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Interannual Survival of *Myotis lucifugus* (Chiroptera: Vespertilionidae) near the Epicenter of White-Nose Syndrome

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Abstract

Reduced populations of *Myotis lucifugus* (Little Brown Myotis) devastated by white-nose syndrome (WNS) persist in eastern North America. Between 2009 and 2013, we recaptured 113 marked individuals that survived between 1 and 6 winters in New England since the arrival of WNS. We also observed signs of reproductive success in 57 recaptured bats.

White-nose syndrome (WNS), caused by an introduced fungus, was first documented in Schoharie County, NY, in 2006 and has since devastated populations of hibernating bats in eastern North America (Turner et al. 2011). By early 2009, WNS had been documented at most hibernacula throughout the Northeast, causing precipitous declines in wintering populations of *Myotis lucifugus* (LeConte) (Little Brown Myotis) (Frick et al. 2010a, Langwig et al. 2012). Acoustic monitoring indicated that activity of Little Brown Myotis on the summer landscape also decreased over 70% after arrival of WNS (Brooks 2011, Dzal et al. 2011, Ford et al. 2011). Accordingly, most summer colonies in the area also declined dramatically in size (e.g., Frick et al. 2010b, Fuller et al. 2012). Still, small numbers of Little Brown Myotis persist at summer roosts in states that have a high incidence of mortality related to WNS. For example, intensive monitoring of a colony at Fort Drum Military

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Installation in New York revealed that individual Little Brown Myotis survived multiple years after arrival of WNS (Dobony et al. 2011). At least 65 bats, including reproductive females and bats initially banded as juveniles survived for up to 4 years from 2009 to 2013 (C. Dobony, US Department of Army, Fort Drum, NY, pers. comm.). These observations indicate that Little Brown Myotis is persisting and reproducing at this site in New York, despite likely exposure each winter to the pathogen that causes WNS, *Pseudogymnoascus destructans* (Gargas, Trest, Christensen, Volk, and Blehert) (Lorch et al. 2011, Minnis and Lindner 2013).

The purpose of this note is to summarize additional scattered evidence of interannual survival of Little Brown Myotis at multiple summer roosts in Massachusetts, New Hampshire, and Vermont. In addition, we discuss anecdotal observations on reproductive success in these colonies, which provide perspectives on untested hypotheses regarding the sub-lethal effects of WNS. Understanding the status and location of persisting colonies of Little Brown Myotis provides a foundation for more deliberate studies into long-term ecological and behavioral effects of WNS on bats.

Between 2005 and 2012, the authors applied 2095 (MA:1179, NH:820, and VT:96) 2.9-mm, split-ring, alloy bands (Porzana, Inc., UK) to the forearms of Little Brown Myotis captured during various research and management activities at 8 summer roosts (MA:3, NH:3, and VT:2). All sites were within the putative migratory range of Little Brown Myotis from WNS-infected hibernacula in New England (Davis and Hitchcock 1965). Because of the nearly ubiquitous occurrence of *P. destructans* in affected areas (Lorch et al. 2013), we assumed that any bats captured in this area in summer 2009 or later represented individuals that hibernated in sites where *P. destructans* was likely present and have somehow remained unexposed to, resisted, or recovered from WNS.

We captured 113 of the 2095 previously banded Little Brown Myotis in subsequent summers between 2009 and 2013 (Table 1). Although our recapture rate is much lower than recapture rates reported in other studies (Frick et al. 2010b, Keen and Hitchcock 1980), we caution that the varied methods that produced these observations were not sufficient to make inferences from these recapture rates. In total, 20 bats survived ≥4 years after being banded. Two of these bats were captured on 3 June 2013 in Princeton, MA, 5 years after being banded there, and two others were recaptured on 20 July 2012 in Cornwall, VT, 6 years after being banded at that location. We recaptured bats in various stages of reproduction (Table 2), thus documenting successful ovulation, fertilization, gestation, and parturition in these colonies. Of the 113 recaptured bats, 15 were initially banded as young-of-the-year and were recaptured up to 4 years later. Nine of these 15 bats exhibited signs of pregnancy or lactation when recaptured, suggesting that they also produced offspring.

Although WNS predominantly affects bats during winter, factors associated with their summer habitats and behavior may influence their response to the disease. Variation in interannual survival and recruitment among maternity colonies may signify potential behavioral, environmental, and/or inherited physiological factors relevant to surviving infection with WNS. Because female Little Brown Myotis exhibit high fidelity to natal roosts (Dixon 2011, Humphrey and Cope 1976), maternally heritable factors (e.g.,

immunocompetence, metabolism) that could contribute to a bat's ability to survive WNS may be traceable to certain summer roosts and have the potential to perpetuate in persisting populations. Environmental and social variables during postnatal development can also influence many aspects of the lives of neonates, such as their symbiotic microbial fauna (Altizer et al. 2003), migratory behavior (Fleming and Eby 2003), exposure to contaminants (Bayat et al. 2014, Yates et al. 2013), availability of prey (Clare et al. 2011), and exposure to pathogens, potentially including *P. destructans*. Ecology and biology of WNS-affected bats during summer may be an important factor influencing the impact of the disease, and this area of study deserves continued attention.

The hibernacula used by the bats reported in this study are largely unknown, although recapturing banded individuals at sites other than where they are banded is generally rare (Griffin 1970). During our study, only 1 individual was banded at a maternity colony and subsequently recaptured at a hibernaculum more than 1 year after initial capture. This bat, a female, was banded in Milford, NH, in summer 2008, and was subsequently observed at Eagle Cave in the central Adirondack Mountains, NY, in March 2009 and again in March 2013 (R. von Linden, New York Department of Environmental Conservation, Albany, NY, pers. comm.). Notably, the same bat was also observed at the summer roost in Milford in 2012.

The data reported in this note represent opportunistic records of multi-year survival at summer roosts and thus corroborate results from Fort Drum, NY, with data from additional sites in Massachusetts, Vermont, and New Hampshire. Still, the current population of Little Brown Myotis in the area most heavily affected by WNS appears strikingly low compared to past censuses. With limited resources and dwindling populations of bats, conservation agencies may need to consolidate research and management and focus on protecting summer colonies with efforts to shield healthier bats from other potential threats to their survival. Understanding the current distribution, behavior, ecology, and genetics of surviving bats may be critical to conserving these populations and developing effective recovery strategies.

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Literature Cited

Altizer S, Nunn CL, Thrall PH, Gittleman JL, Antonovics J, Cunningham AA, Dobson AP, Ezenwa V, Jones KE, Pedersen AB, Poss M, Pulliam JRC. Social organization and parasite risk in mammals: Integrating theory and empirical studies. Annual Reviews in Ecology, Evolution, and Systematics. 2003; 34:517–547.

Bayat S, Geiser F, Kristiansen P, Wilson SC. Organic contaminants in bats: Trends and new issues. Environment International. 2014; 63:40–52. [PubMed: 24263138]

Brooks RT. Declines in summer bat activity in central New England 4 years following the initial detection of white-nose syndrome. Biodiversity and Conservation. 2011; 20:2537–2541.

Clare EL, Barber BR, Sweeney BW, Hebert PDN, Fenton MB. Eating local: Influences of habitat on the diet of Little Brown Bats (*Myotis lucifugus*). Molecular Ecology. 2011; 20:1772–1780. [PubMed: 21366747]

Davis WH, Hitchcock HB. Biology and migration of the bat, *Myotis lucifugus*, in New England. Journal of Mammalogy. 1965; 46:296–313.

Dixon MD. Population genetic structure and natal philopatry in the widespread American bat *Myotis lucifugus*. Journal of Mammalogy. 2011; 92:1343–1351.

Dobony CA, Hicks AC, Langwig KE, von Linden RI, Okoniewski JC, Rainbolt RE. Little Brown Myotis persist despite exposure to white-nose syndrome. Journal of Fish and Wildlife Management. 2011; 2:190–195.

Dzal Y, Mcguire LP, Veselka N, Fenton MB. Going, going, gone: The impact of white-nose syndrome on the summer activity of the Little Brown Bat (*Myotis lucifugus*). Biology Letters. 2011; 7:392–394. [PubMed: 21106570]

Fleming, TH.; Eby, P. Ecology of bat migration. In: Kunz, TH.; Fenton, MB., editors. Bat Ecology. University of Chicago Press; Chicago, IL: 2003. p. 156-208.p. 779

Ford WM, Britzke ER, Dobony CA, Rodrigue JL, Johnson JB. Patterns of acoustical activity of bats prior to and following white-nose syndrome occurrence. Journal of Fish and Wildlife Management. 2011; 2:125–134.

Frick WF, Pollock JF, Hicks AC, Langwig KE, Reynolds DS, Turner GG, Butchkoski CM, Kunz TH. An emerging disease causes regional population collapse of a common North American bat species. Science. 2010a; 329:679–682. [PubMed: 20689016]

Frick WF, Reynolds DS, Kunz TH. Influence of climate and reproductive timing on demography of Little Brown Myotis *Myotis lucifugus*. Journal of Animal Ecology. 2010b; 79:128–136. [PubMed: 19747346]

Fuller NW, Reichard JD, Nabhan ML, Fellows SR, Pepin LC, Kunz TH. Free-ranging Little Brown Myotis (*Myotis lucifugus*) heal from wing damage associated with white-nose syndrome. EcoHealth. 2011; 2:154–162. [PubMed: 21922344]

Griffin, DR. Migration and homing of bats. In: Wimsatt, WA., editor. Biology of Bats. Vol. 1. Academic Press; NY: 1970. p. 233-264.p. 406

Humphrey SR, Cope JB. Population ecology of the Little Brown Bat, *Myotis lucifugus*, in Indiana and north-central Kentucky. Special Publication of the American Society of Mammalogists. 1976; 4:1–81.

Keen R, Hitchcock HB. Survival and longevity of the Little Brown Bat (*Myotis lucifugus*) in southeastern Ontario. Journal of Mammalogy. 1980; 61:1–7.

Langwig KE, Frick WF, Bried JT, Hicks AC, Kunz TH, Kilpatrick AM. Sociality, density-dependence, and microclimates determine the persistence of populations suffering from a novel fungal disease, white-nose syndrome. Ecology Letters. 2012; 15:1050–1057. [PubMed: 22747672]

Lorch JM, Meteyer CU, Behr MJ, Boyles JG, Cryan PM, Hicks AC, Ballmann AE, Coleman JTH, Redell DN, Reeder DM, Blehert DS. Experimental infection of bats with *Geomyces destructans* causes white-nose syndrome. Nature. 2011; 480:376–379. [PubMed: 22031324]

Lorch JM, Muller LK, Russell RE, O'Connor M, Lindner DL, Blehert DS. Distribution and environmental persistence of the causative agent of white-nose syndrome, *Geomyces destructans*, in bat hibernacula of the eastern United States. Applied and Environmental Microbiology. 2013; 79:1293–1301. [PubMed: 23241985]

Minnis AM, Lindner DL. Phylogenetic evaluation of *Geomyces* and allies reveals no close relatives of *Pseudogymnoascus destructans*, comb. nov., in bat hibernacula of eastern North America. Fungal Biology. 2013; 117:638–649. [PubMed: 24012303]

Turner GG, Reeder DM, Coleman JTH. A five-year assessment of mortality and geographic spread of white-nose syndrome in North American bats and a lok to the future. Bat Research News. 2011; 52:13–27.

Yates DE, Adams EM, Angelo SE, Evers DC, Schmerfeld J, Moore MS, Kunz TH, Divoll T, Edmonds ST, Perkins C, Taylor R, O'Driscoll NJ. Mercury in bats from the northeastern United States. Ecotoxicology. 2013; 23:45–55. [PubMed: 24271419]

Table 1

Number of recaptured Little Brown Myotis in Massachusetts, New Hampshire, and Vermont during summer 2009–2013. Numbers in parentheses represent bats that were originally banded as young-of-the-year. Unless noted, all bats reported were female.

	Summer in which the bat was last recovered					
Number of winters survived	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
1	34 (3)	-	-	21 (2)	7 (1)	62 (6)
2	-	-	9* (2)	-	6 (2)	15 (4)
3	-	-	3** (3)	13 (1)	-	16 (4)
4	2	-	-	14 (1)	-	16 (1)
5	-	-	-	-	2	2
6	-	-	-	2	-	2

* Includes 1 adult male recaptured in Framingham, MA, on 12 July 2011.

** Includes 1 adult male recaptured in Milford, NH, on 17 July 2012.

Table 2

Reproductive conditions at time of recapture of Little Brown Myotis recaptured 1–6 years after being banded in Massachusetts, New Hampshire, and Vermont during summer 2006–2013. Numbers in parentheses represent bats that were originally banded as young-of-the-year.

	Number of winters survived						
Condition	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Pregnant	15 (2)	3 (3)	1 (1)	2	1	-	22 (6)
Lactating	9 (2)	1	5	5	1	-	21 (2)
Postlactating	3	-	2	7 (1)	-	2	14 (1)