Post-Construction Monitoring Study for the Headwaters II Wind Farm

Randolph County, Indiana

Year 1 Final Report

May 3 – October 15th, 2022

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EXECUTIVE SUMMARY

Headwaters II Wind Farm, a subsidiary of EDP Renewables, is operating the Headwaters II Wind Farm (Project) in Randolph County, Indiana. This report details the first year of post-construction compliance monitoring studies conducted in 2022, consistent with the Project's Habitat Conservation Plan (HCP) and Incidental Take Permit (ITP; ESPER0025999) for Indiana bat and northern long-eared bat (Covered Species). From March 15 until May 2, 2022, turbines operated with blades feathered under an increased cut-in speed per the US Fish and Wildlife Service *Technical Assistance Letter for Avoidance of Indiana Bat and Northern Long-eared Bat Take at Headwaters II Wind Farm*, issued August 5, 2019. The Project's ITP was issued April 22, 2022, and beginning May 3, turbine blades were feathered under different cut-in speeds based on season for the remainder of the study period per the Project's HCP.

Post-construction monitoring was completed in accordance with the study plan, which was approved by US Fish and Wildlife Service on March 3, 2022. The study plan was designed to achieve a 25% probability of detecting a single bat carcass (*g* of 0.25) for the 49 wind turbines at the Project. The overall goal of this post-construction fatality monitoring study was to generate reliable fatality estimates for the Covered Species and to evaluate compliance with the incidental take authorization granted under the Project's ITP. More specifically, the objectives of this study were to estimate take for the Covered Species using the Evidence of Absence (EoA) framework as outlined in the HCP and to determine if adaptive management was necessary to maintain compliance with the Project's ITP.

Standardized carcass searches for bat carcasses were completed at three plot types: cleared plots, uncleared plots, and road and pad plots, and were conducted by two types of searchers: technician and dog-handler team (consisting of one dog trained to detect carcasses and one handler). The frequency of searches varied across seasons, with more searches occurring when take of Covered Species was considered more likely to occur. Searcher efficiency and carcass persistence trials were also conducted during each season to correct for detection and scavenger bias.

During the study period, four federally listed endangered Indiana bats were found within the fall survey season. No northern long-eared bats were found. Additionally, three evening bats, a state-listed endangered species, were found during the summer (one) and fall (two) seasons. Overall, 341 bats were found during the study. The most commonly found bat species were eastern red bat (38.7 %), silver-haired bat (25.5 %), big brown bat (22.3 %), and hoary bat (10.3 %). Species composition recorded at the Project was similar to the 2021 study at the Project, and other wind facilities in Indiana. One hundred and three bird carcasses were recorded; no federally or state-listed birds were found.

The overall detection probability (*g*) was 0.31 (90% confidence interval: 0.28 – 0.33). Based on the data collected to date, the EoA model estimated the mean annual fatality rates were 14.62 Indiana bats and 1.62 northern long-eared bats. The probability that the annual take rate exceeded the expected annual take rate was 0.67 for Indiana bat and 0.19 for northern long-

eared bat. The cumulative take estimates through 2022 were 13 Indiana bat fatalities and zero northern long-eared bat fatalities. The estimated levels of Indiana bat and northern long-eared bat take were below levels authorized within the ITP. No adaptive management actions are necessary at this time.

STUDY PARTICIPANTS

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Ross Bailey	Field Technician, Crew Lead, Report Writer
Noelle Freeman & Raven	Dog-Handler & Detection Dog

REPORT REFERENCE

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Headwaters II Wind Farm, LLC, a subsidiary of EDP Renewables North America, LLC (EDPR), is operating the Headwaters II Wind Farm (Project) in Randolph County, Indiana. EDPR obtained an Incidental Take Permit (ITP; ESPER0025999, dated April 22, 2022) for the federally listed endangered Indiana bat (*Myotis sodalis* [INBA]) and endangered northern long-eared bat[1] (*M. septentrionalis* [NLEB]; hereafter Covered Species) from the US Fish and Wildlife Service (USFWS).

The Project operated under the terms of a USFWS Technical Assistance Letter (TAL) from March 15 – May 2, 2022. Turbine operations were adjusted to reflect the HCP, and ITP compliance monitoring began May 3, 2022. This report presents the results of the first year of compliance monitoring conducted under the ITP from May 3, 2022 – October 15, 2022. Information for carcasses found during monitoring under TAL operations (March 15 – May 2, 2022) are included in Appendix A, but were considered incidentals and excluded from the analyses in this report as they occurred prior to the start of the compliance monitoring study period. The objectives of this study were to estimate take of the Covered Species using the Evidence of Absence (EoA) framework as outlined in the Habitat Conservation Plan (HCP; Headwaters II 2022) and determine if adaptive management is necessary to maintain compliance with the Project's ITP.

STUDY AREA

The Project is located in southwestern Randolph County, Indiana, roughly between the cities of Winchester, New Castle, and Richmond (Figure 1). Based on the US Geological Survey National Land Cover Database (NLCD), the most dominant land use type is cultivated cropland, which totals approximately 77.7% of the overall study area (NLCD 2019). Deciduous forests (7.6%), hay/pasture land (7.2%), and developed open space (5.5%) make up the remaining major cover types. The remaining area is composed of small areas of herbaceous land, developed land, open water, emergent herbaceous wetlands, shrub/scrub, and woody wetlands that account for less than 1% each of total land cover types (Table 1, Figure 1).

The Project became fully operational on August 1, 2021, and consists of 13 Vestas V136 3.6-megawatt (MW; 105-meter [m; 344.5-foot (ft)] hub height and 67-m [219.8-ft] blade length) turbines and 36 Vestas V150 4.2-MW (105-m hub height and 74-m [242.8-ft] blade length) turbines (Figure 1). All turbines are within the migratory range of the Covered Species, and EDPR adjusted turbine operations during the spring and fall migration period to minimize impacts to the Covered Species. Additionally, EDPR adjusted turbine operations for 29 designated risk turbines during the summer (Table 2). Some turbines were non-operational for a significant portion of the study due to maintenance and were accounted for in analysis (Table 3).

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[1] The northern long-eared bat was listed as threatened when the ITP was received. Its status will change to endangered as of January 30, 2023.

Table 1. **Land cover types, coverage, and percent composition in the Headwaters II Wind Farm Permit Area, in Randolph County, Indiana.**

Habitat[1]	Acres	% Composition
Cultivated crops	24,593	77.7
Deciduous forest	2,406	7.6
Hay/pasture	2,280	7.2
Developed, open space	1,753	5.5
Herbaceous	258	0.8
Developed, low intensity	233	0.7
Open water	55	0.2
Developed, medium intensity	31	0.1
Developed, high intensity	13	<0.1
Emergent herbaceous wetlands	9	<0.1
Shrub/scrub	7	<0.1
Woody wetlands	0.1	<0.1
Total	**31,638[2]**	**100**

[1]. Developed areas include high-, medium-, and low-intensity developed areas, as well as developed open space.

[2]. Sums may not equal total values shown due to rounding.

Data from National Land Cover Database. 2019.

Table 2. **Planned seasonal operational regime at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.**

Season	Turbines	Time of Day	Cut-In Speed	Feathering Below Cut-In[1]?	Temperature Threshold[2]
Spring (TAL) (March 15 – May 2)	49 (All)	0.5 hour before sunset to 0.5 hour after sunrise	5.0 m/s	Yes	No
Spring (May 3 – May 15)	49 (All)	0.5 hour before sunset to 0.5 hour after sunrise	3.0 m/s	Yes	10 °C
Summer (May 16 – July 31)	20	0.5 hour before sunset to 0.5 hour after sunrise	3.0 m/s	Yes	No
	29	0.5 hour before sunset to 0.5 hour after sunrise	5.0 m/s	Yes	No
Fall (August 1 – October 15)	49 (All)	0.5 hour before sunset to 0.5 hour after sunrise	5.0 m/s	Yes	10 °C

[1]. Feathering means that turbine blades will be pitched into the wind such that they spin at less than one rotation per minute.

[2]. Turbines will be feathered below cut-in when temperatures are above the threshold. In practice, the Project feathered on all nights regardless of temperature.

TAL = Technical Assistance Letter; m = meter; s = second.

Table 3.   **Turbines with unanticipated, extended non-operational periods at the Headwaters II Wind Farm in Randolph County, Indiana, from May 3 – October 15, 2022.**

Turbine ID	Non-operational Date Period	Search Plot Type	Summer Risk Turbine
202	May 24 – October 15, 2022	Cleared Plot	Yes
204	July 13 – August 3, 2022	Uncleared Plot	No
205	July 5 – July 29, 2022	Uncleared Plot	No
209	August 2 – August 15, 2022	Road and Pad Plot	No
211	June 13 – August 5, 2022	Uncleared Plot	Yes
220	July 25 – August 11, 2022	Road and Pad Plot	No
223	July 12 – August 15, 2022	Cleared Plot	Yes
230	August 28 – September 8, 2022	Uncleared Plot	NA
241	July 27 – October 15, 2022	Cleared Plot	Yes
248	September 12 – 27, and October 7 – 11, 2022	Road and Pad Plot	NA

* NA (non-applicable) designates turbines that are summer risk turbines but happen to have been non-operational during a season other than the summer
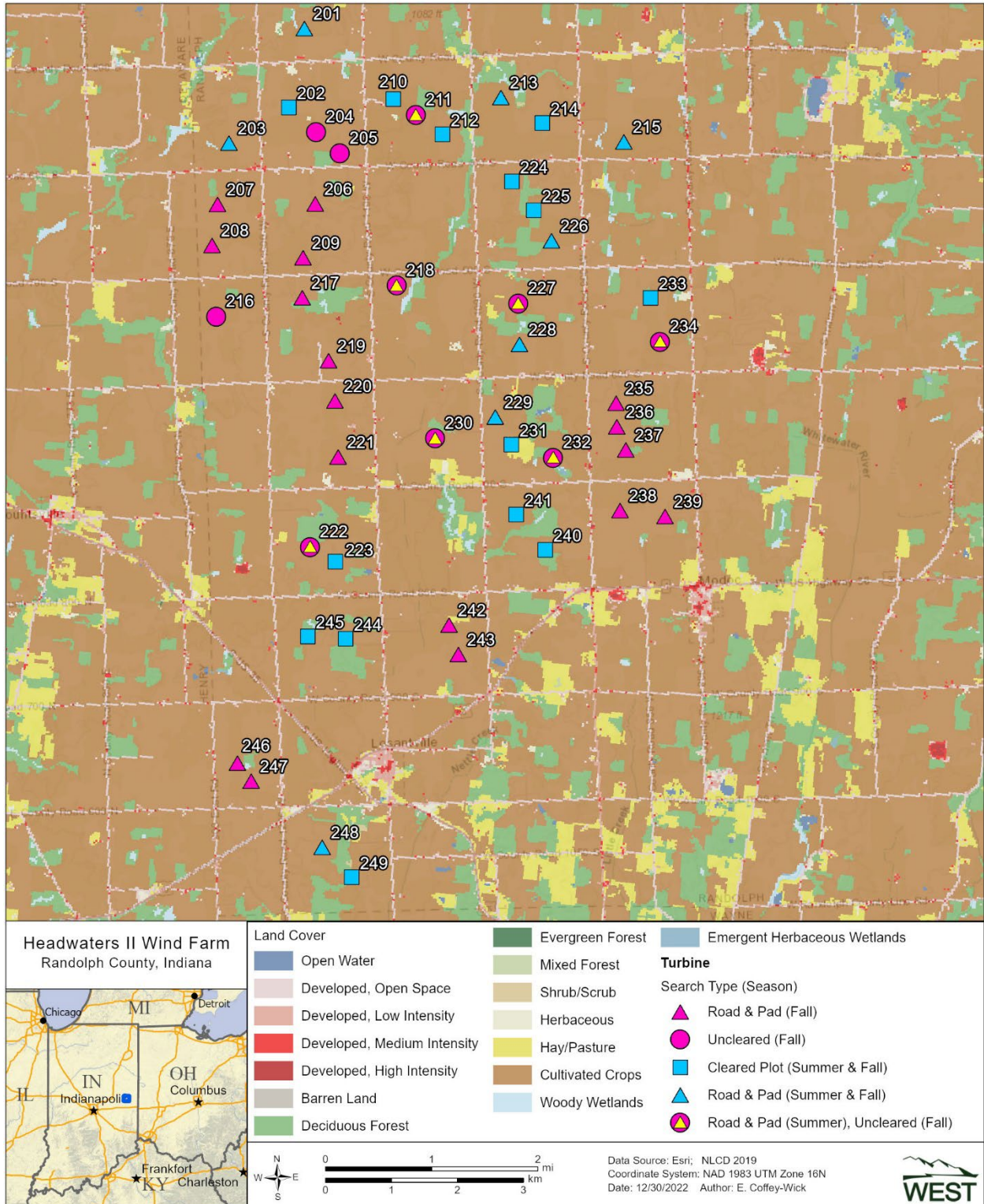
Figure 1. Turbine locations by search type and surrounding land cover at the Headwaters II Wind Farm in Randolph County, Indiana. All turbines had a road and pad plot search type in the spring season (undesignated on map).

METHODS

Western EcoSystems Technology Inc. (WEST) used Project-specific data from previous post-construction monitoring (PCM) studies at the Project (see McAlexander et al. 2022) to develop a study plan that targeted a *g* of 0.25 to meet the monitoring commitments in the HCP. WEST submitted a study plan to EDPR on February 17, 2022 and received approval from the USFWS on March 3, 2022 (M. Reed, USFWS, pers. comm.).

Standardized Carcass Searches

Number of Turbines Sampled, Search Frequency, and Plot Size

Technicians and dog-handler teams conducted standardized carcass searches (carcass searches) from May 3 – October 15, 2022. Search effort varied by season (Table 4), and was designed to maximize effort when the greatest number of Covered Species were expected to occur.

Table 4. Search effort by season and plot type at Headwaters II Wind Farm in Randolph County, Indiana, from May 3 – July 31, 2022.

Season	Plot Type	Search Interval	Number of Turbines	Search Team
Spring (May 3– May 15)	100-m road and pad	14 days	49	Technician
Summer (May 16 – July 31)	100-m road and pad	7 days	15	Technician
	80-m cleared plot	7 days	8	Technician
	80-m cleared plot	7 days	6	Dog-handler Team
Fall (August 1 – October 15)	100-m road and pad	7 days	25	Technician
	80-m cleared plot	7 days	14	Dog-handler Team
	80-m uncleared plot	7 days	10	Dog-handler Team

m = meter.

A technician searched the gravel road and pad areas (road and pad plots) under all 49 turbines to a distance of 100 m (328 ft) from the turbine every other week during the spring (Table 4, Figure 2).

During the summer, summer risk turbines were searched on a weekly interval. A technician searched 15 road and pad plots to a distance of 100 m from the turbine and eight cleared plots within an 80-m (262-ft) radius during the summer. A dog-handler team searched six turbines as cleared plots within an 80-m radius (Table 4, Figure 3). Cleared plots were at turbines where vegetation was regularly mowed within 80-m radius (80-m cleared plots; Figure 4). Vegetation at cleared plots was maintained by Project staff within 10 to 15 centimeters (four to six inches [in]) in height to enhance detectability of carcasses (Figure 3).

All turbines were searched once per week during the fall (Table 4). A technician searched 25 turbines as road and pad plots to a distance of 100-m from the turbine (Table 4). Dog-handler teams searched 14 cleared plots and 10 uncleared plots within an 80-m radius (80-m uncleared plots; Figure 4). Uncleared plots were vegetated with soybeans (*Glycine max*) or grass (*Festuca* spp.) and had up to three transects mowed in a linear star pattern, approximately 1.5 m (4.9 ft) wide, to assist dog teams with plot access but reduce overall crop damages.

Figure 2. **Representative photo of conditions of a 100-meter (328-foot) road and pad plot at the adjacent Headwaters II Wind Farm, Randolph County, Indiana.**

Figure 3. Representative photo of vegetation conditions of a cleared plot at the Headwaters II Wind Farm, Randolph County, Indiana. Photo Credit: Anna Ciecka.

Figure 4. Dog-handler team Noelle Freeman (handler) and Raven (detection dog) performing an uncleared plot search at the Headwaters II Wind Farm, Randolph County, Indiana.

Search Methods

WEST used two types of search methods: a technician, or human only visual search, and a dog-handler team or olfactory search, where the team consisted of one technician/handler and one trained detection dog. All personnel followed the Project's study plan, including proper handling and reporting of carcasses. Carcass searches were conducted during the day, beginning as early as first light.

Road and Pad Searches — Technician

Technicians walked transects spaced five m (16 ft) apart at a rate of approximately 45–60 meters per minute (m/min; 148–197-ft/min) on all gravel road and pad areas within 100-m of the turbine. The technicians scanned the area for carcasses on both sides of the transect out to approximately 2.5 m (8.2 ft) to ensure full visual coverage of each search area. Only technicians searched on road and pad plots.

Plot Searches — Technician

Technicians searched 80-m cleared plots for bat carcasses. The technician walked north-south or east-west oriented transects spaced five m apart at a rate of approximately 45–60 m/min. While walking each transect, the technician scanned the area on both sides, out to 2.5 m for carcasses, thereby surveying the entire plot area.

Plot Searches — Dog-handler Team

Dog-handler teams searched 80-m full plots (including both cleared and uncleared plots) for bat carcasses (Figure 4). Prior to each search, handlers determined the survey start point and the number of transects needed to cover the plot after taking into account wind speed and direction, as well as crop row direction and density (when applicable). Handlers oriented the detection dog to start searches perpendicular to the wind to maximize scent detection. Both wind speed and crop density can affect dispersal of the target odor (i.e., bat carcasses) across the search area. To maximize detection rates during an olfactory search, transect width varied with vegetation density, ranging from five to 10 m (16 to 33 ft) apart in densely vegetated areas, to 10 to15 m (49 ft) in shorter vegetation. Detection dogs were rewarded with either a food reward or a short play session when they correctly alerted to a bat or bird carcass.

Dog-Handler Team Evaluation

Detection dogs were considered candidates for carcass searches if they met basic temperament and obedience criteria, and demonstrated the trainability to detect bat and/or bird carcasses. Temperament characteristics sought after were high-energy, and a high food or toy drive. Prior to conducting searches at the Project, handlers trained their detection dogs on the scent of bat carcasses following methods derived from search and rescue programs and drug detection (Kay 2012, Helfers 2017). Dogs were initially trained with either cotton scent swabs that had been rubbed on bat carcasses, progressing to dehydrated bats, or directly with dehydrated bat carcasses, at increasing distances over a period of three to four weeks. Once the dog achieved a passing grade of 80% or higher in a scent recognition test, consisting of ten blind trial lineups

using dehydrated bats, the dog and handler were evaluated in the field to measure their performance. The detection dog coordinator conducted a two day field evaluation of each dog-handler team; after teams achieved a searcher efficiency of 75% or greater for 15–30 dehydrated bats placed during blind evaluation trials, the teams were approved to conduct carcass searches. Because the objective of the study focused on detecting bat carcasses, dogs were not explicitly trained on native bird carcasses; however, all detection dogs alerted on bird carcasses in the field, and handlers rewarded bird finds in the field to encourage future alerts to bird carcasses. A border collie breed was used at the Project as the primary detection dog.

Data Collection

Technicians recorded the date, start and end times, technician name, turbine number, type of search and if any carcasses were found for each scheduled search. When a carcass was found, technicians placed a flag near it and continued the search. After searching the entire plot, the technician returned to record information for each carcass on a carcass information data sheet, including the date and time, species, sex and age (when possible), technician name, turbine number, measured distance from turbine, azimuth from turbine, location of carcass using Geographic Coordinate System (latitude and longitude), habitat surrounding carcass, carcass condition (e.g., intact, scavenged, dismembered), and estimated time of death (e.g., less than one day, two days).

The condition of each carcass found was recorded using the following categories:

- Intact—a carcass that is complete, not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.

- Scavenged—an entire carcass that shows signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that has been heavily infested by insects.

- Dismembered—a carcass found in multiple pieces distributed more than 1.0 m (3.3 ft) apart from one another due to scavenging or other reasons.

- Injured—a bat or bird found alive.

For bird carcasses, the following category was also used:

- Feather spot—Ten or more feathers (excluding down), or two or more primary feathers at one location indicating predation or scavenging of a bird carcass.

Technicians took digital photographs of each carcass, including any visible injuries, and surrounding habitat. No bird carcasses were collected, but a marker was placed next to each bird carcass to avoid duplicate counting. Bat carcasses were collected under the Project's ITP (ESPER0025999), WEST's Federal Native Endangered and Threatened Species Recovery Permit (TE234121-9), and WEST's State Scientific Collection Permit (2229). Technicians placed each bat carcass in a re-sealable plastic bag labeled with a unique carcass identification number,

turbine number, and date, for storage in a freezer on site. Leather gloves were used to handle all bat carcasses to eliminate possible transmission of rabies or other zoonotic diseases, and to reduce possible human scent bias on any carcasses used later in bias trials. Live, injured bats were recorded and considered fatalities for analysis purposes when observed in search areas, and were handled in accordance with permit conditions (left in place).

Carcasses found in non-search areas (e.g., outside of a plot boundary) or outside of the scheduled searches, were recorded as incidental discoveries and documented following the same protocol for those found during standard searches, but were not included in analysis.

Carcass Identification and Agency Notification

Identification of bird carcasses was verified by biologists with significant field experience in identification of birds and their feathers. A federally permitted bat biologist (TE33467D-0) identified all bat carcasses via photographs throughout the survey period, or in hand at the end of the surveys. The USFWS and the Indiana Department of Natural Resources were notified within 24 hours of the positive identification of any state or federally listed species.

Tissue samples collected from heavily scavenged or decomposed carcasses that could not be positively identified and had potential to be a Covered Species were submitted to a USFWS-approved laboratory, the East Stroudsburg University Wildlife Genetics Institute for identification.

Bat carcasses that were heavily scavenged but did not have potential to be a Covered Species (i.e., fur was present on the wing, or the forearms measured more than 42 millimeters [1.7 in] long) were identified to the closest genus or group possible and were not sent off for further identification. Bat carcasses, or representative hair/tissue samples from individual carcasses, are to be delivered to USFWS by January 31, 2023.

Bias Trials

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the probability that a carcass was found by searchers. Searcher efficiency trials were conducted in the same areas where carcass searches occurred. Technicians conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. Trial carcasses consisted of eastern red bats (*Lasiurus borealis*), silver-haired bats (*Lasionycteris noctivagans*), and big brown bats (*Eptesicus fuscus*) that had previously been found on site or provided by Indiana State University. One hundred twenty-seven carcasses were placed across all seasons and plot types to account for differences in search conditions due to vegetation, topography, or weather.

Multiple trials were conducted in each season to measure potential changes in plot conditions on searcher efficiency over time. Each trial carcass was discreetly marked with a black zip-tie and/or a piece of electrical tape around the upper forelimb for identification as a study carcass.

Carcasses were dropped from waist-height or higher and allowed to land in a random posture. The trial administrator walked in a meandering path and dropped trial carcasses for detection dogs the day prior to the next search to allow time for the scent to pool and disperse, and to eliminate a direct scent trail. For technician search trials, the trial administrator placed carcasses prior to the technician searching the plot, either the night before or the morning of searches depending on work schedules.

Searchers had one chance to locate trial carcasses during the first search after carcass placement. The number and location of trial carcasses found during the subsequent search were recorded, and the number of trial carcasses available for detection during each search was determined immediately after each trial by the person responsible for distributing the carcasses. Following searches, any carcasses that were not detected were checked to confirm availability. One hundred and five trial carcasses were left in place and used for carcass persistence trials.

Carcass Persistence Trials

The objective of carcass persistence trials was to estimate the average probability a carcass would persist, or be available for detection in the field, given the search interval. Carcasses could be removed by scavenging or rendered undetectable by typical farming activities. A minimum of 15 trial carcasses were placed in each season and plot type to incorporate the effects of varying weather and scavenger densities on carcass persistence. No more than two trial carcasses were placed on a plot during the same trial period to avoid potential over-seeding and attracting scavengers.

Technicians monitored the trial carcasses over a 30-day period according to the following schedule, as closely as possible. Carcasses were checked daily for the first four days, then on day 7, 10, 14, 20, and 30. Trial carcasses were monitored until they were completely removed or the trial period ended. Dog-handler teams determined the status of carcasses placed on dog-aided search plots while technicians checked the status of carcasses on plots searched by technicians.

Search Area Mapping

Plot boundaries were used to verify if carcasses were found inside the search areas, and to inform the distribution of carcasses around turbines to estimate the number of carcasses that fell inside or outside of search areas. Full plot and road and pad plot search areas were delineated in prior survey years using an 82-m (269-ft) radius Geographic Information System (GIS) projection and Eos sub-meter global positioning satellite unit to designate non-searchable areas within the plot. The additional 2.0 m (6.6 ft) were added to the radius to account for the width of the turbine tower.

Quality Assurance and Quality Control

Quality assurance and quality control measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, technicians were responsible for inspecting data forms for completeness, accuracy, and legibility. Potentially erroneous data were identified using a series of database queries. Irregular codes or data suspected as questionable were discussed with the technician and/or Project manager.

Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes and measures were implemented. A Microsoft® SQL Server database was developed to store, organize, and retrieve survey data. All data forms and electronic data files were retained for reference.

Statistical Analysis

The EoA (Dalthorp et al. 2017) modeling framework was used to estimate take of Covered Species. EoA was used with data collected in the field to estimate the overall probability of detecting a bat carcass, the take rate of Covered Species, and the number of Covered Species fatalities that occurred. Data used in the EoA model included number of Covered Species fatalities, fatality spatial data from all bats found during surveys, the results of searcher efficiency and carcass persistence trials, the seasonal arrival distribution of bats (described below), and the detection reduction factor (k; described below).

Searcher Efficiency Estimation

Searcher efficiency was estimated separately for technicians and dog-handler teams to account for different modes of detection (i.e., technicians use sight, whereas dogs use scent). EoA uses raw searcher efficiency data (e.g. number of found and available trial carcasses) to inform overall probability of detection. However, to determine if searcher efficiency data should be pooled, or separated by strata such as season and/or plot type, we modeled searcher efficiency using logistic regression. For both technicians and dog-handler team models, model selection was completed using an information theoretic approach known as AICc, or corrected Akaike Information Criterion (Burnham and Anderson 2002). The best model was selected as the most parsimonious model within two AICc units of the model with the lowest AICc value. Searcher efficiency data were input into the EoA software according to the model selection results.

The change in searcher efficiency between successive searches was defined by a parameter called the detection reduction factor (k) that can range from zero to one. When k is zero, it implies a carcass missed on the first search would never be found on subsequent searches. A k of one implies searcher efficiency remains constant no matter how many times a carcass was missed. Huso et al. (2017) estimated a value of $k = 0.67$ for bats, and this value was used to calculate bat fatality estimates using EoA, per the HCP. Searcher efficiency was not significantly different between cleared plots and uncleared plots. To simplify the EoA analysis, these were grouped into a single full plot stratum. Searcher efficiency trials used for analysis were based on the March 15 TAL start date, which included two trials that took place prior to the ITP curtailment start date of May 3 (April 11 and April 27, 2022).

Carcass Persistence Rate Estimation

Data collected during carcass persistence trials were used to estimate the probability carcasses remained available to be located by the searcher, given the search interval (i.e., the time between scheduled searches). The average probability a carcass persisted was estimated using an interval-censored survival regression with four potential distributions: exponential, log-logistic, lognormal, and Weibull distributions (Kalbfleisch and Prentice 2002, Dalthorp et al. 2018). As with searcher efficiency, carcass persistence models were estimated separately by search team

(i.e., plots searched by technicians vs. plots searched by dog-handler teams) to account for different modes of detection. Season and plot type were included as potential covariates for the technician model, and plot type was included as a potential covariate for the dog-handler model. The best model was selected as the most parsimonious model within two AICc units of the model with the lowest AICc value. The parameter estimates of the selected model (α [shape] and β [scale], including the 95% confidence interval [CI] of β) were used as inputs in the EoA Single Class module. Carcass persistence rates were not significantly different between cleared plots and uncleared plots. To simplify the EoA analysis, these were grouped into a single full plot stratum. Trials used for analysis were based on the March 15 TAL start date, which included two trials that commenced prior to the ITP curtailment start date of May 3 (April 11 and April 27, 2022).

Area Adjustment

The search area adjustment accounted for unsearched areas beneath turbines, and was calculated as a probability that ranged from zero to one. The area adjustment was estimated as the product of the proportion of searched area around each turbine and a carcass-density distribution. A truncated weighted maximum likelihood (TWL) modeling approach (Khokan et al. 2013) was used to estimate the carcass-density distribution using site-specific fatality locations. The TWL approach uses weights based on probability of detection and the proportion of area searched in each 1.0-m annulus around the turbine. Due to the variation in turbine sizes (blade lengths range 67-m blade length for V136 3.6-MW turbines and 74-m blade length for V150 4.2-MW turbines, separate area adjustments were fit a priori for each turbine size.[2] Distributions considered were normal, gamma, Gompertz, and Weibull (parameterized according to R Development Core Team [2016] and Yee [2015]). The best model was selected using AICc. The proportion of area searched was calculated in a GIS as the amount of area searched divided by the total area searched at each 1.0-m annulus around the turbine.

Carcasses Excluded from Analysis

Carcasses were excluded from analysis when the carcass was discovered outside of the spatial and temporal scope of the survey design. For example, carcasses found outside a designated plot were not included in the analysis because the TWL fitting procedure accounts for unsearched areas. Carcasses found prior to the start of surveys (e.g., a carcass found on a plot in the spring that was estimated to have died prior to May 3) were also excluded because the carcass occurred outside of the study period. Note that carcasses found on a plot incidentally (e.g. found by maintenance personnel) were included in the analysis if that plot had a scheduled search in the future. If a carcass of a Covered Species had been found outside of the spatial or temporal scope of the survey design it would still be excluded from the area correction estimate, but would be included in the EoA fatality estimate following Dalthorp et al. 2020.

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[2]   The HCP stated the two turbine types would be modeled together. However, advancements in the understanding of the models, along with collected data from the site, now shows that separate turbine area adjustments are more appropriate for analysis.

Covered Species Take and Detection Probability Estimates

EoA was used to estimate the median cumulative take to-date (M^*), mean annual take rate (λ), and evaluate the probability that the estimated take rate (λ) exceeded the expected take rate (τ) for Indiana bat and northern long-eared bat (i.e., Covered Species). Estimates were calculated using the EoA method (Dalthorp et al. 2017), using the Single Class, Multiple Class, and Multiple Years modules of EoA.

The *g* was estimated using the bias corrections for searcher efficiency, carcass persistence, and area searched, as well as the assumed seasonality of risk the Covered Species, which per the HCP, was 7% in the spring, 36% in the summer and 57% in the fall. The seasonal risk is used to weight the contributions of detection probability from different seasons in the overall g estimate. Differences in the level of turbine operations within (e.g., turbines down for maintenance for extended periods within a season) and across seasons (e.g., reduced summer risk) were also accounted for, as described below.

The EoA Single Class module is used to estimate the detection probability for each independent search stratum (e.g. season by plot type combination). This resulted in alpha (α) and beta (β) parameters that defined the beta distribution of detection probability in each stratum. The EoA Multiple Class module was then used to combine detection probability distributions across strata (i.e, 80-m cleared plots, 80-m uncleared plots, and road and pad plots), with weights for each class (density-weighted proportion, or "DWP" in the software) defined by the within-season sampling fraction, relative turbine operations, and seasonal risk. The Multiple Class module of EoA requires weights (DWP) to sum to 1.0 (representing 100% of the risk to bats). When this module is used, unsearched strata are represented with near-zero detection probabilities and beta distribution parameters are set to Ba = 0.01 and Bb = 1,000 (a detection probability of 10^{-5}) for unsearched areas within each stratum. The results from the Multiple Years module (Ba and Bb parameters for the detection probability for the permit term to date) were used to estimate M^* (the median cumulative take over the life of the permit), λ (the underlying annual take rate across the single monitoring period) and its 95% CI, and the probability that λ > τ, where τ is the authorized take number divided by the number of years in the permit. Appendix A shows how the compliance metrics were calculated using the EoA Graphical User Interface[3]. For this study, cross-season relative turbine operations were calculated as the number of visits in each season, during which turbines were operating, divided by the total number of visits in each season. Values were re-scaled to sum to one across the three seasons. Weights for spring, summer, and fall were based on the carcass arrival proportions from the Midwest Wind Energy Multi-Species HCP (USFWS 2016): 0.07% in spring, 36% in summer, and 57% in fall. However, the present analysis only covered a portion of the spring season. Consequently, spring arrival proportions were rescaled to 0.016 (Table 5). The summer risk estimate was multiplied by 0.59 to reflect relatively fewer risk turbines during summer, and the seasonal weights were again rescaled to sum to 1.0 for spring, summer, and fall (Table 5). These values defined the weights for combing the Beta distribution parameters across seasons.

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[2] There may be minor differences between screen shots and the results in the main text because EoA is a stochastic estimator, leading to slightly different estimates each time the modules are run.

Furthermore, the Multiple Years Module was used to estimate the site-wide, cumulative detection probability for 2022. The EoA Multiple Years Module requires the input ρ, which weights the years appropriately for combining Beta distribution parameters. In this module, the weights (ρ in the software) need not sum to 1.0, and a weight of 1.0 is assumed to represent a typical risk year. Weights may be more or less than 1.0 based on turbine operations that differ between years. ρ was calculated separately for the entire study period and for the summer period alone to evaluate the general short-term trigger, and the summer short-tern trigger. The value for ρ in 2022 was 0.92 for the entire study period and 0.94 for the summer period, meaning about 92% of total risk was observed in monitoring data for the full study and 94% of the total summer risk was observed in the summer season (Appendix D4; Table 5).

Likewise, 2022 relative operations define the ρ value by summing the total number of visits during which turbines were operating and dividing that number by the total number of visits. This value was recalculated for the Multiple Years Module because multiple turbines had non-operational periods throughout the monitoring year due to maintenance. The EoA Multiple Years module requires the input ρ, which weights the years appropriately.

Table 5. Seasonal arrival proportions for the Headwaters II Wind Farm in Randolph County, Indiana, from May 3 – October 15, 2022.

Season	Seasonal Arrival Proportion	Cross-season Relative Operation	Risk Turbine Weights	Re-scaled Season Weights
Spring (May 3 – May 15)	0.016	1.000	1.000	0.021
Summer (May 16 – July 31)	0.381	0.942	0.590	0.268
Fall (August 1 – October 15)	0.603	0.936	1.000	0.712

The results from the Multiple Years module (Ba and Bb parameters for the detection probability for the permit term to date) were used to estimate *M** (the median cumulative take over the life of the permit), λ (the underlying annual take rate over the monitoring periods) and its 90% CI, and the probability that $\lambda > \tau$, where τ is the authorized take number divided by the number of years in the permit. Appendix E shows how the compliance metrics were calculated using the EoA Graphical User Interface.

Adaptive Management Triggers

The estimates from the EoA analysis were used to test three adaptive management triggers: a short-term (general) test of whether the estimated take rate exceeded the expected take rate, a short-term (summer) test of whether estimated summer take rate exceed summer expected take rate, and a long-term test of whether permitted take had been met (Dalthorp and Huso 2015). All triggers were tested individually for each of the Covered Species.

Evidence of Absence Short-term Trigger (general)

The EoA general short-term trigger is designed as an early warning signal that the Project may be on the path to exceeding permitted take (T) by the end of the permit term. The short-term trigger is designed to determine if an adaptive management response is needed to prevent the cumulative take estimate from actuating a response to the long-term trigger test. The short-term

trigger tests if the estimated annual take rate (λ) exceeded the expected take rate (τ = T ÷ years in permit) at a confidence level of α = 0.05, per the HCP. The Project short-term trigger is designed to evaluate a rolling window of six years of PCM data. If, within any six-year rolling window, the estimated take rate exceeds the expected take rate with 95% confidence, the short-term trigger would be met, indicating that the minimization plan in the HCP may need to be adjusted to ensure that the median cumulative take estimate (*M**) remains within the permitted limit over the ITP term. Only one year of data was used in this analysis because 2022 was the first year of monitoring under the ITP. Due to limitations with the EoA graphical user interface, for estimates of λ it was necessary to rescale the EoA-produced estimates to represent one full year of operation and monitoring using the ρ value for 2022. For adaptive management triggers associated with λ, it was necessary to scale the annual rate threshold (τ) to represent that the level of risk in the moving average estimate of λ was less than one full year of operation and monitoring.

Evidence of Absence Short-Term Trigger (summer)

The EoA summer short-term trigger is the same as the general short-term trigger, except that it is conditional on finding Covered Species carcasses during summer and informed by compliance monitoring data collected during the summer at the 29 turbines operated under curtailment. The trigger is scaled to reflect the proportion of fatalities expected during the summer (May 16 – July 31) period (25.1%; Section 5.4.3.1.2 of HCP). Thus, 11.96 INBA and 3.11 NLEB predicted to be taken annually with minimization, 3 INBA and 0.78 NLEB are expected annually during the summer. The rolling window was also set at six years for this trigger to include at least one year of monitoring data to inform lambda estimate in any given window. If estimates exceed summer take rates (λ) with 95% confidence (a=0.05), the summer trigger will be activated. Only one year of data was used in this analysis because 2022 was the first year of monitoring under the ITP, along with the values of ρ listed in Appendix D4.

Evidence of Absence Long-term Trigger

The EoA long-term trigger is designed to test if the cumulative take to date is equal to or greater than the permitted take (T). Per the HCP, cumulative take to date (M*) was estimated at a confidence level of α = 0.5 (using the median, or 50th credible bound, of the posterior distribution of estimated mortality). If the cumulative take to date at α = 0.5 is less than or equal to the total permitted take (M* ≤ T), then the Project is in compliance with the ITP. If the cumulative take to date at α = 0.5 is greater than the total permitted take (M* > T), then the take limit has been met and the Project must enact avoidance measures.

RESULTS

Standardized Carcass Surveys

Forty-nine turbines were searched throughout the spring, twenty-nine turbines during the summer, and forty-nine turbines during the fall for 893 searches during the study period. There were 316 dog-aided searches conducted at 207 cleared plots, 109 uncleared plots. Eighty-eight unaided (technician only) searches were conducted at cleared plots, and 489 searches at road and pad

plots. Nine searches were missed (less than 1%) due to turbine maintenance, weather constraints, and/or safety hazards.

Four federally listed endangered Indiana bats (all male gender) and three state-listed endangered evening bats (*Nycticeius humeralis*; two male and one unidentified gender) were found (Table 6, Figure 5; Appendix A).From May 3, 378 bat carcasses and 103 bird carcasses were found during standardized searches and incidentally (Appendix A). No federally or state listed bird species were found. The most commonly found bat species were eastern red bat (135 carcasses; 38.7%) and silver-haired bat (89 carcasses; 25.5%), followed by big brown bat (78 carcasses; 22.3%), and hoary bat (*Aestus cinereus*; 36 carcasses; 10.3%; Appendix C1).

Table 6. **Listed species of bats found at the Headwaters II Wind Farm in Randolph County, Indiana, from May 3 – October 15, 2022.**

Species	Sex	Date Found	Estimated Time of Death (ETOD)	Season of ETOD	Location[3]	Turbine	Summer Risk Turbine?	Distance From Turbine (m)
Indiana bat[1]	male	8/16/22	8–14 days	fall	40.10002, - 85.15479	225	yes	26
Indiana bat[1]	male	8/18/22	0–1 days	fall	40.05379, - 85.15446	240	yes	57
Indiana bat[1]	male	8/23/22	0–1 days	fall	40.08744, - 85.13399	233	yes	33
Indiana bat[1]	male	8/23/22	0–1 days	fall	40.08754, - 85.13458	233	yes	20
evening bat[2]	unknown	5/17/22	2–3 days	summer	40.06927, - 85.17315	230	yes	30
evening bat[2]	male	9/6/22	4–7 days	fall	40.09986, - 85.15452	225	yes	17
evening bat[2]	male	9/19/22	2–3 days	fall	40.11083, - 85.17085	212	yes	41

[1.] Indiana bats are federally listed as endangered, and are a Covered Species of the Habitat Conservation Plan (HCP).

[2.] Evening bats are state-listed as endangered, but are not a Covered Species of the HCP.

[3.] Location is in Decimal Degrees.

m = meters.
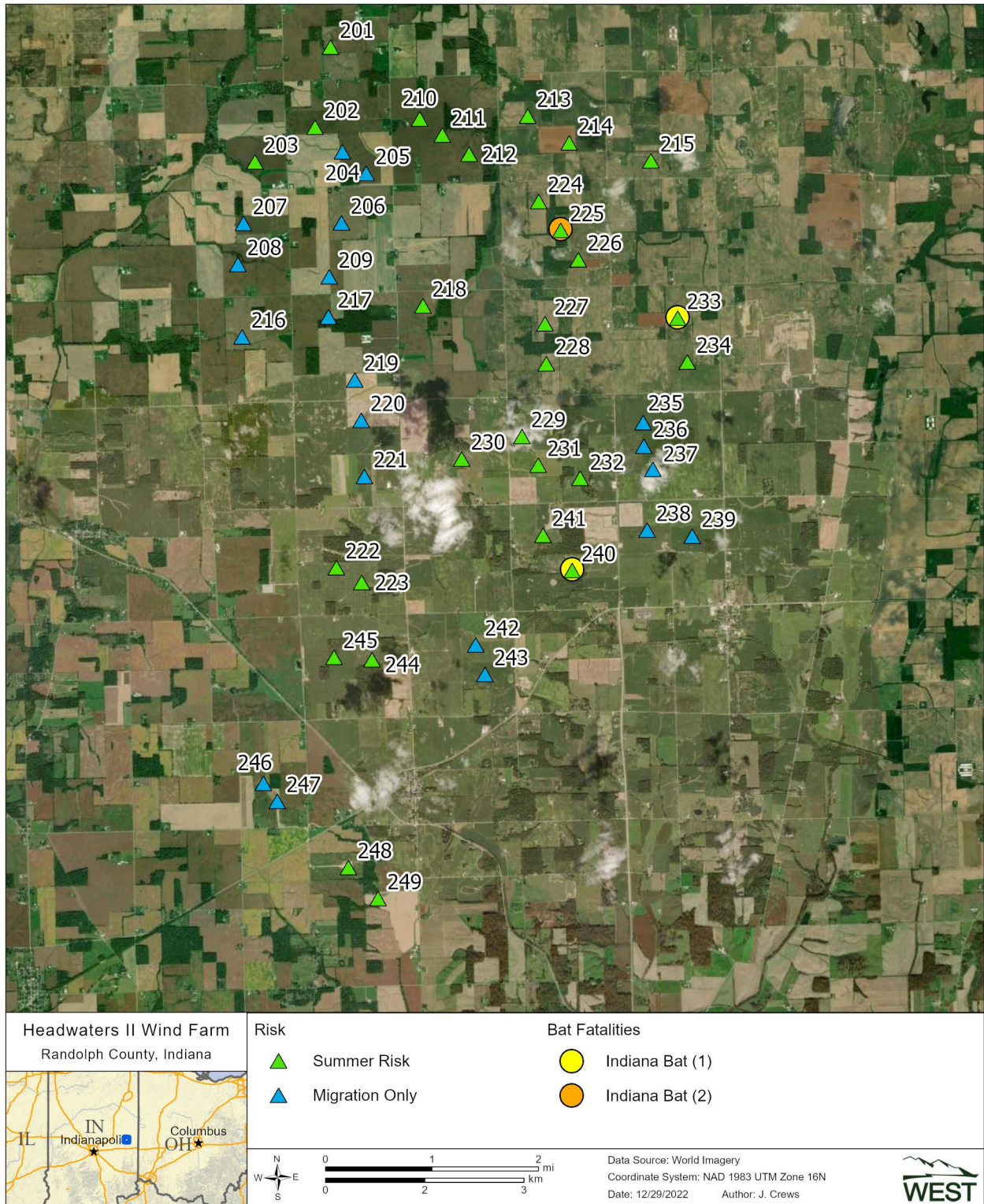
Figure 5. Location of Indiana bat carcasses [in relation to summer risk turbines] at the Headwaters II Wind Farm from May 3 – October 15, 2022.

Statistical Analysis

Bias Trials

<u>Searcher Efficiency Trials</u>

One hundred twenty-seven bats were placed for searcher efficiency trials on 15 separate dates, of which 109 remained available for search teams to find across all plot types. The overall searcher efficiency was 81.7% (Appendix B1). The best-fit model for searcher efficiency on dog-aided searches did not support the inclusion of a covariate, meaning there was not a statistically meaningful difference between searcher efficiency rates across seasons or plot types (Appendix B2). Similarly, the selected model for searcher efficiency on technician searches did not support the inclusion of a covariate (Appendix B3).

<u>Carcass Persistence Trials</u>

One hundred and five carcasses were placed across all plots types to estimate carcass persistence. The best-fit model for carcass persistence rates for dog-aided searches was a lognormal distribution with no covariate (Figure 6; Appendix B4). The best-fit model for carcass persistence rates for technician searches was a loglogistic distribution with no covariate (Figure 6; Appendix B5), meaning that plot type and season were not distinguishable. The average probability that a carcass persisted through a 14-day search interval in the spring was 0.56 (90% CI: 0.47–0.65). The average probability that a carcass persisted through a seven-day search interval was 0.69 (90% CI: 0.58–0.81) for dog-searched plots and 0.70 (90% CI: 0.61–0.79) for technician-searched plots, regardless of plot type (Figure 6).
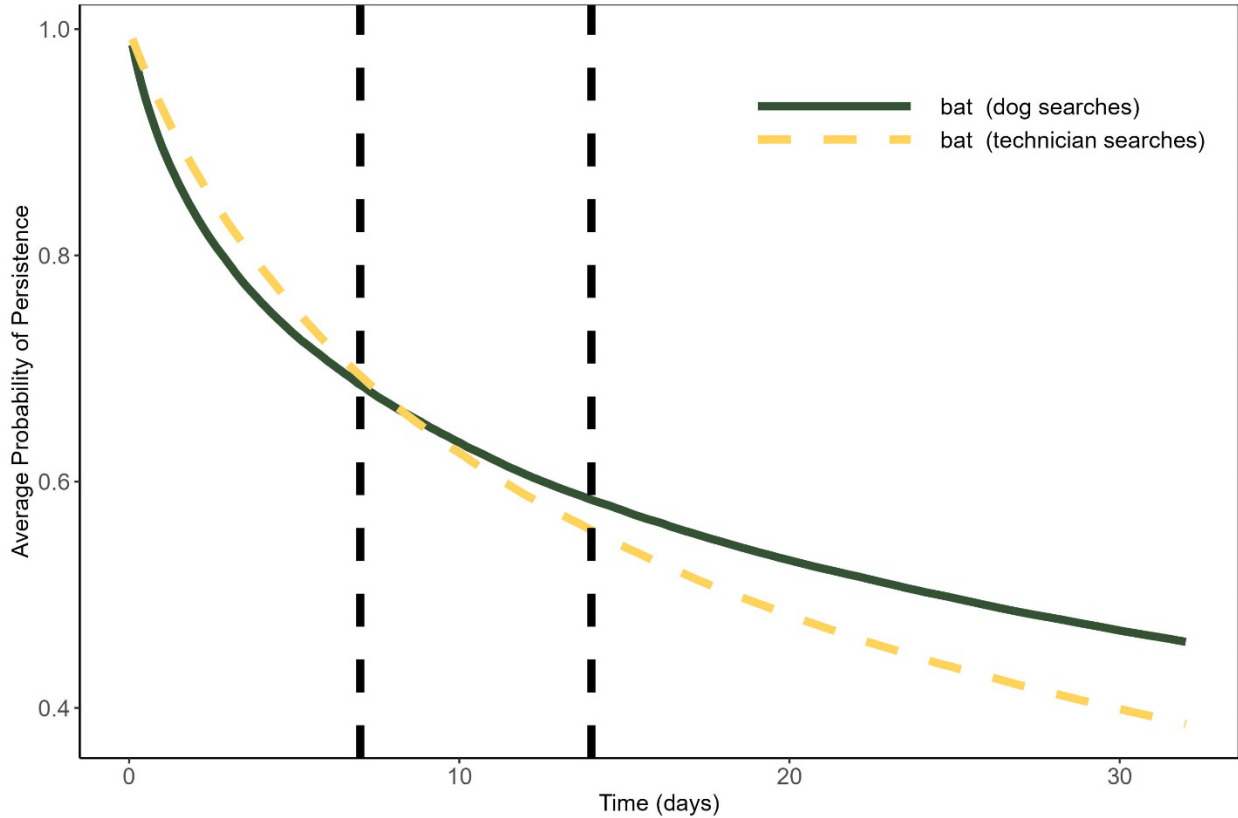
Figure 6. **The average probability of persistence, in days, at different search intervals and for different searcher types at Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.**

Note: The vertical dotted lines indicate the 7 and 14 day search intervals used in this study.

Area Adjustment

Six bat carcasses were excluded from analysis because they were found off plot. Another 23 bats were excluded because they were found outside of the study period. Lastly, four bats were excluded because they were found before the ITP compliance monitoring began, prior to May 3, 2022 (Appendix C).

The best-fit model for the carcass-density distribution of bats at 3.6 MW turbines with respect to distance from turbine base was a normal model (Figure 7; Appendix C2). The best-fit model for the carcass-density distribution of bats at 4.2 MW turbines was a Gompertz model (Figure 8; Appendix C3). Area adjustments were calculated separately for bats on the road and pad plots and full plots. Carcass counts in the spring were not large enough to model carcass distributions separately by season, so due to the similar curtailment regimes in spring, summer, and fall, carcass counts were pooled across seasons to inform one overall carcass-density distribution. The TWL area adjustment for bats at 100-m road and pad plots at 3.6 and 4.2 MW turbines was 0.17 and 0.10 respectively. The TWL area adjustment for bats at full plots at 3.6 and 4.2 MW turbines was and 1.00 and 0.94 respectively (Appendix C4).
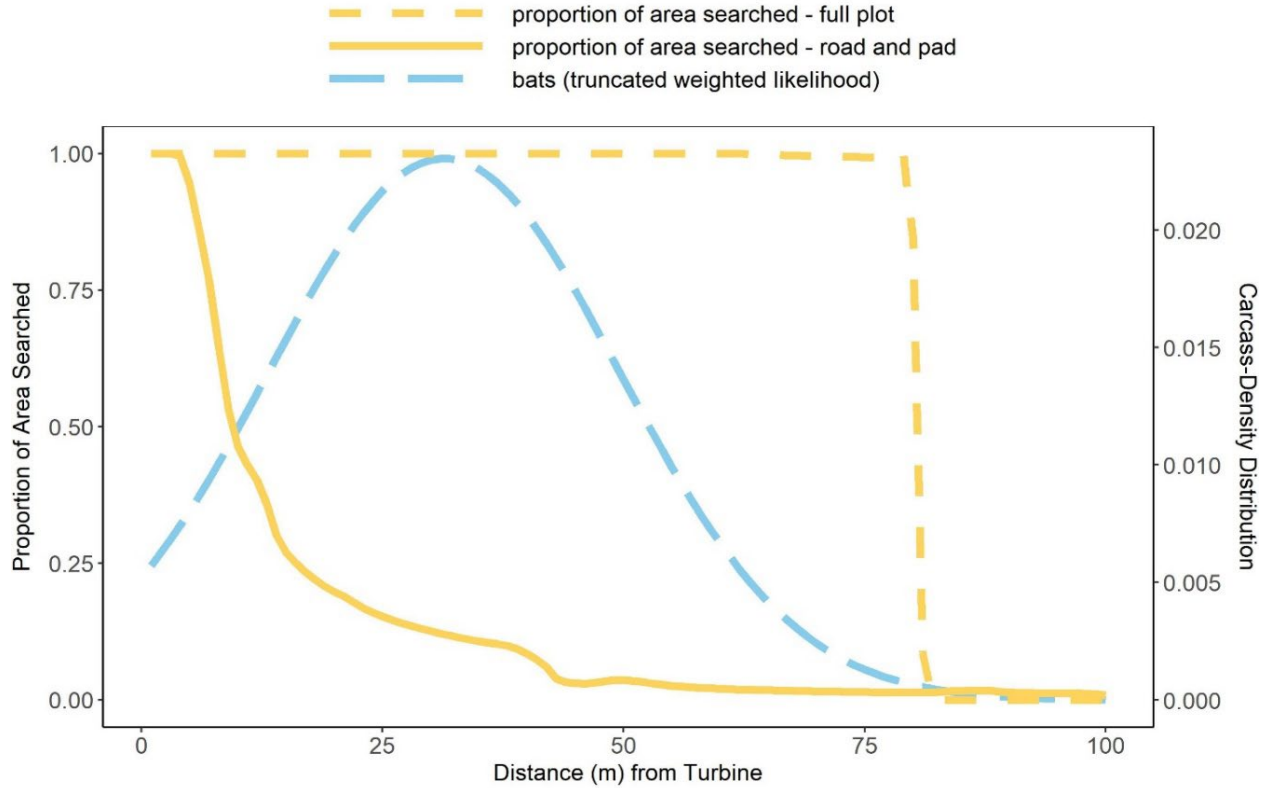
Figure 7.   Density of bat carcasses per area searched at road and pad and full plots for 3.6 MW wind turbines at the Headwaters II Wind Farm, Randolph County, Indiana, from May 3 – October 15, 2022.
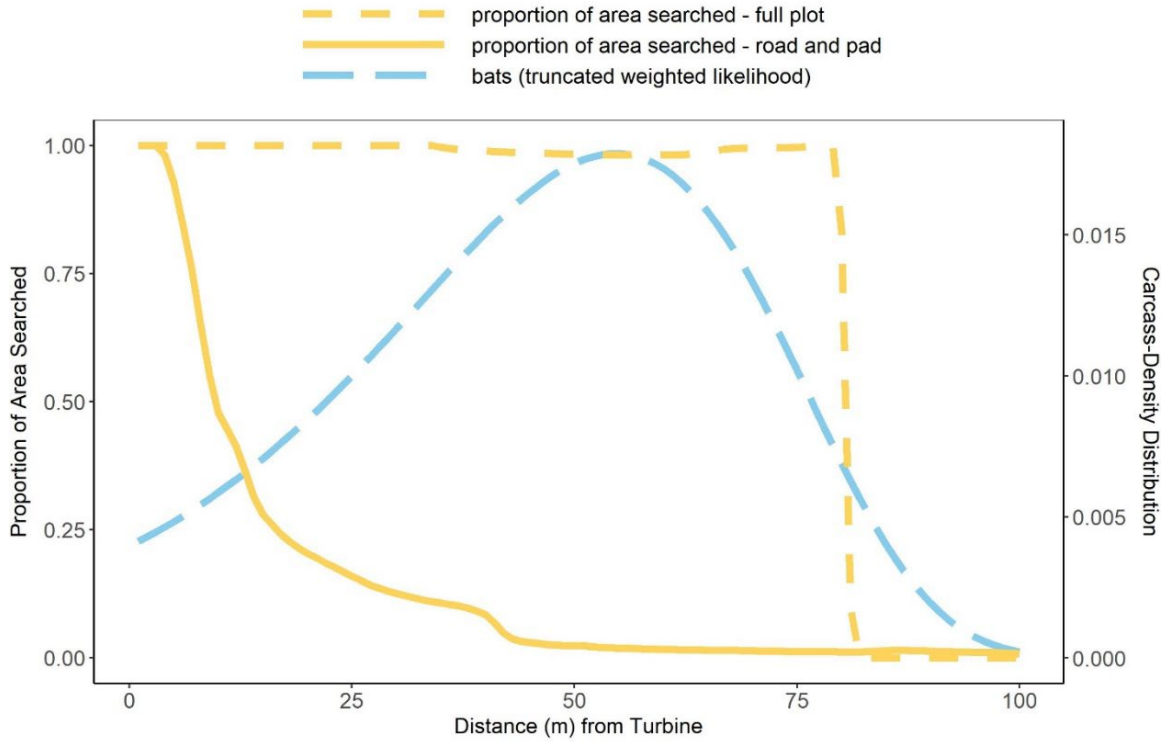
Figure 8. **Density of bat carcasses per area searched at road and pad and full plots for 4.2 MW wind turbines at the Headwaters II Wind Farm, Randolph County, Indiana, from May 3 – October 15, 2022.**

Covered Species Take Estimates

To simplify the EoA analysis, cleared plots and uncleared plots were grouped into one stratum (referred to as "full plots"), since carcass persistence, searcher efficiency, search effort, and the proportion of area searched was not significantly different between these plot types.

Four Indiana bat carcasses were found during the 2022 study. To date, these are the only four Indiana bats found under the ITP. The annual probability of detection distribution (*g*) achieved for the 2022 monitoring period had a mean of 0.31 (90% CI: 0.28–0.33; Table 7). Inputs required to run the EoA Single Class module and stratum-specific *g* distribution values and inputs required for the Multiple Class module are described in Appendix D.

Table 7. **Annual probabilities of detection (g), Ba, Bb, and ρ for the Headwaters II Wind Farm, Randolph County, Indiana, 2022.**

Year	Ba[1]	Bb[1]	*g*	90% CI[2]
2022	293.12	660.05	0.31	0.28-0.33
Short-Term Trigger (general)	293.12	660.05	0.31	0.28-0.33
Short-Term Trigger (summer)	359.28	769.36	0.32	0.3-0.34
Long-Term Trigger	293.12	660.05	0.31	0.28-0.33

[1] Ba and Bb are the parameters for the Beta distribution used to characterize the probability of detection. The g value is the mean of that distribution.

[2] CI = confidence interval.

Mean annual take rates based on 2022 were estimated to be 16.03 (90% CI: 5.9-30.25) Indiana bats per year and 1.78 (90% CI: 0.01-6.85) northern long-eared bats per year (Table 7). The expected average annual take rates reported in the HCP were 11.96 Indiana bats per year and 3.11 northern long-eared bats per year.

Cumulative take under the ITP to-date (2022), *M**, at α = 0.5 (50th credible bound), is estimated to be 13 Indiana bats and zero northern long-eared bat. The total take permitted by the ITP is 359 Indiana bats and 93 northern long-eared bats over the 30-year permit term (Table 10).

Adaptive Management Triggers

Evidence of Absence Short-term Trigger (general)

The general short-term trigger assesses the probability that the estimated annual take rate exceeded the expected annual take rate, $Pr(\lambda > \tau)$. At a 95% confidence level (α = 0.05), $Pr(\lambda > \tau)$ must be greater than or equal to 0.95 for the short-term trigger to fire. For Indiana bat, $Pr(\lambda > \tau)$ = 0.67 and northern long-eared bat, $Pr(\lambda > \tau)$ = 0.19 (Table 8). Neither probability meets or exceeds 0.95, indicating the short-term trigger was not met and no adaptive management actions are necessary (Table 8; Figure 9).

Table 8. Probability the estimated take rates exceeded the expected take rates for studies conducted within the rolling average interval at the Headwaters II Wind Farm, Randolph County, Indiana, ITP Year 1 (2022).

Species	Mean λ (90% CI)	Expected Take Rate (τ)	Pr(λ > τ) [1]	Short-Term Trigger Fires at α = 0.05?
Indiana bat	16.03 (5.9–30.25)	11.96	0.67	No
Northern long-eared bat	1.78 (0.01–6.85)	3.11	0.19	No

[1]. Pr(λ > τ) reads, "the probability that λ (the annual take rate) is greater than τ (the expected annual take rate based on the total permitted take, used as a threshold for adaptive management)." If this probability is less than 0.95 (e.g., α = 0.05 for a 1-sided test), then no adaptive management is triggered because there is not sufficient evidence that the estimated annual take rate is greater than the expected annual take rate.
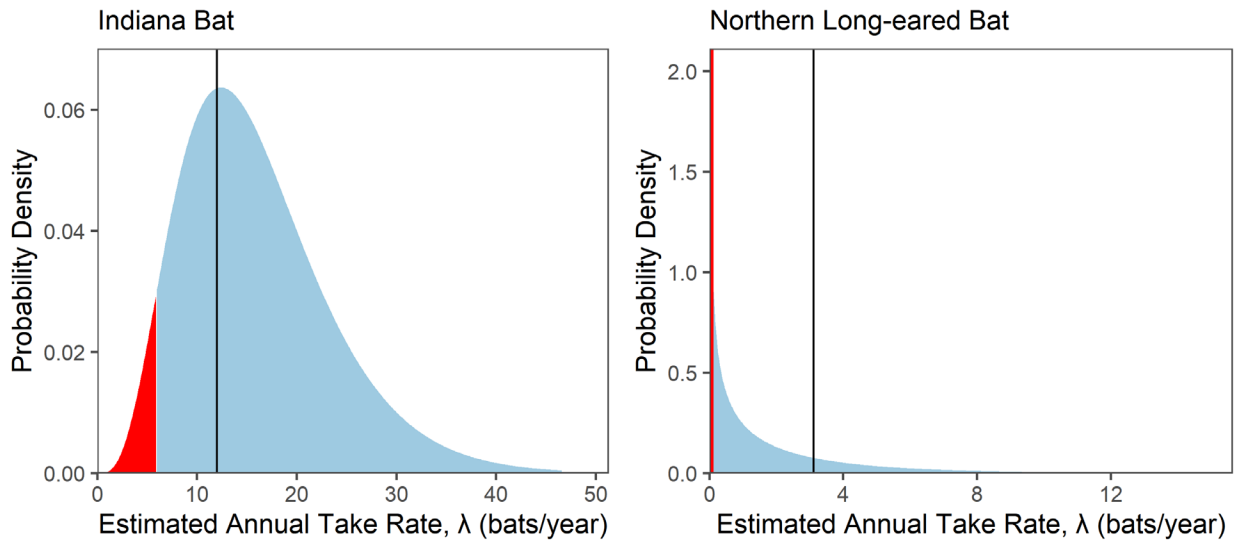
Figure 9. Estimated annual take rates (λ), in bats per year at Headwaters II Wind Farm, Randolph County, Indiana, ITP Year 1 (2022), from May 3 – October 15, 2022.

Note: The red region of the posterior distributions shows the region of the lower 5% quantile of the distributions (red region may not be visible when the posterior distribution is skewed heavily toward zero). The vertical line marks the expected take rate. The short-term trigger evaluates whether the vertical line falls within or to the left of the red region of the posterior distributions. For both species, the short-term trigger is not met because the vertical line (expected take rate) is not within or to the left of the red regions. In other words, the probability that estimated take rate is greater than the expected take rate does not exceed 95%.

Evidence of Absence Short-term Trigger (summer)

The summer short-term trigger assesses the probability that the estimated summer take rate exceeded the expected summer take rate, Pr(λ > τ). At a 95% confidence level (α = 0.05), Pr(λ > τ) must be greater than or equal to 0.95 for the short-term trigger to fire. For Indiana bat, Pr(λ > τ) = 0.18 and northern long-eared bat, Pr(λ > τ) = 0.49 (Table 9). Neither probability meets or exceeds 0.95, indicating the summer short-term trigger was not met and no adaptive management actions are necessary (Table 9; Figure 10).

Table 9. Probability the estimated summer take rates exceeded the expected take rates for studies conducted within the rolling average interval at the Headwaters Wind II Farm, Randolph County, Indiana, ITP Year 1 (2022).

Species	Mean λ (90% CI)	Expected Take Rate (τ)	Pr(λ > τ) [1]	Short-Term Trigger Fires at α = 0.05?
Indiana bat	1.67 (0.01–6.43)	3.00	0.18	No
Northern long-eared bat	1.67 (0.01–6.43)	0.78	0.49	No

[1]. Pr(λ > τ) reads, "the probability that λ (the summer take rate) is greater than τ (the expected summer take rate based on the total permitted take, used as a threshold for adaptive management)." If this probability is less than 0.95 (e.g., α = 0.05 for a 1-sided test), then no adaptive management is triggered because there is not sufficient evidence that the estimated summer take rate is greater than the expected summer take rate.
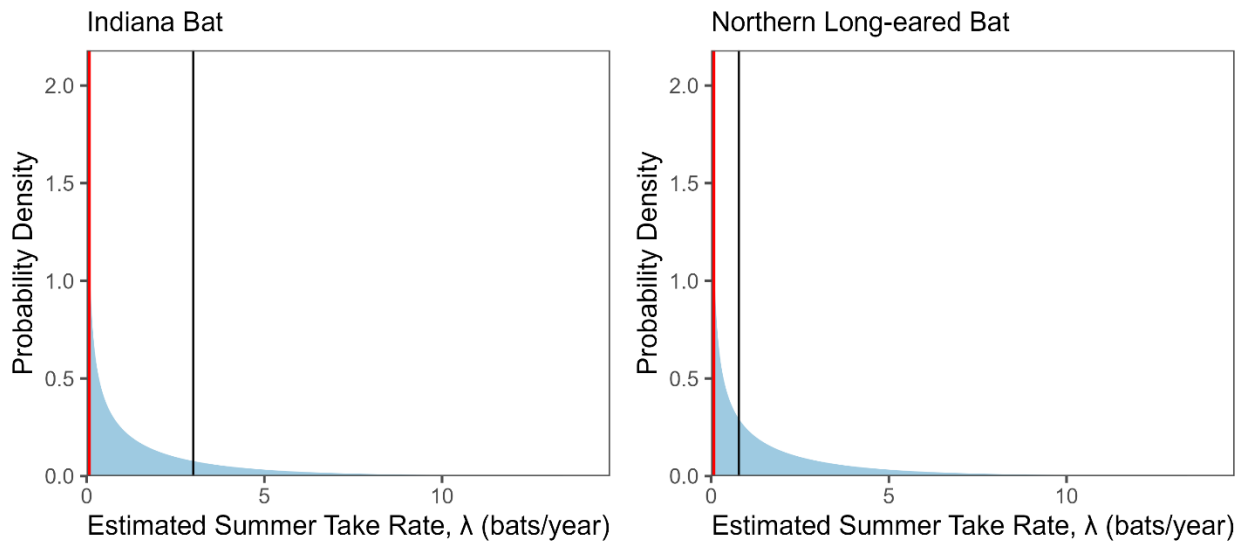
Figure 10. Estimated summer take rates (λ), in bats per year at Headwaters II Wind Farm, Randolph County, Indiana, ITP Year 1 (2022), from May 3 – October 15, 2022.

Note: The red region of the posterior distributions shows the region of the lower 5% quantile of the distributions (red region may not be visible when the posterior distribution is skewed heavily toward zero). The vertical line marks the expected take rate. The summer short-term trigger evaluates whether the vertical line falls within or to the left of the red region of the posterior distributions. For both species, the summer short-term trigger is not met because the vertical line (expected take rate) is not within or to the left of the red regions. In other words, the probability that estimated take rate is greater than the expected take rate does not exceed 95%.

Evidence of Absence Long-term Trigger

The estimated cumulative take to date, *M** at α = 0.5 (50th credible bound), is below the total permitted take for both Covered Species (Table 10). The long-term trigger was not met and the Project is in compliance for both species because *M** < T for both species (Headwaters II 2022). Therefore, an avoidance response is not necessary.

Table 10. **Cumulative take estimates to date using Evidence of Absence for studies conducted within the Incidental Take Permit (ITP) term to date at Headwaters II Wind Farm, Randolph County, Indiana, for ITP Year 1 (2022).**

Species	Cumulative take (M[*])	Permitted take (T[**])	Long-term trigger fires at α = 0.5?
Indiana bat (50th credible bound)	13	359	No
northern long-eared bat (50th credible bound)	0	93	No

CONCLUSIONS

The PCM effort completed in 2022 was consistent with the HCP's monitoring requirements and the Project's 2022 study plan. Four Covered Species carcasses were found with a high probability of detection in 2022. Estimates of potential take for the Covered Species were below the levels authorized by the ITP and no adaptive management actions are necessary.

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Appendix A. Carcasses found during the 2022 Post-Construction Monitoring Surveys.

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
Bats							
TAL monitoring (March 15 – May 2, 2022)[3]							
04/22/2022	silver-haired bat	13	203	Incidental	road and pad	intact	no
04/26/2022	hoary bat	6	208	carcass search	road and pad	scavenged	no
04/27/2022	eastern red bat	22	230	carcass search[2]	road and pad	scavenged	no
04/27/2022	silver-haired bat	6	230	carcass search	road and pad	intact	no
ITP compliance monitoring begins (May 2, 2022)							
05/16/2022	hoary bat	5	214	carcass search	full plot	intact	yes[1]
05/17/2022	evening bat	30	230	carcass search	road and pad	scavenged	no
05/18/2022	eastern red bat	80	245	carcass search	full plot	scavenged	no
05/18/2022	silver-haired bat	40	231	carcass search	full plot	scavenged	no
05/23/2022	silver-haired bat	41	212	carcass search	full plot	scavenged	no
05/30/2022	hoary bat	61	224	carcass search	full plot	scavenged	yes[1]
06/01/2022	silver-haired bat	48	240	carcass search	full plot	intact	no
06/01/2022	silver-haired bat	48	245	carcass search	full plot	intact	no
06/01/2022	silver-haired bat	33	245	carcass search	full plot	scavenged	no
06/02/2022	hoary bat	55	249	carcass search	full plot	scavenged	no
06/02/2022	silver-haired bat	38	223	carcass search	full plot	intact	yes[1]
06/03/2022	silver-haired bat	19	244	carcass search	full plot	intact	yes[1]
06/06/2022	eastern red bat	59	212	carcass search	full plot	scavenged	no
06/06/2022	hoary bat	21	201	carcass search	road and pad	scavenged	no
06/06/2022	silver-haired bat	3	224	carcass search	full plot	scavenged	yes[1]
06/07/2022	hoary bat	18	230	carcass search	road and pad	scavenged	no
06/07/2022	silver-haired bat	67	231	carcass search	full plot	scavenged	no
06/07/2022	silver-haired bat	27	233	carcass search	full plot	scavenged	yes[1]
06/08/2022	silver-haired bat	14	248	carcass search	road and pad	scavenged	no
06/08/2022	silver-haired bat	34	249	carcass search	full plot	intact	no
06/13/2022	eastern red bat	21	210	carcass search	full plot	scavenged	no
06/14/2022	big brown bat	23	234	carcass search	road and pad	scavenged	no
06/14/2022	eastern red bat	58	233	carcass search	full plot	injured	yes[1]
06/14/2022	hoary bat	35	225	carcass search	full plot	scavenged	no
06/14/2022	silver-haired bat	12	201	incidental	road and pad	scavenged	no
06/14/2022	silver-haired bat	18	228	carcass search	road and pad	scavenged	no
06/14/2022	silver-haired bat	43	233	carcass search	full plot	scavenged	yes[1]
06/15/2022	eastern red bat	65	222	carcass search	road and pad	scavenged	no

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
06/15/2022	eastern red bat	67	240	carcass search	full plot	scavenged	no
06/15/2022	eastern red bat	44	240	carcass search	full plot	scavenged	no
06/15/2022	eastern red bat	34	240	carcass search	full plot	scavenged	no
06/15/2022	silver-haired bat	50	245	carcass search	full plot	scavenged	no
06/15/2022	silver-haired bat	36	249	carcass search	full plot	scavenged	no
06/16/2022	eastern red bat	62	223	carcass search	full plot	scavenged	yes[1]
06/16/2022	silver-haired bat	75	223	carcass search	full plot	scavenged	yes[1]
06/20/2022	eastern red bat	51	210	carcass search	full plot	dismembered	no
06/20/2022	eastern red bat	46	210	carcass search	full plot	scavenged	no
06/20/2022	silver-haired bat	70	212	carcass search	full plot	scavenged	no
06/21/2022	big brown bat	82	234	carcass search	road and pad	intact	no
06/21/2022	eastern red bat	66	224	carcass search	full plot	scavenged	yes[1]
06/21/2022	eastern red bat	17	225	carcass search	full plot	scavenged	no
06/21/2022	hoary bat	15	214	carcass search	full plot	scavenged	yes[1]
06/21/2022	silver-haired bat	51	225	carcass search	full plot	scavenged	no
06/22/2022	hoary bat	22	240	carcass search	full plot	scavenged	no
06/22/2022	silver-haired bat	62	240	carcass search	full plot	scavenged	no
06/22/2022	silver-haired bat	29	240	carcass search	full plot	scavenged	no
06/23/2022	silver-haired bat	84	223	carcass search[2]	full plot	scavenged	yes[1]
06/24/2022	big brown bat	80	244	carcass search	full plot	scavenged	yes[1]
06/24/2022	eastern red bat	26	244	carcass search	full plot	scavenged	yes[1]
06/27/2022	eastern red bat	76	224	carcass search	full plot	scavenged	yes[1]
06/28/2022	eastern red bat	21	231	carcass search	full plot	scavenged	no
06/28/2022	eastern red bat	78	233	carcass search	full plot	scavenged	yes[1]
06/28/2022	eastern red bat	79	233	carcass search	full plot	scavenged	yes[1]
06/28/2022	hoary bat	9	231	incidental	full plot	scavenged	no
06/28/2022	silver-haired bat	41	241	carcass search	full plot	scavenged	yes[1]
06/29/2022	eastern red bat	11	222	carcass search	road and pad	scavenged	no
06/29/2022	eastern red bat	17	222	carcass search	road and pad	scavenged	no
06/29/2022	eastern red bat	3	248	carcass search	road and pad	dismembered	no
07/01/2022	eastern red bat	82	244	carcass search[2]	full plot	scavenged	yes[1]
07/04/2022	eastern red bat	0	213	carcass search	road and pad	scavenged	no
07/04/2022	eastern red bat	66	224	carcass search	full plot	scavenged	yes[1]
07/07/2022	big brown bat	48	233	carcass search	full plot	scavenged	yes[1]
07/07/2022	big brown bat	19	240	carcass search	full plot	intact	no
07/07/2022	eastern red bat	22	214	incidental	full plot	scavenged	no

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
07/07/2022	eastern red bat	31	224	incidental	full plot	scavenged	yes[1]
07/07/2022	eastern red bat	51	241	carcass search	full plot	scavenged	yes[1]
07/07/2022	hoary bat	79	241	carcass search	full plot	intact	yes[1]
07/07/2022	silver-haired bat	47	231	carcass search	full plot	scavenged	no
07/08/2022	eastern red bat	47	245	carcass search	full plot	scavenged	no
07/08/2022	eastern red bat	4	249	carcass search	full plot	intact	no
07/11/2022	eastern red bat	81	241	carcass search[2]	full plot	scavenged	yes[1]
07/12/2022	eastern red bat	10	234	carcass search	road and pad	scavenged	no
07/13/2022	eastern red bat	6	223	carcass search	full plot	scavenged	yes[1]
07/13/2022	eastern red bat	25	240	carcass search	full plot	scavenged	no
07/14/2022	big brown bat	62	233	incidental	full plot	scavenged	yes[1]
07/19/2022	big brown bat	12	228	carcass search	road and pad	scavenged	no
07/20/2022	big brown bat	25	240	carcass search	full plot	intact	no
07/20/2022	eastern red bat	7	240	carcass search	full plot	intact	no
07/25/2022	eastern red bat	76	224	carcass search	full plot	scavenged	yes[1]
07/25/2022	hoary bat	27	214	carcass search	full plot	scavenged	yes[1]
07/26/2022	big brown bat	29	228	carcass search	road and pad	scavenged	no
07/26/2022	eastern red bat	51	216	incidental	full plot	scavenged	yes[1]
07/26/2022	eastern red bat	37	226	carcass search	road and pad	scavenged	no
07/26/2022	eastern red bat	9	227	carcass search	road and pad	scavenged	no
07/26/2022	eastern red bat	23	241	carcass search	full plot	scavenged	yes[1]
07/26/2022	hoary bat	35	216	incidental	full plot	scavenged	no
07/27/2022	eastern red bat	73	240	carcass search	full plot	scavenged	no
07/27/2022	eastern red bat	36	240	carcass search	full plot	scavenged	no
07/27/2022	hoary bat	1	240	carcass search	full plot	scavenged	no
07/27/2022	hoary bat	76	240	carcass search	full plot	intact	no
08/01/2022	big brown bat	27	206	carcass search	road and pad	scavenged	no
08/01/2022	big brown bat	47	216	carcass search	full plot	scavenged	yes[1]
08/01/2022	big brown bat	15	216	carcass search	full plot	scavenged	yes[1]
08/01/2022	big brown bat	8	219	carcass search[2]	road and pad	scavenged	no
08/01/2022	eastern red bat	17	212	carcass search	full plot	scavenged	yes[1]
08/01/2022	eastern red bat	34	216	carcass search	full plot	scavenged	yes[1]
08/01/2022	eastern red bat	23	216	carcass search	full plot	scavenged	yes[1]
08/01/2022	eastern red bat	76	216	carcass search	full plot	scavenged	yes[1]
08/01/2022	hoary bat	43	206	carcass search	road and pad	scavenged	no
08/01/2022	unidentified bat	28	205	carcass search	full plot	scavenged	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
08/02/2022	big brown bat	48	214	carcass search	full plot	scavenged	yes[1]
08/02/2022	big brown bat	18	218	carcass search	full plot	scavenged	yes[1]
08/02/2022	big brown bat	10	243	carcass search	road and pad	intact	no
08/02/2022	big brown bat	15	243	carcass search	road and pad	intact	no
08/02/2022	big brown bat	42	243	carcass search	road and pad	scavenged	no
08/02/2022	eastern red bat	25	224	carcass search	full plot	scavenged	yes[1]
08/02/2022	eastern red bat	20	235	carcass search	road and pad	scavenged	no
08/02/2022	hoary bat	42	224	carcass search	full plot	scavenged	yes[1]
08/02/2022	hoary bat	56	224	carcass search	full plot	scavenged	yes[1]
08/02/2022	hoary bat	59	224	carcass search	full plot	scavenged	yes[1]
08/04/2022	big brown bat	23	227	carcass search	full plot	scavenged	yes[1]
08/04/2022	big brown bat	57	240	carcass search	full plot	scavenged	yes[1]
08/04/2022	eastern red bat	37	227	carcass search	full plot	scavenged	yes[1]
08/04/2022	eastern red bat	56	227	carcass search	full plot	scavenged	yes[1]
08/04/2022	eastern red bat	61	227	carcass search	full plot	scavenged	yes[1]
08/04/2022	eastern red bat	58	234	carcass search	full plot	scavenged	yes[1]
08/04/2022	eastern red bat	50	240	carcass search	full plot	scavenged	yes[1]
08/04/2022	eastern red bat	35	240	carcass search	full plot	scavenged	yes[1]
08/04/2022	eastern red bat	23	240	carcass search	full plot	scavenged	yes[1]
08/05/2022	big brown bat	10	249	carcass search	full plot	intact	yes[1]
08/05/2022	eastern red bat	15	232	carcass search	full plot	scavenged	yes[1]
08/05/2022	eastern red bat	11	232	carcass search	full plot	scavenged	yes[1]
08/05/2022	eastern red bat	56	232	carcass search	full plot	scavenged	yes[1]
08/08/2022	big brown bat	12	204	carcass search	full plot	scavenged	yes[1]
08/08/2022	big brown bat	4	207	carcass search	road and pad	scavenged	no
08/08/2022	big brown bat	10	213	carcass search	road and pad	scavenged	no
08/08/2022	big brown bat	8	228	carcass search	road and pad	scavenged	no
08/08/2022	eastern red bat	32	204	carcass search	full plot	scavenged	yes[1]
08/08/2022	eastern red bat	63	205	carcass search	full plot	scavenged	yes[1]
08/08/2022	eastern red bat	18	210	carcass search	full plot	intact	yes[1]
08/08/2022	eastern red bat	12	228	carcass search	road and pad	scavenged	no
08/08/2022	eastern red bat	29	229	carcass search	road and pad	scavenged	no
08/08/2022	hoary bat	15	210	carcass search	full plot	scavenged	yes[1]
08/08/2022	hoary bat	23	212	carcass search	full plot	scavenged	yes[1]
08/08/2022	hoary bat	1	228	carcass search	road and pad	scavenged	no
08/09/2022	big brown bat	24	216	carcass search	full plot	scavenged	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
08/09/2022	big brown bat	26	224	carcass search	full plot	scavenged	yes[1]
08/09/2022	big brown bat	39	225	carcass search	full plot	scavenged	yes[1]
08/09/2022	big brown bat	23	225	carcass search	full plot	scavenged	yes[1]
08/09/2022	big brown bat	30	243	carcass search	road and pad	scavenged	no
08/09/2022	eastern red bat	18	214	carcass search	full plot	scavenged	yes[1]
08/09/2022	eastern red bat	9	216	carcass search	full plot	scavenged	yes[1]
08/09/2022	eastern red bat	56	216	carcass search	full plot	scavenged	yes[1]
08/09/2022	eastern red bat	64	246	carcass search	road and pad	scavenged	no
08/09/2022	eastern red bat	8	248	incidental	road and pad	scavenged	no
08/09/2022	hoary bat	23	233	carcass search	full plot	scavenged	yes[1]
08/09/2022	hoary bat	4	248	carcass search	road and pad	scavenged	no
08/09/2022	hoary bat	3	248	carcass search	road and pad	scavenged	no
08/10/2022	hoary bat	74	227	carcass search	full plot	scavenged	yes[1]
08/11/2022	big brown bat	67	230	carcass search	full plot	scavenged	yes[1]
08/11/2022	big brown bat	57	231	carcass search	full plot	scavenged	yes[1]
08/11/2022	eastern red bat	13	230	carcass search	full plot	scavenged	yes[1]
08/12/2022	big brown bat	8	222	carcass search	full plot	scavenged	yes[1]
08/12/2022	big brown bat	47	244	carcass search	full plot	scavenged	yes[1]
08/12/2022	big brown bat	8	249	carcass search	full plot	scavenged	yes[1]
08/12/2022	big brown bat	5	249	carcass search	full plot	intact	yes[1]
08/12/2022	big brown bat	8	249	carcass search	full plot	intact	yes[1]
08/12/2022	eastern red bat	17	222	carcass search	full plot	scavenged	yes[1]
08/12/2022	eastern red bat	79	222	carcass search	full plot	scavenged	yes[1]
08/12/2022	eastern red bat	29	244	carcass search	full plot	intact	yes[1]
08/14/2022	big brown bat	58	210	incidental	full plot	scavenged	yes[1]
08/14/2022	eastern red bat	8	210	incidental	full plot	scavenged	yes[1]
08/15/2022	big brown bat	21	206	carcass search	road and pad	dismembered	no
08/15/2022	big brown bat	35	228	carcass search	road and pad	scavenged	no
08/15/2022	eastern red bat	21	204	carcass search	full plot	scavenged	yes[1]
08/15/2022	eastern red bat	28	211	carcass search	full plot	scavenged	yes[1]
08/15/2022	eastern red bat	31	211	carcass search	full plot	scavenged	yes[1]
08/16/2022	big brown bat	22	216	carcass search	full plot	scavenged	yes[1]
08/16/2022	big brown bat	31	218	carcass search	full plot	scavenged	yes[1]
08/16/2022	big brown bat	32	224	carcass search	full plot	scavenged	yes[1]
08/16/2022	big brown bat	3	225	carcass search	full plot	intact	yes[1]
08/16/2022	big brown bat	52	225	carcass search	full plot	scavenged	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
08/16/2022	big brown bat	6	229	carcass search	road and pad	scavenged	no
08/16/2022	eastern red bat	27	214	carcass search	full plot	scavenged	yes[1]
08/16/2022	eastern red bat	21	218	carcass search	full plot	intact	yes[1]
08/16/2022	big brown bat	38	218	carcass search	full plot	scavenged	yes[1]
08/16/2022	Indiana bat	26	225	carcass search	full plot	scavenged	yes[1]
08/18/2022	big brown bat	38	230	carcass search	full plot	scavenged	yes[1]
08/18/2022	big brown bat	41	231	carcass search	full plot	scavenged	yes[1]
08/18/2022	eastern red bat	40	227	carcass search	full plot	scavenged	yes[1]
08/18/2022	eastern red bat	33	227	carcass search	full plot	scavenged	yes[1]
08/18/2022	eastern red bat	71	240	carcass search	full plot	intact	yes[1]
08/18/2022	eastern red bat	30	240	carcass search	full plot	scavenged	yes[1]
08/18/2022	eastern red bat	35	240	carcass search	full plot	intact	yes[1]
08/18/2022	Indiana bat	57	240	carcass search	full plot	intact	yes[1]
08/19/2022	big brown bat	45	222	carcass search	full plot	scavenged	yes[1]
08/19/2022	big brown bat	17	245	carcass search	full plot	scavenged	yes[1]
08/19/2022	big brown bat	17	249	carcass search	full plot	scavenged	yes[1]
08/19/2022	eastern red bat	5	232	carcass search	full plot	scavenged	yes[1]
08/19/2022	eastern red bat	65	232	carcass search	full plot	scavenged	yes[1]
08/19/2022	eastern red bat	5	244	carcass search	full plot	scavenged	yes[1]
08/19/2022	eastern red bat	68	245	carcass search	full plot	scavenged	yes[1]
08/19/2022	hoary bat	33	222	carcass search	full plot	scavenged	yes[1]
08/22/2022	big brown bat	33	212	carcass search	full plot	intact	yes[1]
08/22/2022	big brown bat	44	212	carcass search	full plot	scavenged	yes[1]
08/22/2022	big brown bat	16	221	carcass search	road and pad	scavenged	no
08/22/2022	eastern red bat	9	208	carcass search	road and pad	scavenged	no
08/22/2022	eastern red bat	40	212	carcass search	full plot	scavenged	yes[1]
08/22/2022	eastern red bat	32	212	carcass search	full plot	scavenged	yes[1]
08/22/2022	hoary bat	65	211	carcass search	full plot	scavenged	yes[1]
08/22/2022	hoary bat	56	212	carcass search	full plot	scavenged	yes[1]
08/22/2022	hoary bat	20	219	carcass search	road and pad	scavenged	no
08/23/2022	big brown bat	34	216	carcass search	full plot	scavenged	yes[1]
08/23/2022	big brown bat	27	218	carcass search	full plot	scavenged	yes[1]
08/23/2022	big brown bat	37	224	carcass search	full plot	intact	yes[1]
08/23/2022	big brown bat	34	225	carcass search	full plot	scavenged	yes[1]
08/23/2022	big brown bat	26	233	carcass search	full plot	scavenged	yes[1]
08/23/2022	eastern red bat	53	216	carcass search	full plot	scavenged	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
08/23/2022	eastern red bat	43	218	carcass search	full plot6	scavenged	yes[1]
08/23/2022	eastern red bat	3	218	carcass search	full plot	scavenged	yes[1]
08/23/2022	eastern red bat	85	224	carcass search[2]	full plot	scavenged	yes[1]
08/23/2022	eastern red bat	32	224	carcass search	full plot	scavenged	yes[1]
08/23/2022	eastern red bat	53	224	carcass search	full plot	scavenged	yes[1]
08/23/2022	eastern red bat	33	233	carcass search	full plot	scavenged	yes[1]
08/23/2022	eastern red bat	9	233	carcass search	full plot	scavenged	yes[1]
08/23/2022	eastern red bat	40	233	carcass search	full plot	scavenged	yes[1]
08/23/2022	eastern red bat	38	233	carcass search	full plot	scavenged	yes[1]
08/23/2022	Indiana bat	20	233	carcass search	full plot	scavenged	yes[1]
08/23/2022	Indiana bat	33	233	carcass search	full plot	intact	yes[1]
08/25/2022	big brown bat	22	227	carcass search	full plot	scavenged	yes[1]
08/25/2022	big brown bat	5	227	carcass search	full plot	scavenged	yes[1]
08/25/2022	big brown bat	8	230	carcass search	full plot	scavenged	yes[1]
08/25/2022	big brown bat	24	231	carcass search	full plot	scavenged	yes[1]
08/25/2022	big brown bat	54	234	carcass search	full plot	scavenged	yes[1]
08/25/2022	big brown bat	74	240	carcass search	full plot	intact	yes[1]
08/25/2022	eastern red bat	11	230	carcass search	full plot	scavenged	yes[1]
08/25/2022	eastern red bat	8	231	carcass search	full plot	scavenged	yes[1]
08/25/2022	eastern red bat	14	234	carcass search	full plot	scavenged	yes[1]
08/26/2022	big brown bat	59	223	carcass search	full plot	scavenged	yes[1]
08/26/2022	eastern red bat	41	223	carcass search	full plot	scavenged	yes[1]
08/26/2022	eastern red bat	24	232	carcass search	full plot	scavenged	yes[1]
08/26/2022	eastern red bat	26	244	carcass search	full plot6	scavenged	yes[1]
08/26/2022	silver-haired bat	15	222	carcass search	full plot	intact	yes[1]
08/26/2022	unidentified *Lasiurus* bat	18	249	carcass search	full plot	scavenged	yes[1]
08/29/2022	big brown bat	11	211	carcass search	full plot	scavenged	yes[1]
08/29/2022	big brown bat	44	211	carcass search	full plot	scavenged	yes[1]
08/29/2022	eastern red bat	33	211	carcass search	full plot	scavenged	yes[1]
08/29/2022	eastern red bat	53	211	carcass search	full plot	scavenged	yes[1]
08/29/2022	eastern red bat	8	212	carcass search	full plot	scavenged	yes[1]
08/29/2022	eastern red bat	28	212	carcass search	full plot	scavenged	yes[1]
08/29/2022	eastern red bat	62	212	carcass search	full plot	scavenged	yes[1]
08/29/2022	eastern red bat	41	212	carcass search	full plot	scavenged	yes[1]
08/30/2022	big brown bat	5	218	carcass search	full plot	scavenged	yes[1]
08/30/2022	eastern red bat	10	224	carcass search	full plot	intact	no

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search[1]
08/30/2022	eastern red bat	40	224	carcass search	full plot	scavenged	yes[1]
08/30/2022	eastern red bat	21	225	carcass search	full plot	scavenged	yes[1]
08/30/2022	eastern red bat	57	233	carcass search	full plot	scavenged	yes[1]
08/30/2022	eastern red bat	54	233	carcass search	full plot	scavenged	yes[1]
08/30/2022	hoary bat	29	224	carcass search	full plot	scavenged	yes[1]
09/01/2022	big brown bat	46	230	carcass search	full plot	scavenged	yes[1]
09/01/2022	big brown bat	33	240	carcass search	full plot	intact	yes[1]
09/01/2022	eastern red bat	5	227	carcass search	full plot	scavenged	yes[1]
09/01/2022	eastern red bat	10	230	carcass search	full plot	scavenged	yes[1]
09/01/2022	eastern red bat	43	231	carcass search	full plot	scavenged	yes[1]
09/01/2022	eastern red bat	40	234	carcass search	full plot	scavenged	yes[1]
09/01/2022	eastern red bat	29	234	carcass search	full plot	scavenged	yes[1]
09/01/2022	eastern red bat or Seminole bat	74	240	carcass search	full plot	scavenged	yes[1]
09/01/2022	silver-haired bat	29	227	carcass search	full plot	intact	yes[1]
09/01/2022	silver-haired bat	32	227	carcass search	full plot	intact	yes[1]
09/01/2022	silver-haired bat	5	231	carcass search	full plot	intact	yes[1]
09/02/2022	big brown bat	67	232	carcass search	full plot	scavenged	yes[1]
09/02/2022	eastern red bat	14	223	carcass search	full plot	scavenged	yes[1]
09/02/2022	eastern red bat	76	223	carcass search	full plot	scavenged	yes[1]
09/02/2022	eastern red bat	49	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	eastern red bat	43	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	38	222	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	9	222	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	50	222	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	48	222	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	33	223	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	33	223	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	56	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	60	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	43	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	45	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	36	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	38	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	38	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	35	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	46	244	carcass search	full plot	scavenged	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
09/02/2022	silver-haired bat	47	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	50	244	carcass search	full plot	scavenged	no
09/02/2022	silver-haired bat	42	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	52	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	47	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	36	244	carcass search	full plot	scavenged	yes[1]
09/02/2022	silver-haired bat	44	249	carcass search	full plot	scavenged	yes[1]
09/05/2022	big brown bat	29	204	carcass search	full plot	scavenged	yes[1]
09/05/2022	big brown bat	12	204	carcass search	full plot	scavenged	yes[1]
09/05/2022	big brown bat	7	226	carcass search	road and pad	dismembered	no
09/05/2022	eastern red bat	50	212	carcass search	full plot	scavenged	yes[1]
09/05/2022	eastern red bat	38	212	carcass search	full plot	scavenged	yes[1]
09/05/2022	hoary bat	67	208	carcass search	road and pad	scavenged	no
09/05/2022	hoary bat	24	212	carcass search	full plot	scavenged	yes[1]
09/05/2022	silver-haired bat	33	204	carcass search	full plot	scavenged	yes[1]
09/05/2022	silver-haired bat	8	211	carcass search	full plot	scavenged	yes[1]
09/05/2022	silver-haired bat	53	212	carcass search	full plot	scavenged	yes[1]
09/05/2022	silver-haired bat	34	213	carcass search	road and pad	scavenged	no
09/05/2022	silver-haired bat	16	213	carcass search	road and pad	scavenged	no
09/06/2022	big brown bat	57	216	carcass search	full plot	scavenged	yes[1]
09/06/2022	big brown bat	38	229	carcass search	road and pad	scavenged	no
09/06/2022	big brown bat	7	229	carcass search	road and pad	scavenged	no
09/06/2022	big brown bat	52	238	carcass search	road and pad	scavenged	no
09/06/2022	eastern red bat	23	214	carcass search	full plot	scavenged	yes[1]
09/06/2022	eastern red bat	43	224	carcass search	full plot	scavenged	yes[1]
09/06/2022	eastern red bat	21	224	carcass search	full plot	scavenged	yes[1]
09/06/2022	eastern red bat	48	224	carcass search	full plot	scavenged	yes[1]
09/06/2022	eastern red bat	18	225	carcass search	full plot	scavenged	yes[1]
09/06/2022	eastern red bat	9	243	carcass search[2]	road and pad	intact	no
09/06/2022	evening bat	17	225	carcass search	full plot	scavenged	yes[1]
09/06/2022	hoary bat	33	225	carcass search	full plot	scavenged	yes[1]
09/06/2022	silver-haired bat	61	216	carcass search	full plot	scavenged	yes[1]
09/06/2022	silver-haired bat	54	216	carcass search	full plot	scavenged	yes[1]
09/06/2022	silver-haired bat	0	216	carcass search	full plot	scavenged	yes[1]
09/06/2022	silver-haired bat	44	218	carcass search	full plot	scavenged	yes[1]
09/08/2022	big brown bat	21	234	carcass search	full plot	scavenged	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
09/08/2022	eastern red bat	19	227	carcass search	full plot	scavenged	yes[1]
09/08/2022	eastern red bat	63	231	carcass search	full plot	scavenged	yes[1]
09/08/2022	eastern red bat	49	231	carcass search	full plot	scavenged	yes[1]
09/08/2022	eastern red bat	50	232	carcass search	full plot	scavenged	yes[1]
09/08/2022	eastern red bat	25	232	carcass search	full plot	scavenged	yes[1]
09/08/2022	eastern red bat	78	232	carcass search	full plot	scavenged	yes[1]
09/08/2022	eastern red bat	58	234	carcass search	full plot	scavenged	yes[1]
09/08/2022	eastern red bat	31	240	carcass search	full plot	scavenged	yes[1]
09/08/2022	silver-haired bat	22	227	carcass search	full plot	scavenged	yes[1]
09/08/2022	silver-haired bat	41	231	carcass search	full plot	v full plot scavenged	yes[1]
09/08/2022	silver-haired bat	14	234	carcass search	full plot	scavenged	yes[1]
09/09/2022	big brown bat	18	222	carcass search	full plot	scavenged	yes[1]
09/09/2022	big brown bat	37	244	carcass search	full plot	scavenged	yes[1]
09/09/2022	big brown bat	36	245	carcass search	full plot	scavenged	yes[1]
09/09/2022	big brown bat	5	245	carcass search	full plot	scavenged	yes[1]
09/09/2022	eastern red bat	46	222	carcass search	full plot	scavenged	yes[1]
09/09/2022	eastern red bat	45	244	carcass search	full plot	intact	yes[1]
09/09/2022	eastern red bat	21	244	carcass search	full plot	scavenged	yes[1]
09/09/2022	silver-haired bat	32	245	carcass search	full plot	scavenged	yes[1]
09/12/2022	eastern red bat	50	205	carcass search	full plot	scavenged	yes[1]
09/12/2022	eastern red bat	6	211	carcass search	full plot	scavenged	yes[1]
09/12/2022	hoary bat	54	205	carcass search	full plot	scavenged	yes[1]
09/12/2022	silver-haired bat	24	205	carcass search	full plot	scavenged	yes[1]
09/12/2022	silver-haired bat	45	205	carcass search	full plot	scavenged	yes[1]
09/12/2022	silver-haired bat	30	211	carcass search	full plot	scavenged	yes[1]
09/13/2022	eastern red bat	11	225	carcass search	full plot	scavenged	yes[1]
09/13/2022	silver-haired bat	23	214	carcass search	full plot	scavenged	yes[1]
09/13/2022	silver-haired bat	36	218	carcass search	full plot	scavenged	yes[1]
09/13/2022	silver-haired bat	45	218	carcass search	full plot	scavenged	yes[1]
09/13/2022	silver-haired bat	54	225	carcass search	full plot	scavenged	yes[1]
09/13/2022	silver-haired bat	43	238	carcass search	road and pad	dismembered	no
09/14/2022	silver-haired bat	59	212	incidental	full plot	scavenged	yes[1]
09/14/2022	silver-haired bat	39	212	incidental	full plot	intact	yes[1]
09/16/2022	big brown bat	9	245	carcass search	full plot	scavenged	yes[1]
09/16/2022	eastern red bat	24	232	carcass search	full plot	scavenged	yes[1]
09/16/2022	silver-haired bat	30	222	carcass search	full plot	scavenged	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
09/16/2022	silver-haired bat	25	245	carcass search	full plot	scavenged	yes[1]
09/19/2022	evening bat	41	212	carcass search	full plot	scavenged	yes[1]
09/19/2022	hoary bat	12	201	carcass search	road and pad	intact	no
09/19/2022	silver-haired bat	32	204	carcass search	full plot	scavenged	yes[1]
09/19/2022	silver-haired bat	20	211	carcass search	full plot	intact	yes[1]
09/19/2022	silver-haired bat	49	212	carcass search	full plot	scavenged	yes[1]
09/20/2022	big brown bat	44	218	carcass search	full plot	scavenged	yes[1]
09/20/2022	silver-haired bat	18	247	carcass search	road and pad	scavenged	no
09/22/2022	big brown bat	65	231	carcass search	full plot	intact	yes[1]
09/22/2022	hoary bat	48	240	carcass search	full plot	scavenged	yes[1]
09/22/2022	silver-haired bat	79	231	carcass search	full plot	scavenged	yes[1]
09/23/2022	hoary bat	43	245	carcass search	full plot	scavenged	yes[1]
09/23/2022	silver-haired bat	18	230	carcass search	full plot	intact	yes[1]
09/23/2022	silver-haired bat	29	244	carcass search	full plot	scavenged	yes[1]
09/23/2022	silver-haired bat	14	245	carcass search	full plot	scavenged	yes[1]
09/26/2022	silver-haired bat	16	209	carcass search	road and pad	intact	no
09/27/2022	eastern red bat	20	225	carcass search	full plot	scavenged	yes[1]
09/29/2022	silver-haired bat	23	227	carcass search	full plot	scavenged	yes[1]
10/03/2022	silver-haired bat	17	212	carcass search	full plot	scavenged	yes[1]
10/04/2022	silver-haired bat	27	233	carcass search	full plot	scavenged	yes[1]
10/06/2022	hoary bat	27	227	carcass search	full plot	scavenged	yes[1]
10/07/2022	silver-haired bat	47	249	carcass search	full plot	scavenged	yes[1]
10/07/2022	silver-haired bat	53	232	carcass search	full plot	scavenged	yes[1]
10/10/2022	silver-haired bat	25	205	carcass search	full plot	scavenged	yes[1]
10/11/2022	eastern red bat	32	216	carcass search	full plot	scavenged	yes[1]
10/11/2022	silver-haired bat	18	224	carcass search	full plot	scavenged	yes[1]
Birds							
03/16/2022	European starling	2	248	carcass search	road and pad	scavenged	no
03/16/2022	red-tailed hawk	16	240	carcass search[2]	road and pad	scavenged	no
03/16/2022	turkey vulture	48	246	carcass search[2]	road and pad	scavenged	no
03/30/2022	Cooper's hawk	14	241	carcass search[2]	road and pad	intact	no
03/30/2022	horned lark	19	221	carcass search	road and pad	intact	no
04/12/2022	brown creeper	62	204	carcass search	road and pad	scavenged	no
04/12/2022	chipping sparrow	31	227	carcass search	road and pad	intact	no
04/13/2022	golden-crowned kinglet	19	240	carcass search	road and pad	intact	no
05/11/2022	brown-headed cowbird	15	229	carcass search[2]	road and pad	intact	no

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
05/17/2022	brown-headed cowbird	19	240	carcass search	full plot	scavenged	no
05/17/2022	red-tailed hawk	17	228	carcass search	road and pad	intact	no
05/17/2022	red-tailed hawk	49	240	carcass search	full plot	scavenged	no
05/20/2022	American goldfinch	15	244	carcass search	full plot	scavenged	yes[1]
05/23/2022	unidentified sparrow	58	214	carcass search	full plot	scavenged	yes[1]
05/25/2022	European starling	14	240	carcass search	full plot	scavenged	no
05/26/2022	unidentified passerine	52	223	carcass search	full plot	scavenged	yes[1]
05/30/2022	horned lark	16	214	carcass search	full plot	scavenged	yes[1]
05/31/2022	chimney swift	5	240	incidental[2]	full plot	intact	no
05/31/2022	turkey vulture	60	231	carcass search	full plot	scavenged	no
05/31/2022	turkey vulture	73	249	incidental	full plot	intact	no
05/31/2022	turkey vulture	75	249	incidental	full plot	intact	no
06/01/2022	yellow-billed cuckoo	78	240	carcass search	full plot	dismembered	no
06/02/2022	unidentified passerine	78	223	carcass search	full plot	scavenged	yes[1]
06/07/2022	Nashville warbler	83	241	carcass search[2]	full plot	scavenged	yes[1]
06/13/2022	turkey vulture	31	224	carcass search	full plot	scavenged	yes[1]
06/15/2022	chimney swift	21	240	carcass search	full plot	scavenged	no
06/15/2022	mourning dove	1	240	carcass search	full plot	scavenged	no
06/21/2022	horned lark	83	214	carcass search[2]	full plot	scavenged	yes[1]
06/22/2022	turkey vulture	73	233	carcass search	full plot	scavenged	yes[1]
06/22/2022	turkey vulture	28	233	carcass search	full plot	scavenged	yes[1]
06/22/2022	yellow-billed cuckoo	62	249	carcass search	full plot	scavenged	no
06/24/2022	black vulture	55	244	carcass search	full plot	scavenged	yes[1]
06/28/2022	horned lark	23	233	carcass search	full plot	scavenged	yes[1]
06/28/2022	unidentified blackbird	47	241	carcass search	full plot	feather spot	yes[1]
06/29/2022	European starling	26	240	carcass search	full plot	dismembered	no
06/30/2022	unidentified passerine	42	223	carcass search	full plot	feather spot	yes[1]
07/07/2022	turkey vulture	87	241	carcass search[2]	full plot	scavenged	yes[1]
07/10/2022	turkey vulture	24	201	incidental[2]	road and pad	intact	no
07/12/2022	horned lark	18	225	carcass search	full plot	scavenged	no
07/26/2022	purple martin	32	233	carcass search	full plot	scavenged	yes[1]
07/26/2022	turkey vulture	74	216	incidental	full plot	scavenged	no
07/27/2022	cedar waxwing	19	240	carcass search	full plot	scavenged	no
08/02/2022	horned lark	12	224	carcass search	full plot	scavenged	yes[1]
08/02/2022	horned lark	19	224	carcass search	full plot	scavenged	yes[1]
08/02/2022	house sparrow	47	224	carcass search	full plot	intact	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search[h]
08/02/2022	turkey vulture	31	218	carcass search	full plot	dismembered	yes[1]
08/03/2022	turkey vulture	36	204	carcass search	full plot	scavenged	yes[1]
08/04/2022	brown-headed cowbird	15	240	carcass search	full plot	scavenged	yes[1]
08/04/2022	red-tailed hawk	56	230	carcass search	full plot	scavenged	yes[1]
08/04/2022	unidentified passerine	45	227	carcass search	full plot	scavenged	yes[1]
08/04/2022	unidentified passerine	54	240	carcass search	full plot	scavenged	yes[1]
08/05/2022	unidentified large bird	14	232	carcass search	full plot	scavenged	yes[1]
08/08/2022	European starling	23	208	carcass search	road and pad	scavenged	no
08/11/2022	house sparrow	70	231	carcass search	full plot	intact	yes[1]
08/12/2022	unidentified passerine	32	222	carcass search	full plot	scavenged	yes[1]
08/15/2022	pine warbler	61	212	carcass search	full plot	scavenged	yes[1]
08/15/2022	unidentified passerine	80	212	carcass search	full plot	scavenged	yes[1]
08/16/2022	horned lark	52	214	carcass search	full plot	feather spot	yes[1]
08/16/2022	horned lark	75	224	carcass search	full plot	feather spot	yes[1]
08/16/2022	northern flicker	5	224	carcass search	full plot	feather spot	yes[1]
08/16/2022	red-tailed hawk	32	216	carcass search	full plot	scavenged	yes[1]
08/18/2022	horned lark	8	231	carcass search	full plot	scavenged	yes[1]
08/18/2022	killdeer	48	240	carcass search	full plot	feather spot	yes[1]
08/19/2022	red-bellied woodpecker	15	245	carcass search	full plot	scavenged	yes[1]
08/19/2022	unidentified passerine	48	244	carcass search	full plot	scavenged	yes[1]
08/22/2022	blue grosbeak	11	221	carcass search	road and pad	scavenged	no
08/22/2022	horned lark	60	212	carcass search	full plot	feather spot	yes[1]
08/25/2022	Blackburnian warbler	10	240	carcass search	full plot	scavenged	yes[1]
08/25/2022	horned lark	4	231	carcass search	full plot	scavenged	yes[1]
08/25/2022	northern flicker	18	240	carcass search	full plot	scavenged	yes[1]
08/26/2022	unidentified passerine	51	244	carcass search	full plot	feather spot	yes[1]
08/29/2022	purple martin	6	208	carcass search	road and pad	scavenged	no
08/30/2022	horned lark	46	233	carcass search	full plot	scavenged	yes[1]
09/01/2022	American goldfinch	43	231	carcass search	full plot	scavenged	yes[1]
09/01/2022	Tennessee warbler	26	234	carcass search	full plot	scavenged	yes[1]
09/01/2022	Tennessee warbler	29	234	carcass search	full plot	scavenged	yes[1]
09/02/2022	cedar waxwing	32	232	carcass search	full plot	scavenged	yes[1]
09/02/2022	unidentified passerine	49	245	carcass search	full plot	feather spot	yes[1]
09/06/2022	European starling	19	239	carcass search	road and pad	intact	no
09/06/2022	horned lark	30	224	carcass search	full plot	scavenged	yes[1]
09/06/2022	horned lark	12	224	carcass search	full plot	scavenged	yes[1]

Appendix A. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Aided Search
09/06/2022	turkey vulture	51	224	carcass search	full plot	scavenged	yes[1]
09/06/2022	unidentified passerine	44	216	carcass search	full plot	scavenged	yes[1]
09/06/2022	unidentified passerine	43	224	carcass search	full plot	scavenged	yes[1]
09/13/2022	American kestrel	56	224	carcass search	full plot	dismembered	yes[1]
09/13/2022	horned lark	43	224	carcass search	full plot	scavenged	yes[1]
09/15/2022	turkey vulture	80	240	carcass search	full plot	scavenged	yes[1]
09/16/2022	horned lark	35	244	carcass search	full plot	intact	yes[1]
09/19/2022	turkey vulture	78	211	carcass search	full plot	scavenged	yes[1]
09/20/2022	American redstart	109	247	incidental[2]	road and pad	scavenged	no
09/29/2022	turkey vulture	29	234	carcass search	full plot	intact	yes[1]
10/03/2022	blue jay	24	205	carcass search	full plot	intact	yes[1]
10/03/2022	golden-crowned kinglet	64	205	carcass search	full plot	scavenged	yes[1]
10/03/2022	golden-crowned kinglet	50	208	carcass search	road and pad	intact	no
10/04/2022	downy woodpecker	15	225	carcass search	full plot	intact	yes[1]
10/04/2022	golden-crowned kinglet	7	235	carcass search	road and pad	intact	no
10/04/2022	sedge wren	3	235	carcass search	road and pad	scavenged	no
10/07/2022	horned lark	33	231	carcass search	full plot	scavenged	yes[1]
10/10/2022	golden-crowned kinglet	59	201	carcass search	road and pad	scavenged	no
10/10/2022	golden-crowned kinglet	79	204	carcass search	full plot	scavenged	yes[1]
10/11/2022	European starling	17	233	carcass search	full plot	intact	yes[1]
10/11/2022	sedge wren	47	214	carcass search	full plot	scavenged	yes[1]
10/11/2022	turkey vulture	14	236	carcass search	road and pad	scavenged	no

[1]. Dog-aided search.

[2]. Carcass was found outside the search area.

[3]. Carcasses found under TAL curtailment regime were excluded from ITP analysis.

Appendix B. Searcher Efficiency and Carcass Persistence Model Fitting Results.

Appendix B1. Searcher efficiency results by searcher type at the Headwaters II Wind Farm, Randolph County, Indiana from March 15 – October 15, 2022.

Season	Searcher Type	# Placed	# Available	# Found	% Found
Spring	Technician	17	16	14	87.5
Summer	Technician	34	31	28	90.3
	Dog-aided	18	16	13	81.3
Fall	Technician	24	17	12	70.6
	Dog-aided	34	29	22	75.9
Overall	Technician	75	64	54	84.4
Overall	Dog-aided	52	45	35	77.8
Total		**127**	**109**	**89**	**81.7**

Appendix B2. Searcher efficiency models for dog-aided searches (full plots) at the Headwaters II Wind Farm, Randolph County, Indiana from March 15, 2022 to October 15, 2022 (n=45).

Covariates	k Value	AICc	Delta AICc
No Covariates	0.67	49.77	0[1]
Season	0.67	2.01	2.01

[1] Selected model.

AICc = Corrected Akaike Information Criterion.

Delta AICc = Change in AICc.

Appendix B3. Searcher efficiency models for technician searched plots at the Headwaters II Wind Farm, Randolph County, Indiana from March 15, 2022 to October 15, 2022 (n = 64).

Covariates	k Value	AICc	Delta AICc
No Covariates	0.67	57.54	0.77[1]
Season	0.67	58.77	2.00
Season + Plot Search Type	0.67	56.77	0
Plot Search Type	0.67	59.52	2.75

[1]. Selected model.

AICc = Corrected Akaike Information Criterion.

Delta AICc = Change in AICc.

Appendix B4. Carcass persistence models with covariates and distributions for bats at dog-aided search plots (full plots) at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15, 2022 to October 15, 2022 (n = 45).

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
Season	No Covariates	loglogistic	187.83	0
Season	No Covariates	lognormal	187.99	0.16
No Covariates	No Covariates	lognormal	188.87	1.04[1]
No Covariates	No Covariates	loglogistic	189.03	1.20
Season	Season	loglogistic	190.16	2.33
Season	Season	lognormal	190.32	2.49
Season	No Covariates	Weibull	190.56	2.73
No Covariates	Season	lognormal	191.14	3.31
No Covariates	Season	loglogistic	191.22	3.39
No Covariates	No Covariates	Weibull	191.53	3.70
Season	Season	Weibull	192.90	5.07
No Covariates	Season	Weibull	193.62	5.79
Season	-	exponential	206.65	18.82
No Covariates	-	exponential	209.96	22.13

[1] Selected model.

AICc = Corrected Akaike Information Criterion.

Delta AICc = Change in AICc.

Appendix B5. Carcass persistence models with covariates and distributions for bats at technician searched plots at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15, 2022 to October 15, 2022 (n = 45).

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
PlotSearchType	No Covariates	loglogistic	267.39	0
No Covariates	PlotSearchType	loglogistic	267.68	0.29
PlotSearchType	PlotSearchType	loglogistic	267.85	0.46
No Covariates	No Covariates	loglogistic	267.96	0.57[1]
PlotSearchType	No Covariates	lognormal	268.00	0.61
No Covariates	No Covariates	lognormal	268.33	0.94
No Covariates	PlotSearchType	lognormal	268.45	1.06
PlotSearchType	PlotSearchType	lognormal	268.60	1.21
PlotSearchType	No Covariates	Weibull	268.79	1.40
Season	No Covariates	loglogistic	270.29	2.90
PlotSearchType	PlotSearchType	Weibull	270.51	3.12
Season + PlotSearchType	No Covariates	loglogistic	270.68	3.29
No Covariates	No Covariates	Weibull	270.76	3.37

Appendix B5. Carcass persistence models with covariates and distributions for bats at technician searched plots at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15, 2022 to October 15, 2022 (n = 45).

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
Season	No Covariates	lognormal	270.98	3.59
Season + PlotSearchType	PlotSearchType	loglogistic	271.08	3.69
Season + PlotSearchType	No Covariates	lognormal	271.36	3.97
No Covariates	Season	loglogistic	271.61	4.22
No Covariates	PlotSearchType	Weibull	271.64	4.25
No Covariates	Season	lognormal	271.87	4.48
Season + PlotSearchType	PlotSearchType	lognormal	271.93	4.54
No Covariates	Season + PlotSearchType	loglogistic	272.30	4.91
Season + PlotSearchType	No Covariates	Weibull	272.33	4.94
PlotSearchType	Season + PlotSearchType	loglogistic	272.69	5.30
No Covariates	Season + PlotSearchType	lognormal	272.99	5.60
Season	No Covariates	Weibull	273.11	5.72
PlotSearchType	Season + PlotSearchType	lognormal	273.40	6.01
Season	Season	loglogistic	274.04	6.65
Season + PlotSearchType	PlotSearchType	Weibull	274.17	6.78
Season	Season	lognormal	274.64	7.25
No Covariates	Season	Weibull	274.67	7.28
Season + PlotSearchType	Season	loglogistic	274.88	7.49
PlotSearchType	Season + PlotSearchType	Weibull	275.20	7.81
Season	Season + PlotSearchType	loglogistic	275.35	7.96
Season + PlotSearchType	Season	lognormal	275.46	8.07
PlotSearchType	-	exponential	275.75	8.36
No Covariates	Season + PlotSearchType	Weibull	276.02	8.63
Season + PlotSearchType	Season + PlotSearchType	loglogistic	276.30	8.91
Season	Season + PlotSearchType	lognormal	276.33	8.94
Season + PlotSearchType	Season	Weibull	277.02	9.63
Season + PlotSearchType	Season + PlotSearchType	lognormal	277.09	9.70
Season	Season	Weibull	277.44	10.05
Season + PlotSearchType	-	exponential	278.62	11.23
Season + PlotSearchType	Season + PlotSearchType	Weibull	279.13	11.74
Season	Season + PlotSearchType	Weibull	279.48	12.09
No Covariates	-	exponential	279.61	12.22
Season	-	exponential	280.85	13.46

[1] Selected model.

AICc = Corrected Akaike Information Criterion.

Delta AICc = Change in AICc.

Appendix B6. Carcass persistence top models with covariates, distributions, and model parameters for dog-aided and technician search types at the Headwaters II Wind Farm, Randolph County, Indiana, from March 15 – October 15, 2022.

Search Type	Distribution	Estimated Median Removal Time (days)	Parameter 1	Parameter 2
Dog-aided	lognormal[1]	9.45	meanlog = 1.63	sdlog = 2.592
Technician	loglogistic[2]	7.28	shape = 1.041	scale = 1.985

[1] Parameterization follows the base R parameterization for this distribution.

[2] Parameterization follows the FAdist parameterization for this distribution.

Appendix C. Truncated Weighted Likelihood (TWL) Area Adjustment Model Fitting Results.

Appendix C1. Number and percent (%) of bat carcasses found and total included in the area adjustment calculation for the Headwaters II Wind Farm, Randolph County, Indiana, from May 3 – October 15, 2022.

Species	Included in Area Adjustment Total	%	Found Prior to ITP (May 3)[1*]	%	Outside Search Area[1] Total	%	Outside Study Period[1] Total	%	Total Total	%
eastern red bat	135	38.68	1	25	5	83.3	11	47.83	151	39.53
silver-haired bat	89	25.50	2	50[2]	0	0	1	4.35	93	24.35
big brown bat	78	22.35	0	0	1	16.6	8	34.78	87	22.77
hoary bat	36	10.32	1	25	0	0	2	8.70	39	10.21
Indiana bat	4	1.15	0	0	0	0	0	0	4	1.05
evening bat	3	0.83	0	0	0	0	0	0	3	0.79
unidentified bat	2	0.57	0	0	0	0	1	4.35	3	0.79
unidentified *Lasiurus* spp.	2	0.57	0	0	0	0	0	0	2	0.52
Total	**349**	**100**	**3**	**100**	**6**	**100**	**23**	**100**	**382**	**100**

[1] Carcasses not included in analysis.

[2] Four total carcass were found prior to May 3. However, a carcass being found outside of the plot is given a higher priority in analysis. Therefore, one silver-haired bat was analyzed as being "Outside Search Area", rather than under the "Found Prior to ITP" column.

ITP = Incidental Take Permit.

Appendix C2. Search area adjustment models for bats found at 3.6-MW turbines at the Headwaters II Wind Farm, Randolph County, Indiana, from May 3 – October 15, 2022.

Distribution	AICc	Delta AICc
normal	1,860.68	0[1]
Gompertz	1,862.86	2.17
Weibull	1,870.85	10.16
gamma	1,891.92	31.24

[1] Selected model.

Appendix C3. Search area adjustment models for bats found at 4.2-MW turbines at the Headwaters II Wind Farm, Randolph County, Indiana, from May 3 – October 15, 2022.

Distribution	AICc	Delta AICc
Gompertz	8,788.92	0[1]
normal	8,879.48	90.57
Weibull	8,932.10	143.18
gamma	8,972.14	183.22

[1] Selected model.

Appendix C4. Truncated weighted maximum likelihood search area adjustment estimates for the Headwaters II Wind Farm, Randolph County, Indiana, from May 3, 2022 to October 15, 2022 (Bat n = 119, 3.6-MW turbines; Bat n = 230, 4.2-MW turbines).

Size Class	Search Area Type	Distribution	Parameter 1	Parameter 2	Area Adjustment
Bat	full plot 3.6 MW	normal	31.3800	18.1748	1.00
	road and pad 3.6 MW	normal	31.3800	18.1748	0.17
	full plot 4.2 MW	Gompertz	0.0443	0.0443	0.94
	road and pad 4.2 MW	Gompertz	0.0443	0.0443	0.10

* All plots were searched as road and pad plots in the spring.

Appendix D. Inputs for Single Class and Multiple Class Modules in Evidence of Absence.

Appendix D1. Inputs needed to run Evidence of Absence: Single Class Module for the Headwaters II Wind Farm for 3.6 and 4.2-MW turbines, Randolph County, Indiana, from May 3 – October 15, 2022[1]

Season	Turbine Size (MW)	Plot Type[4]	Aided Search	Search Interval (I)	# of Searches	Spatial Coverage(a)	Searcher Efficiency		Carcass Persistence[2]	
							Carcasses Available	Carcasses Found	Shape (α)	Scale (β)
spring	3.6	road/pad	none	14	2	0.17	29	25	0.96	7.28
spring	4.2	road/pad	none	14	2	0.1	29	25	0.96	7.28
summer	3.6	full plot	dog[3]	7	12	1	24	19	5.63	2.25
summer	3.6	full plot	none	7	12	1	29	25	0.96	7.28
summer	4.2	full plot	dog[3]	7	12	0.94	24	19	5.63	2.25
summer	4.2	full plot	none	7	12	0.94	29	25	0.96	7.28
summer	3.6	road/pad	none	7	12	0.17	29	25	0.96	7.28
summer	4.2	road/pad	none	7	12	0.1	29	25	0.96	7.28
fall	3.6	full plot	dog[3]	7	12	1	24	19	5.63	2.25
fall	4.2	full plot	dog[3]	7	12	0.94	24	19	5.63	2.25
fall	3.6	road/pad	none	7	12	0.17	29	25	0.96	7.28
fall	4.2	road/pad	none	7	12	0.1	29	25	0.96	7.28

[1] k was assumed to equal 0.67 for all strata, per Huso et al. (2017).

[2] A log-logistic distribution was used for carcass persistence on technician-searched 100-m road and pad plots and 80-m full plots. The 95% upper and lower confidence intervals on β for dog-aided searches were set to 4.6, 11.54.

[3] A lognormal distribution was used for carcass persistence on all dog-aided full plot searches. The 95% upper and lower confidence intervals on β for dog-aided searches were set to 1.49, 3.

[4] Carcass persistence, searcher efficiency, search effort, and the proportion of area searched was not significantly different between cleared and uncleared plots. To simplify the EoA analysis, cleared and uncleared plots were grouped into one full plot stratum.

m = meter; MW = megawatt.

Appendix D2. Inputs needed to run Evidence of Absence model to combine across plot types within each season: Multiple Class Module for the Headwaters II Wind Farm, Randolph County, Indiana, from May 3 – October 15, 2022.

Season	Plot Type	Ba	Bb	Within-Season Sampling Fraction
spring	road and pad	119.39	1266.55	0.27
spring	road and pad	120.56	2693.51	0.73
summer	full plot	34.86	22.74	0.07
summer	full plot	51.99	31.22	0.07
summer	full plot	40.15	30.46	0.14
summer	full plot	63.94	43.88	0.21
summer	road and pad	136.53	1,117.18	0.10
summer	road and pad	127.95	1,875.4	0.41
fall	full plot	38.15	25.05	0.18
fall	full plot	40.62	30.54	0.29
fall	road and pad	126.06	1,035.45	0.08
fall	road and pad	128.16	1,872.08	0.43
Fall[1]	unsearched	0.10	1,000.00	0.02

m = meter.

[1]. Turbine 241 was down for maintenance throughout the entire fall season and was unable to be searched.

[2]. Carcass persistence, searcher efficiency, search effort, and the proportion of area searched was not significantly different between cleared and uncleared plots. To simplify the EoA analysis, cleared and uncleared plots were grouped into one full plot stratum.

Appendix D3. Inputs needed to run Evidence of Absence model to combine across seasons: Multiple Class Module for the Headwaters II Wind Farm, Randolph County, Indiana, from May 3 – October 15, 2022.

Season	Ba	Bb	Weights (DWP)
Spring (May 3–May 15)	247.59	4570.05	0.020
Summer (May 16–July 31)	359.28	769.36	0.268
Fall (August 1-October 15)	160.77	356.46	0.712

DWP = Density-weighted proportion.

Appendix D4. Inputs needed to run Evidence of Absence model to combine across years: Multiple Years Module for the Headwaters II Wind Farm in Randolph County, Indiana, for May 3 – October 15, 2022.

Year	Ba	Bb	Weights (ρ)[1]
2022 (Full Year)	293.12	660.06	0.92
2022 (Summer Only)	359.28	769.36	0.94

[1]. Weights (ρ) are different between the full year and summer only periods due to different proportional turbine downtime during each time period, and due to only a portion of the full year risk being observed because of the ITP monitoring starting well into the spring risk period.

Appendix E. Screenshots of Inputs for Single Class and Multiple Class Modules in Evidence of Absence.

EoA, v2.0.7 - Single Class Module
Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): 2022-04-02

(•) Formula
Search interval (I): 14
Number of searches: 2

( ) Custom   Edit/View
span = 182, I (mean) = 7

Spatial coverage (a): 0.17
Temporal coverage (v): 1

Estimate g

Searcher Efficiency

( ) Carcasses available for several searches
95% CIs: p ∈ [0.532, 0.679], k ∈ [0.654, 0.817]
p̂ = 0.62, k̂ = 0.736   View   Edit

(•) Carcasses removed after one search
Carcasses available: 29
Carcasses found: 25
p̂ = 0.862, with 95% CI = [0.705, 0.952]
Factor by which searcher efficiency changes with each search (k): 0.67

Persistence Distribution

( ) Use field trials to estimate parameters   View/Edit
Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171
r = 0.407 for lr = 14, with 95% CIs: r = [0.293, 0.526], β = [0.488, 1.854]

(•) Enter parameter estimates manually   View

Exponential
Weibull
Log-Logistic
Lognormal

Parameters
shape (α): 0.96
scale (β): 7.28   lwr 4.6   upr 11.54
r = 0.557 for lr = 14, with 95% CI: r ∈ [0.461, 0.651]

Fatality estimation (M, λ)

Carcass Count (X): 0   Estimate M
Credibility level (1 - α): 0.9   Estimate λ

(•) One-sided CI (M*)   ( ) Two-sided CI

Close

R Estimated detection probability (g)

```
Summary statistics for estimation of detection probability (g)
================================================================
Results:

Full site for full year
   Estimated g = 0.083, 95% CI = [0.0662, 0.101]
   Fitted beta distribution parameters for estimated g: Ba = 77.833, Bb = 859.9139


Full site for monitored period, 02-Apr-2022 through 14-May-2022
   Estimated g = 0.083, 95% CI = [0.0662, 0.101]
   Fitted beta distribution parameters for estimated g: Ba = 77.833, Bb = 859.9139
   Temporal coverage (within year) = 1


Searched area for monitored period, 02-Apr-2022 through 14-May-2022
   Estimated g = 0.488, 95% CI = [0.386, 0.591]
   Fitted beta distribution parameters for estimated g: Ba = 43.7392, Bb = 45.849

================================================================
Input:
Search parameters
   trial carcasses placed = 29, carcasses found = 25
   estimated searcher efficiency: p = 0.862, 95% CI = [0.705, 0.952]
   k = 0.67
   Search schedule: Search interval (I) = 14, number of searches = 3, span = 42
     spatial coverage: 0.17    temporal coverage: 1


Carcass persistence:
   Log-Logistic persistence distribution
     shape (α) = 0.96 and scale (β) = 7.28
     95% CI β = [4.6, 11.54]
     r = 0.557 for lr = 14 with 95% CI = [0.461, 0.651]
     Parameters entered manually
   Uniform arrivals
```

Appendix E1. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Spring 2022, 100-meter road and pad searches at 13, 3.6 megawatt turbines with a blade length of 67 meters, searched at a 14-day interval.

* There is a recently discovered bug in the EoA software that occurs when a single-class stratum has two searches and a log-logistic carcass persistence distribution. This error is caused by a 1 x n matrix representing the persistence distribution being incorrectly converted into an n x 1 vector when the distribution is log-logistic. The n x 1 vector is incorrectly shaped for subsequent calculations within the function, and the GUI cannot complete the calculation. We fixed this bug by editing the source code of the GUI to convert the vector back to a 1 x n matrix and running the analysis in the console in R, but it has yet to be addressed in the GUI itself. This screenshot includes the inputs and outputs with three searches instead of two.

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): 2022-04-02

(•) Formula
- Search interval (I): 14
- Number of searches: 2

( ) Custom   Edit/View

span = 182, I (mean) = 7

Spatial coverage (a): 0.1
Temporal coverage (v): 1

[Estimate g]

Searcher Efficiency

( ) Carcasses available for several searches

95% CIs: p ∈ [0.532, 0.679], k ∈ [0.654, 0.817]

$\hat{p}$ = 0.62, $\hat{k}$ = 0.736   [View] [Edit]

(•) Carcasses removed after one search
- Carcasses available: 29
- Carcasses found: 25

$\hat{p}$ = 0.862, with 95% CI = [0.705, 0.952]

Factor by which searcher efficiency changes with each search (k): 0.67

Persistence Distribution

( ) Use field trials to estimate parameters   [View/Edit]

Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171

r = 0.407 for lr = 14, with 95% CIs: r = [0.293, 0.526], β = [0.488, 1.854]

(•) Enter parameter estimates manually   [View]

Exponential
Weibull
Log-Logistic
Lognormal

Parameters
- shape (α): 0.96
- scale (β): 7.28   lwr 4.6   upr 11.54

r = 0.557 for lr = 14, with 95% CI: r ∈ [0.461, 0.651]

Fatality estimation (M, λ)

Carcass Count (X): 0   [Estimate M]

Credibility level (1 - α): 0.9   [Estimate λ]

(•) One-sided CI (M*)   ( ) Two-sided CI

[Close]

Estimated detection probability (g)

```
Summary statistics for estimation of detection probability (g)
==============================================================================
Results:

Full site for full year
   Estimated g = 0.0489, 95% CI = [0.0388, 0.06]
   Fitted beta distribution parameters for estimated g: Ba = 77.1151, Bb = 1500.9472


Full site for monitored period, 02-Apr-2022 through 14-May-2022
   Estimated g = 0.0489, 95% CI = [0.0388, 0.06]
   Fitted beta distribution parameters for estimated g: Ba = 77.1151, Bb = 1500.9472
   Temporal coverage (within year) = 1


Searched area for monitored period, 02-Apr-2022 through 14-May-2022
   Estimated g = 0.489, 95% CI = [0.384, 0.594]
   Fitted beta distribution parameters for estimated g: Ba = 41.6736, Bb = 43.6069


==============================================================================
Input:
Search parameters
   trial carcasses placed = 29, carcasses found = 25
   estimated searcher efficiency: p = 0.862, 95% CI = [0.705, 0.952]
   k = 0.67
   Search schedule: Search interval (I) = 14, number of searches = 3, span = 42
     spatial coverage: 0.1    temporal coverage: 1
_____
Carcass persistence:
   Log-Logistic persistence distribution
     shape (α) = 0.96 and scale (β) = 7.28
     95% CI β = [4.6, 11.54]
     r = 0.557 for Ir = 14 with 95% CI = [0.461, 0.651]
     Parameters entered manually
   Uniform arrivals
_____
```

Appendix E2. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Spring 2022, 100-meter road and pad searches at 36, 4.2 megawatt turbines with a blade length of 74 meters, searched at a 14-day interval.

Appendix E3. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer 2022, 80-meter full plot, dog-aided searches at two, 3.6 megawatt turbines with a blade length of 67 meters, searched at a 7-day interval

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): `2022-05-15`

○ Formula
  Search interval (I): `7`
  Number of searches: `12`

○ Custom [Edit/View]
  span = 182, I (mean) = 7

Spatial coverage (a): `0.94`
Temporal coverage (v): `1`

[Estimate g]

Searcher Efficiency

○ Carcasses available for several searches
  95% CIs: p ∈ [0.529, 0.682], k ∈ [0.65, 0.815]
  $\hat{p}$ = 0.62, $\hat{k}$ = 0.735 [View] [Edit]

● Carcasses removed after one search
  Carcasses available: `24`
  Carcasses found: `19`
  $\hat{p}$ = 0.792, with 95% CI = [0.602, 0.916]
  Factor by which searcher efficiency changes with each search (k): `0.67`

Persistence Distribution

○ Use field trials to estimate parameters [View/Edit]
  Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171
  r = 0.531 for Ir = 7, with 95% CIs: r = [0.413, 0.653], β = [0.488, 1.854]

● Enter parameter estimates manually [View]

Exponential		Parameters		
Weibull		shape (α)	`5.63`	
Log-Logistic		scale (β)	`2.25` lwr `1.49` upr `3.00`
Lognormal			

r = 0.691 for Ir = 7, with 95% CI: r ∈ [0.578, 0.788]

Fatality estimation (M, λ)

Carcass Count (X): `0` [Estimate M]   ● One-sided CI (M*)   ○ Two-sided CI
Credibility level (1 - α): `0.9` [Estimate λ]

[Close]

R Estimated detection probability (g)

```
Summary statistics for estimation of detection probability (g)
================================================================
Results:

Full site for full year
   Estimated g = 0.57, 95% CI = [0.455, 0.682]
   Fitted beta distribution parameters for estimated g: Ba = 40.9248, Bb = 30.8693


Full site for monitored period, 15-May-2022 through 07-Aug-2022
   Estimated g = 0.57, 95% CI = [0.455, 0.682]
   Fitted beta distribution parameters for estimated g: Ba = 40.9248, Bb = 30.8693
   Temporal coverage (within year) = 1


Searched area for monitored period, 15-May-2022 through 07-Aug-2022
   Estimated g = 0.606, 95% CI = [0.483, 0.724]
   Fitted beta distribution parameters for estimated g: Ba = 37.3775, Bb = 24.258


================================================================
Input:
Search parameters
   trial carcasses placed = 24, carcasses found = 19
   estimated searcher efficiency: p = 0.792, 95% CI = [0.602, 0.916]
   k = 0.67
   Search schedule: Search interval (I) = 7, number of searches = 12, span = 84
     spatial coverage: 0.94    temporal coverage: 1
_____
Carcass persistence:
   Lognormal persistence distribution
     shape (α) = 5.63 and scale (β) = 2.25
     95% CI β = [1.49, 3]
     r = 0.691 for Ir = 7 with 95% CI = [0.578, 0.788]
   Parameters entered manually
   Uniform arrivals
_____
```

Appendix E4. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer 2022, 80-meter full plot, dog-aided searches at four, 4.2 megawatt turbines with a blade length of 74 meters, searched at a 7-day interval.

Appendix E5. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer 2022, 80-meter full plot technician searches at two, 3.6 megawatt turbines with a blade length of 67 meters, searched at a 7-day interval.

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): 2022-05-15

○ Formula

Search interval (I): 7
Number of searches: 12

○ Custom   Edit/View

span = 182, I (mean) = 7

Spatial coverage (a): 0.94
Temporal coverage (v): 1

Searcher Efficiency

○ Carcasses available for several searches

95% CIs: p ∈ [0.529, 0.682], k ∈ [0.65, 0.815]
$\hat{p}$ = 0.62, $\hat{k}$ = 0.735   View   Edit

● Carcasses removed after one search

Carcasses available: 29
Carcasses found: 25

$\hat{p}$ = 0.862, with 95% CI = [0.705, 0.952]

Factor by which searcher efficiency changes with each search (k): 0.67

Persistence Distribution

○ Use field trials to estimate parameters   View/Edit

Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171
r = 0.531 for Ir = 7, with 95% CIs: r = [0.413, 0.653], β = [0.488, 1.854]

● Enter parameter estimates manually   View

Exponential
Weibull
Log-Logistic
Lognormal

Parameters

shape (α): 0.96
scale (β): 7.28   lwr: 4.6   upr: 11.54
r = 0.695 for Ir = 7, with 95% CI: r ∈ [0.605, 0.774]

Estimate g

Fatality estimation (M, λ)

Carcass Count (X): 0   Estimate M   ● One-sided CI (M*)   ○ Two-sided CI
Credibility level (1 - α): 0.9   Estimate λ

Close

Estimated detection probability (g)

```
Summary statistics for estimation of detection probability (g)
==============================================================================
Results:

Full site for full year
    Estimated g = 0.595, 95% CI = [0.496, 0.69]
    Fitted beta distribution parameters for estimated g: Ba = 57.9927, Bb = 39.4671


Full site for monitored period, 15-May-2022 through 07-Aug-2022
    Estimated g = 0.595, 95% CI = [0.496, 0.69]
    Fitted beta distribution parameters for estimated g: Ba = 57.9927, Bb = 39.4671
    Temporal coverage (within year) = 1


Searched area for monitored period, 15-May-2022 through 07-Aug-2022
    Estimated g = 0.633, 95% CI = [0.527, 0.733]
    Fitted beta distribution parameters for estimated g: Ba = 52.537, Bb = 30.4565


==============================================================================
Input:
Search parameters
    trial carcasses placed = 29, carcasses found = 25
    estimated searcher efficiency: p = 0.862, 95% CI = [0.705, 0.952]
    k = 0.67
    Search schedule: Search interval (I) = 7, number of searches = 12, span = 84
      spatial coverage: 0.94    temporal coverage: 1

Carcass persistence:
  Log-Logistic persistence distribution
    shape (α) = 0.96 and scale (β) = 7.28
    95% CI β = [4.6, 11.54]
    r = 0.695 for Ir = 7 with 95% CI = [0.605, 0.774]
    Parameters entered manually
  Uniform arrivals
```

Appendix E6. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer 2022, 80-meter full plot technician searches at six, 4.2 megawatt turbines with a blade length of 74 meters, searched at a 7-day interval.

EoA, v2.0.7 - Single Class Module — □ ✕

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd)   `2022-05-15`

⦿ Formula

Search interval (I)   `7`
Number of searches   `12`

○ Custom   Edit/View

span = 182, I (mean) = 7

Spatial coverage (a)   `0.17`
Temporal coverage (v)   `1`

[Estimate g]

Searcher Efficiency

○ Carcasses available for several searches

95% CIs: p ∈ [0.529, 0.682], k ∈ [0.65, 0.815]
p̂ = 0.62, k̂ = 0.735   [View] [Edit]

⦿ Carcasses removed after one search

Carcasses available   `29`
Carcasses found   `25`

p̂ = 0.862, with 95% CI = [0.705, 0.952]

Factor by which searcher efficiency changes with each search (k)   `0.67`

Persistence Distribution

○ Use field trials to estimate parameters   [View/Edit]

Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171
r = 0.531 for Ir = 7, with 95% CIs: r = [0.413, 0.653], β = [0.488, 1.854]

⦿ Enter parameter estimates manually   [View]

Exponential
Weibull
Log-Logistic
Lognormal

Parameters
shape (α)   `0.96`
scale (β)   `7.28` lwr   `4.6` upr   `11.54`
r = 0.695 for Ir = 7, with 95% CI: r ∈ [0.605, 0.774]

Fatality estimation (M, λ)

Carcass Count (X)   `0`   [Estimate M]   ⦿ One-sided CI (M*)   ○ Two-sided CI   [Close]
Credibility level (1 - α)   `0.9`   [Estimate λ]

R Estimated detection probability (g)   — ☐ ✕

```
Summary statistics for estimation of detection probability (g)
================================================================================
Results:

Full site for full year
    Estimated g = 0.107, 95% CI = [0.0906, 0.125]
    Fitted beta distribution parameters for estimated g: Ba = 132.3182, Bb = 1101.7583


Full site for monitored period, 15-May-2022 through 07-Aug-2022
    Estimated g = 0.107, 95% CI = [0.0906, 0.125]
    Fitted beta distribution parameters for estimated g: Ba = 132.3182, Bb = 1101.7583
    Temporal coverage (within year) = 1


Searched area for monitored period, 15-May-2022 through 07-Aug-2022
    Estimated g = 0.631, 95% CI = [0.527, 0.728]
    Fitted beta distribution parameters for estimated g: Ba = 54.9414, Bb = 32.1693


================================================================================
Input:
Search parameters
    trial carcasses placed = 29, carcasses found = 25
    estimated searcher efficiency: p = 0.862, 95% CI = [0.705, 0.952]
    k = 0.67
    Search schedule: Search interval (I) = 7, number of searches = 12, span = 84
      spatial coverage: 0.17    temporal coverage: 1

Carcass persistence:
  Log-Logistic persistence distribution
    shape (α) = 0.96 and scale (β) = 7.28
    95% CI β = [4.6, 11.54]
    r = 0.695 for Ir = 7 with 95% CI = [0.605, 0.774]
    Parameters entered manually
  Uniform arrivals
```

Appendix E7. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer 2022, 100-meter road and pad technician searches at three, 3.6 megawatt turbines with a blade length of 67 meters, searched at a 7-day interval.

Appendix E8. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer 2022, 100-meter road and pad technician searches at 12, 4.2 megawatt turbines with a blade length of 74 meters, searched at a 7-day interval.

Appendix E9. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Fall 2022, 100-meter road and pad technician searches at four, 3.6 megawatt turbines with a blade length of 67 meters, searched at a 7-day interval.

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): `2022-08-01`

◉ Formula
  Search interval (I): `7`
  Number of searches: `12`

○ Custom   [Edit/View]
  span = 182, I (mean) = 7

Spatial coverage (a): `0.10`
Temporal coverage (v): `1`

[Estimate g]

Searcher Efficiency

○ Carcasses available for several searches
  95% CIs: p ∈ [0.529, 0.682], k ∈ [0.65, 0.815]
  $\hat{p}$ = 0.62, $\hat{k}$ = 0.735   [View]   [Edit]

◉ Carcasses removed after one search
  Carcasses available: `29`
  Carcasses found: `25`
  $\hat{p}$ = 0.862, with 95% CI = [0.705, 0.952]
  Factor by which searcher efficiency changes with each search (k): `0.67`

Persistence Distribution

○ Use field trials to estimate parameters   [View/Edit]
  Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171
  r = 0.531 for lr = 7, with 95% CIs: r = [0.413, 0.653], β = [0.488, 1.854]

◉ Enter parameter estimates manually   [View]

Exponential
Weibull
Log-Logistic
Lognormal

Parameters
  shape (α): `0.96`
  scale (β): `7.28` lwr `4.6` upr `11.54`
  r = 0.695 for lr = 7, with 95% CI: r ∈ [0.605, 0.774]

Fatality estimation (M, λ)

Carcass Count (X): `0`   [Estimate M]   ◉ One-sided CI (M*)   ○ Two-sided CI   [Close]
Credibility level (1 - α): `0.9`   [Estimate λ]

R Estimated detection probability (g)

```
Summary statistics for estimation of detection probability (g)
==================================================================================
Results:

Full site for full year
   Estimated g = 0.0633, 95% CI = [0.0532, 0.0741]
   Fitted beta distribution parameters for estimated g: Ba = 131.7696, Bb = 1950.5419


Full site for monitored period, 01-Aug-2022 through 24-Oct-2022
   Estimated g = 0.0633, 95% CI = [0.0532, 0.0741]
   Fitted beta distribution parameters for estimated g: Ba = 131.7696, Bb = 1950.5419
   Temporal coverage (within year) = 1


Searched area for monitored period, 01-Aug-2022 through 24-Oct-2022
   Estimated g = 0.633, 95% CI = [0.527, 0.733]
   Fitted beta distribution parameters for estimated g: Ba = 52.1023, Bb = 30.2347


==================================================================================
Input:
Search parameters
   trial carcasses placed = 29, carcasses found = 25
   estimated searcher efficiency: p = 0.862, 95% CI = [0.705, 0.952]
   k = 0.67
   Search schedule: Search interval (I) = 7, number of searches = 12, span = 84
     spatial coverage: 0.10    temporal coverage: 1
_____
Carcass persistence:
  Log-Logistic persistence distribution
     shape (α) = 0.96 and scale (β) = 7.28
     95% CI β = [4.6, 11.54]
     r = 0.695 for Ir = 7 with 95% CI = [0.605, 0.774]
     Parameters entered manually
  Uniform arrivals
_____
```

Appendix E10. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Fall 2022, 100-meter road and pad technician searches at 21, 4.2 megawatt turbines with a blade length of 74 meters, searched at a 7-day interval.

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd) `2022-08-01`

⦿ Formula
Search interval (I) `7`
Number of searches `12`

○ Custom Edit/View
span = 182, I (mean) = 7

Spatial coverage (a) `1`
Temporal coverage (v) `1`

Estimate g

Searcher Efficiency

○ Carcasses available for several searches
95% CIs: p ∈ [0.529, 0.682], k ∈ [0.65, 0.815]
$\hat{p}$ = 0.62, $\hat{k}$ = 0.735   View   Edit

⦿ Carcasses removed after one search
Carcasses available `24`
Carcasses found `19`
$\hat{p}$ = 0.792, with 95% CI = [0.602, 0.916]
Factor by which searcher efficiency changes with each search (k) `0.67`

Persistence Distribution

○ Use field trials to estimate parameters   View/Edit
Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171
r = 0.531 for Ir = 7, with 95% CIs: r = [0.413, 0.653], β = [0.488, 1.854]

⦿ Enter parameter estimates manually   View

Exponential
Weibull
Log-Logistic
Lognormal

Parameters
shape (α) `5.63`
scale (β) `2.25` lwr `1.49` upr `3.00`
r = 0.691 for Ir = 7, with 95% CI: r ∈ [0.578, 0.788]

Fatality estimation (M, λ)

Carcass Count (X) `0`   Estimate M   ⦿ One-sided CI (M*)   ○ Two-sided CI
Credibility level (1 - α) `0.9`   Estimate λ

Close

Estimated detection probability (g)

```
Summary statistics for estimation of detection probability (g)
===============================================================
Results:

Full site for full year
    Estimated g = 0.606, 95% CI = [0.482, 0.724]
    Fitted beta distribution parameters for estimated g: Ba = 37.2181, Bb = 24.1742


Full site for monitored period, 01-Aug-2022 through 24-Oct-2022
    Estimated g = 0.606, 95% CI = [0.482, 0.724]
    Fitted beta distribution parameters for estimated g: Ba = 37.2181, Bb = 24.1742
    Temporal coverage (within year) = 1


Searched area for monitored period, 01-Aug-2022 through 24-Oct-2022
    Estimated g = 0.606, 95% CI = [0.482, 0.724]
    Fitted beta distribution parameters for estimated g: Ba = 37.2181, Bb = 24.1742


===============================================================
Input:
Search parameters
    trial carcasses placed = 24, carcasses found = 19
    estimated searcher efficiency: p = 0.792, 95% CI = [0.602, 0.916]
    k = 0.67
    Search schedule: Search interval (I) = 7, number of searches = 12, span = 84
      spatial coverage: 1    temporal coverage: 1
_____
Carcass persistence:
    Lognormal persistence distribution
      shape (α) = 5.63 and scale (β) = 2.25
      95% CI β = [1.49, 3]
      r = 0.691 for Ir = 7 with 95% CI = [0.578, 0.788]
    Parameters entered manually
    Uniform arrivals
_____
```

Appendix E11. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Fall 2022, 80-meter, dog-aided full plot searches at nine, 3.6 megawatt turbines with a blade length of 67 meters, searched at a 7-day interval.

EoA, v2.0.7 - Single Class Module

Edit Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): 2022-08-01

◉ Formula
- Search interval (I): 7
- Number of searches: 12

○ Custom Edit/View
span = 182, I (mean) = 7

Spatial coverage (a): 0.94
Temporal coverage (v): 1

[Estimate g]

Searcher Efficiency

○ Carcasses available for several searches
95% CIs: p ∈ [0.529, 0.682], k ∈ [0.65, 0.815]
$\hat{p}$ = 0.62, $\hat{k}$ = 0.735 [View] [Edit]

◉ Carcasses removed after one search
- Carcasses available: 24
- Carcasses found: 19
$\hat{p}$ = 0.792, with 95% CI = [0.602, 0.916]
Factor by which searcher efficiency changes with each search (k): 0.67

Persistence Distribution

○ Use field trials to estimate parameters [View/Edit]
Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171
r = 0.531 for lr = 7, with 95% CIs: r = [0.413, 0.653], β = [0.488, 1.854]

◉ Enter parameter estimates manually [View]

Exponential
Weibull
Log-Logistic
Lognormal

Parameters
- shape (α): 5.63
- scale (β): 2.25 lwr 1.49 upr 3.00
r = 0.691 for lr = 7, with 95% CI: r ∈ [0.578, 0.788]

Fatality estimation (M, λ)

Carcass Count (X): 0 [Estimate M]
Credibility level (1 - α): 0.9 [Estimate λ]

◉ One-sided CI (M*)   ○ Two-sided CI

[Close]

Estimated detection probability (g)

```
Summary statistics for estimation of detection probability (g)
===============================================================================
Results:

Full site for full year
    Estimated g = 0.568, 95% CI = [0.45, 0.683]
    Fitted beta distribution parameters for estimated g: Ba = 38.8146, Bb = 29.4961


Full site for monitored period, 01-Aug-2022 through 24-Oct-2022
    Estimated g = 0.568, 95% CI = [0.45, 0.683]
    Fitted beta distribution parameters for estimated g: Ba = 38.8146, Bb = 29.4961
    Temporal coverage (within year) = 1


Searched area for monitored period, 01-Aug-2022 through 24-Oct-2022
    Estimated g = 0.604, 95% CI = [0.478, 0.725]
    Fitted beta distribution parameters for estimated g: Ba = 35.4863, Bb = 23.2188


===============================================================================
Input:
Search parameters
    trial carcasses placed = 24, carcasses found = 19
    estimated searcher efficiency: p = 0.792, 95% CI = [0.602, 0.916]
    k = 0.67
    Search schedule: Search interval (I) = 7, number of searches = 12, span = 84
    spatial coverage: 0.94     temporal coverage: 1
_____
Carcass persistence:
  Lognormal persistence distribution
    shape (α) = 5.63 and scale (β) = 2.25
    95% CI β = [1.49, 3]
    r = 0.691 for Ir = 7 with 95% CI = [0.578, 0.788]
    Parameters entered manually
  Uniform arrivals
_____
```

Appendix E12. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Fall 2022, 80-meter, dog-aided full plot searches at 15, 4.2 megawatt turbines with a blade length of 74 meters, searched at a 7-day interval.

EoA, v2.0.7 - Multiple Class Module

Edit   Help

Options

Overall

○ Estimate total mortality (M)

    Credibility level (1 - α) `0.8`

    ● One-sided CI (M*)
    ○ Two-sided CI

● Estimate overall detection probability (g)

Individual classes

○ Calculate g parameters from monitoring data

● Enter g parameters manually

Actions

| Add class | Calculate | Clear | Close |

Class	dwp	X	Ba	Bb	ĝ	95% CI
unsearched	0	0	---	---	0	[0, 0]
spring	0.020	0	247.59	4570.05	0.05139	[0.0453, 0.0578]
summer	0.268	0	359.28	769.36	0.3183	[0.291, 0.346]
fall	0.712	0	160.77	356.46	0.3108	[0.272, 0.351]

R Estimated detection probability (g) for multiple classes

```
Summary statistics for multiple class estimate
=================================================================================
Input: Detection probability, by search class
  Search coverage = 1

  Class         DWP     X    Ba    Bb    ghat     95% CI
  unsearched      0     0   ---   ---      0  [    0,      0]
  spring       0.02     0 247.6  4570  0.051 [0.045, 0.058]
  summer      0.268     0 359.3 769.4  0.318 [0.291, 0.346]
  fall        0.712     0 160.8 356.5  0.311 [0.272, 0.351]
=================================================================================
Results for full site


Detection probability
  Estimated g = 0.308, 95% CI = [0.279, 0.337]
  Fitted beta distribution parameters for estimated g: Ba = 293.0885, Bb = 659.5788

Mortality

Test of assumed relative weights (rho)
  Class         Assumed    Fitted (95% CI)
  unsearched     0.000       NA
  spring         0.020     [0.014, 0.990]
  summer         0.268     [0.001, 0.874]
  fall           0.712     [0.001, 0.914]
  p = 1 for likelihood ratio test of H0: assumed rho = true rho
```

Appendix E13. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Class Module inputs and output for Spring, Summer and Fall 2022, (n=49 in spring and fall, 29 in summer), searched at a 14-day interval in the spring and a 7-day interval in summer and fall.

Appendix E14. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Year Module for Indiana bat rolling average detection probability and short-term adaptive management trigger test. Inputs are based on values reported in the main text. Note that although the weight (ρ) column of the Multiple Years Module is equal to 0.92, the EoA GUI produces a "year-adjusted λ", by calculating the average λ over the number of input rows (years) in the multi-year module of the GUI. Because the ρ values associated with each year in the GUI are scaled so that a rho of 1.0 is equivalent to a typical operations year for the wind farm (but 2022 was not a typical operation year), we would like to calculate the "ρ-adjusted λ". The GUI does not accommodate that calculation. The "ρ-adjusted λ", 16.03, is equivalent to the "year-adjusted λ" (14.68 as seen in the output above) divided by ρ (0.92).
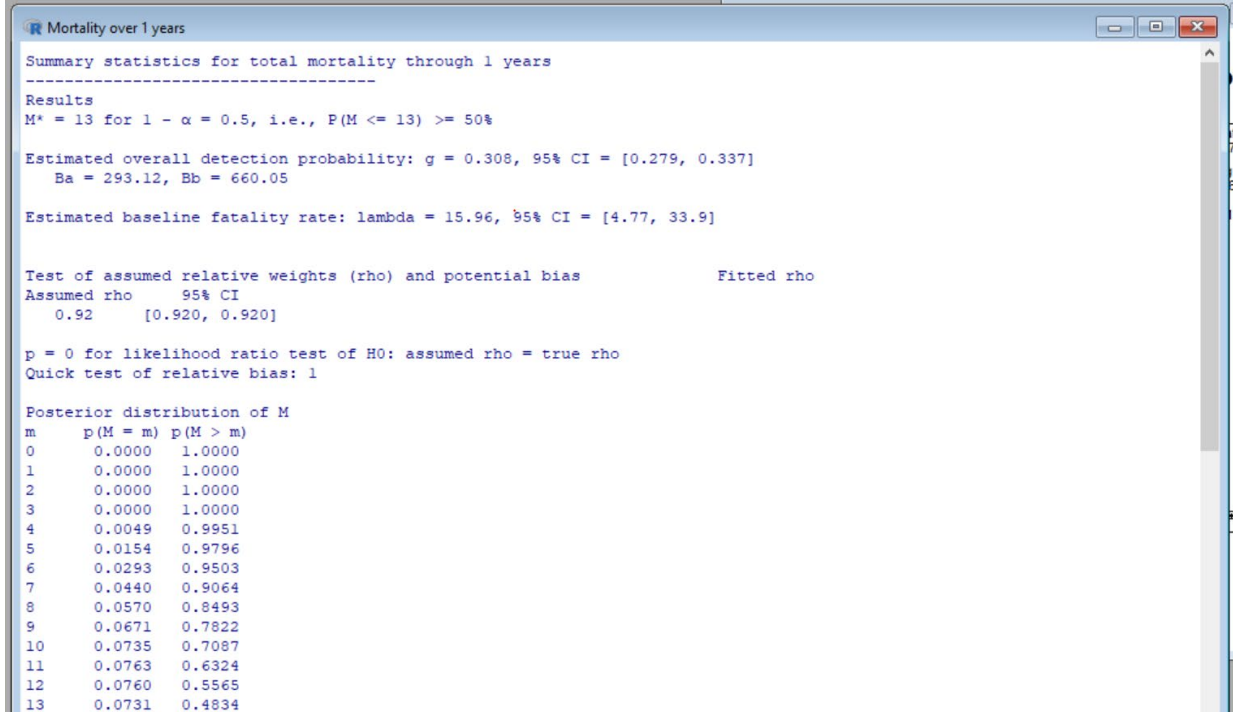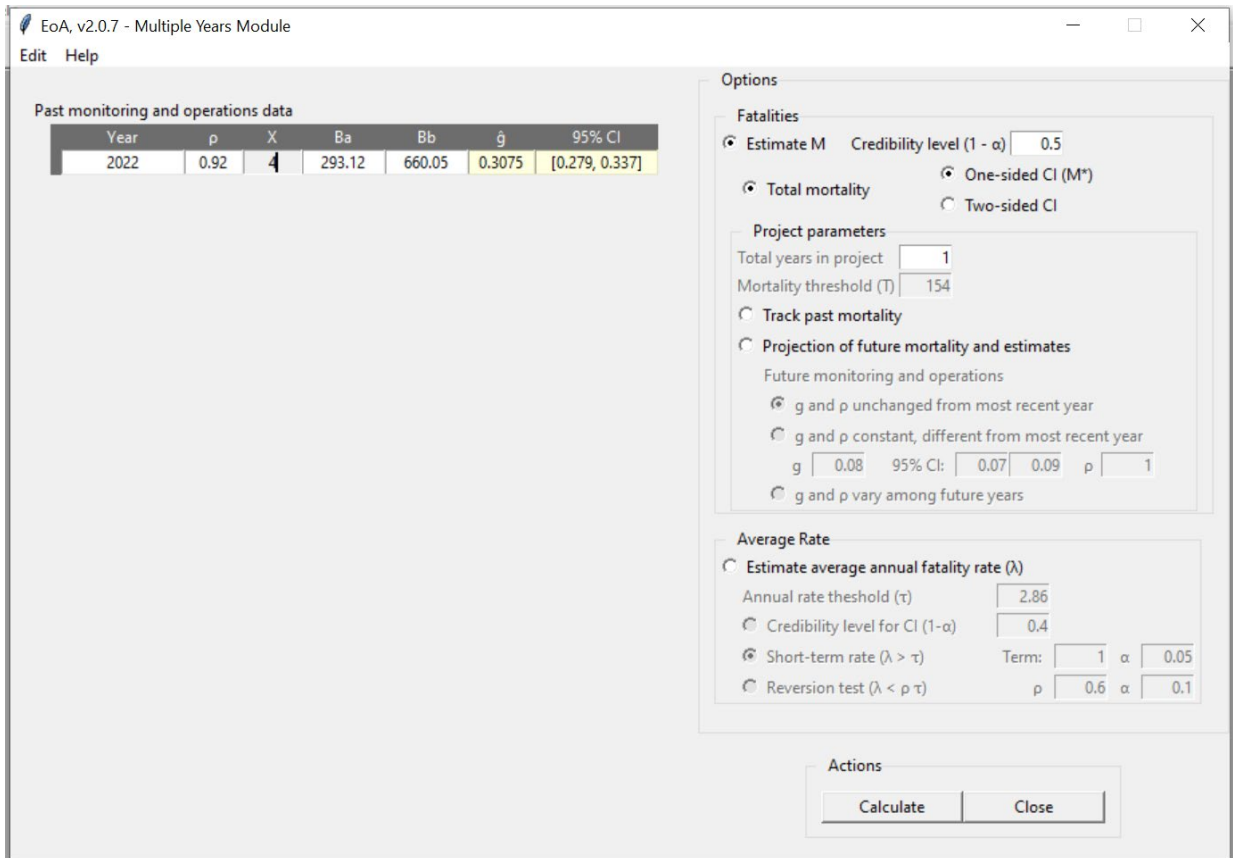
Appendix E15. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Year Module for Indiana bat ITP term-to-date detection probability and cumulative take estimate (M*). Inputs are based on values reported in the main text.
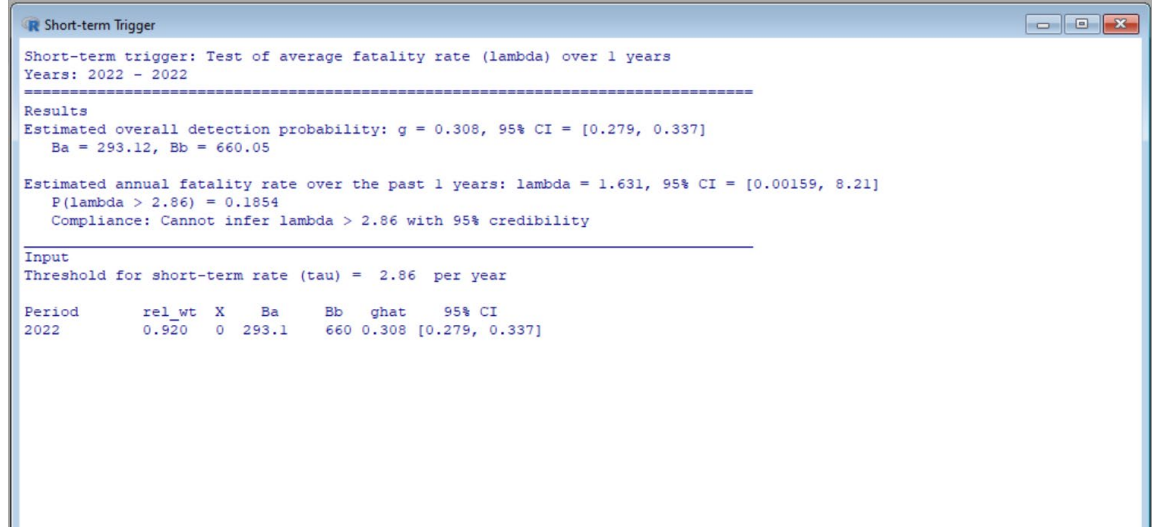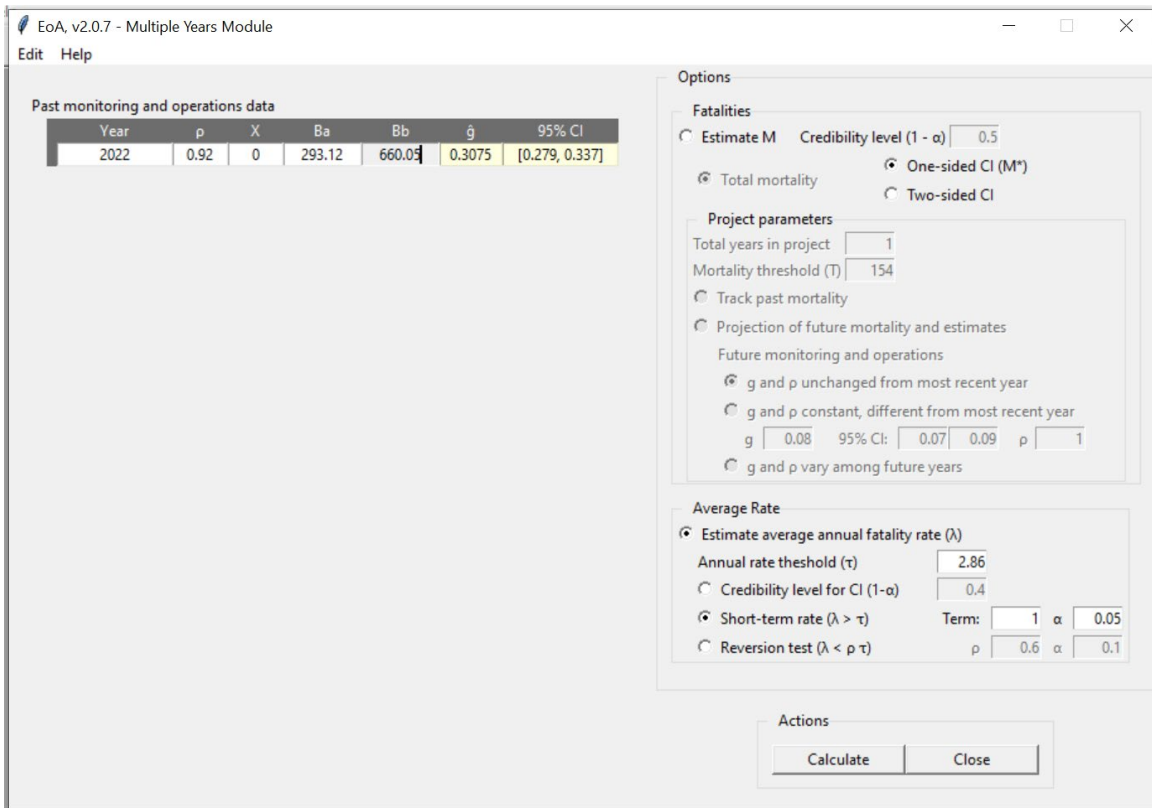
Appendix E16. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Year Module for northern long-eared bat rolling average detection probability and short-term adaptive management trigger test. Inputs are based on values reported in the main text. Note that although the weight (ρ) column of the Multiple Years Module is equal to 0.92, the EoA GUI produces a "year-adjusted λ", by calculating the average λ over the number of input rows (years) in the multi-year module of the GUI. Because the ρ values associated with each year in the GUI are scaled so that a rho of 1.0 is equivalent to a typical operations year for the wind farm (but 2022 was not a typical operation year), we would like to calculate the "ρ-adjusted λ". The GUI does not accommodate that calculation. The "ρ-adjusted λ", 1.78, is equivalent to the "year-adjusted λ" (1.63 as seen in the output above) divided by ρ (0.92).

Appendix E17. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Year Module for northern long-eared bat ITP term-to-date detection probability and cumulative take estimate (M*). Inputs are based on values reported in the main text.