Folia Zool. – 54 (4): 351–358 (2005)

Long-term changes in the numbers of the barbastelle *Barbastella barbastellus* in Poland

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Received 29 September 2004; Accepted 24 October 2005

A b s t r a c t . In order to identify population trends in *Barbastella barbastellus* in Poland we summarised results of long-term winter bat counts conducted between 1985 and 2004 in seven of the most important hibernacula of the species. The results show an upward trend in four of the sites while in the remaining four no trend was found. The numbers of barbastelles in Poland seem stable or even increasing. In Central Europe the species is not threatened as seriously as it is in Western Europe.

Key words: *Barbastella barbastellus*, population trends, hibernation, Poland

Introduction

The barbastelle *Barbastella barbastellus* is included in the IUCN European endangered species list in the VU category (H u t s o n et al. 2001). It is also listed in the II and IV annexes of the European Council Directive on the conservation of natural habitats and of wild fauna and flora. On the other hand, it is not mentioned in the Polish Red Data Book of Animals (G ł o w a c i ń s k i 2001), although the Red List of Threatened Animals in Poland mentions it as a poorly known species in the Data Deficient category (G ł o w a c i ń s k i 2002).

The barbastelle is generally considered an elusive species, not easy to study in the wild due to weak echolocation signals and the location of summer roosts in rather inaccessible places, e.g. under bark of trees. Fortunately, its numbers can be easily monitored in hibernation sites. In Central Europe the barbastelle frequently winters in large underground roosts (R y b á ř 1975, S k l e n á ř 1981, B o g d a n o w i c z 1983, L e s i ń s k i 1986, R i c h a r z 1989, U r b a ń c z y k 1989, U h r i n 1995, F u s z a r a et al. 1996) where it is possible to conduct bat counts without disturbing the animals. Numerous roosts suitable for the hibernation of the barbastelle (mainly disused military structures) are known in Poland. Recently, F u s z a r a et al. (2003) listed the 12 largest Polish hibernacula of the species, where the maximum numbers exceeded 100 individuals.

Monitoring of barbastelle numbers in Poland has been conducted since 1982, although many important roosts were discovered later. The results were partly published (U r b a ń c z y k 1989, K o w a l s k i & L e s i ń s k i 1991, 1994, B e r n a r d 1994, U r b a ń c z y k & G ó l s k i 1994, F u s z a r a et al. 1994, 1996), but so far no paper has attempted to summarise the data in order to identify population trends of barbastelles in Poland.

Study Area and Methods

Our paper summarises results of the barbastelle counts conducted between 1987 and 2004 in seven of the most important bat hibernation sites listed below (their distribution is shown in Fig. 1).
1. "Nietoperek" – a large system (about 30 km) of concrete corridors of a twentieth-century fortification, located 30–50 m below the ground surface; almost 30000 individuals of all bat species hibernate there every winter (U r b a ń c z y k 1991); now a bat reserve.
2. "Szachownica" – a cave (partly disused limestone mine) about 1000 m long; the highest number of bats recorded during a single survey – 1477 (K o w a l s k i & L e s i ń s k i 1991).
3. "Poznań fort I" – one of the ring of city forts built of bricks; the highest number of bats recorded during a single survey – 1816 individuals (J u r c z y s z y n et al. 2003).
4. "Modlin forts" – a ring of late nineteenth/early twentieth-century forts of various sizes (the length of corridors from 150 to 400 m) belonging to the system of the Modlin fortress; about 600 bats hibernate there every winter (L e s i ń s k i 1988).
5. "Konewka" – a WWII concrete bunker designed to shelter a train, approximately 350 m long; the highest number of bats recorded during a single survey – 248 individuals (F u s z a r a & F u s z a r a 2002).
6. "Osowiec fort" – a brick-and-concrete fort located near the Biebrza river, consisting of many short corridors (total length of the inspected part is about 600 m), the highest number of bats recorded during a single survey – 344 individuals (L e s i ń s k i 1994).
7. "Gierłoż/Mamerki" – two groups of WWII German bunkers (Hitler's headquarter and the Oberkommando des Heeres headquarter), where bats hibernate mainly in cellars and small underground tunnels; in this study considered a single site as the distance between them (about 15 km) seems too small to exclude a possibility that they are alternative roosts for the same population of barbastelles; the highest number of bats recorded during a single survey – 555 individuals.

Fig. 1. Location of the study sites (numbered as in the text). 1 – Nietoperek, 2 – Szachownica cave, 3 – Poznań fort I, 4 – Modlin forts, 5 – Konewka, 6 – Osowiec fort, 7 – Mamerki/Gierłoż.

All these sites were surveyed between the 1st and 15th of February (the period of national bat census in Poland), except for the Szachownica cave, where bats were always counted on the

29th of January. In some roosts additional surveys were conducted in late November/early December (Modlin forts, Konewka, Osowiec fort, Gierłoż/Mamerki) or at the beginning of March (Szachownica cave). Bats were not handled, so no information about their sex is available.

The sites differed in respect of the years in which hibernating bats were counted according to the above described scheme (Table 1), while the period common for all the sites seems too short to allow for general conclusions (some of the described hibernacula were discovered only in the early nineties, while in the "Nietoperek" reserve the regime of bat counts changed after 1996). We therefore analysed changes in the number of barbastelles for each site separately. This should not be a source of bias, as the species shows a high degree of site fidelity (L e s i ń s k i 1986) and thus it does not seem likely that individuals hibernating in one of the described hibernacula in one year moved to another of them in the next.

For each of the hibernacula under study a coefficient of determination was calculated and to test for its significance the F value was calculated and its probability read from the F distribution (Z a r 1996).

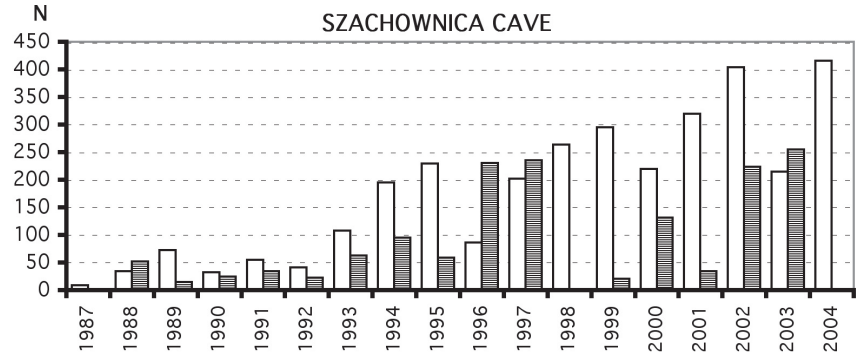
Table 1. Regression coefficients and their statistical significance for the numbers of barbastelles wintering in seven of the most important hibernacula of the species in Poland. NS – not significant.

Hibernation site	Study period	Census time	r^2	P
Nietoperek	1985–1996	February	0.3325	0.0497
Szachownica cave	1987–2004	29 January	0.8019	5.1325 E-07
		March	0.3363	0.0185
Poznań fort I	1988–2004	February	0.6876	3.8667 E-05
Modlin forts	1989–2004	February	0.3738	0.0119
		Nov./Dec.	0.7084	6.3212 E-05
Konewka	1993–2004	February	0.1489	n.s.
		Nov./Dec.	0.1568	n.s.
Osowiec fort	1993–2004	February	0.1647	n.s.
		Nov./Dec.	0.0950	n.s.
Mamerki/Gierłoż	1994–2004	February	0.0062	n.s.

Results

Analysis of the changes in the number of hibernating barbastelles did not reveal a downward trend in any of the hibernacula under study (Fig. 2). In four of them (the "Nietoperek" reserve, the Szachownica cave, the Fort I in Poznań and the forts of Modlin) the number of barbastelles increased significantly over the study period (Table 1). In Modlin and Szachownica, where additional censuses (in November/December and March, respectively) were performed, the upward trend was found for both sets of data. The most pronounced was the increase in the Szachownica cave, where in the early 1980s only a few barbastelles hibernated. By 1996 their number rose to over 200 and in January 2002 exceeded 400 individuals.

Results from the remaining sites, monitored only from the early 1990s, showed no trends. Generally, the numbers of the barbastelle fluctuated in all the sites under study. The fluctuations showed no clear similarities, the hibernacula differed in respect to the years in which the maximum numbers were recorded (Szachownica – 2004, Poznań – 1999, Modlin – 1996, Konewka – 2003, Osowiec – 2001, Mamerki/Gierłoż – 1997, „Nietoperek" – 1992 – but here the data from 1997 on are missing) as well as to the direction of year-to-year changes (Fig. 2).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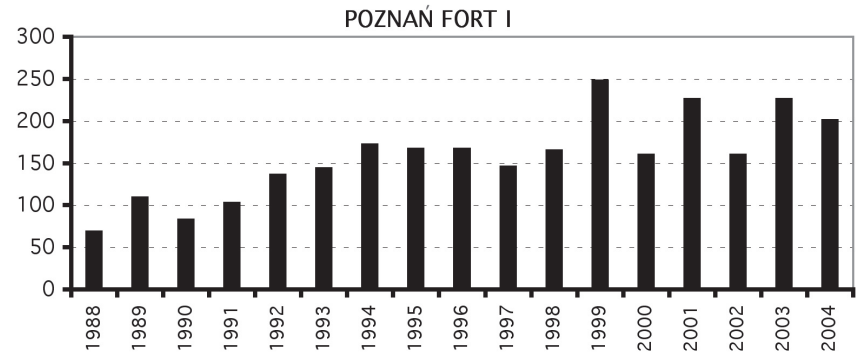
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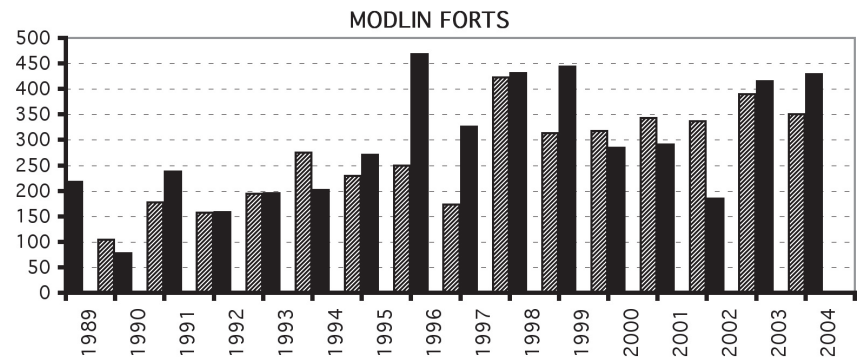
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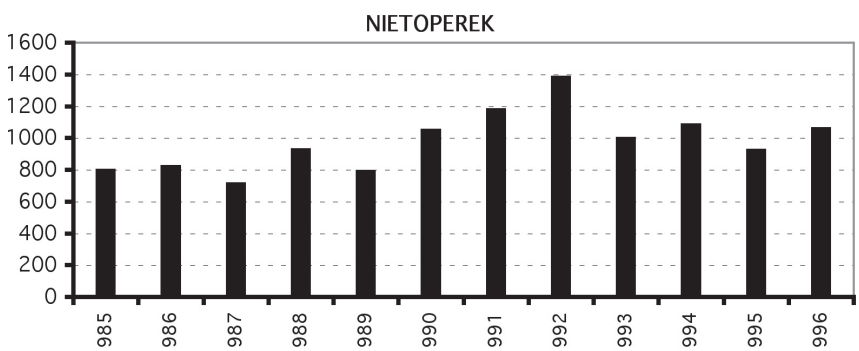
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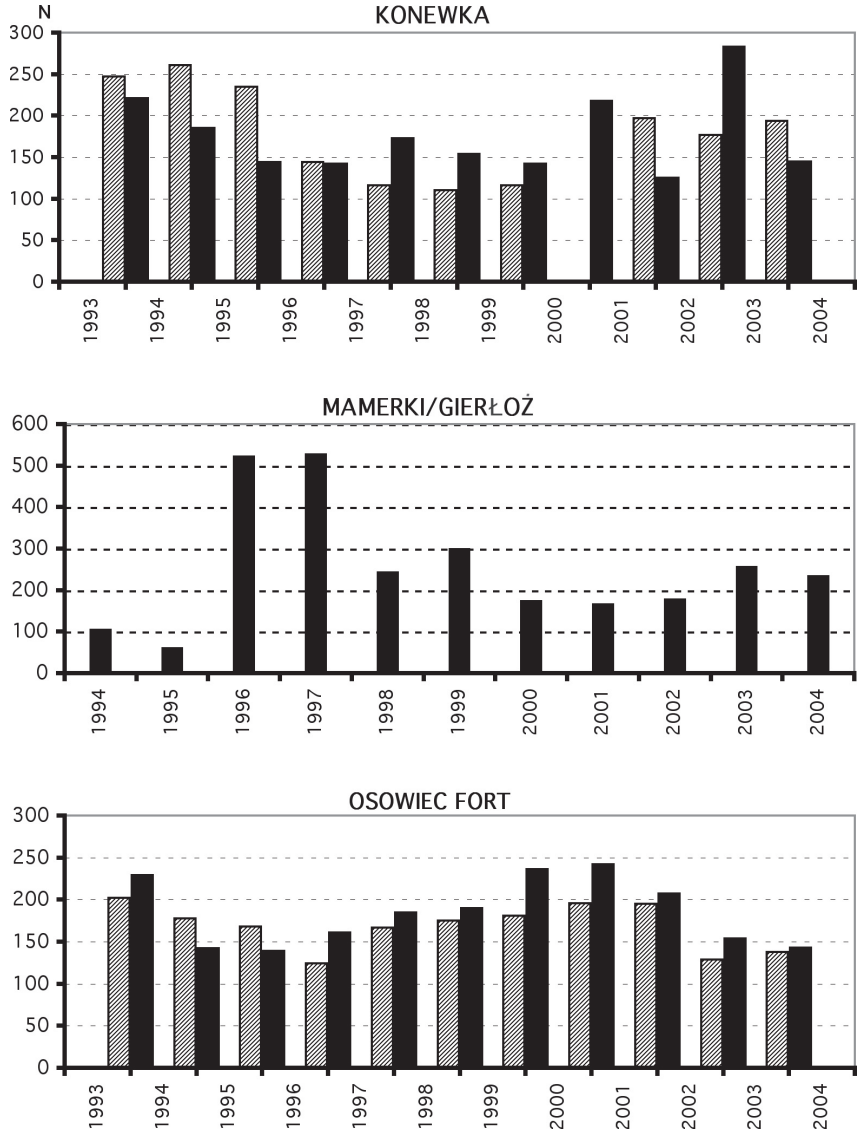

Fig. 2. Changes in numbers of hibernating barbastelles. □ – January 29, ■ – first half of February, ▤ – first decade of March, ▨ – late November/early December.

Results of the additional censuses performed in some of the studied hibernacula in late November/early December were rather similar to the corresponding February data. In the Szachownica cave, on the other hand, many of the results of March counts differed markedly from those obtained at the end of January (Fig. 2).

Discussion

The increase in the numbers of the barbastelle in some of its important hibernation sites in Poland during the last two decades seems to resemble that of some other bat species (e.g. the

Daubenton's bat *Myotis daubentonii*), recorded earlier in many European countries (D a a n 1980, B á r t a et al. 1981). At present, Polish populations of the barbastelle seem to be stable or even growing. No similar results have so far been reported from Western and Southern Europe. In Belgium (F a i r o n & B u s c h 2003), Switzerland (T h e i l e r 2003) and the Balkan Peninsula (P a u n o v i c et al. 2003) the number of barbastelles appears to be decreasing. In Austria and Germany, on the other hand, the populations of the barbastelle are considered stable or even slightly increasing (R u d o l p h et al. 2003, S c h o b e r 2003, S p i t z e n b e r g e r & M a y e r 2003, W e i d n e r & G e i g e r 2003). Similar to our results, a clear upward trend was found in some other Central European hibernacula, e.g. in Lithuania (P a u z a et al. 2003) or the Czech Republic (Ř e h á k & G a i s l e r 1999, W a g n e r 2001), although in one large Slovak hibernaclum a pronounced decrease took place in the 1990s (U h r i n et al. 2002).

The case of the Szachownica cave requires some comment, as it differs from the other sites in that it is a relatively new hibernaculum. Limestone mining finished here as late as 1962 and probably only then did the cave become available to bats (H e j d u k & R a d z i c k i 2003). Therefore, to some extent the spectacular increase in the number of hibernating barbastelles is due to the fact that over the years more and more bats moved there from some other shelters. Nevertheless, as the growth has continued for 40 years since mining ceased, we believe that it also reflects a true population trend.

The fluctuations in the number of hibernating barbastelles could not be easily attributed to differences in weather conditions (e.g. F u s z a r a & F u s z a r a 2002, F u s z a r a et al. 2002). Unfortunately, in most of the hibernacula under study bats are not protected in any way against human disturbance, so we cannot exclude the possibility that bats were occasionally flushed from their shelters or were forced to retreat to deep crevices where they could not be counted.

A comparison of the results obtained at different times of the year suggests that the most useful period for monitoring barbastelle numbers is midwinter (late January/early February), while late autumn (November/December) seems sometimes too early and early spring (March) definitely too late – probably this species, believed to prefer rather low temperatures (R y d e l l & B o g d a n o w i c z 1997), is, in warmer years, reluctant to come to hibernacula and readily abandons them as soon as temperatures rise in spring.

The barbastelle populations inhabiting Poland are probably not threatened as seriously as those from Western Europe, where the bat is still classified as an endangered species (S t e b b i n g s 1988).

A c k n o w l e d g e m e n t s

We thank Michał A d a m i a k , Maurycy I g n a c z a k , Marek K o w a l s k i , Michał W o j c i e c h o w s k i , Błażej W o j t o w i c z and numerous other people who helped us during the field work or allowed us to use their unpublished data.

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