

NGC current. Figure 4.40b shows the results of analysis of gamebag returns from 1995–2002 from 616 estates across the UK. Although there has been a 57.5% increase in

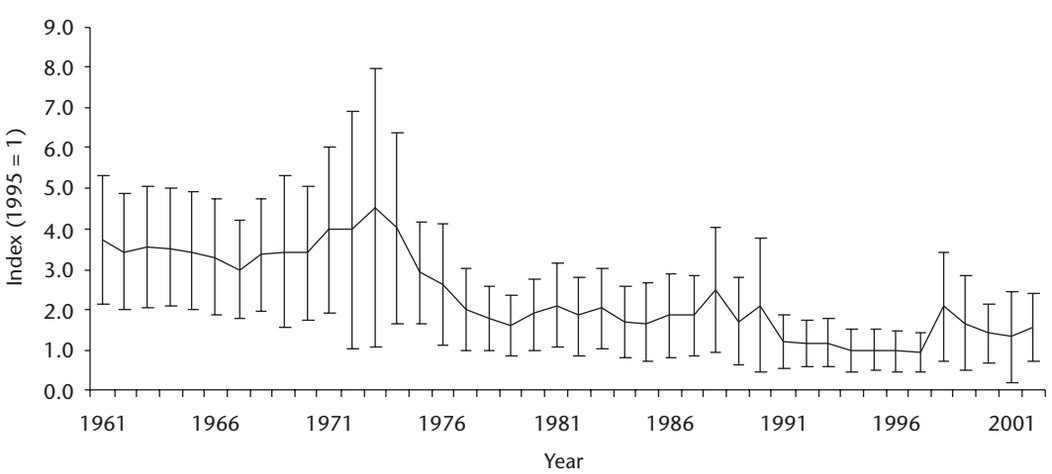


Figure 4.40a UK index of common rat bags with 95% confidence limits from the NGC (1961–2002)

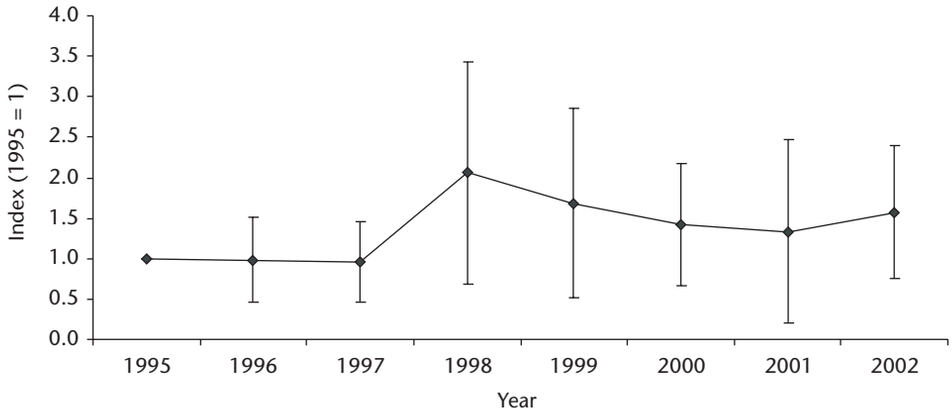


Figure 4.40b UK index of common rat bags with 95% confidence limits from the NGC (1995–2002)

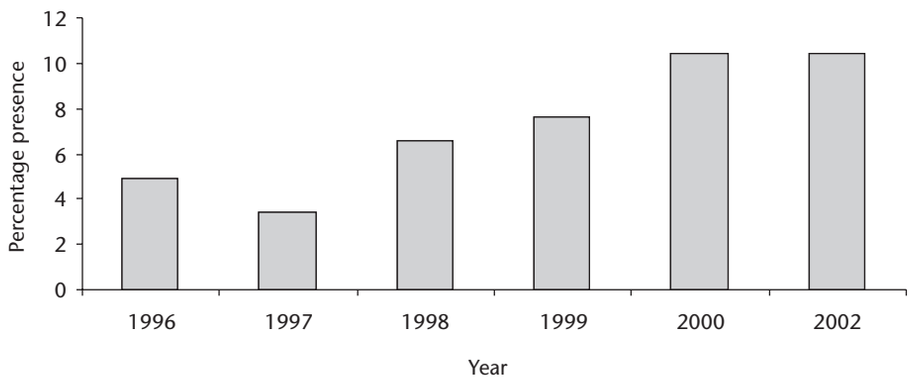


Figure 4.40c UK common rat presence (% of occupied squares) in the BBS (1996–2002)

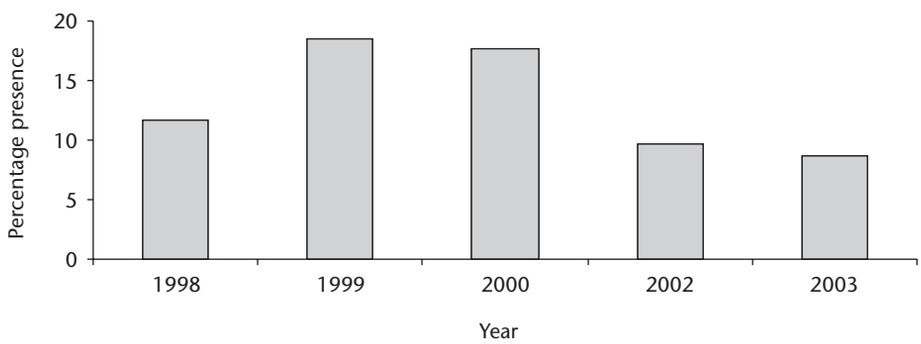


Figure 4.40d UK common rat presence (% of occupied stretches) in the WBBS (1998–2003)

common rat bags during that period, there was no significant trend at the UK level, and confidence limits were very wide. Separate analyses for England and Scotland show that the percentage increase in common rat bags has been greater in England, 64.6% than Scotland, 23.4%, but no significant trends were detected. Results are summarised in Table 4.1.

BBS. Common rat was found on a mean of 7.21% of sites from 1996–2002 and has shown a significant increase in presence on survey sites during that time (Figure 4.40c). These data should be interpreted with great care because in 2000 the method of data collection was modified to make the results more robust, and this may have caused an increase in the number of records for this species in subsequent years.

WBBS. Common rat was found on a mean of 14.9% of sites from 1998–2003. Results from this survey show no significant change in common rat populations during that period (Figure 4.40d).

WMM. In the Signs Survey common rat presence was recorded on 41.3% of sites.

EHCS. The 1996 EHCS found infestation rates to be 0.4% for common rats indoors and 1.7% for common rats

outdoors. Infestation rates were generally higher in rural locations, as has been found in previous surveys. The results of the 2001 survey, when available, should indicate whether there has been a change during the period between the two surveys. Annual surveillance in the EHCS will provide some data in the future on trends in England.

GBW. Common rat was seen in 1,053 gardens in 2003, representing 24.1% of gardens surveyed and shows that this survey will be able to provide population trend information for this species in the future.

Interpretation of survey results: the surveys collecting data on this species show no obvious trend patterns, but this is partly because large annual fluctuations in common rat populations cause wide confidence limits in the trend data. Under such circumstances long datasets with large sample sizes are required to provide robust information on population change. The BBS has detected a significant upward trend between 1995 and 2002 at the UK level, but, as indicated, this could be an artefact of a slight change in the data collection method. The NGC data show wide between year variation in the data, so short term trends are extremely difficult to identify. There are also no obvious patterns in regional trends. Further data are required to make a more robust assessment. It is encouraging that such a wide variety of schemes is providing information on common rats, in the wider countryside and in urban areas, because populations may behave differently in these environments.

Future requirements: most of the multi-species schemes within the TMP are providing information on this species and the ability to detect population changes will improve as the sample sizes increase. Surveillance in all schemes should continue.

41. Ship rat *Rattus rattus*

Introduced, transient mainland populations.

Population estimate: 230–400 on the Shiant Islands (McDonald *et al.*, 1997). Near extinct in the rest of the UK.

Legal and conservation status: W&CA Schedule 9; WMA.

Importance/threats: where populations still exist on offshore islands, they have been linked to predation on ground nesting seabirds.

Historic trends: a widespread and common species since their introduction to GB in Roman times, their range has contracted since the 1950s, replaced by the common rat. There may still be transient populations in Southwark, London and Avonmouth (Macdonald & Tattersall, 2001), and some small populations on offshore islands, including the Outer Hebrides.

Survey schemes providing information on this species: none.

Future requirements: collate records on potential island populations.

42. Common dormouse *Muscardinus avellanarius*

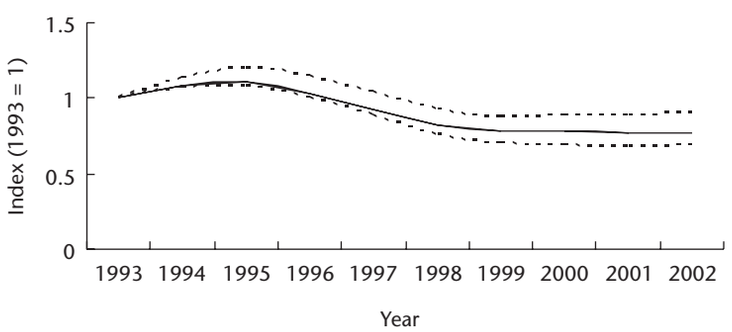
Native, localised.

Population estimate: UK 45,000 (Paul Bright, *pers. comm.*); England ?; Scotland 0; Wales ?; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix III; W&CA Schedules 5&6; HD Annex IV; WMA; SAP; IUCN Red List.

Importance/threats: common dormice are threatened by loss and fragmentation of suitable habitat, thus they are good indicators of the effects of habitat fragmentation. They are better suited to a continental climate of warm dry summers and cold dry winters and they are, therefore, likely to be sensitive to climate change.

Historic trends: common dormice have declined in both distribution and abundance in the 20th Century as a result of woodland loss and habitat fragmentation. Three national surveys have been carried out in 1993, 1997 and 2001, to assess changes in the distribution of the dormouse and to assess whether the species still survived in areas where it was known to occur in Victorian times. Volunteers were asked to search for nuts that had been opened by dormice. The results showed a clear decline in distribution compared with Victorian times, especially in northern England, but many of the sites searched in 1993 were still occupied in 2001. A survey to assess the distribution of the species was carried out in Wales in 1997 by VWT and CCW, with 1,511 sites visited in 237 10 km squares. Dormouse presence was confirmed in 53 10 km squares, with a 70% increase since the previously published 1993 distribution map. However, this increase reflected improved recording rather than an increase in common dormouse distribution. From a sample of 50 sites with pre-1990 records only 68% were positive, indicating the



Figures 4.42a Common dormouse GB population indices from the NDMP (1993–2002)

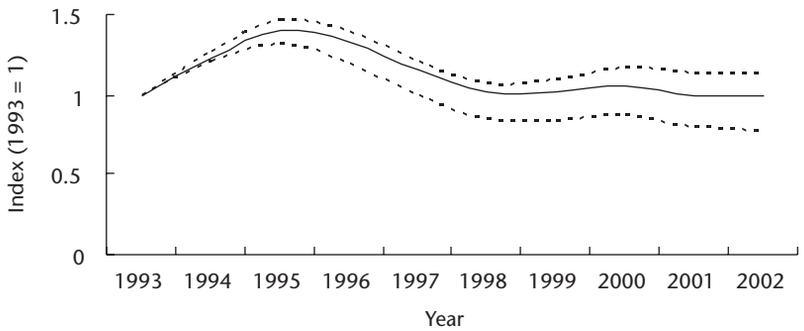


Figure 4.42b Common dormouse population indices in Arable 1 Land Class, from the NDMP (1993–2002)

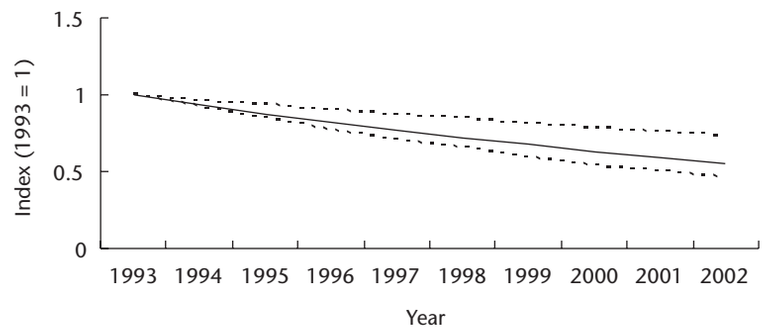


Figure 4.42c Common dormouse population trends in Arable Land Class II from the NDMP (1993–2002)

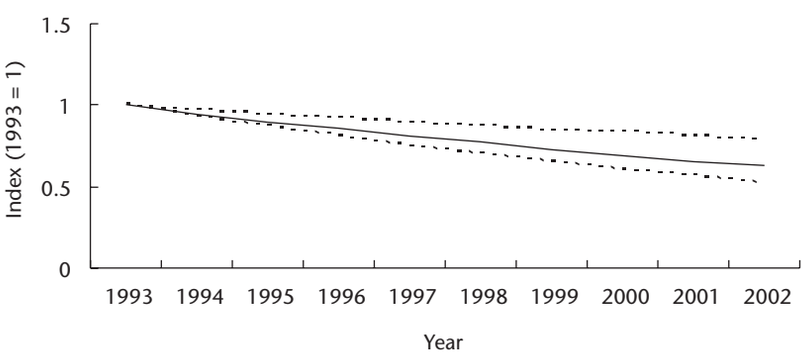


Figure 4.42d Common dormouse population trends in Pastoral Land Class IV from the NDMP (1993–2002)

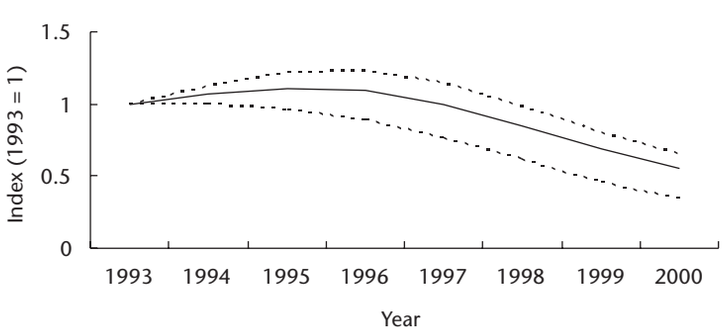


Figure 4.42e Common dormouse population trends in Marginal Upland Land Class VI from the NDMP (1993–2002)

species distribution was still declining in Wales (Jermyn, Messenger & Birks, 2001).

Survey schemes providing information on this species: NDMP.

Information on population trends

NDMP. There has been a significant national downward trend detected from 1993–2002 (Figure 4.42a). Trend analysis shows that dormouse populations have declined in all LCGs, except Arable I, southern England, where populations appear to be stable (Figures 4.42b-e). The overall decline is estimated to be 23% (Sanderson, 2004). The greatest change has been observed at the edge of the species current range in Britain.

Future requirements: the NDMP could be expanded with additional funding to cover sites in other habitats and regions and improve the ability of the scheme to detect Amber Alert declines. Surveillance of key sites needs to be maintained in at least 25 counties, with targeted recruitment of new sites in regions with low sample sizes. The long-term effects of habitat and climate change on population density and breeding success should be monitored.

43. Fat dormouse *Glis glis*

Introduced, locally common.

Population estimate: England 10,000 (Morris, 1997). Absent from the rest of the UK.

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 6 & 9; WMA; IUCN Red List.

Importance/threats: the species has an unusual legal status because of its listing in Appendix III of the Bern Convention and Schedule 6 of the W&CA, which means it is a European protected species and can only be trapped with a licence. However, it is an introduced species, also listed on Schedule 9 of the W&CA, which means that once trapped it cannot be released back into the wild. This provides a dilemma of what to do with trapped animals that may have been taken because of causing disturbance and damage in occupied dwellings. The species can also cause damage to fruit crops and forestry plantations.

Historic trends: the species was introduced into GB in 1902 and has a very restricted distribution in the Chiltern area of Buckinghamshire, Berkshire and Herefordshire. Transect walks through woodland, listening for calling animals, found densities of between 0.8 and 1.7 animals per hectare (Hoodless & Morris, 1993). Generally there seems to have been an increase in distribution since the introduction in 1902, but spread of the species is limited by open countryside to the north-west and urbanisation to the south. Illegal translocations occur and are likely to increase the distribution in a stepwise manner rather than through a steady spread (Pat Morris, *pers. comm.*).

Survey schemes providing information on this species: none.

Additional species information: it is likely that there has been a steady increase in numbers of this species, but there has been no consistent monitoring except at one site (Pat Morris unpublished data 1997–2004 onwards). This shows wide annual fluctuations in numbers, due to immigration/emigration associated with breeding and suppressed breeding, in turn linked to masting years in beech woodland. Fluctuations are sufficiently extreme that they mask any trends, *e.g.* <40 adults in nest boxes in 2003 (and no juveniles) and >100 in 2004, plus 300+ juveniles. Some adults disappear for a whole season then reappear to breed and sampling in intervening years fails to detect them although they are present.

Future requirements: more work is needed to understand the biology of the species before any sort of analysis of numbers is likely to be reliable. It is also likely that *Glis* migrate into buildings in non-masting years. The Bern Convention requires Government to monitor numbers in order to justify licensed trapping, so records on numbers in buildings should be available. These may contain helpful pointers about total numbers based on trapping by licensed trappers, and the data should be analysed to provide crucial information for understanding population size and changes. The restricted distribution means that this species will require a dedicated surveillance scheme.

4.4.5 Carnivora

44. Fox *Vulpes vulpes*

Native, common and widespread.

Population estimate: UK ?; England 195,000; Scotland 23,000; Wales 22,000; Northern Ireland ?

Legal and conservation status: WMA; Protection of Wild Mammals (Scotland) Act; Hunting Act.

Importance/threats: foxes are considered a major predator of ground nesting birds, including game species and those of conservation concern. The species is also a potential vector for the rabies virus, should it ever reach the UK.

Historic trends: available evidence suggests that populations increased throughout the 20th Century, with a concurrent increase in range, although numbers have fluctuated with the availability of the food supply.

Survey schemes providing information on this species: wider countryside NGC, BBS, WBBS, MOR, WMM; urban LWM, GBW.

Information on population trends

NGC historic. Figure 4.44a Shows the results of survey returns from 1,222 estates for 1961–2002 and indicates an upward trend from the 1960s to the 1990s and then appears to stabilise in the mid-1990s. Regional analyses of fox bags over a 25 year period showed a significant increase between 1975 and 2000 in south-east England, East Anglia, the east Midlands, west Midlands, north-east England and east and west Scotland. No significant change was detected in south-west England, Wales or north-west England over the same period. Increases of the greatest magnitude occurred in East Anglia and the west Midlands (Whitlock *et al*., 2003).

NGC current. Figure 4.44b shows the results of analysis of gamebag returns from 1995–2002 from 616 estates across the UK and indicates no significant change at the UK, or country levels (Table 4.1, p. 58). Sample sizes were too small to carry out separate analyses for Wales and Northern Ireland.

BBS. Foxes were seen on a mean of 242 squares from 1995–2002, representing 13.5% of squares surveyed. Figure 4.44c Shows the results of trend analysis for that period and indicates a significant decline in abundance, 17% overall in the UK, but this relates to a decline in 2002, rather than an underlying trend over the entire period. There were some regional trends detected, with significant increases in the westerly lowlands of England and Wales (Table 4.5).

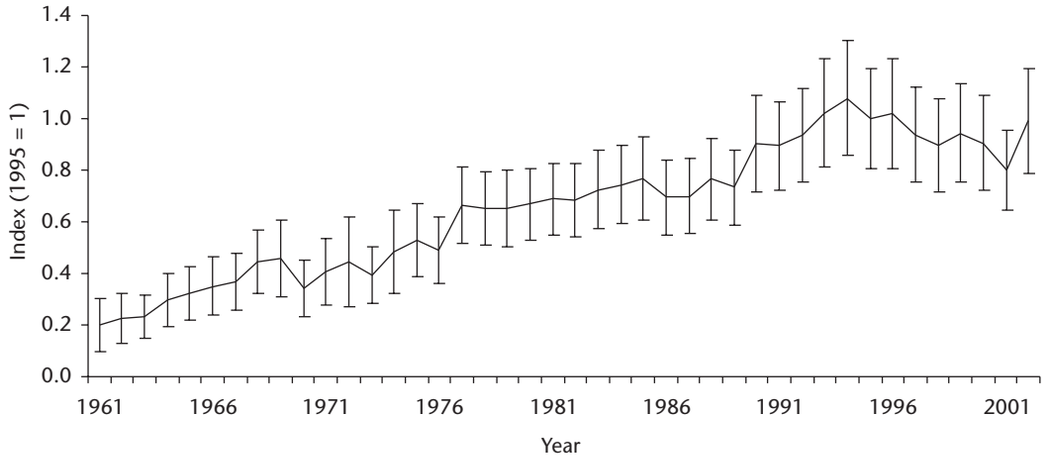


Figure 4.44a UK index of fox bags with 95% confidence limits from the NGC (1961–2002)

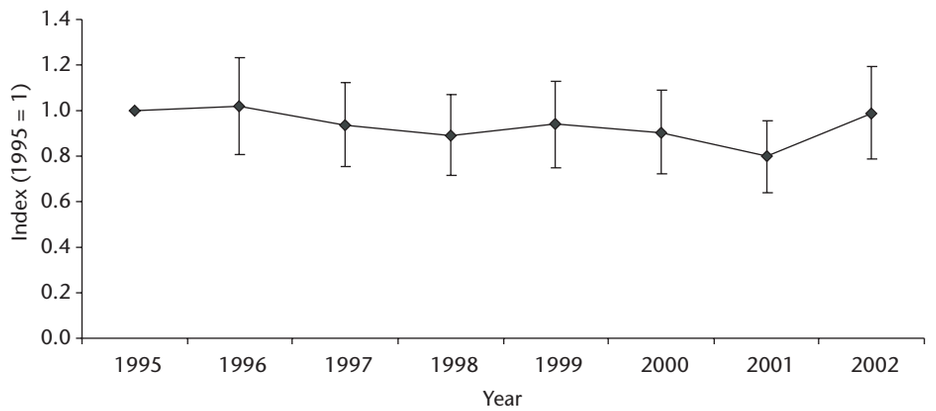


Figure 4.44b UK index of fox bags with 95% confidence limits from the NGC (1995–2002)

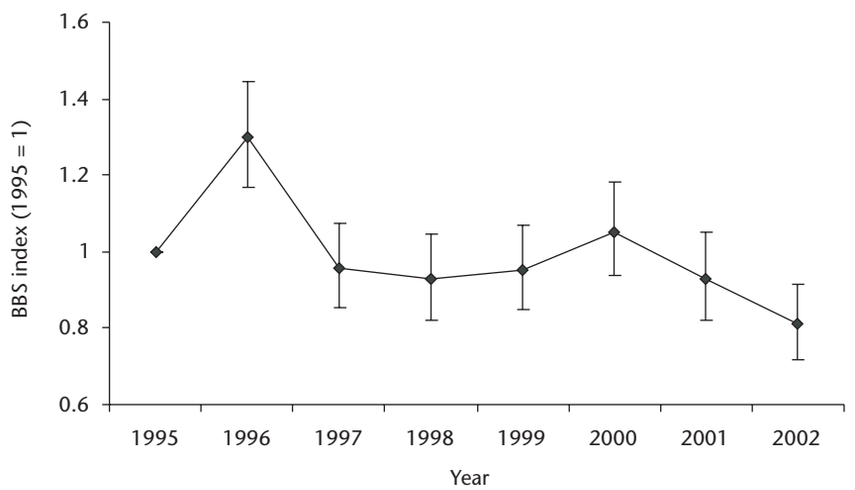


Figure 4.44c UK fox population indices with 95% confidence limits from the BBS (1995–2002)

WBBS. Presence of fox from sightings and field signs was noted in a mean of 43.5% of sites from 1998–2003, but there was no significant population change during that time (Figure 4.44d).

MOR. Foxes were the fifth most frequently seen species in this survey, representing on average 3.9% of sightings from 2001–2003. There appears to have been a slight increase in the number of foxes seen per 100 km driven across GB (Figure 4.44e), and the country breakdown suggest the greatest increase in numbers was in Wales. As yet, there are insufficient data from this survey to carry out trend analyses.

WMM. The sightings and signs components of the schemes both returned good information on foxes. In the sightings component foxes were seen on a mean of 54 squares, representing 9.7% of squares surveyed. In the signs

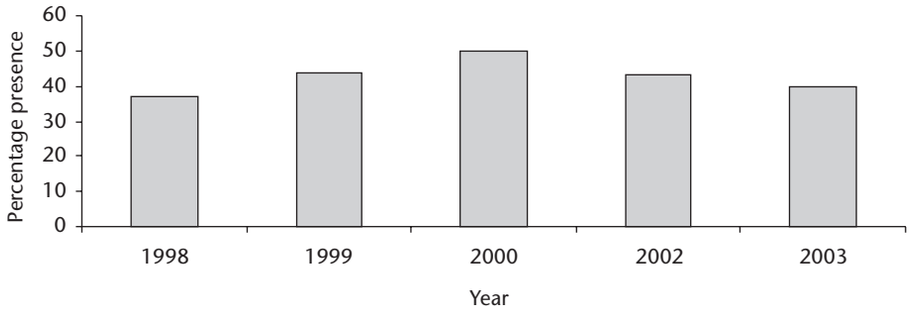


Figure 4.44d UK fox presence (% of occupied stretches) in the WBBS (1998–2003)

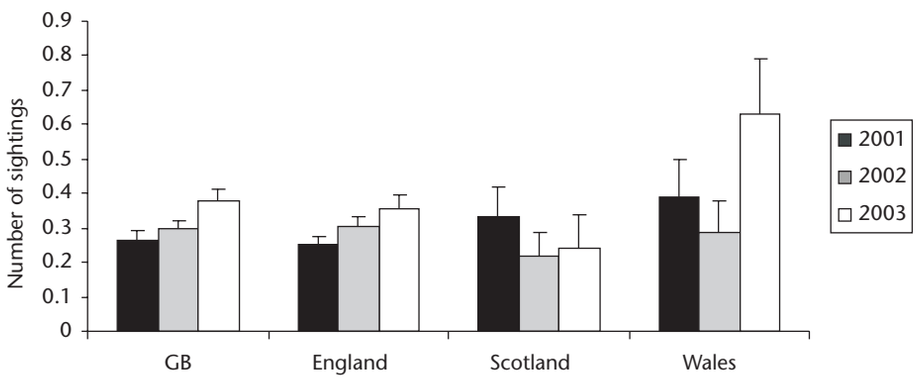


Figure 4.44e Observations of fox road kills at GB and country level, from the MOR survey (2001–2003)

Table 4.5 Fox presence in BBS squares (1995–2002)

Country	Mean squares present	Percent change (sig at $P \leq 0.05$)
UK	242	–19
England	193	NS
Government Office Regions		
South East England	53	NS
South West England	42	NS
Environmental Zones		
(1) Easterly lowlands (England/Wales)	105	NS
(2) Westerly lowlands (England/Wales)	84	42

NS = Not significant

component, fox signs were searched for on a mean of 96.7% or of squares and presence was detected on 50.2% of squares.

LWM. Foxes were seen in 39% of sites in this survey (316 of 808 sites surveyed). If this level of recording continues then it should be possible to detect population change in the urban environment through this survey.

GBW. Foxes were seen in 1,484 gardens during 2003, representing 33.9% of gardens surveyed and this suggests that GBW will be able to provide population trend information for this species in the future.

Interpretation of survey results: it seems there has been a long-term upward trend for this species, which has stabilised in the last few years. Analyses of more recent data from the NGC, BBS and MOR, suggest that fox populations can show quite large between year variation and regional differences in trends that can change over time. It is encouraging that BBS and MOR show the same pattern of recent regional trends, both detecting an increase in Wales. The possibility of detecting urban population trends is also very encouraging. The Mammal Society's National Fox Survey was run in 1999 and 2000 and showed the national fox population to be 258,000 (Webbon *et al.,* 2004).

Future requirements: This species is being covered by a wide range of schemes and if the current level of surveillance continues then robust trend information will be available over the next few years.

45. Pine marten *Martes martes*

Native, locally common in parts of Scotland, very rare in England and Wales.

Population estimate: UK ?; England less than 100; Scotland 3,500; Wales less than 50; Northern Ireland ?

Legal and conservation status: Bern Convention Appendix III; W&CA Schedules 5&6; HD Annex V; WMA.

Importance/threats: predation on game birds and poultry has brought the species into conflict with gamekeepers and farmers and there may be a continued threat from illegal trapping and poisoning. There is evidence that intra-guild competition with foxes may limit pine marten numbers and the high density of foxes in the UK may be a threat to pine marten recovery (Macdonald & Tattersall, 2001). There are proposals to reintroduce pine martens to parts of their former range in England.

Historic trends: the British pine marten population was heavily persecuted in the 19th Century, particularly in England and Wales. By 1914 it was reduced to inhabiting a small area of northern Scotland, with a smaller population said to occur in Wales and several small fragments in northern England (Langley & Yalden, 1977). A survey in 1980–82 (Velander, 1983), showed that the Scottish population had increased its range but there was no evidence of populations in England and Wales. A survey concentrating on these countries was carried out in 1987–88 (Strachan *et al.,* 1996), and results showed that signs of martens were sparse in England and Wales (mean: 0.54 per 500 m) compared to Scotland (mean: 2.64 per 500 m) and that any populations south of Scotland existed at very low densities.

Survey schemes providing information on this species: none.

Information on population trends
None being collected at present.

Additional species information: the pine marten is a difficult species to monitor because it has a restricted distribution and is quite rare within its range. It is also an elusive animal, not readily seen and in the past signs of scats (droppings) have been used to confirm the presence of the species. However, there is general agreement among experts that using scats to assess changes in abundance is an unreliable method because of the lack of any proven relationship between scat abundance and the number of animals present and because of errors in scat identification (Birks *et al.*, 2004). An alternate method could be the use of camera traps, which could potentially identify individuals. However, the equipment for this type of survey is still quite expensive.

Future requirements: the difficulties associated with detecting pine martens in multi-species schemes means that this species will require a single species survey scheme. A pilot scheme should be set-up with the intention of monitoring the distribution and abundance of pine martens in Scotland and assessing the extent of possible relict populations in England and Wales. The pilot should investigate reliable monitoring methods for this species, including tracking plates in tunnels with simultaneous hair collection, live-trapping and camera traps. The pilot should also investigate whether to use trained volunteers with professional coordinators, or professional, seasonal fieldworkers. It is important to monitor fox populations in pine marten habitat to assess the interaction between the two species.

46. Stoat *Mustela erminea*

Native, common.

Population estimate: UK ?; England 245,000; Scotland 180,000; Wales 37,000; Northern Ireland ?

Legal and conservation status: Bern Convention, Appendix III; WMA.

Importance/threats: stoats can have an impact on game bird populations and this brings them into conflict with gamekeepers. They may also suffer from competition with foxes, and may be at risk from secondary poisoning from rodenticides. They may also be susceptible to habitat loss, particularly the disappearance of linear features (McDonald & Birks, 2003).

Historic trends: populations were still abundant in the early 20th Century, but the decline in rabbit prey numbers as a result of myxomatosis caused severe population declines in the 1950s, and then in the early 1960s as a result of increasing fox populations.

Survey schemes providing information on this species: wider countryside: NGC, BBS, WBBS.

Information on population trends
NGC historic. Figure 4.46a shows the results of survey returns from 1,222 estates for 1961–2002 and indicates an overall upward trend in game bag returns until 1975, followed by a downward trend into the 1990s, when the trend appears to stabilize. Analysis of bag data over a 25 year period, from 1975–2000 detected regional differences with significant declines in stoat bags in south-east England, the east Midlands and the west Midlands. Significant increases in stoat bags were observed in north-east England and east Scotland. No change was observed in the other more southerly and westerly regions (south-west England, East Anglia, Wales and north-west England). Confidence intervals for stoat bags tended to be narrow compared to those for other species such as rabbits and common rats (Whitlock *et al*., 2003).

NGC current. Figure 4.46b shows the analysis of gamebag returns from 1995–2002 from 616 estates across the UK with no significant trend detected during that period. Separate analyses for England and Scotland also showed no significant change (Table 4.1, p. 58). Sample sizes were too small to carry out separate analyses for Wales and Northern Ireland.

BBS. Stoat presence was recorded on a mean of 121 squares from 1996–2002, representing 6.8% of squares surveyed and no significant change was detected (Figure 4.46c). These data should be interpreted with great care because in 2000 the method of data collection was modified to make the results more robust, and this may have caused an increase in the number of records for this species in subsequent years.

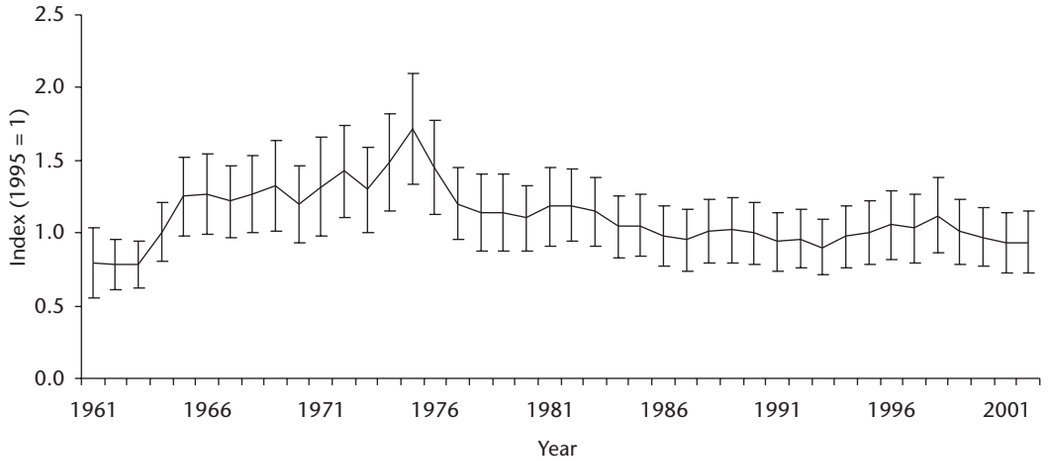


Figure 4.46a UK index of stoat bags with 95% confidence limits from the NGC (1961- 2001)

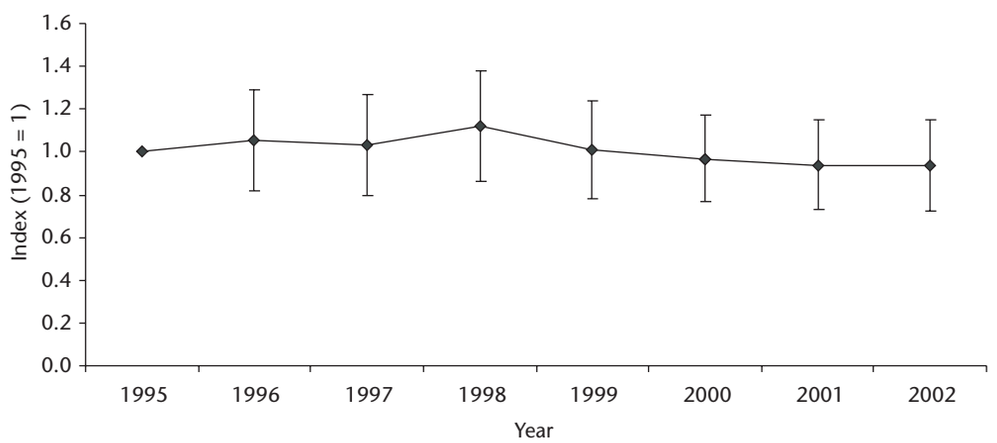


Figure 4.46b UK index of stoat bags with 95% confidence limits from the NGC (1995–2002)

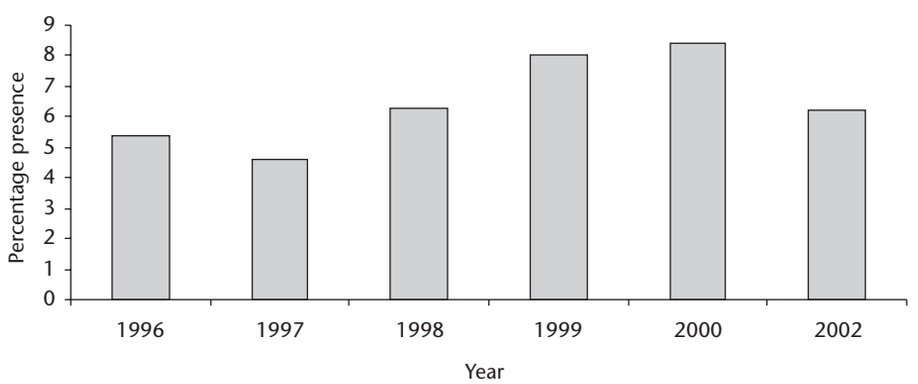


Figure 4.46c UK stoat presence (% of occupied squares) in the BBS (1996–2002)

WBBS. Stoat presence was recorded on a mean of 27.6 survey stretches from 1998–2002, representing 34% of stretches surveyed and a significant decline was detected during that period (Figure 4.46d).

Interpretation of survey results: the long-term data from the NGC suggest that stoat population trends have changed over the last 40 years, from a steady increase to a steady decline, with regional differences in population change. More recent data from the NGC suggests the population has been stable since 1995 and this is supported by results from the BBS. The only survey showing a significant decline in populations is the WBBS, which is restricted to riparian habitats so this may not represent what is happening in the wider countryside.

Future requirements: the NGC is being improved as a surveillance scheme by modifying survey forms to record trapping effort and this will improve the reliability of data in the future. The results of the TEM pilot should be assessed for ability to detect this species. Surveillance of stoats through other multi-species schemes should be

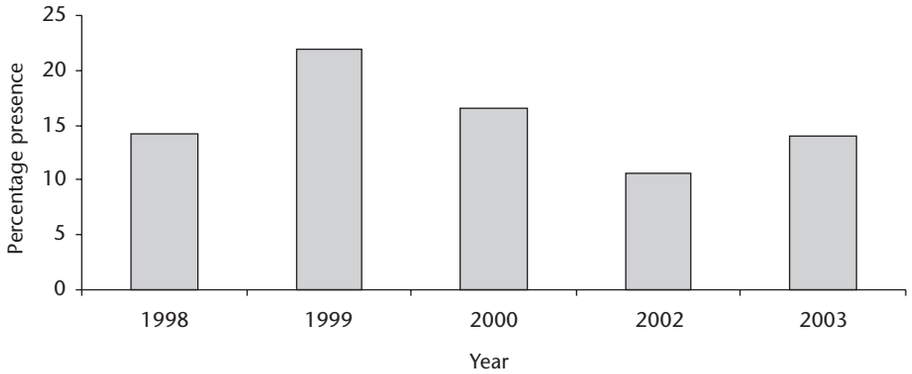


Figure 4.46d UK stoat presence (% of occupied stretches) in the WBBS (1998–2003)

continued. There should be an attempt to increase overall survey sample sizes, if possible, in order to increase detection rates for this species.

47. Weasel *Mustela nivalis*

Native, common.

Population estimate: UK 450,000; England 308,000; Scotland 106,000; Wales 36,000; Northern Ireland 0.

Legal and conservation status: Bern Convention Appendix III; WMA.

Importance/threats: weasels are important predators of birds, through raiding nest boxes and also killing game bird chicks. They are subject to the same threats as stoats, namely the loss of linear features, poisoning with rodenticides and competition with foxes.

Historic trends: weasels were extremely common in the early 20th Century and the advent of myxomatosis and the relaxing of grazing pressure by rabbits allowed vegetation growth and small rodent and weasel populations flourished. Since the 1960s there has been a gradual decline in their populations.

Survey schemes providing information on this species: wider countryside NGC, BBS, WBBS.

Information on population trends

NGC historic. Figure 4.47a shows the results of survey returns from 1,222 estates for 1961–2002 and indicates an overall downward trend for weasel bags. Analysis of bag data over a 25 year period, from 1975–2000 showed significant declines in weasel bags in all southern regions (west England, east England, East Anglia, Wales, east and west Midlands). In north-east and north-west England, east Scotland and west Scotland, the changes were not significant. The magnitude of the declines tended to be greatest in the western regions. Confidence intervals for percentage changes in weasel bags were fairly narrow, as with those for stoat bags (Whitlock *et al*., 2003).

NGC current. Figure 4.47b shows the analysis of gamebag returns from 1995–2002 from 616 estates across the UK with no significant trend detected during that period. Separate analyses for England and Scotland also showed no significant change (Table 4.1, p. 58). Sample sizes were too small to carry out separate analyses for Wales.

BBS. Weasel presence was detected on a mean of 96.3 squares from 1996–2002, representing 5.4% of squares surveyed. No significant change was recorded during that period (Figure 4.47c). These data should be interpreted with great care because in 2000 the method of data collection was modified to make the results more robust, and this may have caused an increase in the number of records for this species in subsequent years.

WBBS. Weasel presence was detected on a mean of 17.6 stretches from 1998–2002, representing 9.7% of stretches

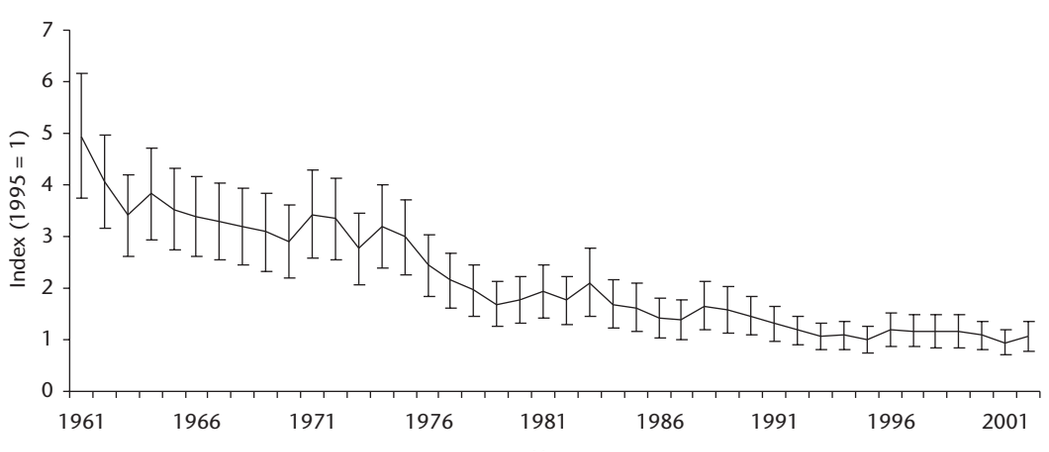


Figure 4.47a UK index of weasel bags with 95% confidence limits from the NGC (1961–2002)

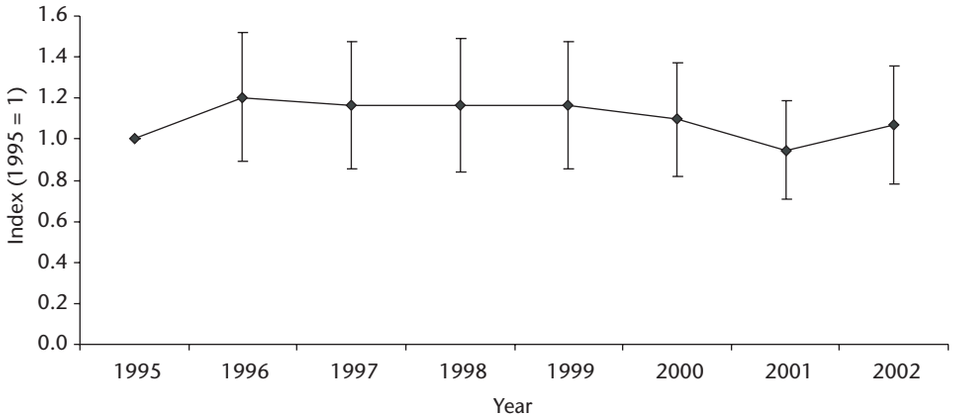


Figure 4.47b UK index of weasel bags with 95% confidence limits from the NGC (1995–2002)

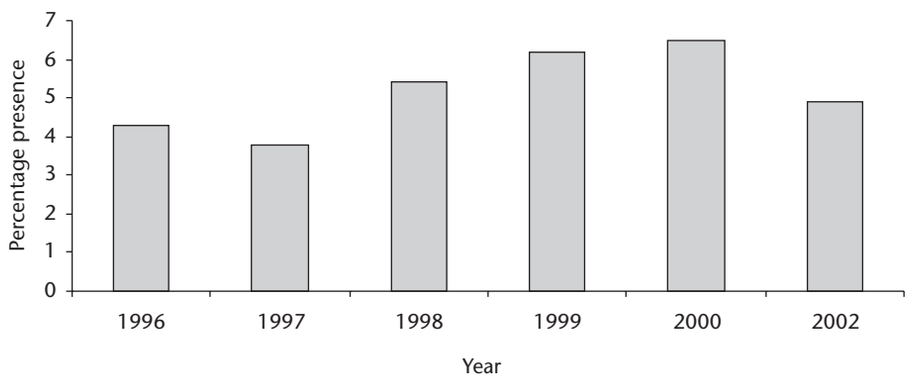


Figure 4.47c UK weasel presence (% of occupied squares) in the BBS (1996–2002)

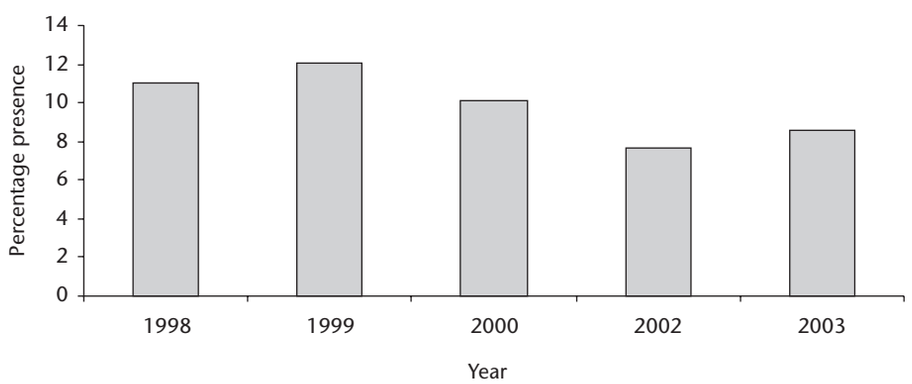


Figure 4.47d UK weasel presence (% of occupied stretches) in the WBBS (1998–2003)

surveyed and a significant decline was detected during that period (Figure 4.47d).

Interpretation of survey results: long-term data from the NGC suggest a decline in weasel populations over the last 40 years, with regional variations in trends. Current data from the NGC suggest that populations are stable and this is supported by information from the BBS. The WBBS shows a significant decline, but sample sizes are quite small and the survey is restricted to riparian habitats so may not be representative of the wider countryside.

Future requirements: the NGC is being improved as a surveillance scheme by modifying survey forms to record trapping effort and this will improve the reliability of data in the future. The results of the TEM pilot should be assessed for ability to detect this species. Surveillance of weasels through other multi-species schemes should be continued. There should be an attempt to increase overall survey sample sizes, if possible, in order to increase detection rates for this species.

48. Polecat *Mustela putorius*

Native, locally common.

Population estimate: UK 38,381; England 20,207; Scotland 483; Wales 17,691; Northern Ireland 0; Birks & Kitchener (1999).

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 6; HD Annex V; WMA.

Importance/threats: polecats may be subject to several threats including loss of genetic integrity through hybridisation with feral ferrets, habitat loss, road kills, accidental trapping, secondary poisoning, interspecific competition with otters, which are increasing in numbers, and possible gassing or trapping of polecats in rabbit burrows, which they frequently use as resting places.

Historic trends: the polecat, like the pine marten, has a restricted distribution in Britain due to past heavy persecution associated with game preservation in the late 19th Century. Having been apparently common and widespread in 1800, its range was dramatically reduced to a main strong-hold in mid-Wales by 1915. The subsequent decline in persecution pressure was matched by anecdotal evidence of a slow recovery. Distribution mapping at the 10 km square level recorded an expansion of the Welsh population from 1962–1991.

A road casualty survey, run by VWT from 1993–1997 (Birks & Kitchener, 1999) aimed to map the extent and pattern of recent range expansion outside the species' historical Welsh stronghold. Combined data from this and previous surveys produced a cumulative total of 473 10 km squares showing polecat presence for 1997 and suggested that in Wales the polecat is well-established and widespread and is firmly re-established in England, occupying more 10 km squares than in Wales, especially in the West Midlands and Welsh borders. Beyond this naturally recolonised range, populations derived from reintroductions are established in Cumbria, the East Midlands and central southern England. In Scotland, a reintroduced population is established in the West Highlands. Further reintroductions are reported from the Highlands, but there is not yet sufficient evidence that populations have re-established themselves there.

In order to improve understanding of the polecat's recovery, a monitoring system based upon co-ordinated live-trapping by volunteers was developed and tested. 136 1 km squares were each live-trapped for seven days within the species' current range in the mid-1990s. Significant regional variations in trapping success were recorded, and these were used to identify the 'current core' of the polecat's range. The live-trapping data, combined with results from the distribution survey, were used to create a new population estimate for the polecat in Britain (Birks & Kitchener, 1999).

Survey schemes providing information on this species: VWT Polecat and Mink Abundance Monitoring.

Information on population trends
VWT Polecat and Mink Abundance Monitoring. A mean of 475,501 km were driven in 2002 and 2003. The majority of km were driven in Wales, particularly in the first year of the survey, but this was less marked in 2003. A mean of 149.5 polecats were seen during the two months of the survey (Birks, 2002, 2003).

Interpretation of survey results: it is too early to provide population trend information on polecats from the existing VWT survey. However, sample sizes are quite large and it should be possible to assess the power of the survey to provide trend data over the next few years.

Future requirements: evaluation of the live-trapping system used in the 1990s suggested that it could form the basis for a national polecat monitoring strategy, but involved high effort with low trapping success (only 48.5% of squares trapped polecats), which would have implications for the involvement of volunteers. Hopefully, the VWT Polecat and Mink Abundance Monitoring will be continued and extended to improve coverage across GB. The potential of the TEM surveillance scheme for this species should be assessed.

49. Feral ferret *Mustela furo*

Introduced, common and widespread.

Population estimate: UK ?; England 200; Scotland 2,250; Wales 50; Northern Ireland ?

Legal and conservation status: WMA.

Importance/threats: threat of introgression upon native polecat populations. Mitochondrial DNA studies in the 1990s revealed that polecats and ferrets are so closely related as to be regarded simply as two forms of the same species and as domestication in ferrets has involved selection against many of the predatory and survival skills found in wild polecats, the ferret phenotype carries competitive disadvantages in the feral state. This is expected to limit the negative impact of introgression upon polecat populations in Britain (Birks & Kitchener, 1999).

Historic trends: unknown for this species. There are known to be populations on islands and some mainland areas.

Survey schemes providing information on this species: VWT Polecat and Mink Abundance Monitoring.

Information on population trends
VWT Polecat and Mink Abundance Monitoring. A mean of 475,501 km were driven in 2002 and 2003, but only three ferrets were seen in 2002 and none in 2003.

Future requirements: the sample sizes obtained in the VWT survey are not large enough to provide trend data for this species. However, the survey is valuable for the other species covered and provides additional distribution information on the feral ferret.

50. Mink *Mustela vison*

Introduced, common and widespread.

Population estimate: UK ?; England 16,500; Scotland 19,450; Wales 1,000; Northern Ireland ? (Jefferies *et al.*, 2003).

Legal and conservation status: DIA; W&CA Schedule 9; WMA; Fur Farming (Prohibition) Act.

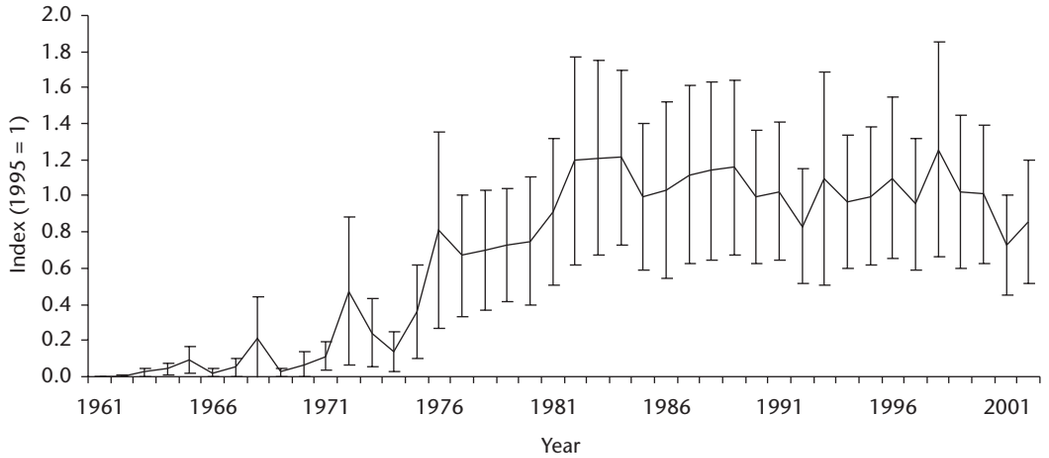


Figure 4.50a UK index of mink bags with 95% confidence limits from the NGC (1961–2002)

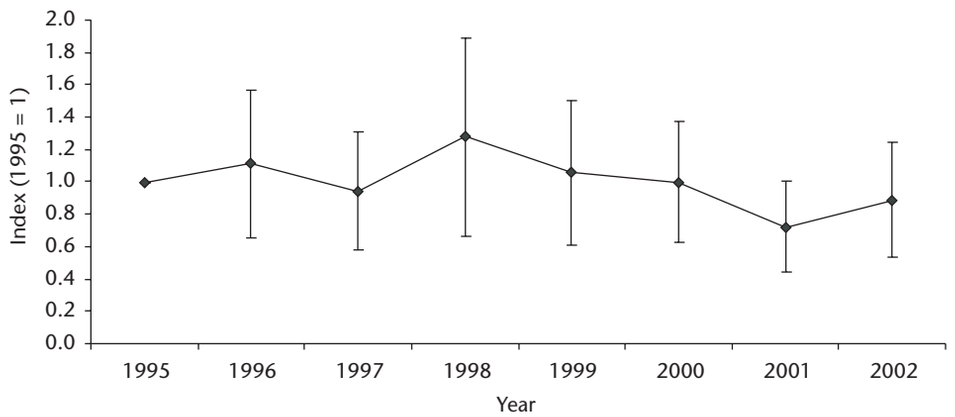


Figure 4.50b UK index of mink bags with 95% confidence limits from the NGC (1995–2002)

Importance/threats: mink are linked to the decline in water vole populations (Macdonald & Strachan, 1999) and have a damaging effect on nesting birds on offshore islands, game birds and fish stocks (Macdonald & Tattersall, 2001). They may also be infected with Aleutian disease, which could pose an additional threat to native carnivores.

Historic trends: first imported into Britain in the late 1920s and introduced to western Europe as escapees from fur farms, mink have spread rapidly across the mainland and to offshore islands such as the Outer and Inner Hebrides.

Survey schemes providing information on this species: NGC, WBBS, Polecat and Mink Abundance Monitoring.

Information on population trends

NGC historic. Figure 4.50a shows the results of survey returns from 1,222 estates for 1961–2002 and charts the increase in abundance with an upward trend from the 1960s to the 1980s. After 15 years of relative stability, there is a recent indication of a downward trend. Error bars represent 95% confidence intervals.

NGC current. Figure 4.50b shows the analysis of gamebag returns from 1995–2002 from 616 estates across the UK, with no indication of a significant trend. However, separate analyses at the country level show a significant downward trend in Scotland, 49.7%, but no significant change in England (Table 4.1, p. 58). Sample sizes were too small to carry out separate analyses for Wales and Northern Ireland.

WBBS. The presence of mink was noted on a mean of 27.8 stretches from 1998–2003, representing 15.4% of stretches surveyed (Figure 4.50c). There was no evidence of population change during this period.

VWT Polecat and Mink Abundance Monitoring. A mean of 475,501 km were driven in 2002 and 2003 and a mean of 26.5 mink were seen during the two months of the survey. The majority of km were driven in Wales, particularly in the first year of the survey, but this was less marked in 2003 (Birks, 2002, 2003).

Interpretation of survey results: the long-term NGC data show that mink populations have steadily increased across the UK over the last 40 years. However, NGC and WBBS trends from 1995 suggest that mink populations have stabilised, with the NGC data indicating substantial population declines in Scotland.

Future requirements: surveillance of this species should continue in the existing schemes. An annual surveillance scheme for riparian mammals, otter, mink and water vole,

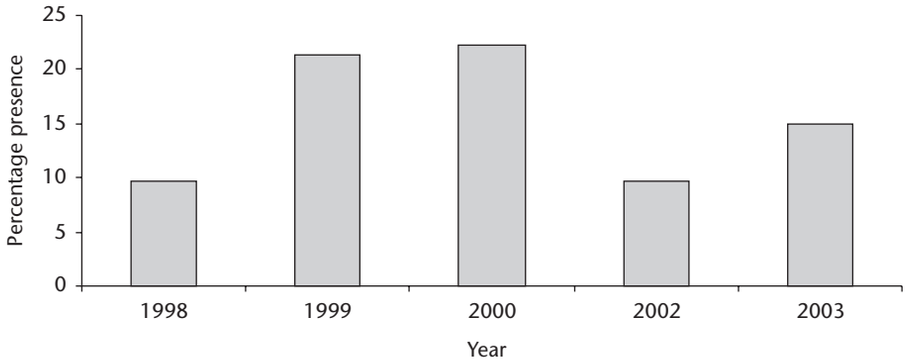


Figure 4.50c UK mink presence (% of occupied stretches) in the WBBS (1998–2003)

should be piloted, using a variety of methods, such as mink rafts, water vole latrine counts and artificial scat stations for otters, to assess between year population variation and overall population trends and this could be linked to the existing WBBS. The national otter surveys are another potential source of information on mink populations, but in the past survey methods have been adapted to concentrate on collecting data on otters to speed up the data collection process, resulting in incomplete data on mink occurrence and distribution. The method of data collection should be standardised across all otter surveys in the future to include mink data, so that changes in mink distribution can also be assessed from survey results.

51. Badger *Meles meles*

Native, common and widespread.

Population estimate: UK 288,000; England 190,000; Scotland 25,000; Wales 35,000; Northern Ireland 38,000 (Feore, 1994).

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 6; Protection of Badgers Act; WMA.

Importance/threats: this species has been alleged to be implicated in the possible spread of Bovine Tuberculosis.

Historic trends: the distribution and abundance of badgers has historically been dependant on changing patterns of agriculture (Cresswell *et al.*, 1989; Reason *et al*., 1993), but in recent history persecution was a contributory factor, until the Badgers Act came into force in 1973.

Two national surveys were undertaken in 1985–1988 and in 1994–1997 to detect changes in the badger population. In the first survey 2,455 1 km squares were surveyed for badger setts and signs of badger activity, with 2,271 resurveyed in the second survey and an additional 307 new squares were added. The data on change were presented by seven land class groups and by 14 regions and showed a 24% increase in the number of badger social groups in Britain during that time and a 77% increase in the total badger population. There were land class and regional differences, with two of the three arable landscapes showing lowest increases. Regionally there was also great variation; whilst in some regions there had been little change or even small declines in the number of badger social groups, in the West Midlands there had been an 86% increase (Wilson *et al*., 1997).

The use of field signs to examine change in badger populations provided a reliable measure of badger numbers across a wide range of population densities and this method has been adapted for wider use in the Winter Mammal Monitoring Survey.

Survey schemes providing information on this species: wider countryside BBS, WBBS, MOR, WMM; urban LWM, GBW.

Information on population trends

BBS. Badger presence was detected on a mean of 234.7 squares from 1996–2002, representing 13.1% of surveyed squares. A significant upward trend was detected during this period (Figure 4.51a). These data should be interpreted with great care because in 2000 the method of data collection was modified to make the results more robust, and this may have caused an increase in the number of records for this species in subsequent years.

WBBS. Badger presence was observed on a mean of 33.4 stretches from 1998–2003, representing 18.5% of sites. There was no significant trend detected during this period (Figure 4.51b).

MOR. Badgers were the fourth most frequently seen species in this survey, representing on average 4% of sightings from 2001–2003. The mean number of badgers seen in GB across all years was 0.31 badgers per 100 km driven, with the highest number, 0.47 per 100 km driven, in Wales (Figure 4.51c). As yet, there are insufficient data from this survey to carry out trend analyses.

WMM. In the signs component, badger presence was searched for on a mean of 89% of squares surveyed and presence was recorded on 34.7% of squares. With only three years of data the time series is too short to carry out trend analysis.

LWM. Badgers were seen in 56/808 sites during 2003, representing 7% of sites. With this level of recording it is unlikely that this scheme will have the power to detect badger population trends. However, it could provide good distribution information for urban environments.

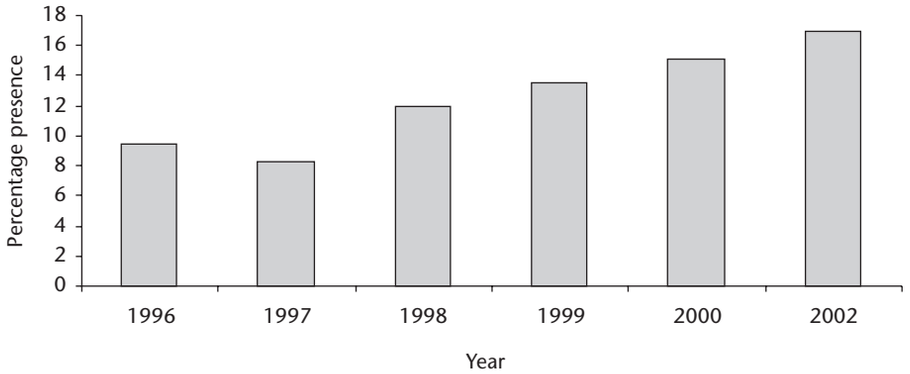


Figure 4.51a UK badger presence (% of occupied squares) in the BBS (1996–2002)

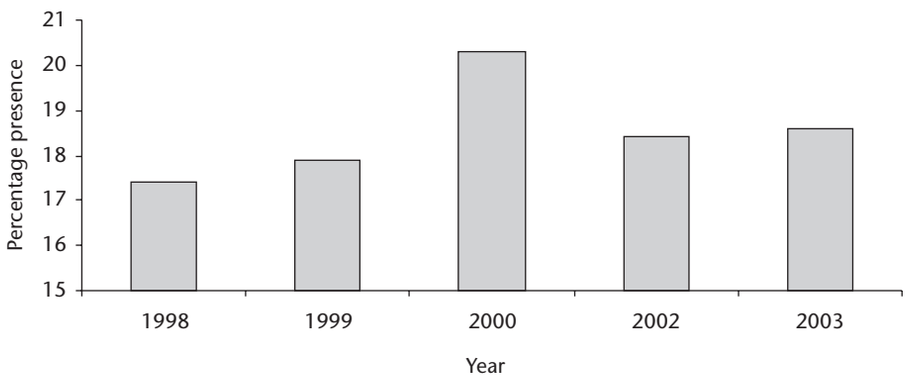


Figure 4.51b UK badger presence (% of occupied stretches) in the WBBS (1998–2003)

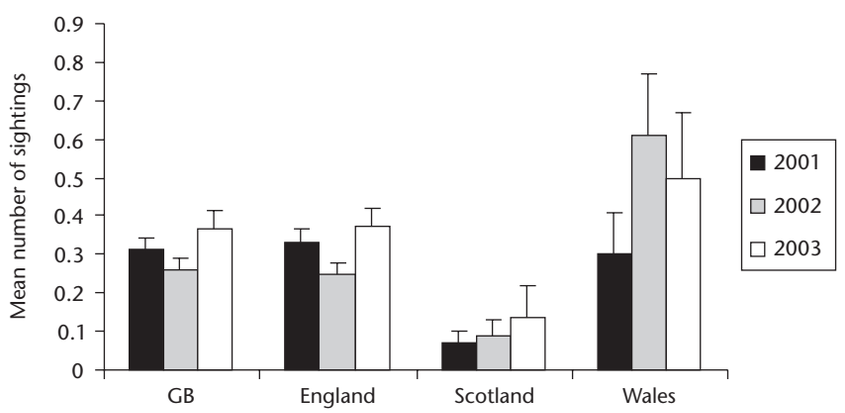


Figure 4.51c Observations of badger road kills at GB and country level, from the MOR survey (2001–2003)

GBW. Badgers were seen in 419 gardens in 2003, representing 9.6% of gardens surveyed, suggesting that GBW could provide population change information for this species in the future.

Interpretation of survey results: the national surveys detected a large increase in badger numbers over a ten year period and evidence from the BBS suggests that populations may still be increasing. However, the BBS data may be subject to bias and there is insufficient information at present from most schemes to confirm any trends.

Future requirements: continued surveillance under existing schemes is required for at least five more years to obtain robust trend information. Work on the relationship between social group size and latrine characteristics would help to refine population trend information (Harris & Yalden, 2004).

52. Otter *Lutra lutra*

Native, localised, but generally increasing.

Population estimate: UK ?; England 977; Scotland 7,948; Wales 540; Northern Ireland ? (Jefferies *et al.*, 2003).

Legal and conservation status: protected under CITES Appendix I & Annex A; Bern Convention Appendix II; W&CA Schedule 5, 6; HD Annexes II and IV; WMA; SAP; IUCN Red List. 73 SACs have been designated.

Importance/threats: the otter is an indicator of the quality of wetlands and waterways. UK populations are

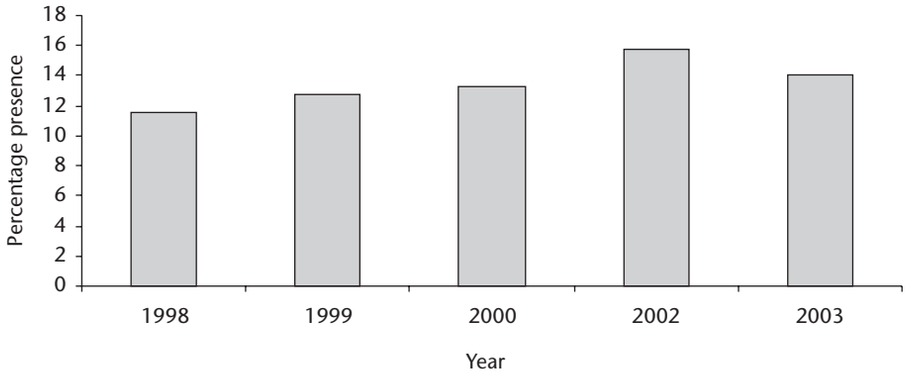


Figure 4.52 UK otter presence (% of occupied stretches) in the WBBS (1998–2003)

internationally important, especially since otter populations have declined across much of their western European range.

Historic trends: common and widespread until at least the mid-18th Century. Persecution by gamekeepers and hunting for sport led to population fluctuations throughout the 19th and early 20th Centuries (Chanin & Jefferies 1978; Jefferies, 1989). However, the largest declines in mainland GB commenced in 1957 as a result of poisoning by organochlorine pesticides. Populations have been making a steady recovery since the early 1980s.

Survey schemes providing information on this species: National Otter Surveys, WBBS.

Information on population trends

National surveys. There has been a 527% increase in occupied sites in England and a 268% increase in Wales between 1978 and 2002 (Crawford, 2003; Jones & Jones, 2004). Results from the fourth survey of Scotland are not available, but results from the first three surveys show a steady increase in the number of positive sites between 1978 and 1994 (Green & Green, 1997). In Northern Ireland the picture is somewhat different. In two surveys conducted 20 years apart, there appears to have been a 9.9% decline in otter presence (Preston *et al*., 2004). Across the whole of the UK there was a 70% increase in occupied sites from 1978–1994. More detailed information on the surveys in each country can be found in a series of reports that are listed on the TMP website (*www.trackingmammals.org*).

WBBS. Otters presence was detected on a mean of 24.6 stretches from 1998–2003, representing 13.6% of stretches surveyed. No significant change in presence was recorded during this period (Figure 4.52).

Interpretation of survey results

The national surveys were not originally designed to detect population trends, but to assess distribution change, largely because there were no reliable methods to measure otter abundance. However, the change in distribution recorded in the surveys has been taken as an indication of change in abundance, although it is not possible to provide trend analysis. An attempt has been made to provide population estimates by Jefferies *et al.* (2003), using data from the first three surveys and their otter population figures are quoted, rather than figures from Harris *et al.* (1995).

The surveys indicate a substantial increase in otter distribution across the whole of GB, with the greatest percentage increase in England, although this probably represents the lowest actual number of otters because of the low starting percent of positive sites. There are regional variations in all countries, with some regions doing much better than others in terms of distribution increase.

Future requirements: the series of national surveys should be repeated at appropriate intervals, but the method of data collection should be standardised across all surveys so that changes in mink distribution can also be assessed from survey results. An annual surveillance scheme for otter, mink and water vole, should be piloted, using a variety of methods, such as mink rafts, water vole latrine counts and artificial scat stations for otters, to assess between year population variation and overall population trends. This could be linked to the existing WBBS.

53. Wildcat *Felis silvestris*

Native, critically endangered (Macdonald *et al.*, 2004).

Population estimate: Scotland, 3,500. Absent from the rest of the UK.

Legal and conservation status: CITES Appendix II, Annex A; Bern Convention Appendix II; W&CA Schedule 5, 6; HD Annex IV; WMA; IUCN Red List.

Importance/threats: an isolated population, separated from the main European populations and under severe threat through hybridisation with feral cats and disease transmission. The species is protected under the W&CA, but is still considered as vermin by some gamekeepers and deliberate or accidental killing may be an important issue. Habitat factors such as development and road building may prevent the extension of the species distribution into southern Scotland.

Historic trends: wildcats were once widespread throughout GB, but they are now rare and found only in the northern half of Scotland. Between 1983 and 1987 the former Nature Conservancy Council, as part of a programme of work on the rarer British carnivores, undertook a

systematic survey of the wildcat population in Scotland. Records of the distribution and status of wildcats were collected from 499 10 km squares in Scotland, with more than 400 people supplying information. No evidence of wildcats was found south of a line between Edinburgh and Glasgow. North of the Central Lowlands, the main populations of wildcats were found to occur in north-east Scotland, Easter Ross, north-east Inverness-shire, Strathspey, east Perthshire and parts of Argyll (Easterbee *et al*., 1991).

Elsewhere, particularly in the mountainous areas of the west and north, wildcat occurrence was found to be sporadic. The density of wildcat populations was generally low, even in areas of suitable habitat, the population in north-west and west Scotland being particularly sparse. Over 30% of populations were reported to have declined in recent years, compared with only 8% reported as increasing. The survey established a baseline of distribution and status of the wildcat in Britain in 1983–1987, against which future changes in status could be compared.

Survey schemes providing information on this species: none.

Additional species information: the species has potentially hybridised with feral cats for about 2,000 years (Macdonald *et al.*, 2004) making it very difficult to distinguish true wildcats from hybrids. Recent population estimates range from 400–4,000 animals.

Future requirements: this species will probably require a single species scheme, using experienced professionals to collect the data. Macdonald *et al.* (2004) note the importance of having a robust set of morphological and genetic characters to provide a confident diagnosis of wildcat.

54. Feral or domestic cat *Felis catus*

Introduced, widespread.

Population estimate: probably over 6,000,000 cats in the UK, of which about 20% are estimated to be feral (Macdonald & Tattersall, 2001).

Legal and conservation status: WMA.

Importance/threats: predation on small mammals, birds and amphibians may pose a threat to native wildlife (Woods, 2001; Woods *et al.*, 2003). Feral cats pose a threat to native wildcats through hybridisation and potentially spreading diseases.

Survey schemes providing information on this species: wider countryside BBS; urban LWM, GBW.

Information on population trends

BBS. The survey started collecting information on this species in 2000 and it remains to be seen whether the sample size will be large enough to provide population information.

LWM. Cats were seen in 533 sites in this survey, representing 61% of urban areas surveyed, suggesting that LWM could provide population information for this species in the future.

GBW. Cats were seen in 3,924 gardens, representing 89.9% of gardens surveyed, indicating that GBW could provide population change information for this species in the future.

Future requirements: two surveys, LWM and GBW are providing information on cat populations and some of the sightings may be feral cats. The BBS may provide some information on feral cat populations in the wider countryside. Continued surveillance in the existing schemes would be advisable to assess the value of future data.

4.4.6 Artiodactyla

55. Wild Boar *Sus scrofa*

Localised introduced populations in GB. Population estimate: probably the low hundreds (Niall Moore, *pers. comm*.).

Legal and conservation status: WMA.

Importance/threats: Wild boar are considered a significant agricultural pest on the continent and also a potential reservoir of swine fever and other diseases (Wilson, 2003; 2004).

Historic trends: there are three confirmed breeding populations on the Kent/East Sussex border, Dorset and Hereford. All are small and localised and probably number (in total for England & Wales) in the low hundreds. It is difficult to say what is happening with the population but numbers overall are probably relatively static or slowly increasing, although the number of breeding populations has increased (Niall Moore, *pers. comm.*).

Survey schemes providing information on this species: none.

Additional species information: Defra's National Wildlife Management Team is monitoring reports of escaped and feral wild boar in England to provide more information on the distribution of this species. This is mostly passive surveillance, but field investigations will continue to be undertaken where appropriate to verify reliable reports from new areas.

Future requirements: the species was added to the NGC list of species in 2004 and there is therefore a potential future source of information on the distribution of this species.

Introduction to deer distribution maps

In order to assess the overall distribution of deer species within the UK, the BDS has carried out two national distribution surveys, the first in 1969 and followed by a similar exercise in Scotland in 1998 and in England and Wales in 2000. These data were consolidated in 2002 and the resulting distribution maps accompany the species accounts (Plates XXIV–XXV). The black dots in the maps indicate the distribution of each species in the 1969 survey (but including additional records up to 1972). The brown dots show the distribution in the 2000 survey (but including additional records post 1972), which is additional to that in

1969. The brown dots, therefore, show the spread of each species over a period of 31 years. The distribution maps have been produced courtesy of the BDS and after Ward (2005).

56. Red deer *Cervus elaphus*

Native, common and increasing.

Population estimate: UK ?; England 8,000 (Deer Initiative, *pers. comm.*); Scotland 347,000; Wales fewer than 500; Northern Ireland ?

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 7; W(NI)O; Deer Acts; WMA.

Importance/threats: the species is economically important for venison and trophy hunting. Red deer can cause damage to commercial crops and forestry and there is a serious over population issue in the Scottish highlands. At high densities they can have severe environmental impacts including structural alteration of vegetation communities and biodiversity loss, although moderate deer densities tend to promote higher biodiversity (White *et al.*, 2004). There is a threat from genetic introgression with introduced Japanese sika deer (Abernethy, 1994; Harrington, 1973). Red deer are a possible source of Bovine Tuberculosis.

Historic trends: the species is believed to be steadily increasing in numbers, particularly in Scotland since the 1960s, but populations may now have stabilised. Also increasing in range and numbers in south and west England.

Survey schemes providing information on this species: NGC, BDS Deer Distribution Surveys, BBS, DI.

Information on population trends

NGC. The NGC has collected data on this species and trends will be available in the next TMP report and subsequent reports about the NGC (see roe deer for information on data analysis).

BDS Surveys. A comparison of the results of these distribution surveys (see Plate XXIV) and additional information suggests a slow but steady expansion of range on the fringes of those populations that existed in 1969 with fewer, isolated, populations being established in central England possibly as a result of the planting of community forests in the mid to late 1990s.

BBS. Red deer were seen on a mean of 56 squares from 1995–2002, representing 3.1% of squares surveyed. Trend analysis detected a significant decline in abundance during this period (Figure 4.56, Table 4.6). However, this does not relate to an underlying decline in this species, but instead relates to a steep decline in 1996, due to a small number of sites recording large herds in 1995, but not in subsequent years. The majority of BBS squares reporting red deer presence are in Scotland.

Interpretation of survey results: Although the BBS has detected a decline in this species, it is recognised that this is due to an artefact of data collection because of clumped distribution of the species and small sample sizes. The BDS distribution surveys provide more robust information on changes in the distribution and possibly size of red deer populations. The indications are that this species has steadily been increasing its range, particularly in Scotland since 1969, and probably there has been a concurrent increase in numbers.

Future requirements: continued surveillance of this species in existing schemes for at least another five years will provide more robust trend information. Analysis of the NGC data will help in the assessment of overall trends. The Great British Deer Survey 2005, and the annual Deer Density and Trend Survey planned to commence in 2006 will provide robust information from surveys designed specifically for deer species.

Table 4.6 Red deer presence in BBS squares (1995–2002)

Country	Mean squares present	Percent change (sig at $P \leq 0.05$)
UK	56	–58
Scotland	44	–58

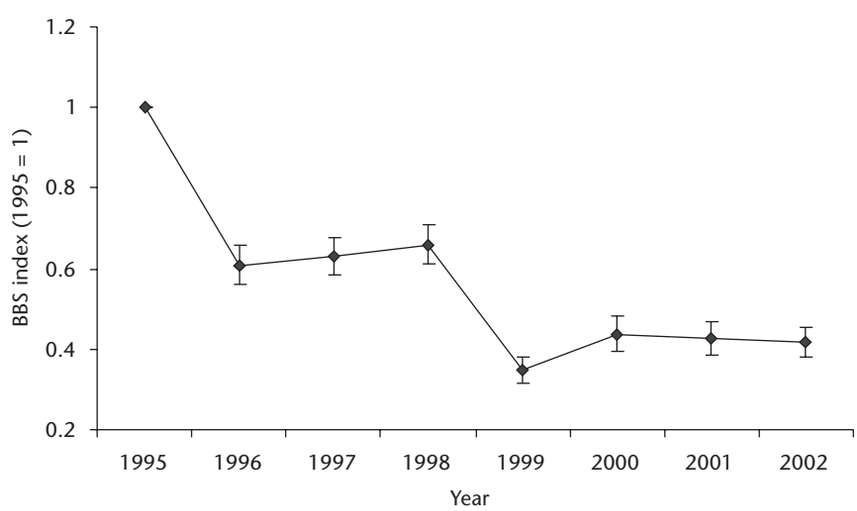


Figure 4.56 UK red deer population indices with 95% confidence limits from the BBS (1995–2002)

57. Sika deer *Cervus nippon*

Introduced, locally common.

Population estimate: UK ?; England 2,500; Scotland 9,000; Wales red deer /sika deer hybrids <100 (Deer Initiative, *pers. comm.*); Northern Ireland ?

Legal and conservation status: W&CA Schedules 7 & 9; Deer Acts; WMA.

Importance/threats: this introduced species occupies about a third of the range of the native red deer and is a serious threat to the genetic integrity of the native species through hybridisation. Sika can reach exceptionally high densities causing great environmental degradation and are also known to cause commercial damage to woodlands (Gill, 1992). As with other deer species, sika are a possible source of Bovine Tuberculosis.

Historic trends: introduced to GB in 1860, the species was maintained in deer parks in the early 20th Century and the population was estimated to be 1,000. There has been a rapid expansion in Scotland since the 1970s and a more localised spread in England, with very few occurring in Wales.

Survey schemes providing information on this species: NGC, BDS Deer Distribution Surveys, DI.

Information on population trends

NGC. The NGC has collected data on this species and trends will be available in the next TMP report and subsequent reports about the NGC (see roe deer for information on data analysis, p. 90).

BDS surveys. The species populations have expanded to double their 1969 range in Scotland, both in the Highlands and in the Borders (see Plate XXIV). Elsewhere, the species has shown a limited expansion although it has been detected in double the number of sites where it was originally recorded in 1969.

Interpretation of survey results: it is difficult to assess the rate of population change from information on changes in distribution. However, assuming some relationship between range expansion and population increase, this species appears to have doubled its range in Scotland, where the largest populations occur, and in other parts of the UK where populations are much smaller. This probably equates to a substantial population increase since 1969.

Future requirements: continued surveillance of this species in existing schemes for at least another five years will provide more robust trend information. Analysis of the NGC data will help in the assessment of overall trends. The BDS Great British Deer Survey 2005, and the annual Deer Density and Trend Survey planned to commence in 2006 will provide robust information from surveys designed specifically for deer species. Same as for red deer (see above p. 88).

58. Fallow deer *Dama dama*

Introduced, widespread and locally common.

Population estimate: UK ?; England 95,000; Scotland <8,000 (DCS in Macdonald & Tattersall, 2001); Wales <5,000 (DI, *pers. comm.*); Northern Ireland ?

Legal and conservation status: Bern Convention Appendix III; W&CA Schedule 7; Deer Acts; WMA.

Importance/threats: a decorative species, popular in parks. The species can cause considerable damage to woodlands and requires management. At high densities they can have severe environmental impacts including structural alteration of vegetation communities and biodiversity loss, although moderate deer densities tend to promote higher biodiversity (White *et al.*, 2004). As with other deer, the species may be a source of Bovine Tuberculosis.

Historic trends: reintroduced into England in the 11th Century (Macdonald & Tattersall, 2001), the species has spread slowly and has a patchy distribution, related to the distribution of ancient deer parks. In the early 20th Century numbers of feral herds were thought to be few when compared with the previous century. Populations are thought to be increasing but there are few reliable estimates.

Survey schemes providing information on this species: NGC, BDS Deer Distribution Surveys, BBS, WMM, DI.

Information on population trends

NGC. The NGC has collected data on this species and

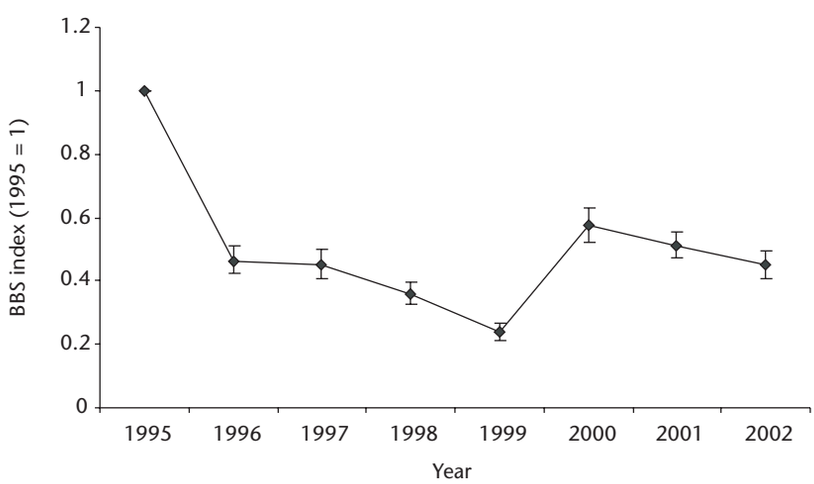


Figure 4.58 UK fallow deer population indices with 95% confidence limits from the BBS (1995–2002)

Table 4.7 Fallow deer presence in BBS squares (1995–2002)

Country	Mean squares present	Percent change (sig at $P \leq 0.05$)
UK	41	–55
England	40	–62

trends will be available in the next TMP report and subsequent reports about the NGC (see roe deer for information on data analysis, p. 90).

BDS surveys. An apparent substantial expansion of range to double that recorded in 1969, especially in East Anglia, the East Midlands and in Wales (see Plate XXIV).

BBS. Fallow deer were detected on a mean of 41 squares from 1995–2002, representing 2.3% of squares surveyed. A significant decline in abundance was detected during this period, 55% overall (Figure 4.58, Table 4.7). However, as with red deer, this does not relate to an underlying decline in fallow deer populations, but rather relates to a steep decline in 1996, due to a small number of sites recording large herds in 1995, but not in subsequent years. The majority of BBS squares reporting Fallow Deer are in England.

WMM. Fallow deer were seen on a mean of 21.3 sites from 2001–2003, representing 4% of the sites surveyed.

Interpretation of survey results: although the BBS has detected a decline in this species, it is recognised that this is due to low survey effort and the localised results do not reflect national trends. The BDS Distribution Surveys provide more robust information on changes in the distribution and possibly size of fallow deer populations. The indications are that this species has steadily been increasing its range, particularly in England since 1969, and probably there has been a concurrent substantial increase in populations.

Future requirements: continued surveillance of this species in existing schemes for at least another five years will provide more robust trend information. Analysis of the NGC data will help in the assessment of overall trends. The BDS Great British Deer Survey 2005, and the annual Deer Density and Trend Survey planned to commence in 2006 will provide robust information from surveys designed specifically for deer species. Same as for red deer (see above, p. 88).

59. Roe deer *Capreolus capreolus*

Native, widespread.

Population estimate: UK 501,000; England 150,000; Scotland 350,000; Wales <1,000; Northern Ireland 0.

Legal and conservation status: Bern Convention III; W&CA Schedule 7; Deer Acts; WMA.

Importance/threats: the most widespread deer species, it is managed for game. Considered a pest in some areas where it causes damage to forestry and agriculture. At high densities they can have severe environmental impacts including structural alteration of vegetation communities and biodiversity loss, although moderate deer densities tend to promote higher biodiversity (White *et al.*, 2004). As with other deer, the species is a possible source of Bovine Tuberculosis.

Historic trends: in the early 20th Century, populations were small and localised in England and were largely the result of introductions, but in Scotland they are considered to be native populations. The species has shown a steady expansion throughout much of eastern, northern and southern England and throughout Scotland. Considered rare in Wales.

Survey schemes providing information on this species: wider countryside NGC, BDS Deer Distribution Surveys, BBS, WBBS, WMM; urban GBW.

Information on population trends

NGC. Changes in spatial density of roe deer in the UK between 1960 and 1999. The NGC roe deer data have been analysed differently from the data for the other species covered by the NGC, to show change in roe deer distribution and abundance during a 40-year period. This method could be used in the future to assess spatio-temporal population change for the other deer species. The data were extracted for 1,422 estates submitting bag records between 1960 and 1999 inclusive. The spatial and temporal changes in roe deer bag density were examined by calculating the mean bag density for each vice-county and each of the ten decades 1960–69, 1970–79, 1980–89 and 1990–99. The mean was a weighted average of all corresponding annual density values, using annual estate area as the weight. The results of the analysis have been reproduced on four maps, each corresponding to a decade (Figure 4.59a Plate XXVI). Within each map, the vice-counties are shaded according to their mean bag density in that decade; the palest shade represents the lowest density, the darkest one the highest density (logarithmic scale). The maps illustrate the spread of roe deer from Scotland southwards, and also from a few limited sites in the south and east towards central England. So far there is little evidence of much change in Wales and the Midlands. Increases of the greatest magnitude occurred in southern England, north-west England and western Scotland.

BDS surveys. This is the most widely distributed species in the UK, showing a substantial expansion of range in southwest England, East Anglia, north-east England and northern Scotland. Movement into Wales was also recorded for the first time in the 2000 survey (see Plate XXV).

BBS. Roe deer were seen on a mean of 246 squares from 1995–2002, representing 13.7% of squares surveyed. A significant continuous increase across the UK was detected during this period, representing 56% overall (Figure 4.59b). Separate country and regional analyses showed that the largest increase was in England, 66% overall, particularly in the south-east and south-west, where 110% increases overall were detected (Table 4.8).

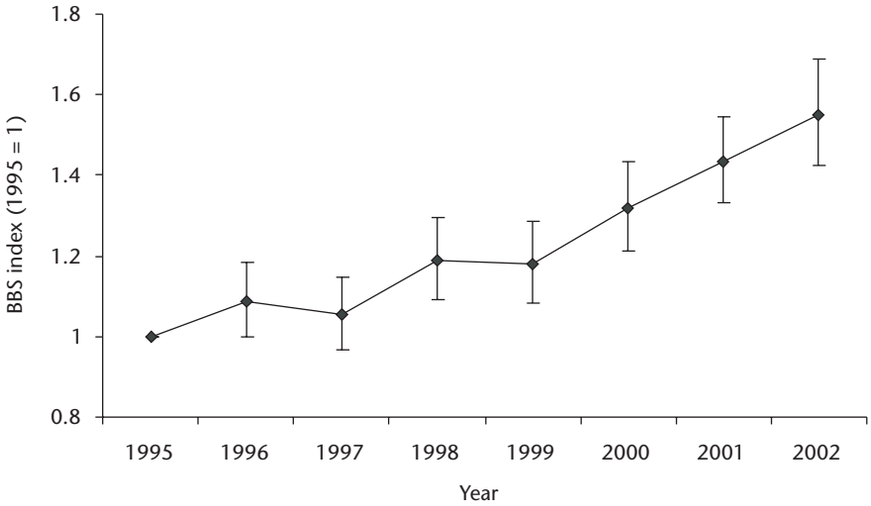


Figure 4.59b UK roe deer population indices with 95% confidence limits from the BBS (1995–2002)

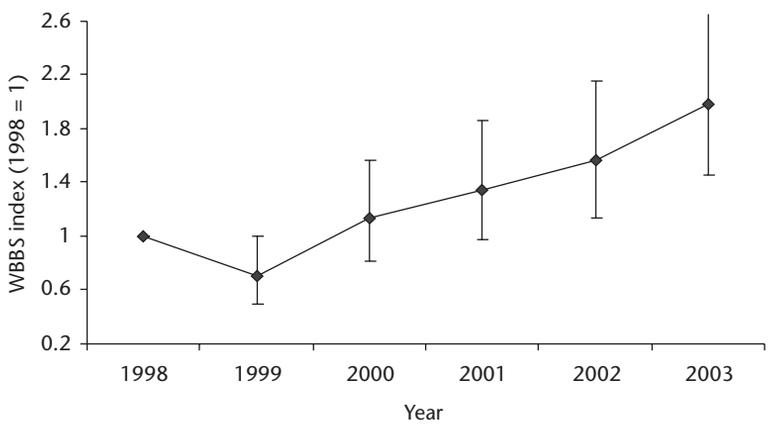


Figure 4.59c UK roe deer population indices with 95% confidence limits from the WBBS (1998–2003)

WBBS. Roe deer were seen on a mean of 38 stretches from 1998–2002, representing 21% of stretches surveyed. A significant increase in abundance was detected during this period (Figure 4.59c).

WMM. Roe deer were seen on a mean of 71.7 survey squares from 2001–2003, representing 13.45% of squares surveyed.

GBW. Roe deer was the most commonly seen deer species observed in 182 gardens in 2003, representing 4.2% of gardens surveyed. This suggests that GBW could provide population information on this species in the future.

Interpretation of survey results: all the surveys show a continuous increase in distribution and relative abundance

Table 4.8 Roe deer presence in BBS squares (1995–2002)

Country	Mean squares present	Percent change (sig at $P \leq 0.05$)
UK	246	56
England	177	66
Scotland	68	45
Government Office Regions		
South East England	59	110
South West England	63	110
Environmental Zones		
(1) Easterly lowlands (England/Wales)	101	68
(2) Westerly lowlands (England/Wales)	65	80

of this species from the 1960s to the present day, providing good evidence of substantial population increase.

Future requirements: continued surveillance of this species in existing schemes for at least another five years will provide more robust trend information. The BDS Great British Deer Survey 2005, and the annual Deer Density and Trend Survey planned to commence in 2006 will provide robust information from surveys designed specifically for deer species.

60. Muntjac *Muntiacus reevesi*

Introduced, locally common and increasing.

Population estimate: UK 40,300; England 40,000; Scotland fewer than 50; Wales fewer than 250; Northern Ireland 0.

Legal and conservation status: Deer Acts; W&CA Schedules 7 & 9; WMA.

Importance/threats: the species causes local damage to market gardens, coppice and woodland plants (Feber *et al.*, 2001). The species can render coppice management uneconomic and ineffective as a conservation tool by preventing regeneration through browsing (Putman, 1996). Muntjac may out compete and oust roe deer in some situations (White *et al.*, 2004). The species is becoming increasingly important for local economies for trophy stalking. As with other deer, the species is a possible source of Bovine Tuberculosis.

Historic trends: introduced into England in 1894 and into the wild from Woburn Abbey in the 1960s, they are now widespread throughout 12 core counties in central England and are increasing their range and abundance at a rapid rate. Their spread appears to be due both to natural migration and to human intervention through accidental and deliberate releases (Chapman *et al*., 1994).

Survey schemes providing information on this species: wider countryside NGC, BDS Deer Distribution Surveys, BBS, WMM; urban GBW.

Information on population trends

NGC. The NGC has collected data on this species and trends will be available in the next TMP report and subsequent reports about the NGC.

BDS surveys. Whilst still confined in the main to the south and east of England the expansion in range of this species is of the greatest magnitude of all deer species. The range of this deer has expanded sevenfold between 1969 and 2000 (see Plate XXV).

BBS. The species was seen on a mean of 47 squares from 1995–2002, representing 2.6% of squares surveyed. A significant continuous increase in the UK, 46% overall, was detected during this period (Figure 4.60, Table 4.9). The largest increase was within its stronghold of England.

WMM. Muntjac were seen on a mean of 16.3 sites from 2001–2003, representing 3.1% of the sites surveyed.

GBW. Muntjac were seen in a mean of 173 gardens during 2003, representing 3.9% of gardens surveyed. This suggests that GBW could provide population information on this species in the future.

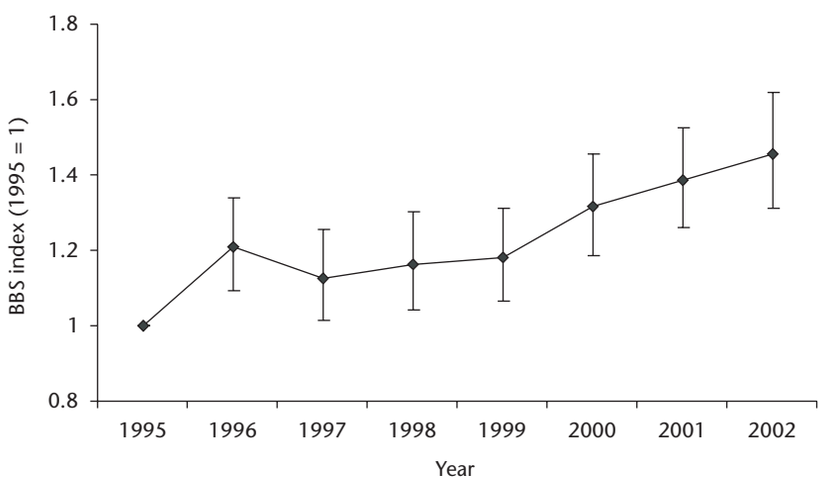


Figure 4.60 UK muntjac population indices with 95% confidence limits from the BBS (1995–2002)

Table 4.9 Muntjac presence in BBS squares (1995–2002)

Country	Mean squares present	Percent change (sig at $P \leq 0.05$)
UK	47	46
England	46	31
Environmental Zones		
(1) Easterly lowlands (England/Wales)	41	NS

NS = Not significant

Interpretation of survey results: all the information suggests that this species has undergone a substantial increase in distribution and abundance in the last 40 years and that the increase has continued in more recent times.

Future requirements: continued surveillance of this species in existing schemes for at least another five years will provide more robust trend information. Analysis of the NGC data will help in the assessment of overall trends. The BDS Great British Deer Survey 2005, and the annual Deer Density and Trend Survey planned to commence in 2006 will provide robust information from surveys designed specifically for deer species. Same as for the red deer (see above p. 88).

61. Water deer *Hydropotes inermis*

Introduced, uncommon and local.

Population estimate: England less than 2,000 (Macdonald & Tattersall, 2001). Absent from the rest of the UK.

Legal and conservation status: WMA; IUCN Red List.

Importance/threats: the UK has an internationally important population of this species, because of increased threats to its existence within its natural range. There are no known significant impacts on forestry agriculture or conservation, but this may change as populations increase in size and range (White *et al.*, 2004).

Historic trends: first reported in the wild in England in 1945, the species is now found in East Anglia, with small isolated populations in Cambridgeshire, Norfolk, Suffolk and Avon. Populations may have increased significantly in recent years.

Survey schemes providing information on this species: BDS Deer Distribution Surveys.

Information on population trends

BDS surveys. Although this deer has seen a doubling of its range since 1969, that range is still the smallest of any of the deer species, and is confined to local expansion around its original location at the time of the first survey (see Plate XXV).

Interpretation of survey results: the available evidence suggests that this species has increased its distribution and that there has probably been a concurrent population expansion.

Future requirements: the BDS Great British Deer Survey 2005, and the annual Deer Density and Trend Survey planned to commence in 2006 may provide robust information from surveys designed specifically for deer species. Same as for the red deer (see above p. 88).

62. Feral goat *Capra hircus*

Introduced, well established.

Population estimate: UK ?; England 315; Scotland 2,650; Wales 600; Northern Ireland ?

Legal and conservation status: WMA.

Importance/threats: regarded as pests and regularly culled to reduce damage to forestry and agriculture. Considered by many as a desirable part of local fauna, as well as being an important food source for golden eagles in Scotland.

Historic trends: probably one of the earliest domesticated animals to be introduced to the UK. The early history and distribution are documented by Whitehead (1972).

Survey schemes providing information on this species: none.

Future requirements: continue local surveillance through established counts.

63. Feral sheep *Ovis aries*

Introduced onto offshore islands, local.

Population estimate: UK 2,100; England 150; Scotland 1,850; Wales 100; Northern Ireland ?

Legal and conservation status: WMA.

Importance/threats: two forms occur in the UK, the Soay and the Boreray, both classified by the Rare Breeds Survival Trust as 'Rare Breeds'. There is a potential threat to these populations from diseases or parasites introduced from the mainland.

Historic trends: cyclical changes in numbers that are driven by periods of food depletion due to high numbers, leading in turn to population crashes. There is no indication of long term trends in feral sheep numbers.

Survey schemes providing information on this species: none.

Future requirements: continue local surveillance through established counts.

4.4.7 Diprotodontia

64. Red-necked wallaby *Macropus rufogriseus*

Introduced, local.

Population estimate: UK fewer than 50 individuals.

Legal and conservation status: W&CA Schedule 9; WMA.

Importance/threats: harsh winters reduce numbers and traffic accidents may be a significant cause of death.

Historic trends: overall, the number of feral red-necked wallabies in GB appears to be declining, with three out of four free-living populations going extinct or not being viable in recent years.

Survey schemes providing information on this species: none.

Future requirements: local surveys to assess distribution and abundance.

5. Future directions

5.1 Introduction

The previous chapters in the TMP First Report have looked at the history and current work of the TMP in setting up a UK network of mammal surveillance and monitoring. The essential role played by volunteers in data collection has been discussed and data and information on the population status of each resident terrestrial mammal species in the UK have been provided. The quality and detail of information varies greatly between species, depending on survey coverage, funding availability and the ease with which species can be surveyed. This chapter aims to draw together the information on individual species and to look into the future at the quality and breadth of data the TMP would like to provide for each mammal species, how this could be achieved and how the information could be used.

5.2 UK trends overview

5.2.1 Species coverage

Table 5.1a (Plate XXIX–XXX) provides an overview of trend information for all species currently included in TMP schemes, excluding the bats. The table lists all the schemes, the species for which data are available, provides a summary of historic trends over the last 100 years up to 1995, and indicates whether populations are currently increasing, stable or declining, based on available data. Table 5.1b (Plate XXXI) gives an overview of trend information for resident bat species currently covered by the NBMP. Where a significant trend has been detected total percentage change from the baseline of the survey is given, where available. Table 5.1c (Plate XXXII) lists all the species, including the bats, not currently included in any surveillance scheme. Feral cat has been included in the species list because of its impact on other species. The Irish hare, considered a subspecies of the mountain hare, has been included as a separate taxon in Table 5.1a, because it has been the subject of a separate series of surveys.

At present the TMP surveillance and monitoring programme is collecting information on 37 of the 65 mammals listed in this report, including 11 of the 16 resident bat species (Tables 5.1a & 5.1b). Overall, this represents 57% of the UK terrestrial mammal fauna. There are sufficient data for 33 species and one subspecies to make some assessment of overall current population change. The remaining three species, water shrew, field vole and house mouse do not have sufficient data at present to assess current trends, but data are being collected in at least one scheme in the TMP surveillance and monitoring programme.

Trend analysis, measured using sightings, signs, or number of occupied sites, has been carried out for 29 species, including 11 bats, representing 45% of UK terrestrial mammals. Of the remaining five species for which some assessment was possible, there is good information on changes in abundance and overall population size for the Irish hare, but only from a comparison of two surveys carried out two years apart and data are not sufficient for trend analysis. Polecat, otter, sika deer and water deer populations have been assessed from periodic surveys looking at changes in distribution, but it has not been possible to carry out trend analysis on the data.

The three tables (5.1a, 5.1b & 5.1c) show that the dataset on population trends for UK mammals is not complete. As yet there is no robust population trend information for the majority of species, because the time series are too short, the survey sample sizes are too small or the species are not included in any of the surveillance schemes. Some of these issues will automatically improve over the next few years as more years of data are added to existing schemes, providing longer times series. For some surveys annual sample sizes can be increased by engaging more volunteers and targeting areas of poor coverage. New schemes can be included in the overall programme to cover many of the species listed in Table 5.1c. Furthermore, with greater standardisation of survey methods between the schemes it may be possible to combine data for individual species from several schemes in order to give large enough samples for trend analysis. The existing datasets will grow over time and will be able to provide robust results on percentage change for more species.

The mammals listed in Table 5.1c not currently covered in the TMP surveillance programme fall into two groups. The first group contains species that are relatively rare or have restricted distributions. This includes the five remaining bat species, except Leisler's bat, which is rare in mainland GB but relatively common in Northern Ireland, red squirrel, ship rat, pine marten, wildcat, wild boar, feral goat and feral sheep and red-necked wallaby. These species are either seldom seen, heard or their signs observed and so they are very difficult to survey and require complex methods, or they have such small populations that the best approach is to target surveys in particular areas and this does not fit well with the general TMP approach of widespread random surveying using volunteers.

It is probable that Bechstein's bat, barbastelle, red squirrel, pine marten and wildcat will all need single species schemes designed specifically to address their ecology in order to collect sufficient information. The ship rat is practically extinct in the UK and there are no plans to survey this species. Wild boar has been added to the NGC list of species and so there should be more information for this species in the next few years. Feral goat, feral sheep and red-necked wallaby could be surveyed on a local basis.

The second group includes mainly small mammals, shrew, voles and mice. Some are restricted to islands, such as Orkney, Guernsey and Skomer voles, or have very restricted distributions, such as the fat dormouse, and require local surveillance. The other species in this group are often very abundant and widespread but their populations can fluctuate widely and because of their small size they are also not easy to hear or see. Survey methods for these species include live-trapping, hair tube surveys, sign surveys and more indirect methods such as counting small mammal remains in owl pellets (Flowerdew *et al*., 2004; Love *et al*., 2000; Mallorie & Flowerdew, 1994;). A sensible approach for small mammals would be to pilot a survey which assesses the merits of different methods at the same time, with the results from each method providing cross calibration for the others.

5.2.2 Patterns in population trends

Native and introduced species

Of the 33 species and one subspecies for which some assessment of current (1995 onwards) population change is possible, 25 (73.5%) are natives. Ten native species including greater horseshoe bat, lesser horseshoe bat, Natterer's bat, Daubenton's bat, common pipistrelle, polecat, badger, otter, red deer and roe deer have shown increasing populations since 1995, with common pipistrelle, otter and roe deer showing increases of more than 50%. Four species including mole, whiskered bat, Brandt's bat and soprano pipistrelle show stable populations at present. For moles, the BBS shows a significant increase, but this could be affected by a change in recording methods in 2000. The smaller WBBS riparian survey shows no change. It is possible that mole populations have increased, but more years of data are required before this can be confirmed. For red deer, the trends in the surveys are contradictory. This may be because red deer is a herding species and therefore has a very clumped distribution and this is likely to affect annual variation in sightings on random squares, the method used in the BBS. For this reason the increase in distribution measured between the two BDS deer surveys is considered to be more reliable.

Three native species including mountain hare, water vole and common dormouse, have shown significant declines, with water vole showing declines of more than 50%. For eight natives including hedgehog, serotine, noctule, brown long-eared bat, Irish hare, fox, stoat and weasel, the trends are not clear. There is evidence of a long-term decline in UK hedgehog populations, with regional declines in parts of eastern England and a significant decline in riparian habitats. Other evidence suggests stable or increasing populations. There are some indications of declines for serotine, noctule, brown long-eared bat, and evidence of long-term and possible current declines in weasel populations. Although Irish hare populations have shown significant increases from 2002–2004, the dataset is too short at present to provide robust trends.

Of the nine introduced species, representing the remaining 26.5% of species for which a current assessment is possible, rabbit has shown a significant decline since 1995. Six introduced species populations including grey squirrel, common rat, sika deer, fallow deer, muntjac and water deer probably have increasing populations, and two species, brown hare and mink, have stable or declining populations, but the trends are less clear than for the other species.

To summarise, 40% of natives appear to be increasing, 12% appear to be declining, 16% appear to have stable populations at present, and for 32% the trends are unclear. Of the introduced species 66% appear to be increasing, 11% declining, and 22% are stable.

In all cases the trend information taken from the 1995 baseline provides a short time series and future years of surveillance will provide increasingly robust information, but there may always be some difficulties in interpretation of overall trends where results differ between surveys.

5.3 Future progress

Mammal surveillance and monitoring has made great progress in the last few years and a long-term suite of surveillance schemes is now in place, providing some information on the majority of terrestrial UK mammals. TMP First Report is the first published general account of the work of the TMP, but the intention, for the future, is to provide an annual update on progress made with the surveillance and monitoring programme. Reporting annually will raise the profile of mammals and ensure that the organisations in the TMP continue to improve the surveillance network and continue to increase the coverage of species. However, there is still a need to plan for the future, so that in 5–10 years time there will be some information for all our terrestrial mammal species. There are several issues that the TMP will need to consider to achieve this.

5.3.1 Country and regional trends

The majority of existing surveys are providing good data at a UK level, or for species with restricted distributions, at the appropriate country level. However, coverage in Scotland, Wales and particularly Northern Ireland for some species is quite poor and regional analyses in England are only possible, at present, for a very limited number of widespread and common species. To provide population trends at country level requires sample sizes for each country that are as large as those required for trend analysis across the whole of the UK. For example, if 40 sites are required across the UK to provide a UK trend, then 40 sites are required in each country to provide country trends, giving a total of 160 sites across the UK. Generally this is not a problem for providing trends in England, but is a much greater problem in Scotland, Wales and Northern Ireland. Table 3.1 showed mean annual coverage of sites in the different countries and indicated that on average approximately 75% of survey sites are in England, 13% in Scotland, 11% in Wales and 1% in Northern Ireland. As a proportion of the UK, England has approximately 53% of the land area, Scotland 32%, Wales 9% and Northern Ireland 6%; hence, it is clear that there is a bias towards

England and Wales in terms of survey coverage. It is also clear that Scotland and Northern Ireland are under-represented in surveys. As already highlighted in chapter 3, volunteers for most surveys are allocated sites that are in their local area from a pool of randomly selected sites, and the majority of volunteers are in England. (Land area statistics taken from those websites listed under "Area statistics" in the References).

Some surveys, for example the NGC and the BBS, which are both long-running surveys with relatively large sample sizes, are able to provide country and regional trends for some species. Mammals on Roads and Garden BirdWatch have large enough sample sizes to provide country and regional information, but need more years of data before robust trends can be assessed. A broad regional analysis has been carried out for the common dormouse using results from the NDMP (see Figures 4.42b–4.42e).

Country and regional level information is also available for otter, with the national otter survey reports providing detailed information on distribution change by region, (Crawford, 2003; Jones & Jones, 2004; Green & Green, 1997; Preston *et al*., 2004). The surveys covering water vole, badger, brown hare and polecat also looked at regional trends (Birks & Kitchener, 1999; Hutchings & Harris, 1996; Strachan *et al*., 2000; Wilson *et al*., 1997). With longer time-series and increased sample sizes other TMP surveys will be able to provide country and regional level information.

It is also not possible to provide population trends in Environmental Zones for the majority of species, with current sample sizes. This is mainly the result of the numbers and distribution of volunteers and the difficulty of covering remote areas using a volunteer network. General solutions to providing trend information at smaller spatial scales might involve targeted recruitment of new volunteers and the shared use of professionals to survey remote areas.

5.3.2 Collection of habitat data

At present there is no consistent collection of habitat information across all TMP schemes. This is a major gap in the data provision of the TMP because broad habitat divisions are an alternative way of assessing population changes. An example of what can be done with habitat data is provided in the most recent BBS report (Newson & Noble, 2004) where interpolated mapping has been used to assess changes in brown hare distribution from 1995–2002. A geostatistical analysis method, Kriging, was applied to the BBS mammal data to predict the distribution of brown hare across the UK. Data from the BBS on sightings of brown hare were combined with Land Cover Map 2000 data (LCM2000) to predict brown hare occurrence on unsurveyed squares. LCM2000 data provides information on the proportions of each of 27 habitat classes in each 1 km square across the UK (Haines-Young *et al*., 2000). In these trial analyses, data were classified into seven aggregate habitat classes and each habitat in turn was used as a predictor of relative abundance. Once the best predictor habitat had been determined, a second habitat variable was added to the model to examine whether this improved the reliability of predictions further.

Figures 5.1a, 5.1b & 5.1c (Plate XXVIII) show the results of the interpolation exercise. The results broadly agree with the distribution map produced by Arnold (1993) and the relative abundance predictions with the results of the national brown hare survey (Hutchings & Harris, 1996). Results of the BBS geostatistical analysis show that this method has great potential for improving the understanding of finer scale spatial patterns in relative abundance or distribution. The method also provides a way of assessing change in addition to the production of regional indices or visually through the production of distribution maps of species presence. It is quite possible that statistically valid maps of this type could be produced in a similar way for some other species from a variety of schemes.

The trial also demonstrates the importance of habitat requirements for the brown hare, and how information of this type at a 1 km scale, such as the LCM2000 data used here, can improve the predictions. It is therefore, very important that the TMP considers the use of the LCM2000 data in the future, for analyses of this type, but also to provide contextual habitat information for all the 1 km squares surveyed in the TMP schemes. This would be a way of standardizing the collection of habitat data and remove what can be an onerous task for the volunteers. A calibration exercise, comparing the LCM2000 data with habitat information collected by volunteers at the 1 km square level, would be a good starting point for assessing the feasibility of using the LCM2000 data more widely.

5.3.3 Increasing species coverage – introducing new schemes

There are still insufficient data for nearly 60% of terrestrial mammals and this situation needs to be addressed. Some of the species are already covered by existing schemes and, as the datasets grow, population trend information will be available for them. The main groups in need of new schemes have already been identified, small mammals and those for which single species schemes are likely to be most appropriate, such as wildcat, red squirrel, Bechstein's bat and pine marten. It is no coincidence that these two groups of species are the last to be included in the TMP network, because they are the most difficult to survey and finding the right methods to use and locating funding for the surveys will be priorities over the next few years. A detailed summary of the future survey requirements for each species, which are needed to produce an integrated surveillance and monitoring programme for UK mammals, is given by Harris & Yalden (2004).

5.3.4 Cooperative working within the TMP – pooling resources where possible

The organisations that make up the TMP have begun to work more closely together, sharing information and expertise and often jointly running surveillance schemes. The TMP First Report is a good example of the commitment of the organisations involved with the TMP to

provide reliable trend data in a co-ordinated way. However, the fact that many of the schemes were already in existence before the TMP was formed means that there are still differences in the way that data are collected, stratified and analysed in the various schemes. The TMP is assessing the value of closer co-operation, through linking surveillance schemes, jointly managing volunteer networks, sharing technical expertise and training facilities, standardising survey design and presentation of results and amalgamating the data from surveys where possible, to give more robust and accurate trends.

One way of doing this is sharing information to assess the comparability of species trends from different schemes. An example is provided in a comparison carried out by Whitlock *et al.* (2003) using gamebag indices for fox, rabbit and grey squirrel from the last eight years of the NGC compared with abundance indices from the BBS for the same period. The results showed a good level of concurrence, for all three species (see Figures 5.2a, 5.2b & 5.2c).

This comparison helps to reinforce the validity of data from both surveys and suggests that the data collected by the NGC prior to 1995, when there were no other surveys to compare with, are probably a fairly accurate representation of population changes for the species they have surveyed. In the future, comparisons between surveys and across time periods will help to provide a full picture of what is happening to individual species over time and in different areas.

5.4 Uses of the data

5.4.1 Monitoring threatened species

Surveillance and monitoring are essential activities to assess the effectiveness of conservation management and policy. It has already been shown that significant population changes can be detected, alarming trends highlighted and predictions made about future trends. Monitoring and surveillance data can be used to assess progress with Biodiversity Action Plans and examples of this are already happening – the otter surveys have shown that the BAP targets for otters have already been met in most of the UK, the NDMP has shown that despite the very important conservation work on providing nest boxes and reintroducing dormice to sites where they once occurred, the species is still in decline, particularly at the northern edge of its range. The NBMP has recorded encouraging increases in the populations of lesser horseshoe and common pipistrelle bats, while highlighting potential problems with other species.

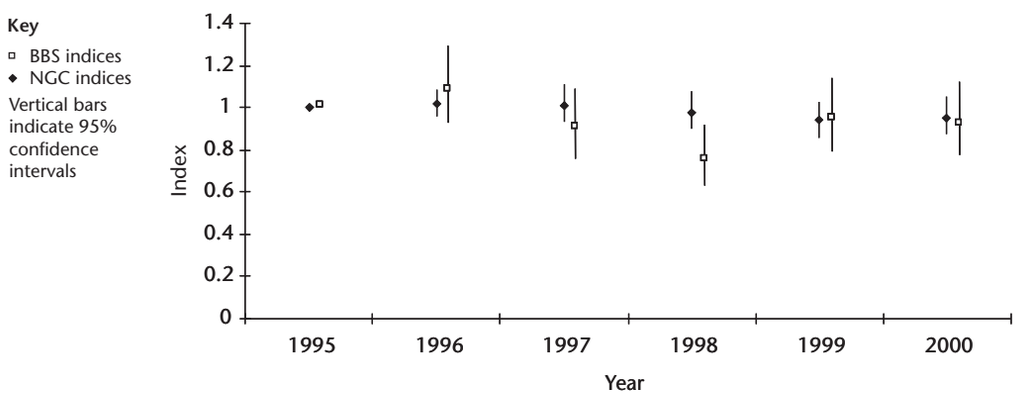


Figure 5.2a NGC and BBS indices for fox, 1995–2000. No significant differences are apparent in the annual indices for fox from either NGC bag data or BBS data. Note that the confidence intervals are narrower for NGC data for fox, as a result of a larger sample size.

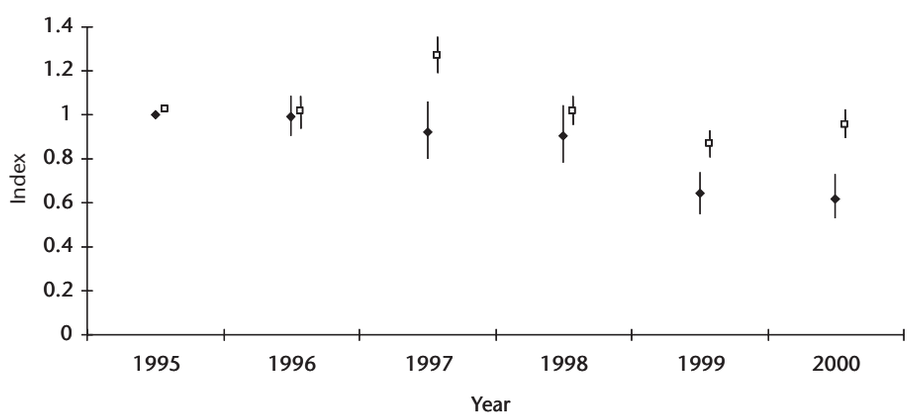


Figure 5.2b NGC and BBS indices for rabbit, 1995–2000. The indices show a similar pattern of variation for rabbits, although the rabbit index for BBS data is consistently higher in years from 1997 onwards. Error bars are wider for NGC data, probably due to the large variability in rabbit bags. There is agreement between BBS and NGC rabbit indices in 1999, where both rabbit bags recorded by the NGC and rabbit numbers recorded in the BBS were significantly lower than in preceding years.

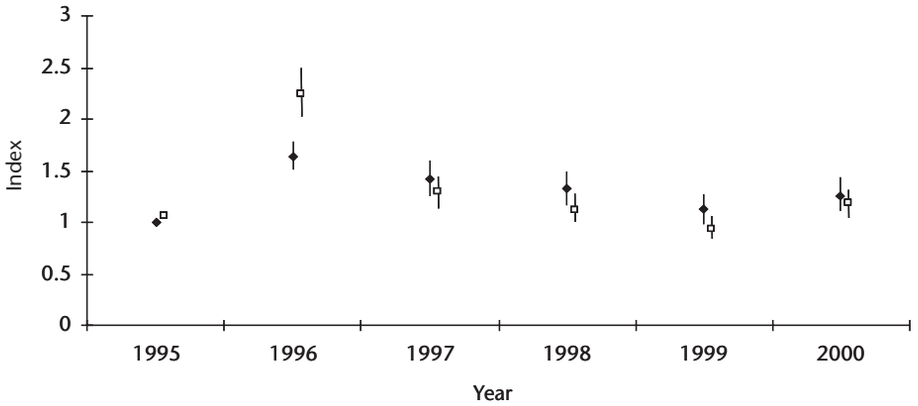


Figure 5.2c NGC and BBS indices for grey squirrel, 1995–2000. Grey squirrel indices show good correspondence between NGC and BBS data, with a similar overall pattern of variation between years, and significantly higher values in 1996 relative to 1995 for both datasets. Error bars are comparable between the NGC and BBS although the 1996 index for the latter has a slightly wider error bar.

5.4.2 Assessing species of conservation concern and wildlife management priorities

Since the UK BAP lists of priority species were published in 1995, there has been much new information gathered. There have been changes in species status and in the UK administration, with devolution of environmental responsibilities. Ten years on, the lists of priority habitats and species are being reassessed to ensure that they reflect current UK and national priorities and, in conjunction with this process, a new Red List of UK mammals is proposed.

The Red List, using IUCN criteria, and the process of assessing mammal data to determine species of conservation concern, are the first steps towards selecting priority BAP mammal species requiring conservation action. The IUCN criteria use a 50–80% population loss over 10 years or three generations, whichever is the longer time period (*www.iucnredlist.org*), to identify species that are Vulnerable, Endangered or Critically Endangered. The TMP surveillance and monitoring programme has provided invaluable data to aid this process and will help to ensure that the priority list of mammals for the UK BAP will be delivered by the end of 2005.

In a similar way the TMP can provide information on populations of species that are of wildlife management concern, *e.g.* rabbit, grey squirrel and deer. A recent consultation on managing deer populations recognised the poor quality of data available on population trends for deer and this is an area where the co-ordinated approach of the TMP could be invaluable (The sustainable management of wild deer populations in England: an action plan. Available at: *www.forestry.gov.uk/pdf/deerstrategyengland301204.pdf/$file/deerstrategyengland301204.pdf*).

5.4.3 Provide distribution data for NBN

The TMP is collecting a great deal of information on mammals annually. While the principal intention is to provide population trends, these data can also be added to the existing database of distribution records held by the NBN and accessed through the NBN Gateway. This information will greatly help to increase our understanding of mammal distribution across the UK.

5.4.4 Spread of zoonotic diseases

Mammals are associated with the spread of several zoonotic diseases and in some cases can be a significant reservoir for disease in humans *e.g.* Lyme disease and Wiel's disease. Other zoonotic diseases may be carried by a variety of mammal species, but occur infrequently in humans in the UK, or occur in northern Europe and have the potential to be introduced into the UK in the future. A summary is provided in Duff (2004). There are a few examples that may be of particular interest in terms of the changing size and distribution of some mammal species populations.

Lyme disease is spread to humans by the bite of the common tick, *Ixodes ricinus* and tick populations are increasing as a result of growing deer populations. Good knowledge of the distribution of deer species and areas where they occur in highest densities is important to be able to advise the public on the likely risk.

Tick borne encephalitis (TBE) is a disease that is spreading across continental Europe, and could occur in the UK in the future. The disease is linked to wood mice, particularly yellow-necked mice, and to deer species, which are implicated in the maintenance of the larval stage of the ticks. The current distribution of the yellow-necked mouse in the UK is limited to the southern half of England, but the effects of climate change could allow the species to spread further north. Again, information on population and distribution change, particularly in relation to deer populations is important to understand the potential spread of TBE in the UK.

The death of a bat worker in Scotland in 2002 from rabies, which he is believed to have contracted from a bat infected with European Bat Lyssavirus (EBLV) and the fact that there have been several Daubenton's bats found in the UK with the virus, suggests that EBLV may be endemic in certain UK bat populations. Knowledge of bat species distribution and trends will help to inform decisions on providing advice to the public regarding this disease.

5.5 Costs of the TMP surveillance programme

Assessing the cost of setting-up and running the TMP is quite a complex exercise and there is likely to be quite a high margin of error involved. However it is useful to have some idea of the cost of providing the current level of information and the additional costs of completing the programme and providing comprehensive mammal surveillance across the UK. Some of the problems in assessing costs arise from the varied nature of the surveillance schemes and the way they are run. Some are run as single-species schemes, others as multi-species schemes, some collect data throughout the year, others collect data during specific periods, some require a great deal of field work on the part of surveyors, volunteer or professional, others require comparatively little time involvement.

All the surveys have certain elements in common, in that they require at least one member of professional staff to act as co-ordinator for the survey, plus specialist advice on aspects such as statistics, mammal ecology and marketing, as well as office space with attendant overheads to accommodate the staff and office equipment such as computers and other materials. The cost of each survey involves annual advertising to recruit volunteers, printing and posting of survey forms, inputting and analysis of the data and interpretation and dissemination of the results. In addition there is a cost of managing the volunteer networks, in terms of liaising with the volunteers, answering questions, providing training materials and running training workshops, providing feedback and assessing the quality of volunteer input.

Considering all these factors, a reasonable average cost of running an annual single species surveillance scheme might be between £40–50,000. To run a single survey multi-species scheme would be slightly more expensive, given that there are more data to input and potentially a larger network of volunteers with more complexity of survey methods, and might reasonably cost between £60–70,000. To run two or more single or multi-species schemes would require some additional resources, in terms of managing the schemes, producing survey forms, training the larger volunteer networks and inputting larger amounts of data and would require more members of staff. However, there should be some savings involved in terms of equipment and accommodation costs. So two schemes might cost between £80–90,000 and as more schemes are added to a particular group, the cost of each additional scheme is likely to be proportionately less.

It should be noted that these are average costs and the variation between schemes can be quite wide. For example in the NBMP, the colony counts survey, covering six species, is estimated to cost approximately £12,000 annually, while the Daubenton's survey, covering one species is estimated to cost £48,000 (BCT, 2004). The NDMP, covering one species, is estimated to cost approximately £15,000 annually (Valerie Keeble, *pers. comm.*). The variation is caused by degree of difficulty of the survey, number of volunteers involved, volunteer turnover, training requirement, sample sizes required etc. However, overall the average estimated costs seem quite accurate considering that the NBMP costs approximately £110,000 to run per annum, involving three multi-species schemes and one single species scheme.

Using this analysis it is possible to provide a very rough estimate of the total cost of the TMP surveillance and monitoring programme and to estimate the additional cost of providing a comprehensive mammal surveillance network. Within the existing programme there are several different combinations of organisations and survey schemes, with one organisation running a single species survey, one running a multi species survey, one running two multi-species and one single species surveys, one running three multi-species surveys and so on. It should be noted that most of the organisations running the surveys are working in partnership with one or more of the other organisations in the TMP, but generally one organisation takes the lead in running each of the surveys.

Taking into consideration the arrangement of surveys, it is estimated that the cost of the TMP programme at present is somewhere in the region of £500,000. This does not include the self-funding GBW, but does include some input from the BBS and WBBS, although they are mainly collecting information on birds. It also does not include the national otter surveys, which were conducted by professionals. In order to increase the programme to cover all species, there is a need to include single-species schemes for red squirrel, pine marten, wildcat and fat dormouse, a multi-species small mammals survey, a multi-species mustelids survey, a riparian species survey and a multi-species deer survey. These surveys would add approximately £350,000 to the total, bringing the total to £850,000. This is the very approximate cost of providing a comprehensive programme of surveillance, with cross calibration of results on most species to ensure that new surveillance information could be checked and validated.

It should be noted that much of the existing funding for mammal surveillance is provided by the NGO community. Some surveillance schemes, such as the NBMP, receive substantial government funding because of the protection status of the species they are monitoring, for example all bats are protected under national and international legislation, but BCT also have a financial commitment to ensure the NBMP continues to operate a full programme. Many other schemes receive little or no government support and there is very little extra funding available at present to complete the programme of work, despite the fact that several of the species without surveillance schemes are important for either conservation or wildlife management reasons. The NGO mammal community commits a great deal of funding to ensure that the TMP surveillance programme continues to operate, but it is unlikely that they will have additional funds in the future to build on what already exists, and without additional government funding the mammal surveillance programme is unlikely to be completed.

The sum of £850,000 is a large amount of money. However, it has to be balanced against the estimated value of the data already being collected. In chapter 3 the total value of

volunteer input was estimated to be approximately £4.5 million annually and comparing these two figures it is easy to see that the mammal surveillance programme is extremely good value.

Based on the size of the countries in the UK it is estimated that comprehensive mammal surveillance in England would cost approximately £450,500, in Scotland approximately £272,000, Wales £76,500 and Northern Ireland £51,000. However, this would only apply if mammal surveillance continued to be coordinated at a UK level. The cost would be much greater for individual countries to set up their own surveillance schemes.

5.6 Conclusions

This chapter completes the TMP First Report and shows the complexity and extent of the work being carried out on mammal surveillance. The TMP intends to produce annual updates on mammal population trends and to produce a full report on the work of the partnership at five yearly intervals. The TMP, in this report, has begun to pull together the different strands of the very good work that has been underway in separate areas for different lengths of time, as well as starting up new pilot initiatives, and in doing this has shown the considerable benefits of co-operative working.

The next five years will involve ensuring that all the schemes delivering long-term population trend information are as financially secure as possible, while continuing to investigate ways of delivering the necessary information as economically as possible. This may well involve closer co-operation between organisations where their interests overlap and development of new ways of collating and analysing data, including web-based data entry and dissemination. Another equally important consideration will be locating additional funding sources to pilot new schemes and provide a comprehensive programme of information for all UK mammals.

None of this would be possible without the continued commitment of the volunteers. It has been shown that their input is immensely valuable and the TMP could not exist without them. The valuable contribution made by the NGOs has also been recognised and their contribution to the overall programme of surveys is extremely important, both financially and in terms of their expertise in running surveillance schemes and supporting large networks of volunteers. The organisations within the Partnership come from a variety of sectors in the mammal community and may have very different reasons for their existence as well as different objectives in collecting the surveillance information. Some receive considerable government support to collect data because they are involved with internationally or nationally protected species, such as the bats. For many other species there is very little government funding provided to carry out the necessary work and the majority of the funding burden falls on the NGOs who may find it difficult to maintain or increase their input in the face of increasing demand for information. It should be recognised that it is important to know the status of all mammal species, because it provides a complete and balanced picture, which is needed by the many organisations involved, now and in the future. We should, therefore, continue to seek the necessary funding to carry out the work.

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Area statistics: can be downloaded from these three websites. For England: *www.gatch.freeserve.co.uk/england/statistics.htm;* for Scotland *www.scotland.gov.uk/library/stat-ses/sest2-1.htm;* for Wales *www.data-wales.co.uk/wstats.htm*

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Appendix I The Partnership

The Tracking Mammals Partnership was launched in July 2003 and currently comprises 24 organisations. Below the organisations are listed in alphabetical order, with each providing some information on their role and objectives as a member of the TMP.

Bat Conservation Trust

www.bats.org.uk

The BCT, through its management of the National Bat Monitoring Programme, has been producing bat population trends since 1997. We are delighted to be involved with the TMP as it provides a strong voice for all mammal conservation and monitoring and the opportunity to work collaboratively on common issues with other TMP organisations. Volunteer action delivers the majority of mammal monitoring and a workshop on identifying best practice for managing volunteers, run jointly by the TMP and the NBN, provided useful information and was a good example of the advantages of working collaboratively.

The Bat Conservation Trust is the only UK organisation solely devoted to the conservation of bats and their habitats. This is achieved by: campaigning nationally, locally and internationally for bat conservation, enabling local action through our network of volunteers, encouraging research into bat ecology and monitoring bat populations, supporting and advising people who find bats in their property and encouraging everyone to appreciate and enjoy bats.

Bristol University

www.bris.ac.uk

The University is committed to excellence in teaching and learning within an environment of internationally recognised research. In pursuit of its mission the University aims to: enhance its status as an internationally recognised research university in which staff pursue their ideas with rigour and integrity through independent enquiry; provide excellent teaching at all levels in an environment enriched by research so that students may develop intellectually and individually; produce graduates who are adaptable and alert to the benefits of lifelong learning and who meet the requirements of employers (local, national and international) from all sectors; give greater emphasis to growth in postgraduate student numbers, particularly research students; maintain a balance of basic and strategic research with a substantial element of contract research and promote learning through the application of knowledge; promote interdisciplinary research both within itself and with other institutions; recruit and retain excellent staff and improve their effectiveness through the provision of appropriate training and development in accordance with a policy of equal opportunities; optimise the use of resources to improve the working environment and range of services for students and staff; wherever possible improve the quality of the environment for the people who live and work in the University and for the wider community; achieve a level of income which will allow for balanced growth, adequate capital investment and maintenance of a level of reserves sufficient to provide a sound financial base for future development.

British Association for Shooting and Conservation

www.basc.org.uk

The British Association for Shooting and Conservation (BASC) has over 121,000 members throughout the UK. Those members are a valuable resource that can be called on to help with mammal surveillance and monitoring.

BASC, through our Green Shoots programme, are actively involved with increasing biodiversity on land that is shot over by our members. Our recent survey of members in Cheshire showed that shooting takes place on just under one third of the county, and generated some 6,600 new biological records, which were given to the Cheshire Biological Record Centre. BASC are presently securing funding to carry out similar projects in North Wales, Northern Ireland and other counties in England.

Through the Green Shoots programme BASC members are increasingly interested in getting involved with biological recording, many of them already participate in BTO counts, so could be encouraged to take on additional areas for mammals. BASC members will also be contributing to the BDS Deer Distribution Survey.

British Deer Society

www.bds.org.uk

The British Deer Society is a registered charity, founded in 1963 to conserve the six species of deer wild within the UK.

Its objectives are: the promotion, in the public interest, of research into the habits of and the scientific study of deer in the British Isles, with particular reference to their relationship to the natural habitat, forestry, agriculture and areas to which the public have access; the promotion, in the public interest, of knowledge of methods of management, humane treatment and humane control of deer.

It achieves these objectives by creating awareness through a continuing programme of education, research,

exhibitions, shows, deer management training, and the quarterly house journal DEER. It is designed for members with a complete range of deer interests, deer watchers, photographers and artists, conservationists, deer managers and stalkers, professionals, scientists, and researchers

It is organised into regional branches throughout the UK with links throughout the world, which carry out local activities and events both social and educational with talks, demonstrations, field and range days. It educates through publications, display material, talks and a website and provides advice for educators, farmers, estate managers, gardeners and the public. It makes recommendations to public bodies and government departments on legislation, deer management policy, highway planning considerations and more

The BDS maintains support for vital deer research work through funding, grants and voluntary contributions and manpower. It is an active facilitator for all organisations involved in deer research and welfare and runs an ongoing national deer count and survey work

Finally, it provides training through structured courses designed to ensure students have the best possible tuition to meet current national standards in Deer Stalking Certificate Levels 1 and 2, Practical Stalker, Deer Management, Range Conducting Officer, Home Reloading Course, Deer Photography and Deer Recognition.

The BDS involvement in the TMP is seen as a natural extension of its role in facilitating research into deer related projects, especially its own deer distribution survey and its density and trend analysis. Much ill-informed comment in both public and governmental arenas concerning numbers of deer in the UK and their effect on forestry, agriculture, urban living and road traffic make the collection and interpretation of accurate data a priority for the BDS. Operating within the umbrella of TMP affords the opportunity to achieve such an aim in a structured and credible environment.

British Trust for Ornithology

www.bto.org

The British Trust for Ornithology (BTO) is a charity dedicated to conducting high quality research in field ornithology through a partnership between volunteer and professional ecologists, the results of which are used to provide evidence and advice on bird conservation. The BTO collects and analyses data on the abundance of mammals through a number of surveys. Data are gathered where they help to explain patterns of bird abundance or where they can be collected relatively simply as an extension of the existing bird survey work and are of additional conservation value and interest to BTO members. The BTO supports the aims of the TMP and will continue to do so by contributing data on mammal abundance, by making use of its extensive network of experienced volunteers and its considerable experience in the statistical analysis of temporal and spatial data and the development of online surveys. The BTO supports the wide dissemination of information on the status of mammal species, and results of surveys or analyses related to mammals will be reported on the BTO website, in collaboration with other members of the TMP.

Central Science Laboratory

www.csl.gov.uk

The Central Science Laboratory undertakes research and provides scientific support for Government, NGO and commercial organisations relating to the ecology of wildlife species and the management of associated interactions with human interests. It thus has an ongoing interest in the status of UK mammal populations in terms of both overabundant species which may require management and species which need to be conserved to promote biodiversity.

Countryside Council for Wales

www.ccw.gov.uk

The Countryside Council for Wales (CCW) is the Government's statutory adviser on sustaining natural beauty, wildlife and the opportunity for outdoor enjoyment in Wales and its inshore waters. With English Nature and Scottish Natural Heritage, CCW delivers its statutory responsibilities for Great Britain as a whole, and internationally, through the Joint Nature Conservation Committee. The availability of robust scientific information is essential to enable CCW to carry out its advisory functions and to manage its National Nature Reserves. CCW commissions and undertakes its own programme of research, but is also reliant on collaborative projects for this information and to provide a UK perspective on some of our most threatened species.

The TMP has successfully combined the expertise of the key organisations and individuals working for the conservation of British mammals, including that most valuable asset – the volunteer network, without whom much of this work would not be possible.

Deer Commission for Scotland

www.dcs.gov.uk

The Deer Commission for Scotland was constituted by the Deer (Scotland) Act 1996, as the successor to the Red Deer Commission. It is the Non-Departmental Public Body charged with furthering the conservation, control and sustainable management of all species of wild deer in Scotland, and keeping under review all matters, including welfare, relating to wild deer.

DCS collects statutory annual cull returns from landholdings where deer are shot. These are collated in the annual report along with venison dealer records.

DCS's approach to involvement in counting red deer on the 'open range' has been changing over the last few years in response to increasing resource constraints. In order to

spend public money on deer counting DCS has to demonstrate public benefit. Consequently DCS's limited resources are targeted at: a) counting to assist its Priority Site Process; b) counting to promote best practice in collaborative deer management."

Deer Initiative

www.thedeerinitiative.co.uk

The Deer Initiative (DI) is a wide partnership of statutory, non-statutory, voluntary and private interests. Whilst originally set up by the Forestry Commission and still, in the main, funded by the Forestry Commission and English Nature, it has a core staff whose activities are both to co-ordinate the relevant activities of the partners and to deliver some functions directly. The aim of the DI is "to ensure the delivery of a sustainable, well managed wild deer population in England and Wales". It is our view, based on the evidence available, that the geographic range of deer species has been increasing by between 1–5% annually for the last 40 years (Gill, 2001). Researchers believe that there is currently no reason why the trend in increasing deer numbers and range expansion should not continue (Fuller & Gill, 2001).

The DI provides advice and information on all issues relating to wild deer and their management and facilitates collaborative deer management through Deer Management Groups. Our aim is to promote deer management at a landscape scale and where herding species are present across the whole of their range. To achieve this we require accurate and timely information on deer distributions and densities. We currently collect data on deer distributions and densities from DMGs and our own monitoring and are happy to share this data with the TMP. We are also maintaining a UK wide database on road traffic accidents involving deer on behalf of the Highways Agency and subject to their agreement will make that data available to the partnership.

The DI is therefore a committed partner in the TMP as it recognizes the need to collate information regarding the status of deer in the UK to support future management strategies. However we acknowledge the finite resources that are available to collect data and hope that by working in partnership with other organisations through the TMP we can maximize the information available to all.

Department for Environment, Food and Rural Affairs (Defra)

www.defra.gov.uk

Defra's aim is sustainable development, which means a better quality of life for everyone, now and for generations to come, including: a better environment at home and internationally, and sustainable use of natural resources; economic prosperity through sustainable farming, fishing, food, water and other industries that meet consumers' requirements; thriving economies and communities in rural areas and a countryside for all to enjoy.

A key Defra objective is to protect and improve the rural, urban, marine and global environment and to lead integration of these with other policies across Government and internationally.

Defra has a key role in the TMP through funding projects and contributing expertise. We regard the Partnership as a vital collaborative project which will advance our knowledge of the status of British mammals. An improved understanding of mammal abundance and distribution will help us to achieve this objective.

English Nature

www.english-nature.org.uk

English Nature is the Government's independent agency that champions the conservation of wildlife and geology throughout England. As a public service organisation, we work with Government, industry, charities, landowners and managers, and local communities to achieve our mission of wildlife gain: to sustain and enhance England's natural heritage for all to enjoy, now and in the future. Part of our work includes advising Government on nature conservation issues, meeting UK Biodiversity Action Plan targets for wildlife, and commissioning and financially supporting nature conservation research projects. We know that many mammal populations have declined due to habitat loss from human influences, such as agricultural intensification and development pressures, competition from non-native species and pollution. However, for a substantial number of species there is very little information on what is happening to their populations. The organisations in the TMP run co-ordinated annual surveys with the help of a countrywide network of volunteers. This will provide, for the first time, a comprehensive nationwide assessment of trends in population changes of all mammals that will act as an early warning system and measure the success of our conservation effort. English Nature needs good quality data to direct future conservation and wildlife management priorities, which will help to ensure the survival of our native mammalian species.

Environment Agency

www.environment-agency.gov.uk

The Environment Agency is the leading public body protecting and improving the environment in England and Wales. It's our job to make sure air, land and water are looked after by everyone in today's society, so that tomorrow's generations inherit a cleaner, healthier world. Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

The Environment Agency needs information on biodiversity to enhance our decision making processes and to ensure that our activities achieve positive environmental outcomes. This may include information to help us successfully achieve our UK BAP action plans or to help

manage our impacts and those of others on mammals and the environment in which they live.

The TMP provides the Agency with a valuable source of biodiversity information and a network of organisations with many years experience of managing volunteer monitoring programmes. We in turn support and publicise the work of the TMP through our work protecting the environment. We also ensure that we share our data and monitoring techniques with our partners and promote integrated environmental assessment to derive better information from individual data sources.

Environment and Heritage Service (Northern Ireland)

www.ehsni.gov.uk

Environment and Heritage Service (EHS) is the Government's Nature Conservation Agency in Northern Ireland. Northern Ireland has only a limited number of terrestrial mammals probably because they failed to cross the land connections with Britain before these were broken by rising sea levels at the end of the last ice-age. A few of these 18 species such as the Irish Stoat and Irish hare show marked genetic differences from their UK counterparts and some species, although identical to those in Britain, utilise different types of habitat.

EHS makes use of data collected by volunteer ornithologists and botanists and a similar contribution from people with an interest in mammals can only add value to our biodiversity efforts. Most of the surveillance and monitoring of mammals done in the past in Northern Ireland has been done by professionals and has therefore been limited by available budgets. The wealth of experience in the use of volunteers within the TMP network will enable more efficient use to be made of available funds.

Forestry Commission

www.forestry.gov.uk

The Forestry Commission is the Government Department responsible for forestry policy throughout Great Britain. The mission of the Forestry Commission is to protect and expand Britain's forests and woodlands and increase their value to society and the environment. Forestry is a devolved matter in England, in Scotland and in Wales. The three commissions report directly to their appropriate Minister, providing advice on policy and implementing that policy within the relevant country.

The objective of the Forestry Commission GB is to take the lead, on behalf of all three administrations, in the development and promotion of sustainable forest management and to support its achievement nationally. Each of the countries has its own strategy and mission, and delivers the forestry policy of each country through specific objectives and strategies.

The Forestry Commission also has four executive agencies. Our public forests are managed by Forest Enterprise agencies – one each in England, Scotland and Wales – on behalf of the Forestry Commission in that country. Together they manage a total of more than 1,000,000 hectares of land.

Forest Research is a GB-wide agency which aims to deliver high-quality scientific research and surveys, to inform the development of forestry policies and practices, and promote and provide advice on high standards of sustainable forest management. Biodiversity is high on its agenda and the Commission has an interest in the distribution and abundance of the wildlife in its forests and other woodlands – both rare species needing conservation action and those pest species causing damage to trees or other conservation interests. The Commission regards the TMP, via its network of participating organisations, as a valuable source of biodiversity monitoring information, which will advance the knowledge of the status, abundance and distribution of many British mammals and assist decision making. Commission staff contribute time and expertise to the Partnership.

Game Conservancy Trust

www.gct.org.uk

The Game Conservancy Trust (GCT) is a registered charity devoted to research and education on game species (birds and mammals), together with their habitats and associated species. Within this remit, population trends of UK mammals are clearly of considerable interest. The GCT is also a membership organisation with 23,000 subscribing members, many of whom are rural landowners. As a result of this, and through its advisory and educational roles, the GCT can claim to have considerable knowledge of and influence on widespread management practices that affect mammals.

One of the GCT's assets is an historical database of bag records from shooting estates throughout the UK, the National Gamebag Census (NGC). The NGC is unique for the historical perspective it can give on current mammal population trends. For contemporary monitoring, it provides extensive UK coverage at low cost and without access problems. The range of species, which includes lagomorphs, mammalian predators and introduced mammals, covers many that are poorly monitored by other schemes. Being part of the TMP is tangible evidence that the contributions made by NGC participants are valued at the national level.

Joint Nature Conservation Committee

www.jncc.gov.uk

The Joint Nature Conservation Committee (JNCC) is the forum through which the three country conservation agencies – the Countryside Council for Wales, English Nature and Scottish Natural Heritage – deliver their statutory responsibilities for Great Britain as a whole, and internationally. These responsibilities, known as special functions, contribute to sustaining and enriching biological

diversity, enhancing geological features and sustaining natural systems. The special functions are principally: to advise ministers on the development of policies for, or affecting, nature conservation in Great Britain and internationally; to provide advice and knowledge to anyone on nature conservation issues affecting Great Britain and internationally; to establish common standards throughout Great Britain for the monitoring of nature conservation and for research into nature conservation and the analysis of the results; and to commission or support research which the Committee deems relevant to the special functions.

The TMP has successfully brought together a great deal of knowledge on the majority of terrestrial UK mammals and expertise in carrying out surveillance and monitoring. The provision of population trends at different spatial scales in a co-ordinated and standardised way will help JNCC to assess the status of individual species at UK and country levels. It will also help JNCC to provide information and advice to government on the state of biodiversity in order to assist in UK policy decisions and international reporting requirements.

The Mammal Society

www.mammal.org.uk

The Mammal Society is the voice for British mammals and the only organisation solely dedicated to the study and conservation of all British mammals. In 2004 we celebrated our 50th anniversary and the significant contributions The Mammal Society has made towards the conservation of numerous British mammals using sound scientific methods to achieve our objectives.

Surveying and monitoring British mammals is a key aspect to our work, from our first survey in 1954 on the brown hare to our work on otter populations in the 1960s, which first established their decline in numbers, to our more recent work on yellow-necked mice, foxes and water shrews amongst others.

The Mammal Society believes in working in partnership with others to share expertise and make the best use of charity resources and also in making scientific and biodiversity data widely available. We are therefore delighted to be part of the TMP to deliver annual mammal monitoring information.

People's Trust for Endangered Species

www.ptes.org
www.mtuk.org

The People's Trust for Endangered Species (PTES) and its restricted fund, Mammals Trust UK (MTUK), are committed to working to conserve the UK's mammals in their natural habitats for future generations to enjoy. We work towards this goal by funding both scientific research and practical work in the field, purchasing reserves, involving supporters in nationwide surveys, holding regular conferences and providing opportunities for our supporters and members of the general public to learn more about British mammals and to watch them in the wild.

We believe that recording the changes in the numbers and distribution of British mammals over time, and unravelling the often complex causes underlying them, are the only basis on which effective conservation measures can be planned for the future.

In partnership with English Nature and Royal Holloway, University of London, (RHUL), we run the National Dormouse Monitoring Programme, which has shown that dormouse populations are continuing to decline, in spite of all the work that is being carried out by many organisations to conserve them. We are continuing to run the Mammals on Roads survey (with financial help from JNCC and scientific input from RHUL) and in 2004 data were collected for the second year of Living with Mammals, a scheme designed to look at how mammals use the built environment.

PTES/MTUK is delighted to be funding or helping to fund, a number of the other surveillance schemes included in the overall programme outlined in this document.

We fully support the TMP initiative and look forward to working in cooperation with all its members as we jointly aspire to emulate the success of the bird world.

Queen's University, Belfast

www.qub.ac.uk

Queen's University Belfast's School of Biology and Biochemistry is the leading conservation science institute in Northern Ireland and is a partner in Quercus, Northern Ireland's research centre for biodiversity and conservation biology.

Queen's has a long track record of work on mammals and we are the only institution equipped to conduct extensive mammal surveillance and monitoring work in Northern Ireland. We have been the main parties in national surveys of bats, otters, badgers, foxes, hares, squirrels, rodents, seals and other mammal groups. Four members of the academic staff, three postdocs and over 10 postgraduate students and contract research staff are actively engaged in work related to mammal conservation, behaviour and ecology.

Queen's is committed to continuing research on mammals and to providing support for local and national agencies interested in conservation and monitoring of mammals. We are pleased to be involved in the TMP as key representatives of research and monitoring work undertaken in Northern Ireland.

Royal Holloway University of London

www.rhul.ac.uk

Royal Holloway, University of London has a long history of work on mammal populations, conservation and behaviour. We set up the first monitoring programme for a

terrestrial mammal (the common dormouse) in the early 1990s. The National Dormouse Monitoring Programme now yields high quality annual data on dormouse population trends in different regions and landscapes – precisely the data that the TMP aspires to acquire for all UK mammals. We have pioneered the use of mammal counts along roads (in the Mammals on Roads survey) as a method of population monitoring and have developed new techniques to monitor mammals living near built land, mustelids, the fat dormouse and riparian species. Our goal is to combine, wherever possible, scientific research with conservation action on the ground.

Scottish Natural Heritage

www.snh.gov.uk

Scottish Natural Heritage (SNH) has been involved with the TMP and its predecessor Working Group since its inception in 1999. SNH continues to be involved for the following reasons: many mammals are under-recorded over much of Scotland, particularly the remoter parts of the country, reflecting low human population density, and consequently a low density of biological recorders; for most Scottish mammals, there is little or no information on population trends and the TMP currently represents the only cost-effective means of gathering such information; the data generated helps to inform decisions concerning species conservation and management. One example concerns the issue of licences under the EU Habitats Directive where there is a need to ensure that authorised actions will not be detrimental to the maintenance of the population of the species concerned at favourable conservation status in its natural range.

Overall, the Partnership and the surveys that it co-ordinates provide an excellent opportunity for engaging the general public in mammal surveillance and conservation.

Welsh Assembly Government

www.wales.gov.uk

We are the Wildlife Unit within the Welsh Assembly Government's Department for Environment, Planning and the Countryside. This Department gives advice on the legislation covering the control of vertebrate pests causing damage to agriculture, fisheries and property and where appropriate issues licences to permit otherwise prohibitive action to be taken. We are therefore constantly involved in the investigation of mammal-related problems and need to be aware of population trends. The Wildlife Unit is also the point of contact for members of the public wishing to report the suspected poisoning of wildlife and pets by pesticides. Frequently there is overlap between these two areas – poisoning of wildlife can be caused by illegal or reckless attempts at pest control. Similarly, legal pest control can result in a range of wildlife falling victim to secondary poisoning, and in some cases direct poisoning. An example of the latter would be mice and voles feeding on common rat baiting points placed outside. Another example of an interaction is the competition between red and grey squirrels – in many instances control of the latter is undertaken to help populations of the former.

It is therefore self-evident that our unit will benefit from being within the Partnership as we are very interested in population trends of mammals such as badger, rabbit, fox, mink, grey squirrel, polecat and deer. We are also charged with the task of investigating sightings and possible livestock losses caused by big cats. It is therefore likely that information will flow in both directions.

The Wildlife Trusts

www.wildlifetrusts.org

The Wildlife Trusts are a unique partnership of 47 local Wildlife Trusts covering the whole of the UK, the Isle of Man, The Scilly Isles and Alderney. The partnership campaigns for the protection of wildlife and invests in the future by helping people of all ages to gain a greater appreciation and understanding of nature. Collectively The Wildlife Trusts have approximately 530,000 members and manage almost 2,500 nature reserves, covering more than 80,000 hectares of land, ranging from inner city urban sites to the UK's finest wildlife areas.

We are actively engaged in mammal conservation throughout the UK from the national to the local level and over the years our staff and volunteers have dedicated considerable time and resources to monitoring British mammal populations. Being part of the TMP enables the Trusts to contribute more effectively to the collective efforts of organisations concerned with mammal monitoring for the benefit of mammal conservation overall.

Wildlife Conservation Research Unit (University of Oxford)

www.wildcru.org

The Wildlife Conservation Research Unit (WildCRU) undertakes conservation projects throughout the world and has a wealth of experience studying both endangered and pestilential species, as well tackling the related issues of environmental management and community involvement. The WildCRU has contributed to a number of national surveys and reports to government on the status and future monitoring of mammals in the UK and is committed to addressing and solving the issues affecting British wildlife.

The TMP provides the WildCRU with a collaborative framework of like-minded organisations, which together can achieve more significant objectives, and exercise a greater influence on policy than any single body could alone. The synergisms of developing ideas in parallel with partners, while building on a co-operative conservation platform, also has major benefits both for the WildCRU and to the mammal species we need to monitor and safeguard.

The WildCRU also has considerable experience of working with volunteers. Specifically we are looking at what methods of training are suitable and effective for volunteer teams while simultaneously yielding effective results. We are trying to establish techniques that are easy to use, replicable over a broad scale, cost effective and, importantly, give the participating volunteers enjoyment and broaden their understanding of ecological monitoring.

With the enormity of the task of trying to systematically monitor all of Britain's mammal species we hope that the expertise we have gained from both our broad-ranging scientific research, as well as our experience of training and deploying volunteers, will be of benefit to the TMP.

NBN and BRC involvement with the TMP

www.nbn.org.uk

Neither the Biological Records Centre, nor the National Biodiversity Network are involved directly in mammal surveillance and monitoring as such. However, the BRC has been involved with the establishment of the TMP from its inception, and the NBN, through its Societies & Schemes Development Officer, has been involved particularly with the data collection and management aspects of the TMP, and more recently with supporting TMP seminars.

The principal reasons for involvement with the TMP are: to support the voluntary sector organisations involved in collecting biodiversity data, particularly with developing their capacity to carry out survey work for the future; to assist with the planning and development of future data and information-gathering processes, and in particular to facilitate the use of data through the NBN; and to liaise between the organisations involved with the TMP and other partners in the NBN and BRC/CEH staff.

In order to carry this forward, the intention would be for the NBN Development Officer to continue to assist with the promotion of relevant technical seminars and workshops, to help with facilitating training of volunteers in the TMP and its partner organisations, and to assist in the development of data systems and information provision where possible.

Appendix II Legislation and conservation initiatives pertaining to mammals

Legislation is listed in chronological order with website addresses where more information can be obtained. Information on national and international conservation legislation can also be found on the JNCC website at *www.jncc.gov.uk*

DIA – Orders under the Destructive Imported Animals Act, 1932
e.g. The Mink Keeping (Prohibition) (England) Order 2004
www.hmso.gov.uk/si/si2004/20040100.htm

CITES – Convention on International Trade in Endangered Species of Wild Flora and Fauna 1975
www.cites.org; *www.ukcites.gov.uk*

Bern Convention – Convention on the Conservation of European Wildlife and Natural Habitats 1979
www.ecnc.nl/doc/europe/legislat/bernconv.html

CMS – Bonn Convention – The Convention on the Conservation of Migratory Species of Wild Animals 1979
www.cms.int

W&CA – Wildlife & Countryside Act 1981 (as amended)
www.naturenet.net/law/wca.html

The Wildlife (Northern Ireland) Order 1985
www.hmso.gov.uk/legislation/northernireland/nisr/yeargroups/1980–1989/1985/1985oic/aos/no171.htm

EUROBATS – Agreement on the Conservation of Populations of European Bats 1991. An Agreement under the CMS
www.eurobats.org

Deer Acts 1991
http://www.hmso.gov.uk/acts/acts1991/Ukpga_19910054_en_1.htm#end

CBD – Convention on Biological Diversity 1992
www.biodiv.org

The Habitats Directive – European Communities Directive 92/43/EEC, on the Conservation of Natural and Semi-natural Habitats and of Wild Flora and Fauna 1992.
www.ecnc.nl/doc/europe/legislat/habidire.html

SAC – Special Areas of Conservation
www.jncc.gov.uk/page-23

Protection of Badgers Act 1992
www.hmso.gov.uk/acts/acts1992/Ukpga_19920051_en_1.htm

The Conservation (Natural Habitats, &c.) Regulations 1994
www.hmso.gov.uk/si/si1994/Uksi_19942716_en_1.htm

Deer (Scotland) Act 1996 (as amended)
www.hmso.gov.uk/acts/acts1996/1996058.htm

WMA – Wild Mammals (Protection) Act 1996
www.hmso.gov.uk/acts/acts1996/1996003.htm

CRoW Act – Countryside and Rights of Way Act 2000
www.hmso.gov.uk/acts/acts2000/20000037.htm

Fur Farming (Prohibition) Act, 2000
www.hmso.gov.uk/acts/acts2000/20000033.htm

Fur Farming (Prohibition) (Scotland) Act 2002
www.scotland-legislation.hmso.gov.uk/legislation/scotland/acts2002/20020010.htm

Protection of Wild Mammals (Scotland) Act, 2002
www.scotland-legislation.hmso.gov.uk/legislation/scotland/acts2002/20020006.htm

Nature Conservation (Scotland) Act 2004
www.hmso.gov.uk/legislation/scotland/acts2004/20040006.htm

Hunting Act, 2004
www.legislation.hmso.gov.uk/acts/acts2004/20040037.htm

Conservation initiatives

BAP and SAP – UK Biodiversity Action Plans and Species Action Plans 1995
www.ukbap.org.uk
www.ehsni.gov.uk/natural/biodiversity/publcations.shtml

IUCN Red list – The World Conservation Union Red List of threatened species
www.iucnredlist.org

Appendix III Glossary of terms

Aleutian mink disease or ADV: is a parvovirus that affects Raccoons (family Procyonidae), skunks (family Mephitidae) and mink, ferrets and possibly other members of the Mustelidae family.

Amber Alert: a decline of 25% in numbers over 25 years, a signal of the degree of reduction in abundance of a species (see also *Red Alert*).

Commensal: an organism participating in a symbiotic relationship in which one species derives some benefit while the other is unaffected.

Cryptosporidium: is a protozoan organism which causes the parasitic infection Cryptosporidiosis. It exists in either the free-swimming (trophozoite) form or the oocyst (dormant) form. *Cryptosporidium parvum* is now recognised as a human pathogen which can cause severe diarrhoeal illness.

European Bat Lyssavirus (EBLV): a strain of rabies found in bats across Northern Europe. On rare occasions it is known to infect other animals and humans. On two occasions sheep have been infected and it was detected in a stone marten in Germany. Since 1977 there have been four human deaths in Europe attributed to EBLV infections, all in cases where the person had been in close contact with bats and received no post-exposure treatment.

Environmental Zones: six broad land categories derived from the ITE Land Classification as a means of allocating 1 km squares to equivalent groupings for the purpose of taking stratified samples of the British countryside.

Haantan fever: a zoonotic disease caused by hantavirus, a member of the Bunyaviridae family, found in parts of Europe, North America and the Far East. It is transmitted from rodents to humans in saliva, droppings or urine.

Interpolation: 1. to insert between or among others; 2. to change by putting in new material; 3. to estimate a missing value by taking an average of known values at neighbouring points. Spatial interpolation is the procedure of estimating the value of properties at unsampled sites within the area covered by existing observations. In almost all cases the property must be interval or ratio scaled.

Kriging: a method of interpolation which predicts unknown values from data observed at known locations. This method uses variograms to express the spatial variation, and it minimises the error of predicted values, which are estimated by spatial distribution of the predicted values.

Leptospirosis: is a potentially serious bacterial illness that is most common in the tropics. It is caused by *Leptospira interrogans*, a corkscrew-shaped bacterium (spirochete). Leptospirosis can affect many parts of the body. Infected wild and domestic animals pass Leptospirosis-causing bacteria in their urine. People get Leptospirosis by contact with fresh water, wet soil, or vegetation that has been contaminated by the urine of infected animals.

Lyme disease: a zoonotic disease of wild deer. Caused by the bacterium (spirochete) *Borrelia burgdorferi*, Lyme disease is spread to humans by the bite of the common tick *Ixodes ricinus.* About 1000 cases are diagnosed in the UK annually.

Monitoring: study of the abundance of individuals in one or more populations of a species through time. Monitoring requires that targets are set, management recommendations made and carried out, the effectiveness of the management assessed and changes made to improve the process. Monitoring involves surveillance not only of the species in question but of, so far as possible, the other factors likely to affect populations of that species, such as climate, other species, habitat and food.

Population(s): all the organisms of a species that constitute a specific group or occur in a specified habitat.

Q-fever: is a zoonotic disease caused by *Coxiella burnetii*, a species of bacterium that is distributed globally. Cattle, sheep and goats are the primary reservoirs, but infection has been noted in a wide variety of other animals, including other species of livestock and in domestic pets.

Red Alert: a decline of 50% in numbers over 25 years, a signal of the degree of reduction in abundance of a species (see also *Amber Alert*).

Salmonella: is a rod-shaped, motile bacterium. There is a widespread occurrence in animals, especially in poultry and swine. Environmental sources of the organism include water, soil, insects, factory surfaces, kitchen surfaces, animal faeces, raw meats, raw poultry and raw seafoods.

Sampling: an approach where a group of items (a sample) is selected for study from a population; the sample should be representative of the population. In random sampling each item is chosen entirely by chance and each member of the population has an equal chance of being in the sample.

Stratified sampling: the act of dividing a larger population or area into subgroups, using systematic sampling, then taking a random sample from each subgroup.

Surveillance: consists of repeated and standardised observations of abundance over time, using methods that enable changes in numbers to be detected.

Zoonotic disease: a disease that can be transmitted from animals to humans.

Appendix IV List of acronyms

BAP: UKBAP Biodiversity Action Plans

BASC: British Association for Shooting & Conservation

BBS: Breeding Bird Survey

BDS: The British Deer Society

BRC: Biological Records Centre, CEH Monks Wood

BTO: British Trust for Ornithology

CBC: Common Bird Census

CBD: Convention on Biological Diversity

CCW: Countryside Council for Wales

CEH: Centre for Ecology and Hydrology

CITES: Convention on International Trade in Endangered Species of Wild Flora and Fauna

CMS: Convention on the Conservation of Migratory Species of Wild Animals, the Bonn Convention

CRoW Act: Countryside and Rights of Way Act 2000

CS2000: Countryside Survey 2000

CSL: Central Science Laboratory, York

DCS : Deer Commission for Scotland

Defra: Department for Environment, Food and Rural Affairs

DI: The Deer Initiative

DIA: Destructive Imported Animals Act, 1932

DNA: Deoxyribonucleic acid

DoE: the former Department for the Environment

EBLV: European Bat Lyssavirus

EHCS: English House Condition Survey

EHS: Environment and Heritage Service, Northern Ireland

EN: English Nature

FC: Forestry Commission

FSS: Forensic Science Service

GAM: generalised additive model

GBW: Garden BirdWatch

GCT: Game Conservancy Trust

GOR: Government Office Region (in England)

HAP: UKBAP Habitat Action Plans

HD: Habitats Directive

IUCN: International Union for the Conservation of Nature

JNCC: Joint Nature Conservation Committee

LWM: Living with Mammals

MIYG?: Mammals in Your Garden?

MTUK: Mammals Trust UK

NBMP: National Bat Monitoring Programme

NBN: National Biodiversity Network

NCC: Nature Conservancy Council

NDMP: National Dormouse Monitoring Programme

NGC National Gamebag Census

NGO: non-governmental organisation

NNRs: National Nature Reserves

PTES: People's Trust for Endangered Species

QUB: Queen's University, Belfast

RHD: rabbit haemorrhagic disease

RHUL: Royal Holloway, University of London

RSPB: Royal Society for the Protection of Birds

RTAs: Road Traffic Accidents

SAP: UKBAP Species Action Plans

SNH: Scottish Natural Heritage

TBE: tick borne encephalitis

TEM: Tracking Elusive Mustelids

TMP: Tracking Mammals Partnership

TMS The Mammal Society

UK BAP: UK Biodiversity Action Plan

VLA: Veterinary Laboratories Agency

VWT: Vincent Wildlife Trust

WBBS: Waterways Breeding Bird Survey

W&CA: Wildlife & Countryside Act, 1981

WildCRU: Wildlife Conservation Research Unit, University of Oxford

WMA: Wild Mammals (Protection) Act, 1996.

WMM: Winter Mammal Monitoring

WSS: The Mammal Society's Water Shrew Survey

The Tracking Mammals Partnership is a collaborative initiative, involving 24 organisations with a variety of interests in mammals. It aims to improve the quality, quantity and dissemination of information on the status of species in the UK.

Many sectors of the mammal community and Government at all levels, require good quality data on the distribution and population trends of all UK mammals. The information is used to guide conservation and wildlife management policy.

Joint working within the partnership ensures a co-ordinated approach to standardising survey design, assessing where information is missing, and exchanging data and expertise. By sharing best practice, and information on new technology and data collected, the whole can become greater than the sum of its parts. The partners are also cooperating to recruit, train and support the network of volunteers who carry out the surveys.

This is the first of a series of reports on the work carried out by the Partnership, bringing together the wealth of information currently available in one place.

Participating organisations:

BASC
BTO
The Bat Conservation Trust
British Deer Society
CSL
Cyngor Cefn Gwlad Cymru Countryside Council for Wales
defra Department for Environment Food and Rural Affairs
Deer Commission for Scotland
thedeer initiative
English Nature
Environment Agency
Environment and Heritage Service
Forestry Commission
The Game Conservancy Trust
Joint Nature Conservation Committee
The Mammal Society
People's Trust for Endangered Species
Queen's University Belfast
Royal Holloway University of London
Scottish Natural Heritage
The Wildlife Trusts
University of Bristol
Llywodraeth Cynulliad Cymru Welsh Assembly Government
Wild Cru

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