

## Longevity and winter roost fidelity in bats of central Poland

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Data concerning life span of the bats inhabiting Poland are scarce. The Lesser Horseshoe bat *Rhinolophus hipposideros* that lived minimum 21 years and the Mouse-eared bat *Myotis myotis* (min. 11 years) are regarded to be the oldest. Taking into consideration the maximum life span of bats recorded in Europe one can suppose that these do not illustrate the longevity of bat species living in Poland. Migrations of bats have been studied only in southern Poland (KOWALSKI et al. 1957) showing differences in winter roost fidelity of particular species. Some data on relation of bats to their winter roosts were published by KRZANOWSKI (1959).

The aim of this study is determination of winter roost fidelity from year to year in bats, migrations between winter roosts, and life span of different species of bats in central Poland.

The research covered three areas: Modlin Forts, underground roosts in Warsaw, and caves in the Wieluń Upland. Modlin Forts (52°23' - 52°32' N; 20°33' - 20°48' E) comprise a chain of 24 units surrounding the Modlin Fortress, of which 10 were under study. They are built of concrete and the length of the corridors ranges from 80 to 460 m. The most abundant species there was the Barbastelle bat *Barbastella barbastellus* followed by the Daubenton's bat, *Myotis daubentonii* and the Mouse-eared bat (LESIŃSKI 1988). The underground roosts of Warsaw (52°12' - 52°17' N; 21°00' - 21°04' E) comprise three forts situated around Cytadela (northern part of the city), Elizeum (the centre) and the underground of Fosa (southern part of the city) of unknown origin. All of them are built of brick and the dominant species there was the Natterer's bat *Myotis nattereri* (FUSZARA & KOWALSKI 1995). The caves in the Wieluń Upland (51°03' - 51°05' N; 18°48' - 18°49' E) are made in limestone. The biggest one is Szachownica. It is situated 5 km from the other seven caves located on the Zelce hill. Some of its

corridors were converted into big rooms during the excavation of limestone. This cave attracts about 90% of the bats wintering in this area. The dominant species in the caves of the Wieluń Upland were the Natterer's bat and the Mouse-eared bat (LESIŃSKI 1983, KOWALSKI & LESIŃSKI 1991).

Bats were individually marked with metallic bands from 1979 to 1990. In Modlin Forts the most intensive banding was performed in winter seasons 1979/80 - 1982/83, in Warsaw in 1984/85 - 1989/90, and in Szachownica cave in 1981/82 - 1983/84. In total 2055 bats of 11 species were ringed (tab. I). The most frequent monitoring was carried out in the periods of bat banding and directly afterwards (usually every two weeks), however, since 1991 only twice a season. Only in the Szachownica cave bats were recounted every 14 days in the seasons 1993/94 - 1997/98, and in the biggest fort of Modlin every 10 days in the seasons 1996/97 and 1997/98. This paper sums up the data collected by 1 April 2000.

### Results

Among 2055 banded bats, 464 individuals (22.6%) were recaptured 644 times. The percentage of the recaptured bats was 12.3 in the Wieluń Upland, 22.2 in Warsaw, and 26.7 in Modlin Forts (tab. I). The frequency of observations of the banded bats was different depending on the species and roost (from 4.8 to 44.4 for the species in which more than 10 individuals had been ringed). The most frequently recaptured bat categories were: males of the Serotine bat *Eptesicus serotinus*, Mouse-eared bat, and Barbastelle bat (more than 40% of the bats ringed) in Modlin Forts, males of the Natterer's bat and females of the Daubenton's bat (more than 30%) in Warsaw, males and females of the Brandt's bat *Myotis brandtii* (more than 20%) in the Wieluń Upland. The recaptures of bat

Table 1. Number of banded (Nb) and recaptured (Nr) bats in three complexes of winter roosts in central Poland

| Species, sex                     | Modlin Forts |     |       | Warsaw |    |      | Wieluń Upland |    |       |
|----------------------------------|--------------|-----|-------|--------|----|------|---------------|----|-------|
|                                  | Nb           | Nr  | %     | Nb     | Nr | %    | Nb            | Nr | %     |
| <i>M. myotis</i> , males         | 32           | 13  | 40,6  | 3      | 0  | 0    | 53            | 4  | 7,5   |
| <i>M. myotis</i> , females       | 25           | 4   | 16,0  | 2      | 0  | 0    | 43            | 5  | 11,6  |
| <i>M. bechsteinii</i> , males    | 0            | –   | –     | 0      | –  | –    | 17            | 1  | 5,9   |
| <i>M. bechsteinii</i> , females  | 0            | –   | –     | 0      | –  | –    | 5             | 1  | 20,0  |
| <i>M. nattereri</i> , males      | 44           | 7   | 15,0  | 58     | 21 | 36,2 | 67            | 10 | 14,9  |
| <i>M. nattereri</i> , females    | 32           | 2   | 6,2   | 59     | 9  | 15,8 | 53            | 3  | 5,7   |
| <i>M. mystacinus</i> , males     | 0            | –   | –     | 0      | –  | –    | 18            | 1  | 5,5   |
| <i>M. mystacinus</i> , females   | 0            | –   | –     | 0      | –  | –    | 7             | 2  | 28,6  |
| <i>M. brandtii</i> , males       | 0            | –   | –     | 0      | –  | –    | 52            | 13 | 25,0  |
| <i>M. brandtii</i> , females     | 0            | –   | –     | 0      | –  | –    | 14            | 3  | 21,4  |
| <i>M. daubentonii</i> , males    | 245          | 36  | 14,7  | 29     | 7  | 24,1 | 37            | 3  | 8,1   |
| <i>M. daubentonii</i> , females  | 273          | 42  | 15,4  | 63     | 10 | 15,9 | 24            | 2  | 8,3   |
| <i>M. dasycneme</i> , males      | 2            | 0   | 0     | 0      | –  | –    | 11            | 2  | 18,2  |
| <i>M. dasycneme</i> , females    | 2            | 1   | 50,0  | 0      | –  | –    | 1             | 1  | 100,0 |
| <i>E. serotinus</i> , males      | 18           | 8   | 44,4  | 0      | –  | –    | 0             | –  | –     |
| <i>E. serotinus</i> , females    | 4            | 0   | 0     | 0      | –  | –    | 0             | –  | –     |
| <i>P. auritus</i> , males        | 39           | 9   | 23,1  | 21     | 4  | 19,0 | 53            | 7  | 13,2  |
| <i>P. auritus</i> , females      | 30           | 9   | 30,0  | 7      | 0  | 0    | 42            | 2  | 4,8   |
| <i>P. austriacus</i> , males     | 6            | 4   | 66,7  | 0      | –  | –    | 0             | –  | –     |
| <i>P. austriacus</i> , females   | 2            | 2   | 100,0 | 0      | –  | –    | 0             | –  | –     |
| <i>B. barbastellus</i> , males   | 350          | 143 | 40,9  | 1      | 0  | 0    | 5             | 2  | 40,0  |
| <i>B. barbastellus</i> , females | 197          | 67  | 34,0  | 5      | 4  | 80,0 | 4             | –  | –     |
| Total                            | 1301         | 347 | 26,7  | 248    | 55 | 22,2 | 506           | 62 | 12,3  |

species occurring in low numbers were relatively more frequent than the recaptures of abundant species.

Recaptures of banded bats were much more frequent for the first two winters than later on (tabs. 2, 3, 4). However, in many species banded individuals were recorded even after more than 10 years (tab. 5). In most species male bats lived longer than the females, only in the Barbastelle

bat and the Daubenton's bat in the Modlin Forts the life spans of males and females were similar.

Sixteen banded bats were found in other winter roosts than the place of marking (0.6-7 km, tab. 6). Fifteen of them were bats hibernating in Modlin Forts and one in the caves of the Wieluń Upland. In 5 cases the migrations took place during one winter season. Moreover one bat banded in the Modlin Forts in winter was found in sum-

Table 2. Number of bats recaptured in the Wieluń Upland in relation to season after banding

| Species, sex                    | Season after banding |   |    |     |    |   |    |     |      |    |   |    |     |      |     |
|---------------------------------|----------------------|---|----|-----|----|---|----|-----|------|----|---|----|-----|------|-----|
|                                 | 0                    | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | XIII | XIV |
| <i>M. myotis</i> , males        | 1                    | 1 |    |     |    |   |    |     |      |    |   |    | 1   |      |     |
| <i>M. myotis</i> , females      | 4                    |   | 1  |     |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. bechsteinii</i> , males   | 1                    |   |    |     |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. bechsteinii</i> , females | 1                    |   |    |     |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. nattereri</i> , males     | 4                    | 2 | 5  | 1   |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. nattereri</i> , females   | 1                    | 1 |    |     |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. mystacinus</i> , males    | 1                    |   |    |     |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. mystacinus</i> , females  | 2                    |   |    |     |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. brandtii</i> , males      | 7                    | 2 |    |     |    | 1 |    |     |      |    |   |    | 1   |      |     |
| <i>M. brandtii</i> , females    |                      |   | 2  |     |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. daubentonii</i> , males   | 1                    | 1 |    |     |    |   |    |     |      |    |   | 1  |     |      | 1   |
| <i>M. daubentonii</i> , females | 1                    |   |    |     |    |   |    |     |      |    |   |    |     |      |     |
| <i>M. dasycneme</i> , males     |                      |   |    |     | 1  |   |    |     | 1    |    |   |    |     | 1    | 1   |
| <i>M. dasycneme</i> , females   |                      |   |    |     |    |   |    | 1   |      |    |   |    |     |      |     |
| <i>P. auritus</i> , males       | 1                    | 2 | 1  |     |    |   |    | 1   |      |    |   |    | 1   |      |     |
| <i>P. auritus</i> , females     | 1                    |   |    |     |    |   |    |     |      |    |   |    |     | 1    |     |
| <i>B. barbastellus</i> , males  |                      |   |    |     |    |   |    |     | 1    |    |   |    | 1   | 1    |     |

Table 3. Number of bats recaptured in the Modlin Forts in relation to season after banding

| Species, sex                     | Season after banding |    |    |     |    |   |    |     |      |    |   |    |
|----------------------------------|----------------------|----|----|-----|----|---|----|-----|------|----|---|----|
|                                  | 0                    | I  | II | III | IV | V | VI | VII | VIII | IX | X | XI |
| <i>M. myotis</i> , males         | 9                    | 6  | 1  |     |    |   |    |     |      |    |   |    |
| <i>M. myotis</i> , females       | 3                    | 1  | 1  |     |    |   |    |     |      |    |   |    |
| <i>M. nattereri</i> , males      | 6                    | 3  |    |     | 1  |   |    |     |      |    |   |    |
| <i>M. nattereri</i> , females    | 4                    |    |    |     |    |   |    |     |      |    |   |    |
| <i>M. daubentonii</i> , males    | 14                   | 21 | 6  | 1   |    |   |    | 2   | 2    | 1  | 2 | 1  |
| <i>M. daubentonii</i> , females  | 22                   | 11 | 8  | 1   | 1  |   |    | 1   | 1    |    | 1 | 1  |
| <i>M. dasycneme</i> , females    | 1                    |    |    |     |    |   |    |     |      |    |   |    |
| <i>E. serotinus</i> , males      | 3                    | 4  | 1  | 1   |    |   |    |     | 1    |    |   |    |
| <i>P. auritus</i> , males        | 7                    |    |    | 1   |    |   |    |     |      |    |   |    |
| <i>P. auritus</i> , females      | 1                    | 1  |    |     |    |   |    |     |      |    |   |    |
| <i>P. austriacus</i> , males     | 4                    |    |    |     |    |   |    |     |      |    |   |    |
| <i>P. austriacus</i> , females   | 1                    |    |    |     |    |   |    |     |      |    |   |    |
| <i>B. barbastellus</i> , males   | 88                   | 61 | 35 | 5   | 2  | 6 | 4  | 2   | 3    | 3  | 1 |    |
| <i>B. barbastellus</i> , females | 39                   | 30 | 15 | 1   | 2  | 2 |    |     |      | 1  | 1 |    |

Table 4. Number of bats recaptured in Warsaw in relation to season after banding

| Species, sex                     | Season after banding |   |    |     |    |   |    |     |      |    |   |   |
|----------------------------------|----------------------|---|----|-----|----|---|----|-----|------|----|---|---|
|                                  | 0                    | I | II | III | IV | V | VI | VII | VIII | IX | X |   |
| <i>M. nattereri</i> , males      | 11                   | 5 | 3  | 5   | 3  | 1 |    |     |      |    | 1 |   |
| <i>M. nattereri</i> , females    | 2                    | 2 | 4  | 2   |    |   |    |     |      |    |   |   |
| <i>M. daubentonii</i> , males    | 2                    | 3 | 3  |     | 1  | 2 | 1  |     |      |    | 1 | 1 |
| <i>M. daubentonii</i> , females  | 7                    | 1 |    |     | 2  | 1 |    |     |      |    |   |   |
| <i>P. auritus</i> , males        | 2                    | 1 | 1  |     |    |   |    |     |      |    |   |   |
| <i>B. barbastellus</i> , females | 4                    |   |    |     |    |   |    |     |      |    |   |   |

Table 5. The oldest observed bats of different species (older than 4 years)

| Roost location<br>Species | Sex    | Date of banding | Place of banding | Date of recapture | Place of recapture | Min. age           |
|---------------------------|--------|-----------------|------------------|-------------------|--------------------|--------------------|
| <b>Modlin Forts</b>       |        |                 |                  |                   |                    |                    |
| <i>M. nattereri</i>       | male   | 11 II 1981      | Janowo Fort      | 8 XII 1984        | Janowo             | 4 years 5 months   |
| <i>M. daubentonii</i>     | male   | 9 X 1981        | Strubiny I Fort  | 29 XII 1992       | Strubiny I         | 11 years 5 months  |
| <i>M. daubentonii</i>     | female | 30 X 1980       | Strubiny I Fort  | 28 X 1991         | Strubiny I         | 10 years 3 months  |
| <i>E. serotinus</i>       | male   | 7 XI 1981       | Błogosławie Fort | 31 I 1990         | Błogosławie        | 8 years 5 months   |
| <i>B. barbastellus</i>    | male   | 11 XII 1980     | Goławice I Fort  | 13 II 1991        | Janowo             | 10 years 7 months  |
| <i>B. barbastellus</i>    | female | 27 I 1980       | Goławice I Fort  | 17 XII 1989       | Janowo             | 10 years 5 months  |
| <b>Warsaw</b>             |        |                 |                  |                   |                    |                    |
| <i>M. nattereri</i>       | male   | 28 I 1990       | Traugutta Fort   | 14 II 1999        | Fort Traugutta     | 9 years 7 months   |
| <i>M. daubentonii</i>     | male   | 3 XII 1987      | Fosa cellar      | 14 XII 1999       | Fosa               | 12 years 5 months  |
| <i>M. daubentonii</i>     | female | 6 XI 1985       | Traugutta Fort   | 25 XI 1990        | Fort Traugutta     | 5 years 4 months   |
| <b>Wieluń Upland</b>      |        |                 |                  |                   |                    |                    |
| <i>M. myotis</i>          | male   | 27 III 1982     | Szachownica Cave | 7 III 1994        | Szachownica Cave   | 12 years 8 months  |
| <i>M. brandii</i>         | male   | 24 III 1984     | Szachownica Cave | 11 IV 1996        | Szachownica Cave   | 12 years 9 months  |
| <i>M. dasycneme</i>       | male   | 28 XI 1982      | Szachownica Cave | 22 XI 1996        | Szachownica Cave   | 14 years 4 months  |
| <i>M. dasycneme</i>       | female | 29 I 1982       | Szachownica Cave | 29 I 1990         | Szachownica Cave   | 8 years 6 months   |
| <i>M. daubentonii</i>     | male   | 9 III 1982      | Szachownica Cave | 25 I 1996         | Szachownica Cave   | 14 years 6 months  |
| <i>P. auritus</i>         | male   | 8 XI 1986       | Szachownica Cave | 26 X 1993         | Szachownica Cave   | 7 years 3 months   |
| <i>B. barbastellus</i>    | male   | 25 II 1983      | Szachownica Cave | 3 V 1996          | Szachownica Cave   | 13 years 10 months |

Table 6. Movements of bats banded in winter roosts in central Poland in 1980 - 1991

| Species                | Sex    | Date of banding | Place of banding  | Date of recapture | Place of recapture              | Distance |
|------------------------|--------|-----------------|-------------------|-------------------|---------------------------------|----------|
| <i>M. myotis</i>       | male   | 8 X 1980        | Czarnowo Fort     | 6 XI 1980         | Goławice I Fort                 | 6 km     |
| <i>B. barbastellus</i> | female | 23 III 1980     | Goławice I Fort   | 15 XI 1980        | Błogosławie Fort                | 4 km     |
| <i>B. barbastellu</i>  | male   | 9 II 1980       | Goławice I Fort   | 6 XII 1980        | Błogosławie Fort                | 4 km     |
| <i>B. barbastellus</i> | male   | 26 I 1981       | Goławice II Fort  | 9 II 1981         | Goławice I Fort                 | 1,5 km   |
| <i>M. myotis</i>       | male   | 25 V 1980       | Goławice I Fort   | 17 XI 1981        | Janowo Fort                     | 5 km     |
| <i>B. barbastellus</i> | male   | 22 XI 1981      | Goławice II Fort  | 5 XII 1981        | Goławice I Fort                 | 1,5 km   |
| <i>M. myotis</i>       | female | 12 X 1981       | Goławice I Fort   | 23 I 1982         | Janowo Fort                     | 5 km     |
| <i>B. barbastellus</i> | male   | 23 XI 1980      | Czarnowo Fort     | 6 II 1982         | Goławice I Fort                 | 6 km     |
| <i>B. barbastellus</i> | male   | 9 II 1982       | Strubiny I Fort   | 31 XI 1986        | Błogosławie Fort                | 4 km     |
| <i>B. barbastellus</i> | male   | 28 XI 1984      | Janowo Fort       | 9 III 1991        | Strubiny I Fort                 | 3 km     |
| <i>M. daubentonii</i>  | female | 9 X 1981        | Strubiny I Fort   | 7 XI 1989         | Strubiny II Fort                | 0,6 km   |
| <i>M. daubentonii</i>  | male   | 2 X 1982        | Strubiny I Fort   | 18 X 1989         | Janowo Fort                     | 3 km     |
| <i>B. barbastellus</i> | female | 27 I 1980       | Goławice I Fort   | 17 XII 1989       | Janowo Fort                     | 5 km     |
| <i>B. barbastellus</i> | male   | 27 I 1980       | Goławice I Fort   | 5 XII 1989        | Błogosławie Fort                | 4 km     |
| <i>B. barbastellus</i> | male   | 19 XI 1984      | Goławice I Fort   | 13 II 1991        | Janowo Fort                     | 5 km     |
| <i>P. auritus</i>      | male   | 15 I 1984       | Błogosławie Fort  | 24 VII 1987       | Łubiec (forest compartment 122) | 26 km    |
| <i>M. daubentonii</i>  | male   | 17 X 1981       | Stalagmitowa Cave | 29 I 1982         | Szachownica Cave                | 7 km     |

mer in a bird nest box located in the Kampinos National Park at a distance of 26 km, and the remains of one Natterer's bat banded in the Szachownica cave were found in a pellet of the Tawny owl residing in the opening of the cave.

### Discussion

In this study the frequency of the recapture of bats banded in winter roosts was high, 22.6%. According to HARMATA (1996) it was 6.5% for all species and 6.8% for the species hibernating regularly in Poland. It seems also very low in other European countries (e.g. GAISLER & HANÁK 1969). The high frequency of recaptures in our study was most probably caused by frequent visits to their hiding places. This is supported by the fact that the lowest frequency of recaptured bats was in the Wieluń Upland, where the visits were least frequent, and the highest frequency was in the Modlin Forts where the visits were most frequent. Frequent recaptures of the *Barbastelle* bat and the Natterer's bat noted in our study have not been previously documented (GAISLER & HANÁK 1969, HARMATA 1996). Interestingly, bats of the species wintering in small numbers were more frequently recaptured. It also concerns the species that probably hibernate in other types of hiding places in higher numbers (the Serotine bat, the Grey Long-eared bat *Plecotus austriacus*, probably the Pond bat *Myotis dasycneme*). Perhaps the inclination to hibernate

in forts is an individual feature and the few individuals hibernating in these constructions avoid roosts typical for their species.

More frequent reappearance of bats within 2 years after banding may be caused by natural factors. However, irregular monitoring might have had some effect on the results. Visits were more frequent in the years of banding and directly afterwards. On the basis of the material collected it is impossible to examine the rate of mortality or decrease in the abundance of bat species in the study area.

Maximum life spans of seven species recorded in this study (*Myotis nattereri*, *Myotis brandtii*, *Myotis dasycneme*, *Myotis daubentonii*, *Eptesicus serotinus*, *Plecotus auritus*, *Barbastella barbastellus*) are the longest longevity records in Poland. This fact however cannot be explained by an exceptional longevity of bats hibernating in these winter roosts, but rather by a high number of banded bats and regular monitoring that covered many years.

Surprisingly, there are few recorded migrations between different winter roosts, especially within the Modlin Forts although some of the distances between roosts cover only several hundred meters. Many individuals vanish from the site where they were banded for some time, and then they reappear. They might have been hidden in places inaccessible to observers but in the Modlin Forts and in the underground roosts

of Warsaw the number of such hiding places was very small so we expect that in the neighbourhood there are other winter roosts that have not been monitored.

### Summary

Between 1979 and 1990, 2055 bats were banded with metal rings in their hibernation sites in Central Poland. Until year 2000, 464 individuals (22.6%) were recaptured. Rate of recapture was the highest during first two seasons after banding, then it fell rapidly. Few individuals were recaptured even more than 10 years after banding, e.g. *Myotis daubentonii* - 14 years 6 months, *Myotis dasycneme* - 14 years 4 months, *Barbastella barbastellus* - 13 years 10 months, *Myotis brandtii* - 12 years 9 months. Movements between winter roosts were scarce and short (up to 6 km. long).

### Zusammenfassung

Zwischen 1979 und 1990 wurden 2055 Fledermäuse in Winterquartieren Zentral-Polens mit Metallringen markiert. Bis zum Jahr 2000 konnten davon 464 Individuen (22,6%) wiedergefunden werden. Die Wiederfundrate war in den ersten beiden Jahren nach der Beringung am höchsten, danach fiel sie stark ab. Wenige Individuen konnten mehr als 10 Jahre nach der Markierung wiedergefunden werden, z. B. Wasserfledermaus, *Myotis daubentonii* (14 Jahre, 6 Monate), Teichfledermaus, *Myotis dasycneme* (14 Jahre, 4 Monate), Mopsfledermaus, *Barbastella barbastellus* (13 Jahre, 10 Monate), Große Bartfledermaus,

*Myotis brandtii* (12 Jahre, 9 Monate). Nachweise für Überflüge zwischen verschiedenen Winterquartieren waren selten und kurz (bis 6 km).

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