Distribution, abundance and conservation of *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus* in Europe

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Bandit and Soprano Pipistrelle Bats in Europe

Abstract

Pipistrelles are widely spread throughout Europe and are the smallest of European bats. They are protected by law throughout Europe but much research still needs to be done since much of the research is outdated due to the recent recognition of the separate species of *Pipistrellus pipistrellus* and *Pipistrellus pygmaeus*. Total population sizes are unknown, although factors affecting their abundance are fairly widely studied and include habitat loss, roost disturbance and pollution. Methods for managing bat populations involve improving hunting flight paths as well as protecting shoreline trees and roosts (in particular maternity roosts).

Introduction

Pipistrellus pipistrellus, which used to be known as the Common pipistrelle but which has more recently come to be known as the Bandit pipistrelle due to the dark band of fur across its eyes, and *Pipistrellus pygmaeus*, the Soprano pipistrelle, are the smallest of the European bats at between 3.5 and 4.5cm in length with a wingspan of up to 25cm and weighing between 3 and 8 grams (BBC, 2006). Much of the information for these two species is intermingled since they were only formally recognised as different species in 1999 (Haddow, undated), hence the need to, for the moment at least, discuss the two together. Much of their behaviour and distribution can also be applied to all European bat species, making them important keystone species in bat conservation (Haddow, undated). Their maximum age is cited as 16 years (BCT, 2005; BBC, 2006), although on average they tend to only live for around 4 years (MacDonald & Barrett, 1993). They are distributed over most of Europe, occupying a wide variety of different habitats and feeding on a variety of different insects.

The main and most obvious difference between the two species is the difference in the frequency at which they echolocate. Until 1993 it was thought that *P. pipistrellus* had two types of calls that it used under different circumstances. However Jones and van Parijs (1993) determined that the bats actually never changed the frequency of their calls and that roosts never contained both types of pipistrelle. The two frequencies that *P. pipistrellus* and *P. pygmaeus* call at are 45kHz and 55kHz respectively. The higher intensity call of *P. pygmaeus* lent it its English name of Soprano pipistrelle, whilst the Bandit pipistrelle remained as *P. pipistrellus*.

Males of both species reach sexual maturity after almost a year, females in the autumn around 2-3 months after birth. Males occupy territories all year although they only defend them during the mating season, when females will visit them to mate (University of Bristol, 2005). A male may have a harem of up to 10 females at any one time (BBC, 2006). During the mating season the bats' social calls alter and they smell strongly of musk.

Mating takes place between August and September, and after a gestation period of around 40-50 days (Altringham, 2003) the young are born the following year between June and July, with generally one young being born although on mainland Europe females sometimes give birth to twins (BBC, 2006). All young in a roost are born within a period of two weeks (MacDonald & Barrett, 1993) and take their first flight three weeks after they're

born. After 5 weeks they will have left the nursery roost and no more than a week later they will be fully weaned and foraging independently (See Fig 1).

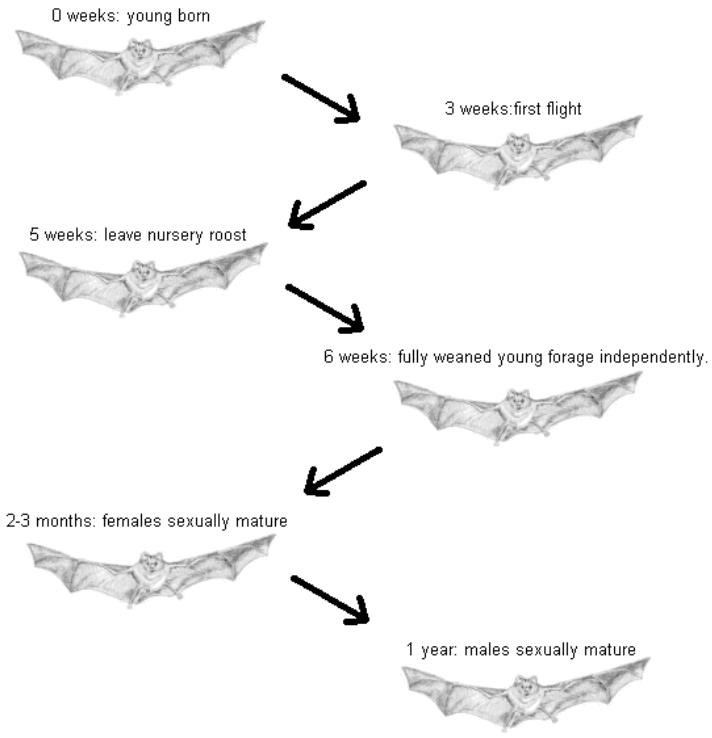

Fig 1: Summary of birth to maturity sequence of *P. pipistrellus* and *P. pygmaeus*

In summer *P. pipistrellus* and *P. pygmaeus* roost in buildings and trees and in winter the same roosts are occupied as well as exposed crevices in walls. When roosting in houses they are more likely to be found in houses that are linked to feeding grounds by tall trees (Altringham, 2003). Individuals may use as many as 20 roosts in a year, often changing roosts every few days (Forestry Commission, 2005). They are mainly found in bat boxes in the summer, and only leave the boxes when temperatures rise above 40ºC (Lourenço & Palmeirim, 2004). They've also proven to be relatively insensitive to cold, with relatively few hibernation hours over winter, as they will forage whenever the temperature is above 8°C (Avery, 1991).

. *Pipistrellus* species are found in the largest groups during the breeding season when maternal colonies are formed. At other times during the winter they roost in small numbers in mixed-sex colonies (Haddow, undated; University of Bristol, 2005). Colonies of up to 100,000 individuals have been found in caves in Romania but this is unusual especially since both species of *Pipistrellus* prefer to roost in buildings that are less than 30 years old (Cornforth, 2002; BCT, 2005). *P. pygmaeus* roosts in much larger colonies than *P. pipistrellus*, with *P. pygmaeus* colonies averaging 288 (BCT, 2005) and typically ranging between 200 and 500 although colonies as large as 1000 individuals have been found (Haddow, undated), and *P. pipistrellus* colonies averaging 66 (BCT, 2005). However there seems to be dispute over colony sizes. The University of Bristol (2005) states that *P. pygmaeus* colonies range between 20 and 50, not 200 and 500, and the same source also puts *P. pipistrellus* colony sizes at between 20 and 50 individuals, which clearly does not agree with the average size of 66 as quoted by the BCT (2005). Speakman *et* al (1995) puts maternal colony sizes at between 10 and 1500 individuals and references Avery (1991) as an example, although this was written before the two species were formally recognised as separate and so includes both *P. pipistrellus* and *P. pygmaeus* colonies.

Pipistrellus are nocturnal insectivores, leaving the roosts an average of 20 minutes after sunset (MacDonald & Barrett, 1993, University of Bristol, 2005), and feeding over waterbodies and their banks, marshes, meadows, hedgerows, open woodland, wood edges, farmland, gardens and around street lights (Haddow, undated; MacDonald & Barrett, 1993; BCT, 2005;). *P. pygmaeus* has been found to favour riparian habitat (thin strips of vegetation bordering a stream/river) whereas *P. pipistrellus* is more of a generalist, hunting wherever it can find sufficient prey and shelter (Vaughan *et al*, 1997). Emergence from the roosts is in short, sudden bursts and has been suggested to be a method for confusing predators (Speakman *et al*, 1995; Altringham, 2003). They can travel as far as 5km from the roost to feed (Avery, 1999), and between May and June the bats will return to the roost some time between midnight and dawn (MacDonald & Barrett, 1993), although it may be earlier than this on cold nights and foraging period varies according to weather conditions (University of Bristol, 2005). From June to August when the maternal colonies form, females with young will emerge for two short periods during the night: the first time just after dark and the second just before dawn (Swift *et al*, 1985; MacDonald & Barrett, 1993), travelling between 1 and 2 km from the roost each time (MacDonald & Barrett, 1993). There is intermittent activity throughout the night with females and juveniles returning to and leaving the roost at different times (MacDonald & Barrett, 1993; University of Bristol, 2005). The return of bats to the roost is obvious from the 'dawn swarming' that occurs, where all of the bats returning to the roost swarm around the entrance for a short period before they go inside to roost for the day.

Vaughan *et al* (1997) and Barlow (1997) both found that the diet of both species of pipistrelles was very similar, hunting mainly Diptera, although Vaughan found that both *P. pipistrellus* and *P. pygmaeus* favoured Chironomidae whereas Barlow found that although *P. pygmaeus* favoured Chironomidae, *P. pipistrellus* favoured Psychodidae, Anisopodidae and Muscidae. An explanation for these differing opinions may be that Vaughan *et al* were not yet taking into account the two differing species and the greater numbers of *P. pygmaeus* meant that the species were considered to prefer Chironomidae.

Both species catch and consume prey in flight, although there appear to be differing views on the height above ground at which both species fly and hunt: the Bat Conservation Trust (BCT) states that they fly at slightly above head height (BCT, 2005) whereas Russ (1999) indicates that they usually fly between 5 and 10 metres above the ground. Their flight is agile and seemingly erratic (BCT, 2005; University of Bristol, 2005).

Factors affecting abundance and distribution

Fig 2: Image reproduced from Waller, J. and Waller, J. (2003) Available from: **www.jwaller.co.uk/batgroup/pipistrelle.asp [Accessed 29th Jan 2006]**

Both species occur across most of Europe, with *P. pygmaeus*'s range extending further north than *P. pipistrellus* and is also more common further south in the Mediterranean, and both species ranges are limited in northern Scandinavia due to climatic conditions (Meyer & von Helverson, 2001) (See Fig 2).

Due to the recent classification of *P. pipistrellus* and *P. pygmaeus* as different species it is difficult to make any clear assumptions about population sizes. The last comprehensive bat count numbered the total British pipistrelle population at around 2 million individuals (Harris, 1995) but this was before they were recognised as two species. Despite their as yet unthreatened status their numbers are thought to have declined by as much as 70% in the years between 1978 and 1993 (Harris, 1995).

Bats are generally feared by people due to their low, erratic flight paths and their habit of hunting around street lamps and outdoor lighting. Their preference for establishing maternity roosts in houses also leaves them vulnerable, especially since their social calls are audible to humans and their smell can be found offensive.

Bats are threatened by several factors:

Habitat loss. Bat flight paths are well established, and hunting bats will often follow the same flight path every night (University of Bristol, 2005). These flight paths tend to follow obvious features such as hedgerows, wood edges and rivers in order to travel between roost and feeding ground. Habitat loss and fragmentation due to factors such as agricultural intensification disrupts these flight paths (Russ & Montgomery, 2002), leaving the bats vulnerable to attack by predators as well as limiting the amount of feeding grounds that they can reach.

Insecticide use. Since pipistrelles are insectivorous the decline of insect populations through the use of insecticides is a major factor. Pipistrelles can consume as many as 3,000 midges in one night (MacDonald & Barrett, 1993; BCT, 2005), so a decline could badly affect localised populations. The build up of pesticides in the food chain following sometimes excessive application to the land is likely to affect bat population vitality through a cumulative effect from hunting insects (Haddow, undated).

Pollution. Water body pollution can cause a decline in insect populations, which will lead to a decline in pipistrelle populations. Studies of bat populations both upstream and downstream of sewage outlets in a river showed that *P. pipistrellus* activity declined by 55% and *P. pygmaeus* activity declined by 51% downstream of the sewage outlets. It should be noted, however, that the decline in pipistrelles is not necessarily representative of all species (Vaughan *et al*, 1996). Industrialised areas can have lower pipistrelle populations than rural areas due to a decline in prey availability as well as a decrease in water quality (Gerell & Gerell Lunderg, 1993).

Roost disturbance. Although pipistrelles are small mammals with an average lifespan of only 4 years they follow the same reproductive strategy as larger, longer lived mammals by breeding only once a year and producing never more than two young. Their slow reproductive rate (Barclay *et al*, 2004) means that their population is highly vulnerable to fluctuations. Disturbance of roosts (in particular nursery roosts) can reduce their breeding success rate still further.

Hibernation disturbance. Due to the decline in prey availability during the winter, bats go into torpor. This conserves their fat stores and allows them to survive the winter. Whenever the temperature is warm enough for prey to become available the bats will fly out to hunt and then return to torpor with a drop in temperature. If torpor is disturbed in any way the bats fat stores can be adversely affected, lowering their chance of surviving the winter.

Building work during the winter can often disturb the bats and their delayed reactions due to coming out of torpor can mean that they are unable to get away before their roost is destroyed (Haddow, undated).
Despite their protection by law, people still fear bats. Their status means that building work is often not allowed to be carried out until the roost has been inspected by professionals and as a result it is possible that people simply kill or dislodge the bats without informing the local bat groups.

Methods for conserving bats

Bat boxes. Bat boxes provide convenient, safe roosting sites for pipistrelles. Areas such as wetlands and marshes are ideal for bats since they support large numbers of insects and drinking places, but they don't have many natural roost sites, resulting in them having relatively small populations if at all. Bat boxes in these areas can help to increase local wetland bat populations, especially regarding maternity roosts, as (Flaquer *et al*, 2006) found when they studied the effects of bat boxes on wetland populations of *P. pygmaeus* in North East Spain.
In Southern Europe pipistrelles are often evicted from roosts in houses, leaving problems in finding other suitable roosts. Studies of bat boxes determined that *P. pygmaeus* has a high heat tolerance and so even in the Mediterranean black bat boxes were preferred, with large numbers of individuals colonising the boxes. Black bat boxes were better at emulating the temperature of house roosts (Lourenço & Palmeirim, 2004).
Habitat management. Agricultural intensification around Europe means a reduction in the number of suitable habitats for bats. Loss of riverbank trees and other vegetation through overgrazing or deliberate felling causes breaks in pipistrelle flight paths, leading to greater vulnerability to predators. Methods for improving bat habitats include improving riverline vegetation to allow for bat flight paths (Russ & Montgomery, 2002).
Current EU legislation to improve water quality in Europe will aid in the increase of insect numbers and diversity around rivers, leading to an increase in bat populations.
Anyone undertaking work that may adversely affect bat roosts, whether in woodland management or building works, must be able to demonstrate that there was no deliberate intention to damage roosts and that all possible precautions were taken. In woodland management this means that the manager(s) should have mapped out areas where roosts are and left connections between the roosts and possible feeding grounds (Forestry Commission, 2005). The Forestry Commission also recommends that trees lining waterways be left as natural reserve trees, as well as a connecting line of trees from roost areas to outside areas such as hedgerows and marshes etc. An example map is shown below (Fig 3.).

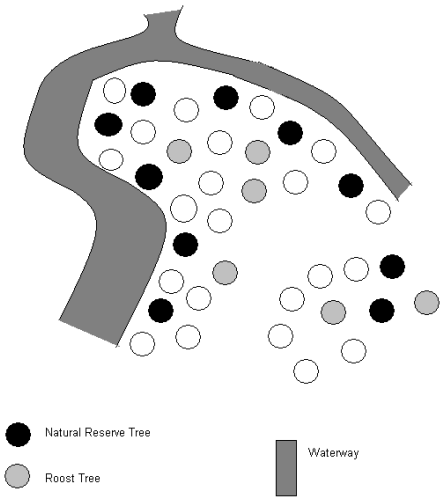

Fig 3: Image drawn by E. Strong with reference to images produced by Forestry Commission (2005).

Conclusion

Bats and the law. In Europe (excluding some of the Channel Islands) both species of pipistrelle are protected under the Convention On The Conservation Of European Wildlife and Natural Habitats (Bern, 1979), the Convention of Conservation of Migratory Species of Wild Animals (Bonn, 1980), the Agreement On The Conservation of Bats In Europe (London, 1991), and the Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (EC, 1992). The UK also protects them under the Wildlife and Countryside Act 1981, the Conservation (Natural Habitats) Regulations 1994, the Countryside and Rights of Way Act 2000, Planning Policy Guidance: Nature Conservation 1994, and the Nature Conservation (Scotland) Act 2004 (Haddow, undated; Cornforth, 2002; BCT, 2005). These laws prevent the deliberate disturbance, injury, capture or killing of bats and the deliberate damage or destruction of roost accesses (Moore *et al*, 2003).

An increase in populations of pipistrelle bats is something that should be aimed towards, and not just because the law dictates that it should be so. However it has been suggested that a large increase in the pipistrelle population can affect populations of other bat species such as the Horseshoe bat (Arlettaz *et al*, 2000).

It is rare that an area is purely managed to increase the local bat population, and as seen in the above paragraph an increase in one species may lead to a decrease in another. However, habitats are often managed to increase diversity and an increase in insect life often leads to an increase in many other species such as birds and their predators. A healthy pipistrelle population is therefore desirable since it is indicative of a healthy insect population, however this can often mean a clash of interests between the bats and other land uses. Building works can be halted due to roosting bats, and woodland managers are obligated to survey their entire wood for possible bat roosts. There are methods for preventing the return of bats to buildings, for example certain setting foams can be used to block the entrances to roosts, but they can only be used having consulted organisations such as English Nature (Moore *et al*, 2003). Setting up bat boxes in the surrounding trees can help to move roosts away from the house but it is rare for roosts to badly affect the humans they co inhabit with and indeed roosts can often go undetected by the homeowners.

In summary it is possible to conserve bats without causing too much disruption or additional cost to the actual land use. Current water directives state that riverside vegetation should be conserved as it will help to improve the water quality as well as prevent river bank erosion. Since the natural reserve trees recommended by the forestry commission are almost all by river banks this means that two objectives are achieved in one. Bats do not cause excessive damage to houses, and pipistrelles have not been found to carry rabies unlike other bat species so there is no danger to humans or pets. Although many things can disrupt bat populations the above paper documents a few simple ways of protecting them that do not add excessive cost to proceedings.

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