

Contents

Preface	3
Bats - flying with their hands and seeing with their ears	4
Forests - space to live	5
Living and sleeping - villa or container housing	6
Going out for dinner - where and what do bats hunt in forests?	12
Significance of specific "forest types"	16
What is a "forest bat"?	17
What to do?	18
Step by step	19
Literature	19



Brandt's bat taking off

Bats in Forests - Information and recommendations for forest managers
"Landschaft als Lebensraum", vol. 4; July 2001.

Editors: German Association for Landcare
Deutscher Verband für Landschaftspflege (DVL)
Eyber Str. 2, D-91522 Ansbach, Germany
Tel. ++49-(0)981/9504-247, Fax ++49-(0)981/9504-246
email: info@lpv.de, internet: www.lpv.de

Federal Agency for Nature Conservation
Bundesamt für Naturschutz (BfN)
Konstantinstr. 110, D-53179 Bonn
Tel. ++49-(0)228/8491-0, Fax ++49-(0)228/8491-200
email: pbox-presse@bfm.de, internet: www.bfn.de

Editorial work: Angelika Meschede
Wolfram Gühler (DVL)
Peter Boye (BfN)

Text: Angelika Meschede

English text: Edited by Dr. Ann Thorson (England)

Photos: Klaus-Gerhard Heller (p. 2, p. 4 middle, p. 12 gipsy moth, p. 17, p. 18 bottom, p. 19 top), Otto von Helversen (p. 4 top, p. 5 bottom), Andreas Zahn (cover - Bechstein's Bat, mountain forest, pp 5 & 6 top, pp 7, 10, 13 all, p. 16 river, mountain forest, p. 18 middle, pp 19 & 20 bottom), Angelika Meschede (cover - riparian forest, old tree, p. 6 bottom, pp 8, 9 & 14 all, p. 15 top & middle, p. 16 top left), all other pictures and backgrounds taken from archives of DVL or Schmidt & Schmidt

Design: Heike Schmidt, Dipl. Kommunikations-Designerin (FH)

Print: Schmidt & Schmidt, Gesellschaft für Werbung & Promotion mbH, Fürth

Printed on acid-free paper

Preface

Those who have visited a forest at dusk or at night surely have noticed the silent hunters of the night: bats! All 20 bat species regularly occurring in Germany use the forest in one way or another, either as a dwelling or as a hunting ground - some only during the summer when rearing young in their nursery colonies, some in the winter for hibernation, a few species exclusively, others rarely. But what do we know about the habitat requirements of these animals?

This booklet summarizes the results of a research and development project (R & D) which was conducted nationwide by the German Association for Landcare (Deutscher Verband für Landschaftspflege) from 1996 to 1998 on behalf of the Federal Agency for Nature Conservation. Titled "Ecology of bats in forests with special regard to migratory species and formulation of conservation recommendations", the aim of the project was to develop precise recommendations for forest management that support the conservation of bats.

More than 50 experts and bat workers all over Germany were involved in addressing the question of what a forest has to provide in terms of roosting and foraging habitats for bats. The results of all these investigations and the already published data on this topic were gathered and analysed in order to develop well-founded recommendations for forest management.

The German Association for Landcare is the umbrella organisation of landcare associations, numbering 130 nationwide, in which land users such as farmers and foresters as well as conservationists and local politicians cooperate on equal terms to promote "landscape as a biotope". Almost one-third of central Europe, which has been shaped and designed by humans for thousands of years, is covered with forests, and the landcare associations are dedicated to sustainable forest use. With this brochure we want to support forest managers in their commitment to this cause. We hope to contribute towards satisfying the legitimate human demand for the raw material timber without disregarding the function of the forest biotope as a part of the landscape.

In this context forestry can claim a long tradition. 200 years ago, the Thuringian forester Dr. Johann Matthäus Bechstein was the first ever to call for the conservation of bats in our forests. To honor him, a newly discovered bat species was named after him in 1817. A well-deserved naming, as it turned out, since among our indigenous bat species this is the one that uses forests most intensively.

In conclusion, I should like to thank the Federal Agency for Nature Conservation for supporting this project.

Josef Göppel (Member of State Parliament)
Dipl.-Forstwirt (forester)
Chairman of DVL



"In forests they [the bats] must be protected as useful animals without any restrictions."
Johann Matthäus Bechstein (1792), Thuringian forester





Brandt's whiskered bat

Bats – flying with their hands and seeing with their ears

Their scientific name explains the first part: "Chiroptera" meaning "hand wings", because their wings correspond to our hands. Being the only actively flying mammals, bats invaded the aerial realm at least 50 million years ago. And to escape competition for food by diurnal birds they turned night into day.

Bats became famous especially for their orientation and foraging methods: thanks to ultrasonic calls and echolocation they do not depend on their eyes in the darkness. The huge ears of the long-eared bat, for example, detect even the faintest echos reflected from delicately structured surfaces like foliage, bark, and flying insects.



This bat has strikingly big ears, which together with the broad wings allow a slow and successful foraging flight even when manoeuvring through dense vegetation. Long-eared bats mainly hunt for moths, including forest pests such as the gipsy moth and green oak tortrix. Colonies of

females - so-called

Brown long-eared bat (Plecotus auritus)

nursery colonies - are found in tree holes, sometimes quite small, with free access or covered by foliage. Accidental findings in cut trees reveal that now and then tree holes are used as winter shelters as well.



The biggest native bat weighs about 30 g. Nursery colonies may consist of a large number of individuals and can usually be found in the bellfries of churches and attics of big buildings. In some parts of Germany, especially in the south, colonies of up to several hundred females are found. Only males live in

tree roosts in forests during the summer, but for hunting all animals

Greater mouse-eared bat (Myotis myotis)

fly into forests, where they spent about 75 % of their foraging time. This shows the need for extended forests as feeding grounds in the vicinity of nursery colonies. To be suitable for the greater mouse-eared bat a forest should have a partly open floor where the bats can best hunt for their main prey, ground beetles. Forests like great halls accommodate the bats' requirements best: free airspace above ground to support a slow search flight and scattered leaf litter, which causes the moving ground beetles to make a rustling noise. Only occasionally have greater mouse-eared bats been found in tree holes during hibernation.

Forests – space to live

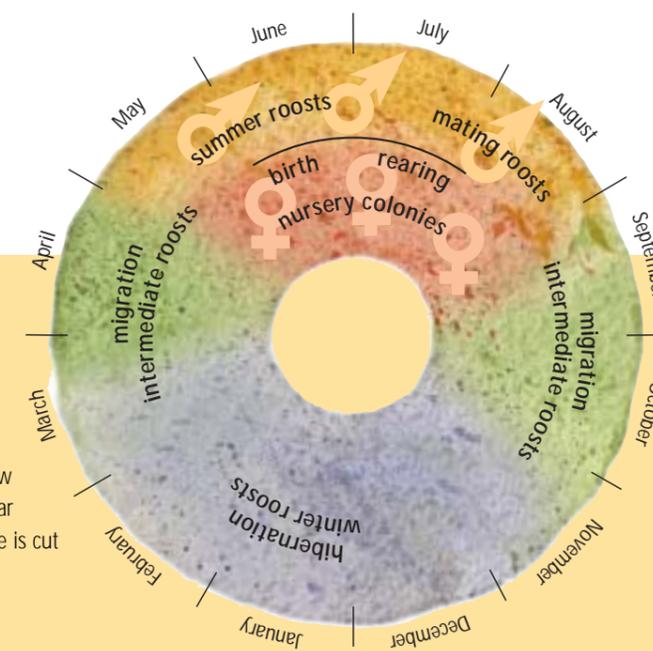
When are bats in forests?

In short, during the whole year! In summer as well as in winter! In summer females of a given species gather together in nursery colonies where they rear their young, while males mostly stay solitary. Cold periods are often slept away in hollow trees, seldom in cracks behind bark. During this time of the year bats are found only accidentally, for example when a roost tree is cut (see photo p. 6).

Why are bats in forests?

In forests two essential resources are available next to each other: roost sites and feeding grounds. Resting and foraging are therefore guaranteed. With 29 % of Germany being covered by forests, an area of 10.5 million hectares is theoretically available as bat habitat. The open cultivated landscape, however, often no longer provides suitable conditions because structures like hedges or solitary trees are missing and the food supply for bats is severely restricted by the use of insecticides.

One has to closely examine the habits and demands of all bat species to understand the requirements that must be met by a forest in order to be a "bat forest"! We now know: not every forest is suitable for bats.





Brown long-eared bat (*Plecotus auritus*)

Living and sleeping – villa or container housing

Roosting requirements of bats are still not completely understood for all species. As a rule, however, a roost site has to offer:

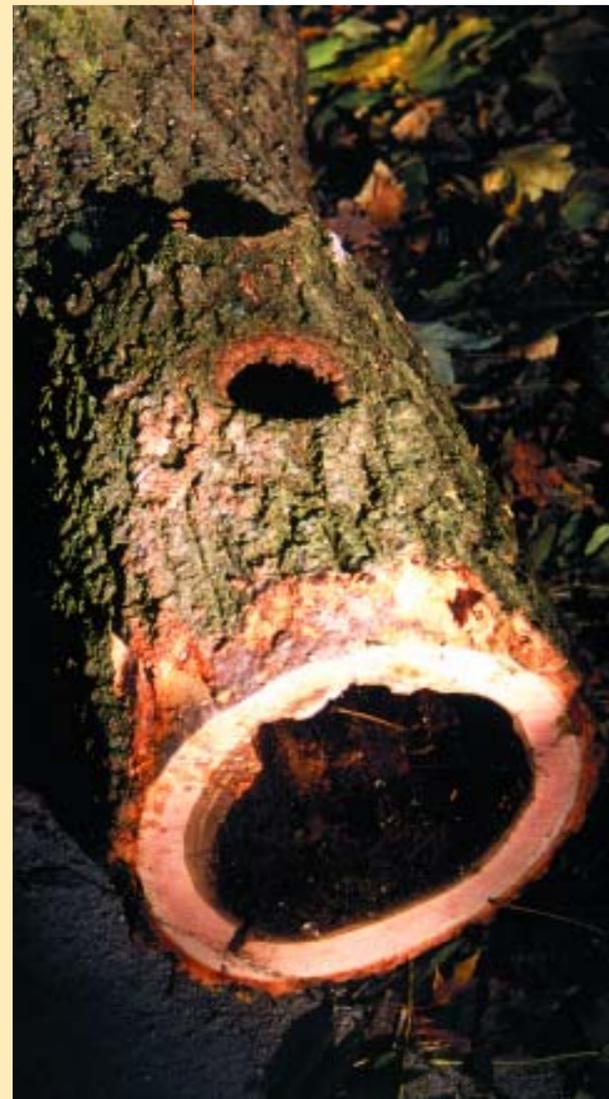
- protection against wind and water
- stable microclimate
- protection against predators (e.g. marten)
- enough room to establish a colony.

Most bat species change roosts frequently, sometimes daily. Therefore, a single old tree hole is not sufficient for the survival of a bat population. Possible reasons for frequent roost changes are:

- influence of parasites
- predator avoidance (to confuse the predator)
- microclimate not suitable
- becoming acquainted with potential new roost sites
- competition, displacement
(many other animal species are also looking for a hiding place).

Under natural conditions, holes and cracks develop in the trunks of trees of a certain age or diameter, as a result of storm damage, rotting, woodpeckers, and lightning. These offer ideal roost conditions for about 50 different animal species, among them at least 10 bat species. One might call tree holes "villas", as they are often big enough to shelter a couple of hundred bats. Particularly striking tree-hole dwellers are noctules and Leisler's bats. They are typical "tree bats" but also accept nest boxes as a substitute roost site.

Deployment of a new array of breeding boxes helps to increase and maintain the roost supply in forests and therefore probably helps to preserve the bat population. Their short life span and dependence on maintenance, however, make them an unsatisfactory alternative to lost natural roosts. They can even turn out to be traps when used for hibernation, because most of them are not frost-resistant. Records of noctules frozen to death in nest boxes have been accumulating for some years. Artificial breeding boxes can only be a temporary substitute, a sort of "container housing", when a forest lacks natural roost sites (particularly in coniferous monocultures). The aim should be to reduce the number of nest boxes on a long-term basis without causing a short-term lack of roost sites. Therefore, a reduction must be accompanied by a restoration of natural roost sites. Deployment of a new array of breeding boxes is useful only in connection with a simultaneous change in forest management, with the aim of permanently supplying a sufficient number of hole trees.



cut branch containing a bat roost



Weighing about 30 g, the noctule is thought to be the biggest native bat species next to the greater mouse-eared bat. Characteristics are the velvet-like brownish fur, relatively short and broad ears and a mushroom-like lobe at the base of the ear. Long and narrow wings enable fast hunting flights in the open air. Like many migratory birds, noctules cover long distances between their summer roost areas and hibernaculum twice a year. Distances of more than 1,000 km are possible, for example from the northern part of Brandenburg to Switzerland. Most of the nursery roosts, where 20 to 50 females rear their young, are located in the north and northeast of Germany and Europe. Wintering areas are less well definable. During migration in April, May, and again starting at the end of August, large numbers of noctules become concentrated particularly along rivers. Here, riverine forests play an important role in providing roost sites and foraging grounds during migration and hibernation. Noctules are known for their large hibernating colonies. For example, a bridge near Kiel gives shelter to up to 5,000 individuals. Old trees can also accommodate several hundred bats in holes and cracks. Noctules live in tree roosts year-round, being located in branches as high up as the tree top. During summer roosts are sometimes changed every two to three days. Several tree holes in close proximity are necessary for social behaviour, particularly in the mating season.

Noctule bat (*Nyctalus noctula*)



*The smaller of the two *Nyctalus* species is only half the size of the noctule and occurs much more rarely. Having a similar appearance, young individuals of the noctule can be confused with Leisler's bat. Like the noctule, Leisler's bat is distributed all over Germany and as a migratory bat travels long distances. Summer and winter populations are probably well separated from one another, but this topic still needs a lot of research. The recovery of banded bats reveals long-distance relationships, for example from southern Thuringia to southern France or Saxony-Anhalt to Spain. Up to 70 females gather in a nursery colony, but large wintering colonies like those of noctules have not yet been observed.*

Leisler's bat (*Nyctalus leisleri*)

Sometimes single Leisler's bats mingle with colonies of the bigger sister species. As others do, this bat species chooses year-round tree roosts like crevices, holes and cracks in the trunk as far up as the tree top. During the active period of the year it changes shelters every two to four days.

*Both *Nyctalus* species fly fast and prey on insects, mainly in the free airspace. Hunting grounds are not located in closed forest stands but rather above open, large bodies of water such as lakes and reservoirs and in places with abundant potential prey. Roosts can be 10 or more kilometers away from foraging areas.*

Potential tree roosts



Forked trees can provide large cavities. Radio-tracking revealed that Leisler's bats use such cavities as roosts.



Tracking in the forest – even non-specialists can detect roosts occupied by bats.

A long-term roost sometimes shows conspicuous signs such as excrement overflowing from a **woodpecker's hole**. This can be observed most often in roost trees of colonies of Daubenton's bats.



In the tops of old trees **hollow branches** often break off after storms. Sometimes they turn out to contain old bat roosts.



As a result of lightning strokes and storm damage, **fissures in stems** can widen to spacious cavities due to decay. Thus they can provide enough room for nursery colonies of 50 individuals (as in the photo) or even hibernating colonies of 700 noctule bats.



Some species do not require much space. These bats prefer narrow cracks and physical contact with back and belly. **Crevices and loose bark** can serve as hiding places, but are often ignored by foresters and destroyed by thinning. Radio-tracking studies in the research project revealed that, e.g., barbastes almost exclusively occupied roosts behind detached bark, which they changed frequently. The species of tree was not important.





This medium-sized bat, weighing about 10 g, is extremely rare and close to extinction throughout Germany. No records exist from the northernmost regions of Germany. The bat's long fur is almost black. Barbastelles prefer to hide in narrow crevices, touching the walls with both back and belly: behind pieces of loose bark (even on very thin trees), on buildings behind shutters, always in the vicinity of or even inside forests.

Barbastelle (*Barbastella barbastellus*)

Small maternity colonies, often including no more than 10-15 females, change roosts frequently, sometimes daily. The animals mainly hunt in woods at canopy level. Flying relatively fast, barbastelles use forest paths as links between foraging grounds. Most winter shelters are underground.



Another medium-sized bat can be seen regularly throughout Germany and is common at ponds, lakes and other calm bodies of water.

It typically hunts in prolonged flights at a constant low height above the water surface, continually raking insects from the surface as it flies. Chironomids are the main prey. Regionally high population densities may occur, e.g. in an area rich in ponds northwest of Erlangen, where a density of 65 individuals per square kilometer was calculated. Suitable roosts for establishing nursery colonies are found in the surrounding forests.

Daubenton's bats are typical tree dwellers. They easily cover distances of seven to eight kilometers between roost and hunting area. Nevertheless, tree holes (like woodpecker holes or cracks in stems, often in living trees) are more suitable when they are located at forest edges and no further away than 1.5 km from the nearest water.

Daubenton's bat (*Myotis daubentonii*)

*The large number of colonies found in red beeches (*Fagus sylvatica*) has been linked with the high heat storage capacity of this tree species. Shelters are changed every three to four days. Winter roosts usually are located underground.*



Logging and roost suitability

For wood production trees are harvested when their economic value is maximal - that is, when the trees are relatively young. Most trees, however, would develop natural holes and roost sites only at an age well beyond the age of harvesting. Therefore, most commercial forests in Germany do not offer a sufficient supply of natural roosts for tree dwellers.

Natural maximum age and age of maturity for harvesting of the main tree species in commercial forests. Values (years) are site-dependent and may vary (from SCHERZINGER 1996, modified and supplemented).

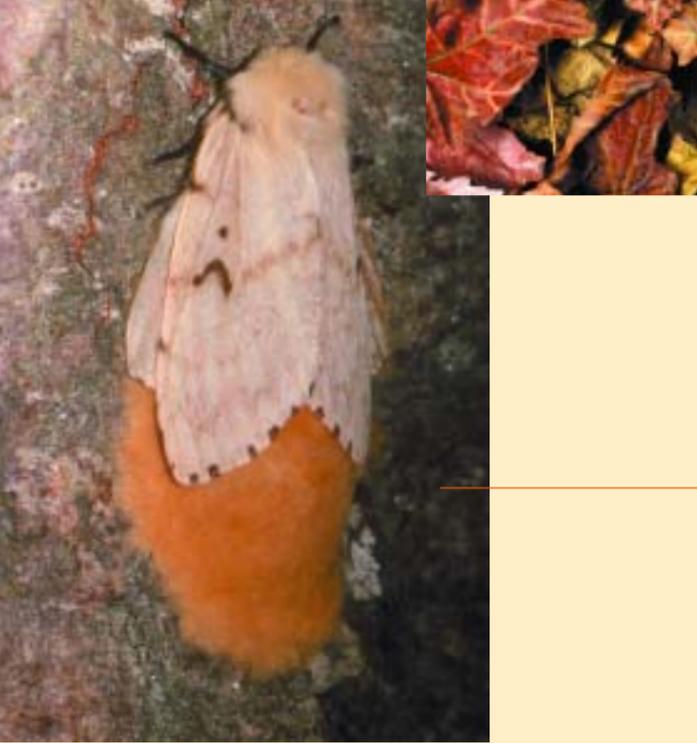
Tree species	Natural maximum age (years)	Maturity for harvesting in commercial forests (years)
Common oak (<i>Quercus robur</i>), Chestnut oak (<i>Quercus petraea</i>)	900	160 - 240
Red beech (<i>Fagus sylvatica</i>)	400 - 600	120 - 160
Hornbeam (<i>Carpinus betulus</i>)	160	100
Sycamore (<i>Acer pseudoplatanus</i>)	250 - 270	100
Lime tree (<i>Tilia</i>)	800 - 1,000	80 - 120
Alder (<i>Alnus</i>)	100 - 150	60 - 100
Poplar (<i>Populus</i>)	200 - 400	50 - 80
Elm (<i>Ulmus</i>)	500 - 800	80 - 120
Spruce (<i>Picea</i>)	300 - 400	90 - 120
Fir (<i>Abies</i>)	200 - 400	120 - 140
Pine (<i>Pinus</i>)	300 - 600	100 - 160



Conclusions

1. To serve as roost sites tree holes have to fulfill several basic functions throughout the year, such as providing space for establishing colonies and for social behaviour, protection against weather and predators, stable microclimate.
2. Bats use a large variety of tree roosts.
3. Woodpecker holes are the main tree-hole type for some species. Therefore, woodpecker conservation is bat conservation.
4. Tree-hole supply depends on the woodpecker population density, which itself depends on the age of stands and the proportion of deciduous trees.
5. To describe an "optimal" roost site for bats or even just single species seems almost impossible considering the discrepancies in the available evidence. The following criteria at least encourage colonisation by bats:
 - free of draft
 - no influx of rain water
 - being carved out upwards and downwards from the entrance or completely open at the bottom
 - unhindered flight path towards the hole entrance, which should be 2 m above ground or higher for the fast-flying species, and hidden but not completely covered hole entrance for the species flying slowly in dense vegetation (e.g. Bechstein's, Natterer's and brown long-eared bat).
6. For permanent colonisation a surplus number of holes has to be provided to reduce the risk of sudden loss of suitable quarters.

In order to offer a sufficient number of roost sites to a natural community of bat species, a 120-year-old commercial forest stand has to permanently provide 25 to 30 tree holes per hectare of suitable tree stand. This equals an average density of 7 to 10 roost trees per hectare.



Gipsy moth

Going out for dinner – where and what do bats hunt in forests?

At night there seems to be quiet in the woods! However, many acoustic signals are emitted in the ultrasonic frequency range, which lies beyond the range audible to humans. Only "social communication" calls of bats can be heard by humans, because the low frequencies of such calls are well within the range of human hearing. That is why bat colonies that perform noisy social behaviour are often detectable while walking through a dusky forest. Prey detection by bats, on the other hand, remains inaudible to us without technical equipment.

All of our native bats prey exclusively on arthropods, such as insects, spiders, harvestmen etc. They can consume up to a third of their body weight per night. A noctule or greater mouse-eared bat (weighing about 30 g) feeds on 10 g of insects, a pipistrelle (weighing about 5 g) only on 1.5 to 2 g. In the course of a summer this amounts to a fairly large number of insects. A Daubenton's bat, for example, feeds on about 60,000 midges, a greater mouse-eared bat on 9,000 ground beetles between May and October. A colony of 300 greater mouse-eared bats digests 550 kg insects in one summer, mainly in forests.

The importance of bats in biological pest control becomes evident when considering that this huge amount of biomass also includes forest pests (e.g. green oak tortrix). For example, during one outbreak of green oak tortrixes a colony of 800 greater mouse-eared bats was observed to consume an estimated 55,000 moths every night! For this reason alone, support for bats benefits forest owners and foresters.

All strata and structures in forests are used by bats as foraging areas. Which niche is used by which species is determined by the specific combination of anatomy, wing shape and echolocation behaviour.



This medium-sized bat is characterized by long ears, although they are shorter than those of long-eared bats. In combination with the broad wings, these ears enable the bats to detect and glean sitting prey from leaves and stems by performing slow search and

Bechstein's bat (*Myotis bechsteinii*)

hovering flights. Spiders and harvestmen are also eaten frequently. In summer, Bechstein's bat uses forests more intensely than any other native bat species. Nursery colonies, which rarely consist of more than 20 females, are established in tree holes. Animals of several nursery colonies within a given forest area are closely related and form a social unit. On average, roosts are changed every two days. Single Bechstein's bats have also been found behind bark and in cavities as low as the base of the trunk. The foraging area of a nursery colony of 20 individuals covers at least 250 hectares consisting of multi-storeyed deciduous or mixed forest with a rather thin understorey. Only underground winter shelters are known for Bechstein's bat.



This species is similar in size to Bechstein's bat and the brown long-eared bat. All three species

weigh about 10-12 g. In summer, Natterer's bat lives in tree holes as well as in cavities on and in buildings. Even trees of small diameter may be of interest. Roosts are changed every one to four days. The importance of woods as hunting grounds may vary with the seasons: results of our research project showed that the time spent hunting in forests increased in late summer and autumn.

Natterer's bat (*Myotis nattereri*)

Thus, the energy reserves needed for hibernation are partly acquired in forests. Natterer's bat hunts in all layers between the canopy and the understorey. Some of its prey is gleaned from surfaces. Winter roosts are found in underground cavities.

Potential foraging habitats

Fast hunting flights in **free airspace** are performed above the tree tops or, in certain forest types (e.g. with a hall-like appearance), below the tree crowns. This is the way noctules and Leisler's bats but also barbastelles hunt.



- Hunt in free airspace (above the canopy)
- Hunt in free airspace (in forest gaps, above open space and waters)
- Gleaning (from foliage, trunks, and branches)
- Surface Gleaning (from open forest floor)

The search for prey in **dense vegetation of the lower storeys** demands special adaptations. These adaptations have been evolved particularly by Bechstein's bat, Natterer's bat and the brown long-eared bat, whose main hunting strategy is to glean sitting prey from leaves and trunks.



Ponds in forests and at forest edges increase the insect supply and serve as hunting grounds for all species.

Forest gaps caused by falling trees - e.g. during storms - are suitable foraging habitats for almost all species.



Due to low light intensity in dense beech forests, the **open forest floor** is at best partly covered with scattered leaf litter. These are ideal foraging conditions for the greater mouse-eared bat, which preferably feeds on ground beetles, detecting them by their rustling noise in the leaf litter. **Free airspace** between tree trunks is used by fast-flying species.

Forest paths are occasionally used as links between two foraging areas. Along these paths inner forest edges rich in flowers and therefore of high insect abundance may develop. At the same time they provide **open floor** suitable for hunting ground beetles.

One of the main outcomes of the research project is the importance to bats of a well developed system of **links between the forest and its surrounding cultivated landscape**. Such links are forest edges, hedges, creeks, and their accompanying coppices. Inner and outer forest edges rich in flowers, forest meadows, ponds, small clearings, and gaps in the forest function as guiding structures and sites for food production.





riverine forest

The significance of specific "forest types"

Resting in riverine forests

In former times river valleys were characterized by large riparian forests which were formed mostly by the dynamics of the flowing water. Two conditions essential for bats are fulfilled in riverine forests: numerous roosts and prey in abundance. That is why these woods are particularly interesting to migratory species on their long-distance journeys twice a year. Noctules and Leisler's bats, as well as Nathusius' pipistrelles, may be found in high numbers in forests along large rivers during several weeks of the year. Whether the rivers themselves are important for orientation during migration remains to be investigated in future studies. Compared to migratory birds very little is known about migratory behaviour and spatial memory in bats.

The remnants of our riparian forests, where still present, should be managed according to the site conditions. Expansion of forest areas along rivers and restoration of the natural water regime are of high priority. For some bat species these forests probably are the most important biotopes in all the regions through which they pass during migration between summer and winter areas.

High up

Montane forests (800 m above sea level and higher), open and rocky areas and mountain pastures are parts of an important complex of biotopes for bats. 19 bat species have been recorded in the montane forest zone, seven of which established nursery colonies. Brown long-eared bats, whiskered bats, and common pipistrelles are found regularly, and northern bats occasionally. The mountain forest plays an important role in providing roost sites as well as for food production. The appropriate forest management should include site-specific and indigenous tree species. Harsh weather conditions cause a fast development of potential roosts behind the bark of dead or dying trees, faster than in most lowland forests.



mountain forest

Conclusions

To improve foraging habitats and food supply for bats in forests it is necessary to develop forests rich in structures, including indigenous tree species typical of the site, while taking into account local and regional site conditions. Management that tolerates natural serial stages, i.e. initial phase, growing phase, optimum phase, and decay phase comes closest to this goal. Areas of succession may develop next to each other or intermeshed, appearing as differently aged forest stands of various phenotypes from forest gaps to old stands. The different developmental phases provide all hunting habitats needed by bats within a small area.

Weighing only 6 to 8 g, *Nathusius' pipistrelle* (together with the common pipistrelle) is one of the smallest bat species. All the more remarkable is its flight performance during the twice-yearly migration, similar to that of the noctule and Leisler's bat.

The animals regularly cover distances of 1,000 km or more, the farthest distance of 1,900 km having been documented between Latvia and southern France.

During migration *Nathusius' pipistrelles* can be found in considerable numbers in riverine forests. These forests play an important role in April/May and August/September as roost sites and feeding grounds, for this as well as for

Nathusius' pipistrelle (*Pipistrellus nathusii*)

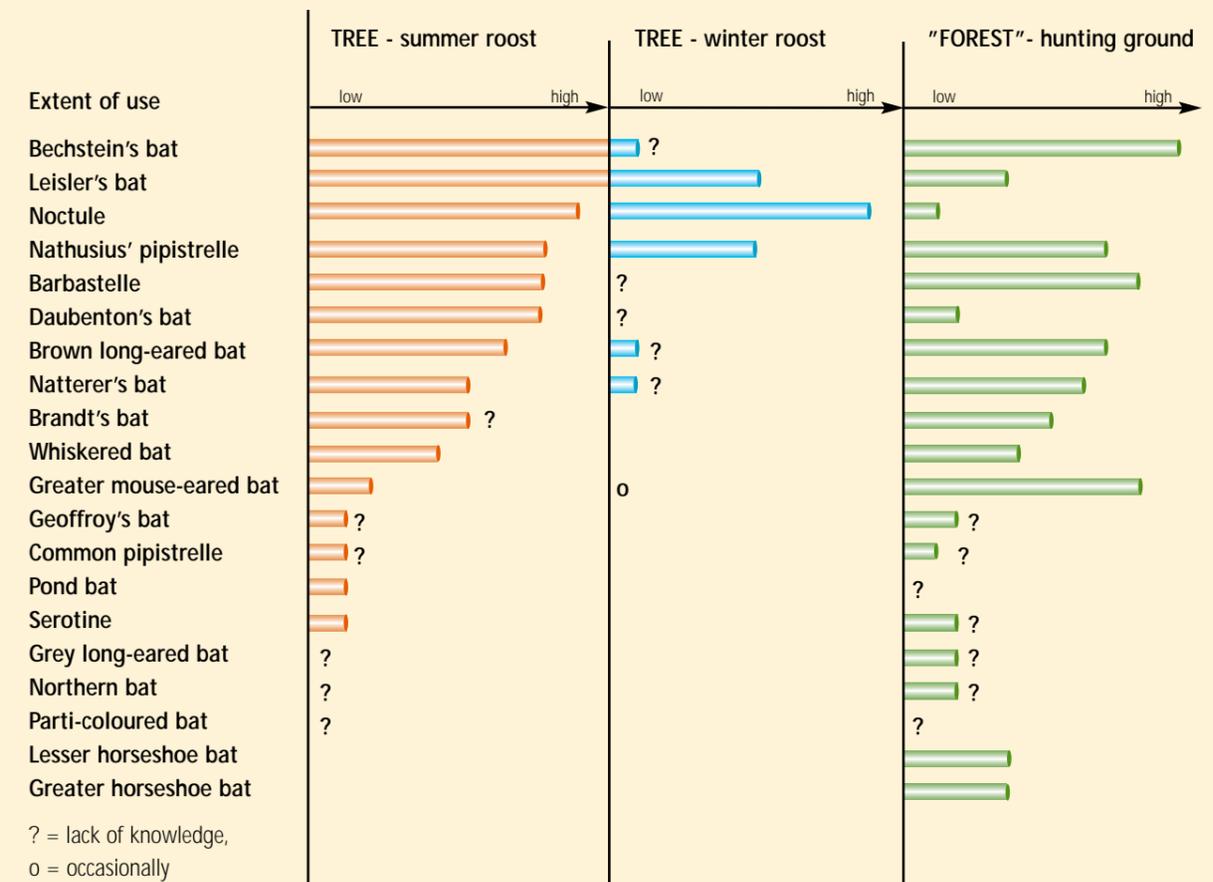
other species. Similarly, the maternity colonies in the northern and

northeastern parts of Germany are located in forests close to water. Tree holes, hollow branches, crevices, cracks in tree trunks, and loose bark are typical roosts. In winter small groups gather together in trees for hibernation.



What is a "forest bat"?

What makes a bat that lives in a forest a "forest bat"? Possible criteria for ranking a bat species as a "forest bat" include the extent to which it uses forests for roosting and for foraging. The following graph outlines such a ranking. In Central Europe, Bechstein's bat is the species most dependent on forest habitats to provide roost sites and foraging grounds in summer. Research results clearly show that not all forests are the same: a well-structured deciduous or mixed deciduous forest seems to meet the demands of this species best. But none of our bats uses the forest exclusively.



What to do?

Recommendations for measures to improve the forest as a biotope for bats

Roosts and food are the essential resources. These two major resources can be improved by taking targeted forestry measures. The following suggestions are not intended to be implemented within the same forest stand, but rather represent a list of all possible actions to be taken depending on the site conditions, the practicability, and the spectrum of bat species.

Aims for bat conservation

- initializing a two-level roost-site network aiming at a permanent and long-term roost supply of 25 to 30 tree holes per hectare of old stand, equalling 7 to 10 roost trees per hectare
- promotion of feeding habitats for species that forage in open air space (e.g. Leisler's bat)
- promotion of hunting habitats for species that feed in dense vegetation (e.g. Bechstein's bat, Natterer's bat, brown long-eared bat)
- support of a canopy with high food production (e.g. for Bechstein's bat, whiskered and Brandt's bat)
- support of canopy gaps as a source for food production for all bat species
- free airspace about 1 m above the ground and open forest floor (important for the greater mouse-eared bat)
- structures and sources of food in general (particularly for Nathusius' pipistrelles, common pipistrelle, whiskered and Brandt's bat, but also for all other species)

Recommendations for forest management

- level 1: securing a network of trees that already show holes due to rotting or made by woodpeckers, cracks in the trunk, or loose bark. Distances between hole hot spots should not exceed 1,000 m
- level 2: developing a network of successors for trees of level 1. If possible, chosen trees should already show signs of holes or ecological qualities like a fungus infestation
- mark and protect known roost trees (summer and winter roosts)
- clearings or clearcuts no larger than 0.5 - 1 ha through natural processes or measures of restocking
- harvesting trees in clusters
- establishing ponds (200 m² minimum)
- increase of the substratum and intermediate layer up to 20 - 30 % coverage
- partial thinning of the canopy to increase light intensity and thus promote undergrowth (density of canopy about 80 %)
- toleration of succession areas
- introducing deciduous tree species suitable for the site, e.g. oak, beech, hornbeam (species with high insect abundance)
- no harvesting of old trees (especially oak) and enhancement of the amount of light incident on such trees and their surroundings to increase insect abundance
- creation of areas free of undergrowth by promoting one-layered "hall-like" stands
- development of dense canopy to decrease light intensity, by promotion of medium-sized trunks (40 - 50 cm diameter at breast height), by increasing the age of trees (targeted thinning) which in turn increases space between trees
- "designing" inner forest margins along waysides, e.g. by promoting tall perennial herbs
- development of outer margins of forests (minimum 30 m in depth) by "natural development" as links between forest and open cultivated landscape, continued by hedges, tree lines, ditches etc.
- establishing ponds (100 - 200 m² minimum) and forest meadows
- re-establishing wet forest parts by closing drainages and/or diverting waters; restoration of riparian forests and old river beds
- no use of pesticides, especially insecticides in case of pest infestation, but reliance on preventive steps

Bechstein's bat (*Myotis bechsteini*)



Being a small bat of only 5 to 7 grams, Brandt's bat is highly mobile. When considering the needs of this bat, the importance of links between forests and the surrounding landscape becomes clear. Females of a tree-dwelling nursery colony regularly flew up to 11 km along hedges and ditches to their foraging areas. They hunted to a great extent inside their roost forest, mainly before the young were born. As in the case of Natterer's bat, the seasonal use of the forest as a hunting ground is striking. Crevice-like tree holes and cracks in tree trunks are the most important natural roosts. In winter Brandt's bats are mainly found in underground shelters.

Brandt's bat (*Myotis brandtii*)

Step by Step

With this information we have tried to outline the habitat requirements of bats in forests and to derive recommendations for forest management intended to assist bat conservation as well as the conservation of many other animal species. Be it not harvesting a single tree or be it developing forest margins - every small step is a step in the right direction.

We want to emphasize that we specifically addressed commercial forests intended for the production of the renewable raw material timber for human demand. They cover 96 % of the woodland in Germany. Thoughts about the establishment of nature reserves are presented elsewhere.

Literature

- GEBHARD, J. (1997): Fledermäuse. (Bats) Birkhäuser, Basel-Boston-Berlin; 381 pp. (in German)
- MESCHEDE, A. & HELLER, K.-G. (2000): Ökologie und Schutz von Fledermäusen in Wäldern. (Ecology and conservation of bats in forests) Schriftenreihe für Landschaftspflege und Naturschutz Vol. 66, Landwirtschaftsverlag, Münster; 374 pp. (in German)
- RICHARZ, K. & LIMMBRUNNER, A. (1999): Fledermäuse. Fliegende Kobolde der Nacht. (Bats. Flying goblins of the night) 2nd ed., Franck-Kosmos, Stuttgart; 192 pp. (in German)
- SCHERZINGER, W. (1996): Naturschutz im Wald. Qualitätsziele einer dynamischen Waldentwicklung. (Nature conservation in forests. Goals of dynamic forest development) Eugen Ulmer, Stuttgart; 447 pp. (in German)
- SCHÖBER, W. & GRIMMBERGER, E. (1997): The Bats of Europe and North America: Knowing Them, Identifying Them, Protecting Them (W. Charlton translator). TFH Publications; 160 pp.



Addresses

Please report findings of marked bats, for example in nest boxes, to the banding centers:

Bands showing "Mus. Bonn":

Dr. Hubert Roer/Dr. Rainer Hutterer,
Zoologisches Forschungsinstitut
und Museum Alexander König,
Adenauerallee 160, D-53113 Bonn,
Tel. ++49-(0)228/9122-285 (Dr. Roer),
Tel. ++49-(0)228/9122-261 (Dr. Hutterer),
Fax ++49-(0)228/216979.

Bands showing "ILN Dresden", "SMU Dresden" or "FMZ Dresden":

Dr. Ulrich Zöphel,
Sächsisches Landesamt für Umwelt und Geologie,
Zur Wetterwarte 11, D-01109 Dresden,
Tel. ++49-(0)351/8928-318,
Fax ++49-(0)351/8928-202.

Contacting local bat experts:

- via the Agencies for Nature Conservation of the federal states / "Länder"
- via the Nature Conservation Authorities of districts and counties
- via the editors of this booklet, the Federal Agency for Nature Conservation and the German Association for Landcare.

The Federal Agency for Nature Conservation

The Federal Agency for Nature Conservation is the main scientific federal authority for national and international nature conservation and landscape management.

The Federal Agency for Nature Conservation

- advises the federal administration on nature conservation and landscape management issues
- supports major nature conservation projects in the federal states / "Länder" and pilot projects for nature conservation (test and development projects)
- approves the import and export of protected plant and animal species
- does independent research work and funds research and development projects
- informs about nature conservation.

The Federal Agency for Nature Conservation has its seat in Bonn and operates branches at Leipzig and on the island of Vilm near Rügen.

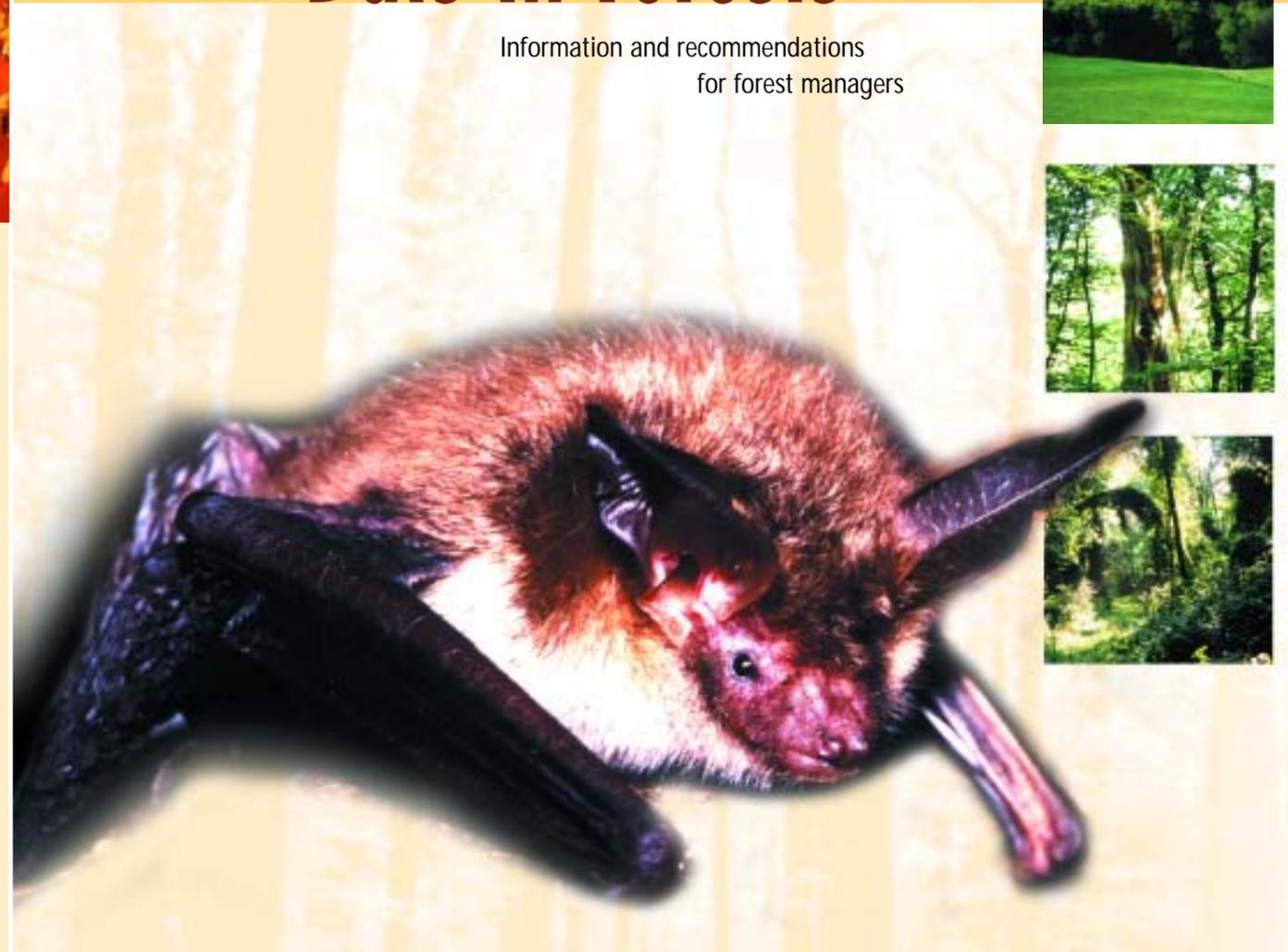
Federal Agency for Nature Conservation
Konstantinstr. 110
D-53179 Bonn
Tel. ++49-(0)228/8491-0
Fax ++49-(0)228/8491-200
email: pbox-presse@bfm.de
internet: www.bfn.de

Natterer's bat (Myotis nattereri)



Bats in Forests

Information and recommendations
for forest managers



"Landschaft als Lebensraum" vol. 4

