

## Notes

# Little Brown Myotis Persist Despite Exposure to White-Nose Syndrome

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## Abstract

We monitored a maternity colony of little brown myotis *Myotis lucifugus* on Fort Drum Military Installation in northern New York in 2009 and 2010 for impacts associated with white-nose syndrome. Declines in colony numbers presumed to be caused by white-nose syndrome were initially discovered in the spring 2009. Although colony numbers have continued to decline, we determined that a minimum of 12 individual banded female little brown myotis survived over multiple years despite exposure to white-nose syndrome. Our results also provide evidence that 14 of 20 recaptured female little brown myotis were able to heal from wing damage and infection associated with white-nose syndrome within a given year, and seven of eight recaptures from within both 2009 and 2010 showed evidence of reproduction.

Keywords: little brown myotis; white-nose syndrome

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## Introduction

White-nose syndrome (WNS), a disease that has decimated bat populations in eastern North America, was first detected in Howe's Cave in Schoharie County, New York, in the winter of 2006 (Blehert et al. 2009). White-nose syndrome has spread throughout the northeastern United States and portions of Ontario, New Brunswick, and Quebec, Canada, and as far south as Tennessee (USFWS 2011). Additionally, evidence of the presumptive causative agent of the disease, the novel psychrophilic fungus *Geomyces destructans* (Blehert et al. 2009; Gargas et al. 2009), has been detected on bats as far south and

west as Missouri and Oklahoma (USFWS 2011). To date, WNS has severely impacted some of the Northeast's most common bat species, including little brown myotis *Myotis lucifugus* (Figure 1), which is now considered to be at significant risk of regional extinction (Frick et al. 2010).

Although initial evidence of WNS was discovered in New York in 2006 (Blehert et al. 2009), declines within bat communities suspected to be attributable to WNS at Fort Drum Military Installation were not identified until 2008 (Hawkins and Gumbert 2009; *Supplemental Material*, Report S1; <http://dx.doi.org/10.3996/022011-JFWM-014>, S1). In response, this study was initiated in May of 2009





**Figure 1.** A female little brown myotis *Myotis lucifugus* captured and banded from a white-nose syndrome–infected maternity colony at Fort Drum Military Installation, New York, in 2010.

and focused on monitoring a summer maternity colony of little brown myotis for impacts associated with WNS. This maternity colony had occupied the historic nineteenth century LeRay Mansion (Mansion) for over 20 y; however, the long-term use of the structure led to guano accumulation in wall cavities and inaccessible attic space and raised concerns for human health and structural integrity. In response, a bat house was installed approximately 200 m from the Mansion in 2004, and exclusion efforts were initiated in an attempt to relocate the colony. Individual bats were documented using both roosts interchangeably throughout the exclusion period; however, approximately 70% of bats had moved into the bat house by the final stages in 2008. The highest nightly emergence counts of the colony were documented on 7 July 2008, when 1,200 individuals were observed (832 at the bat house, 368 at the Mansion; C. Dobony, unpublished data). A small number of bats (i.e., <20) are still known to use the LeRay Mansion, but exclusion was considered complete and successful by the winter of 2008–2009.

Although numbers at the colony have declined since 2008 (presumably from WNS; C. Dobony, unpublished data), this is one of only a few monitored summer colonies remaining in New York and New England that are known to contain little brown myotis of any numerical significance (i.e., >100 individuals; A. Hicks, S. von Oettingen, U.S. Fish and Wildlife Service, personal communication). The history of monitoring and the continued existence of this colony, despite the known regional declines due to WNS, make this a valuable site for WNS research. Therefore, to

determine why this summer maternity colony of little brown myotis was persisting, we examined physical and demographic parameters of bats post WNS infection. During the spring and summer of 2009 and 2010, we documented physical damage and healing of wing membranes and survival and reproduction of individual little brown myotis at this colony.

## Methods

We conducted our study at Fort Drum, a 43,000+ ha United States Army installation in Jefferson and Lewis counties in northern New York state (44°00'N, 75°49'W). Fort Drum includes a cantonment area, main impact area, airfield, and 18 training areas. Approximately 57% of the installation (~25,000 ha) is forested with associations of mature northern hardwood types of sugar maple *Acer saccharum*, American beech *Fagus grandifolia*, white ash *Fraxinus americana*, and white pine *Pinus strobus* and early successional habitat dominated by red maple *Acer rubrum*, gray birch *Betula populifolia*, and quaking aspen *Populus tremuloides*. Beaver ponds, small lakes, wet meadows, and other wetland systems comprise approximately 20% of the land cover (~8,000 ha). Extensive development is concentrated within the cantonment area and certain firing ranges encircling the main impact area; only scattered training facilities and other structures are found throughout the relatively undeveloped maneuver areas in the remainder of the installation. Elevations range from 125 to 278 m.

We conducted emergence counts of little brown myotis at the bat house in Fort Drum's cantonment area

**Table 1.** Number of little brown myotis *Myotis lucifugus* captured by sampling period, age class, and wing condition score, from a maternity colony at Fort Drum Military Installation, New York, 2009 and 2010.

Year	Month	Age	Captures	Recaptures	Newly banded	Wing condition score <sup>a</sup>			
						0	1	2	3
2009	May	Adult	38	0	38	4	11	15	7
2009	August	Adult	28	8	20	17	10	0	0
		Juvenile	24		24	21	3	0	0
		Unknown	5		5	3	2	0	0
2010	May	Adult	47	5	42	2	19	22	4
2010	June	Adult	20	11	9	6	5	8	1
2010	July	Adult	20	11	9	8	11	0	0
		Juvenile	20		20	13	0	0	0
		Unknown	22		22	2	2	0	0

<sup>a</sup> Suspected white-nose syndrome infection was assessed by visually inspecting wing membranes of bats for damage and ranking the condition numerically from 0 to 3, where 0 indicated no evidence of damage and 3 indicated the highest level of damage. Methodology followed Reichard and Kunz (2009).

on 10 June and 16 July 2009 and 8 June and 12 July 2010. Counts conducted in early June were considered to represent only adults at the colony because juvenile bats are not typically volant at this time (C. Dobony, unpublished data). Counts in July were assumed to represent both adults and juveniles post-volancy. The time and number of bats exiting the roost was recorded. Counts began approximately one half hour before sunset and lasted until bats finished emerging and/or darkness precluded accurate counting.

We captured bats from the bat house using coarse nylon bird netting (E.I. du Pont de Nemours and Company, Wilmington, DE) to funnel individuals into either a double frame harp trap (183 cm wide by 183 cm high; Bat Conservation and Management, Carlisle, PA) or two low visibility mistnets (6 m wide by 2.6 m high; Avinet Inc., Dryden, NY) on 21 May and 19 August of 2009 and 11 May, 2 June, and 19 July 2010. We determined species (based on pelage and body measurements), sex, age (adult vs. juvenile based on amount of epiphyseal-diaphyseal calcification of long bones in the wing), and reproductive condition (based on presence of obvious nipples, associated either with or without expression of milk). Individual bats were also marked with a metallic split-ring band with a unique identification number (Porzana Ltd., Icklesham, UK) and assessed for evidence of suspected prior WNS infection.

Suspected WNS infection was assessed by visually inspecting wing membranes of bats for damage and ranking the condition numerically from 0 to 3, where 0 indicated no evidence of damage and 3 indicated the highest level of damage (Reichard and Kunz 2009). Additionally, a subset of bats was sampled for the presence of *G. destructans* during each sampling period using two methods. Dorsal surfaces of wing and tail membranes were streaked directly onto culture media plates (Sabouraud dextrose agar with chloramphenicol and gentamycin) that were then refrigerated at approximately 4°C and monitored for *G. destructans* growth. Surfaces of the wing and tail membranes on each bat were also sampled using moistened sterile swabs. Swab samples

were preserved with 10% formalin and subsequently checked microscopically for the presence of the morphologically distinctive conidia of *G. destructans* (Gargas et al. 2009). We initially attempted to randomly sample a minimum of five individual bats within each category of wing damage (i.e., 0, 1, 2, 3) during the May 2009 sampling effort. During subsequent sampling efforts, we attempted to recapture marked individuals to resample; however, if we were unable to do so, we randomly chose additional unmarked individuals in different wing damage categories to reach our sampling goals. We sampled only adult bats during May 2009 and 2010, and June 2010, and both adult and juvenile bats during August 2009 and July 2010. Because we were unsure how many juveniles we would capture during our efforts, we opportunistically sampled as they were encountered. Each bat was handled with new disposable latex gloves and all equipment was decontaminated or sterilized between individual bats to avoid cross-contamination during sample collection.

## Results

On 10 June 2009, approximately 213 adults were observed during emergence counts, and on 16 July, approximately 320 animals (adults and juveniles) were observed exiting the bat house. This represented a decline of approximately 73% from the known observed 1,200 individuals at the colony in 2008. Numbers dropped again in 2010, to a high count of approximately 145 animals (adults and juveniles) on 12 July. This represented a decline in colony size of approximately 88% from 2008 levels.

In 2009, we captured 95 bats (87 new captures, 8 recaptures—all from within 2009) over two sample periods, and in 2010, we captured 129 bats (102 new captures, 27 recaptures—14 from 2009, 13 from within 2010) over three sample periods (Tables 1 and 2; *Supplemental Material*, Text S1, <http://dx.doi.org/10.3996/022011-JFWM-014.S2>, and Data S1, <http://dx.doi.org/10.3996/022011-JFWM-014.S3>). The majority (14 of 20) of female bats that initially exhibited wing damage in May, exhibited less damage upon recapture later in the

**Table 2.** Recapture summary with wing condition scores of individual adult female little brown myotis *Myotis lucifugus* monitored at a maternity colony at Fort Drum Military Installation, New York, 2009 and 2010.

Bat ID	Wing condition score <sup>a</sup>				
	2009		2010		
	May	August	May	June	July
30439	1	0			
30703	0	0			
30707	2	0			
30708	3	1			
30710	2	0			
30712	0	0	2		1
30713	1	0			
30724	2	0			
30437	2		2		
30440	2		1		
30444	0			1	
30706	2			0	
30720	0			0	
4756		0	2		
4779		0	2		
4759 <sup>b</sup>		0		1	
4772 <sup>b</sup>		0		2	0
4758		1			1
4768		1			1
4909			1	2	
4972			2	2	
4976			2	2	
4980			1	0	
4991			2	2	
4992			2	0	
4998			2		0
4997			3		1
4901			3		1
4904			1		1
4910			1		0
4974			2		1
4986			1		1

<sup>a</sup> Suspected WNS infection was assessed by visually inspecting wing membranes of bats for damage and ranking the condition numerically from 0 to 3, where 0 indicated no evidence of damage and 3 indicated the highest level of damage. Methodology followed Reichard and Kunz (2009).

<sup>b</sup> Bats originally captured as Juveniles in 2009.

summer (Table 2). Seven of eight female recaptures from both May to August 2009 and May to July 2010 showed evidence of post-lactation (i.e., obvious nipples with no expression of milk). The remaining recapture from 2009 showed no evidence of reproduction, whereas the status of the remaining bat in 2010 was not determined. Additionally, three bats originally captured in August 2009 that showed evidence of reproduction, also showed evidence of reproduction upon recapture in July 2010. Of the remaining

19 known adult female bats (first time captures) for which reproductive status was determined in August 2009, 12 showed evidence of post-lactation. Of the remaining nine known adult female bats (first time captures) for which reproductive status was determined in July 2010, five showed evidence of lactation or post-lactation.

*G. destructans* was documented on bats in both 2009 and 2010 through microscopic isolation of conidia consistent with the physical description of the fungus (Gargas et al. 2009; Meteyer et al. 2009). In May 2009, conidia were isolated from live fungal growth on 1 of 15 media plates and from 2 of 13 swab samples. In August 2009, conidia were isolated from live fungal growth on 1 of 17 media plates and 2 of 16 swab samples. In May of 2010, conidia were isolated from live fungal growth on 16 of 27 media plates and 11 of 27 swab samples. No conidia were isolated from live fungal growth in either June ( $n = 19$ ) or July ( $n = 25$ ) of 2010; however, rapid overgrowth from other bacteria and fungi on the media plates potentially precluded our ability to detect *G. destructans*. Conidia were isolated from 1 of 19 swab samples in June 2010 and 1 of 29 swab samples in July 2010.

## Discussion

All evidence (i.e., locality of the colony, decline in colony size, detection of *G. destructans* at the colony, documentation of wing damage on returning bats in the spring, and known population declines with confirmed histopathology of WNS in surrounding hibernacula) strongly supports the hypothesis that observed declines in this colony were attributable to WNS. It has been unclear whether bats infected with WNS in their hibernaculum can heal and survive within and across years. Reichard and Kunz (2009) documented reduced numbers of captured bats with high wing damage scores as the summer progressed; however, they were unable to discern if this was due to bats with high wing damage scores dying on the landscape or healing. Because they found limited healing or improvements in wing conditions of their recaptured bats, they suggested the lower abundance of high wing damage scores found later in the summer was most likely attributable to death. However, our banding recoveries at the Fort Drum colony illustrate that bats are indeed able to heal from varying wing injuries presumably caused by WNS within 30–90 d of arrival at the roost. Faure et al. (2009) documented similar healing rates in presumably unaffected, healthy big brown bats *Eptesicus fuscus* that had human-induced wounds (biopsies) similar in nature to WNS damage. Depending on the degree and location of the damage, they noted a relatively wide range (27–127 d) for healing times.

Almost all of the recaptured bats within individual years that had suspected wing damage from WNS when emerging from hibernation also later showed evidence of recent lactation. Moreover, a small number of reproductive bats originally captured in 2009 also showed evidence of reproduction when recaptured in 2010. In contrast, newly captured bats each year had much lower reproductive rates (i.e., ~63% in 2009 and ~56% in 2010). This suggests that some impacted bats can partition energy into healing, while maintaining a seemingly



normally reproductive cycle, while others may not. However, it is unknown whether these recaptured bats were successful in rearing pups to volancy.

Our recapture observations also demonstrate that 12 banded female individuals survived from 2009 to 2010, five of which initially had suspected wing damage from WNS in 2009 (two bats had wing scores of 1, while three bats had wing scores of 2). These individuals, at a minimum, were infected and survived both winters of 2008–2009 and 2009–2010. This indicates that some individuals can either survive a long-term WNS infection or heal and survive an infection, only to become re-infected the subsequent fall or winter. These cumulative effects of repeated damage from WNS on individual bats, and in turn, on population viability are still unknown. Repeated infection may eventually interfere with the ability of bats to be able to both heal and reproduce within the maternity season. Although one individual captured in both 2009 and 2010 continued to exhibit no wing damage or other visible signs of infection, six of seven individuals that had no visible wing damage in 2009, showed light to moderate wing damage in 2010, suggesting new infections of WNS are still occurring on an annual basis. Until we understand more about yearly infection rates, the true impact from WNS will be unknown.

Multiyear acoustic and netting studies on Fort Drum have documented the genesis of a probable localized extirpation of myotine bats from the landscape (C. Dobony, personal observation; Winhold et al. 2011; *Supplemental Material*, Report S2; <http://dx.doi.org/10.3996/022011-JFWM-014.S4>). Indeed, WNS has caused mortality levels high enough across the range of once common bat species, such as little brown myotis, northern myotis *Myotis septentrionalis*, and eastern small-footed bat *Myotis leibii*, to warrant their consideration for protection under the U.S. Endangered Species Act (K. Gifford, U.S. Fish and Wildlife Service, personal communication; ESA 1973; CBD 2010; Kunz and Reichard 2010). Nevertheless, even in light of these devastating developments, our historic little brown myotis maternity colony continues to persist (albeit at greatly reduced numbers), and our findings show that individual little brown myotis (and perhaps other myotines) can heal from WNS infection during the summer and survive multiple presumed WNS infection cycles.

### Supplemental Material

Please note: The *Journal of Fish and Wildlife Management* is not responsible for the content or functionality of any supplemental material. Queries should be directed to the corresponding author for the article.

**Report S1.** Hawkins JA, Gumbert MW. 2009. Summer 2008 bat survey and radiotelemetry study conducted at Fort Drum, Jefferson, and Lewis counties, New York. Report of Copperhead Environmental Consulting, Inc. to Fort Drum Military Installation, Fort Drum, New York.

Found at DOI: <http://dx.doi.org/10.3996/022011-JFWM-014.S1> (771 KB PDF).

**Text S1.** Readme text consisting of definitions of worksheet titles, column headings, variables, and terms found in Data S1.

Found at DOI: <http://dx.doi.org/10.3996/022011-JFWM-014.S2> (12 KB DOCX).

**Data S1.** Raw sample data of captured and recaptured little brown myotis *Myotis lucifugus* at Fort Drum Military Installation, New York, compiled from 5 sampling periods on May 21 and August 19, 2009, and May 11, June 2, and July 19, 2010.

Found at DOI: <http://dx.doi.org/10.3996/022011-JFWM-014.S3> (33 KB XLSX).

**Report S2.** Winhold L, Mann A, Brack V Jr. 2011. Summer mist net surveys for the Indiana bat (*Myotis sodalis*) on Fort Drum Military Installation, Jefferson and Lewis Counties, New York. Report of Environmental Solutions & Innovations, Inc. to Fort Drum Military Installation, Fort Drum, New York.

Found at DOI: <http://dx.doi.org/10.3996/022011-JFWM-014.S4> (684 KB PDF).

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