NIETOPERZE II, 2(2001)
PL ISSN 1640-2677

Assessing the European distribution of the pond bat (*Myotis dasycneme*) using bat detectors and other survey methods

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Abstract: The occurrence and distribution of the pond bat *Myotis dasycneme* in its Eurasian range is not known well enough to effectively protect the species. Different survey methods and their effectiveness to reveal the species occurrence are discussed. Characteristics enabling identification and assessment of the pond bat with the help of bat detectors are described. An approach to assessment of the pond bat's occurrence and distribution on a European scale is proposed.
Key words: European assessment, survey methods, bat detector, pond bat, *Myotis dasycneme*, flight style, flight image, sound characteristics

INTRODUCTION

The pond bat *Myotis dasycneme* is recorded from the eastern seaboard of the North Sea to the River Yenisey in Russia and from about 60°N to a southern limit varying between *c.* 50°N and *c.* 44°N. It has been considered one of Europe's rarer and more threatened species and is included in The 1996 IUCN Red List of Threatened Animals. The species is included in Appendix II of the Bern Convention on the Conservation of European Wildlife and Natural Habitats, Appendix II of the Bonn Convention on the Conservation of Migratory Species of Wild Animals (and its Agreement on the Conservation of Bats in Europe) and Annex II and Annex IV of the EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora. It has some protection through national legislation in most range states. Lack of information on its ecological needs, occurrence and population trends, however, prevents this status to be transformed into effective conservation. This have been reasons for the Council of Europe to ask for the production of an European Action Plan for the Conservation of the pond bat *M. dasycneme* in Europe (Limpens *et al.*, 2000).

The distribution map in the recent Atlas of European Mammals (Mitchell-Jones *et al.*, 1999), as well as the assessment of its occurrence and distribution in the Action Plan demonstrate that in large parts of its range no detailed information on the species occurrence and distribution is available (Fig. 1). Effective implementation of conservation measures, however, asks for its occurrence and distribution to be known. The Action Plan therefore recommends active survey work directed on the pond bat to be organised by the national bat groups, and to be supported financially and logistically by their respective governments. Positive signs such as detailed improvement of the knowledge on the distribution of the species in national or regional survey projects (Limpens *et al.*, 1997; Kapteyn, 1995), locating maternity roosts in areas where the species was not known to occur (*e.g.* Schikore & Zimmermann, 2000), or recording the species quite easily in new areas within its range by applying bat detectors (Fig 1; Limpens, 2000) demonstrate the feasibility of this goal.

Fig. 1. Tentative distribution of the pond bat (*Myotis dasycneme*) in Europe. Dots: grid cells with occurrence of pond bat in The Atlas of European Mammals (after Mitchell-Jones *et al.* 1999), Line and dotted line: Distribution of the pond bat as assessed in the Revised Action Plan on the Conservation of the pond bat (*Myotis dasycneme)* in Europe (after Limpens *et al.* 2000). Double circles sites where the Pond bat was observed in or as a result to recent bat detector workshops (Limpens, 2000)

In order to stimulate effective assessment of the occurrence and distribution of the Pond bat *M. dasycneme* within its Eurasian range this paper addresses the following questions: Which methods are practical and effective when used to survey the pond bat? What characteristics can be used to identify and survey the pond bat with the help of a bat detector? How could survey work, on a regional, national and European scale, be organised effectively?

SYSTEMATIC ASSESSMENT

Distribution is generally studied and presented as presence or absence of species in a grid cell system, possibly with higher level of information on their landscape use (presence/absence of species, of unspecified roosts, of maternity roosts, mating roosts, hibernation roost, hunting habitat, flight path). A systematic survey or assessment of the occurrence and distribution of bats needs all grid cells to be studied (Limpens & Roschen, 1996). In assessing distribution of bats currently a number of different survey methods are being used (Tab. 1). To judge their effectiveness we have to consider if, when the particular species is present in the area, a certain method will reveal the occurrence, distribution, and/or landscape use of the species, and how much effort this will cost (Limpens & Roschen, 1996, 2001; Limpens *et al.*, 1997). The scale and goals of the intended survey are important in judging the usefulness of certain methods. Assessing the landscape use of a colony of pond bats on a specific site *e.g.* asks for other methods than trying to establish its distribution on a national or even European scale.

Table 1. Effectiveness of possible survey methods in the assessment of roosts, hunting sites and flight paths of the Pond bat *Myotis dasycneme* (after Limpens *et al.*, 1997; Limpens & Roschen, 2001)

Myotis dasycneme	attics and lofts	buildings	underground sites	tree hollows	bat boxes	netting near potential roosts	netting on flight path or in hunting habitat	bat detector in hunting habitat	bat detector in tracking flight paths & swarming	publicity work	collection of specimen found dead or alive	radio tracking
roosts	■■	■	■■	●	●	✚/■			■■■	■	■	■■
hunting sites							■	■■■				■■
flight paths							■■	■■■	■■■			■■
effort	■■	■■■	■■	■■■	■■■	■■■	■■■	■■	■■	■■	■	■■■

■ = survey incomplete
■■ = survey relatively incomplete
■■■ = survey relatively complete

● = accidental findings
✚ = only indications

■ = relatively little effort
■■ = intermediate
■■■ = relatively much of effort

In the pond bat we are dealing with a species, which in summer is almost exclusively dwelling in buildings, uses flight paths along waterways and vegetation to commute between roost and hunting habitat, and hunts over a wide range of typically open water landscapes. In winter it is known to use a wide range of underground sites for hibernation. We have to consider what methods are available, and how practical and effective they are in revealing the information we need in the case of the pond bat.

EFFECTIVENESS OF AVAILABLE METHODS

The following methods (Table 1) are appropriate for the assessment of occurrence and distribution of the pond bat. Some of the methods are also used for other ecological studies. In this paper they are only addressed with respect to their value as a survey method.

Visual inspection of attics and lofts

Since attics and lofts are being used as roost sites by pond bats, we can use this possibility as an 'search image' for a relatively effective survey of the (maternity) roosts of the species. Of course methods directed on roosts will not reveal flight paths and hunting sites. Because also other roost types are being used, like hollow walls and roof edges *e.g.* which cannot easily be inspected, even a complete inspection of all possible attics and lofts in an area will not reveal all roosts present.

Visual inspection of other buildings

Inspection of other buildings might reveal data, but because we lack a 'search image', and in build up areas there will simply be to much buildings which could be inhabited, this approach in general will not be very effective. However, in areas with only very small villages and high numbers of hunting pond bats in the field inspection of all possible buildings might be feasible.

Visual inspection of underground sites

Since pond bats hibernate in underground sites and the species is not particularly hiding away in crevices, visual inspection of hibernation sites is relatively effective for finding hibernation sites.

In rare cases, however, *e.g.* when construction work on buildings is being done in winter, we learn about pond bats hibernating *e.g.* under roof tiles. Therefore we know that even inspection of all possible underground sites which are large enough to be inspected by us, will not reveal all pond bat hibernation sites.

Visual inspection of tree hollows or bat boxes (and bird boxes)

Visual inspection of tree hollows or bat boxes (and bird boxes) is method applied in the study bat communities. In rare cases pond bats are being observed in such situation. This will not be an effective method in the assessment of the pond bat.

However, although the mating system of the pond bat is very poorly known, there are some data available on mating groups in bat boxes. Bat box schemes in forests along their expected migratory routes might reveal information on their mating system and on the routes they use in migration.

Netting near potential roosts

Netting near potential roosts is relatively ineffective, and only useful when there already are indications of a roost being used by bats and visual inspection is not possible. Unless bats are seen emerging from the roost it will not provide definite information on where the bats are roosting.

Netting on flight paths

Netting on potential flight paths without previous indications of the presence of the species is rather ineffective. The approach can be successful when pond bats were observed in their hunting habitat, and clear connections (a canal, a smaller stream or hedge row from village to river or lake *e.g.*) between the hunting habitat and the build up area where the roost may be expected, as well as narrow passages (*e.g.* under a bridge) where a net could be positioned are available. The method is rather time consuming.

Netting in hunting habitat

Although occasionally pond bats are caught in nets over water, netting in potential hunting habitat, and even in habitat where the species was observed *e.g.* with a detector, is relatively difficult and therefore ineffective as an survey method. Its typical hunting habitat tends to be large and very open and the bats will have a lot of opportunity to avoid the nets. Additionally it is very difficult and time consuming to 'sample' large areas or many sample points with nets. While netting in the middle of larger water bodies is hardly feasible, sample points tend to concentrate on the water banks. With this survey method directed at the hunting habitat of course no roosts can be found.

Bat detector in hunting habitat

The relatively loud and specific echolocation sound used when hunting over water provides a high likelihood of detection and identification and hence good potential for survey work with a bat detector. In a relatively fast low effort mode, large areas or many sample points along, and with boats also on the open water habitat can be 'sampled' effectively and a survey can be relatively complete.

Bat detector in tracking back flight paths and locating swarming bats

Using a bat detector to identify and track back flight paths is effective, especially when clear connections (a canal or hedge row from village to river or lake *e.g.*) between the hunting habitat and the build up area are present in the landscape. Systematic mapping of the commuting routes is relatively easy. Again the method allows the observer to sample many potential flight paths with relatively low effort. When pond bats are observed on their flight path it is relatively easy to follow the bats in the direction of their roost. The detector facilitates searching for bats swarming near their roost in the morning twilight period (Limpens, 1993). Trying to locate roosts via tracking of flight paths gives us opportunities to easily find roosts in buildings *e.g.* in hollow walls, at the roof edge, under roof tiles etc. where visual inspection inside the roost is not possible. In this way the survey can be more complete than when only (potential) roost visits are used to survey the roosts.

In areas where the species was observed hunting and villages are rather small, it need not be necessary to track back the flight path. In such cases just trying to locate swarming bats in the early morning may give good chances in finding roosts.

Publicity work

Through media the general public can be stimulated to report roosts or bats found grounded. Although many roosts of *e.g.* pipistrelle bats *Pipistrellus pipistrellus* may be reported, in our experience pond bats roosts in houses are hardly noticed nor reported by the public (Kapteyn, 1995; Limpens *et al.*, 1997). Non the less, requests for information via the media might be useful in situations where high densities of hunting bats, and maybe even flight paths directed to a certain village were observed.

Collection of specimen

Collection of specimen in musea, and the culture of sending dead found animals to musea can reveal data on the distribution of (pond) bats. This culture should be kept alive, but because its a random process will never be an effective method to study distribution.

Radio-telemetry

Radio-telemetry or radio tracking on it self cannot be seen as a method for large scale survey work to be applied by larger group of (volunteer) observers. It is rather time consuming, needs experience, expensive equipment, licences *et cetera*. However, when appropriate sites for netting are available, it is possible to follow radio-tagged bats and find their roost.

In a systematic survey directed at grid cells, we have to consider which methods can be applied, for every grid cell and all the landscapes present in it. We have to ask questions such as: Are underground sites or church attics to inspect present? Are narrow channels leading from lake or river to the village present? Are there practical sites for netting?

Which methods are effective and practical to be applied will then be dependent on the scale of the survey and the level of detail of information we seek. Scaling down from a European to a more regional scale, different questions concerning occurrence and distribution become relevant. On a European scale the occurrence of the species, or the incidence of reproduction in areas from which this is unknown, could be assessed by concentrating work on the most optimal and easy to work in habitats, i.e. by surveying larger open water bodies with the detector and inspecting attics and lofts near such water bodies visually. On a more regional scale the landscape use (occurrence and distribution of hunting sites, flight paths, maternity, hibernation, mating roosts) would need assessment through more intensive survey work using *e.g.* bat detectors, visual inspection of potential roost sites and netting. On any level we optimise our chance of finding the species by applying combination of available methods. The bat detector, which can be applied fast and flexible, should always be one of the approaches.

IDENTIFICATION OF THE POND BAT WITH THE BAT DETECTOR ON THE BASIS OF SOUND AND FLIGHT BEHAVIOUR

Identification of bat species based on sound and flight behaviour always needs training and experience. Echolocation sounds from the pond bat range from relatively soft and short FM pulses in more cluttered environment, to long and loud fm-QCF pulses when hunting above or commuting along larger open water. Especially the latter reveals a specific frequency range allowing discrimination in sound analysis and can be recognised in field as sounds with a distinct and specific tonal quality. Combined with visual characteristics such as size, flight image / morphology in flight, as well as flight style and speed, this provides an excellent basis for positive identification (Ahlén 1981, 1993; Helmer *et al.*, 1987; Limpens, 1994 –1998).

In Tables 2, 3 and 4 features which can been seen and heard in the field allowing the identification of the pond bat *M. dasycneme* (*e.g.* Ahlén, 1990; Britton *et al.*, 1997; Kapteyn, 1993a, 1993b, 1995; Limpens & Roschen, 1995; Limpens, 1994–1998) are described in comparison to the Daubenton's bat *Myotis daubentonii* which is quite similar at least in flight style (*e.g.* Ahlén, 1990; Kalko & Schnitzler, 1989; Kalko,1991; Limpens & Roschen, 1995; Limpens, 1994–1998). The descriptions are relative to other species which are subject of study and teaching in workshops on the identification of bats on their echolocation and flight behaviour (Limpens *et al.*, 1997; Limpens, 1994–1998), but are no subject of discussion in this paper. Flight style and echolocation behaviour of *Myotis capaccinii* is almost identical to *M. daubentonii*.

The visual and audible features of a pond bat hunting above the water can be described in the following comprehensive manner: a large bat – in comparison to the Daubenton's bat – with a white belly and long and narrow wing, flying significantly faster and straighter than Daubenton's bat while skimming the water surface in long loopes, and using a significantly slower and galloping rhythm of longer and louder pulses (Fig. 2). Especially distinctive are the QCF-

Table 2. Flight behaviour of Daubenton's bats and pond bats while hunting or commuting over water

Daubenton's bat	**Pond bat**
flies close to the water surface	flies close to the water surface, somewhat higher when commuting
flies parallel to the water surface, in a 2D plane skimming the surface	flies parallel to the water surface, in a 2D plane skimming the surface
in regular circles	straight flight in regular long loopes
wings parallel to water surface	wings parallel to water surface
relatively fast flight regular non hectic flight	significantly faster flight regular non hectic flight
taking insects from or just above the water surface (thrawling) taking insects from the air (aerial hawking)	taking insects from or just above the water surface (thrawling) taking insects from the air (aerial hawking)
rarely hunting above water bank	occasional fast movement above water bank and vegetation
mostly above smaller open water surface	mostly larger open water surfaces

Table 3. Flight image of Daubenton's bats and pond bats as can be seen while hunting or commuting over water

Daubenton's bat	**Pond bat**
'white' belly	white' belly
middle sized	significantly larger
relatively long and narrow wings	relatively long (and narrow) wings

Table 4. Echolocation behaviour of Daubenton's bats and pond bats while hunting or commuting over water

Daubenton's bat	**Pond bat**
3–7 ms pulse length	5–>15 ms relatively long pulses
steep FM	steep FM to shallow fm–QCF–fm *
dry – (to hunch of tonal quality) tick tick tick = sharp	dry – to loud smacking sounds * tick tick tick – to pjiep pjup pjup *
loud	relatively loud to very loud *
70 kHz ↘ 25 kHz 45–40 kHz	60–50 kHz ↘ 25 kHz 40–35 kHz
middle fast pulse rate variable pulse rate regular acceleration of pulse rate in curves	slower pulse rate galloping rhythm
two stroke rhythm: **tick** tick **tick** tick	

* the pond bat will change from 'relatively short steep and dry FM sounds' to 'longer, shallow fm-QCF-fm sounds with tonal quality' when moving from more closed habitats to more open habitats.

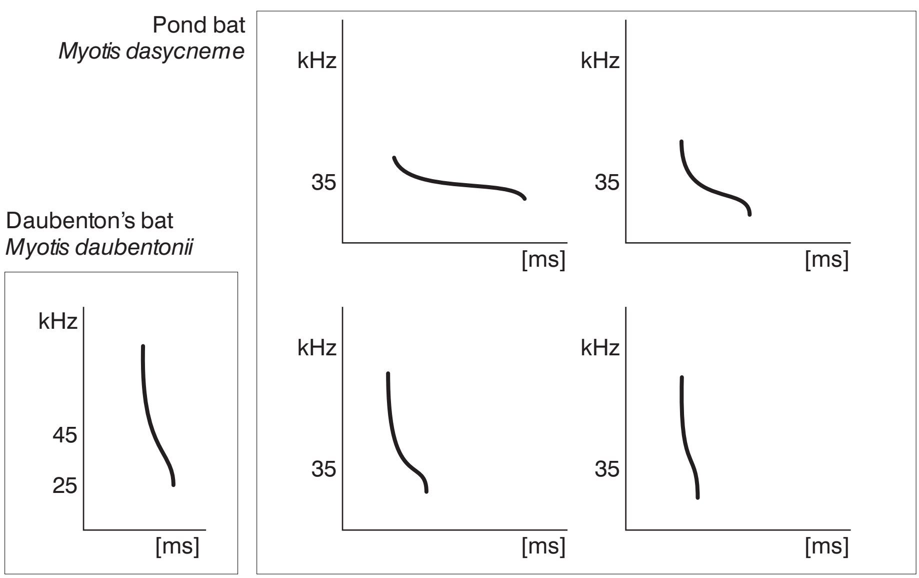

Fig. 2. Schematic sonagrams of the echolocation pulses of the Daubenton's bat and the pond bat

pulses used while hunting or commuting over large open water, revealing tonal quality, a fast and sudden ‘pjiep pjup pjup’ on 35 kHz, where only 2 to 3 pulses are heard because of the great speed at which the bat will pass the observer.

A EUROPEAN APPROACH

As stated above, effective implementation of conservation measures needs the occurrence and distribution to be known. On the European scale, and recognising the limited number of bat workers and equipment available, we have to go about this pragmatically. Assessment of the occurrence of the species and maybe proof of reproduction in regions and landscapes where it would be expected to occur would be the first goals (Fig. 1). Naturally our efforts start in low land landscapes with larger rivers and lakes.

To get to this information we should concentrate on the following programme:

1. the survey of larger open water with a bat detector in lowland, river and lake landscapes
2. the survey of attics and lofts in villages in (lowland) areas with larger open water, and especially there where pond bats were observed under 1.
3. the survey of or ‘checking’ on possible routes between villages and such water with a bat detector, and especially there where pond bats were observed under 1.
4. tracking back flight paths and locating swarming bats, where routes where observed under 3.
5. the survey of attics and lofts, especially in villages where routes where observed under 3.
6. the survey of underground sites in and near the lowland areas with larger open water, and especially there where pond bats were observed under 1.
7. the survey underground sites in elevated areas surrounding the lowland, and especially there where pond bats were observed under 1.

Besides for point 4. the survey or survey programme could set off at any point. I hope that many colleagues throughout the distribution range of the pond bat will take this proposal as a starting point to their assessment of the pond bat.

ACKNOWLEDGEMENTS

The information and insights presented in this paper could not have been developed without exchange of experience and ideas with many colleagues in survey projects and workshops throughout Europe. Reseach project have been made possible by the Netherlands Ministry for Agriculture, Fisheries and Nature Conservation, The German Federal Agency for Nature Conservation, The Dutch Mammal Society, The Netherlands Bat Research Foundation, the Naturschutzbund Deutschland and WWF-Netherlands.

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