Annual numbers of hibernating Daubenton's bats (*Myotis daubentonii*) and pond bats (*M. dasycneme*) in the dune areas of Meijendel and Uilenbosch

Peter H.C. Lina[1], Aldo M. Voûte[2], Anne-Jifke Haarsma[3], Alphons H.H.M. Bongers[4] & Bart (C.)A. Noort[5]

[1] Naturalis Biodiversity Center, P.O Box 9517, NL-2300 RA Leiden, the Netherlands, e-mail: peter.lina@naturalis.nl
[2] Soest, the Netherlands
[3] Animal Ecology and Physiology, Institute for Water and Wetlands Research, Radboud University, Nijmegen, the Netherlands
[4] Vleermuiswerkgroep Defensieterreinen, Ouderkerk a/d Amstel, the Netherlands
[5] Stichting Zoogdierwerkgroep Zuid-Holland, Heijermanswende 53, NL-2182 WV Hillegom, the Netherlands

Abstract: Since the winter of 1977, the populations of hibernating bats have been monitored in five complexes of bunker corridors of the former Atlantic Wall remaining from World War II in the dune areas of Meijendel and Uilenbosch, which are located in the municipalities of Wassenaar and The Hague (Province of Zuid-Holland, the Netherlands). Through management measures, such as closing the entrances for uncontrolled human trespassers and increasing the number of safe hanging locations, significant numbers of Daubenton's bats *(Myotis daubentonii)* and pond bats *(Myotis dasycneme)* now use these complexes. In addition, small numbers of the whiskered bat *(Myotis mystacinus),* brown long-eared bat *(Plecotus auritus)* and Natterer's bat *(Myotis nattereri)* occasionally hibernate in these complexes. The dune areas in which these complexes are located have been designated as Natura 2000 areas in which the presence of the large numbers of pond bats hibernating there has played an important role. The five complexes together form the most important mating and winter sites of the pond bat in Western Europe.

The authors dedicate this paper to Christiaan Smeenk (1942-2017), formerly mammal curator of Naturalis Biodiversity Center, for his years of enthusiastic participation in the winter monitoring of bats in the Meijendel dune area. His wisdom will remain with us.

Keywords: dune areas, Meijendel, Uilenbosch, pond bats, Daubenton's bats, hibernation, annual numbers, Natura 2000.

Introduction

The dune areas of Meijendel and Uilenbosch are situated just north of The Hague (Province of Zuid-Holland, the Netherlands). The area of Meijendel is predominantly a drinking water extraction area that is managed by Dunea Duin & Water (Dunea), a water supply company. The area has a number of artificial lakes that exist due to the infiltration of river water. The area is mostly owned by the State Forestry Service (Staatsbosbeheer) and is leased to Dunea. Most of the seawall is managed by the Rijnland Water Board and a small part, in the south, by the Delfland

Figure 1. Locations of the bunker-corridor complexes in the dune areas of Meijendel and Uilenbosch.

Water Board. The adjacent Uilenbosch area is owned, managed and used by the Ministry of Defence. The Delfland, DWL and Moffenslag complexes are managed by Dunea, the Wassenaarse Slag complex by the State Forestry Service and the bunkers and corridor complexes in the Uilenbosch area by the Ministry of Defence. Once a year in the winter between 15 December and 15 February, the bats hibernating in these complexes are monitored with the minimum possible disturbance. In addition to the winter counts, other studies focused on the pond bat were carried out in the complexes in the period 2002-2015 (Haarsma et al. 2019, Haarsma et al. in prep.). The locations of the complexes are shown in figure 1.

This paper provides an overview of the annual numbers of hibernating Daubenton's bats *(Myotis daubentonii)* and pond bats *(M. dasycneme)* in the dune areas of Meijendel and Uilenbosch from 1977 to 2020.

The hibernation sites

The Wassenaarse Slag complex

This complex of subterranean man-sized corridors and some remaining bunkers is located on the Wassenaarse Slag. The complex is more than 800 metres long and has more than 100 ventilation shafts. The history of the construction, the various functions of the complex and its use during World War II have been described by Neisingh & Verbeek (1994) and Kras (2014).

Shortly after World War II, the bunkers and corridors fell into disuse. The corridors were substantially filled up with sand. From the 1960s onwards, most of the bunkers that were connected with the corridors were demolished. This was done by blowing up the bunkers or crushing them with heavy machinery. However, a large part of the corridors that connected the bunkers

Figure 3. A cluster of Daubenton's bats and a single pond bat, seen from below in bat box. *Photo: Christian Dietz.*

Figure 2. The type of bat box installed in the bunker complexes. *Photo: Christian Dietz.*

remained intact. Just before the complete demolition of the complex, 35 bats were observed (33 Daubenton's bats and two whiskered bats) on 20 December 1976 in a part of the corridors that was accessible at that time. This observation gave rise to the plan to set up the corridor complex and the remaining bunkers for bats. This led to the entrance of the complex being provided with a grille in 1977[1]. From then onwards, under the supervision of the State Forestry Service, a process of de-sanding and provisional restoration of the complex began with the ventilation and exit shafts being sealed with tiles or concrete plates. This work took place over a number of years.

[1] In this paper January of each year is taken as the winter date, so for example 1977 = the winter of 1976-1977

Between 1993 and 2007, guided tours within the complex took place during summer months. Due to observed cave-ins of, and cracking in, the roof, the complex was closed to visitors from 2007. Between 2014 and 2017, repair work was carried out in which most of the cracks and crevices were closed (Noort et al. 2021).

A special type of bat box was installed to the walls to provide additional shelters throughout the complex (figures 2 and 3). From 2015, guided tours were again organized in a part of the complex. Another part of the complex is reserved as a bat reserve all year round. A separate entrance has been made for visitors to minimize negative effects on the climate in the bat section (Noort et al. 2021).

After the first discovery of hibernating bats in the Wassenaarse Slag complex in December 1976, hibernating bats in the complex were counted annually, usually in the third week of December. The first two hibernating pond bats were observed in the winter of 1979. These animals were the first winter record of this species outside the limestone area in southern Limburg. The annual numbers of hibernating Daubenton's bats and the pond bats from the winter of 1977 until the winter of 2020 are given in figure 4. Since 2013, both Daubenton's bat and the pond bat have been in decline, for reasons that are unclear. The animals may have suffered from the renovation works, which has changed the humidity and temperature in the complex, with the

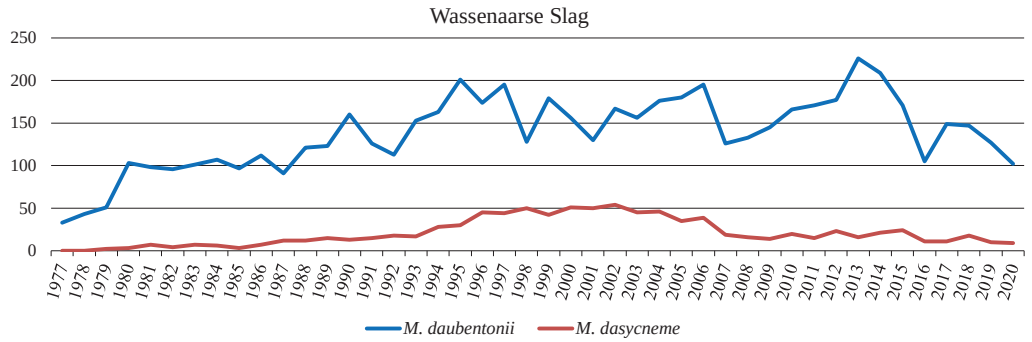

Figure 4. Annual numbers of hibernating *Myotis daubentonii* and *M. dasycneme* in the Wassenaars Slag complex.

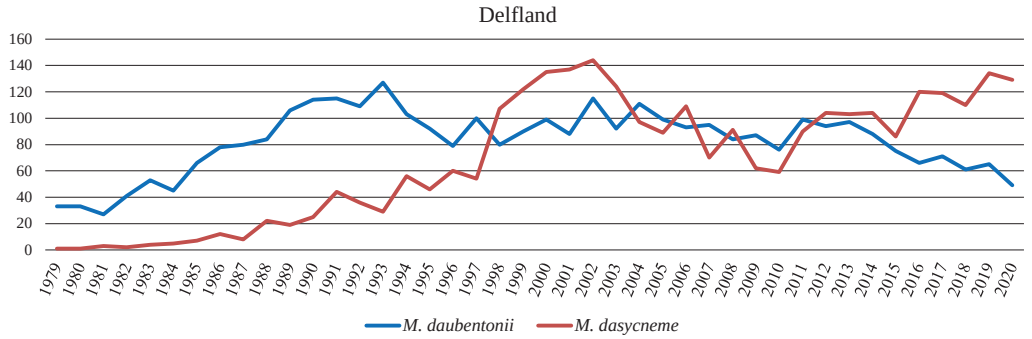

Figure 5. Annual numbers of hibernating *Myotis daubentonii* and *M. dasycneme* in the Delfland complex.

complex becoming drier. The tours in the summer months have possibly also played a role (Noort et al. 2021).

The Delfland complex

The Delfland complex also has subterranean, man-sized corridors, connected to a number of bunkers. The complex has a length of 320 metres. The complex used to be part of the former, and larger, Stützpunkt Marine Seeziel Batterie Scheveningen-Nord XXXX ML complex of corridors (Ambachtsheer 1995) to which the DWL complex also belonged. Despite regular monitoring and enforcement, the Delfland complex is regularly broken into, often in the autumn and winter season, which has very negative consequences for the bats (Noort et al. 2021). The complex has been inspected for hibernating bats since the winter of 1979 and an entrance grille was installed during the summer of 1980. In the summer of 2011 bat boxes (figures 2 and 3) were installed to the walls throughout the complex to provide additional hiding places (Noort et al. 2021). The annual numbers of Daubenton's bat and the pond bat from the winter of 1979 until the winter of 2020 are shown in figure 5.

The DWL complex

As mentioned above, the complex used to be part of the former larger Batterie Scheveningen-Nord corridor complex. It is also a complex of underground, man-sized corridors connecting several bunkers. As with the Delfland complex, the censuses began in the winter of 1979 and the entrance was grilled during the summer of 1980. For a long time, the complex had an accessible corridor length

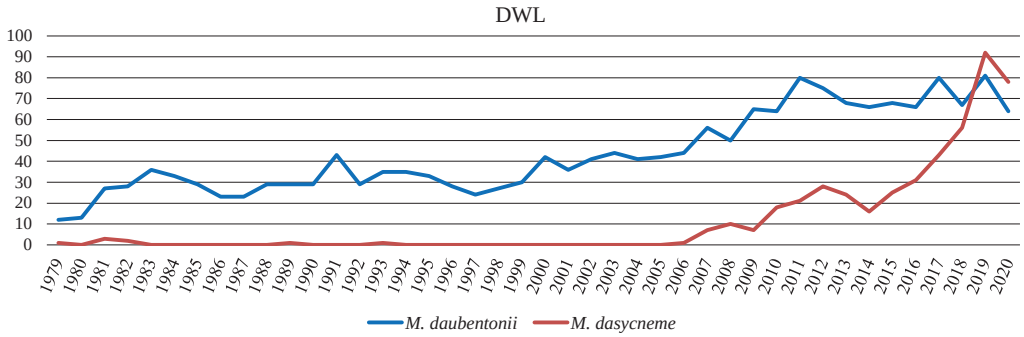

Figure 6. Annual numbers of hibernating *Myotis daubentonii* and *M. dasycneme* in the DWL complex.

of just 80 metres and only two bunkers. In 2007, more than 350 metres of corridors and three bunkers were added which had not been accessible before to people (and probably for bats as well). While there was a steady increase of hibernating Daubenton's bats after the closure, until the winter of 2006 hardly any pond bats were found, in contrast to the very nearby Delfland complex. It was not until the winter of 2007 that the number of this species increased. Occasionally, a few hibernating brown long-eared bats (max. four), whiskered bats (max. two), and Natterer's bats (max. two) were observed. Since the complex was optimized in 2014, the use by the pond bat has grown to about 90 animals. Bat boxes (figures 2 and 3) were also installed in this complex. Banding research has shown that there is no exchange of pond bats between the Delfland and the DWL complexes despite the short distance between the two complexes (110 metres as the crow flies) (Noort et al, 2021). The annual numbers of both Daubenton's bat and the pond bat from the winter of 1979 until the winter of 2020 are given in figure 6.

The Moffenslag complex

This complex is located between the Delfland and DWL complexes and the Wassenaarse Slag complex and also has underground man-sized corridors and some bunkers. The censuses here started in 1984. In the first three winters, no bats were found. It was not until the winter of 1987 that the first hibernating Daubenton's bats were found and then in the winter of 1994, the first pond bats. Since then, the number of animals of both species has steadily increased. Since 2011, the complex has been closed with a solid steel grille. A dramatic decline occurred in 2017 and the numbers had not yet recovered to the previous levels by the winter of 2020. Bat boxes have also been installed in this complex (figures 2 and 3). The annual numbers for both species from the winter of 1984 until the winter of 2020 are given in figure 7. A few hibernating brown long-eared bats (max. six), whiskered bats (max. two), and Natterer's bats (max. one) have occasionally been observed.

The Uilenbosch complex

The Uilenbosch complex is a cluster of 23 larger and smaller bunkers and corridors. Between 1983 and 2000, most of the bunkers and corridors were de-sanded and closed with solid doors. Bat boxes were installed in five of the seven largest corridors in 2015 and in the other bunkers (except one) in 2019. The censuses began in the winter of 1982 but were interrupted for two years in the winters of 1990 and 1991. Illegal trespassing frequently occurs every year. The repair, and increasing strengthening of, the constructions and doors has the full attention of the Ministry of Defence.

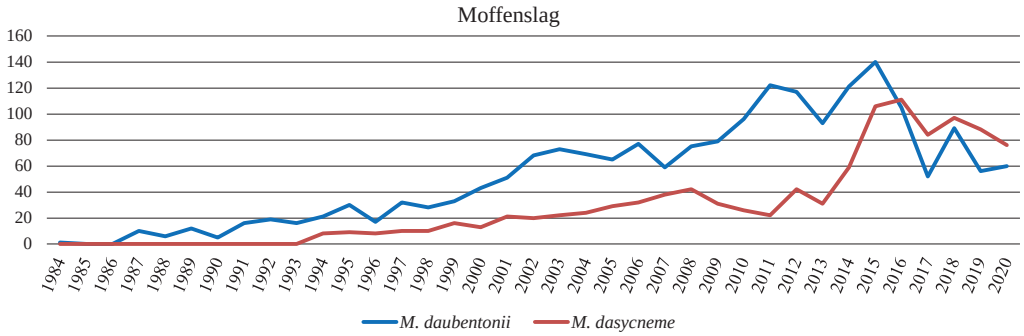

Figure 7. Annual numbers of hibernating *Myotis daubentonii* and *M. dasycneme* in the Moffenslag complex.

Daubenton's bats and pond bats are the dominant hibernating species in the Uilenbosch cluster. Figure 8 shows the annual numbers between 1982 and 2020 of both species in the cluster. In the smaller bunkers, the brown long-eared bat, whiskered bat and Natterer's bat are also observed. The population of hibernating pond bats here has strongly increased to numbers exceeding 250 (272 in 2020) and accounts for about 27% of the hibernating pond bats in the Netherlands and about 8% of the known hibernating individuals of this species in Europe (Noort et al. 2021).

Discussion and Conclusions

Voûte & Lina (1986), who also refer to similar studies abroad, have shown that closing potential hibernation sites of bats with grilles or doors with fly-in slits, thereby avoiding uncontrolled human access, can lead to an increase in the numbers of hibernating bats. Their research drew upon evidence of substantially higher numbers of hibernating Daubenton's bats and pond bats, in the Wassenaarse Slag, Delfland and DWL complexes after the entrances of these complexes were closed. However, extreme caution is recommended with closing measures with doors and walls, as in some situations (such as large limestone mines) this has caused a decline of species that prefer a more dynamic climate (Daan & Wichers 1968, Baranauskas 2006, Haarsma 2011).

Uncontrolled access to hibernation sites can lead to disturbance of bats and can cause a shift in hanging positions (from clusters on the ceiling to hidden in crevices, Haarsma, 2011). The direct effect of human disturbance is often hard to measure, as other (indirect) human activities may also have an effect. It is possible that the public summer excursions into part of the Wassenaar Slag complex is influencing the downward trends of the populations of Daubenton's bats and pond bats there and the part of the complex that is used for public excursions should probably be completely physically closed off from the core part where most bats usually hibernate. The objectives of Natura 2000 should take priority here.

In the absence of sufficient shelters in the complexes, the installation of bat boxes appears to have a great added value, which the pond bat especially benefits from; large groups of up to 30 pond bats have been observed in the boxes (Noort et al. 2021). In each of the bunkers, on average over 80% of the pond bat population can be found hidden in these bat boxes. The use of such boxes is recommended for similar hibernation sites elsewhere, particularly where pond bats hibernate.

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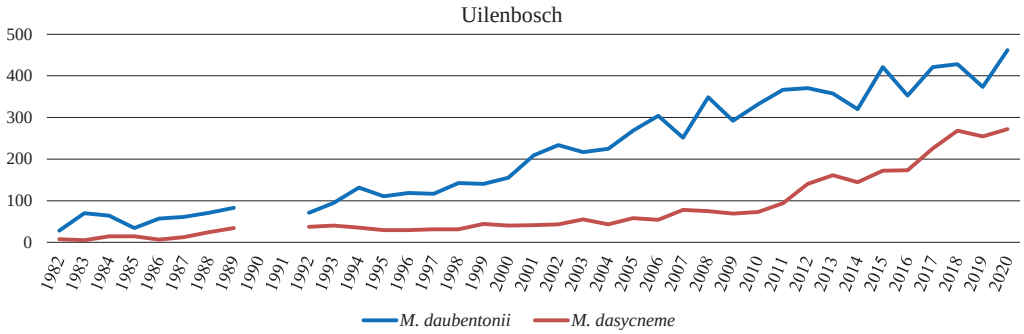

Figure 8. Annual numbers of hibernating *Myotis daubentonii* and *M. dasycneme* in the Uilenbosch cluster of complexes.

have significantly increased over the years. Our special thanks go to Peter H. van Deursen of the State Forestry Service for his initiatives to preserve the bunker complexes. The authors also want to thank the many volunteers who have helped monitoring the bats, which has significantly increased the knowledge about the hibernating bats in both dune areas.

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