

Addendum 3 – An Update to Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper [with Northern Long-eared Bat Addition]

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Introduction

This addendum serves as an update to the *Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper* (Niver et al. 2014; white paper) and its subsequent Addendums 1 and 2 (Niver et al. 2018, Armstrong et al. 2022; addendums). Given that white-nose syndrome (WNS) continues to variably impact Indiana bats (IBAT, *Myotis sodalis*) and northern long-eared bats (NLEB, *Myotis septentrionalis*), the U.S. Fish and Wildlife Service (USFWS) has taken an adaptive management approach by periodically examining new data when available and when warranted, revising the Range-wide Indiana Bat and Northern Long-eared Bat Survey Guidelines (guidelines) and associated recommended survey level of effort (LOE). This update considered additional IBAT and NLEB post-WNS mist-net capture data (2016-2022) and provides revised species-specific mist-netting survey LOE recommendations. Herein, we only discuss sections where changes have been made from the white paper or subsequent addendums (Niver et al. 2014, Niver et al. 2018, Armstrong et al. 2022); guidelines users should defer to these previous documents for all other (un-updated) sections (including LOEs for acoustic surveys). Please note that the revised LOE recommendations are range-wide and replace all prior regional recommendations (i.e., pre- and post-WNS LOEs for IBAT).

Methods

Mist-netting Data Sources and Analysis

With the assistance of the U.S. Geological Survey Virginia Cooperative Fish and Wildlife Research Unit, we analyzed post-WNS mist-net survey data collected from 2016-2022 that was submitted to the USFWS mostly from recovery permit holders (issued under section 10(a)(1)(A)), along with state, federal and other private sources. For the range-wide summer survey guidance, this data set included 891 distinct mist-netting survey sessions across 12 states for IBAT and 1,064 distinct mist-netting survey sessions across 19 states for NLEB. The data set included capture records from May 15 - August 15 and only where IBAT or NLEB had been captured or where surveys occurred within 8 km or 5 km buffers of other post-WNS IBAT

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and/or NLEB captures, respectively. In addition, for year-round active NLEB survey guidance, we identified 357 mist-netting survey sessions conducted from mid-February through mid-November (again collected from 2016-2022) in the Coastal Plain of North Carolina, South Carolina and Virginia where NLEB potentially are present on the landscape year-round. We then created summer detection histories for IBAT and NLEB, and late winter to fall detection histories for NLEB following MacKenzie et al. (2002) using Program Presence to estimate simple site occupancy (Ψ) and nightly detection probability (ρ ; <https://www.usgs.gov/software/presence>). Resulting values of Ψ and ρ were then used to calculate necessary LOE duration to assume species absence following the formula provided by Wintle et al. (2012).

Results

Summer site Ψ for IBAT and NLEB was 0.5971 and 0.5958, respectively for the nationwide post-WNS mist-netting datasets. The nightly ρ for IBAT and NLEB for these data were 0.4644 and 0.2514, respectively. For NLEB in the southeastern Coastal Plain over February to November mist-net surveys, Ψ was 0.3101 and ρ was 0.3693. Table 1 shows necessary mist-netting LOE.

Table 1. Mist-netting level of effort (LOE)⁸.

	Probability of Absence			
	0.90	0.95	0.99	1.00
Indiana bat (<i>Myotis sodalis</i> ; IBAT) nationwide summer non-linear LOE (nights/123 acres)	6	6	8	12
Northern long-eared bat (<i>Myotis septentrionalis</i> ; NLEB) nationwide summer non-linear LOE (nights/123 acres)	10	12	18	26
Northern long-eared bat (<i>Myotis septentrionalis</i> ; NLEB) southeastern Coastal Plain February-November non-linear LOE (nights/123 acres)	6	6	10	14

Survey Implications

Data from previous mist-netting LOE calculations for IBAT and NLEB were limited to the available data at the time – the results presented herein are more robust (in geographic and temporal scope) and now better mirror the range-wide approach for USFWS calculation of acoustic LOE for both species (Armstrong et al. 2022). The emphasis on known post-WNS summer captures/roost buffers allow us to pivot from our original regional “WNS-impacted” LOE trigger analysis for IBAT to a range-wide approach in what is now a largely all-WNS impacted environment (see Niver et al. 2014 and Armstrong et al. 2022). To determine presence or probable absence of either species at the 90% level of confidence, 6 mist-net nights are required for IBAT and 10 for NLEB for non-linear projects (per 123-acres of suitable habitat) and 2 mist-net nights are required for IBAT and 4 for NLEB for linear projects (per 1 km of suitable habitat). In the year-round active portion of the NLEB range in the summer, 6 mist-net

⁸ Calculated LOEs rounded up to the next whole even number.

nights are required from February to November for non-linear projects (per 123-acres of suitable habitat) and 2 mist-net nights are required for NLEB for linear projects (per 1 km of suitable habitat). These survey efforts are the minimum LOE recommended to assess for species probable absence and increasing the mist-netting LOE to a probability of absence confidence score of 1.00 (see Table 1 for LOEs) can provide much-needed post-WNS documentation of extant maternity colonies along with the discovery of new sites (Ford et al. 2023).

Future Research

Additional non-summer season acoustic survey LOE work is planned in 2023-2024 for a wider portion of the southern range where NLEB may be active on the landscape in fall, winter and spring. Similarly, there is a need to examine summer acoustic LOE for northwestern portions of the NLEB range (i.e., South Dakota, Montana and Wyoming). An analysis of the mist-netting summer season LOE for little brown bats (*Myotis lucifugus*) and tricolored bats (*Perimyotis subflavus*) from 2016-2022 is currently underway, as is tricolored bat LOE for southern areas where activity may occur year-round. We anticipate continuing to analyze additional mist-netting data to facilitate periodic updates to mist-netting LOE as WNS continues to impact imperiled bat species across their ranges. We may also modify survey methods to better address differences among species in subsequent years and are continuing to explore different analytical approaches to assessing presence determinations.

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