Rare or underestimated? – The distribution and abundance of the pond bat (*Myotis dasycneme*) in Poland

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Abstract: The paper summarises the distribution and abundance of the globally vulnerable and nationally endangered pond bat *(Myotis dasycneme)* in Poland and is based on all the available published and unpublished data. The species was recorded in 105 UTM squares, scattered across almost the whole of Poland. In addition fossil remains, mostly from the Holocene age, were found in 13 squares. Evidence of pond bat breeding (nursing) was obtained from 10 UTM squares, restricted to the lakelands of northern Poland and the valleys of the large rivers in the central part of the country. Only two nursery roosts, used respectively by a maximum of 481 and 391 individuals, were found. The remaining summer records (41 UTM squares) were sightings or captures of adult males, non-breeding females or unsexed individuals and were widely dispersed in areas located far from known reproduction sites. The summer roosts (*n*=21) were located mainly in buildings, bridge crevices and bird and bat boxes. Sixty-seven hibernation sites of pond bat were found, mainly in old fortifications, cellars and caves. 63% (*n*=42) of them were used by single individuals and only three held 10 or more individuals (maximum *n*=34). In the two regularly monitored sites the number of pond bats has fluctuated in recent years and in one site it even increased. Most of the available bat data (winter censuses, bird and bat boxes, owl pellets, road casualties, fossil remains, mist netting) shows that pond bats account for less than 1% of the Polish bat assemblages. However this figure reached 2.1 - 2.7% (and in one instance 17.5%) of the total number of bats netted in some regions of the northern lakelands. Many areas that are potentially attractive for breeding populations of pond bat have not yet been surveyed, suggesting that the species in Poland may be much more common and numerous than previously thought.

Keywords: bats, Chiroptera, Vespertilionidae, endangered species, conservation status, riparian habitats.

Introduction

In Europe the distribution range of the pond bat (*Myotis dasycneme* Boie, 1825) extends from southern Sweden, Finland and Russia in the north, to Belgium and France in the west and Croatia, Serbia, Bulgaria and Ukraine in the south (Horáček 1999, Limpens et al. 2000, Benda et al. 2003, Siivonen & Wermundsen 2003). A vagrant individual was recently also found in Great Britain (Hutson 2005). Within this distribution range, reproduction (i.e. nursing) has been observed in the Netherlands, Denmark, northern Germany, Hungary, Latvia, Estonia and Russia (Limpens et al. 2000). The pond bat is a stenotopic species that prefers a lowland landscape with a dense network of patches of still or slow-moving freshwater and uses a specialised hunting tactic (trawling). Its continued survival is a high conservation priority (Horáček & Hanák 1989, Limpens et al. 2000) and it was included in the 1996 IUCN Red List of Threatened Animals and classified as vulnerable (VU) in the Palearctic Region (Hutson et al. 2001). As a result the pond bat is included in Appendix II of the EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora

(92/43/EEC) as a species that demands creation of special areas of conservation (SAC) within the Natura 2000 Network. It is legally protected at the international level through the Bern Convention on the Conservation of European Wildlife and Natural Habitats, the Bonn Convention on the Conservation of Migratory Species of Wild Animals and the Agreement on the Conservation of Populations of European Bats (EUROBATS) and is nationally protected in all European countries. While generally considered as a rare, patchily distributed and seriously threatened species in Western and Central Europe, it is one of the most abundant bat species within its Russian range (Strelkov & Iljin 1990, Bolshakov & Orlov 2000).

In 1986 it was thought that the population of the pond bat was as small as 3,000 in Western Europe and that the world population was about 7,000 individuals (Stebbings & Griffith 1986). More recently the number of pond bats in countries designated as population centres, i.e. Hungary, Latvia, the Netherlands and Russia, has been estimated as between 100-200,000 (Limpens et al. 2000), indicating a substantial earlier underestimation. This discrepancy was largely caused by a lack of surveys on the occurrence and abundance of the pond bat over most of its range (Limpens et al. 2000). In Western Europe, the only available data concerning long-term population changes are from the Netherlands. Population trends based on calculations by Statistics Netherlands (CBS) indicate that the numbers in hibernation sites have more than doubled between 1986 and 2005 (Verboom 2006). A similar increase was also found earlier in Estonia (Piusa Caves; Lutsar et al. 2000) and recent information from other parts of Europe within the range of the pond bat indicate that the numbers are stable or slightly increasing (e.g. Baagøe 2001).

In Poland the pond bat has traditionally been treated as a rare species confined to lowland areas with an abundance of water (Kowalski 1955, Kowalski & Ruprecht 1981). The first comprehensive review of the distribution of Polish mammals listed 33 localities of pond bat (Ruprecht 1983) but made no clear distinction between winter and summer locations. About half of the distribution data were drawn from pond bat remains found in owl pellets. There were no confirmations of the species breeding in Poland in the 20th century even though it was suspected that this occurred in some areas. An earlier claim by Horáček and Hanák (1989), that Krzanowski (1956) provided direct evidence of the reproduction, appears to be a misunderstanding (Ciechanowski et al. 2002). Horáček and Hanák (1989) also speculated that the pond bat avoids large areas of the Polish lakelands (e.g. the Masurian and Pomeranian regions) as it prefers linear water bodies (canals, blind river branches) rather than large lakes. The "Action Plan for the Conservation of the Pond Bat *Myotis dasycneme* in Europe" (Limpens et al. 2000) estimated roughly 1,000 individual pond bats in Poland. The species is classified as an endangered species (EN) in the National Red Data Book (Wołoszyn 2001) but the statement that it had strongly declined in recent years is not supported by any literature or original field data. Recently, localities of pond bat have been identified in almost all regions of Poland (Sachanowicz et al. 2006) although there has been no up-to-date review of the species' distribution and status in the country, which is essential for planning national conservation measures. This review seeks to fill this gap by presenting the current state of knowledge on the distribution, abundance and status of the pond bat in Poland.

Material and methods

In describing the distribution of the pond bat in Poland, we have used all the available data, including both published (81 publications, 262 records) and unpublished reports (39 Polish and foreign bat workers, 88 records). These include both recent and historical information (from the C19th to June 2007). This information was obtained trough a variety of methods: mist netting, surveys of summer and winter roosts, radio-tracking individuals captured in their summer colonies, ultrasound detection and observations of foraging or commuting bats and

Table 1. The total number of localities and UTM squares, where the pond bat has been recorded. [1] Nurseries, captures or findings of lactating females and juveniles in May–August; [2] Swarming sites were included, however all of them appeared to also be hibernacula. March–April and September–October were considered as transitional periods.

Type of record	Number of localities	Number of UTM squares
summer breeding[1]	13	10
summer non-breeding	47	41
winter and transitional quarters[2]	69	39
undetermined period	26	26
owl pellets	13	13
museum specimens	5	5
total	171	105

collecting dead specimens and owl pellets (see Limpens 2001 for review on methods). Here we apply the terms 'breeding' and 'reproduction' as synonyms for nursing, so breeding is only acknowledged if a nursery roost, lactating female or juvenile individual was recorded in a particular site. Three localities where the pond bat was claimed to be present were rejected as doubtful, either because the method used was insufficient to recognise the species (Sitowski 1948) or the author did not provide any details about the place, date and method (Čmak 1968). In addition we separately review fossil records of the species. A complete synopsis of all these records and their references is given in Annexes 1-5. All localities were attributed to the particular UTM coordinates, using Gnomon 3.3 software (Desmodus, Poland). We also analysed the use of particular types of roosts used by pond bats, as well as the percentage of pond bats within available bat samples – netted, counted in roosts, collected as road casualties, extracted from owl pellets and fossil material (only samples where n>100 individuals were included).

Results

General and summer distribution

In total, the pond bat has been recorded as present at 171 sites, located in 105 UTM squares (table 1). These sites were spread across the whole of the country, with no limit of distribution and no clear distribution pattern (figure 1). Concentrations of records (Warsaw area, the Upper Narew and Biebrza Basins) and those regions where any recorded localities are lacking (including some parts of the Northern Lakelands) were associated with different intensity of bat surveys conducted in these areas. However, some distinct distribution patterns can be found when summer and winter records are separately considered. In summer almost all the records were obtained from the low-lying parts of the country, with only three records from localities in the Southern Uplands and one from mountainous areas (the Sudety Mountains) (figure 2). The lack of records from the Carpathians was not due to a low intensity of survey efforts, but rather to the avoidance of higher altitudes by pond bats in summer. We cannot, however, exclude the incidental occurrence of pond bat in the Polish Carpathians outside of its hibernation period, as the species has been discovered in the Slovakian part of the Tatra Mountains and foothills, both at foraging sites and cave entrances (Pjenčák et al. 2003).

Evidence of breeding was found in only ten UTM squares (Annex 1), all concentrated in the lakelands (Masurian, Pomeranian) or large river valleys (Vistula, Warta). Recent breeding records (1990-2005) are restricted to the northern and central parts of the country (figure 2). Two currently active nursery roosts, one

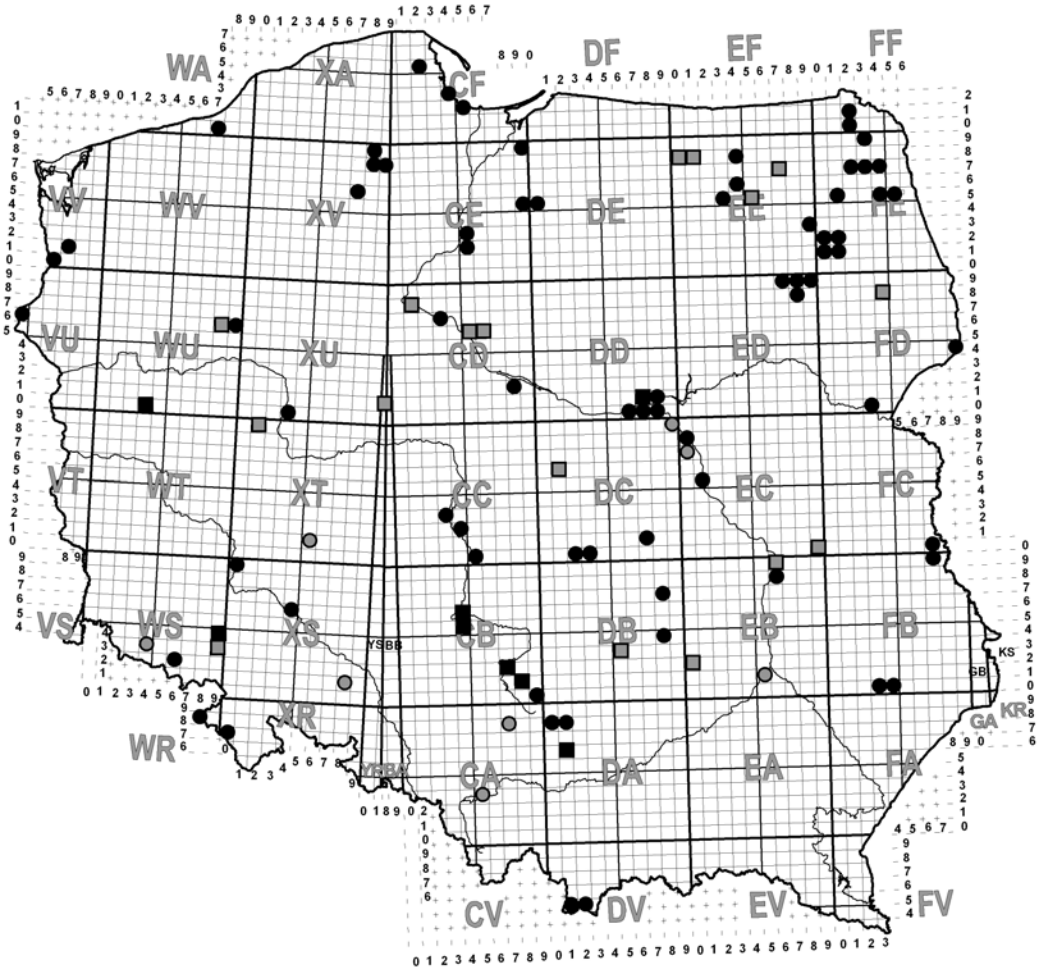

Figure 1. Distribution of the pond bat in Poland. Grey circles – records before 1939, grey squares – records from 1939 to 1983; black circles – new records since publication of Ruprecht (1983); black squares – sites where the presence of pond bat was recorded before 1983 and confirmed later. Complete list of numbered localities and records in Annexes 1-4.

in the wooden church in Jeleniewo (Suwałki Lakeland, UTM FF 20) and the other in an old forester's lodge in Lubnia (Pomeranian Lakeland, UTM XV 88) (Wojciechowski et al. 1999, Ciechanowski et al. 2003a) were used by maximum numbers of 481 and 391 individuals, respectively. Both of these roosts are protected as Natura 2000 sites (PLH 200001 and PLH 220015 respectively). In the 19th century, a third nursery roost was reported in an old church in Trześnia (Sandomierska Forest, southern Poland, Jachno 1868) but no data about its size are available. The remaining breeding records relate to lactating females and juveniles that were mist-netted above rivers (five localities), feeding grounds of radio-tracked lactating females (two localities), a juvenile killed in a road accident (one locality) and a historical record of a female with a juvenile in a tree hole, probably a satellite roost, in Sokolniki near Trześnia. Analysis of the data (figure 2) indicates the presence of at least three other

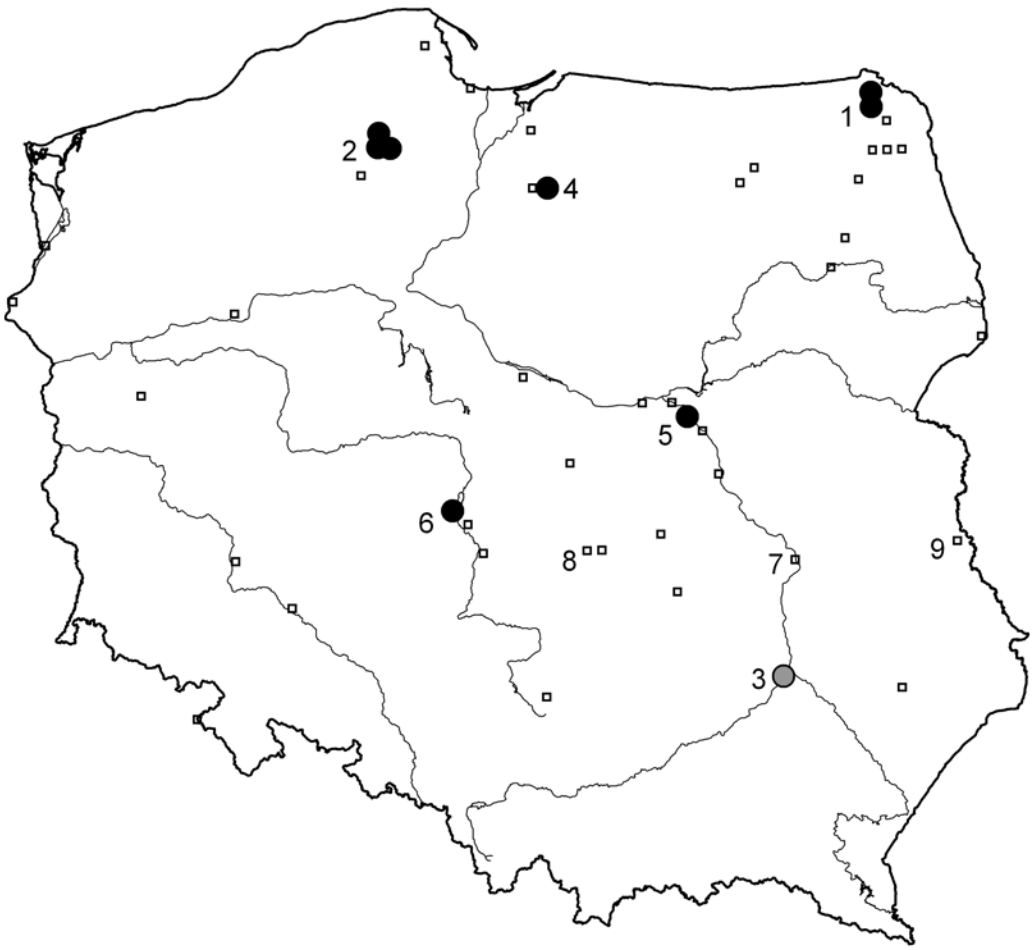

Figure 2. Summer distribution of the pond bat in Poland. Large black circles – breeding sites recorded between 1990 and 2007, large grey circle – historical breeding site from 19th century, small open squares – non-breeding records. Known and suspected nursery colonies: 1 – Jeleniewo, 2 - Lubnia and the environs of Wdzydze Lake, 3 – Trześnia, 4 – Iława Lake Region, 5 – Vistula river valley near Warsaw, 6 – Upper Warta river valley; recorded colonies of males: 7 – Puławy, 8 – Golesze, 9 – Żłobek.

nursery roosts situated in Iława Lake Region, the Vistula river valley (near Warsaw) and the Upper Warta river valley. The largest concentration of breeding records was noted around Wdzydze Lake (Pomeranian Lakeland, UTM XV 88, 89, 98), where, apart from the nursery colony in Lubnia, 14 lactating females and 6 juvenile individuals were netted over the Wda river at four distant localities (Ciechanowski et al. 2006b).

The remaining summer records were mostly of single adult males (both netted and found in roosts) and were widely distributed across the low-lying parts of Poland (figure 2). Non-lactating or non-pregnant adult females were recorded in just four localities. Some individuals found in roosts remained unsexed or the original publications did not provide data about their sex and status. In three instances (Puławy, Golesze, Żłobek), small summer colonies of 9-12 males

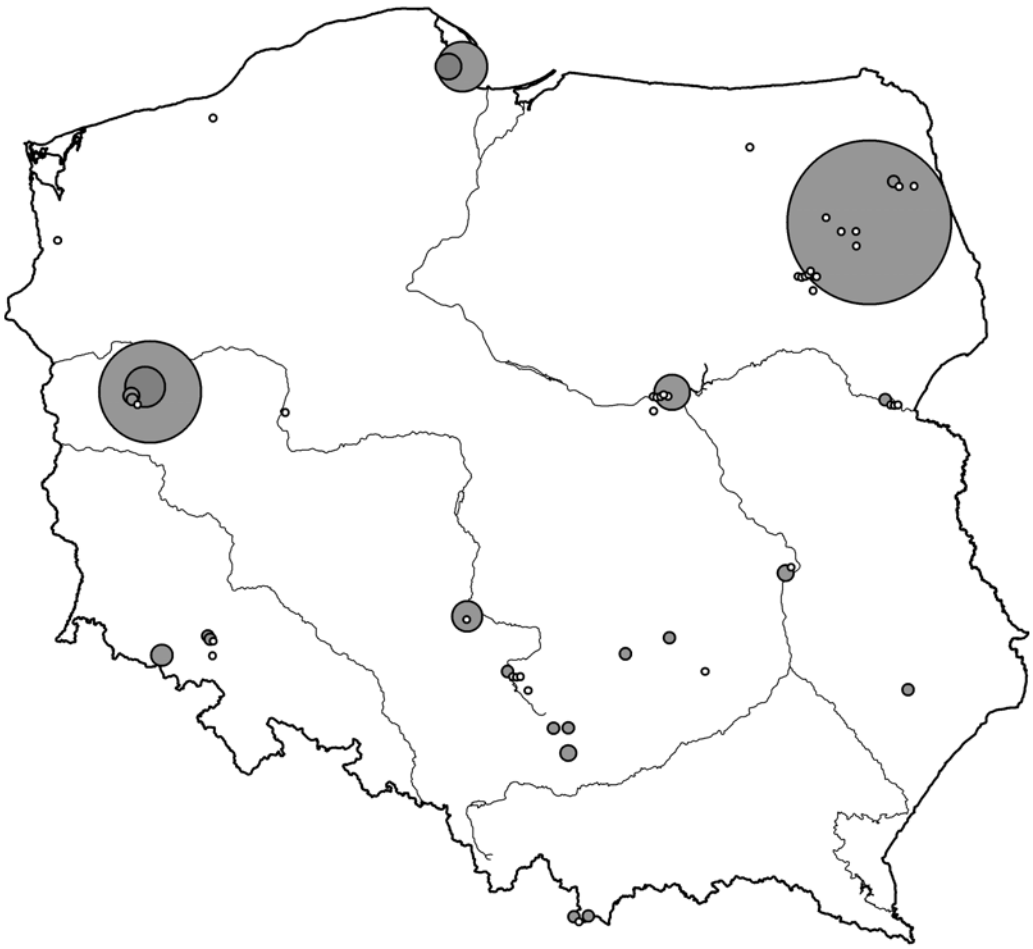

Figure 3. Winter distribution of the pond bat in Poland. Size of circles reflects maximum number of individuals counted during one census.

were found (Annex 2). The distribution of non-breeding individuals seems to be unaffected by the size and density of water systems and they even occur in the dry lowlands and uplands of southern Poland. In ten summer localities the occurrence of pond bat was determined by the use of ultrasound detectors and observations of flying individuals, mostly in the typically-preferred biotope of large water surfaces. Some historical data on foraging individuals over the fish ponds of Lower Silesia (Pax 1925) and the Dunajec River in the Pieniny Mountains (Sitowski 1948) should be regarded as doubtful (e.g. Kowalski 1955) as they were based exclusively on visual observations.

Winter distribution and abundance

Hibernacula, spring and autumn transitional roosts and underground swarming sites associated with these bats are widely, although unevenly, distributed across the country (figure 3). In most winter roosts (n=42, 63%) single individuals were found and only in 13 hibernacula (19%) were two bats counted simultaneously. Larger winter sites are even rarer: occurrence of 3-5 in-

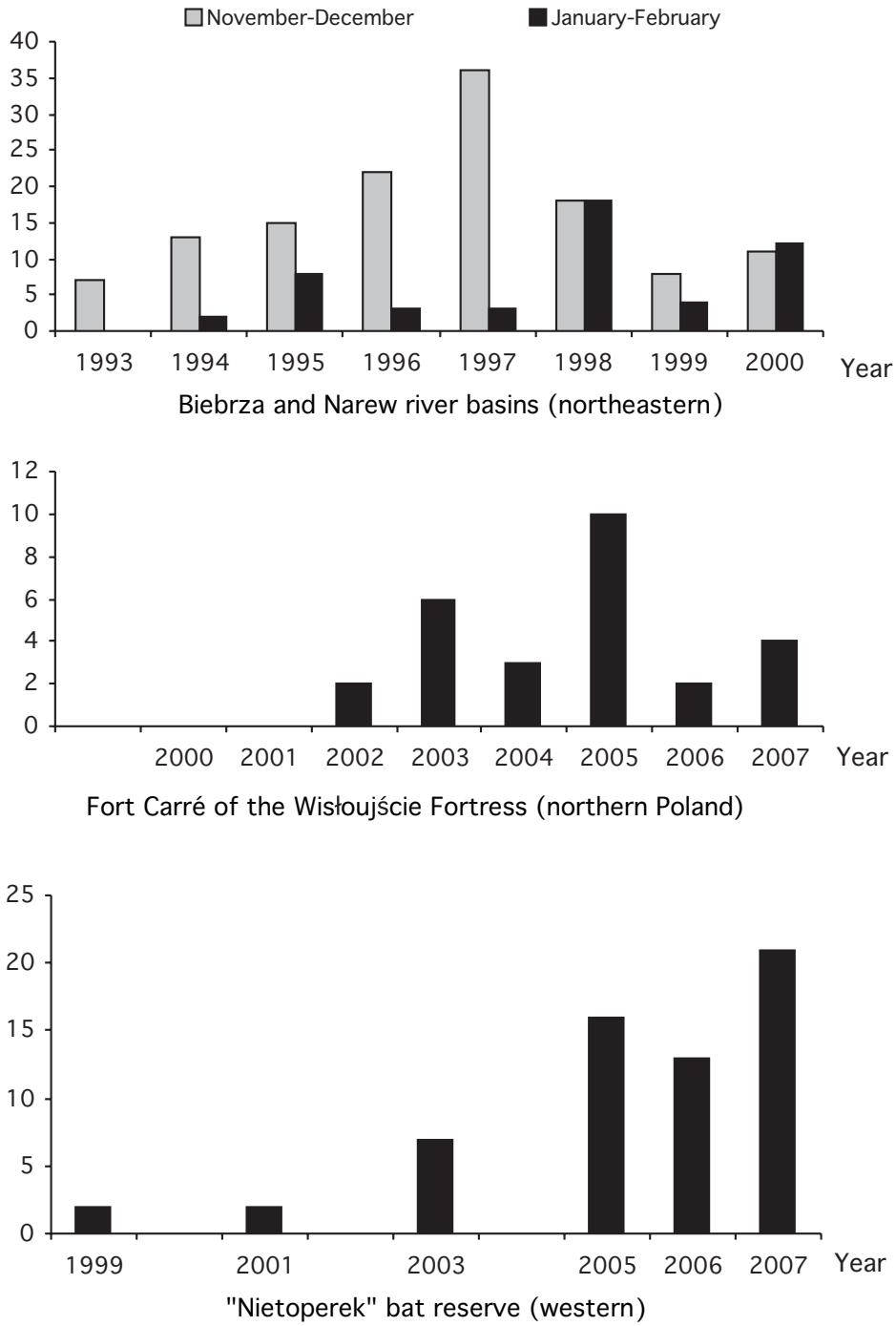

Figure 4. Changes of pond bat numbers in the largest Polish hibernacula. Data from all the regularly monitored sites in the Biebrza and Narew river basins (Osowiec, Piątnica, Drozdowo, Trzcianne, Downary) were pooled together.

dividuals was found in seven roosts (10%), 6-9 individuals in three roosts (4%), while only three sites (4%) were used by 10 or more hibernating pond bats (Annex 3).

All the main hibernacula of the pond bat are located in lowland river valleys or in lakeland areas (figure 3). The site with the most wintering individuals is in Fort Osowiec II in the Biebrza Valley (up to 34 bats); with the other large winter sites being the underground corridors of the "Nietoperek" bat reserve (up to 21) and the Wisłoujście Fortress on the Baltic Sea coast (up to eleven). The biggest concentration of hibernacula and hibernating individuals, consisting of 16 different roosts, is around the swampy surrounds of the Biebrza and the Upper Narew River Basins. These accounted for 9.7% (n=165) of all hibernacula surveyed in that region (Kowalski et al., 2003). The Międzyrzecki Fortified Front accounts for relatively large numbers of pond bats, wintering not only in the main underground fortification system (see above) but also in three smaller bunkers, where an additional ten individuals were found in 2001. Several individuals were regularly captured in this area during autumn swarming (Łupicki et al. 2001). Several winter sites of the pond bat have also been found in the karstic uplands and mountainous areas in the south of the country, which is rich in caves and abandoned mines (figure 3). In most cases these contained only 1-2 hibernating individuals. Although the species was recorded in 7.9% (n=132) of the caves in the Kraków-Częstochowa Upland and Sudety Mountains these 16 localities are dispersed across an area more than twice the size of the Upper Narew and Biebrza Basins (Nowak & Kozakiewicz 2000, Postawa & Zygmunt 2000, Furmankiewicz & Furmankiewicz 2002, Nowak et al. 2002). Between 1999 and 2007 the number of pond bats at the "Nietoperek" bat reserve increased. Strong fluctuations in numbers were observed and between 1993 and 2000 at the five sites in the Upper Narew and Biebrza basins between 2000-2007 at Fort Carré / Wisłoujście Fortress (figure 4). Significantly more pond bats were counted in November-December than in January-February in the latter area (Wilcoxon test, T=1.00, Z=2.20, P<0.03).

The species hibernates in the Carpathians only incidentally and this exclusively in the highest part, the Tatra Mountains. The highest recorded recent European sightings of pond bat are all located here; in the Magurska, Psia and Miętusia Wyżnia caves (at 1465, 1410, and 1393 masl, respectively – Nowak et al. 2001). There are no winter records of the species from any other parts of the Carpathians (e.g. the Beskidy Mountains), although numerous surveys have been conducted in the sandstone tectonic caves in that region (Mleczek 2002), or amongst the winter bat colonies of Western Pomerania (Dzięgielewska 2002, Bernard & Samoląg 2002, Gawlak et al. 2002).

Fossil occurrence

The distribution of fossil and sub-fossil records (28 localities, 13 UTM squares) is restricted to upland and mountainous regions where cave deposits occur (figure 5). Remains that resemble the pond bat were described as *M. dasycneme subtilis* from the basal Pliocene of the Kraków-Częstochowa Upland by Kowalski (1956), although this was later considered as conspecific with *Myotis delicatus* Heller, 1936 (Horáček and Hanák 1989). Pond bat was also found in late Pliocene deposits in two localities in the same region (Annex 5). Remains of the pond bat, which were identical with recent species, were also found in 4 Pleistocene and 21 post-glacial (Holocene) sites in the Kraków-Częstochowa and Roztocze Uplands and in the Świętokrzyskie, Sudety, Tatra and Pieniny Mountains (figure 5). In the Holocene period, pond bats reached even higher altitudes than they nowadays, visiting the caves that are now located above the tree-line in the Tatra Mountains (in the Nad Dachem, Studnia w Kazalnicy and Ptasia Caves at 1570, 1545 and 1627 masl respectively – Piksa & Wołoszyn 2001). Recently three Polish caves containing post-glacial remains of the pond bat have been used by the species for hibernation (Postawa 2004).

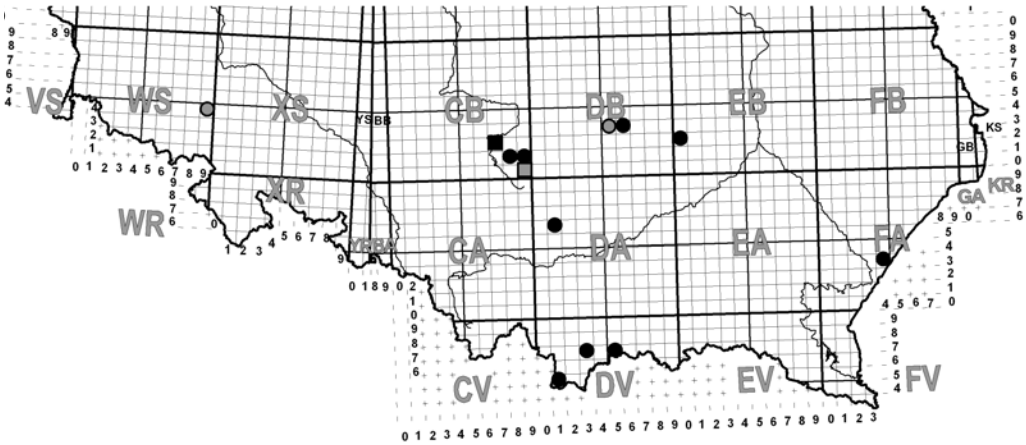

Figure 5. Distribution of fossil remains of the pond bat in Poland. Black circles – Holocene sites, grey circles – Pleistocene, grey squares – sites from the Pleistocene and Pliocene periods, black squares – sites from the Holocene, Pleistocene and Pliocene periods. Complete list of numbered localities and records in Annex 5.

Percentage of the species in bat assemblages

The pond bat appears to be one of the rarest bat species in Poland. In bat assemblages it usually constitutes less than 1% of all bats, irrespective of the sampling method employed. In national banding programmes it accounted for 0.44% of the total bat number in 1939-1953 (Kowalski et al. 1957), 0.38% in 1950-1960 (Krzanowski 1960) and 0.59% in 1975-1994 (Harmata 1996). It constitutes 0.73% of the 1,240 bat remains found in barn owl (*Tyto alba*) (Ruprecht 1979) pellets and 0.58% of the 172 bat remains in the food of tawny owl (*Strix aluco*) (Ruprecht 1979, Kowalski & Lesiński 1990, Ruprecht 1990, Kowalski & Lesiński 2002), collected across all of Poland. Among the 4,334 bats found in Polish bird and bat boxes 0.30% were identified as pond bats. Pond bats used this type of roost only in the north-eastern part of the country, where they accounted for 0.93% of 1,401 records (Kowalski & Lesiński 1994). Among the 157 bat road casualties on Polish roads, 1.3% belonged to the pond bat (Lesiński 2007).

The species was also rare in bat assemblages in the Holocene period. It accounts for just 0.19% of sub-fossil bat remains found in cave sediments in the Kraków-Częstochowa Uplands (Postawa 2004), 0.34% in those in the Tatra Mountains (Piksa & Wołoszyn 2001) and 0.56% in the Pieniny Mountains (Alexandrowicz et al. 1985, Ochman & Wołoszyn 2003).

Pond bat is also an uncommon species during bat winter censuses, constituting about 0.02% of the 139,959 bat winter records between 1988 and 1992 (Wołoszyn 1994) and 0.2% of 1,221 bats hibernating in small village cellars throughout the country (Lesiński et al. 2004). The occurrence of pond bat in winter assemblages during February censuses varied between regions, from 0.04-0.05% in the caves of the Tatra Mountains (Piksa & Nowak 2000) and the fortifications of the Masurian Lakeland (Fuszara et al. 2002) to 0.15% in caves in the Sudety Mountains (Furmankiewicz & Furmankiewicz 2002), 0.29% in caves of the Wieluń Uplands (Kowalski et al. 2002) and 1.70% in anthropogenic underground sites in the Biebrza and Narew valleys (Lesiński & Kowalski 2002). In post-Soviet military bunkers in the Podlasie Lowland pond bats constituted just 0.1% of bats counted between December and February, although it reached 1.8% in September-November (Sachanowicz 2007). Exceptionally high proportions of pond bat were observed in winter samples from the bunkers at the Międzyrzecki Fortified Front, away from the main underground system (2.78%; Szkudlarek et al. 2001), in the November-December sample from

the Biebrza and Narew Valleys (5.4%; Lesiński & Kowalski 2002) and in autumn and winter samples from the Wisłoujście Fortress (5.2% and 3.0%, respectively; Ciechanowski et al. 2006a). In the largest Polish hibernaculum, the underground system of the "Nietoperek" bat reserve, only 0.05% (16 out of 32,200) of bats counted in the 2004/2005 winter season were identified as the pond bat (authors' unpublished data).

The percentage of pond bats among bats captured in mist nests over water bodies in Poland is generally low. It varies from none in most areas of southern and central Poland (Kowalski et al. 1996, Rachwald et al. 2001, Mysłajek 2002, Mysłajek et al. 2002, Sachanowicz & Krasnodębski 2003) to 0.5% in Western Pomerania (Wojtaszyn 2002) and 2.1-2.7% in the eastern part of the Northern Lakeland belt (Ciechanowski et al. 2002, Postawa & Gas 2003). The summer assemblage of bats in the Wdzydze Landscape Park (Eastern Pomerania) appears to be unique in Poland, as the pond bat constitutes 17.5% of all bats captured there in mist nets above the rivers and is the second most numerous species recorded by this method (Ciechanowski et al. 2006b). There is little data about the numbers of pond bat among bats swarming at the entrances of underground roosts, figures vary from none in mountainous areas (Furmankiewicz & Górniak 2002, Węgiel et al. 2004) to 1.1%-3.3% in the Międzyrzecki Fortified Front on the western lowlands (Łupicki & Kowalcze-Łupicka 1999, Łupicki et al. 2001).

Habitat use

No systematic survey on habitat selection by pond bats in Poland has been conducted, but some conclusions may be drawn from the material reviewed in this paper (Annexes 1-4 in supplementary material). Summer roosts, including all nurseries and male colonies, are mostly located in buildings (lofts, spaces inside roofs and wall cavities: 8 sites). Non-breeding individuals were observed in bird and bat boxes, bridge crevices and, exceptionally, in caves (table 2). The only two observations of pond bats roosting in tree holes were made in the 19th century. One of them, made in August 1861 in a hollow hornbeam tree in Kaskada Park in Warszawa, could have been a mating roost (Wałecki 1881). Pond bats in Poland only hibernate in underground shelters, mainly in fortifications and caves, small cellars (in north-eastern Poland), sporadically in mines, underground quarries and once in a village well (table 2). Exceptionally, the species has been found in a greenhouse in winter (Krzanowski 1963) and in a sewer pipe on 17th September (7 ♂♂, unknown locality; Krzanowski 1959b). Observations of copulating individuals, hidden in crevices in the internal brick walls of the Wisłoujście Fortress (autumn 2002) were evidence that some hibernacula may also be used as mating roosts (Sachanowicz & Ciechanowski 2005).

Observations and captures of foraging or commuting pond bats have been made on large and medium-sized rivers (n=10), lakes (n=9), small rivers and streams (n=7), fish ponds (n=5), canals (n=4), oxbow river branches (n=2), a campsite near a river (n=1), artificial reservoirs (n=1) and an old park (n=1). Initial radio-tracking observations conducted in Jeleniewo (n=5 ♀♀ ad. tagged) revealed that the feeding grounds were located 2.2 - 4.8 km from the nursery roost, exclusively over large mesotrophic lakes (Kokurewicz & Furmankiewicz, unpublished data).

Discussion

Although the pond bat is considered as endangered in Poland (Wołoszyn 2001) it seems to be quite widespread in all of the lowland parts of the country and is recorded as breeding in five areas (figure 2). Other large areas are utilised mostly by non-breeding individuals that may live solitarily and disperse much more widely than breeding females. Another water-surface forager, daubenton's bat (*Myotis daubentonii* (Kuhl, 1817)) reveals local sex segregation in summer, when pregnant and lactating females occupy areas much closer to optimal foraging sites than adult males (Encarnação et al. 2006). the pond bat appears to express a similar pattern on a much wider geographical scale. This

discontinuous distribution of pond bat has also been observed in the rest of its European range. The concentrations of maternity roosts are known in only a few European regions (mainly the lowlands of the Netherlands and Belgium, Eastern Jutland in Denmark, the northern German lakelands and the Tisza river basin in Hungary) which are commonly recognised as the reproduction centres, while there are regular non-breeding bat records from other regions (Horáček & Hanák 1989, Limpens et al. 2000, Van de Sijpe et al. 2004). Occurrence of the species in small, partially isolated, areas as is observed in Western and Central Europe seems to be characteristic only in the edge zone of the species' distribution range. It is difficult to decide if the widespread occurrence of the pond bat in Latvia (Pētersons & Vintulis 1998) indicates that this might also be another reproduction centre or rather the Latvian population is an extension of a continuous core range, that also covers large areas of Russia, where the pond bat is one of the dominant species in bat assemblages (see Strelkov & Iljin 1990, Bolshakov & Orlov 2000, Chistyakov 2001).

Scattered, spatially restricted populations of habitat specialists are generally recognised to be in serious threat of extinction and it has often been suggested in the past that this was the situation faced by the pond bat, especially as there was evidence that these islands of distribution have shrunk seriously in the past (as indicated by sub-fossil materials from some European countries, Horáček & Hanák 1989). However, the pond bat in Poland seems to be much more common and much less threatened than previously stated (Limpens et al. 2000, Wołoszyn 2001). No long-term population trends of the species could be traced in Poland, largely because national bat monitoring is mainly based on winter censuses of the underground roosts (Wołoszyn 1994) in which only a few dozen individual hibernating pond bats are usually counted. Such a small sample is highly sensitive to stochastic phenomena (e.g. accidental deaths of particular individuals) and cannot reflect any more general trends in the population at large. Moreover, estimating bat numbers from winter roosts, where censuses traditionally take place in January and February, can be inappropriate for the pond bat, which reaches much higher numbers in autumn (Lesiński & Kowalski 2002) and later probably hides in inaccessible places. Wintering pond bats observed in Poland usually hibernate in deep and narrow crevices (authors' observations) so might often be overlooked in some site censuses. The total number of individuals inhabiting the two known maternity roosts is several times higher than in all recently visited hibernacula – so we do not know where most of the Polish pond bats spend the winter. This situation is very similar to that observed in the Netherlands, where the known summer population of pond bats is 20 times higher than the winter one (Limpens et al. 2000). Overall, there is no evidence to suggest any recent decline of the species in Poland, as the winter counts reveal only fluctuations or even possibly a periodic increase in the numbers of pond bats.

There are however, much more important reasons for rejecting the hypothesis about any decline in this species. Firstly, the abundance of the pond bat in Poland seems to be strongly underestimated, as it was previously in the Netherlands, where systematic and goal-directed surveys between 1986 and 1993 revealed a population 4-5 times larger than previously estimated (Limpens et al. 2000). Low dominance indices (<1%) for pond bats obtained from most Polish samples might imply that it is a rare species. Most of the intensive bat surveys, however, have been carried out in regions that do not have the optimal habitat conditions for pond bats. In some localities, the species is both common and numerous, as netting surveys in the Wdzydze area and Biebrza basin have recently shown. Although mist netting appears to be an effective method for pond bat surveys, it may only work well under specific conditions, where medium-sized rivers and canals serve as commuting corridors (cf. Limpens 2001). In other regions that are potentially suitable for the pond bat, surveys need to be based on inspections of lofts and attics and on ultrasound detection, combined with visual observations of foraging individuals. These surveys need to be conducted by people familiar with the species (Limpens 2001). No such studies have yet been carried out in most of the lakeland or

fishpond regions of Poland and there has been no systematic bat survey done in either Żuławy Wiślane (delta of the Vistula river) or the delta of Odra river regions, where the landscapes, rich in canals, ditches and blind river branches are suitable for pond bats.

In addition, the range of optimal hunting habitats for pond bats is much wider than has been previously suggested (Horáček & Hanák, 1989). Both the known Polish nurseries for the pond bat are located in young, post-glacial lakeland landscapes, which are only rich in lakes (mesotrophic rather than eutrophic) but without any broad canals or slowly flowing, large rivers. Such landscapes, formerly considered as unfavorable for the species, resemble the habitat utilised by the Latvian population (Pētersons & Vintulis 1998) which has one of the highest population densities in the European Union (Limpens et al. 2000). In the light of this knowledge, breeding populations of pond bat can sustain themselves in any areas rich in large water bodies, and it is very likely that other maternity roosts will be discovered in geographically similar other regions of Poland (e.g. the Lubuskie Lakeland, the southern part of Pomerania or Polesie) that have not yet been properly surveyed. Given this possibility and recent records, it is possible that Poland could be recognised as another European reproduction centre in Europe, joining those already identified by Limpens et al. (2000). Equally it may be possible to treat Polish breeding colonies as stepping stones within a larger, continuous, reproduction area that ranges from northern Germany, across the Baltic States and onto the Russian populations. There is however one gap in this distribution, in Lithuania, where despite frequent summer records the only known nursery is in the north-east of the country and possibly represents an extension of the large Latvian population (Mickevičiene et al. 1999). In southern Lithuania, bordering Poland, the pond bat appears to be a rare bat, and there are only a few records of non-breeding bats (Pauža & Paužiene 1999), although these do include the largest hibernaculum in the country, the Paneriai tunnel in Vilnius, used by about 85 individuals (Baranauskas 2006).

Any hypothesis about numerous, but locally distributed and mostly undiscovered, summer populations of pond bats in Poland is not necessarily shaken by a lack of large winter aggregations, even though mass hibernation of the species (500-1700 in one site) is known from Denmark (Baagøe 2001) and Russia (Bolshakov & Orlov 2000). Only in Danish Jutland, there is evidence of one population of pond bats reproducing and hibernating in the same area (Baagøe 2001). In general the species has strong migratory tendencies (with female movements up to 300 km). A large part of the lowland Dutch population migrates to the hilly area of Limburg and German mountains, where there are optimal hibernacula (Roer 2001). Similarly, Polish summer populations could leave the country for winter. Equally, the Polish main hibernacula could be simply still remain undiscovered because of their observed tendency to aggregate in large numbers in a just few of many available sites (cf. Bolshakov & Orlov 2000).

It is not possible to predict whether any natural or anthropogenic factors could lead to a serious decline of the pond bat in Poland in the near future. The pond bat, as a synanthropic species, makes great use of buildings as maternity roosts in the summertime. Recent renovation, rebuilding and demolition activities could be a threat for the pond bat, as old houses, with deep crevices, slowly disappear from the Polish landscape. A second threat could be increasing and uncontrolled disturbance of hibernation sites by tourists. Despite the legal protection that bats are afforded in Poland and the designation of the largest hibernacula as Natura 2000 sites, sight-seeing in underground sites in winter is still possible and in some places, such as the "Nietoperek" bat reserve, it is steadily increasing (authors' unpublished data).

Wołoszyn (2001) suggested water pollution as the main threat for the species and this was partially confirmed by field studies by Van de Sijpe et al. (2004), who recorded higher pond bat activity over waterways with mild and moderate pollution than over heavily polluted ones. Yet this result may also be influenced by other un-

studied factors (e.g. proximity of roosts) and the methodological issues associated with calculating hunting activity solely from qualitative data (presence/absence in the number of surveys). In polluted areas there is evidence of heavy metals, PCBs and pesticides being absorbed by the aquatic chironomid flies which are the main prey of the pond bat. Dead pond bats, collected in less contaminated areas, contained PCBs at concentrations known to inhibit reproduction among some other mammals (Reinhold et al. 1999). However, water quality has improved in some Polish waters in recent years including in Wdzydze Lake, which is part of the Pomeranian refuge of the pond bat (Żmudziński 1997). On the other hand many of waters in northern Poland are still heavily polluted by untreated sewage effluents.

Even if the picture of the status of pond bat in Poland painted here appears more optimistic than earlier thought, this should not diminish conservation efforts. In future, the emphasis of these might change towards focusing on protecting an internationally important population rather than a local peculiarity. The conservation of unevenly distributed species on a European scale should focus on those regions with the strongest and most viable populations, where the pond bat is still common and widespread. This is in line with the goals of the Habitat Directive and Natura 2000 Network, which recommend prioritising the protection of populations / areas with Pan-European significance (Hoffman et al. 2004). However, establishing such areas for pond bats requires developing comparable data, based on extensive inventories, which are far from complete in most of the countries that acceded to the EU between 2004 and 2007 (cf. Limpens 2001).

Acknowledgements: We are very grateful to Phil Richardson for correcting the English. We are also grateful to everybody who made their unpublished data available to this review (their contributions are acknowledged in the Annex by their initials): Gerben Achterkamp (*GA*), Sławomir Chmielewski (*SC*), Jakub Paweł Cygan (*JPC*), Robert Dróżdż (*RD*), Joanna Furmankiewicz (*JF*), Maciej Fuszara (*MF*), Judyta Gulatowska (*JG*), Mariusz Gwardjan (*MG*), Janusz Hejduk (*JH*), Maurycy Ignaczak (*MI*), Radosław Jaros (*RJ*), Anne Jifke Haarsma (*AJH*), Hans Huitema (*HH*), Krzysztof Kasprzyk (*KK*), Paweł Kmiecik (*PK*), Marek Kowalski (*MK*), Bart Kranstauber (*BK*), Ireneusz Krasnodębski (*IK*), Grzegorz Lesiński (*GL*), Peter H. C. Lina (*PHCL*), Czesław Nitecki (*CN*), Tomasz Nitkiewicz (*TN*), Agnieszka Ostrach-Kowalska (*AO-K*), Wojciech Pawenta (*WP*), Michał Piskorski (*MP*), Tomasz Postawa (*TP*), Agnieszka Przesmycka (*AP*), Ireneusz Ruczyński (*IR*), Aleksandra Szarlik (*AS*), Rafał Szkudlarek (*RS*), Marcin Urban (*MU*), Ben Verboom (*BV*), Michał Wojciechowski (*MW*), Zbigniew Wojciechowski (*ZW*), Agnieszka Wower (*AW*) and Sławomir Zalasa (*SZ*). In addition we would like to thank Joanna Furmankiewicz (Wrocław University) for her invaluable help during the radio-tracking study at the Jeleniewo nursery roost.

References

Alexandrowicz, S.W., A. Nadachowski, J. Rydlewski, P. Valde-Nowak & B.W. Wołoszyn 1985. Subfossil fauna from a cave in the Sobczański Gully (Pieniny Mts., Poland). Folia Quaternaria 56: 57-78.

Baagøe, H. J. 2001. Danish bats (Mammalia: Chiroptera): Atlas and analysis of distribution, occurrence and abundance. Steenstrupia 26 (1): 1-117.

Bagrowska-Urbańczyk, E. & Z. Urbańczyk 1983. Structure and dynamics of a winter colony of bats. Acta Theriologica 28: 183-196.

Baranauskas, K. 2006. New data on bats hibernating in underground sites in Vilnius, Lithuania. Acta Zoologica Lithuanica 16: 102-106.

Bernard, R. & J. Samoląg 2002. Dekady Spisu Nietoperzy 1993-1999 w Strzalinach (północnozachodnia Polska). Nietoperze 3: 17-25.

Bolshakov, V.N. & O.L. Orlov 2000. The Species Composition of Bats Hibernating in Caves in the Central Ural Region. In: B.W. Wołoszyn (ed.). Approaches to Biogeography and Ecology of Bats. Proceedings of the VIIIth EBRS Vol. 1: 175-180. CIC ISEZ PAN, Kraków, Poland.

Chistyakov, D.V. 2001. Present State of the Bat Community Hibernating in Artificial Caves near St. Petersburg. In: B.W. Wołoszyn (ed.). Distribution, Ecology, Paleontology and Systematics of Bats: 47-57. Proceedings of the VIIIth EBRS. Vol. 2. CIC ISEZ PAN, Kraków, Poland.

Ciechanowski, M. & A. Przesmycka 2001. Stwierdzenie nocka łydkowłosego *Myotis dasycneme* (Boie, 1825) i nocka wąsatka *Myotis mystacinus* (Kuhl, 1817) w Gdańsku. Nietoperze 2: 69-73.

Ciechanowski, M., A. Przesmycka & K. Sachanowicz 2006a. Species composition, spatial distribution and population dynamics of bats hibernating in Wisłoujście Fortress. Lynx 37: 79-93.

Ciechanowski, M., A. Przesmycka & K. Sachanowicz 2006b. Nietoperze (Chiroptera) Wdzydzkiego Parku Krajobrazowego. Parki Narodowe i Rezerwaty Przyrody 25: 85-100.

Ciechanowski, M., A. Przesmycka, A. Benedycka, A. Biała & K. Sachanowicz 2003a. Stwierdzenia rozrodu nocka łydkowłosego *Myotis dasycneme* (Boie, 1825) na Pojezierzu Pomorskim. Nietoperze 4: 103-105.

Ciechanowski, M., A. Zwolicki, M. Wojciechowski, A. Benedycka & A. Biała 2003b. Ssaki (Mammalia) projektowanego rezerwatu „Torfowiska Wiszące nad Jeziorem Jaczno" (Pojezierze Suwalskie) i jego otoczenia. Parki Narodowe i Rezerwaty Przyrody 22: 473-477.

Ciechanowski, M., L. Kozirόg, J. Duriasz, A. Przesmycka, A. Świątkowska, J. Kisicka & K. Kasprzyk 2002. Bat fauna of the Iława Lakeland Landscape Park (northern Poland). Myotis 40: 33-45.

Čmak, J. 1968. Ssaki (Mammalia) w biotopach Chełmowej Góry na tle fauny ssaków Świętokrzyskiego Parku Narodowego. Folia Forestalia Polonica 14: 239-266.

Dzięgielewska, M. 2002. Zimowe liczenia nietoperzy w Szczecinie w latach 1996-1999. Nietoperze 3: 7-15.

Encarnação, J.A., U. Kierdorf, D. Holweg, U. Jasnoch & V. Wolters 2005. Sex-related differences in roost-site selection by Daubenton's bats *Myotis daubentonii* during the nursery period. Mammal Review 35: 285-294.

Furmankiewicz, J. & J. Górniak 2002. Seasonal changes in number and diversity of bat species (Chiroptera) in the Stolec mine (SW Poland). Przyroda Sudetów Zachodnich Suppl. 2: 49-70.

Furmankiewicz, J. & M. Furmankiewicz 2002. Bats hibernating in the natural caves in the Polish part of the Sudetes. Przyroda Sudetów Zachodnich Suppl. 2: 15-38.

Furmankiewicz, J., M. Furmankiewicz & S. Telatyński 2001. Nowe obserwacje nocka łydkowłosego *Myotis dasycneme* (Boie, 1825) w polskiej części Sudetów Zachodnich. Przyroda Sudetów Zachodnich 4: 153-156.

Fuszara, E., M. Fuszara & M. Wojciechowski 2002. Monitoring liczebności nietoperzy w zimowiskach na Pomorzu Mazurskim w latach 1992-1999. Nietoperze 3: 65-76.

Gas, A. & T. Postawa 2001. Bat fauna of the Studnisko Cave. Studia Chiropterologica 2: 3-16.

Gawlak, A. 1996. Stanowisko nocka łydkowłosego *Myotis dasycneme* (Boie, 1825) w Poznaniu. Przegląd Przyrodniczy 7 (1): 96-97.

Gawlak, A., G. Wojtaszyn & M. Gmaj 2002. Zimowe spisy nietoperzy na Pomorzu Środkowym. Nietoperze 3: 27-32.

Godawa, J. & B.W. Wołoszyn 1990. Nietoperze (Mammalia: Chiroptera) Ojcowskiego Parku Narodowego. Prądnik. Prace Muzeum Szafera 1: 143-148.

Godawa, J. 1995. Zmiany w faunie nietoperzy Ojcowskiego Parku Narodowego w latach 1950-2000: seria badań kontrolnych w latach 1988-1989. Prądnik. Prace Muzeum Szafera 9: 251-256.

Grzywiński, W., J. Nowak & A. Węgiel 2004. Nietoperze Ojcowskiego Parku Narodowego - stan poznania. In: J. Partyka (ed.). Zróżnicowanie i przemiany środowiska przyrodniczo-kulturowego Wyżyny Krakowsko-Częstochowskiej. Tom I. Przyroda: 363-368. Ojcowski Park Narodowy, Ojców, Poland

Gulatowska, J. & M. Kowalski 2004. Największe zimowisko nocka łydkowłosego *Myotis dasycneme* na Nizinie Mazowieckiej. Nietoperze 5: 118-120.

Haitlinger, R. 1976. Nietoperze Dolnego Śląska. Przegląd Zoologiczny 20 (1): 124-134.

Harmata, W. 1996. Wyniki obrączkowania nietoperzy w Polsce w latach 1975-1994. In: B. W. Wołoszyn (ed.). Aktualne problemy ochrony nietoperzy w Polsce: 25-40. CIC ISEZ PAN, Kraków, Poland.

Hejduk, J. & G. Radzicki 1996. Dynamika liczebności nietoperzy zimujących w Jaskini "Szachownica" (w sezonach 1993/94 i 1994/95). In: B. W. Wołoszyn (ed.). Aktualne problemy ochrony nietoperzy w Polsce: 41-55. CIC ISEZ PAN, Kraków, Poland.

Hoffman, J., A. Nowakowski & D. Metera 2004 (ed.). Integrating Natura 2000. Rural Development and Agri-Environmental Programmes in Central Europe. IUCN Foundation Poland, Warsaw, Poland.

Horáček, I. & V. Hanák 1989. Distributional status of *Myotis dasycneme*. In: I. Horáček, V. Hanák & J. Gaisler (eds.). European Bat Research 1987: 565-590. Charles University Press, Praha, Czech Republic.

Horáček, I. 1999. *Myotis dasycneme* (Boie, 1825). In: A.J. Mitchell-Jones, G. Amori, W. Bogdanowicz, B. Kryštufek, P.J.H. Reinjders, F. Spitzenberger, M. Stubbe, J.B.M. Thissen, V. Vohralik & J. Zima (eds.). The Atlas of European Mammals: 108-109. Academic Press, London, UK.

Hutson, A.M. 2005. Migrants, vagrants and stowaways. Bat News 77: 4-5.

Hutson, A.M., S.P. Mickleburgh & P.A. Racey 2001. Microchiropteran Bats. Global Status Survey and Conservation Action Plan. IUCN/SSC Chiroptera Specialist Group, Gland, Switzerland and Cambridge, UK.

Ignaczak, M. & J. Manias 2004. Nietoperze zasiedlające mosty w środkowej Polsce. Nietoperze 5: 75-83.

Jachno, J. 1868. Dalszy ciąg zapisków fauniczych w Sandomierskiej Puszczy. Sprawozdanie Komisji Fizjograficznej 2: 73-77.

Janyszak, S. & M. Jurczyszyn 1988. Nocek łydkowłosy na Pomorzu Zachodnim. Biuletyn CIC 2 (4): 5.

Jurczyszyn, M. 1994. Nietoperze (Chiroptera) Roztoczańskiego Parku Narodowego i otuliny. Fragmenta Faunistica 37: 389-399.

Kasprzyk, K. & I. Ruczyński 2001. The structure of bat communities roosting in bird nest boxes in two pine monocultures in Poland. Folia Zoologica 50: 107-116.

Kliś, T., J. Furmankiewicz & T. Kokurewicz 2001. Zmiany liczebności i składu gatunkowego nietoperzy hibernujących w jaskiniach góry Połom (Góry Kaczawskie, Sudety Zachodnie) w latach 1964-2001. Studia Chiropterologica 2: 47-66.

Kowalski, K. 1953. Materiały do rozmieszczenia i ekologii nietoperzy jaskiniowych w Polsce. Fragmenta Faunistica 6: 541-567.

Kowalski, K. 1955. Nasze nietoperze i ich ochrona. Polska Akademia Nauk, Zakład Ochrony Przyrody, Kraków, Poland.

Kowalski, K. 1956. Insectivores, bats and rodents from Early Pleistocene bone breccia of Podlesice near Kroczyce (Poland). Acta Palaeontologica Polonica 1: 331-398.

Kowalski, K., A. Krzanowski & R.J. Wojtusiak 1957. Report on bat-banding in Poland in the years 1939-1953. Acta Theriologica 1: 109-158.

Kowalski, K., M. Młynarski, A. Wiktor & B.W. Wołoszyn 1963. Postglacjalna fauna z Józefowa, pow. Biłgoraj. Folia Quaternaria 14: 1-32.

Kowalski, M. & G. Lesiński 1986. Fauna drobnych ssaków w Janowie (woj. stołeczne) na podstawie analizy zrzutek płomykówki (*Tyto alba* Scop.). Przegląd Zoologiczny 30: 327-331.

Kowalski, M. & G. Lesiński 1990. The food of the tawny owl (*Strix aluco* L.) from near a bat cave in Poland. Bonner Zoologische Beiträge 41: 23-26.

Kowalski, M. & G. Lesiński 1994a. Bats occupying nest boxes for birds and bats in Poland. Nyctalus (N.F.) 5: 19-26.

Kowalski, M. & G. Lesiński 1995. Skład gatunkowy i wybiórczość kryjówek nietoperzy w Puszczy Kampinoskiej. Przegląd Przyrodniczy 6 (2): 99-108.

Kowalski, M. & G. Lesiński 2002. Nietoperze w diecie sów na Nizinie Mazowieckiej i Podlaskiej. Nietoperze 3: 255-261.

Kowalski, M. & R. Dróżdż 2002. Zimowy monitoring nietoperzy w sztucznej jaskini w Bochotnicy w latach 1987-1999. Nietoperze 3 (1): 128-135.

Kowalski, M., G. Lesiński & M. Ignaczak 2002. Zimowy monitoring nietoperzy w jaskiniach na Wyżynie Wieluńskiej w latach 1981-1999. Nietoperze 3 (1): 119-128.

Kowalski, M., G. Lesiński, B. Wojtowicz & T. Nitkiewicz 2003. Zimowe stanowiska nocka łydkowłosego *Myotis dasycneme* (Boie, 1825) w północnej części Podlasia. Nietoperze 4 (2): 162-166.

Kowalski, M., I. Krasnodębski, K. Sachanowicz, R. Dróżdż & B. Wojtowicz 1996. Skład gatunkowy, wybiórczość kryjówek i miejsc żerowania nietoperzy w Puszczy Kozienickiej. Kulon 1 (1-2): 25-41.

Kozakiewicz, K. & M. Strzałka 1996. Dynamika liczebności nietoperzy hibernujących w Jaskini Nietoperzowej w sezonie zimowym 1994/95. In: B.W. Wołoszyn (ed.). Aktualne problemy ochrony nietoperzy w Polsce: 85-100. CIC ISEZ PAN, Kraków, Poland.

Kozikowski, A. & L. Niedzielski 1954. Nietoperze (Chiroptera) wprzęgnięte do walki ze szkodliwymi owadami leśnymi. Sylwan 48 (1): 23-30.

Krzanowski, A. 1956. Nietoperze (Chiroptera) Puław. Wykaz gatunków i uwagi biologiczne. Acta Theriologica 1 (4): 87-105.

Krzanowski, A. 1959a. Some major aspect of population turnover in wintering bats in the cave in Puławy (Poland). Acta Theriologica 3: 27-43.

Krzanowski, A. 1959b. Unusual summer hiding-place of bats. Acta Theriologica 2: 284-285.

Krzanowski, A. 1960. Investigations of flights of Polish bats, mainly *Myotis myotis* (Borkhausen 1797). Acta Theriologica 4: 175-184.

Krzanowski, A. 1963. Kompletna lista nietoperzy Puław. Przegląd Zoologiczny 7: 284-286.

Lesiński, G. & M. Kowalski 2002. Zimowy monitoring nietoperzy w Dolinie Narwi i Biebrzy w latach 1992-1999. Nietoperze 3: 53-60.

Lesiński, G. 1983. Nietoperze jaskiń Wyżyny Wieluńskiej. Przegląd Zoologiczny 27 (4): 465-478.

Lesiński, G. 1988. Skład gatunkowy i liczebność nietoperzy w fortach modlińskich w ciągu roku. Przegląd Zoologiczny 32 (4): 575-587.

Lesiński, G. 1988. Spis nietoperzy zimujących w „Nietoperku" z grudnia 1985. Wszechświat 89 (9): 209.

Lesiński, G. 1989. Nocek łydkowłosy w ptasich budkach. Wszechświat 90: 183.

Lesiński, G. 2001. Nietoperze Kotliny Biebrzańskiej i terenów przyległych. Parki Narodowe i Rezerwaty Przyrody 20 (2): 51-64.

Lesiński, G. 2003. Nietoperze. In: Andrzejewski R. (ed.). Kampinoski Park Narodowy Vol. I: 647-654. Kampinoski Park Narodowy, Izabelin, Poland.

Lesiński, G. 2007. Bat road casualties and factors determining their number. Mammalia 71: 138-142.

Lesiński, G., M. Kowalski, J. Domański, R. Dzięciołowski, K. Laskowska-Dzięciołowska & M. Dzięgielewska 2004. The importance of small cellars to bat hibernation in Poland. Mammalia 68: 345-352.

Limpens, H.J.G.A. 2001. Assesing the European distribution of the pond bat (*Myotis dasycneme*) using bat detectors and other survey methods. Nietoperze 2: 169-178.

Limpens, H.J.G.A., P.H.C. Lina & A.M. Hutson 2000. Action plan for the conservation of the pond bat (*Myotis dasycneme*) in Europe. Council of Europe Publishing, Strasbourg, France.

Lutsar, L., M. Masing & L. Poots 2000. Changes in the number of hibernating bats in the caves of Piusa (Estonia), 1949-1999. Folia Theriologica Estonica 5: 101-117.

Łupicki, D. & M. Kowalcze-Łupicka 1999. Dominacja gatunków nietoperzy odławianych przy głównym wjeździe do podziemi MRU przed i po zmianach konstrukcji kraty zamykającej w 1995 r. In: R. Dzięciołowski (ed.). Materiały Konferencyjne, XIII Ogólnopolska Konferencja Chiropterologiczna, Błażejewko, 5-7 XI 1999: 31. PTOP „Salamandra", Poznań, Poland.

Łupicki, D., R. Szkudlarek, P. Schick & I. Dudek 2001. Wykorzystanie obiektów podziemnych przez nietoperze w rezerwacie "Nietoperek" w okresie jesiennym. Nietoperze 2 (1): 93-101.

Madeyska, T. 1981. Środowisko człowieka w środkowym i górnym paleolicie na ziemiach polskich w świetle badań geologicznych. Studia Geologica Polonica 69: 1-125.

Mickevičiene, I., E. Mickevičius & K. Baranauskas 1999: Notes on summer distribution of bats in Lithuania. Acta Zoologica Lithuanica 9: 16-19.

Mikusek, R. & B. Pikulska 1999. Ssaki Parku Narodowego Gór Stołowych. Szczeliniec 3: 109-119.

Mleczek, T. 2002. Zimowe spisy nietoperzy na Pogórzu Karpackim w latach 1993-1999. Nietoperze 3: 163-169.

Mysłajek, R.W. 2002. Nietoperze *Chiroptera* Parku Krajobrazowego Beskidu Małego. Nietoperze 3: 263-269.

Mysłajek, R.W., K. Henel & S. Nowak 2002. Nietoperze Chiroptera rezerwatu „Łężczok" koło Raciborza. Nietoperze 3: 271-276.

Nikodem, Z. 1982. Materiały do fauny nietoperzy (Chiroptera) Lubelszczyzny. Przegląd Zoologiczny 26 (2): 197-204.

Nowak, J. & K. Kozakiewicz 2000. Zimowe spisy nietoperzy na Wyżynie Krakowskiej w latach 1993-1999. Studia Chiropterologica 1: 43-56.

Nowak, J., A. Gawlak & G. Wojtaszyn 2001. Nocek łydkowłosy *Myotis dasycneme* (Boie, 1825) w Tatrach. Nietoperze 2 (1): 63-67.

Nowak, J., W. Grzywiński & M. Wieczorek 2002. Zimowe spisy nietoperzy na Wyżynie Krakowskiej w latach 2000-2002 na tle 15 lat badań. Prądnik. Prace Muzeum Szafera 13: 217-228.

Ochman, K. & B.W. Wołoszyn 2003. Bats (Chiroptera). In: P. Valde-Nowak, A. Nadachowski & T. Madeyska (eds.). Obłazowa Cave. Human activity, stratigraphy and palaeoenvironment: 118-125. Institute of Archaeology and Ethnology, Polish Academy of Sciences, Kraków, Poland.

Pauža, D. H. & N. Paužiene 1998. Distribution and Status of Lithuanian Bats. Proceedings of Latvian Academy of Sciences, Section B 52 (1/2): 44-48.

Pax, F. 1925. Säugetiere. In: Wirbeltierfauna von Schlesien: 97-140. Gebrüder Borntraeger. Berlin, Germany.

Pētersons, G. & V. Vintulis 1998. Distribution and Status of Bats in Latvia. Proceedings of Latvian Academy of Sciences, Section B 52 (1/2): 37-43.

Piksa, K. & B.W. Wołoszyn 2001. The postglacial bat remains from the Polish Tatra caves. Lynx (n.s.) 32: 301–311.

Piksa, K. & J. Nowak 2000. The Bat Fauna of the Polish Tatra Caves. In: B.W. Wołoszyn (ed.). Approaches to Biogeography and Ecology of Bats: 181-190. Proceedings of the VIIIth EBRS. Vol. 1. CIC ISEZ PAN, Kraków, Poland.

Pjenčák, P., S. Danko & S. Matis 2003. Netopiere Tatranského národného parku a širšieho okolia. Vespertilio 7: 139-160.

Postawa, T. & A. Gas 2003. Fauna nietoperzy Wigierskiego Parku Narodowego (północno-wschodnia Polska). Studia Chiropterologica 3-4: 31-42.

Postawa, T. & J. Zygmunt 2000. Zmiany liczebności nietoperzy (Chiroptera) w Jaskiniach Wyżyny Częstochowskiej w latach 1975-1999. Studia Chiropterologica 1: 83-114.

Postawa, T. 2004. Changes in bat fauna during the Middle and Late Holocene as exemplified by thanatocoenoses dated with ^{14}C AMS from Kraków-Częstochowa Upland caves, Poland. Acta Chiropterologica 6: 269-292.

Rachwald, A., P. Boratyński & W. K. Nowakowski 2001. Species composition and night-time activity of bats flying over rivers in Białowieża Primeval Forest (Eastern Poland). Acta Theriologica 46: 235-242.

Reinhold, J.O., A.J. Hendriks, L.K. Slager & M. Ohm 1999. Transfer of microcontaminants from sediment to chironomids and the risk for the Pond bat *Myotis dasycneme* (Chiroptera) preying on them. Aquatic Ecology 33: 363-376.

Ruprecht, A.L. 1979. Bats (Chiroptera) as constituents of the food of barn owls *Tyto alba* in Poland. Ibis 121: 489-494.

Ruprecht, A.L. 1979. Food of the Barn owl, *Tyto alba guttata* (C.L.Bh.) from Kujawy. Acta Ornithologica 19: 493-511.

Ruprecht, A.L. 1983. *Myotis dasycneme* (Boie, 1825). In: Z. Pucek & J. Raczyński (ed.). Atlas of Polish Mammals: 69-70, map no. 43. Polish Scientific Publishers, Warszawa, Poland.

Ruprecht, A.L. 1990. Nietoperze (Chiroptera) w składzie pokarmu sów z Puszczy Nadnoteckiej. Przegląd Zoologiczny 34: 349-358.

Sachanowicz, K. & I. Krasnodębski 2003. Skład gatunkowy i antropogeniczne kryjówki nietoperzy w Lasach Łukowskich. Nietoperze 4: 27-38.

Sachanowicz, K. & M. Ciechanowski 2005. Nietoperze Polski. Multico Oficyna Wydawnicza, Warszawa, Poland.

Sachanowicz, K. 2003. Zimowe stanowiska nietoperzy *Chiroptera* w południowej części Wysoczyzny Drohiczyńskiej i w regionie Podlaskiego Przełomu Bugu (Nizina Podlaska). Nietoperze 4 (1): 5-19.

Sachanowicz, K. 2007. Structure and dynamics of the bat assemblage inhabiting military bunkers. Nyctalus (N.F) 12 (1): 28-35.

Sachanowicz, K., M. Ciechanowski & K. Piksa 2006. Distribution patterns, species richness and status of bats in Poland. Vespertilio 9-10: 151-173.

Sitowski, L. 1948. Przyczynek do znajomości fauny Parku Narodowego w Pieninach. Ochrona Przyrody 18: 133-142.

Stebbings, R.E. & F. Griffith 1986. Distribution and status of bats in Europe. Institute of Terrestrial Ecology, Abbots Ripton, Huntingdon, UK.

Strelkov, P.P. & V.J. Iljin 1990. The bats (Chiroptera: Vespertilionidae) of the south Middle Volga and Lower Volga provinces. In: P.P. Strelkov (ed.). Fauna, systematic and evolution of mammals (Rodentia, Chiroptera): 45-167. Proceedings of the Zoological Institute, Leningrad, Russia.

Styka, R. 2000. Fauna drobnych ssaków Sobiborskiego Parku Krajobrazowego na podstawie analizy zrzutek puszczyka *Strix aluco* i płomykówki *Tyto alba*. In: Materiały VIII Ogólnopolskiej Konferencji Teriologicznej "Bioróżnorodność i ochrona ssaków": 103-104. 25-27.09.2000. KUL & UMCS, Lublin, Poland.

Szkudlarek, R. & M. Dzięgielewska 2003. Nietoperze w rezerwacie „Bielinek" – wstępne wyniki badań. Folia Universitatis Agriculturae Stetinensis 231 (92): 193-198.

Szkudlarek, R. & R. Paszkiewicz 1999. Zimowe stanowiska rzadkich gatunków nietoperzy w Sudetach Zachodnich, Przyroda Sudetów Zachodnich 2: 83-88.

Szkudlarek, R., R. Paszkiewicz, T. Blohm, E. Nowak & D. Łupicki 2001. Bunkry Ziemi Lubuskiej jako schronienia nietoperzy. Nietoperze 2 (1): 86-92.

Urbańczyk, Z. & Z. Gólski 1994. Zimowe spisy nietoperzy na Ziemi Lubuskiej w latach 1988-1992. In: B.W. Wołoszyn (ed.). Zimowe spisy nietoperzy w Polsce: 1988-1992. Wyniki i ocena skuteczności: 149-157. CIC ISEZ PAN, Kraków, Poland.

Van de Sijpe, M., B. Vandendriessche, P. Voet, J. Vandenberghe, J. Duyck, E. Naeyaert, M. Manhaeve & E. Martens 2004. Summer distribution of the Pond bat *Myotis dasycneme* (Chiroptera, Vespertilionidae) in the west of Flanders (Belgium) with regard to water quality. Mammalia 68: 377-386.

Verboom, B. 2006. Winterverblijven voor vleermuizen in Limburg. VZZ report 2006.033. Zoogdiervereniging VZZ, Arnhem, The Netherlands.

Wałecki, A. 1881. Fauna zwierząt ssących Warszawy i jej stosunek do fauny całego kraju. Pamiętnik Fizyograficzny 1 (3): 268-291.

Węgiel, A., R. Szkudlarek & T. Gottfried 2004. Skład gatunkowy, aktywność i struktura populacji nietoperzy odławianych latem przy otworach jaskiń w Beskidach. Nietoperze 5 (1-2): 94-105.

Wojciechowski, M., K. Kasprzyk & M. Jefimow 1999. Pierwsze stwierdzenie kolonii rozrodczej nocka łydkowłosego *Myotis dasycneme* (Boie, 1925) na terenie Polski. In: R. Dzięciołowski (ed.). Materiały Konferencyjne, XIII Ogólnopolska Konferencja Chiropterologiczna, Błażejewko, 5-7 XI 1999: 46. PTOP „Salamandra". Poznań, Poland.

Wojtaszyn, G. 2002. Nietoperze Pojezierza Wałeckiego. Przegląd Przyrodniczy 13 (1-2): 199-211.

Wojtaszyn, G., T. Rutkowski & W. Stephan 2006. Nowe stanowisko nocka łydkowłosego *Myotis dasycneme* (Boie, 1825) na Pobrzeżu Bałtyku. Chrońmy Przyrodę Ojczystą 62 (2): 101-103.

Wołoszyn, B.W. 1962. Nietoperze z jaskiń Gór Świętokrzyskich. Przegląd Zoologiczny 6 (2): 156-162.

Wołoszyn, B.W. 1964. Nowe obserwacje nad nietoperzami z jaskiń Gór Świętokrzyskich. Przegląd Zoologiczny 8 (3): 286-289.

Wołoszyn, B.W. 1968. Badania nietoperzy Dolnego Śląska, Przegląd Zoologiczny 12 (2): 208-220.

Wołoszyn, B.W. 1987. Pliocene and pleistocene bats of Poland. Acta Palaeontologica Polonica 32: 207-325.

Wołoszyn, B.W. 1989. Nietoperze – *Chiroptera*. In: K. Kowalski (ed.). Historia i ewolucja lądowej fauny Polski. Folia Quaternaria 59-60: 129-141.

Wołoszyn, B.W. 1994. Dekady Spisu Nietoperzy w Polsce z perspektywy 5-ciu lat badań (1988-1992) – Podsumowanie. In: B.W.Wołoszyn (ed.). Zimowe spisy nietoperzy w Polsce: 1988-1992. Wyniki i ocena skuteczności: 186-218. CIC ISEZ PAN, Kraków, Poland.

Wołoszyn, B.W. 2001. *Myotis dasycneme* (Boie, 1825). Nocek łydkowłosy. In: Z. Głowaciński (ed.). Polska czerwona księga zwierząt. Kręgowce: 51-52. Państwowe Wydawnictwo Rolnicze i Leśne, Warszawa, Poland.

Żmudziński, L. 1997. Rekolonizacja głębokiego dna Wdzydz Południowych dowodem poprawy czystości jeziora. Przegląd Przyrodniczy 8 (3): 73-77.

Samenvatting

Zeldzaam of onderschat? - Het voorkomen van de meervleermuis (*Myotis dasycneme*) in Polen

Dit artikel geeft een overzicht van het voorkomen van de meervleermuis (*Myotis dasycneme*) in Polen, gebaseerd op alle beschikbare gepubliceerde en ongepubliceerde gegevens. De soort is waargenomen in 105 UTM-hokken, verspreid over een groot deel van Polen. Daarnaast zijn fossiele resten, vooral uit het Holoceen, gevonden in 13 UTM-hokken. Voortplanting is vastgesteld in 10 UTM-hokken, uitsluitend in het noordelijk merengebied en in de riviervalleien van het centrale deel van Polen. Er zijn slechts twee kraamkolonies gevonden, met respectievelijk 481 en 391 individuen. De overige zomerwaarnemingen (41 UTM-hokken) zijn verspreid door het land gedaan, ook in delen ver verwijderd van de voortplantingsgebieden. Het gaat hier om zichtwaarnemingen en vangsten van volwassen mannetjes, vrouwtjes die niet aan de voortplanting deelnamen of dieren waarvan het geslacht onbekend was. Zomerverblijven (*n*=21) waren vooral gevestigd in gebouwen, holtes in bruggen en vogel- en vleermuiskasten. Winterverblijfplaatsen (*n*=67) van de meervleermuis bevonden zich hoofdzakelijk in oude forten, kelders en grotten. Hiervan werd 63% (*n*=42) bezet door één dier, terwijl in slechts drie verblijven tien of meer (maximaal 34) dieren werden gevonden. In twee verblijven waar regelmatig werd geinventariseerd fluctueerden de aantallen meervleermuizen in de laatste jaren, in een ander winterverblijf namen de aantallen zelfs toe. Het merendeel van de beschikbare data (wintertellingen, vogel- en vleermuiskasten, braakballen van uilen, verkeersslachtoffers, fossiele resten, mistnet-vangsten) laat zien dat meervleermuizen minder dan 1% uitmaken van de vleermuizen in Polen. In enkele delen van het merengebied van noordelijk Polen is het percentage meervleermuizen in mistnet-vangsten echter hoger, 2,1 - 2,7%, in één geval zelfs 17,5%. Veel gebieden die in potentie geschikt zijn als leefgebied voor de meervleermuis zijn nog niet onderzocht. Dit suggereert dat de meervleermuis in Polen wel eens veel algemener zou kunnen zijn dan tot dusver werd gedacht.

Received: 17 January 2007
Accepted: 7 October 2007

Annex 1. Breeding records of the pond bat in Poland. Explanations: r. – river, l. – lake(s), rs – survey of roost, nt – netting, tr – radiotracking of individuals from Jeleniewo nursery, ad. – adult, juv. – juvenile, lact. – lactating, act. – sexually active. If no symbol is given, the numbers refer to the unsexed individuals or that no data about sex and age are available. Capital italics (e.g. *AP*) represent the initials of unpublished data owners (explained in the acknowledgements) or of the authors (*MC* – Mateusz Ciechanowski, *KS* – Konrad Sachanowicz, *TK* – Tomasz Kokurewicz).

UTM square	Locality	Method	Date	Number and status of bats	Source
XV 88	Lubnia, forester's lodge	rs (nursery)	17.07.2002	107[1]	Ciechanowski et al. 2003a
			19.07.2003	160	*MC & KS*
			07.07.2004	321[2]	*MC & AP*
			07.07.2005	391[3]	*MC & AP*
			15.07.2006	252[4]	*MC*
			27.06.2007	231[5]	*MC*
XV 89	Loryniec, Wda r.	nt	11.07.2002	9 ♀♀ ad. lact., 1 ♀ juv., 1 ♂ juv.	Ciechanowski et al. 2003a
XV 89	Schodno l., outflow of Wda	nt	23.08.2004	1 ♀ ad. lact.	Ciechanowski et al. 2006
			01.09.2004	2 ♀♀ juv.	Ciechanowski et al. 2006
			27.07.2005	1 ♂ juv.	Ciechanowski et al. 2006
XV 89	Płocice, Wda r.	nt	15.07.2002	1 ♀ juv.	Ciechanowski et al. 2006
XV 98	Borsk, Wda r.	nt	12.07.2003	5 ♀♀ ad. (4 lact.)	Ciechanowski et al. 2006
CC 33	Mikołajewice, old branch of Warta r.	nt	26.06.2004	1 ♀ ad. lact.	*MI*
DC 99	Łomianki, on road	found dead	12.08.1997	1 ♀ juv.	Lesiński 2003
DE 05	stream between Januszewskie and Czerwica l.	nt	11.07.1999	1 ♀ juv.	Ciechanowski et al. 2002
EB 51	Trześnia, church loft	rs (nursery)	06.1867	*large number*	Jachno 1868
EB 51	Sokolniki tree hole	rs	25.06.1867	1 ♀ with juv.	Jachno 1868
FF 20	Jeleniewo, church loft	rs (nursery)	09.07.1997	476	*MW*
			10.07.1999	481 (♀♀ ad. + juv.)	Wojciechowski et al. 1999
			25.07.2002	467 (♀♀ ad. + juv.)	*TK & JF*
			31.07.2002	315	*TK & JF*
FF 20	Szelment Wielki l.	tr	24.07 - 04.08.2002	11	*TK & JF*
FF 21	Szurpiły l.	tr	24.07 - 04.08.2002	12	*TK & JF*

[1]nt: 1 ♀ juv., 1 ♂♂ juv.; [2]nt: 2 ♀♀ ad. lact., 1 ♂ juv.; [3]nt: 2 ♀♀ ad. (1 lact.), 1 ♂ juv.; [4]nt: 1 ♀ ad. lact., 1 ♀ juv.; [5]nt: 2 ♀♀ ad. lact., 1 ♂ juv.

Annex 2. Non-breeding summer records of *Myotis dasycneme* in Poland. Explanations: r. – river, l. – lake(s), f.d. – forest district, dt – foraging or commuting bat, observed with ultrasound detector, rs – survey of roost, nt – netting, ad. – adult, juv. – juvenile, act. – sexually active. If no symbol is given, the numbers refer to the unsexed individuals or that no data about sex and age are available. Capital italics (e.g. *MW*) represent the initials of unpublished data owners (explained in the acknowledgements) or of the authors (*MC* – Mateusz Ciechanowski, *KS* – Konrad Sachanowicz, *TK* – Tomasz Kokurewicz).

UTM square	Locality	Method	Date	Number and status of bats	Source
VU 46	Bielinek, Old Odra r.	dt	1999		Szkudlarek & Dzięgielewska 2003
VV 60	Lower Odra Valley, canals	dt	2001		*RS*
WR 88	Kudowa Zdrój	dt	07.1999		*RS* in: Mikusek & Pikulska 1999
WU 30	Międzyrzecz Fortified Front ("Nietoperek" bat reserve), undergrounds	nt	31.07.2001	1 ♂	*TK* et al.
WU 96	Trzcianka, narrow between Długie l. & fish ponds	nt	13.05.2000	1 ♂	Wojtaszyn 2002
XS 09	Tarchalice, old branch of Odra r.	dt	2003		*JF*
XS 46	Odra r. near Wrocław	dt	2001		*RS*
XV 76	Struga Siedmiu Jezior, between Płęsno and Skrzynka l.	nt	14.08.2002	1 ♂ ad.	*MK*
CB 90	Wielkanocna Cave	rs	15.08.1998	3 (1 ♂ ad.)	*MI*
CC 33	Jeziorsko reservoir	nt	07.1995	1 ♂ ad.	*JH*
CC 33	Warta II, Mazur ox-bow lake, crevice in a bridge	rs	20.07.2003	2	Ignaczak & Manias 2004
CC 42	Nobela, Niniwka r., crevice in a bridge	rs	12.10.2003	1	Ignaczak & Manias 2004
CC 42	Kolasa, Niniwka r., crevice in a bridge	rs	08.06.2003	1	Ignaczak & Manias 2004
CC 50	Brody, Grabia r., crevice in a bridge	rs	20.05.2003	1	Ignaczak & Manias 2004
CD 82	Gociąż l., bird box	rs	29.06.1993	1 ♂ ad.	Kasprzyk & Ruczyński 2001
CE 95	Fabianki, Liwa r.	nt	07.1997	2	Ciechanowski et al. 2002
CE 99	"Lake Drużno" nature reserve	dt	29.07.2001	1	*MC*
		nt	26.08.2002	1	*CN* (photo), *MC* (det.)
CF 25	Wejherowo, Reda r.	nt	21.08.2002	1 ♂ ad.	*MC*
			21.08.2004	1 ♂ ad.	*MC*
CF 52	Gdańsk-Sobieszewo, bat box	rs	30.07.2006	1 ♂ ad.	*MC*
DB 87	Chlewiska, church	rs	11.06.1993	1 ♂ ad.	*SC & MK*
DC 16	Rydwan and Okręt fish ponds	nt	07.1972	1	*ZW*
DC 20	Golesze, building loft	rs (colony)	1997-1998	up to 10 ♂♂	*SZ*
DC 30	Tomaszów Mazowiecki, Pilica r.	nt	03.09.1999	2 ♂♂ ad.	*JH*, *WP* & *RJ*
DC 71	Wólka Magierowa, Drzewiczka r.	nt	04.08.1995	1 ♂ ad. act.	*MK, GL & AO-K*
DD 60	Kromnów f.d., Kampinos Forest, bird box	rs	03.08.1989	1 ♂ ad.	Kowalski & Lesiński 1995
DD 80	Łomna, church loft	rs	21.07.1984	1 ♂ ad.	Kowalski & Lesiński 1995
			15.06.1991	1 ♂ ad.	Kowalski & Lesiński 1995
DD 80	Kiełpin, on road	found dead	22.09.1999	1	Lesiński 2003
DE 05	canal between Twaruczek and Płaskie l.	nt	11.07.1999	1 ♀ ad.	Ciechanowski et al. 2002
DE 21	Kostkowo f.d., bat box	rs	26.07.2005	1 ♂ ad.	*JG & AS*
EB 69	Puławy, loft of forester's lodge,	rs (colony)	1952	9 ♂♂, 1 ♀	Krzanowski 1956
EC 08	Warszawa-Marymont, Kaskada Park, hollow *Carpinus betulus* tree	rs	08.1861	1 ♂, 1 ♀	Wałecki 1881
EC 15	Czersk, church loft	rs	25.07.1992	1	*IK*
ED 79	Motyka, bat box	rs	09.06.2004	1 ♂ ad.	*MK & TN*
ED 99	Wierciszewo, campsite near Biebrza r.	dt	30.08.2004		*GA & AJH*
EE 35	Mikołajskie l.	dt	08.08.1994		*BV & HH*
EE 46	canal between Łuknajno and Śniardwy l.	dt	09.08.1994		*BV & HH*
FB 30	Zwierzyniec, city park	nt	03.07.1989	1 ♂ ad.	Jurczyszyn 1994
FC 70	Żłobek, barn	rs (colony)	07.2000	12 ♂♂	*MP*
FD 94	Białowieża Forest, Hwoźna r., bridge	nt	02.06.2007	1 ♂ ad.	*IR*
FE 01	Gugny, bird boxes	rs	30.06.1987	7 (3 ♂♂)	Lesiński 2001
			05.08.1988	4 ♂♂ ad.	Lesiński 2001
FE 15	Dręstwo l.	dt	15.08.1994		*BV* & *HH* in: Lesiński 2001
FE 27	Rospuda r., bridge	nt	03.06.2007	1 ♂ ad.	*BK*
FE 37	bridge between Necko and Białe l.	dt	02.06.2007		*BK*

UTM square	Locality	Method	Date	Number and status of bats	Source
FE 39	narrow between Okrągłe and Wigry l.	nt	07.07.1995	1	Postawa & Gas 2003
			04.07.1996	1	Postawa & Gas 2003
			07.07.1996	1	Postawa & Gas 2003
FE 39	narrow between Białe and Wigry l.	nt	11.07.1995	1	Postawa & Gas 2003
FE 47	Augustowski Canal	nt	25.08.1996	1 ♂ ad. act.	*RD*
FF 21	Jaczno water-mill	nt	04.07.1998	1 ♂	Ciechanowski et al. 2003b

Annex 3. Hibernacula (November-February), transitional roosts (March-April, September-October) and associated swarming sites (netting) of the pond bat in Poland. Explanations: rs – survey of roost, nt – netting at the entrance, ad. – adult. If no symbol is given, the numbers refer to unsexed individuals. Capital italics (e.g. *MW*) represent the initials of unpublished data owners (explained in the acknowledgements) or of the authors (*MC* – Mateusz Ciechanowski, *KS* – Konrad Sachanowicz, *TK* – Tomasz Kokurewicz).

UTM square	Locality	Method	Date	Number and status of bats	Source
VV 71	Szczecin, near the pier of the bridge on the Berlin-Szczecin motorway	found grounded	12.03.1988	1	Janyszak & Jurczyszyn 1989
WS 62	Kowary, adit near Hydromech	rs	01.1998	3	Szkudlarek & Paszkiewicz 1999
			11.1998	3	Szkudlarek & Paszkiewicz 1999
			11.1999	3	Szkudlarek & Paszkiewicz 1999
			01.1999	4	Szkudlarek & Paszkiewicz 1999
			16.12.1999	3	Furmankiewicz et al. 2001
			16.03.2000	3	Furmankiewicz et al. 2001
WS 93	Książ, under the castle	rs	1972-1974	1 ♂	Haitlinger 1976
WS 94	Północna Duża Cave	rs	01.11.1964	1 ♂	Wołoszyn 1968, 1971
			21.03.1971	1 ♂, 1 ♀	Haitlinger 1976
			23.01.1972	2 ♂♂	Haitlinger 1976
			05.02.1973	2 ♂♂	Haitlinger 1976
			03.12.1973	1 ♂	Haitlinger 1976
			15.01.2000	1 ♀	Kliś et al. 2001
WS 94	Nowa Cave	rs	23.01.1972	1 ♂	Haitlinger 1976
			01.04.1973	1 ♀	Haitlinger 1976
			17.03.1974	1 ♂, 1 ♀	Haitlinger 1976
WS 94	Szczelina Wojcieszowska Cave	rs	02.02.2001	1	Kliś et al. 2001
WU 30	Międzyrzecz Fortified Front ("Nietoperek" bat reserve), underground	rs	31.10.1975	1	Bagrowska-Urbańczyk & Urbańczyk 1983
			03.01.1975	1	Bagrowska-Urbańczyk & Urbańczyk 1983
			07-08.12.1985	1	Lesiński 1988a
			1989	2	Urbańczyk & Gólski 1994
			1991	2	Urbańczyk & Gólski 1994
			1992	3	Urbańczyk & Gólski 1994
			01.02.1995	3	*KS* et al.
			22.11.1998	3	*TK* et al.
			06.01.1999	2	*TK* et al.
			20.01.2001	2	*TK* et al.
			18.01.2003	7	*TK* et al.
			15.01.2005	16	*TK* et al.
			14.01.2006	13	*TK* et al.
			13.01.2007	21	*TK* et al.
		nt[1]	12.08 -24.09.1994	1	Łupicki & Kowalcze-Łupicka 1999
			18.08 -10.09.1995	10	Łupicki & Kowalcze-Łupicka 1999
			08.09.2000	3	Łupicki et al. 2001
			13.10.2000	3	Łupicki et al. 2001
WU 30	Pieski, bunker PzW 741	rs	21.11.1998	1	Szkudlarek et al. 2001
			17.01.1999	3	Szkudlarek et al. 2001
			26.01.2000	4	Szkudlarek et al. 2001
			14.02.2001	5	Szkudlarek et al. 2001

UTM square	Locality	Method	Date	Number and status of bats	Source
			25.03.2001	8	Szkudlarek et al. 2001
			21.02.2002	2	*MW & TK*
		nt	17.08.1999	4	Łupicki et al. 2001
			10.09.1999	2	Łupicki et al. 2001
			24.09.1999	2	Łupicki et al. 2001
			10.10.1999	1	Łupicki et al. 2001
			16.08.2000	2	Łupicki et al. 2001
			02.09.2000	1	Łupicki et al. 2001
			19.09.2000	2	Łupicki et al. 2001
WU 30	Wysoka, military tunnel	rs	14.02.2001	3	Szkudlarek et al. 2001
			24.03.2001	1	Szkudlarek et al. 2001
			20.02.2001	1	*MW & TK*
WU 30	Stare Kursko, bunker PzW 754-757	rs	13.10.1998	1	Szkudlarek et al. 2001
			26.01.2000	2	Szkudlarek et al. 2001
			14.02.2001	1	Szkudlarek et al. 2001
WU 30	Pieski, bunker PzW 743	rs	26.01.2000	1	Szkudlarek et al. 2001
			25.03.2001	1	Szkudlarek et al. 2001
WA 70	Koszalin, air-raid shelter	rs	31.01.2005	1	Wojtaszyn et al. 2006
XR 07	Młoty, Obiegowa Adit	rs	05.03.2005	1	*PK*
XU 30	Poznań Fortress, Fort I	rs	09.12.1995	1 ♂	Gawlak 1996
CB 45	Szachownica Cave	rs	28.03.1981	1 ♂	Lesiński 1983
			06.03.1982	2 ♂♂	Lesiński 1983
			29.01.1982	1 ♂, 1 ♀	Lesiński 1983
			29.01.1983	1 ♂	Lesiński 1983
			29.01.1994	4	*MK, MI & KS*
			1993/94	max. 3	Hejduk & Radzicki 1996
			1994/95	max. 3	Hejduk & Radzicki 1996
			29.01.1995	2	*MI*
			29.01.1996	6	Kowalski *et al*. 2002
			29.01.2000	4	*MI*
			29.01.2001	4	*MI*
			29.01.2002	5	*MI*
		nt	07.09.2002	3 ♂♂ ad.	*MI*
			28.09.2002	1 ♂	*MI*
CB 46	Stalagmitowa Cave	rs	28.11.1982	1 ♂	Lesiński 1983
CB 72	Towarna Cave	nt	11.05.2000	1	*TP & AW*
CB 72	Pod Sokolą Górą Cave	rs	21.11.1993	2	Postawa & Zygmunt 2000
			20.11.1977	1	Postawa & Zygmunt 2000
			07.11.1993	1	Postawa & Zygmunt 2000
			05.02.1994	1	Postawa & Zygmunt 2000
			02.02.1995	1	Postawa & Zygmunt 2000
			27.10.1993	1	Postawa & Zygmunt 2000
CB 72	Koralowa Cave	rs	28.10.1951	1 ♀	Kowalski 1953
CB 72	Studnisko Cave	rs	02.03.2001	1	Gas & Postawa 2001
CB 81	Wiercica Cave	rs	06.11.1963	1	Skuratowicz 1968
			10.11.1996	1	Postawa & Zygmunt 2000
			12.02.1998	1	Postawa & Zygmunt 2000
			14.02.1998	1	Postawa & Zygmunt 2000
CD 37	Toruń, Fort V	rs	03.2000	max. 3	*KK*

UTM square	Locality	Method	Date	Number and status of bats	Source
			31.01.2003	1	*KK*
CF 43	Gdańsk, Wisłoujście Fortress, Fort Carré	rs	11.02.2002	2	Ciechanowski et al. 2006a
			14.09.2002	8	Ciechanowski et al. 2006a
			24.09.2002	2	Ciechanowski et al. 2006a
			24.10.2002	1	Ciechanowski et al. 2006a
			21.11.2002	6	Ciechanowski et al. 2006a
			21.12.2002	6	Ciechanowski et al. 2006a
			21.01.2003	4	Ciechanowski et al. 2006a
			16.02.2003	6	Ciechanowski et al. 2006a
			22.03.2003	5	Ciechanowski et al. 2006a
			18.09.2003	6	*MC & KS*
			19.12.2003	4	*MC & AP*
			24.02.2004	3	*MC & AP*
			18.02.2005	10	Ciechanowski et al. 2006a
			08.02.2006	2	Ciechanowski et al. 2006a
			05.02.2007	4	Ciechanowski et al. 2006a
		nt	06.10.2000	4 ♂♂	Ciechanowski & Przesmycka 2001
			21.10.2000	1 ♀	Ciechanowski & Przesmycka 2001
			14.09.2002	1 ♂	*MC & KS*
			14.09.2003	5 ♂♂	*MC & KS*
CF 43	Gdańsk, Wisłoujście Fortress, Prochownia	rs	24.02.2004	1	*MC & AP*
			18.02.2005	1	Ciechanowski et al. 2006a
			08.02.2006	5	Ciechanowski et al. 2006a
			05.02.2007	1	Ciechanowski et al. 2006a
		nt	15.10.2006	1 ♀	*MC*
DV 15	Psia Cave	rs	17.03.2000	2	Nowak et al. 2001
			02.03 -25.04.2000	1	Nowak et al. 2001
DV 15	Miętusia Wyżnia Cave	rs	11.02.2001	1	Nowak et al. 2001
DV 25	Magurska Cave	rs	31.12.1998	2	Nowak et al. 2001
			07.01.2001	1	Nowak et al. 2001
			10.03.2000	1	Nowak et al. 2001
DA 08	Zegar Cave	rs	29.01.1998	2	Postawa & Zygmunt 2000
			10.02.1998	2	Postawa & Zygmunt 2000
			11.02.1999	2	Postawa & Zygmunt 2000
			11.03.1998	2	Postawa & Zygmunt 2000
DA 16	Biała Cave	rs	1985	1	Godawa 1995
DA 16	Nietoperzowa Cave	rs	08.03.1987	1	Godawa & Wołoszyn 1990
			12.03.1988	1	Godawa & Wołoszyn 1990
			10.02.1995	3	Kozakiewicz & Strzałka 1996
DA 16	Łokietka Cave	rs	11.02.1997	2	Nowak & Kozakiewicz 2000
DA 16	Jama Ani Cave	rs	15.02.2001	1	Nowak et al. 2002
DA 16	Zbójecka Cave	rs	27.02.2001	1	Nowak et al. 2002
			2003	3	Grzywiński et al. 2004
DB 53	Adit in Miedzianka	rs	26.09.1960	2	Wołoszyn 1962
			29.12.1960	2	Wołoszyn 1962
			13.02.1961	1	Wołoszyn 1962
			04.01.1963	1 ♂	Wołoszyn 1964

UTM square	Locality	Method	Date	Number and status of bats	Source
DB 84	Bukowa Góra, adit	rs	15.02.2000	2	*MG*
DD 70	Fort Cybulice I	rs	25.10.1984	1 ♂ ad.	Kowalski & Lesiński 1995
DD 71	Fort Goławice	rs	05.12.1979	1 ♂ dead	Lesiński 1988b, Ruprecht 1983
			22.12.1981	1 ♂	Lesiński 1988b
DD 71	Fort Strubiny	rs	17.11.1981	1 ♀	Lesiński 1988b
DD 71	Modlin, citadel	rs	07.04.1998	1	*GL*
DD 71	Fort Henrysin	rs	23.11.1996	1	*MF & GL*
DD 80	Fort Janówek III	rs	02.02.1997	1	*GL & PHCL*
			29.03.1998	1	*GL*
			10.02.1998	2	Gulatowska & Kowalski 2004
			07.12.2003	3	Gulatowska & Kowalski 2004
			27.12.2003	4	Gulatowska & Kowalski 2004
			30.01.2004	5	Gulatowska & Kowalski 2004
			27.02.2004	7	Gulatowska & Kowalski 2004
			11.12.2005	9	*JG & MK*
DD 81	Fort Czarnowo	rs	13.11.1987	1 ♀	Lesiński 1988b
			29.11.1987	1 ♀	Lesiński 1988b
EB 02	Łagów, Zbójecka Cave	rs	02.02.1960	1	Wołoszyn 1962
EB 68	Bochotnica, artificial cave	rs	30.11.1987	1 ♀	*MK*
			03.02.1988	1 ♂	*MK*
			13.02.1989	1 ♂	*JPC*
			08.02.1992	2	Kowalski & Dróżdż 2002
			02.2000	3	*MP & MU*
			02.2001	2	*MP*
			09.03.1991	1 ♀	*MK*
			26.03.2002	1	*MP & MU*
EB 69	Puławy artificial cave	rs	02.01.1952	1 ♀	Krzanowski 1956, 1959a
EB 69	Puławy, cellar of the Sybilla Temple	rs	25.11.1954	1 ♂	Krzanowski 1956
EB 69	Puławy, greenhouse	rs	?	1	Krzanowski 1963
ED 79	Piątnica, fort	rs	02.12.1990	1	Kowalski et al. 2003
			02.12.1992	1	Kowalski et al. 2003
			09.12.1996	1	Kowalski et al. 2003
ED 79	Kalinowo, cellar	rs	24.01.2002	1	Kowalski et al. 2003
ED 79	Drozdowo, cellars of brewery	rs	01.12.1993	1	Kowalski et al. 2003
			04.02.1994	1	Kowalski et al. 2003
			05.12.2000	1	Kowalski et al. 2003
			03.12.2002	1	Kowalski et al. 2003
			09.12.2003	1	Kowalski et al. 2003
ED 79	Drozdowo, Dolna Street, cellar	rs	05.12.2000	1	Kowalski et al. 2003
			31.01.2001	1	Kowalski et al. 2003
ED 79	Drozdowo, Kraska Street	rs	29.11.1999	1	Kowalski et al. 2003
			04.02.2000	1	Kowalski et al. 2003
ED 88	Pniewo, cellar	rs	17.12.2002	1	Kowalski et al. 2003
ED 89	Żelechy, village well	rs	27.01.2002	1	Kowalski et al. 2003
ED 89	Żelechy, cellar	rs	09.12.2003	1	Kowalski et al. 2003
EE 48	Giżycko, Boyen Fortress	rs	1992-1999	1	Fuszara et al. 2002
EE 93	Łojki, cellar	rs	14.02.2003	1	Kowalski et al. 2003
FB 40	Senderki, artificial caves	rs	20.02.2002	2	*MP & MU*
FD 30	Anusin, bunker SM AN 2	rs	29.10.1994	1	Sachanowicz 2003

UTM square	Locality	Method	Date	Number and status of bats	Source
FD 30	Anusin, bunker SM AN 7	rs	28.10.1995	1 ♂	Sachanowicz 2003
			02.12.1995	1	Sachanowicz 2003
FD 30	Anusin, bunker SM AN 11	rs	26.10.1996	1	Sachanowicz 2003
			13.02.1999	2	Sachanowicz 2003
FD 30	Anusin, bunker SM AN 14	rs	26.10.1996	1 ♀	Sachanowicz 2003
			28.12.1995	1	Sachanowicz 2003
FE 02	Osowiec, Fort Zarzeczny	rs	14.12.2003	1	Kowalski et al. 2003
FE 11	Trzcianne, cellar	rs	09.12.1997	1	Lesiński 2001
			06.02.1998	1	Lesiński 2001
			19.01.1999	1	Lesiński 2001
			08.12.2002	1	Lesiński 2001
			11.02.2003	1	Kowalski et al. 2003
FE 12	Downary, cellar	rs	07.02.1992	1	Lesiński 2001
			04.02.1997	1	Lesiński 2001
			09.12.1997	1	Lesiński 2001
			06.02.1998	1	Lesiński 2001
			22.01.1999	1	Lesiński 2001
			04.01.1992	1	Kowalski et al. 2003
			30.01.1999	1	Kowalski et al. 2003
			15.02.2000	1	Kowalski et al. 2003
			20.11.2000	1	Kowalski et al. 2003
			29.11.2001	1	Kowalski et al. 2003
			04.02.2002	1	Kowalski et al. 2003
			18.02.2002	1	Kowalski et al. 2003
FE 12	Osowiec, Fort Centralny	rs	26.11.1993	6	Lesiński 2001
			03.02.1994	2	Lesiński 2001
			05.12.1994	13	Lesiński 2001
			13.02.1995	8	Lesiński 2001
			23.11.1995	15	Lesiński 2001
			01.02.1996	2	Lesiński 2001
			26.11.1996	21	Lesiński 2001
			09.12.1997	34	Lesiński 2001
			04.02.1997	2	Lesiński 2001
			06.02.1998	16	Lesiński 2001
			11-12.1998	18	Lesiński 2001
			02.1999	2	Lesiński 2001
			11-12.1999	8	Lesiński 2001
			02.2000	11	Lesiński 2001
			29.11.2000	9	Lesiński 2001
FE 45	Hamulka, cellar	rs	10.02.2003	2	Kowalski et al. 2003
FE 45	Trzyrzeczki, cellar	rs	30.12.2000	1	Lesiński 2001
FE 55	Kamienna Stara, bunker 84	rs	10.02.2003	1	Kowalski et al. 2003

[1]entrance A64 (Wysoka)

Annex 4. Localities of the pond bat in Poland with undetermined status or dates. Explanations: f. i. – forest inspectorate, f. d. – forest district, obs – visual observation of foraging or commuting individuals, pl – remains extracted from owl pellets, rs – survey of roost, juv. – juvenile, coll – collected (museum) specimen (UAM – Adam Mickiewicz University of Poznań; ISEZ – Institute of Animal Systematics and Evolution PAS, Kraków; MIZ – Museum and Institute of Zoology PAS, Warszawa). If no abbreviation is given, the numbers refer to unsexed individuals or that no data about sex, age and reproduction status are available. Capital italics (e.g. *KK*) represent the initials of unpublished data owners (explained in the acknowledgements).

UTM square	Locality	Method	Date	Number and status of bats	Source
WS 43	Cieplice, fish ponds	obs		frequently recorded	Pax, 1925
WU 86	Folsztyn	pl (*Tyto alba*)	07.05.1984	1	Ruprecht 1990
XT 19	Jeziory f. i.	coll (UAM)	1965	1	Ruprecht 1983
XT 51	Milicz, fish ponds	obs, coll (UAM)		1	Pax 1925
XS 81	Niemodlin, fish ponds	obs		frequently recorded	Pax 1925
YU 01	Hutka f. d., Skorzęcin f. i., bat boxes	rs	1950-1951	3 times	Kozikowski & Niedzielski 1954
CB 45	Szachownica Cave	pl (*Strix aluco*)	01-02.1987 -1988	1	Kowalski & Lesiński 1990
CD 18	Solec Kujawski	pl	1964		Ruprecht 1979b, 1983
CD 56	Ciechocinek	pl (*Tyto alba*)	1960		Ruprecht 1964 in: Ruprecht, 1983
CD 66	Sumin	pl	1971		Ruprecht 1983
CE 52	Grudziądz, The Citadel	rs	05.02.2003	1 (mummified)	*KK*
CE 53	Pokrzywno, the old castle	pl (*Strix aluco*)	10.04.2001	1	*KK*
EC 90	Michów	pl	1961		Nikodem 1982, Ruprecht 1983
DV 57	Pieniny, Dunajec river[1]	obs			Sitowski 1948
DA 16	Biała Cave	coll (ISEZ)		1	Ruprecht 1983
DB 93	Świętokrzyski National Park[2]				Čmak 1968
DB 94	Świętokrzyski National Park[2]				Čmak 1968
DC 99	Warszawa-Marymont	coll (MIZ)	XIX century	1	Ruprecht 1983
DD 71	Fort Janowo	pl (*Tyto alba*)	14.10.1984	1	Kowalski & Lesiński 1986
EB 69	Włostowice	pl	1955		Ruprecht 1983
EE 08	Reszel	pl	1961		Ruprecht 1983
EE 18	Święta Lipka	pl	1961		Ruprecht 1983
EE 55	Kociołek	pl	1961		Ruprecht 1983
EE 77	Zelki	pl	1961		Ruprecht 1983
FB 79	Osowa, game-keeper's cottage	pl (*Strix aluco*)	1990-1991	1	Styka 2000
FD 48	Białystok	coll	1979	1	J. Kupryjanowicz in: Ruprecht 1983
CA 53	Pszczyna, fish ponds	obs		frequently recorded	Pax 1925
CA 78	Tuliszów	coll	1866	1 juv.	Wałecki 1881
EC 07	Jeziorna	coll (MIZ)	XIX century	1	Ruprecht 1983

[1]doubtful according to Kowalski (1955), thus not included in the analysis

[2]no details on date, status nor localities were given, thus we regarded these records as doubtful and rejected them from the analysis

Annex 5. Fossil records of the pond bat in Poland

UTM square	Locality	Period	Source
WS 94	Wschodnia Cave	Pleistocene	Zotz 1939 in: Wołoszyn 1987
CB 72	Maurycego Cave	Holocene	Postawa 2004
CB 72	Pod Sokolą Górą Cave	Holocene	Postawa 2004
CB 72	Studnisko Cave	Holocene	Postawa 2004
		Pleistocene	Bednarczyk in: Horáček & Hanák 1989
CB 72	Urwista Cave	Pliocene	Horáček & Hanák 1989
CB 72	Zamkowa Dolna Cave	Pliocene	Wołoszyn 1987
CB 81	Trzebniowska Cave	Holocene	Postawa 2004
CB 90	Studnia Szpatowców Cave	Pliocene[1]	Kowalski 1956
CB 90	Żabia Cave	Pleistocene	Horáček & Hanák 1989
CB 91	Kryształowa Cave	Holocene	Postawa 2004
DV 15	Czarna Cave	Holocene	Piksa & Wołoszyn 2001
DV 15	Nad Dachem Cave	Holocene	Piksa & Wołoszyn 2001
DV 15	Piwnica Miętusia Cave	Holocene	Piksa & Wołoszyn 2001
DV 15	Ptasia Cave	Holocene	Piksa & Wołoszyn 2001
DV 15	Studnia w Kazalnicy Cave	Holocene	Piksa & Wołoszyn 2001
DV 15	Szczelina Chochołowska Cave	Holocene	Piksa & Wołoszyn 2001
DV 15	Wysoka Cave	Holocene	Piksa & Wołoszyn 2001
DV 15	Zimna Cave	Holocene	Piksa & Wołoszyn 2001
DV 37	Obłazowa Cave	Holocene	Ochman & Wołoszyn 2003
DV 57	cave in Szopczański Gorge	Holocene	Alexandrowicz et al. 1985
DA 16	Bramka Cave	Holocene	Madeyska 1981
DA 16	Na Tomaszówkach Dolnych Cave	Holocene	Postawa 2004
DB 56	Kozi Grzbiet	Pleistocene	Wołoszyn 1987
DB 63	Raj Cave	Holocene	Wołoszyn 1987
EB 02	Zbójecka Cave in Łagów	Holocene	Wołoszyn 1989
FA 43	Józefów, karst fissures	Holocene	Kowalski et al. 1963

[1]as *Myotis dasycneme subtilis*