Hibernating bats at Klein Heidekamp (Schaarsbergen, Arnhem, the Netherlands)

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Abstract: The Klein Heidekamp complex is a military encampment functionally connected with the Deelen air force base, north of Arnhem, the Netherlands. Bats hibernate here in two rather large cellars (670 and 375 m^3), in the remains of a destructed large building, and in two smaller sites (120 and 56 m^3). Bats were surveyed here for the first time in 1982, when 81 animals were found while only the largest cellar was accessible. Since 1988 all four sites could be inspected and the total number of bats increased steadily to more than 1000 in cold winters with 1580 as a maximum. On average more than 890 bats have been counted here annually over the last five winters (2016-2020). The dominating species by far is Daubenton's bat (*Myotis daubentonii*) with Natterer's bat (*M. nattereri*) as a runner-up from zero in the first winters to a level of around 300 in the past five years. The presence of two speci-mens of pond bat (*M. dasycneme*) during the first visit in 1982 made Klein Heidekamp the second known hiber-nation locality of this species in the Netherlands outside the marl quarries in the south of the province of Limburg. The number of pond bats increased to around 60 animals annually in recent winters. Whiskered bat (*Myotis mys-tacinus/brandtii*) was represented yearly by less than ten specimens over the whole period. Brown long-eared bat (*Plecotus auritus*) usually counts up to less than 20 animals with more than 30 as an exception. Solitary specimens of greater mouse-eared bat (*M. myotis*) occur here on rare occasions. Being situated within a military settlement the location is fenced in and well-guarded, hence it is a safe hibernaculum for the highest numbers of bats in the province of Gelderland.

Keywords: Daubenton's bat *Myotis daubentonii*, Natterer's bat *M. nattereri*, pond bat *M. dasycneme*, brown long-eared bat *Plecotus auritus*, whiskered bat *M. mystacinus/brandtii*, greater mouse-eared bat *M. myotis*, safe (well-guarded) hibernaculum, Province of Gelderland.

Introduction

Deelen airfield is located north of Arnhem, province of Gelderland, the Netherlands (figure 1). It was built here starting in 1940 by the German occupiers ("Fliegerhorst Deelen") and is still in use as a military airport. Around a centrally located open area with runways, there are several complexes with service buildings. The Klein Heidekamp complex, built during the war, is the closest to Arnhem. This contribution describes the development of the number of hibernating bats from the first count in 1982 until 2020 in four sites at this location, which are so close together that they are considered one hibernation site.

Description of the sites

Three of the four sites are the unconnected cellars (KHK1: 670, KHK2: 375 and KHK3: 56 cubic metres) of one large building that was bombed in the war. Afterwards, the above-ground remains were completely demolished

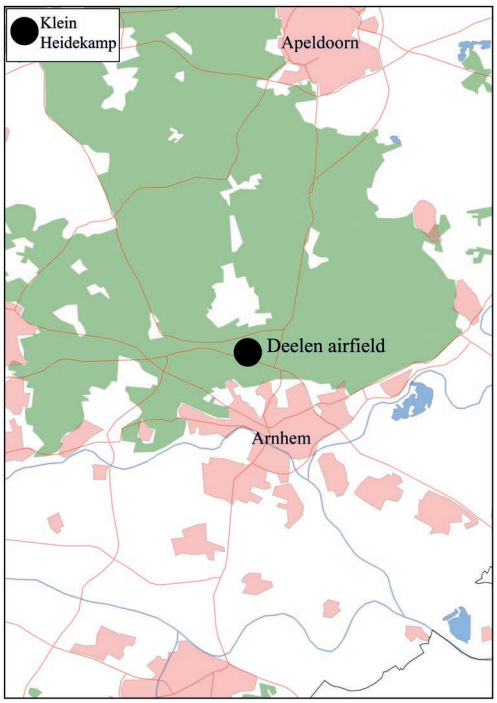

Figure 1. Location of the military complex 'Klein Heidekamp'.

and the cellars were covered with a layer of soil. The cellars have brick and plaster walls. The two large cellars (KHK1 and KHK2) are internally subdivided and therefore have a lot of wall surface. All three cellars are about 2.4 metres high, the largest (KHK1) has a central part of about 2.9 metres high (figure 2). The fourth site (KHK4) is an enclosed section (about 120 metres long, 1 metre wide and 1.2 metres high) of a masonry pipe duct that lies below ground level and held the pipes of the original central heating system. Both large cellars (KHK1 and KHK2) are accessible via an external staircase and a standing door with an entrance opening for bats, the two other sites (KHK3 and KHK4) via a horizontal hatch on a masonry entrance with entrance openings for bats (figure 3). The Klein Heidekamp military complex as a whole can be characterised as a wooded area with scattered service buildings.

The surveys

The largest cellar (KHK1) was first visited in 1982, when 81 bats were found. Outside the marl quarries, this number was only exceeded in Fort Rijnauwen and the Wassenaarse Slag bunker complex. Until 1987, the numbers in this cellar rose to 378 bats. In retrospect, the results of the first counts were too low because certain areas had been overlooked earlier, especially covered window wells in the outer walls of the cellars. Cellar KHK2 was initially inaccessible to both bats and inspection until the entrance was excavated in 1987. In the first winter census after that, 15 bats were counted in this cellar. The difference in the number of bats between the two shelters (KHK1 and KHK2) gradually became smaller. The smallest cellar (KHK3) and the section of the pipe duct (KHK4) were made safer for inspection in 1996 and since then have been surveyed simultaneously with the larger cellars. Since 1994, more than 700 bats have been counted annually in the four sites together, with the highest numbers being 1530 in 1997 and 1580 in 2006 (figure 4). The results of two bat surveys in 1996 are remarkable. During the "official" count in mid-January (included in the graph) 1021 bats were counted in the four cellars, the first count above 1000 for this location. During a visit (for technical reasons) to the cellars at the beginning of February, it was found that the numbers had clearly increased. Therefore, a second survey was conducted in mid-February, resulting in 1576 bats. The increase was explained a result from frost as low as -15 degrees Celsius shortly after the first count. In 1997, when 1530 bats were counted, there was also a sharp drop in temperature (from +7 to -7 degrees) shortly before the survey date. In other years with high numbers (more than 1000 bats in 2002, 2006, 2009, 2010 and 2013) too, there was a drop in temperature to below zero shortly before the count (source: www.wintergekte.nl). The high numbers could not be explained by strikingly lower survey results in other more or less

Figure 2. Interior of the largest cellar (KHK1). *Photo: Ruud Kaal.*

nearby known winter roosts.

Whiskered/Brandt's bat (*Myotis mystacinus/brandtii*)

From the first counts onwards, the number of whiskered/Brandt's bats has remained low. Usually zero to five specimens are found, with eight specimens in 1983 at the maximum. Twice (1982, 1998) seven and twice six specimens (2005 and 2011) were counted. On a few occasions the presence of a Brandt's bat was suspected, but this could not be confirmed by experts with the help of photographs.

Natterer's bat (*Myotis nattereri*)

In the first two counts (1982 and 1983), no Natterer's bats were found. This is in line with the then existing image of Natterer's bat as a rare species with greatly reduced numbers (Daan 1980). From 1984 onwards, the species was present in small numbers and gradually increased to more than 50 specimens in 1998. From 2005 onwards, the numbers remained above 100 and the species increased further. In the five most recent winters (2016-2020), an average of more than 300 Natterer's bats were counted. During this period, one out of three bats at Klein Heidekamp was a Natterer's bat.

Daubenton's bat (*Myotis daubentonii*)

At Klein Heidekamp, Daubenton's bat has been the most numerous species ever since the first surveys. The increase in the total number of bats in the first twenty years was mainly due to the increase in the number of Daubenton's bats. On three occasions, more than 1000 Daubenton's bats were counted (1342 in 1997, 1019 in 2002 and 1265 in 2006). In mild winters, the numbers are sometimes lower by hundreds. During the last ten winters

Figure 3. Entrance of one of the two smaller sites. *Photo: Ruud Kaal.*

the number has varied between 468 (in 2019) and 680 (in 2012). During surveys in 2017 and 2018, a flavistic ('yellow') Daubenton's bat was found and in 2019 even two specimens (Glas 2019) and in 2020 again one specimen.

Greater mouse-eared bat *(Myotis myotis)*

For four winters in a row (2000-2003), one specimen was found at Klein Heidekamp. Afterwards, in 2007 and 2020, one specimen was present. In the province of Gelderland, the greater mouse-eared bat is only rarely found in winter quarters.

Pond bat (*Myotis dasycneme*)

During the first census (in 1982), two pond bats were found as a surprise. Outside the marl quarries, hibernating pond bats had only been found in the bunker complexes between The Hague and Wassenaar. At Klein Heidekamp the number gradually increased to a maximum of 73 specimens in 2012. Since then, around 60 specimens have been found here. Elsewhere in Gelderland, but only on the Veluwe, the species is also found in small numbers. Including Klein Heidekamp, there are less than 100 specimens in total.

Brown long-eared bat (*Plecotus auritus*)

At Klein Heidekamp brown long-eared bats are present in varying numbers. Twice they were completely absent (1992 and 2007) and the maximum was 43 specimens (1997). In most winters less than 20 specimens were found. After counting 31 specimens in 2013, fewer than 10 brown long-eared bats have been found every year since.

Relationship between winter and summer roosts

Hardly anything can be said about the possible relationship between the numbers of bats found in winter at Klein Heidekamp and summer roosts and maternity colonies in the

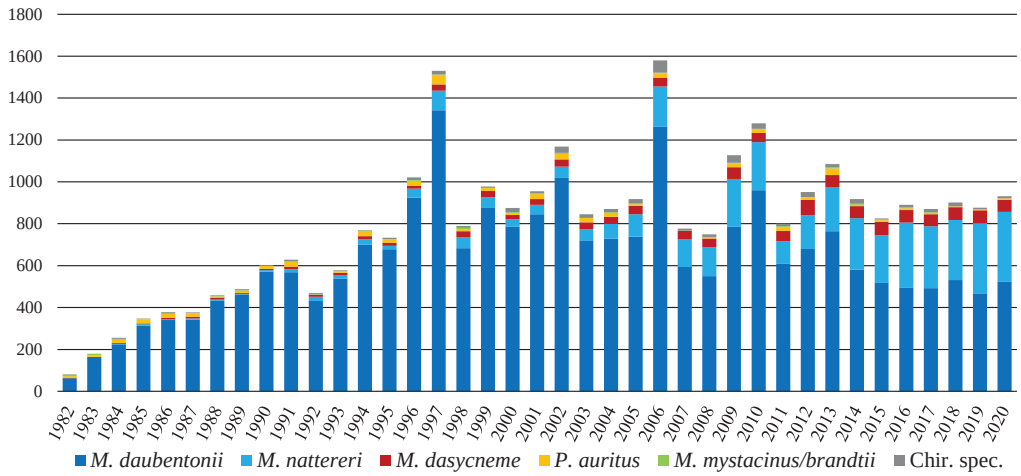

Figure 4. Evolution of the number of bats at the four sites at Klein Heidekamp; since 1988 these sites are counted simultaneously each year. In the years 2000-2003, 2007 and 2020 the number of unidentified bats (Chir. spec.) includes one specimen of *Myotis myotis*.

vicinity due to the almost complete lack of focused studies in summer. During a survey at the airport and one neighbouring complex, brown long-eared bats were found in the attics of five buildings. In addition, a tree on the airport itself was found to be a roost of Daubenton's bats (Staro Bos- en Natuurbeheer 2005). Brown long-eared bats, including juveniles, were also found by the second author on attics of buildings on Klein Heidekamp and three other complexes around Deelen airfield at a distance of 1 to 5 kilometres from Klein Heidekamp. Because no simultaneous count of all these attics took place, it is not possible to determine the numbers of long-eared bats this concerns. A summer roost of this species was found by coincidence in a tree about 2.5 km from Klein Heidekamp. No summer colonies of Daubenton's bat and Natterer's bat are known around Klein Heidekamp. Foraging Daubenton's bats are found in summer over nearly all water bodies in the north of Arnhem (Arnhem-Noord) and to a lesser extent in the south of Arnhem (Arnhem-Zuid). The numbers of these are difficult to estimate, but they appear to be far below the numbers of hibernating specimens at Klein Heidekamp. In summer, small numbers of pond bats are seen foraging above the river Rhine near Arnhem. North of Arnhem individual Natterer's bats have been found in bat boxes. This also applies to brown long-eared bats, of which several were found in one box on two occasions.

Opportunities and threats

Klein Heidekamp is a fenced and guarded military area. The chance of disturbance of the roosts by people is therefore virtually zero. A second very favourable circumstance is the cooperation of the service responsible for the maintenance of the buildings, which includes the winter roosts. From the very first winters, improvements and repairs have been made possible. In 2004, for example, steel supports were placed in both large cellars to reinforce the ceilings with the largest spans (figure 2).

Bat mortality due to predation has been recorded. From the first year of visits until 2006, it was found that domestic cats were catching bats when they were flying in and/or out. The numbers of bats found dead and

sometimes regurgitated outside of the cellars KHK1 and KHK2 were not systematically recorded but at times there were several dozen animals. From around 1996 onwards, gnawed on and injured bats were regularly found in cellars KHK1 and KHK2. Again, no systematic records were kept, but there were at times dozens of these. In 2010, camera recordings made it clear that this was caused by wood mice. The third predator, a marten, has been observed in the pipe duct (KHK4) several times. No cats have been spotted since 2006, in 2010 the cracks under the cellar doors were closed with wire netting against wood mice (*Apodemus sylvaticus*) and in 2016 the pipe duct was made inaccessible for martens by narrowing the entrance.

Klein Heidekamp offers the opportunity for new members of the Vleermuiswerkgroep Gelderland (the Gelderland bat working group) to become acquainted with hibernating bats. Nearly every year an excursion to Klein Heidekamp is organized in September, when several dozen bats are already present but have not yet begun their hibernation. At that time, there are mainly Daubenton's bats and pond bats, as has been described for other winter roosts (Haarsma 2013).

Discussion and conclusion

Members of the Vleermuiswerkgroep Gelderland have surveyed over 200 winter roosts with bats each year for the past five years. In those years (2016-2020), a yearly average of 4586 bats were found, of which 894 (19.5%) on average at Klein Heidekamp (Vleermuiswerkgroep Gelderland, 2016-2020). For Daubenton's bats this is 24.1% (501 of 2077) and for Natterer's bats 25.8% (312 of 1206). For pond bats Klein Heidekamp is by far the most important winter roost in Gelderland. As can be seen in the graph (figure 4) the numbers of bats counted per winter vary widely, by up to 50% (1580 in 2006, 777 in 2007). This variation mainly concerns Daubenton's bat and Natterer's bat and may be related to differences between winters with and winters without frost prior to the surveys. It is possible that at the onset of (severe) frost, Daubenton's bats and Natterer's bats leave other, as yet unknown (perhaps not frost-free) roosts for more climatically stable roosts such as Klein Heidekamp. Based on differences in numbers between milder and more severe winters, this behaviour has long been attributed to long-eared bats by bat counters. Bekker (2022, in this issue) has investigated, partly based on the data from Klein Heidekamp, whether this presumed behaviour is statistically testable for long-eared bats. The differences per winter between the numbers of pond bats at Klein Heidekamp are too small to assume this presumed behaviour for this species.

Domestic cats, martens and wood mice have been known as predators of bats for some time (Bekker & Mostert 1991). In a number of winter quarters in the province of Zuid-Holland, the predation pressure by wood mice has been calculated at up to 2.7% per month (Haarsma & Kaal 2016, with images from Klein Heidekamp). No such calculations can be made for Klein Heidekamp, but given the count results, mortality by predation seems to have had little or no influence on the numbers of hibernating bats here.

Klein Heidekamp harbours by far the highest number of hibernating bats in Gelderland. This seems to be particularly significant at population level for Natterer's bat, Daubenton's bat and pond bat. This idea is supported by the higher numbers in counts after a period of frost. The winter quarters at Klein Heidekamp also have a function in late summer as a swarming location, as was recently confirmed by research into the significance of the Veluwe for pond bats (van Adrichem & Jansen 2021). Conservation and management of the sites mentioned is therefore of great importance from the point of view of bat protection and a great responsibility, which fortunately is recognised and assumed by all concerned, especially by the Ministry of Defence.

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