

Addendum 1 - Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper

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Introduction

This provides an update to the 2014 Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper (Niver et al. 2014). Given that impacts from white-nose syndrome (WNS) continue to result in population declines to Indiana bats 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) is taking an adaptive management approach and revising the Range-wide Indiana Bat Summer Survey Guidance as warranted over time.

This addendum is the first modification to the survey level of effort (LOE) since acoustics were incorporated into the protocols. The analyses have not been completed for netting and no recommendations for changing LOE for mist netting are available at this time. We only discuss sections where changes have been made. For example, no changes in the calculation for determining LOE were made; therefore, that section is not included in this update.

Methods

Updated Acoustic Data Sources

The U.S. Geological Survey (USGS) conducted acoustic surveys at sites with recent history of Indiana bat maternity colonies in Virginia, Ohio, and Kentucky in 2017 (Table 1). The USGS also included acoustic sampling conducted by the Department of Army in 2017 from Fort Drum, New York in the analyses (Table 1). This expanded the number of post-WNS acoustic studies considered for developing LOE from 1 in 2014 to 5. Nights when detectors were deployed and minimum weather standards were not met were removed from analyses.

Estimating Detection Probabilities and Occupancy Rates

The USGS analyzed the resulting detection histories following MacKenzie et al. (2002) using the software package PRESENCE to estimate detection probabilities p and occupancy rates Ψ (<http://www.mbr-pwrc.usgs.gov/software/presence.shtml>) for various geographic locations across the survey May 15-August 15 period. The USGS compared models incorporating region (Appalachian, Northeast, Coastal Piedmont, and Lower Ohio Valley) and season represented by early (May 15-June 14), mid (June 15-July 14) and late (July 15-Aug 15) based upon AIC, an *information-theoretic* approach to model selection, with smaller values indicating a more parsimonious model (Burnham and Anderson 2002).

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Results

Although, the best supported model for assessing occupancy and detection probability was $\psi(\text{region})P(\cdot)$, the null model at $< 2 \Delta\text{AIC}$ units from the top model also was supported (Table 2). However, when considering separate LOE by region or combined across the range, both model results provided the same ultimate conclusion in terms of recommended LOE (Table 3). Across the surveys, detection probability was constant at 0.26, whereas estimated occupancy rates ranged from 0.51 to 0.54 (Table 3).

2018 Level of Effort

We made the following recommendations to Service management in November 2013 and received their approvals. We recommended identifying the minimum level of acoustic detector sites or net sites to achieve 90% confidence in any negative result. In other words, for every 100 projects we would likely incorrectly come to the conclusion that Indiana bats are not present when they really are 10 times. Given the similar detection probabilities for acoustic surveys across all the study areas, we recommended simplifying this portion of the protocols to be a single range-wide standard.

When considering the recently revised detection probabilities and occupancy estimates, the new acoustic minimum LOE required to maintain 90% confidence that Indiana bats will be detected if present is 8 detector nights across the species' distribution/123 acres of suitable habitat (Table 3, Figure 1)(4 detector nights previously had been required).

For future years, as effects of WNS are better understood, it may make sense to revise the summer guidance by units smaller than an Indiana bat RU. We recommended evaluating summer netting and acoustic detection probabilities and occupancy rates and/or evaluating winter count information to assist with this decision.

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., J.D. 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.

Recommended Citation for this Document

Niver, R.A., R.A. King, M.P. Armstrong, and W.M. Ford. 2018. Addendum 1 - Methods to Evaluate and Develop Minimum Recommended Summer Survey Effort for Indiana Bats: White Paper. Accessed [Date]
<http://www.fws.gov/midwest/Endangered/mammals/inba/inbasummersurveyguidance.html>

Table 1. 2017 Acoustic Survey Information Used for Determining Range-wide Indiana Bat Level of Effort.

Site	Region	Acoustic Type	Detectors	Nights Sampled
Fort Drum, New York	Northeast	zero-crossing	5	43
Fort A.P. Hill, Virginia	Coastal/Piedmont	zero-crossing	3	67
Edge of Appalachia, Ohio	Appalachian	zero-crossing	3	65
Fort Knox, Kentucky	Lower Ohio Valley	zero-crossing	3	63
Ballard WMA, Kentucky	Lower Ohio Valley	zero-crossing	3	59

Notes: "Nights sampled" is the maximum number of nights sampled after poor weather events were removed.

Table 2. Indiana Bat Occupancy and Detection Model Selection Values

Model	AIC	Δ AIC	AICw	Supported Model
$\Psi(\text{region})P(\cdot)$	625.32	0.00	0.52	yes
$\Psi(\cdot)P(\cdot)$	625.49	0.17	0.48	yes
$\Psi(\cdot)P(\text{season})$	637.44	12.12	0.00	no
$\Psi(\text{region})P(\text{season})$	637.61	12.29	0.00	no

Notes: Δ AIC is the difference in AIC values between each model and the best supported AIC model; AICw is the model weight.

Table 3. Varying Level of Effort Based on Indiana Bat Detection and Occupancy Rates

Region	Ψ	Std. err	P	Std. err	Days Required at set α						
					0.001	0.01	0.05	0.10	0.15	0.20	0.25
Northeast	0.51	0.02	0.26	0.02	23.2	15.5	10.0	7.5	5.9	4.8	3.8
Coastal/Piedmont	0.52	0.05	0.26	0.02	23.4	15.7	10.1	7.6	6.1	4.9	4.0
Appalachian	0.53	0.07	0.26	0.02	23.5	15.8	10.3	7.8	6.2	5.1	4.1
Lower Ohio Valley	0.54	0.10	0.26	0.02	23.7	16.0	10.4	7.9	6.4	5.2	4.3
Combined	0.51	0.07	0.26	0.02	23.2	15.5	10.0	7.5	5.9	4.8	3.8

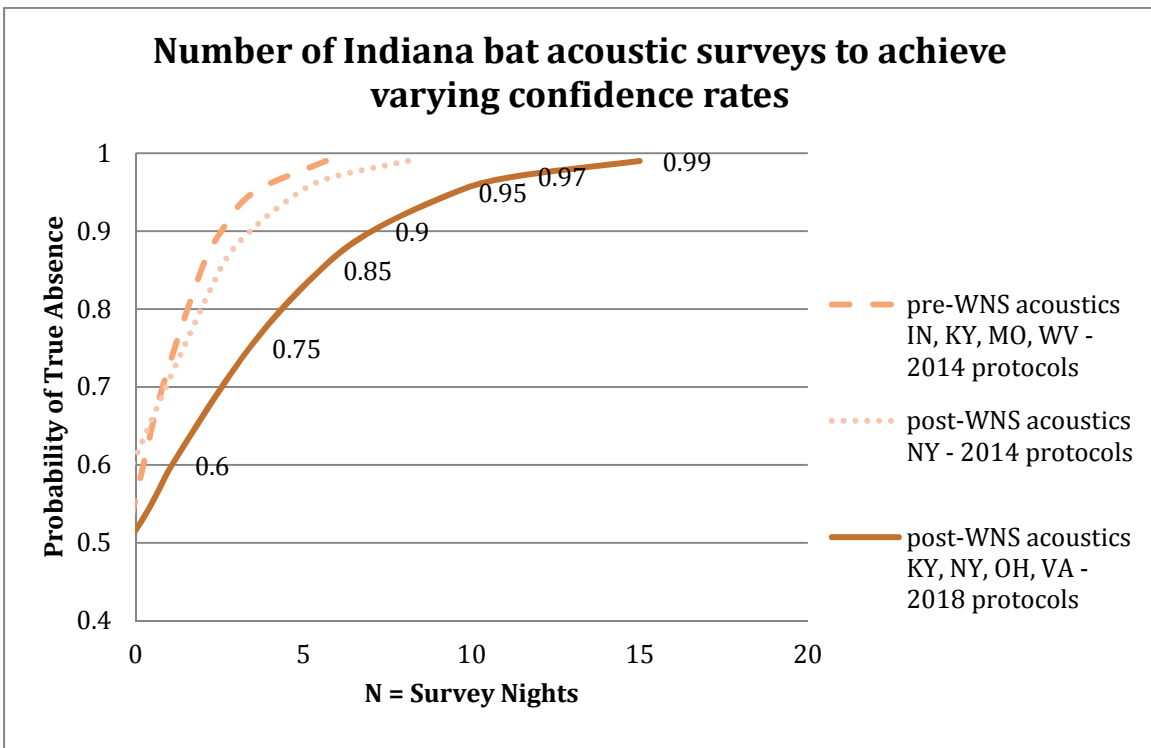


Figure 1. Comparison of acoustic data available for 2014 vs. 2018 Indiana bat summer survey protocols.