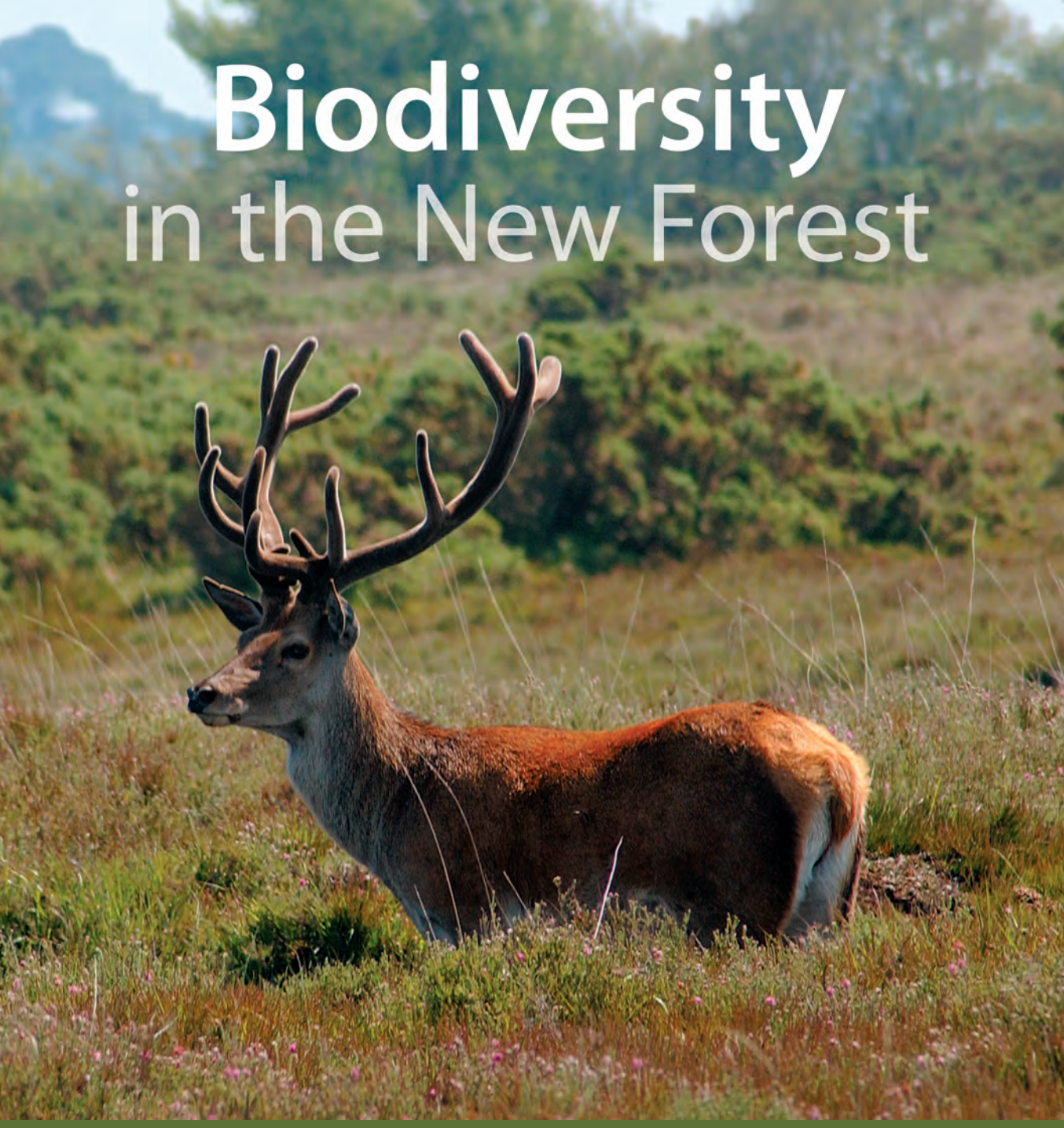
Biodiversity in the New Forest



Edited by Adrian C. Newton

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Dedicated to the memory of
Muriel Eliza Newton (1929–2009),
who loved the New Forest,
especially the donkeys.

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Back cover: Wood Crates (Adrian Newton)

The maps in this book are for illustrative purposes only, and do not represent the legal definition of National Park boundaries or any other feature

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2 Bats

Colleen Mainstone

Introduction

Bechstein's bat *Myotis bechsteinii* and the barbastelle bat *Barbastellus barbastella* are two of the rarest bats in Europe. Both species have specialist ecological niches, and seem to require areas of mature deciduous woodland for roosting. Until recently only a handful of colonies of either species were known in the UK. Much of the New Forest is suitable for both species and there are a handful of historical and more recent local records of their presence. Considering these factors, its extent and its position within the more southerly UK ranges of these bats, it is possible that the New Forest could support significant populations of these species. A project was established by Hampshire Bat Group in 2005 to establish the distribution of both species in the area. This chapter provides a summary of current understanding of the ecology and distribution of these rare bats in the UK and highlights some of the results of preliminary surveys of them in the New Forest. In addition, to provide context, an overview is presented of the current status of other bat species in Hampshire.

Status and distribution of bats in Hampshire

There are 16 species of bat resident and breeding in the UK, of which most have been recorded in Hampshire within the past 100 years (Table 5).

Greater and lesser horseshoe bats were once more widely distributed in Hampshire with records from Lyndhurst, Romsey, Winchester, Portsmouth and Southampton as well as Christchurch and Boscombe (now in the county of Dorset) (Vesey Fitzgerald 1944). A greater horseshoe roost survived as late as 1926; this was divided between Winchester Cathedral and a church to its west (Robert Stebbings, pers. comm.). A greater horseshoe roost in the far west of Hampshire has only supported a few males in the past 20 years; Stebbings (pers. comm.) remembers the site supporting a colony at one time. Stebbings also knew Sdeuard Bisserot, who spent most of his life in the New Forest, and stated that with the exception of the loss of a vast Daubenton's roost in Christchurch Priory, bat populations had not changed much over time. The greater mouse-eared bat *Myotis myotis* is possibly extinct in the UK, with only localised records of an

Table 5
UK status and distribution of bats recorded in Hampshire.

Species	Status in the UK (Entwistle *et al*. 2001)	Hampshire records since 1940
Bechstein's bat *Myotis bechsteinii*	Rare and restricted	New Forest and woodland in south-east of county (also Isle of Wight)
Barbastelle *Barbastella barbastellus*	Rare and widespread	New Forest and Mottisfont woodlands (also Isle of Wight). Detector records for south and north of county
Greater horseshoe bat *Rhinolophus ferrumequinum*	Rare and restricted	Three recent records of individuals in south-west and south-east of the New Forest. Last known maternity colony in Winchester Cathedral 1944*
Lesser horseshoe bat *Rhinolophus hipposideros*	Rare and restricted	No recent records with exception of grounded bat in Portsmouth
Grey long-eared bat *Plecotus austriacus*	Rare and restricted	Only one record in SW of the New Forest (Isle of Wight appears to be a stronghold)
Brown long- eared bat *Plecotus auritus*	Common and widespread	Likely to be common and widespread
Common pipistrelle *Pipistrellus pipistrellus*	Common and widespread	Likely to be common and widespread
Soprano pipsitrelle *Pipistrellus pygmaeus*	Common and widespread	Likely to be common and widespread
Nathusius' pipistrelle *Pipistrellus nathusii*	Rare and restricted occasional records elsewhere in Hampshire	Bat detector records from New Forest and
Noctule *Nyctalus noctula*	Frequent and widespread	Likely to be frequent and widespread
Leisler's bat *Nyctalus leislerii*	Rare outside Ireland, otherwise frequent and widespread	Historical records in east Hampshire and more recent very occasional bat detector records central and south-west Hampshire
Whiskered bat *Myotis mystacinus*	Scarce/widespread	Too few data to evaluate
Brandt's bat *Myotis brandtii*	Scarce/widespread	Too few data to evaluate
Daubenton's bat *Myotis daubentonii*	Common and widespread	Too few data to evaluate
Natterer's bat *Myotis nattereri*	Frequent and widespread	Too few data to evaluate
Serotine *Eptesicus serotinus*	Frequent and widespread	Too few data to evaluate but believed to have declined recently

individual in neighbouring West Sussex after a known roost site was destroyed.

Harris *et al.* (1995) estimated the pre-breeding population of Bechstein's bat to be 1500 in England. At the time, however, there had been no evidence of the species breeding in the UK (and the species had not then been recorded in Wales). Vesey Fitzgerald (1944) reviewed the status of bats in Hampshire and described Bechstein's bat as 'very rare', noting its distribution in Hampshire as the Isle of Wight (1909); Burley, New Forest (1834); Brockenhurst, New Forest (1886); and Harewood Forest near Marlborough (1939). He also noted the earliest records of barbastelle in the county, describing them as 'not uncommon, but nowhere plentiful', mainly occurring in the south of the county and in the Isle of Wight, but with 10 records for the mid and north of the county.

A small number of both Bechstein's and barbastelle bats have been accidentally caught in the New Forest in more recent years during the course of mist netting surveys for birds. A few records were also obtained during surveys to assess the viability of moving the some of the campsites in 2003 (at Hollands Wood, Round Hill and New Park), and incidental records have been obtained during public bat walks, bat box checks and from a few casualties handed to New Forest Keepers. In the mid-1990s, English Nature (now Natural England) undertook a bat detector survey of a sample area of 72 km² of the New Forest, confirming it as 'outstandingly rich in bats' (Tubbs 2001). In the late 1990s, English Nature erected some bat boxes near to a record of an injured female Bechstein's bat at Hollands Wood near Lyndhurst, but no Bechstein's or barbastelle bats were ever recorded in them.

Overview of bat ecology

All bats in the UK are insectivorous, using echolocation to locate prey and to navigate. Some bats, however, use vision for both purposes and to varying degrees. Bats roost in crevices, cracks and cavities in trees, caves and man-made structures such as buildings, bridges, tunnels and mines. Female bats congregate in maternity roosts in summer to give birth and raise what is normally a single youngster. Pups are born blind and naked but are able to fly at between three and six weeks of age depending on the species. Bats mate mainly in autumn, the females exhibiting delayed fertilisation. After copulation females retain the sperm during the hibernation period, which lasts between November and March in most species. Fertilisation then occurs in springtime after the ovum has been released from the ovary, birth occurring in midsummer.

In general all species of bat have declined since the 1900s (Harris *et al.* 1995, Stebbings 1988). The principal causes of decline are habitat loss and fragmentation, modern silvicultural practices, agricultural intensification, use of pesticides and infrastructural development leading to loss of traditional roost sites. Modern building methods and materials do not leave gaps that can allow bats (and birds) into cavities in new and renovated buildings. This bodes very badly for future bat populations, many of which have adapted to roost in lofts, cellars, cavity walls, underneath tiles or slates and in the soffit boxes of buildings, often favouring heated domestic dwellings to raise their young in summer.

All bats in the UK are protected by law (i.e. Conservation (Natural Habitats) Regulations (as amended) and the Wildlife and Countryside Act 1981), and it is an offence to kill, injure or disturb a bat or to block access to, damage or destroy its place of shelter (roost site). Because bats frequently use multiple roost sites throughout the year, a roost site is protected even when a bat is not present. If works are necessary that would contravene the legislation, then a licence must be obtained from the statutory nature conservation agency. Survey licences may also be required for certain survey techniques or where bats may be disturbed.

Ecology of Bechstein's and barbastelle bats

Much of the published information on Bechstein's and barbastelle bats in the UK has been written by David Hill and Frank Greenaway based on research in southern England, and woodlands in West Sussex in particular. This review draws upon findings from these studies but also includes reference to some emerging research and observational accounts in the UK (by G. Billington, J. Flanders, M. Zeale, C. Mainstone and P. Hope). Reference is also made to research on both species in Germany and Switzerland.

Bechstein's bat is one of Europe's rarest bats and is confined in the UK mainly to the south of the country at altitudes less than 150 m (Hill and Greenaway 2006), although it is found at higher altitudes in mainland Europe. It is widespread within its range, which stretches from the Iberian Peninsula to the Ukraine, and is at the northern border of its range in the UK. Although it is widespread in Europe, its populations are believed to be low (although local densities can be high). Its population has declined throughout its range and it is considered 'Vulnerable' (IUCN 2001). It was probably common in Neolithic times when its woodland habitat was very much more widespread, as fossil remains in Grimes Graves in Norfolk suggest (Yalden 1992).

During 2005 and 2006, Hill and Greenaway reviewed the probable distribution of Bechstein's bats in southern England using a combination of GIS mapping and field surveys. In 2005 they surveyed a suitable woodland in each of 52 10-km squares across Hampshire, Surrey, East and West Sussex and Kent. Ten Bechstein's and one barbastelle bat were captured out of a total of 143 bats (11 species). In 2006, 15 Bechstein's and one barbastelle were captured out of 128 bats (11 species) from sites in East and West Sussex (Hill and Greenaway 2008).

A replicable survey protocol has now been established to develop baseline data on the national distribution of Bechstein's bat in conjunction with the Bat Conservation Trust (BCT) and some local bat

groups. This project is planned to be phased throughout the region and will run from 2008 to 2010/2011.

In the UK, Bechstein's bats show a significant preference for trees as roost sites, although bat boxes have successfully attracted bats and there are two records of roosts in buildings. Roost sites are most commonly found in cavities excavated by woodpeckers in oak *Quercus* sp. (or ash *Fraxinus excelsior* on the Isle of Wight). Greenaway and Hill (2004) describe an ideal Bechstein's wood to be deciduous, uneven in age, 40–50 ha in extent and to be semi-natural or ancient in origin, with a dense understorey and a watercourse. They state that areas of continuous high forest or smaller woodlands linked by suitable hedgerows could also support Bechstein's, however populations may be almost exclusively male or non-breeding females. Where they occur in prime habitat, the density of Bechstein's bats can be high, with multiple colonies found within a 10-km square.

In the UK, Greenaway and Hill (2004) also suggested that Bechstein's colonies could survive in oak and mixed hardwood forest plantations, as long as there were adequate suitable roost sites and a dense understorey. They cited three oak plantations with an 80–180 year-old class, which exhibited thick understorey layers that supported thriving Bechstein's populations. They also noted that within this habitat, the presence of conifers seemed to have no detrimental effect; in fact small areas of conifers may even have advantages in certain circumstances (Greenaway and Hill 2004). Hill and Greenaway (2008) caution that an entire community of woodland bats could be adversely affected by understorey clearance and that such management should only proceed after a thorough survey of the woodland for bats.

Female Bechstein's bats rear their young in maternity roosts between May and early July, with births beginning towards the end of June (Fitzimmons *et al.* 2002). Group sizes within roost sites vary as individuals regularly split off and regroup within the colony range. This constant 'fission–fusion' behaviour makes population estimates difficult, but average colony size is believed to be 15–40 animals, with a maximum of 80 (Kerth and Konig 1999). Day roost selection and an individual's choice of roost mates is believed to be influenced by reproductive status rather than relatedness, animals gaining mutual benefit from body warmth, grooming and shared knowledge about roosts (Kerth and Konig 1999).

Kerth and Morf (2004) undertook intensive behavioural studies of adjacent Bechstein's colonies roosting in bat boxes in Bavaria, where individuals were fitted with subcutaneously implanted transponders (PIT-tags). This allowed intensive monitoring of individuals on a daily basis without disturbing roosts and affecting behaviour. Some individuals were also radio tracked. In one colony (Blutsee) adult females (18 in number) used 68 roosts and adult males 69 roosts during the three-year survey period. Twenty-eight roosts were exclusive to females and 27 exclusive to males; 41 were used by both sexes, although mixed use was rare, occurring on only 37/515 census days and mostly in autumn or spring. No adult males were ever observed roosting together.

Genetic analysis and mark–recapture studies have shown that Bechstein's females show absolute natal philopatry, forming independent breeding colonies composed of maternally closely related bats (Kerth *et al.* 2002). Females were observed attacking 'foreign' females as they attempted to enter their roost. In Germany, four colonies whose genetic pedigree was known were studied over a five-year period. Despite considerable fluctuations in population size, no immigration to individual colonies was found during that time. Individual bats roosted with most other colony members at some time, but most females had significant positive associations with several other particular individuals (Kerth and Morf, 2004). In the UK, Bechstein's bats forage mainly in deciduous woodland but they also forage and roost in mature orchards on mainland Europe. Use of hedgerows and parkland habitats for foraging has also been recorded in recent years (P. Hope and C. Mainstone, pers. obs.).

The core foraging area of individual female Bechstein's bats is smaller than for most other species of bat. Schofield and Morris (2000) and Kerth *et al.* (2000) calculated mean foraging areas for individual Bechstein's bats to be 21.9 ha (range 6.9–50.5) and 21 ha (range 9.9–37.5), respectively. In the West Sussex study (Fitzsimons *et al.* 2002) these were somewhat smaller; five bats tracked on foot used foraging areas ranging from 0.7 to 2.5 ha. However, account was taken of different methodologies used between the two studies, and after recalculating data to ensure comparability, the mean foraging area in the West Sussex study was still small, calculated to be 11.4 ha per bat (range 5.5–17.2). The maximum distance between foraging area and the main roost site of females during the radio tracking period in this study was 1.4 km. The foraging areas and maximum distance travelled to them from roost sites for Bechstein's bats studied at sites in southern England and the Isle of Wight were similar to those of Fitzsimons (C. Mainstone and P. Hope, pers. obs. 2008/9). Kerth *et al.* (2001) in their studies suggested that young female Bechstein's may inherit foraging areas from their mothers and remain faithful to them.

Siemers and Swift (2006) studied resource partitioning between Bechstein's and Natterer's bats, two species that are morphologically similar, although Bechstein's bats have longer ear length (19–29 mm) than Natterer's bats (13–20 mm). Their studies supported the idea that Bechstein's bats hunt by listening for prey, whereas Natterer's bats use echolocation and associative learning. In their study, Bechstein's bats foraged mainly on moths, flies and earwigs, harvestmen and crickets (i.e. 'louder' prey) whereas Natterer's bats foraged mainly on diurnal flies, spiders and longhorn flies (i.e. more 'silent' prey). There were considerably more tympanate moths in the diet of Bechstein's than in that of Natterer's bats. Tympanate moths are known to be able to 'hear' echolocation and take evasive action to avoid capture.

Bats in the genus *Myotis,* such as Bechstein's, demonstrate autumnal (and sometimes springtime)

swarming. This has been observed mainly at underground sites and is believed to be at least partly related to mating. Swarming may assist with gene flow in these otherwise socially closed societies (Kerth *et al.* 2002). If, as has been suggested, females range further in autumn then this could also assist in genetic mixing.

Kerth and Morf (2004) concluded that most genetic mixing occurs at swarming sites to which males and females must travel great distances, frequently flying across open non-forested areas. They also suggested a much less common phenomenon for gene dispersal may be by females colonising new areas, probably by small groups of females moving to new areas adjacent to their former colonies. This may occur in response to changes in habitat, allowing new areas to become available.

The barbastelle bat is also one of the rarest bats in Western Europe and has also declined within its range in recent years. It occurs from southern Scandinavia south to Morocco, and east towards Turkey and the Caucasus. In continental Europe it is a bat of forested uplands; in the UK it is believed to be confined to lowland woodlands and river valleys. It is also considered 'Vulnerable' (IUCN 2001).

Harris *et al.* (1995) estimated the UK population of barbastelles to be in the region of 5,000 (4,500 in England and 500 in Wales). Arnold (1993) noted its UK distribution to be south of a line between the Tees, although Millais (1904) noted its presence in Cumbria in 1904–06. Even in suitable woods such as Ebernoe Common in West Sussex, the density of barbastelle bats is low, with fewer than one female or juvenile per 6 km^2 (although this does include large areas of unusable arable land) (Greenaway 2004).

Barbastelle roosts are most commonly found in oak and beech *Fagus sylvatica* woodland, bats frequently making use of apparently fragile roost locations behind flaking bark. Although most records of roost sites are in trees, some building roosts have also been recorded (mainly in barns). Cavities in trees accessed by small holes are also used, as are crevices in split and torn limbs and trunks, normally in areas of humid unmanaged woodland (e.g. non-intervention areas of ancient semi natural woodland or derelict coppice). Greenaway and Hill (2004) also found that in the UK, barbastelle maternity colonies tend to roost on the northern or north-western side of the brows of low wooded hills, normally in ancient or semi-natural woodland, and frequently with a high humidity associated with a dense understorey. Similarly, Russo *et al.* (2004 and 2005, in Switzerland) suggested that barbastelle bats avoided roosting in wood pasture with a homogenously loose canopy cover, preferring different vertical layers in a woodland with dominant, codominant and intermediate trees. Greenaway (2004) suggested that the holly understorey in the colony area studied in West Sussex helped to generate these conditions, providing a wide range of microclimates together with a mixture of roost sites. On the continent, Rydell *et al.* (1996) studied the foraging habits of three barbastelle colonies (in Germany and Switzerland) where roost sites were located in villages 'surrounded by agricultural land, mostly unfertilised grassland and patches of woodland'.

Greenaway (2004) found that barbastelle bats in West Sussex roosted deep in massive hollow trunks during cold winters, within areas of dense evergreen vegetation (i.e. the understorey of holly). Severe cold may have driven them underground or into buildings. In spring and autumn they were frequently located roosting behind loose bark, often low down in deep cover. Dead tree stumps projecting above holly were sometimes used to gain warmth from sunshine during warmer conditions, enabling them to move roost locations according to changing daily conditions. In late spring, pregnant females returned from more dispersed areas to form communal day roosts, but returned to individual foraging territories at night. Communal roosting bats changed roost sites more frequently than in springtime but similar sites were used. Extreme hot weather resulted in a move towards areas with dense cover around the roost site presumably used to buffer the microclimate. As pregnancy advanced bats moved to roost sites that were more protected, frequently using cracks in large boughs. The cracks chosen were commonly those where the tree had tried to repair the injury, and where growth around the crack had formed a more protected site for the bats. After birth, mothers remove youngsters to form splinter groups, frequenting roost sites in splits and behind loose bark. By early August these splinter groups reformed to one large group, still regularly moving between roost sites before disbanding in late August or September. Juveniles often remained in the area long after dispersal of adults, and some adults remained to overwinter (Greenaway 2001).

Barbastelle bats feed almost exclusively on moths, probably captured in flight, although some other prey items such as spiders may be gleaned (Vaughan 1997, Rydell *et al.* 1996). The diet of barbastelles is unusual because of the high percentage of moths, which require a specialised foraging strategy (i.e. gleaning like long-eared or Bechstein's bats, or flutter detection using very high frequencies like horseshoe bats). Barbastelles probably use both gleaning and aerial hawking techniques (Rydell *et al.* 1996).

Barbastelle bats have a unique echolocation call using two contrasting types of pulse while foraging. A short relatively weak broadband frequency sweep (maximum 42 kHz) follows a stronger narrowband pulse at 32 kHz, followed by a steep frequency sweep (Rydell *et al.* 1996). Barbastelle bats may use either or both pulses alternately to suit the situation. Barbastelles can also emit echolocation pulses through their nose (Kolb 1970). Their large, forward-pointing ears are also typical of species that echolocate in clutter. Sierro and Arlettaz (1997) describe barbastelle as a 'typical aerial-hawking species although they hunted exclusively above the forest canopy'. The species has seemingly evolved a peculiar foraging technique to overcome the defence system of its probably tympanate prey. According to these authors, the diet of *Barbastella* appears one of the narrowest among Palaearctic bats, although Zeale (2008/9 unpublished) recorded a range of macro moths

in barbastelle droppings analysed by DNA. As a result of its specialisation in foraging habits, it is probably relatively vulnerable to changes in the abundance of moth populations, compared with other more flexible aerial-hawking bats.

In Greenaway's studies (2004), barbastelle mothers with young foraged within 1 km of roost sites and returned to them frequently. Female bats shared long sections of flight lines and foraging areas but normally these tapered to an area used by a single bat. Later as the young developed, foraging areas increased, with individuals recorded flying up to 30 km per night (although more typically 8 km). Greenaway (2004) noted a seasonal pattern to foraging, with riverine areas preferred in spring, meadows and hedgerows in summer and dense woodland in winter. He noted however that bats could be adaptive when highly productive foraging resources were available, such as a well-used coastal grassland strip used by a colony in Norfolk (Greenaway 2001). He also suggested that where flight routes are not wooded, double hedgerows are important for foraging and commuting.

Billington (2000) radio tracked 17 adult female barbastelle bats during July in Horner Wood NNR (Somerset). He noted favoured foraging areas as headwaters of three local rivers, mainly around scrub and unimproved pasture, particularly in the south and west slopes of coombes bordering moorland and western and southern slopes of woodland and moorland. He noted the most dominant habitat of these areas as European gorse *Ulex europaeus.* Bats also foraged along small tree-lined watercourses and occasionally were recorded foraging over gardens and around low-level street lighting. He also noted that bats commuted and foraged in groups, and had 'socialising places' where they would meet at regular intervals before dispersing more widely. Billington (2000) recorded over 66% of tagged bats together in one place on several occasions.

Hampshire Bat Group Surveys

A project focusing on the New Forest area and Bechstein's and barbastelle bats in particular was instigated after four barbastelles were heard and seen foraging in the canopy of a conifer ride in Burley Inclosure, during a bat group survey in autumn 2005. The project was set up by the current author and Paul Hope of the Hampshire Bat Group with the following aims:

- assess the distribution of barbastelle and Bechstein's bats in the New Forest;
- record roost sites;
- influence positive management of the Forest and surrounding areas for bats;
- train volunteers and land managers in survey techniques;
- raise awareness of the value of the Forest for bats.

There is a range of ways that new volunteers with a varying degree of skills can contribute, but removal of bats from nets and the harp trap is restricted to licence holders or occasionally those training for a licence. Training and support is given where necessary to assist with detector surveys, radio tracking and roost emergence/re-entry counts; all of these are non invasive surveys that with some training and support people may assist with. Promotion of the project has been achieved through a number of talks and presentations, a leaflet and published articles in our own literature/website. The cost of equipment to undertake this work has been provided through grant funding from the New Forest National Park Sustainability Fund and the New Forest Trust. An equipment loan has been gratefully received from Hampshire Bat Group and Ecological Planning & Research.

During bat detector surveys, bat echolocation calls are recorded using time expansion Pettersson D240x detectors and Sony HiMD minidisks. The ability to record calls is valuable, as positive verification of species such as barbastelle can be made by using software analysis of sonograms; in this case the software used is 'Batsound' (Pettersson Electronik). Many woodland specialist species are hard to detect and/or identify using this method, and capture is necessary to confirm their identification to species level. Mist nets and harp trap are used either in dense woodland to capture foraging bats, or along rides and tracks to catch commuting bats. Bechstein's and barbastelle bats are fitted with rings so that they can be identified if recaptured. Surveys began in 2006 and are likely to continue until 2012/13. Females of both species and occasionally males are also radio tracked. Two other rare species with scant records in the Forest, Nathusius' pipistrelle and grey long-eared bat, will also be radio tracked if captured. Nathusius' pipistrelle is rare as a breeding species in the UK, although spring and autumn records suggest that it is more frequently recorded as a migrant visitor.

Bechstein's bats (like long-eared bats) have a quiet echolocation call, and as a canopy feeder they infrequently stray low enough to be within hearing range of a bat detector, and may be less likely than some species to pass within range of mist nets or a harp trap. An effective method recently devised for surveying Bechstein's bat is an 'acoustic lure', which plays ultrasonic, digitally constructed or recorded bat social calls of different species (Hill and Greenaway 2005, 2008). Bats are attracted to the calls and a proportion of these are captured in nearby nets or harp traps. If fitted with radio tags, bats can then be followed back to roost sites and information on the numbers of bats, bat foraging and commuting routes can also be obtained. All of this work is potentially disturbing and is managed to minimise disturbance to local communities of bats by avoiding areas close to potential roost sites and not returning to sites more than three times per year. A licence has been obtained from Natural England (the statutory nature conservation agency in England) to use the acoustic lure, to catch and to fit radio transmitters to bats.

Initial desktop research began with an evaluation of existing records, and a study of Ordnance Survey and Forestry Commission stock maps to evaluate the

composition of tree species, woodland management, aspect and the location of waterbodies. Areas with the greatest potential to support maternity colonies of both species were then visited with a view to sampling with bat detectors and capture techniques. It was not possible to undertake a detailed evaluation of the areas owing to the sheer size of the Forest and limitations of the volunteer resource.

Two types of acoustic lure have been used to date, one developed by Sussex University ('Sussex Autobat') that simulated bat social calls played through an amplifier and speaker system ('Ultra Sound Advice', USA), the other using our own pre-recorded calls from a Pettersson D1000x bat detector linked to amplifier and speakers. Data on all species of bat captured are recorded including weight, forearm measurements and other measurements that can help identify cryptic species (for example tragus and thumb length in long-eared bats). Records of any marks on each bat are noted as is the sex and sexual status and general health of each animal. Bats can be aged by examination of the degree of ossification at the joints of the wing bones up until the autumn of their first year. Dropping (faecal) samples are taken from barbastelle bats and sent to Bristol University as part of a wider PhD project on the foraging ecology of the species.

Radio transmitters (tags, provided by Biotrack) are fixed between the scapulae of a bat with an adhesive (Ostomy adhesive solution, Salts Healthcare). These weigh less than 5% of a bats body weight (Aldridge and Brigham 1998). Heavily pregnant bats are not tagged. Because tags are light and small, and battery life is limited to 10–14 days. Signals rarely travel more than 500 m in dense woodland and frequently even less distance where the topography undulates. Bechstein's and barbastelle bats are ringed using 2.9 mm metal rings supplied from the Mammal Society. Sika radio tracking receivers with 3 element flexible Yagi antennae (Biotrack) are used to track bats on foot, whilst magmount omnidirectional antennae fitted to cars are often essential when tracking the fast moving barbastelle. During radio tracking, bat positions are fixed using either triangulation between pairs of surveyors or by closely following the bat (close approach method). Because GPS locations in woodland can be inaccurate, a known reference point is used for taking bearings. The tracking method is normally dictated by the resources available to us at the time, the topography, habitat and bat species.

Once bats have been located, evening emergence and dawn re-entry surveys are undertaken to monitor numbers of bats. As both species make frequent re-entry and re-emergences at dawn and dusk in midsummer, accurate counts are difficult and nightshot video with an infrared illuminator is sometimes used to gain a better estimate of numbers of bats. Each identified roost tree is monitored at dusk (and/or dawn) for at least the lifetime of the tag. Actual roost points on trees are often unclear, particularly where they are high in the canopy, and are often obscured by foliage on lower branches when return visits in the winter are necessary.

Between April 2006 and October 2007, over 40 people were involved in the project although most work has been performed by a core of 8–10 regular volunteers. During this time period 60 individuals of 10 species of bat have been captured. Table 6 shows the number and sex of each species captured during the period including 11 Bechstein's and seven barbastelle bats. Twenty tree roost sites of the two main target species have been located, consisting of 13 Bechstein's and seven barbastelle roosts (Figure 16). (A noctule roost was also located with 27 bats emerging from a well used tree hole in August 2007.) Of the Bechstein's roosts, seven were in oak, six in beech; of the barbastelle roosts four were in oak and three in beech

Figure 16
Map to show distribution of Bechstein's and barbastelle bat records, New Forest, 2006 and 2007.

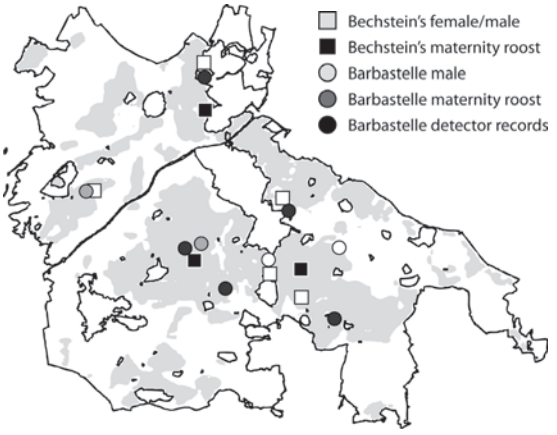

Table 6
Species of bat captured in the New Forest during April 2006–October 2007.

Species	Male	Female	Total
Bechstein's *Myotis bechsteinii*	5	6	11
Barbastelle *Barbastellus barbastella*	2	5	7
Brown long-eared *Plecotus auritus*	5	11	16
Daubenton's *Myotis daubentonii*	2	1	3
Natterer's* *Myotis nattereri*	2	3	5
Noctule *Nyctalus noctula*	1	2	3
Common and soprano pipistrelles *Pipistrellus pipistrellus/pygmaeus*	6	2	8
Serotine *Eptesicus serotinus*	1		1
Whiskered/Brandt's** *Myotis mystacinus/brandtii*	3	2	5
Totals	28	32	60

* 27 Natterer's bats were also ringed from Forestry Commission bat boxes at Castle Hill, Burley.

** Whiskered and Brandt's bats are cryptic species and identification can only be confirmed by DNA analysis. Some features are considered to be suggestive of species and these are used as a guide. During our investigations in the New Forest, the majority of bats encountered so far have shown features that most strongly suggest they were whiskered bats.

(Tables 7 and 8). All of the Bechstein's maternity roost sites were in cavities accessed by holes; one in a rot hole in an oak, the rest in woodpecker holes in oak and beech. Of the barbastelle maternity roosts four were crevices in beech or oak, two under flaking bark (oak) and one unknown. Barbastelle bats have not been recorded using woodpecker or rot holes during our studies so far.

Taken together with records of greater horseshoe, Nathusius' pipistrelle and grey long-eared bat, the presence of 13/14 species of bat were confirmed in the New Forest during the period autumn 2005–October 2007. By the end of October 2007, three breeding colonies of Bechstein's bats had been located (Anderwood, Fritham, and Matley Ridge near Denny) and two barbastelle colonies (Mark Ash and Red Shoot). The minimum distance between groups of Bechstein's maternity roost trees which we have recorded has been 5 km (average 7 km); because of the small range of this species, we consider each maternity roost and/or pregnant or lactating female we have captured between mid May and August to represent a separate colony. Barbastelles have a much larger range and such judgements are therefore more difficult to make. Two groups of trees were located that were used by barbastelle bats during the peak maternity periods, separated by a distance of 7 km. We found approximately 45 and 60 bats present at both sites

Table 7
Characteristics of roost sites in the New Forest used by more than five bats.

Observation dates while roost site occupied	Species	No of bats (range during period counted)	Tree species	Roost feature
4–6 June 2006	Bechstein's	1–6	Oak	Not seen (high in canopy)
6–10 August 2006	Bechstein's	3–30	Oak	Hole 3 m on north side
28 August 2006–1 September 2006 (approx 30 bats also present 21 August 2007)	Barbastelle	7–30	Oak	Split 4.5 m on south side
28 August 2006–1 September 2006	Barbastelle	7–15 7–12	Beech Oak	Split 3.5 m on north side Flaking bark 5 m on east side
29–30 April 2007	Bechstein's	40–41	Beech	Hole 20 m on west side
19–22 August 2007	Barbastelle	20–45	Oak	Split 7 m on underside of north-west lateral bough

Table 8
Number of bats radio-tracked and tagged, and the number of trees used as roost sites during radio-tracking periods.

Capture date	Species	Sex	Ring number	Tag number	Nights tracked/ located	Number of roost sites used in period
28 May 2006	Bechstein's	Male	n/a	173.285	3	3
3 June 2006	Bechstein's	Female	n/a	173.294	3	2
30 June 2006	Bechstein's	Female	n/a	Not tagged/pregnant	n/a	n/a
5 August 2006	Bechstein's Bechstein's	Male Female	n/a n/a	n/a 173.239	n/a 7	n/a 3
11 August 2006	Bechstein's	Male	n/a	n/a	n/a	n/a
27 August 2006	Barbastelle	Female	n/a	173.214	6	3
10 September 2006	Bechstein's Barbastelle	Male Male	n/a n/a	n/a 173.294	n/a bat lost	n/a
10 September 2006	Barbastelle	Male	n/a	n/a	n/a	n/a
10 March 2007	Barbastelle	Male	n/a	173.248	20	3
28 April 2007	Bechstein's Barbastelle	Female Female	4401 4402	173.775 173.309	4 8	3 1
29 April 2007	Bechstein's	Female	4403	173.737	4	2
14 July 2007	Bechstein's	Male	4404	173.774	4	1
19 August 2007	Barbastelle	Female	4405	173.751	4	2 min
22 August 2007	Barbastelle	Female	4406	173.752	n/a	n/a
23 August 2007	Bechstein's	Male	4407	173.970	7	2 min
12 October 2007	Bechstein's	Female	4408	173.799	9	3

Plate 1
Barbastelle early spring roost. Photo: C. Mainstone

Plate 2
Barbastelle maternity roost in beech tree. Photo: C. Mainstone

(Mark Ash and Red Shoot) on the same night in 2007. We have interpreted these to represent two separate colonies.

In addition to female summer roosts, male Bechstein's bats have been captured and tracked to roosts in three locations (Bramshaw, Shave Green and Pinnick Wood) together with a single female just north of Lyndhurst in October 2007. A male Bechstein's bat was captured at Shave Green in May 2008. Male barbastelles have been captured in a number of locations north and south of Lyndhurst and Brockenhurst (Denny Wood, Matley, Ivy Wood, Hollands Wood, Whitley Wood, Water Copse, Rhinefield), and detector surveys have recorded this species in all of the areas where they have been captured, in addition to Bramshaw. Some of these records include late autumn/early winter foraging and roost sites for both species. By the end of September 2008, surveys had been undertaken in approximately 30% of the area planned. Early in May 2009 we located a new barbastelle colony in Godshill Wood in the north-west of the county.

Although the survey is at an early stage, the indications are that both species are present, at least to some degree, throughout the New Forest woodland areas. There appear to be no shortage of natural tree roosting sites for bats in the Forest, however heavy grazing of the understorey, particularly in the A&O woodlands (see Chapter 13) may affect the Forest's ability to support as large a population of these species (and their moth prey) as it otherwise might. In this context, the mixed deciduous woodland areas with small pockets of conifer and unthinned plantation 'understorey' may be important foraging sites for bats roosting in adjacent stands.

Both species are certain to forage outside the wider National Park boundary as well as much of the private land within it; most of this has so far been inaccessible and may remain unsurveyed. We may only be able to extrapolate therefore from the locations and habitat types of these areas as to how they may function, but some areas of deciduous woodland where ponies are excluded may provide rich areas for bats. The barbastelle bat is likely to forage outside the protected areas of the Forest; bats roosting in Red Shoot Wood for example are likely to use the Avon Valley. Bats at Brockenhurst and areas to its east and west are likely to include some of the extensive areas of private land along the Beaulieu and Lymington rivers within their ranges. The relationship between the colony of barbastelle bats at Mottisfont, situated outside the Park and approximately 10 km to its north-eastern edge, and those in the New Forest, is unknown. As well as the private woodland blocks, mature garden trees as well as the extensive network of mature hedgerows and hedgerow trees are also likely to be used by both species. (A female Bechstein's bat we radio-tracked in 2007 moved regularly between Forest and farmland over hedgerows in Fritham village.) Hopefully over time relationships can be built with landowners and confidences gained to allow access to survey some of these areas.

The value of heathland, conifer forest and the edge habitats these create is unknown for both species. In April 2007 we radio-tracked two female Bechstein's bats (from a roost of 42), foraging along heathland/conifer edge and within conifer woodland at Matley. The tree was exposed with no adjacent canopy cover and very scant understorey, although it was adjacent to denser woodland. It is unclear how representative the radio-tracked bats foraging behaviour was of the

Plate 3
Bechstein's bat main roost tree. Photo: Paul Hope

Plate 4
Bechstein's bat maternity roost. Photo: Paul Hope

group as a whole, however they continued to forage in both habitats almost exclusively during the tracking period.

All of the bats radio-tracked during the project have in fact foraged for periods in areas of conifer and conifer/mixed woodland. In some areas, roost trees appear to be protected by adjacent conifer stands, which may help to shelter mature trees and play a part in maintaining the appropriate microclimates. Coniferous trees (as well as some of the more recent unthinned oak plantations) could also be providing some degree of varied woodland structure, as well as shelter and habitat for invertebrates, particularly during winter. As Greenaway and Hill (2004) noted, Bechstein's can occur in young plantations including areas of conifer as long as roost sites are available (as they evidently are in the New Forest). Other researchers have also found Bechstein's roosting in or in close proximity to conifer woodland. For example two maternity roost trees (Bechstein's bat) were located in conifer woodland and a hedgerow boundary in Dorset; the bats used the conifer to commute between areas of broadleaf, where they appeared to forage (John Flanders, pers. comm.).

Challenges and opportunities for the future

The New Forest is indisputably a special place for a range of rare as well as common species of flora and fauna. Whether or not habitats are managed, they will change over time, reflecting an environment that is naturally in a constant state of flux. The need to accommodate the increasing pressures from recreational use (see Chapter 1) and a silvicultural output from the Forest are increasing.

A number of conservation objectives require management within the New Forest. Management in the A&O woodlands is kept to a minimum, but some management does occur, notably removal of non-native species such as rhododendron and pollarding of holly. Some of the holly management has been instigated to protect and enhance internationally important lichen communities (see Chapter 9), but pollarding around roosting sites and in key foraging areas is likely to have a negative affect on the microclimates of the habitats used by woodland bats, at least in the short term. Clearly, an understanding of the tolerances of all of the species likely to be affected and a management approach combining the needs of these is required.

An extensive programme of wetland and watercourse management is underway, much of it within mixed woodland blocks (see Chapter 17). Both of these programmes are vital to maintain the important floral and faunal communities of the Forest and will ultimately benefit woodland bats. There is however a danger that too much intensive felling and removal of vegetation along streamsides could again have at least a short term negative effect on bat species such as Bechstein's, and a longer term approach to management of areas (perhaps in rotation) would be advisable. Large areas of conifers have been removed from the Forest and a programme of further removal is planned, largely to recreate heaths and lawns on sites where these were formerly present. Again an understanding and appreciation of the role that some of these areas play for woodland bats should be incorporated in and inform any management planned over a period of time.

Management of the plantations in the Inclosures is ultimately for a timber crop, and methods and timing of extraction and thinning are largely influenced by economics. Some of the plantation oaks have a dense understorey that will provide foraging resources for bats where this may be depleted in adjacent areas such as the A&O woodlands. Again an appreciation of those areas utilised by some of the more important roosts (e.g. maternity sites) could play an important role in the management of such a large and complex area. A planned approach to the positive management of some of these young and semi-mature oak plantations could be adopted to encourage recruitment of new colonies of bats or extension of existing adjacent colony ranges over time. Similarly, management practices such as linking or maintaining links between colonies, between roosts and foraging sites and improving habitat where it has become or is becoming degraded, could also be integrated.

Raising awareness of the ecological needs of bats and gaining confidences with private landowners could help to achieve a positive gain for a wide range of species, not just bats. The incorporation of management for bats within existing incentive schemes is probably something that has not been fully capitalised upon, and could be an important tool in for the protection and enhancement of these habitats in the future. The role of habitats adjacent to but outside the Forest may become increasingly important in the longer term given some of the projections of the impacts of climate change, particularly on sea level rise and on the potential demise of tree species such as beech. Incentive schemes outside the National Park itself therefore should also be utilised to promote positive and informed land management for both species.

The New Forest is a unique and fascinating place with a complex suite of habitats. It faces increasing pressures both from the demands from the public for recreation and threats to some of its traditional rural communities from modern day economics. There are large gaps in our knowledge about the needs and tolerances of not only bats but a wide range of species. This lack of knowledge must be tackled and communications improved so that the most appropriate collaborative management decisions can be made to enable the biodiversity of the Forest and its surroundings to thrive. The Hampshire Bat Group will continue surveys over the coming years. The Group looks forward to the contribution it can make towards unravelling some of the mysteries of our rare bats.

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