Addendum 2 – An Update to the Indiana Bat Summer Survey Level of Effort Trigger and to Include Minimum Recommended Effort for Northern Long-eared Bats

March 2022

Mike P. Armstrong[1], R. Andrew King[2], Robyn A. Niver[3], Jill S. Utrup[4], Vona Kuczynska[5], Emily D. Thorne[6], Jesse De La Cruz[6], Sabrina M. Deeley[6], Katherine M. Gorman[6], Alexander Silvis[7], Robin E. Russell[8] and W. Mark Ford[9]

Introduction

This provides an update to the *Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper* (Niver et al. 2014) and the subsequent Addendum 1 (Niver et al. 2018). Given that impacts from white-nose syndrome (WNS) continue to result in population declines to Indiana bats (IBAT, *Myotis sodalis*) in the Northeast (where the disease was initially discovered) and with varying degrees across the entire range of the species, the U.S. Fish and Wildlife Service (Service) has taken an adaptive management approach by periodically examining current data and when warranted, revising the Range-wide Indiana Bat Survey Guidelines and associated recommended summer survey effort. This update considers IBAT and northern long-eared bat (NLEB, *Myotis septentrionalis*) population declines due to WNS and incorporates additional survey data for both species. We previously lacked sufficient data to provide species-specific survey level of effort (LOE) recommendations for the NLEB separately from the IBAT, but recently collected data (2017-2021) have now made this possible.

This addendum provides 1) an assessment for reexamining the Service's "trigger" to modify IBAT survey LOE values for mist-netting for the Midwest and Ozark-Central recovery units (RU) and 2) provides a range-wide minimum recommended LOE for surveys for the NLEB. Herein, we only discuss sections where changes have been made from the previous white paper (Niver et al. 2014) and subsequent addendum (Niver et al. 2018) and defer to these previous versions for unchanged sections. For example, equations for determining LOE (methodology) remain the same as used previously (Niver et al. 2014, Niver et al. 2018) for both acoustics and mist-netting; therefore, that section is not included in this update.

[1] U.S. Fish and Wildlife Service, Frankfort, KY
[2] U.S. Fish and Wildlife Service, Bloomington, IN
[3] U.S. Fish and Wildlife Service, Headquarters
[4] U.S. Fish and Wildlife Service, Bloomington, MN
[5] U.S. Fish and Wildlife Service, Columbia, MO
[6] Virginia Polytechnic Institute and State University, Blacksburg, VA
[7] West Virginia Division of Natural Resources, Elkins, WV
[8] U.S. Fish and Wildlife Service, Fort Collins, CO
[9] U.S. Geological Survey, Blacksburg, VA

Methods

Updated Acoustic Data Sources

The U.S. Geological Survey (USGS) and Virginia Polytechnic Institute and State University (VPISU) with assistance of personnel from Alabama Wildlife and Freshwater Fisheries, Cleveland Metro Parks, Georgia Division of Natural Resources, Missouri Botanical Garden, North Carolina Wildlife Resources Commission, Tennessee Wildlife Resources Agency, U.S. Army, U.S. Forest Service, U.S. Fish and Wildlife, Virginia Department of Conservation and Recreation Service, conducted full spectrum and frequency-division/zero-crossing acoustic surveys during the summer of 2020 and 2021 at 16 and 29 sites, respectively, of IBAT and/or NLEB maternity colonies in Alabama, Arkansas, Georgia, Illinois, Indiana, Kentucky, Missouri, New Jersey, New York, North Carolina, Ohio, Tennessee, Virginia, West Virginia and Wisconsin (Figure 1). For IBATs, this expanded the post-WNS number of survey sites where the species was confirmed as present from 4 in 2017 (included in 2018 addendum) to 8 in 2020, and finally to 13 in 2021. For NLEBs, 2020 data collection included 10 survey sites and 12 in 2021. An additional 6 sites for IBATs and 8 sites for NLEBs each were considered "within range" but without documented maternity colonies in 2020, and 12 and 15, respectively, for 2021 LOE assessment modeling. Nights when detectors were deployed and minimum weather standards were not met were coded as "rain."

Mist-netting Data Sources

There were no targeted mist-netting studies for NLEBs in 2020 and only limited surveys occurred in New York and Virginia that were not sufficient in duration for inclusion herein, though in both states, NLEBs were captured. However, the USGS and VPISU analyzed recent NLEB mist-netting capture records (2016-2019) from known NLEB post-WNS maternity colony sites from the District of Columbia, New York, North Carolina and West Virginia (Figure 1).

Estimating Detection Probabilities and Occupancy Rates for Acoustics and Mist-netting

The USGS and VPISU analyzed the resulting detection histories following MacKenzie et al. (2002) using the R software package *unmarked* to estimate nightly occupancy (Ψ) detection probability (ρ) (https://cran.r-project.org/web/packages/unmarked/index.html) for the various geographic locations across the acoustic survey effort for IBATs and NLEBs and mist-netting for NLEBs (Figure 1). The USGS compared models incorporating the IBAT RUs: Appalachian, Ozark-Central, Midwest, and Northeast and an additional group of Southeast U.S. sites located outside of the IBAT RUs, but within the NLEB range. Comparisons were based upon AIC values, with an *information-theoretic* approach to model selection, with smaller values generally indicating a more parsimonious model (Burnham and Anderson 2002). For consistency with existing recommendations and since RUs have not been designated for the NLEB, sites for the NLEB were also partitioned by IBAT RUs.

Sites that fell outside of currently designated IBAT RU boundaries, but that have been confirmed to have IBAT or NLEBs following the original RU designations were assigned to the nearest RU. For IBAT, presence at Fort A.P. Hill in Virginia and for NLEB presence and Marine Corps Base-Quantico in Virginia were assigned to the Appalachian RU. The NLEB presence at

Governor Dodge State Park and Horicon Marsh National Wildlife Refuge was assigned to the Midwest RU (Figure 1). Sites located in the Southeast (i.e., Georgia and North Carolina) and far outside of previously designated IBAT RUs were placed in a Southeast group. These sites included Whitehall Forest and Ocumulgee WMA in Georgia and Pineola Bog and North River Game Land in North Carolina that were surveyed to begin data collection for tricolored bat (*Perimyotis subflavus*) and/or little brown bat (*Myotis lucifugus*) as was a site with tricolored bat presence at Jessieville-Winona Fourche Ranger District in Arkansas assigned to the Ozark-Central RU (Figure 1).

Acoustic data model covariates included 1) binary designations of recent confirmed presence of a maternity colony versus possible maternity colony presence from being "within range" (Roost), 2) no rain versus rain (Rain), 3) site variables of detector placement within a) interior forest, b) forest riparian/wetland and c) forest/field edge (Habitat) and 4) geographic region (Region). NLEB mist-netting model covariates were 1) day of year (DOY), 2) month, 3) year and 4) region.

Results

Indiana Bats Acoustics

The number of rain-free detector nights for all IBAT and other species discussed below across all RU's by individual detector ranged from 7 to 90 (55.01 ± 1.59 nights). The best supported model for predicting probability of occurrence and site occupancy of IBATs was ρ(Roost),Ψ(Region); however, the ρ (Rain+Roost)Ψ(Region) was within 1.85 AIC units and considered the most informative for survey protocol purposes since nights not meeting required weather standards are excluded for monitoring purposes (Table 1). Occupancy varied greatly by region (Table 2). Potential LOE was calculated by regions from sites with known maternity colonies for nights with no rain. At $\alpha = 0.1$, the Ozark-Central RU returned the longest required LOE of ~ 10 detector nights, with ~ 9 detectors nights in the Midwest, with ~ 6 detector nights in the Northeast, with ~ 4 detector nights at the Southeast sites outside the designated RUs, and ~ 3 detector nights in the Appalachians (Table 2, Figure 2).

Northern Long-eared Bats Acoustics

The best supported acoustic model (post-WNS) for NLEBs was ρ(Rain+Roost), Ψ(Region+Habitat), though ρ(Rain+Roost), Ψ(Region) was within 2.16 AIC units (Table 3). Similar to IBATs, occupancy varied by region, as more survey sites contained recent known maternity colonies (Table 4). The LOE was calculated by regions from sites with (recent) known maternity colonies for nights with no rain inclusive of all habitat types using the ρ(Rain+Roost), Ψ(Region). At $\alpha = 0.1$, the Ozark-Central RU returned the longest required LOE of ~14 detector nights, with ~13 detector nights in the Midwest, ~12 detector nights in the Southeast, ~9 detector nights in the Appalachians, and ~ 6 detector nights in the Northeast (Table 4, Figure 3).

Northern Long-eared Bats Mist-netting

The best supported mist-netting model (post-WNS) for NLEBs where maternity colonies were known was ρ (DOY) Ψ(.).; however, there were 3 other models that also had strong empirical

support (ΔAICc < 2) and were considered competing (Table 5). No geographic covariate (i.e., region or state) contributed, indicating variability was temporal (less with increasing years, summer months within a year, or days within the summer season). As such and owing to the similar AIC_c weights among competing models, we used ρ (.) Ψ(.) as our selected model. Using our selected model, the LOE at $\alpha = 0.1$ showed that ~16 net-nights are required (Table 6, Figure 4).

Survey Implications

Indiana Bat LOE

Based on our findings, we recommend an increase in the IBAT acoustic LOE from 8 to 10 rain-free detector nights for non-linear projects (per 123 acres) and from 2 to 4 detector nights per km of suitable habitat for linear projects starting in 2022(Table 7). We also recommend that mist netting LOE remain the same as previous years with 42 net-nights for non-linear projects and 10 net-nights for linear projects necessary in the Northeast and Appalachian RUs and 9 and 2 net-nights, respectively, for the Midwest and Ozark-Central RUs (Table 7).

Updated Indiana Bat LOE Trigger Analysis

Since 2014, the Service has required a significantly higher LOE for mist net surveys within fully "WNS-impacted" IBAT RUs (Northeast and Appalachian) than in RUs that had not yet been as severely impacted by WNS (Midwest and Ozark-Central) (Figure 5). Niver et al. (2014) originally recommended that a RU be considered "WNS-impacted" if 1) it has a ≥30% decline in its total RU population (Trigger #1), *or* 2) if ≥50% of Priority 1 and 2 IBAT hibernacula within a RU decline by ≥30% from their most recent pre-WNS population estimates (Trigger #2).

Because the Northeast and Appalachian RUs are already considered to be WNS-impacted, the trigger analyses are only needed for the Midwest and Ozark-Central RUs. For these analyses, the most recent "pre-WNS" population estimates are from 2011 and 2013 for the Midwest and Ozark-Central RUs, respectively. We have been conducting a new trigger analysis approximately every two years as new winter population data become available from state and federal partners. Results from a recently completed trigger analysis using 2019 data are presented in Table 8.

Based on these recent data, Trigger #1 has not yet been met for the Midwest or Ozark-Central RUs. Numerically speaking, the RU-wide numbers in these RUs have not experienced the same magnitude of WNS-associated declines as seen in the Northeast and Appalachian RUs, whereby 2014, had suffered approximately 70% and 90% declines, respectively. Overall population declines in the Midwest and Ozark-Central have been less severe over time than in the eastern RUs. In contrast, Trigger #2 has been numerically met in both the Midwest and Ozark-Central RUs, indicating that at least half of the largest hibernacula in both RUs have experienced considerable population declines (≥30%) since WNS arrived. As noted in the recent 5-year review (FWS 2019) and further supported by this trigger analysis, the winter distribution of IBAT populations apparently has changed after the arrival of WNS in these RUs, with remaining populations becoming more concentrated into fewer, large Priority 1 and 2 sites within their respective geographic regions.

Because a large disparity remains in the overall percentage of post-WNS population decline between the Midwest and Ozark-Central RUs, and the Northeast and Appalachian RUs, we paused to reassess the wording and intent of our originally defined triggers. The primary reasons the Ozark-Central RU has only experienced 2% decline post-WNS is because the vast majority of IBATs overwinter in two very large sites (Lime Kiln Mine in MO and Magazine Mine in IL), one of which has experienced a relatively small decline and the other has actually had significant growth in population size since the onset of WNS.

> *Solution*—The Service has decided to revise the 2014 trigger standard to now require that both Trigger #1 *and* Trigger #2 need to be met rather than just one or the other as originally written. Thus, the Midwest and Ozark-Central RUs will remain at the lower LOE for mist netting until such time that Trigger #1 has also been met. For future years, as effects of WNS on summer survey results are better calibrated, it may require revising the summer guidance by subunits smaller than the current RU. We recommend continuing to evaluate summer netting and acoustic detection probabilities and occupancy rates and/or winter count information but also exploring how additional geo-spatial analyses of winter populations may improve our decision-making process.

Northern Long-eared Bat LOE

We now have sufficient data available to provide acoustic and netting minimum LOE recommendations specifically for the NLEB for the first time. Although there were differences in recommended acoustic LOE across the range, starting in 2022, we recommend using a range-wide LOE of 14 detector nights or 16 net nights for non-linear projects (≤123 acres) of suitable habitat to achieve 90% confidence in any negative result and 4 detector nights or 4 net nights per km of habitat for linear projects (Table 7).

Future Research

Additional targeted surveys are planned in 2023 and are anticipated to further inform the minimum recommended IBAT and NLEB LOEs in the future as population levels and distributions are fluid on the post-WNS landscape. Currently, data for the assessment metrics for the gray bat (*Myotis grisescens*), little brown bat and tri-colored bat are being examined. We may also modify survey methods to address differences among species in subsequent years and we are continuing to explore different analytical approaches to assessing presence determinations.

Literature Cited

Burnham, K. P., and D. R. Anderson. 2002. Model selection and inference-a practical information theoretic approach. Second edition. Springer-Verlag, New York, New York, USA.

MacKenzie, D.I., JD. Nichols, G.B. Lachman, S. Droege, J.A. Royle, and C.A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecological Society of America 83(8):2248-2255.

2020-2021 Acoustic Level of Effort Sites

1 – Bankhead National Forest, AL
2 – Jessieville Winona Fourche Ranger Distric, AR
3 – Oakmulgee National Forest, AL
4 – Whitehall Forest, GA
5 – Ocmulgee Wildlife Management Area, GA
6 – Cypress Creek National Wildlife Refuge, IL
7 – Beanblossom Bottoms Nature Preserve, IN
8 – Morgan-Monroe State Forest, IN
9 – Ballarg Wildlife Management Area, KY
10 – Fort Campbell Military Reservation, KY/TN
11 – Fort Knox Military Reservation, KY
12 – Yellowbank Wildlife Management Area, KY
13 – Shaw Nature Reserve, MO
14 – North River Game Land, NC
15 – Pineola Bog, NC
16 – Great Swamp National Wildlife Refuge, NJ
17 – Wallkill River National Wildlife Refuge, NJ
18 – Fort Drum Military Reservation, NY
19 – Battelle Darby Creek Metro Park, OH
20 – Catoosa Wildlife Management Area, TN
21 – Wilson County Artificial Roost, TN
22 – Fort A.P. Hill Military Reservation, VA
23 – Marine Corps Base Quantico, VA
24 – Sky Meadows State Park, VA
25 – Horicon Marsh National Wildlife Refuge, WI
26 – Governor Dodge State Park, WI
27 – The Fernow Experimental Forest, WV
28 – The Jug Wildlife Management Area, WV
29 – Lewis Wetzel Wildlife Management Area

Northern Long-eared Maternity Colony Mist-netting Capture Sites

A – Fire Island National Seashore, NY
B – Ohio Valley Region, WV
C – Rock Creek Park, DC
D – Marine Corps Base Quantico, VA
E – North River Game Land, NC

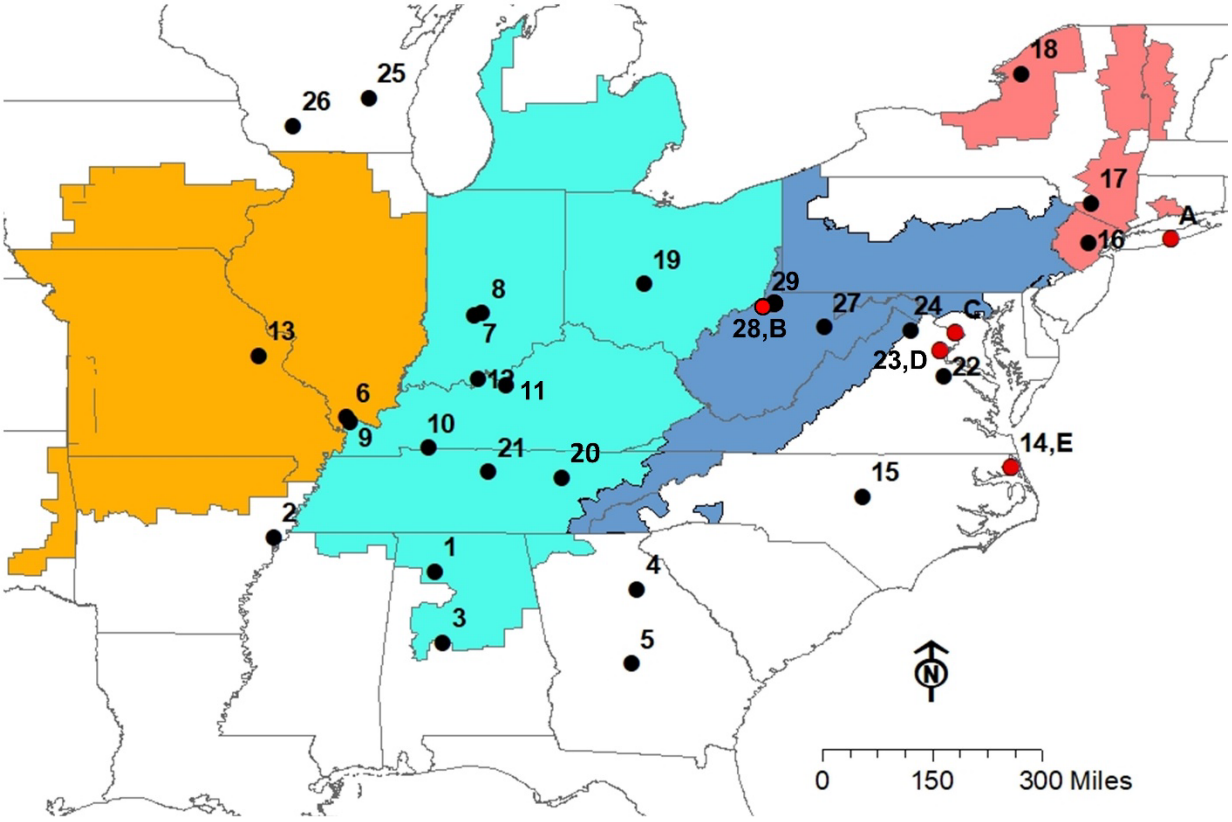

FIGURE 1. U.S. Fish and Wildlife Service acoustic level of effort monitoring sites May-August, 2020-2021 (black dots) and netting level of effort calculated from current and recent past (2016-2019) NLEB (Myotis septentrionalis) study sites (red dots). Shaded areas represent the four IBAT Recovery Units (orange=Ozark-Central, cyan=Midwest, blue=Appalachian, and pink=Northeast).

TABLE 1. Akaike Information Criterion (AIC) table for IBAT (*Myotis sodalis*) acoustic occupancy and detection models, May-August, 2020-2021. Covariates were Roost (confirmed or within range; binary), Rain (rain or no rain on nightly basis; binary), Region (Appalachian, Ozark-Central, Midwest, and Northeast recovery units and Southeastern sites; categorical) and Habitat Type (forest, riparian/wetland or forest/field edge; categorical).

Model	AIC_c	ΔAIC_c	w_i	K
P(roost) Ψ(region)	7749.29	0.00	0.59	7
P(rain+roost) Ψ(region)	7751.14	1.85	0.23	8
P(roost) Ψ(region+habitat)	7752.28	2.99	0.13	9
P(rain+roost) Ψ(region+habitat)	7754.19	4.90	0.05	10
P(roost) Ψ(.)	7767.87	18.58	0.00	3
P(rain+roost) Ψ(.)	7769.66	20.36	0.00	4
P(roost) Ψ(habitat)	7771.24	21.95	0.00	5
P(rain+roost) Ψ(habitat)	7773.05	23.76	0.00	6
P(year) Ψ(.)	7817.70	68.40	0.00	4
P(.) Ψ(region)	7873.44	124.15	0.00	6
P(rain) Ψ(region)	7874.98	125.69	0.00	7
P(.) Ψ(region+habitat)	7876.50	127.21	0.00	8
P(rain) Ψ(region+habitat)	7878.10	128.80	0.00	9
P(.) Ψ(.)	7892.40	143.10	0.00	2
P(.) Ψ(Year)	7894.26	144.97	0.00	4
p(.) Ψ(habitat)	7895.82	146.52	0.00	4
P(rain) Ψ(habitat)	7897.33	148.04	0.00	5

TABLE 2. Level of survey effort required (acoustic detector nights for non-linear projects) to reach certainty of absence at given alpha levels for the IBAT (*Myotis sodalis*) within known maternity colony areas for the Appalachian, Ozark-Central, Midwest and Northeast recovery units and Southeast sites based on the top supported model, May-August, 2020-2021.

		Within a Known Maternity Area Occupancy and Detection				**Detector Nights required at set *α***					
Region	**No. Detector sites used**	**Ψ**	**SE**	**ρ**	**SE**	**0.001**	**0.01**	**0.05**	**0.10**	**0.20**	**0.25**
Appalachia	42	0.26	0.09	0.32	0.01	15.20	9.20	4.92	2.99	0.88	0.14
Midwest	61	0.75	0.06	0.32	0.01	20.76	14.76	10.48	8.55	6.44	5.70
Northeast	17	0.50	0.09	0.32	0.01	17.91	11.91	7.63	5.70	3.59	2.85
Ozark-Central	20	0.85	0.08	0.32	0.01	22.41	16.41	12.13	10.19	8.09	7.35
Southeast	2	0.37	0.15	0.32	0.01	16.53	10.53	6.25	4.32	2.21	1.47
All	142	0.60	0.04	0.32	0.01	18.96	12.97	8.69	6.75	4.65	3.90

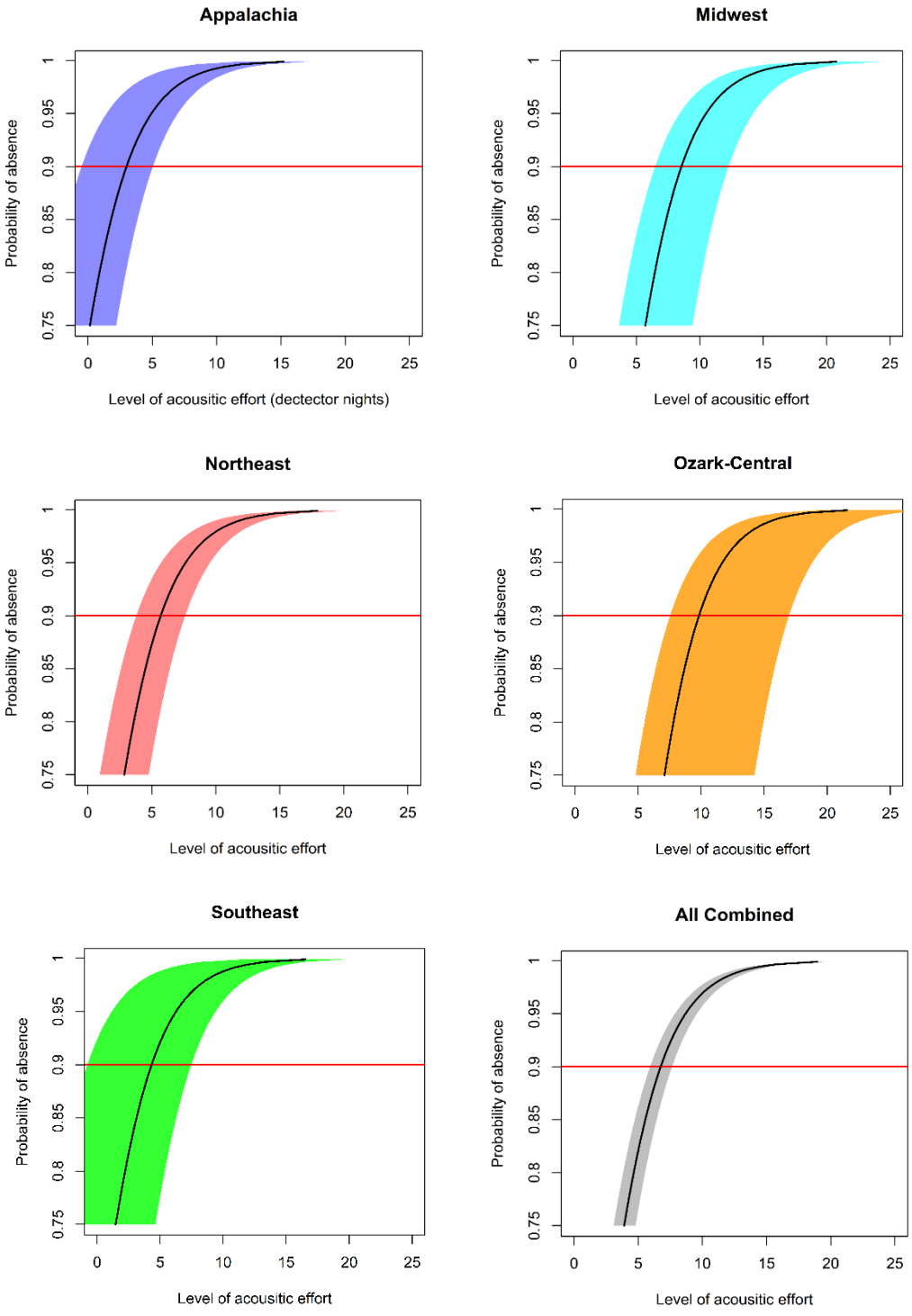

FIGURE 2. Acoustic level of effort with 95% confidence interval for IBAT (*Myotis sodalis*) at sites with known maternity roosts for Appalachian, Ozark-Central, Midwest and Northeast IBAT recovery units and Southeast sites as well as range-wide. Red line indicates the 90% confidence level for probability of absence.

TABLE 3. Akaike Information Criterion (AIC) table for NLEB (*Myotis septentrionalis*) acoustic occupancy and detection models, May-August, 2020-2021. Covariates were Roost (confirmed or within range; binary), Rain (rain or no rain on nightly basis; binary), Region (using Appalachian, Ozark-Central, Midwest, and Northeast IBAT [*Myotis sodalis*] recovery units and Southeastsites; categorical) and Habitat Type (forest, riparian/wetland or forest/field edge; categorical).

Model	AIC_c	ΔAIC_c	w_i	K
P(rain+roost) Ψ(region+habitat)	9281.93	0.00	0.75	11
P(rain+roost) Ψ(region)	9284.09	2.16	0.25	9
P(rain+roost) Ψ(habitat)	9296.01	14.08	0.00	7
P(rain+roost) Ψ(.)	9298.60	16.67	0.00	5
P(roost) Ψ(region+habitat)	9302.35	20.42	0.00	10
P(roost) Ψ(region)	9304.60	22.67	0.00	8
P(roost) Ψ(habitat)	9316.61	34.68	0.00	6
P(roost) Ψ(.)	9319.34	37.41	0.00	4
P(rain) Ψ(region+habitat)	9337.26	55.33	0.00	9
P(rain) Ψ(region)	9339.34	57.41	0.00	7
P(rain) Ψ(habitat)	9350.97	69.04	0.00	5
P(rain) Ψ(.)	9353.58	71.65	0.00	3
P(.) Ψ(region+habitat)	9356.88	74.95	0.00	8
P(.) Ψ(region)	9359.03	77.10	0.00	6
P(.) Ψ(habitat)	9370.71	88.78	0.00	4
P(.) Ψ(.)	9373.38	91.45	0.00	2
P(.) Ψ(year)	9374.37	92.44	0.00	4

TABLE 4. Level of survey effort required (acoustic detector nights for non-linear projects) to reach certainty of absence at given alpha levels for NLEB (*Myotis septentrionalis*) using the Appalachian, Ozark-Central, Midwest and Northeast IBAT (*Myotis sodalis*) recovery units and Southeast sites based on the top supported model, May-August, 2020-2021.

		Occupancy and Detection				Detector Nights required at set α					
Region	**No. Detector sites used**	**Ψ**	**SE**	**ρ**	**SE**	**0.001**	**0.01**	**0.05**	**0.1**	**0.2**	**0.25**
Appalachian	46	0.68	0.07	0.28	0.01	23.29	16.25	11.23	8.96	6.49	5.61
Midwest	60	0.90	0.04	0.28	0.01	27.71	20.68	15.65	13.38	10.91	10.03
Northeast	18	0.44	0.10	0.28	0.01	20.29	13.25	8.23	5.95	3.49	2.61
Ozark-Central.	20	0.91	0.07	0.28	0.01	28.07	21.03	16.01	13.73	11.26	10.39
Southeast	11	0.87	0.12	0.28	0.01	26.81	19.77	14.75	12.48	10.01	9.13
All	155	0.76	0.03	0.28	0.01	24.53	17.50	12.47	10.20	7.73	6.85

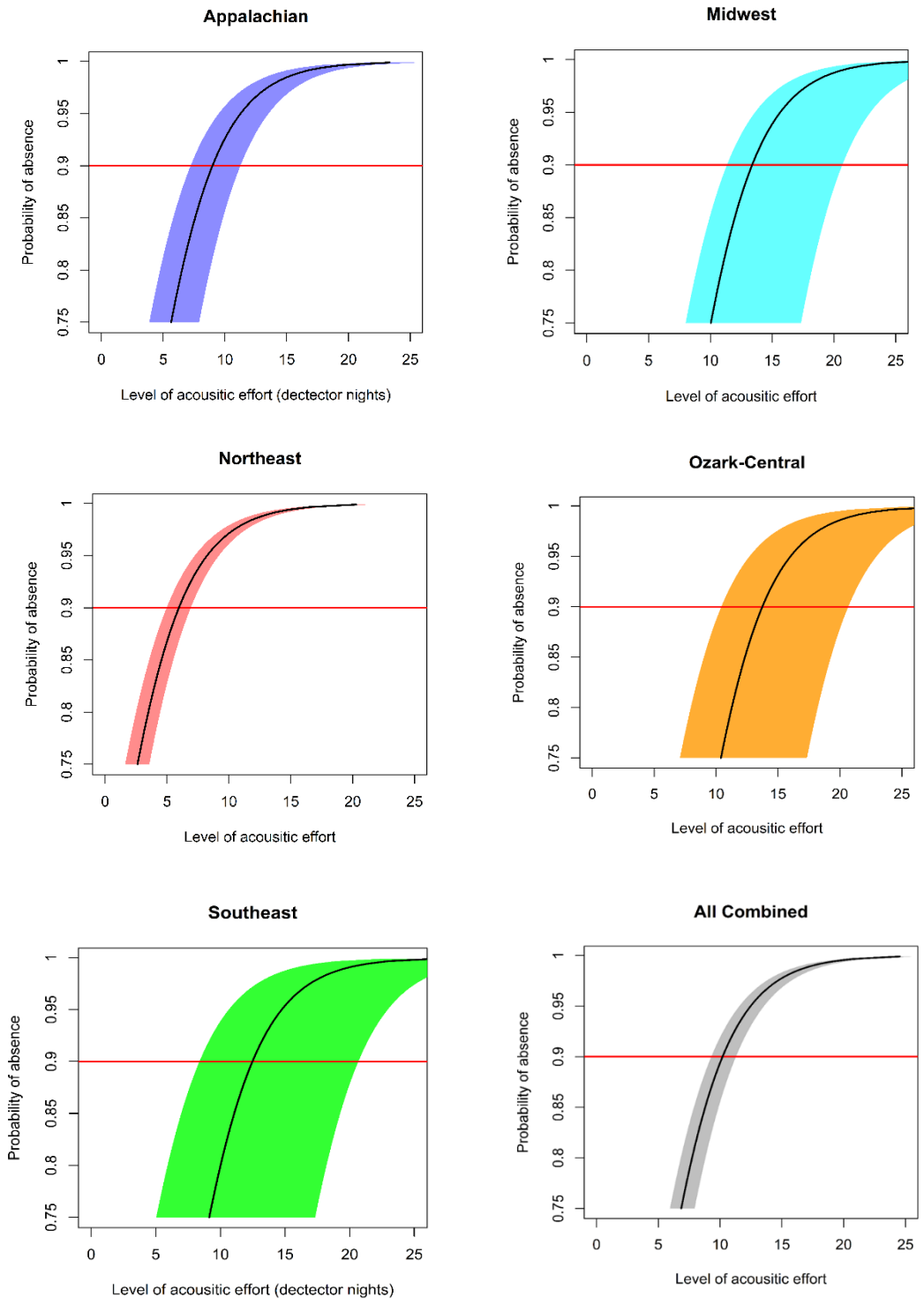

FIGURE 3. Acoustic level of effort with 95% confidence interval for NLEB (*Myotis septentrionalis*) at sites with known maternity roosts using the Appalachian, Ozark-Central, Midwest and Northeast IBAT (*Myotis sodalis*) recovery units and Southeast sites as well as range-wide. Red line indicates the 90% confidence level for probability of absence.

TABLE 5. Akaike Information Criterion (AIC) table for NLEB (*Myotis septentrionalis*) mist-netting occupancy and detection models at known maternity colony areas, 2016-2019 (see Figure 1). Covariates were DOY (day of year; continuous), Month (categorical), year (categorical), Region (Appalachian, Ozark-Central, Midwest, Northeast IBAT [*Myotis sodalis*] recovery units and Southeast sites; categorical) and State (state; categorical).

Model	K	AIC_c	ΔAIC_c	W_i
ρ (DOY) Ψ(.)	3	368.95	0.00	0.22
ρ (.) Ψ(Month)	6	369.03	0.08	0.21
ρ (.) Ψ(.)	2	369.60	0.65	0.16
ρ (DOY) Ψ(Month)	7	370.68	1.73	0.09
ρ (.) Ψ(Year)	6	370.92	1.97	0.08
ρ (.) Ψ(Region)	4	371.91	2.96	0.05
ρ (.) Ψ(Month+Region)	8	372.08	3.12	0.05
ρ (DOY) Ψ(Year)	7	372.29	3.34	0.04
ρ (DOY) Ψ(Region)	5	372.76	3.81	0.03
ρ (.) Ψ(State)	6	373.62	4.67	0.02
ρ (DOY) Ψ(Month+Region)	9	373.90	4.95	0.02
ρ (.) Ψ(Year+Region)	8	375.07	6.12	0.01
ρ (DOY) Ψ(State)	7	375.32	6.37	0.01
ρ (DOY) Ψ(Year+Region)	9	375.97	7.02	0.01

TABLE 6. Level of mist-netting survey effort required (net nights) to reach certainty of absence at given alpha levels for NLEB (*Myotis septentrionalis*) based on top supported model, 2016-2019 (see Figure 1).

Occupancy and Detection				Days required at set α					
Ψ	**SE**	**ρ**	**SE**	**0.001**	**0.01**	**0.05**	**0.1**	**0.2**	**0.25**
0.92	0.16	0.25	0.05	32.50	24.46	18.72	16.13	13.31	12.31

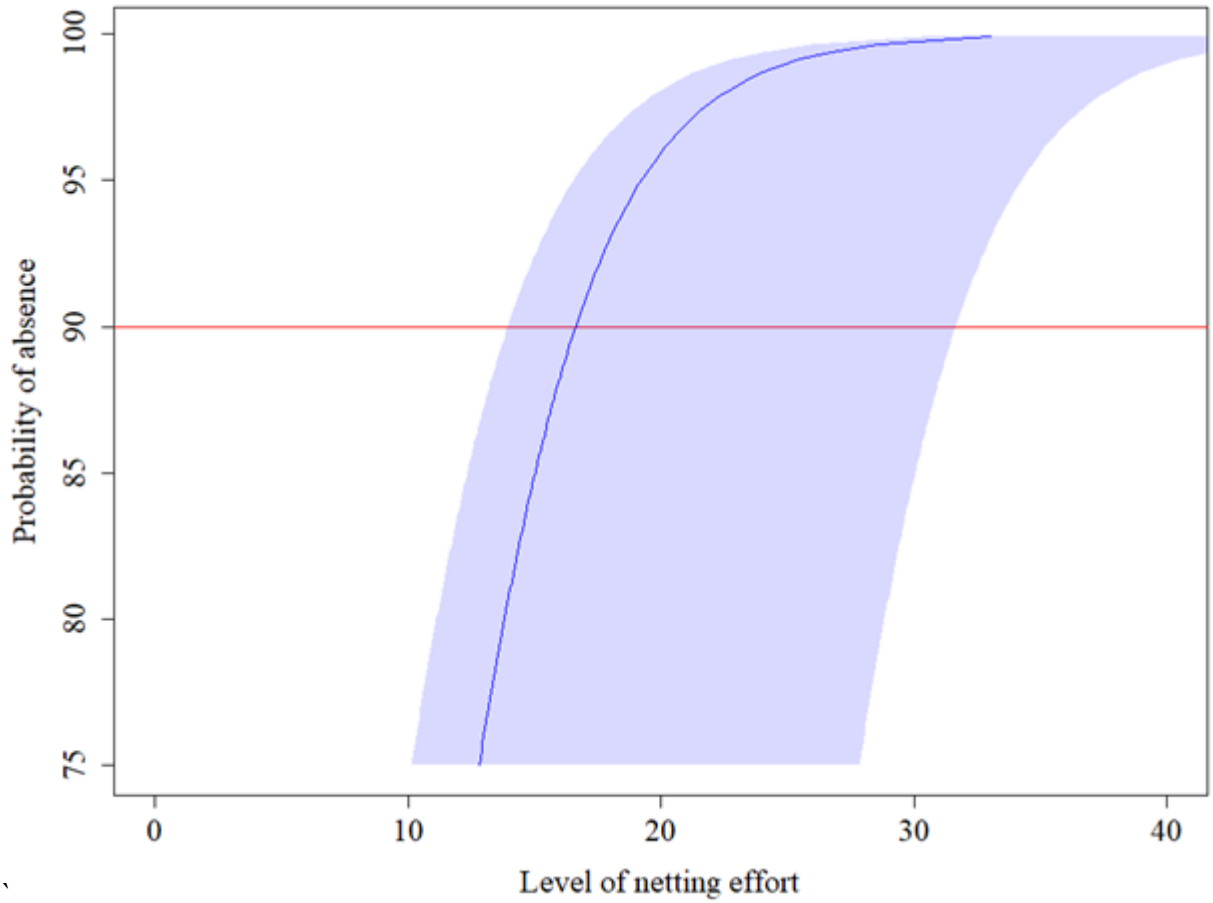

FIGURE 4. Range-wide mist-netting level of effort with 95% credible interval for NLEB (*Myotis septentrionalis*) at sites with known maternity roosts, 2016-2019 (see Figure 1). Red line indicates the 90% confidence level for probability of absence.

TABLE 7. The U.S. Fish and Wildlife Service's recommended minimum survey level of effort for presence/probable absence surveys for the IBAT (*Myotis sodalis*) and the NLEB (*Myotis septentrionalis*) for linear and non-linear projects.

	Indiana Bat			Northern Long-eared Bat	
	Netting (net nights)		Acoustic (detector nights)	Netting (net nights)	Acoustic (detector nights)
	Northeast & Appalachian RUs	Midwest & Ozark-Central RUs	Range-wide	Range-wide	Range-wide
Linear Projects (per km of habitat)	10	2	4	4	4
Non-linear Projects (per 123 ac. of habitat)	42	9	10	16	14

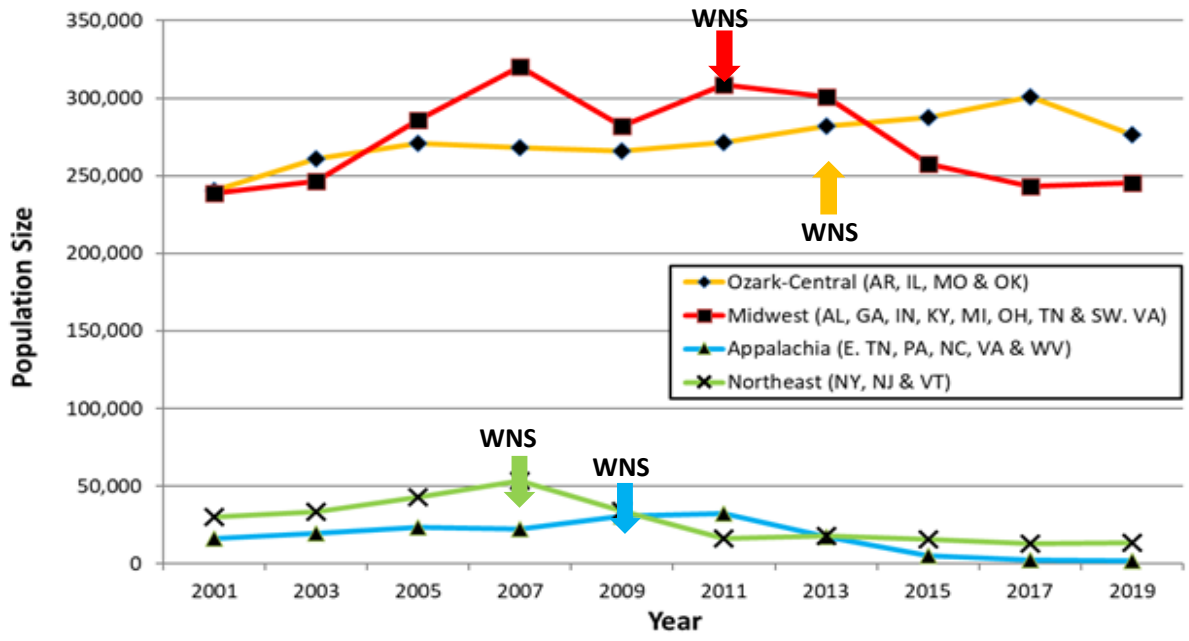

FIGURE 5. IBAT (*Myotis sodalis*) population estimates by recovery unit from 2001 to 2019. (color-coded arrows depict approximate time of arrival of white-nose syndrome within multiple sites in each Recovery Unit).

TABLE 8. Updated trigger analysis for IBAT (*Myotis sodalis*) mist net survey LOE for the Midwest and Ozark-Central Recovery Units (RU) using the most recent population data available (i.e., 2019 data).

Recovery Unit	**TRIGGER #1**: Has the RU as a whole experienced ≥30% decline from its most recent pre-WNS population estimate?	**TRIGGER #2**: Have ≥50% of P1 and P2 sites in the RU had a ≥30% decline from their most recent pre-WNS population estimates? (Analysis included all P1 andP2 sites with ≥1,000 IBATs in the most recent pre-WNS year.)
Midwest (pre-WNS = 2011)	**NO**. 20% decline from 2011-2019. An additional loss of 29,628 bats would be required to meet this trigger.	**YES**. 14 out of 28 sites or 50% have experienced a ≥30% decline post-WNS.
Ozark-Central (pre-WNS = 2013)	**NO**. 2% decline from 2013-2019. An additional loss of 78,825 bats would be required to meet this trigger.	**YES**. 9 out of 17 sites or 53% have experienced a ≥30% decline post-WNS.

Recommended Citation for this Document:

Armstrong, M.P., R.A. King, R.A. Niver, J.S. Utrup, V. Kuczynska, E.D. Thorne, J. De La Cruz, S.M. Deeley, K.M. Gorman, A. Silvis, R.E. Russell, and W.M. Ford. 2022. Addendum 2 – An Update to the Indiana Bat Summer Survey Level of Effort Trigger and Inclusion of Minimum Recommended Effort for Northern Long-eard Bats. U.S. Fish and Wildlife Service, Region 3, Bloomington, MN. 16 pp.
https://www.fws.gov/library/collections/range-wide-indiana-bat-and-northern-long-eared-bat-survey-guidelines