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Winter activity of *Myotis septentrionalis*: Role of temperature in controlling emergence from a hibernaculum

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Winter activity of *Myotis septentrionalis*: Role of temperature in controlling emergence from a hibernaculum

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Abstract

We acoustically monitored a small mine in southeastern Nebraska known to be a hibernaculum for the Northern Long-eared Myotis (*Myotis septentrionalis*) for two winters (2014-2015 and 2015-2016). Some *M. septentrionalis* emerged on nights with mild temperatures throughout both winters. There was an 89% probability of detecting this species when temperature at sunset was >5°C. Our results indicated that acoustical surveys outside mines or caves in winter, particularly on nights with mild temperatures, are an effective method of identifying hibernacula of *M. septentrionalis* and potentially other species without disturbing individuals by entering the hibernaculum or by netting individuals as they exit their winter quarters. However, the effectiveness of acoustical surveys is impacted by the certainty of identification of calls to species.

Keywords: acoustics, bats, bat detector, emergence, *Myotis septentrionalis*, Nebraska, Northern Long-eared Myotis, winter

Winter emergence from hibernacula seems to be common for many temperate, cave-dwelling species of bats (Boyles et al. 2006, Geluso 2007, 2008, Lausen and Barclay 2006, Schwab and Mabee 2014, White et al. 2014). For example, winter activity has been reported for most species in the genus *Myotis*, including the Northern Long-eared Myotis (*Myotis septentrionalis*; Boyles et al. 2006), which has a more northerly distribution than many *Myotis* in North America (Caceras and Barclay 2000). This species is known to emerge from hibernacula in winter in the northeastern and central United States (Griffin 1945, Whitaker and Rissler 1992).

Understanding winter emergence of *M. septentrionalis* from hibernacula is useful because it allows researchers to more effectively monitor this difficult-to-detect species. For example, *M. septentrionalis* often roosts in cracks in caves and mines and can be overlooked during underground surveys (Caire et al. 1979, Whitaker and Rissler 1992). Moreover, many populations of *M. septentrionalis* in eastern North America have been decimated by white-nose syndrome (e.g., Frick et al. 2015). Thus, traditional methods to locate hibernating individuals in caves or mines might not be adequate to identify new or repopulated hibernacula, a key resource for this federally listed species. Recording echolocation calls with acoustic detectors as bats leave hibernacula in winter is a non-invasive method to assist in identification of hibernacula. By using acoustics, we sought to determine whether *M. septentrionalis* emerges from its hibernacula during winter, and whether emergence and winter activity are related to temperature. We conducted an acoustical survey to gather information about the probability of activity in winter that will allow researchers to determine when and how long to leave detectors at a site to maximize sampling efficiency.

During two consecutive winters, (18 December 2014 - 11 March 2015 and 25 November 2015 - 11 March 2016) we used a Wildlife Acoustics SM2Bat+ detector to monitor bat activity at the entrance of a small mine on the Platte River near Cedar Creek in Cass County, Nebraska (exact location withheld by landowners request). With the growing use of acoustics, it is important to distinguish calls to species (Lemen et al. 2015). Repeated netting of the mine entrance and visual surveys of this hibernaculum demonstrated that only three species of bats are present (*M. septentrionalis*, *Perimyotis subflavus,* and *Eptesicus fuscus*). All three species have calls that can be readily distinguished from each other. We used Kaleidoscope Pro 3.0 to identify calls to species and then vetted calls by eye (White et al. 2016).

Counts of bat passes per night for *M. septentrionalis* were converted to a binary variable (detected/not detected) for each night as the variable, Activity (White et al. 2014). Temperature at sunset (C°) was recorded at a nearby weather station at Murray, Nebraska and was used as the variable, Temperature. The variable, Days, was coded as the number of days after 24 November. Year was coded as one for winter 2014-2015 and two for winter 2015-2016. We analyzed these data using a logistic regression (glm() in R) with Activity as the dependent variable and Temperature, Days, and Year as independent variables (R Core Team 2013).

Myotis septentrionalis was active at low levels throughout the winter (Fig. 1). Individuals were detected on 89% (41 of 46) of winter nights when sunset temperature was >5°C, but only 6% (3 of 47) of nights <-5°C. There was about a 50% probability of detecting this species when temperature at sunset was >-2°C (Fig. 2). Year and Date were not statistically significant, but Temperature had a highly significant relationship with Activity (Intercept = 0.52692; Temperature coefficient = 0.26; Pr > | z | = 2.59e-11 on 189 df).

Given the relatively low level of activity in winter as compared to spring (Fig. 1), it is reasonable to assume that even on mild winter nights only a portion of the colony of *M. septentrionalis* is active. Thus, it is likely that mines with many individuals of *M. septentrionalis* will have more nights with bats flying than mines with fewer bats. In this mine, we have limited information on the population size of *M. septentrionalis* overwintering; in four years of spring surveys we have never netted more than 20 individuals at the entrance of this mine. Yet, even with relatively few bats in this mine, our findings indicate there is a high chance of detecting *M. septentrionalis* outside hibernacula in winter.

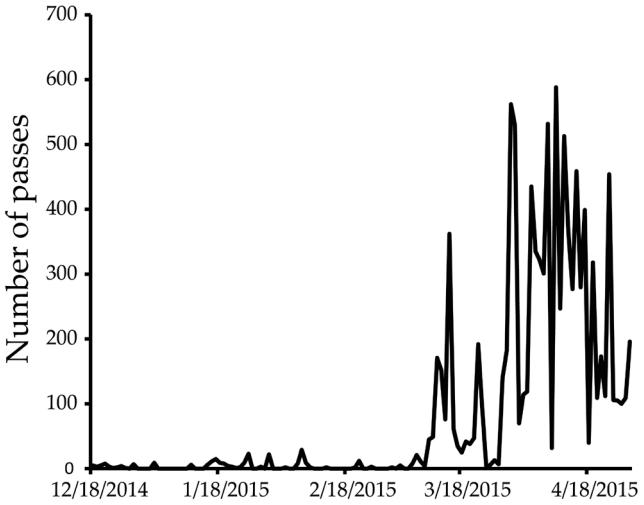

Figure 1. Relationship between date (winter to spring 2014-2015) and number of call sequences of the Northern Long-eared Myotis (*Myotis septentrionalis*) at a mine entrance in southeastern Nebraska. *Myotis septentrionalis* was detected throughout the winter on mild nights. This figure also illustrates the difference between the low number of bat passes detected in winter during hibernation and the higher number in spring after hibernation is over.

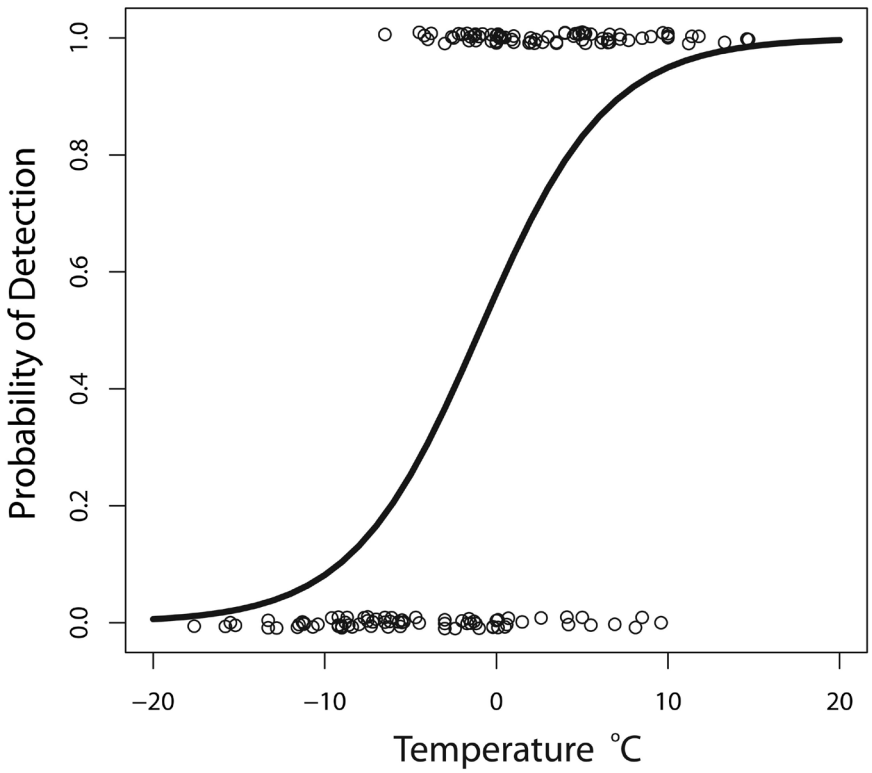

Figure 2. Logistic regression shown as the curved line of the relationship between temperature and probability of detecting calls from the Northern Long-eared Myotis (*Myotis septentrionalis*) at a mine entrance in southeastern Nebraska during two winters, 2014-2015 and 2015-2016. Circles represent nights of acoustical survey; circles plotted as 1.0 on y-axis indicate that one or more bat passes were identified and those plotted as 0.0 indicate that no bat passes were identified for that night. A slight jitter was introduced into the detected (1.0) and not detected (0.0) binary data to make viewing of overlapping points possible.

Winter activity of *M. septentrionalis* was related to temperature as individuals were commonly active on evenings with sunset temperatures >5°C. Similarly, Whitaker and Rissler (1992) showed that *M. septentrionalis* was more likely to emerge from a hibernaculum on mild winter nights in Indiana. Winter activity also has been shown to be related to temperature in other species of temperate bats (e.g., Lausen and Barclay 2006, Schwab and Mabee 2014, White et al. 2014). Given that 5°C at sunset is not unusual weather in winter in Nebraska, acoustical surveys should work well for finding hibernacula of *M. septentrionalis* in this region. In Nebraska, *M. septentrionalis* is active with movements between summer roosts and hibernacula in November and March (White et al. in prep., Geluso et al. 2004). Therefore, any search for hibernacula should be conducted in December, January, or February in Nebraska. Naturally the timing of hibernation may be locality specific and should be taken into account for work in other areas.

It is important to note that in the spring of 2014 we swabbed individuals of *M. septentrionalis*, *P. subflavus*, and *E. fuscus* at this mine and detected no positive results for *Pseudogymnoascus destructans* (*Pd*), the fungus that causes white-nose syndrome (WNS). However, in the spring of 2015 and 2016, individuals of all three species from the mine tested positive for *Pd*. This represented the first documented case of the fungus in Nebraska (White-nosesyndrome.org 2016). Careful examination of bats in white and UV light showed no symptoms of WNS. It is known that WNS can alter the behavior of bats and cause more activity in winter (Cryan et al. 2010). Thus, there is a chance that even though there were no symptoms of the disease, a low level infection of *Pd* might alter behavior, and our estimates of the activity of bats in relation to temperature might be biased by presence of the fungus.

Acknowledgments

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