

**Post-construction Monitoring Study for the
Headwaters II Wind Farm
Randolph County, Indiana**

**Year 2 Final Report
April 3 – October 15, 2023**



Prepared for:

EDP Renewables

Attn: Erin O'Shea

1501 McKinney Street, Suite 1300
Houston, Texas 77010

Prepared by:

Aaron McAlexander, Whitley Felver, Riley Knoedler, and Faith Kulzer

Western EcoSystems Technology, Inc.
400 West 7th Street, Suite 200
Bloomington, Indiana 47404

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EXECUTIVE SUMMARY

Headwaters II Wind Farm, LLC, a subsidiary of EDP Renewables North America, LLC, is operating the Headwaters II Wind Farm (Project) in Randolph County, Indiana. This report details the post-construction monitoring studies conducted in 2023, consistent with the Project's Habitat Conservation Plan (HCP) and Incidental Take Permit (ITP; ESPE0025999) for Indiana and northern long-eared bats (Covered Species). The Project obtained the ITP on April 22, 2022, and has completed monitoring in 2022 and 2023. Turbines operated as outlined within the Project's HCP.

Post-construction monitoring was completed consistent with the study plan, which was approved by US Fish and Wildlife Service on March 1, 2023. 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 Project (i.e., a study-wide g). 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 pads, and were conducted by two types of searchers: a human technician and detection-dog team (consisting of one dog trained to detect carcasses and one handler). The frequency of searches varied across seasons, with more searches occurring when the take of Covered Species was more likely to occur. Searcher efficiency and carcass persistence trials were also conducted during each season to correct for detection and scavenger bias.

Six federally listed endangered Indiana bats were found at the Project throughout the study period, with one found during the summer and five found during the fall season. No northern long-eared bats were found at the Project. Three evening bats, state-listed as an endangered species, were found during the summer (one) and fall (two) seasons. Four hundred sixteen bats were found during the study. The bat species were eastern red bat (43.2%), silver-haired bat (26.3%), big brown bat (16.6%), and hoary bat (10.7%).

In accordance with the HCP, three types of adaptive management triggers were tested for the Covered Species: a short-term (general) test of whether the estimated take rate during all seasons exceeded the expected take rate, a short-term (summer) test of whether the estimated take rate during the summer season exceeded the expected take during the summer season, and a long-term test of whether the permitted take had been met. The g for 2023 was 0.24 (95% confidence interval [CI]: 0.22–0.26). Based on the data collected to date (2022 and 2023 studies), the EoA model estimated the mean annual fatality rates were 20.07 Indiana bats and 0.97 northern long-eared bats. The probability the summer take rate exceeded the expected summer take rate was 0.34 for Indiana bat and 0.35 for northern long-eared bat. The cumulative summer take estimates through 2023 were three Indiana bat fatalities and 0.78 northern long-eared bat fatalities. The probability that the annual take rate exceeded the expected annual take rate was 0.92 for Indiana

bat and 0.07 for northern long-eared bat. The cumulative take estimates through 2023 were 37 Indiana bat fatalities and zero northern long-eared bat fatalities. The estimated levels of Covered Species take were below levels authorized within the ITP. No adaptive management actions are required at this time.

DRAFT

STUDY PARTICIPANTS

Aaron McAlexander	Project Manager, Permitted Bat Biologist
Rhett Good	Senior Reviewer
Whitley Felver	Field Supervisor, Detection Dog Coordinator, Report Writer
Allie Byrd	Field Supervisor
Paul Rabie, Ph.D.	Senior Statistician
Riley Knoedler	Statistician, Evidence of Absence Analyst
Faith Kulzer	Lead Client Analyst
Britten Vincent	GIS Technician
Joshua Zalewski	Technical Editor
Ross Bailey	Field Technician
Blair Pfeifer	Dog Handler
Boone/Buzzard	Detection Dogs

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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; ESPE0025999, dated April 22, 2022) for the federally listed as endangered Indiana bat (*Myotis sodalis*) and the federally listed as endangered northern long-eared bat (*M. septentrionalis*; collectively, Covered Species) from the US Fish and Wildlife Service (USFWS). The Project has completed monitoring in 2022 and 2023, as required by the ITP. This report presents the results of the second year of compliance monitoring conducted under the ITP from April 1 to October 15, 2023. 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) and determine if adaptive management was necessary to maintain compliance with the Project's ITP.

STUDY AREA

The primary land cover type within 100 meters (m; 328 feet [ft]) of the turbines (i.e., within the Permit Area) is cultivated crops, which covers 77.7% of the Permit Area. The next most common land cover types are deciduous forest, which covers approximately 7.6% of the site, hay/pasture (7.2%), and developed open space (5.5%). All other land cover types collectively make up less than 1.0% of the total land cover (National Land Cover Database 2021; Figure 1).

The Project became fully operational on August 1, 2021, and consists of 13 Vestas V136 3.6-megawatt (MW; 105.0-m [344.5-ft] hub height and 67.0-m [219.8-ft] blade length) turbines and 36 Vestas V150 4.2-MW (105-m hub height and 74.0-m [242.8-ft] blade length) turbines (Table 1, Figure 1). All turbines are within the migratory range of the Covered Species, and EDPR adjusted turbine operations during the spring, summer, and fall as described within the ITP (Table 2). Some turbines were non-operational for a portion of the study due to maintenance and were accounted for in analysis (Table 3).

Table 1. Phases, turbines, and operational dates of the Headwaters II Wind Farm, Randolph County, Indiana.

Phase	Turbine Type	Number of Turbines	Commercial Operational Date	Hub Height (m)	Blade Diameter (m)
I	Vestas V136 3.6-MW	13	2021	105	67
II	Vestas V150 4.2-MW	36	2021	105	74

m = meter; MW = megawatt.

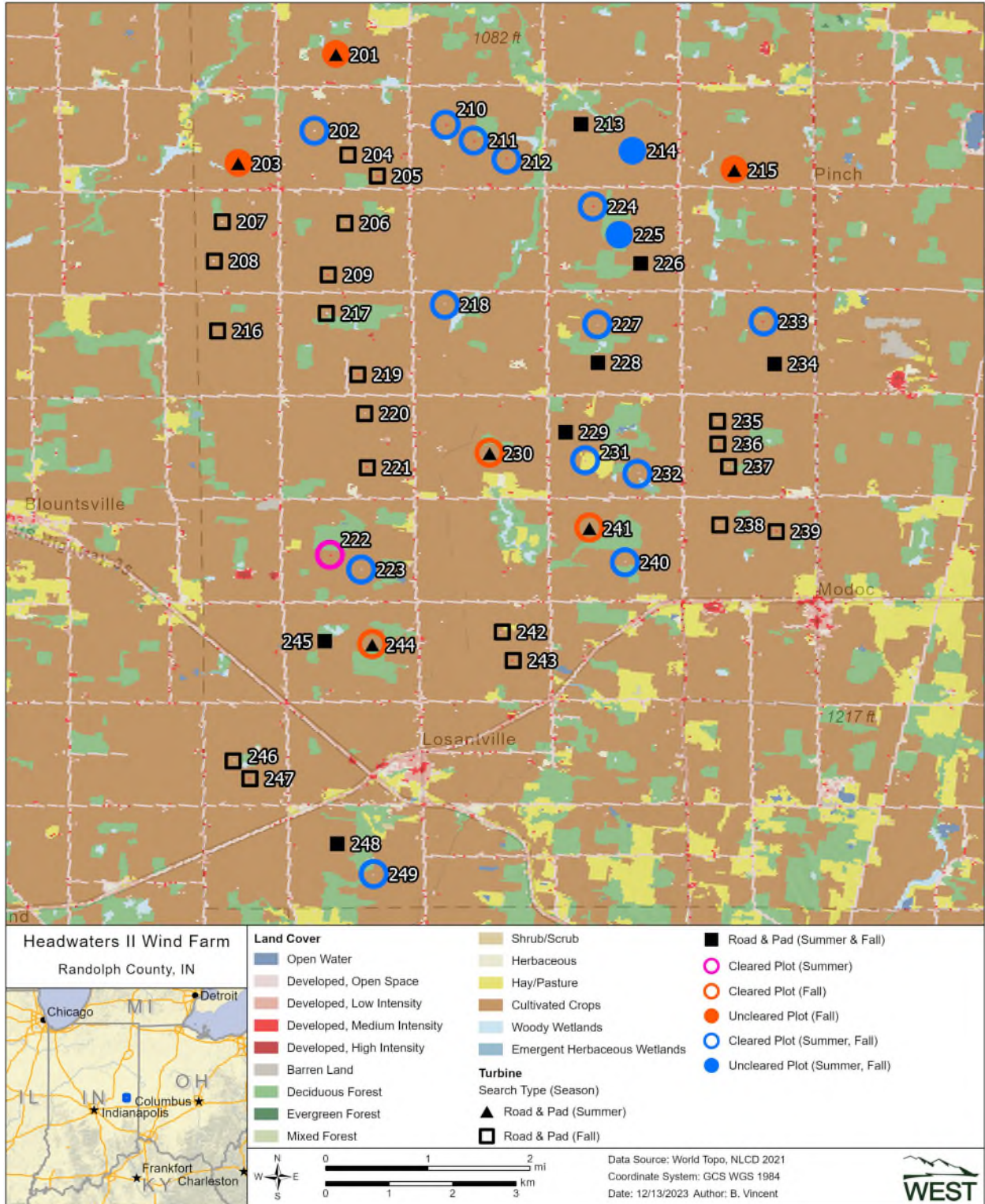


Figure 1. Turbine, by plot type, and surrounding land cover at the at the Headwaters II Wind Farm, Randolph County, Indiana. All turbines had a road and pad plot search type in the spring season (undesigned on map)

Table 2. Seasonal turbine operations regime at the Headwaters II Wind Farm, Randolph County, Indiana.

Season	Turbines	Time of Day	Cut-In Speed	Feathering Below Cut-In? ¹	Temperature Threshold ²
Spring (April 1 – May 15)	All	0.5 hour before sunset to 0.5 hour after sunrise	Manufacturer's cut-in speed ³	Yes	10°C
Summer (May 16 – July 31)	20	0.5 hour before sunset to 0.5 hour after sunrise	Manufacturer's cut-in speed ³	Yes	None
	29	0.5 hour before sunset to 0.5 hour after sunrise	5.0 m/s	Yes	None
Fall (August 1 – October 15)	All	0.5 hour before sunset to 0.5 hour after sunrise	5.0 m/s	Yes	10°C
Winter (October 16 – March 31)	All	Normal turbine operation			

¹ Feathering means turbine blades were pitched into the wind such that they spin at less than approximately one rotation per minute.

² Turbines will be feathered below cut-in when temperatures are above 10 degrees Celsius (°C).

³ The manufacturer's cut-in wind speed is 3.0 meters/second (m/s; 9.8 feet/s) across all Project turbines.

Table 3. Turbines with extended, non-operational periods at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Turbine ID	Non-operational Date Period	Search Plot Type	Summer Risk Turbine
207	May 1 – 8, 2023	Road and pad plot	NA
208	July 8 – 19, 2023	Road and pad plot	No
222	June 8 – July 5, 2023	Cleared plot	Yes
222	July 7 – 19, 2023	Road and pad plot	Yes
222	July 21 – September 26, 2023	Uncleared plot	Yes
230	May 22 – June 6, 2023	Road and pad plot	Yes
230	September 1 – 12, 2023	Cleared plot	NA
232	July 11 – 24, 2023	Cleared plot	Yes
244	August 28 – September 20, 2023	Cleared plot	NA
246	May 31 – June 11, 2023	Road and pad plot	No
247	April 1 – May 15, 2023	Road and pad plot	No
247	May 16 – July 5, 2023	Road and pad plot	No
247	July 7 – 27, 2023	Road and pad plot	No
247	July 29 – 31, 2023	Road and pad plot	No
247	August 1 – September 27, 2023	Road and pad plot	NA
247	October 4 – 10, 2023	Road and pad plot	NA
248	April 1 – May 7, 2023	Road and pad plot	NA
248	July 9 – August 1, 2023	Road and pad plot	Yes

ID = identification.

NA – not applicable since turbine was non-operational outside of the summer season

METHODS

Western EcoSystems Technology, Inc. (WEST) used Project-specific data from the previous post-construction monitoring study at the Project (see McAlexander et al. 2023) to develop a study plan that targeted a probability of detection (*g*) of 0.25 (McAlexander and Ciecka 2023) to meet the monitoring commitments in the HCP. WEST submitted a study plan to the USFWS on January 25, 2023, and received approval on March 3, 2023 (M. Reed, USFWS, pers. comm.).

Standardized Carcass Searches

Number of Turbines Sampled, Search Frequency, and Plot Size

Human technicians and detection-dog teams (consisting of one dog trained to detect carcasses and one handler) conducted standardized carcass searches (carcass searches) from April 3 – October 15, 2023. Search effort varied by season (Table 4, Figure 1), 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, Randolph County, Indiana, from April 3 – October 15, 2023.

Season	Plot Type	Search Interval (days)	Number of Turbines	Search Team
Spring (April 1 – May 15)	100-m road and pad	7.0	49	Technician
	100-m road and pad	3.5	14	Technician
Summer (May 16 – July 31)	80-m cleared plot	7.0	13	Detection-dog team
	80-m uncleared plot	7.0	2	Detection-dog team
	100-m road and pad	3.5	29	Technician
Fall (August 1 – October 15)	80-m cleared plot	7.0	15	Detection-dog team
	80-m uncleared plot	7.0	5	Detection-dog 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 from the turbine every week during the spring (Table 4).

During the summer, only turbines designated as summer risk turbines (29 turbines; Headwaters II Wind Farm, LLC, 2022) were searched. A detection-dog team searched 13 turbines with summer risk as cleared plots and two as uncleared plots with an 80-m (262-ft) radius once a week. A technician searched 14 road and pad plots to a distance of 100 m from the turbine, twice weekly.

All turbines were searched once per week during the fall (Table 4), except for Turbine 222, which remained inoperable throughout a majority of the fall monitoring period (Table 3). Additionally, three turbines (231, 230, 249) changed plot type during the season due to site safety concerns, scheduled turbine maintenance, and plot crop type. A technician searched 29 turbines as road and pad plots to a distance of 100 m from the turbine twice a week (Figure 2). Detection-dog teams searched 15 turbines that were regularly mowed with an 80-m radius (80-m cleared plots;

Figure 3) and five turbines as uncleared plots with an 80-m radius (80-m uncleared plots; Figure 4).

Vegetation at the 80-m cleared plots was mowed and maintained by Project staff within 10 to 15 centimeters (four to six inches) in height to enhance detectability of carcasses. Uncleared plots were vegetated with soybeans (*Glycine max*) or grass (*Festuca* spp.) and had approximately three transects mowed in a linear star pattern, 1.5 m (5.0 ft) wide, to assist detection-dog teams with plot access while reducing overall crop damages.



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



Figure 3. Detection-dog team Blair Pfeifer and Buzzard (detection dog) performing a cleared plot search at the Headwaters II Wind Farm, Randolph County, Indiana.

Photo credit: Anna Ciecka.



Figure 4. Representative photo of vegetation conditions of an uncleared plot at the Headwaters II Wind Farm, Randolph County, Indiana. Pictured is detection-dog Buzzard.

Photo credit: Blair Pfeifer.

Search Methods

WEST used two types of search methods: a technician, or human-only visual search, and a detection-dog team, or olfactory search, where the team consisted of one technician/handler and one dog. All personnel were trained to follow 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 Searches

Technicians walked transects spaced five m (16 ft) apart at a rate of approximately 45–60 m (148–197 ft) per minute on all road and pad plots within 100 m of the turbine [and all 100-m cleared plots]. The technicians scanned the area for carcasses on both sides of the transects out to approximately 2.5 m (8.2 ft) to ensure full visual coverage of each search area. Technician searches were only conducted on road and pad plots.

Plot Searches—Detection-dog Teams

Detection-dog teams searched 80-m full plots (including both uncleared and uncleared plots) for bat carcasses. Prior to each search, handlers determined the survey start points 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 windspeed 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 and wind speed, ranging from five to 10 m (33 ft) apart in densely vegetated areas, to 10–15 m (33–49 ft) in shorter vegetation. Detection dogs were rewarded with either a food reward or a short play session when they correctly alerted to a bird or bat carcass.

Detection-dog 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). Detection dogs were initially trained with either cotton scent swabs that had been rubbed on bat carcasses or directly with dehydrated bat carcasses at increasing distances over a period of three to four weeks. Once the detection dog achieved a passing grade of 80% or higher in a scent recognition test, consisting of 10 blind trial lineups using bat carcasses, the dog and handler were evaluated in the field to measure their performance. The detection dog coordinator conducted a 2-day field evaluation of each detection-dog team; after teams achieved a searcher efficiency of 75% or greater for 15–30 bats placed during blind evaluation trials, the teams were approved to conduct carcass searches. Because the objective of the study was to focus 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. Breeds used at the Project as detection dogs included a Belgian Malinois and German Shepard mix.

Data Collection

Technicians recorded the date, start and end times, technician name, turbine number, type of search, and if any fatalities 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 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, 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), 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—10 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 (2263). 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 covered by nitrile or latex gloves were used to handle all bat carcasses to eliminate possible transmission of rabies or other zoonotic diseases. 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 study period, were recorded as incidental discoveries and documented following the same protocol for those found during standard searches.

Carcass Identification and Agency Notification

Identification of bird carcasses were verified by biologists with significant field experience in identification of birds and their feathers. Federally permitted bat biologists 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 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, 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 forearms measured > 42 millimeters [1.7 inches]) 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 the Illinois Natural Heritage Database repository (J. Wieringa, USFWS, pers. comm.) by January 31, 2024.

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 and detection-dog teams 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*), big brown bats (*Eptesicus fuscus*), and silver haired bats (*Lasionycteris noctivagans*) that had previously been found on site.

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 secured 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 prior to scheduled searches and to eliminate a direct scent trail. For technician trials, the trial administrator placed carcasses prior to searchers arrival at a 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 search were recorded, and the number of trial carcasses available for detection was determined immediately after each trial by the person responsible for distributing the carcasses.

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. 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 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 days 7, 10, 14, 21, and 30. Ninety-five carcasses used to test searcher efficiency were left in place and used for carcass persistence trials. No more than three trial carcasses were placed on a plot to avoid potential over-seeding and attracting scavengers. Trial carcasses were monitored until they were completely removed, or the trial period ended. Detection-dog teams were used on the

80-m cleared and uncleared plots to determine when carcasses were removed, while technicians determined the status of carcasses placed on 100-m roads and pads.

Search Area Mapping

Technicians recorded the boundaries of 100-m roads and pads and 80-m cleared plots using an Eos sub-meter Global Positioning System satellite unit. Unsearchable areas within plot boundaries were also mapped. The 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.

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) 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 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 the Covered Species. EoA was used with data collected in the field to estimate the overall probability of detecting a bat fatality, the take rate of Covered Species, and the number of Covered Species carcasses that occurred. Data used in the EoA model included number of Covered Species fatalities, the searched area adjustment (“DWP” in the software), 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 detection-dog 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 detection-dog 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 that was missed on the first search would never be found on subsequent searches. A k of one implies searcher efficiency remained 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.

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 type (i.e., plots searched by technicians versus plots searched by detection-dog teams) to account for different modes of detection. 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 of β) were used as inputs in the EoA Single Class module.

Search 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 search area adjustment was estimated as the product of the proportion of searched area around each turbine and a carcass-density distribution. The proportion of area searched was calculated in a geographic information system as the amount of area searched divided by the total area searched at each 1-m annulus around the turbine. 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-m annulus around the turbine. Due to the variation in turbine sizes, separate search area adjustments were fit a priori for each turbine size. An additional model was fitted with area adjustment pooled across all turbines. Distributions considered were normal, gamma, Gompertz, and Weibull (parameterized according to R Development Core Team [2016] and Yee [2015]). Fitted models were checked for validity and excluded from consideration if the estimated variance was negative or infinite, if the statistical fitting algorithm returned indicated an error, or if the fitted distribution indicated less than 5% of carcasses within the maximum search radius (after Dalthorp and Huso 2023). The best model was selected using AICc after excluding invalid models.

Carcasses Excluded from Analysis

Fatalities were excluded from the 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 April 1) 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, but within the same season. If a fatality 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 search area adjustment but would be included in the EoA fatality estimate following Dalthorp et al. (2020).

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 the 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 search area, as well as the assumed seasonality of risk the Covered Species. The seasonal risk was 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 study period was separated into search strata, where each search stratum was defined by a number of turbines and a length of time. Within each search stratum, all of the bias corrections were the same. For example, in spring, all road and pad searches had the same searcher efficiency, carcass persistence, and search area. The EoA Single Class module was used to estimate the detection probability in each search stratum. This resulted in alpha (α) and beta (β) parameters that defined the beta distribution of detection probability in each stratum.

Each search stratum potentially had a different number of turbines and turbine operations, and a different amount of risk to the Covered Species (i.e., arrival proportion) compared to other search strata. We calculated weights for each strata in order to calculate an overall probability of detection. For example, a search stratum with five turbines had less weight than a search stratum with 15 turbines. The EoA Multiple Class module was used to combine detection probability distributions across strata. In the software, stratum weights are called “DWP.” The module was used twice, first to combine plot search type strata within each season (i.e., for fall 1, 80-m cleared plots, 80-m uncleared plots, and roads and pads), and second to combine season strata.

The weights for combining the plot search type strata within each season were the within-season sampling fraction (i.e., the proportion of turbines in fall 1 that were searched as roads and pads) multiplied by the relative operation of turbines (i.e., the proportion of fall 1 road and pad turbines that were operating). Any turbines with low search effort within any season were part of an “unsearched” stratum, and the beta distribution parameters were set to $B_a = 0.01$ and $B_b = 1,000$ (a detection probability of 10^{-5}). The weights were standardized to sum to 1 within each season.

Bat fatality is consistently higher in the fall compared to other seasons (Arnett et al. 2008, Lloyd et al. 2023). Therefore, it was important to account for differing amounts of risk by season. Differing risk by season, for spring, summer, and fall were based on the carcass arrival proportions

from the Midwest Wind Energy Multi-Species HCP (USFWS 2016): 7% in spring, 36% in summer, and 57% in fall. Summer turbine operations were discounted by 40.8% because 29 (59.2%) of the Project turbines pose risk to Covered Species in the summer. The weights for combining season strata were carcass arrival proportions (Table 5) multiplied by relative operation of turbines (Table 5, “Relative Operation of Turbines”) and by the proportion of turbines that posed risk (Table 5, “Risk Turbine Weights”). The weights were standardized to sum to 1 across seasons (Table 5, “Re-scaled Season Weights”).

Table 5. Seasonal arrival proportions for the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023, adjusted based on the number of turbines considered to have risk in each season, and differing amounts of turbines that were non-operational in each season.

Season ¹	Seasonal Arrival Proportion	Within – season		Re-scaled Season Weights
		Relative Operation of Turbines	Risk Turbine Weights	
Spring (April 1 – May 15)	0.070	1	1.000	0.0823
Summer 1 (May 16 – July 6)	0.243	1	0.592	0.1691
Summer 2 (July 7 – July 29)	0.117	1	0.592	0.0814
Fall 1 (August 1 – August 17)	0.128	1	0.980	0.1474
Fall 2 (August 18 – October 15)	0.422	1	1.000	0.5197

¹. Summer and fall seasons were split to account for changes in searched turbines due to maintenance (non-operational turbines) or adjustments due to site safety. In summer 1, there were 15 full plots and 14 road pads. In summer 2, there were 15 full plots and 13 road pads. Fall 1 and 2, both, had 20 full plots and 28 road pads, but Turbine 222 (unsearched) was only operational for a portion of fall 2.

Each year of the study potentially had different impacts to the Covered Species depending on the operation of the turbines. Inoperable turbines were considered to have no chance of killing bats, therefore a relative turbine operations weight was used to combine detection probability distributions across strata, and is defined as the fraction of nights when turbines operated. Given that turbines at every project undergo routine maintenance, starting with 2023, operations were considered normal unless the proportion of operational turbines was less than 0.9 during the study period. The Multiple Years Module was used to estimate the site-wide, cumulative detection probability in 2022–2023. The EoA Multiple Years Module weighted the years using the turbine operation proportion for that year. In the software, the year weights were called p . To evaluate the general short-term trigger and the summer short-term trigger, p was calculated separately for the entire study period and for the summer period alone. The value for p in 2023 was 1 for the entire period (Appendix D4). Since ITP monitoring did not begin until partway through the spring, and significant turbine downtime occurred throughout the year, the value for p in 2022 was set to 0.92.

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 past two 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, and the probability that $M^* \geq T$, where T is the permitted amount of take for each species. Appendix D describes how the compliance metrics were calculated using

the EoA Graphical User Interface. Appendix E are representative screenshots of the inputs for the Single Class and Multiple Class Modules.¹

Adaptive Management Triggers

The estimates from the EoA analysis were used to test three types of 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 the estimate take rate during the summer season exceed the expected take during the summer maternity season, and a long-term test of whether permitted take had been met (Dalthorp and Huso 2015). Both the short- and long-term triggers were tested individually for each of the Covered Species.

Evidence of Absence Short-term Trigger (general)

The EoA 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 ($\tau = T \div \text{years in permit}$) at a confidence level of $\alpha = 0.05$, per the HCP. The Project's short-term trigger is designed to evaluate a rolling window of six years of post-construction monitoring data. If, within any 6-year rolling window, the estimated take rate exceeds the expected take rate with 95% confidence, the short-term trigger would be met, indicating 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. Two years of data (2022 and 2023) were used in this analysis.

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 Indiana bat and 3.11 northern long-eared bat were predicted to be taken annually with minimization, and 3.0 Indiana bat and 0.78 northern long-eared bat were 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. Two years of data were used in this analysis (2022 and 2023).

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 $\alpha = 0.5$ (using the median, or 50th credible bound, of the posterior distribution

¹. There may be very minor differences between screen shots (Appendix E) and the results in the main text because EoA is a stochastic estimator, leading to slightly different estimates each time the modules are run.

of estimated fatality). If the cumulative take, to date, at $\alpha = 0.5$ is less than the total permitted take ($M^* < T$), then no changes are necessary. If the cumulative take, to date, at $\alpha = 0.5$ is greater than or equal to the total permitted take ($M^* \geq T$), then the take limit has been met and the Project must enact avoidance measures.

RESULTS

Standardized Carcass Searches

A total of 1,575 searches were conducted during the spring, summer, and fall monitoring seasons; 22 searches (less than 2%) were missed due to turbine maintenance, weather constraints, and/or safety hazards (Appendix A).

Six Indiana bat carcasses (federally listed as endangered; 1.53%) and three evening bat carcasses (*Nycticeius humeralis*; state-listed as endangered; 0.77%) were found (Table 6, Figure 5). No other federally or state-listed bat species were found.

Four hundred sixteen bat carcasses and 121 bird carcasses were found during surveys and incidentally (Appendix A). The most commonly found bat species were eastern red bat (169 carcasses; 43.2%) and silver-haired bat (103; 26.3%), followed by big brown bat (65; 16.6%), and hoary bat (*Lasiurus cinereus*; 42; 10.7%; Appendix C1). Three evening bats (0.77%), and six Indiana bats (1.53%) were also found. (Appendix A). Thirty-one heavily scavenged bats (e.g., wing membrane only, bones, or partial carcasses) were sent off for identification via deoxyribonucleic acid (DNA) analysis; 13 were identified as big brown bat, seven were identified as eastern red bat, and 11 were identified as silver haired bat. All six Indiana bats underwent DNA analysis to verify species, regardless of the condition the carcass was found. DNA analysis was also used to determine sex and species on all Indiana bats. DNA testing resulted in a positive identification for all the samples submitted.

Additionally, one carcass was recorded as an unidentified, non-*Myotis* spp. based on relatively long forearm length measurements, furred uropatagium, and non-*Myotis* spp. dentine structure. The carcass was unable to be collected due to a site safety concern. Two carcasses were recorded as unidentified *Lasiurus* spp. and did not have DNA samples submitted for further identification.

Table 6. Listed species of bats found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Species	Sex	Date Found	Estimated Time of Death (ETOD)	Season Found	Location ³	Turbine	Plot Type	Summer Risk Turbine?	Distance From Turbine (m)
Indiana bat ¹	male	5/22/23	0–1 days	summer	40.11375, -85.17556	211	Cleared	Yes	66
Indiana bat ¹	female	9/14/23	0–1 days	fall	40.10373, -85.15880	224	Cleared	Yes	24
Indiana bat ¹	female	9/14/23	0–1 days	fall	40.09990, -85.15473	225	Uncleared (soy)	Yes	6
Indiana bat ¹	female	9/15/23	4–7 days	fall	40.08763, -85.13376	233	Cleared	Yes	47
Indiana bat ¹	male	9/23/23	0–1 days	fall	40.08740, -85.13390	233	Cleared	Yes	41
Indiana bat ¹	female	9/23/23	4–7 days	fall	40.05337, -85.15394	240	Cleared	Yes	14
evening bat ²	unknown	5/18/23	2–3 days	summer	40.11057, -85.17114	212	Cleared	Yes	40
evening bat ²	unknown	8/20/23	2–3 days	fall	40.10863, -85.13851	215	Uncleared (soy)	Yes	46
evening bat ²	unknown	9/5/23	4–7 days	fall	40.12594, -85.19464	201	Uncleared (soy)	Yes	57

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 represents latitude and longitude in decimal degrees (North American Datum 83).

m = meters.

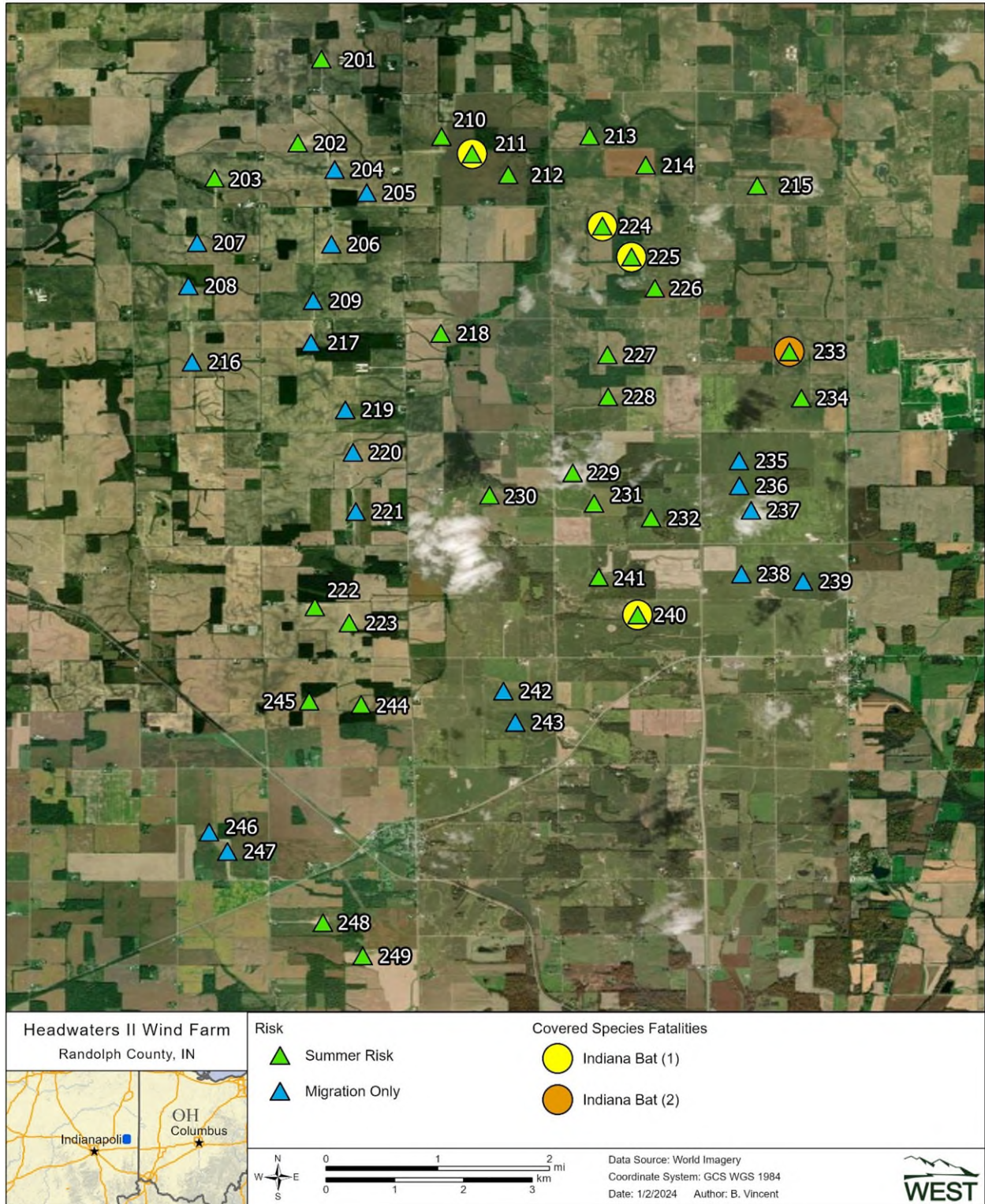


Figure 5. Location of Covered Species carcasses in relation to summer risk turbines at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Statistical Analysis

Bias Trials

Searcher Efficiency Trials

One hundred eight bats were placed for searcher efficiency trials on 15 separate dates, and 99 were available for search teams to find across all plot types. The best-fit model for searcher efficiency on 80-m plots did not support the inclusion of plot type or season as a covariate, meaning there was not a statistically meaningful difference between searcher efficiency rates on uncleared and cleared plots between seasons (Appendix B). The best-fit model for searcher efficiency on roads and pads did not support the inclusion of season as a covariate, meaning there was not a statistically meaningful difference between searcher efficiency rates across seasons (Appendix B). Overall searcher efficiency rates were approximately 89% for roads and pads searched by technicians and 85% on full plots searched by detection-dog teams (Table 7).

Table 7. Searcher efficiency results by plot type at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Season	Plot Type	Number Placed	Number Available	Number Found	% Found
Spring	Road and pad	16	15	14	93.33
Summer	Road and pad	18	15	12	80.00
	Cleared plot	15	15	15	100
Fall	Uncleared plot	11	10	8	80.00
	Road and pad	15	15	14	93.33
	Cleared plot	17	15	12	80.00
	Uncleared plot	16	14	11	78.57
Overall Full Plots (Cleared and Uncleared)		59	54	46	85.19
Overall Road and Pads		49	45	40	88.89
Overall		108	99	86	86.87

Uncleared and cleared plots were combined for analysis.

Carcass Persistence Trials

Ninety-five carcasses were placed to estimate carcass persistence. The best-fit model for carcass persistence rates on 80-m cleared and uncleared plots searched by detection dogs was based on a lognormal distribution with no covariates, which suggests carcass persistence did not vary by season (Appendix B). The best-fit model for carcass persistence on technician searched road and pad plots did not support the inclusion of season as a covariate, meaning it was not a statistically meaningful difference between carcass persistence rates across seasons (Appendix C). The average probability that a carcass persisted through a 3.5-day search interval 0.71 (90% CI: 0.62–0.80) on road and pad plots. The average probability that a carcass persisted through a 7.0-day search interval 0.66 (90% CI: 0.56–0.75) on full plots and 0.61 (90% CI: 0.51–0.70) on roads and pads (Figure 6).

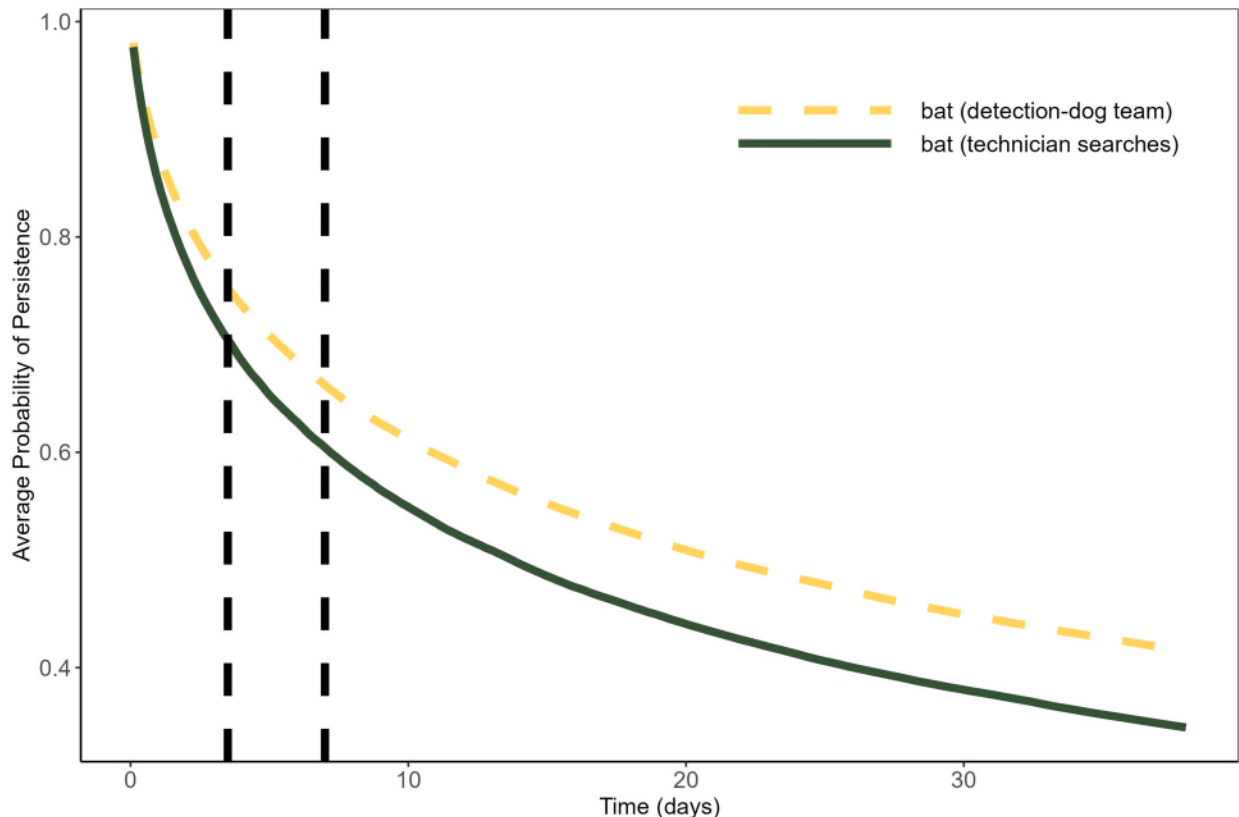


Figure 6. The average probability of persistence, in days, at different search intervals at Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023. Detection-dog teams searched 80-meter cleared and uncleared full plots and technicians searched 100-meter road and pad plots.

Note: The vertical dashed lines indicate the 3.5- and 7-day search intervals used in this study.

Search Area Adjustment

Twenty-five of the 391 bats found during the study period were excluded from modeling the search area adjustment for EoA. Ten bat carcasses were excluded from analysis because they were found off plot. Another 15 bats were excluded because their estimated time of death was prior to the start of surveys (Appendix C).

Models of carcass distribution from the turbine base with the lowest AICc included turbine type as a covariate. However, the models generated for the 3.6 MW turbines failed to meet validity standards, including issues with negative variance, infinite variance, and failure to meet a minimum cumulative density of 0.05 (i.e., 5% of carcasses) within 100 m (maximum search radius) of the turbine. Therefore, we used the model with the lowest AICc score that lacked turbine type as a covariate, and the selected model used a Weibull distribution (Figure 7; Appendix C). The TWL area adjustment for bats at 100-m road and pad plots was 0.11 and the TWL area adjustment for bats at full plots was 0.81 (Table 8; Appendix C).

Table 8. Truncated weighted maximum likelihood search area adjustment estimates for the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Search Area Type	Number of Bats*	Distribution	Parameter 1	Parameter 2	Search Area Adjustment
100-m road and pad	91	Weibull	1.6820	56.9782	0.11
80-m full plot	300	Weibull	1.6820	56.9782	0.81

*Number of bats included in the area adjustment analysis by plot type.

Number of turbines searched by turbine type and sample sizes by turbine type are provided in Appendix C.

m = meter.

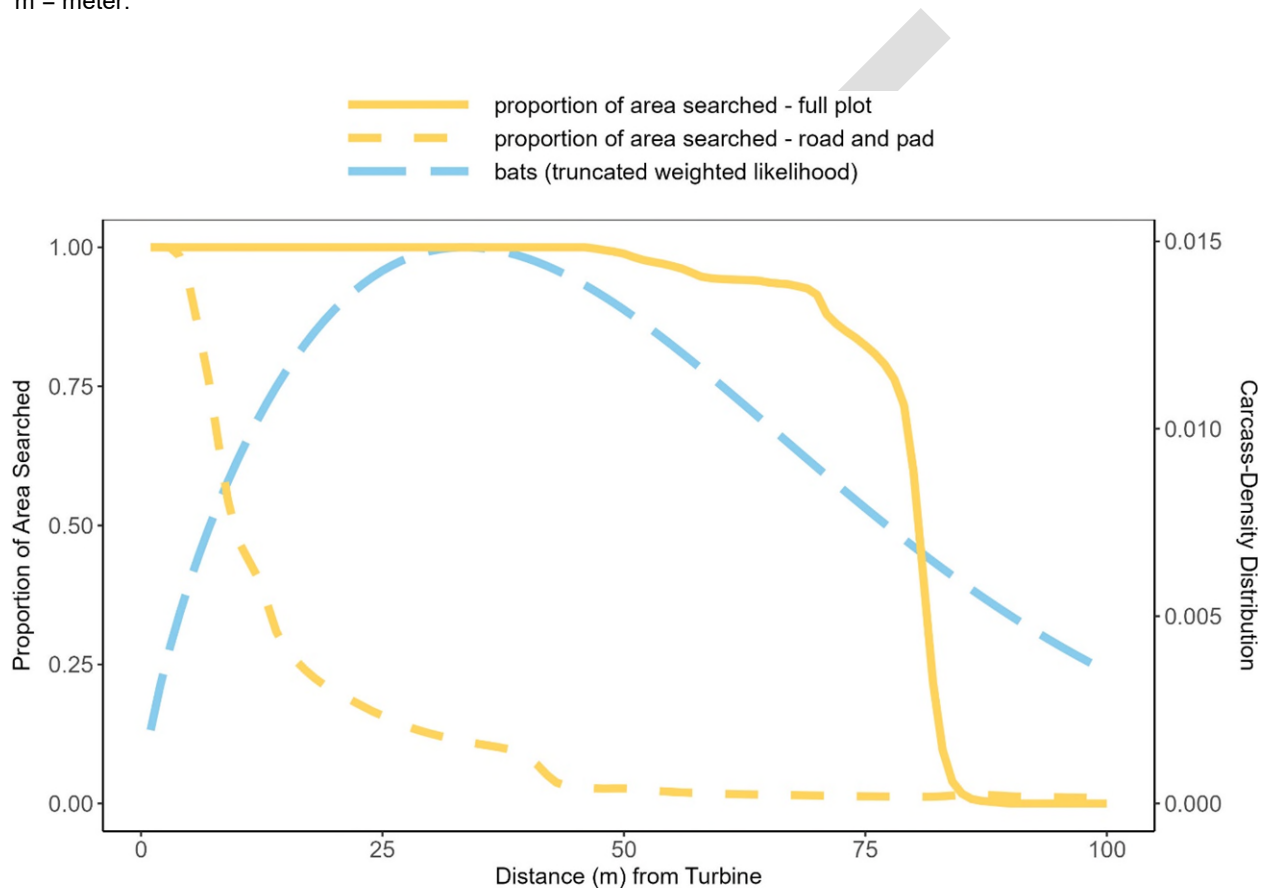


Figure 7. Density of bat carcasses per area searched at all roads and pads and full plots (cleared and uncleared) at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Covered Species Take Estimates

Six Indiana bat carcasses were found during the 2023 study. To date, 10 Indiana bats and zero northern long-eared bats have been found under the ITP. The annual probability of detection distribution achieved for the 2023 study period had a mean of 0.24 (90% CI: 0.22–0.26; Table 9). 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 9. Probability of detection (g), Ba, and Bb, for the Headwaters II Wind Farm in Randolph County, Indiana, based on two years of monitoring.

Year	Ba ¹	Bb ¹	g ¹	90% CI
2022	293.12	660.05	0.31	0.28-0.33
2023	369.98	1153.91	0.24	0.22-0.26
Short-term Trigger (general; last two years)	648.673	1722.536	0.27	0.26-0.29
Short-term Trigger (summer; last two years)	509.961	1168.473	0.30	0.28-0.33
Long-term Trigger (cumulative)	648.673	1722.536	0.27	0.26-0.29

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

CI = confidence interval of g.

Mean annual take rates based on the combined 2022 and 2023 monitoring years were estimated to be 20.07 (90% CI: 11.04–31.3) Indiana bats per year and 0.97 (90% CI: 0–3.67) northern long-eared bats per year (Table 9). 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 and 2023 monitoring years), M^* , at $\alpha = 0.5$ (50th credible bound), is estimated to be 37 Indiana bats and zero northern long-eared bats (Table 10). The total take permitted by the ITP is 359 Indiana bats and 93 northern long-eared bats over the 30-year permit term.

Adaptive Management Triggers

Evidence of Absence Short-term Trigger (general)

The short-term trigger assesses the probability the estimated take rate, calculated from all monitoring years, to date, under the ITP, exceeded the expected take rate, $\Pr(\lambda > \tau)$. At a 95% confidence level ($\alpha = 0.05$), $\Pr(\lambda > \tau)$ must be greater than or equal to 0.95 for the short-term trigger to fire. For Indiana bat, $\Pr(\lambda > \tau) = 0.92$, and northern long-eared bat, $\Pr(\lambda > \tau) = 0.07$, neither probability meets or exceeds 0.95, indicating the short-term trigger was not met and no adaptive management actions are required as described within the HCP (Table 10; Figure 8).

Table 10. Probability the estimated take rates exceeded the expected take rates for studies conducted within the rolling average interval at the Headwaters II Wind Farm in Randolph County, Indiana, Incidental Take Permit Year 1 (2022) and Year 2 (2023).

Species	Mean λ (90% CI) ²	Expected Take Rate (τ)	$\Pr(\lambda > \tau)$ ¹	Short-Term Trigger Fires at $\alpha = 0.05$?
Indiana bat	20.07 (11.04–31.3)	11.96	0.92	No
northern long-eared bat	0.97 (0–3.67)	3.11	0.07	No

¹ $\Pr(\lambda > \tau)$ 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 (i.e., $\alpha = 0.05$ 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.

²CI = confidence interval.

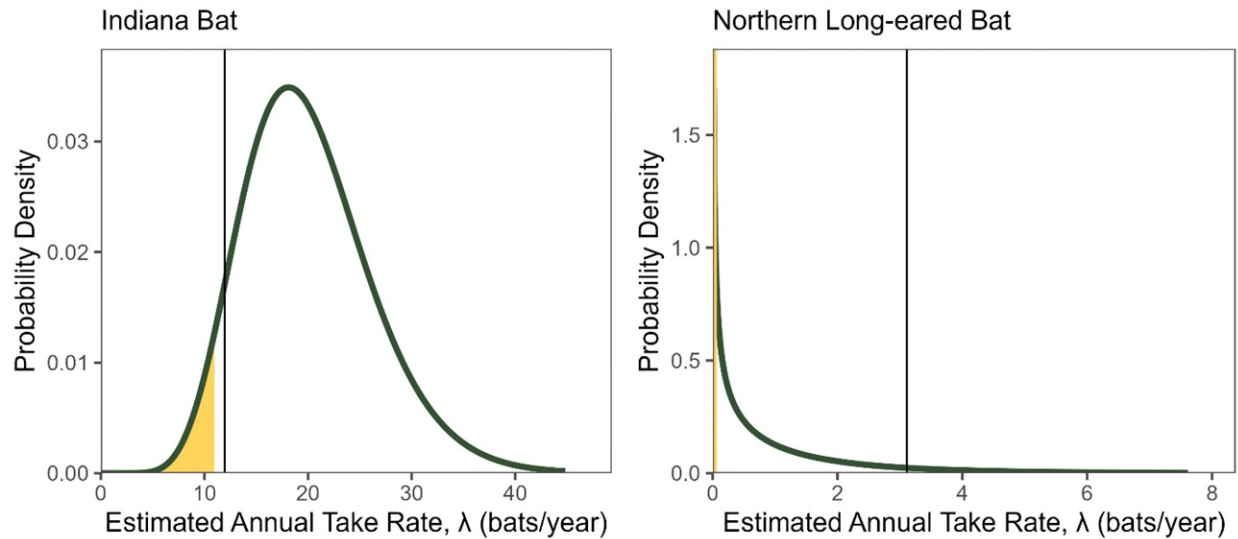


Figure 8. Estimated annual take rates (λ), in bats per year at Headwaters II Wind Farm, Randolph County, Indiana, Incidental Take Permit Year 1 (2022) and Year 2 (2023).

Note: The yellow region of the posterior distributions shows the region of the lower 5% quantile of the distributions (yellow 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 yellow region of the posterior distributions. For both species, the short-term trigger was not met because the vertical line (expected take rate) was not within or to the left of the yellow regions. In other words, the probability that estimated take rate was 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, calculated from all monitoring years to date under the ITP, exceeded the expected summer take rate, $\Pr(\lambda_{\text{summer}} > \tau_{\text{summer}})$. At a 95% confidence level ($\alpha = 0.05$), $\Pr(\lambda_{\text{summer}} > \tau_{\text{summer}})$ must be greater than or equal to 0.95 for the short-term trigger to fire. For Indiana bat, $\Pr(\lambda_{\text{summer}} > \tau_{\text{summer}}) = 0.34$, and for northern long-eared bat, $\Pr(\lambda_{\text{summer}} > \tau_{\text{summer}}) = 0.35$ (Table 11). Neither probability meets or exceeds 0.95, indicating the summer short-term trigger was not met and no adaptive management actions are required as described within the HCP (Table 11, Figure 9).

Table 11. 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, Incidental Take Permit Year 1 (2022) and Year 2 (2023).

Species	Mean λ (90% CI)	Expected Take Rate (τ)	$\Pr(\lambda > \tau)^*$	Short-Term Trigger Fires at $\alpha = 0.05$?
Indiana bat	2.68 (0.31–6.99)	3.00	0.34	No
Northern long-eared bat	0.89 (0.01–3.43)	0.78	0.35	No

* $\Pr(\lambda > \tau)$ 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 (i.e., $\alpha = 0.05$ 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.

CI = confidence interval.

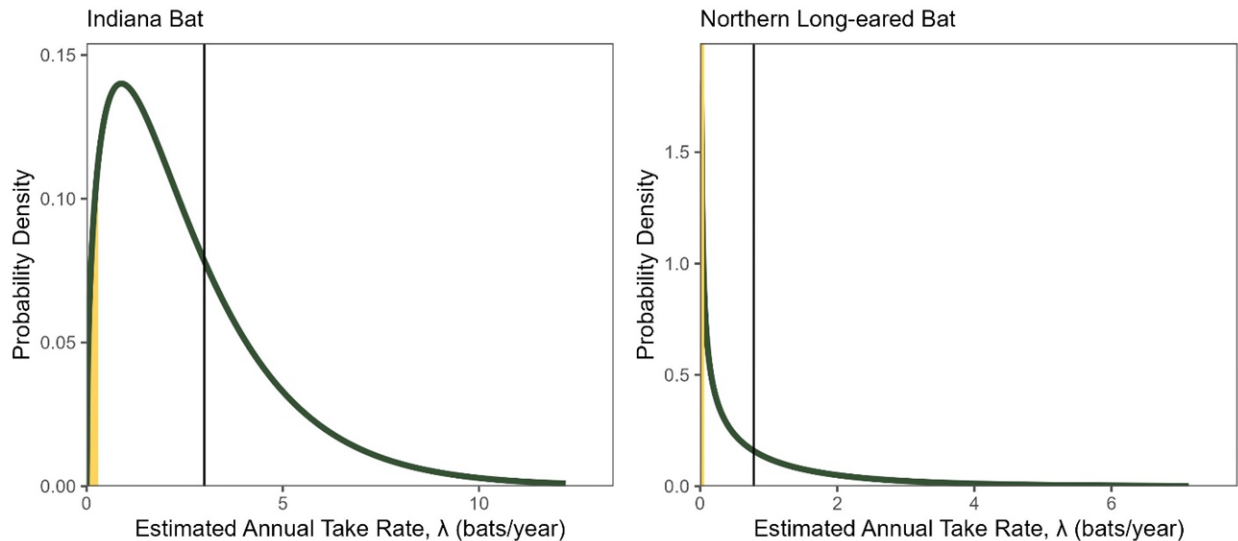


Figure 9. Estimated summer take rates (λ), in bats per year, at Headwaters II Wind Farm, Randolph County, Indiana, Incidental Take Permit Year 1 (2022) and Year 2 (2023).

Note: The yellow 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 yellow 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 yellow 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 $\alpha = 0.5$ (50th credible bound), is below the total permitted take for both Covered Species (Table 12). The long-term trigger was not met, and the Project is in compliance for both species because $M^* < T$ for both species. Therefore, an avoidance response is not required.

Table 12. 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, from ITP Year 1 (2022) and Year 2 (2023).

Species	Cumulative Take (M^*)	Permitted Take (T)	Long-term Trigger Fires at $\alpha = 0.5$?
Indiana bat (50 th credible bound)	37	359	No
northern long-eared bat (50 th credible bound)	0	93	No

CONCLUSIONS

The post-construction monitoring effort completed in 2023 was consistent with the HCP’s monitoring requirements and the Project’s 2023 study plan. Six covered species carcasses were found. Estimates of potential take for the Covered Species were below the levels authorized by the ITP and no adaptive management actions are required, as described within the HCP.

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Appendix A. Carcasses Found during the 2023 Post-construction Monitoring Surveys

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Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
04/12/2023	eastern red bat	16	228	carcass search	road and pad	scavenged
04/19/2023	silver-haired bat	5	212	carcass search	road and pad	scavenged
04/20/2023	eastern red bat	24	219	carcass search	road and pad	scavenged
04/20/2023	eastern red bat	5	249	carcass search	road and pad	scavenged
04/20/2023	silver-haired bat	9	230	carcass search	road and pad	intact
04/26/2023	eastern red bat	4	208	carcass search	road and pad	intact
04/26/2023	silver-haired bat	12	203	carcass search	road and pad	scavenged
04/26/2023	silver-haired bat	2	207	carcass search	road and pad	intact
04/26/2023	silver-haired bat	3	227	carcass search	road and pad	intact
05/03/2023	silver-haired bat	23	233	carcass search	road and pad	intact
05/11/2023	hoary bat	20	238	carcass search	road and pad	scavenged
05/11/2023	silver-haired bat	10	229	carcass search	road and pad	scavenged
05/15/2023	big brown bat	36	202	incidental	full plot	scavenged
05/15/2023	silver-haired bat	78	202	incidental	full plot	scavenged
05/16/2023	eastern red bat	38	224	carcass search	full plot	intact
05/16/2023	eastern red bat	43	225	carcass search	full plot	intact
05/16/2023	silver-haired bat	57	225	carcass search	full plot	scavenged
05/18/2023	big brown bat	13	201	carcass search	road and pad	dismembered
05/18/2023	eastern red bat	9	202	carcass search	full plot	intact
05/18/2023	evening bat	40	212	carcass search	full plot	intact
05/19/2023	eastern red bat	26	232	carcass search	full plot	scavenged
05/19/2023	eastern red bat	26	232	carcass search	full plot	scavenged
05/19/2023	silver-haired bat	30	232	carcass search	full plot	intact
05/22/2023	Indiana bat	66	211	carcass search	full plot	scavenged
05/23/2023	hoary bat	1	225	carcass search	full plot	scavenged
05/30/2023	big brown bat	14	245	carcass search	road and pad	scavenged
05/30/2023	eastern red bat	54	222	carcass search	full plot	scavenged
06/01/2023	big brown bat	55	203	carcass search	road and pad	scavenged
06/01/2023	hoary bat	72	231	carcass search	full plot	dismembered
06/05/2023	hoary bat	76	202	carcass search	full plot	scavenged
06/06/2023	big brown bat	24	215	carcass search	road and pad	injured
06/06/2023	big brown bat	17	222	carcass search	full plot	scavenged
06/06/2023	silver-haired bat	15	224	carcass search	full plot	scavenged
06/12/2023	silver-haired bat	78	211	carcass search	full plot	scavenged
06/13/2023	silver-haired bat	7	230	carcass search	road and pad	scavenged
06/14/2023	eastern red bat	29	241	carcass search	road and pad	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
06/16/2023	hoary bat	23	233	carcass search	full plot	scavenged
06/20/2023	silver-haired bat	26	203	carcass search	road and pad	scavenged
06/23/2023	eastern red bat	54	232	carcass search	full plot	scavenged
06/23/2023	silver-haired bat	35	232	carcass search	full plot	scavenged
06/23/2023	silver-haired bat	6	232	carcass search	full plot	scavenged
06/26/2023	big brown bat	60	202	carcass search	full plot	scavenged
06/26/2023	eastern red bat	41	212	carcass search	full plot	intact
06/27/2023	eastern red bat	50	224	carcass search	full plot	intact
06/27/2023	eastern red bat	59	245	carcass search	road and pad	intact
07/03/2023	big brown bat	20	202	carcass search	full plot	scavenged
07/04/2023	eastern red bat	44	223	carcass search	full plot	scavenged
07/06/2023	big brown bat	3	245	carcass search	road and pad	scavenged
07/06/2023	eastern red bat	7	201	carcass search	road and pad	scavenged
07/06/2023	eastern red bat	17	214	carcass search	full plot	scavenged
07/06/2023	eastern red bat	20	227	carcass search	full plot	intact
07/06/2023	eastern red bat	5	249	carcass search	road and pad	intact
07/06/2023	silver-haired bat	54	231	carcass search	full plot	scavenged
07/07/2023	eastern red bat	45	232	carcass search	full plot	scavenged
07/07/2023	hoary bat	35	240	carcass search	full plot	scavenged
07/10/2023	big brown bat	38	210	carcass search	full plot	scavenged
07/10/2023	eastern red bat	47	202	carcass search	full plot	scavenged
07/10/2023	eastern red bat	59	210	carcass search	full plot	intact
07/11/2023	big brown bat	47	224	carcass search	full plot	scavenged
07/11/2023	eastern red bat	20	224	carcass search	full plot	scavenged
07/11/2023	eastern red bat	21	244	carcass search	road and pad	scavenged
07/11/2023	eastern red bat	34	249	carcass search	full plot	intact
07/13/2023	hoary bat	106	231	carcass search ²	full plot	intact
07/19/2023	big brown bat	35	210	carcass search	full plot	scavenged
07/19/2023	eastern red bat	41	202	carcass search	full plot	scavenged
07/19/2023	eastern red bat	14	249	carcass search	full plot	scavenged
07/20/2023	eastern red bat	57	227	carcass search	full plot	intact
07/20/2023	eastern red bat	48	227	carcass search	full plot	intact
07/20/2023	eastern red bat	14	245	carcass search ²	road and pad	scavenged
07/20/2023	hoary bat	4	215	carcass search	road and pad	intact
07/21/2023	big brown bat	35	240	carcass search	full plot	scavenged
07/21/2023	eastern red bat	44	240	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
07/21/2023	hoary bat	44	240	carcass search	full plot	scavenged
07/25/2023	eastern red bat	40	223	carcass search	full plot	scavenged
07/25/2023	eastern red bat	50	249	carcass search	full plot	scavenged
07/25/2023	eastern red bat	9	249	carcass search	full plot	scavenged
07/27/2023	hoary bat	8	245	carcass search ²	road and pad	scavenged
07/29/2023	big brown bat	0	218	carcass search	full plot	scavenged
07/29/2023	big brown bat	74	218	carcass search	full plot	scavenged
07/29/2023	big brown bat	1	240	carcass search	full plot	intact
07/29/2023	eastern red bat	62	233	carcass search	full plot	scavenged
07/29/2023	eastern red bat	50	240	carcass search	full plot	scavenged
07/29/2023	hoary bat	60	240	carcass search	full plot	scavenged
08/01/2023	big brown bat	8	246	carcass search	road and pad	scavenged
08/01/2023	big brown bat	9	246	carcass search	road and pad	scavenged
08/01/2023	eastern red bat	21	201	carcass search	full plot	scavenged
08/01/2023	eastern red bat	25	201	carcass search	full plot	scavenged
08/01/2023	eastern red bat	35	230	carcass search	road and pad	scavenged
08/01/2023	eastern red bat	34	244	carcass search	full plot	scavenged
08/01/2023	eastern red bat	59	244	carcass search	full plot	scavenged
08/01/2023	eastern red bat	40	246	carcass search	road and pad	scavenged
08/01/2023	eastern red bat	16	249	carcass search	full plot	scavenged
08/01/2023	hoary bat	67	249	carcass search	full plot	scavenged
08/02/2023	eastern red bat	51	240	carcass search	full plot	scavenged
08/04/2023	eastern red bat	75	224	carcass search	full plot	scavenged
08/04/2023	eastern red bat	45	227	carcass search	full plot	scavenged
08/04/2023	hoary bat	14	227	carcass search	full plot	scavenged
08/07/2023	big brown bat	61	210	carcass search	full plot	scavenged
08/07/2023	big brown bat	54	212	incidental	full plot	scavenged
08/07/2023	big brown bat	57	212	carcass search	full plot	scavenged
08/07/2023	eastern red bat	4	208	carcass search	road and pad	scavenged
08/07/2023	eastern red bat	2	229	carcass search	road and pad	scavenged
08/08/2023	big brown bat	32	249	carcass search	full plot	scavenged
08/08/2023	big brown bat	43	249	carcass search	full plot	scavenged
08/08/2023	big brown bat	20	249	carcass search	full plot	scavenged
08/08/2023	eastern red bat	60	201	carcass search	full plot	scavenged
08/08/2023	eastern red bat	30	244	carcass search	full plot	intact
08/08/2023	hoary bat	11	249	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
08/10/2023	eastern red bat	87	206	carcass search	road and pad	dismembered
08/10/2023	eastern red bat	25	236	carcass search	road and pad	scavenged
08/10/2023	hoary bat	47	225	carcass search	full plot	scavenged
08/10/2023	hoary bat	23	227	carcass search	full plot	scavenged
08/10/2023	hoary bat	3	248	carcass search	road and pad	scavenged
08/11/2023	big brown bat	55	241	carcass search	full plot	scavenged
08/11/2023	eastern red bat	55	202	incidental	full plot	intact
08/11/2023	hoary bat	60	240	carcass search	full plot	scavenged
08/14/2023	big brown bat	17	243	incidental	road and pad	scavenged
08/14/2023	big brown bat	15	244	carcass search	full plot	scavenged
08/14/2023	eastern red bat	59	211	carcass search	full plot	intact
08/14/2023	eastern red bat	44	211	carcass search	full plot	scavenged
08/14/2023	eastern red bat	19	236	carcass search	road and pad	scavenged
08/14/2023	hoary bat	35	215	carcass search	full plot	scavenged
08/14/2023	hoary bat	40	244	carcass search	full plot	scavenged
08/15/2023	eastern red bat	24	201	carcass search	full plot	scavenged
08/15/2023	eastern red bat	5	249	carcass search	full plot	scavenged
08/17/2023	big brown bat	30	208	carcass search	road and pad	scavenged
08/17/2023	eastern red bat	29	217	carcass search	road and pad	intact
08/17/2023	eastern red bat	1	220	carcass search	road and pad	intact
08/17/2023	eastern red bat	25	221	carcass search	road and pad	scavenged
08/17/2023	eastern red bat	52	224	carcass search	full plot	scavenged
08/17/2023	eastern red bat	47	224	carcass search	full plot	scavenged
08/17/2023	eastern red bat	47	227	carcass search	full plot	scavenged
08/17/2023	eastern red bat	74	242	carcass search	road and pad	intact
08/17/2023	eastern red bat	36	242	carcass search	road and pad	intact
08/17/2023	eastern red bat	35	242	carcass search	road and pad	scavenged
08/17/2023	eastern red bat	24	243	carcass search	road and pad	intact
08/17/2023	eastern red bat	9	248	carcass search	road and pad	intact
08/18/2023	big brown bat	11	241	carcass search	full plot	scavenged
08/18/2023	eastern red bat	48	240	carcass search	full plot	scavenged
08/18/2023	eastern red bat	66	240	carcass search	full plot	scavenged
08/18/2023	eastern red bat	26	241	carcass search	full plot	intact
08/18/2023	eastern red bat	44	241	carcass search	full plot	scavenged
08/18/2023	hoary bat	33	240	carcass search	full plot	scavenged
08/20/2023	big brown bat	77	212	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
08/20/2023	eastern red bat	44	202	carcass search	full plot	dismembered
08/20/2023	eastern red bat	57	212	carcass search	full plot	scavenged
08/20/2023	evening bat	46	215	carcass search	full plot	scavenged
08/21/2023	eastern red bat	53	217	carcass search ²	road and pad	scavenged
08/21/2023	eastern red bat	7	238	carcass search	road and pad	scavenged
08/22/2023	eastern red bat	53	201	carcass search	full plot	scavenged
08/22/2023	eastern red bat	59	201	carcass search	full plot	scavenged
08/22/2023	eastern red bat	57	244	carcass search	full plot	scavenged
08/22/2023	eastern red bat	36	244	carcass search	full plot	scavenged
08/22/2023	eastern red bat	15	244	carcass search	full plot	scavenged
08/22/2023	hoary bat	21	203	carcass search	full plot	intact
08/23/2023	hoary bat	43	249	carcass search	full plot	scavenged
08/24/2023	big brown bat	20	218	carcass search	full plot	scavenged
08/24/2023	big brown bat	53	225	carcass search	full plot	scavenged
08/24/2023	eastern red bat	34	204	carcass search	road and pad	scavenged
08/24/2023	eastern red bat	8	206	carcass search	road and pad	scavenged
08/24/2023	eastern red bat	25	217	carcass search	road and pad	scavenged
08/24/2023	eastern red bat	35	218	carcass search	full plot	scavenged
08/24/2023	eastern red bat	69	224	carcass search	full plot	scavenged
08/24/2023	eastern red bat	26	224	carcass search	full plot	scavenged
08/24/2023	eastern red bat	18	227	carcass search	full plot	scavenged
08/24/2023	eastern red bat	31	246	carcass search	road and pad	scavenged
08/24/2023	silver-haired bat	18	224	carcass search	full plot	scavenged
08/25/2023	big brown bat	20	236	carcass search	road and pad	scavenged
08/26/2023	big brown bat	56	230	carcass search	full plot	scavenged
08/26/2023	eastern red bat	44	230	carcass search	full plot	scavenged
08/26/2023	eastern red bat	20	240	carcass search	full plot	dismembered
08/26/2023	eastern red bat	24	240	carcass search	full plot	scavenged
08/26/2023	eastern red bat	34	241	carcass search	full plot	scavenged
08/26/2023	hoary bat	60	241	carcass search	full plot	scavenged
08/26/2023	silver-haired bat	27	240	carcass search	full plot	dismembered
08/28/2023	big brown bat	7	206	carcass search	road and pad	dismembered
08/28/2023	big brown bat	3	246	carcass search	road and pad	scavenged
08/28/2023	eastern red bat	42	207	carcass search	road and pad	intact
08/28/2023	eastern red bat	20	207	carcass search	road and pad	intact
08/28/2023	eastern red bat	17	208	carcass search	road and pad	intact

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
08/28/2023	eastern red bat	14	213	carcass search	road and pad	scavenged
08/28/2023	eastern red bat	11	239	carcass search	road and pad	intact
08/28/2023	eastern red bat	18	245	carcass search	road and pad	intact
08/28/2023	hoary bat	14	246	carcass search	road and pad	scavenged
08/28/2023	silver-haired bat	15	213	carcass search	road and pad	intact
08/28/2023	silver-haired bat	12	219	carcass search	road and pad	dismembered
08/29/2023	eastern red bat	71	202	carcass search	full plot	scavenged
08/29/2023	eastern red bat	5	202	carcass search	full plot	scavenged
08/29/2023	eastern red bat	29	215	carcass search	full plot	scavenged
08/29/2023	hoary bat	40	212	carcass search	full plot	scavenged
08/29/2023	silver-haired bat	9	202	carcass search	full plot	dismembered
08/29/2023	silver-haired bat	20	210	carcass search	full plot	intact
08/29/2023	silver-haired bat	40	215	carcass search	full plot	scavenged
08/30/2023	big brown bat	45	201	carcass search	full plot	scavenged
08/30/2023	eastern red bat	33	201	carcass search	full plot	scavenged
08/30/2023	eastern red bat	66	201	carcass search	full plot	scavenged
08/30/2023	eastern red bat	39	203	carcass search	full plot	scavenged
08/30/2023	eastern red bat	38	244	carcass search	full plot	intact
08/30/2023	eastern red bat	18	249	carcass search	full plot	scavenged
08/30/2023	hoary bat	37	201	carcass search	full plot	intact
08/30/2023	silver-haired bat	5	201	carcass search	full plot	intact
08/30/2023	silver-haired bat	18	203	carcass search	full plot	intact
08/30/2023	silver-haired bat	9	249	carcass search	full plot	intact
08/30/2023	silver-haired bat	2	249	carcass search	full plot	intact
08/31/2023	big brown bat	5	221	carcass search	road and pad	intact
08/31/2023	big brown bat	53	224	carcass search	full plot	intact
08/31/2023	big brown bat	12	227	carcass search	full plot	scavenged
08/31/2023	big brown bat	21	245	carcass search	road and pad	intact
08/31/2023	eastern red bat	1	225	carcass search	full plot	intact
08/31/2023	eastern red bat	27	225	carcass search	full plot	scavenged
08/31/2023	eastern red bat	11	225	carcass search	full plot	scavenged
08/31/2023	eastern red bat	51	227	carcass search	full plot	scavenged
08/31/2023	eastern red bat	36	227	carcass search	full plot	scavenged
08/31/2023	silver-haired bat	6	208	carcass search	road and pad	scavenged
08/31/2023	silver-haired bat	28	213	carcass search	road and pad	scavenged
08/31/2023	silver-haired bat	19	235	carcass search	road and pad	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
09/01/2023	eastern red bat	51	223	carcass search	full plot	dismembered
09/01/2023	eastern red bat	33	223	carcass search	full plot	dismembered
09/01/2023	eastern red bat	43	230	carcass search	full plot	scavenged
09/01/2023	eastern red bat	63	232	carcass search	full plot	intact
09/01/2023	eastern red bat	37	233	carcass search	full plot	scavenged
09/01/2023	eastern red bat	24	240	carcass search	full plot	scavenged
09/01/2023	eastern red bat	71	241	carcass search	full plot	scavenged
09/01/2023	eastern red bat	60	241	carcass search	full plot	scavenged
09/01/2023	eastern red bat	11	241	carcass search	full plot	scavenged
09/01/2023	eastern red bat	51	241	carcass search	full plot	scavenged
09/01/2023	eastern red bat	43	241	carcass search	full plot	scavenged
09/01/2023	hoary bat	27	230	carcass search	full plot	scavenged
09/01/2023	hoary bat	33	241	carcass search	full plot	scavenged
09/01/2023	silver-haired bat	19	223	carcass search	full plot	scavenged
09/01/2023	silver-haired bat	27	223	carcass search	full plot	intact
09/01/2023	silver-haired bat	41	232	carcass search	full plot	scavenged
09/01/2023	silver-haired bat	70	233	carcass search	full plot	scavenged
09/01/2023	silver-haired bat	56	240	carcass search	full plot	scavenged
09/01/2023	silver-haired bat	30	240	carcass search	full plot	scavenged
09/01/2023	silver-haired bat	24	240	carcass search	full plot	scavenged
09/01/2023	silver-haired bat	41	241	carcass search	full plot	scavenged
09/04/2023	big brown bat	74	211	carcass search	full plot	intact
09/04/2023	eastern red bat	21	202	carcass search	full plot	scavenged
09/04/2023	eastern red bat	74	211	carcass search	full plot	scavenged
09/04/2023	eastern red bat	31	212	carcass search	full plot	scavenged
09/04/2023	eastern red bat	63	215	carcass search	full plot	intact
09/04/2023	eastern red bat	83	239	carcass search ²	road and pad	scavenged
09/04/2023	eastern red bat	2	239	carcass search	road and pad	scavenged
09/04/2023	silver-haired bat	35	202	carcass search	full plot	scavenged
09/04/2023	silver-haired bat	53	202	carcass search	full plot	scavenged
09/04/2023	silver-haired bat	66	202	carcass search	full plot	scavenged
09/04/2023	silver-haired bat	62	202	carcass search	full plot	scavenged
09/04/2023	silver-haired bat	37	204	carcass search	road and pad	scavenged
09/04/2023	silver-haired bat	63	210	carcass search	full plot	scavenged
09/04/2023	silver-haired bat	41	211	carcass search	full plot	scavenged
09/04/2023	silver-haired bat	49	211	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
09/04/2023	silver-haired bat	41	216	carcass search ²	road and pad	intact
09/04/2023	silver-haired bat	18	217	carcass search	road and pad	scavenged
09/04/2023	silver-haired bat	23	238	carcass search	road and pad	scavenged
09/04/2023	silver-haired bat	8	242	carcass search	road and pad	scavenged
09/05/2023	big brown bat	41	201	carcass search	full plot	scavenged
09/05/2023	big brown bat	53	201	carcass search	full plot	scavenged
09/05/2023	big brown bat	39	201	carcass search	full plot	scavenged
09/05/2023	big brown bat	60	203	carcass search	full plot	scavenged
09/05/2023	eastern red bat	53	201	carcass search	full plot	scavenged
09/05/2023	eastern red bat	32	203	carcass search	full plot	scavenged
09/05/2023	eastern red bat	68	203	carcass search	full plot	scavenged
09/05/2023	eastern red bat	67	223	carcass search	full plot	scavenged
09/05/2023	eastern red bat	51	223	carcass search	full plot	scavenged
09/05/2023	evening bat	57	201	carcass search	full plot	scavenged
09/05/2023	silver-haired bat	56	201	carcass search	full plot	scavenged
09/05/2023	silver-haired bat	27	203	carcass search	full plot	scavenged
09/05/2023	silver-haired bat	46	203	carcass search	full plot	intact
09/05/2023	silver-haired bat	39	203	carcass search	full plot	scavenged
09/05/2023	silver-haired bat	70	203	carcass search	full plot	scavenged
09/05/2023	silver-haired bat	27	223	carcass search	full plot	intact
09/05/2023	silver-haired bat	60	223	carcass search	full plot	dismembered
09/05/2023	silver-haired bat	59	223	carcass search	full plot	scavenged
09/05/2023	unidentified bat	35	201	carcass search	full plot	scavenged
09/06/2023	eastern red bat	36	249	incidental	full plot	intact
09/06/2023	silver-haired bat	15	249	carcass search	full plot	scavenged
09/06/2023	silver-haired bat	54	249	carcass search	full plot	scavenged
09/06/2023	silver-haired bat	69	249	carcass search	full plot	scavenged
09/06/2023	silver-haired bat	26	249	carcass search	full plot	scavenged
09/07/2023	big brown bat	39	217	carcass search ²	road and pad	scavenged
09/07/2023	big brown bat	65	227	carcass search	full plot	intact
09/07/2023	big brown bat	32	246	carcass search	road and pad	intact
09/07/2023	big brown bat	6	246	carcass search	road and pad	scavenged
09/07/2023	big brown bat	8	246	Incidental ²	road and pad	scavenged
09/07/2023	eastern red bat	9	208	carcass search	road and pad	scavenged
09/07/2023	eastern red bat	69	225	carcass search	full plot	scavenged
09/07/2023	eastern red bat	65	227	carcass search	full plot	intact

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
09/07/2023	hoary bat	51	225	carcass search	full plot	scavenged
09/07/2023	hoary bat	27	225	carcass search	full plot	scavenged
09/07/2023	silver-haired bat	32	206	carcass search	road and pad	scavenged
09/07/2023	silver-haired bat	21	214	carcass search	full plot	scavenged
09/07/2023	silver-haired bat	43	224	carcass search	full plot	scavenged
09/07/2023	silver-haired bat	58	227	carcass search	full plot	scavenged
09/07/2023	unidentified <i>Lasiurus</i> spp. bat	12	216	carcass search	road and pad	dismembered
09/08/2023	big brown bat	51	233	carcass search	full plot	scavenged
09/08/2023	eastern red bat	63	232	carcass search	full plot	scavenged
09/08/2023	silver-haired bat	60	232	carcass search	full plot	scavenged
09/08/2023	silver-haired bat	18	232	carcass search	full plot	scavenged
09/08/2023	silver-haired bat	59	233	carcass search	full plot	scavenged
09/08/2023	silver-haired bat	45	241	carcass search	full plot	scavenged
09/09/2023	eastern red bat	79	241	incidental	full plot	intact
09/10/2023	eastern red bat	50	211	carcass search	full plot	scavenged
09/10/2023	eastern red bat	29	211	carcass search	full plot	scavenged
09/10/2023	eastern red bat	51	212	carcass search	full plot	scavenged
09/10/2023	eastern red bat	40	215	carcass search	full plot	scavenged
09/10/2023	eastern red bat	21	215	carcass search	full plot	scavenged
09/10/2023	hoary bat	27	202	carcass search	full plot	intact
09/10/2023	unidentified <i>Lasiurus</i> spp. bat	41	211	carcass search	full plot	scavenged
09/11/2023	big brown bat	35	246	carcass search	road and pad	scavenged
09/11/2023	hoary bat	44	227	incidental	full plot	intact
09/13/2023	silver-haired bat	32	225	incidental	full plot	intact
09/14/2023	Indiana bat	24	224	carcass search	full plot	intact
09/14/2023	Indiana bat	6	225	carcass search	full plot	dismembered
09/14/2023	big brown bat	61	224	carcass search	full plot	scavenged
09/14/2023	big brown bat	36	243	carcass search	road and pad	scavenged
09/14/2023	eastern red bat	3	225	carcass search	full plot	intact
09/14/2023	eastern red bat	14	242	carcass search	road and pad	scavenged
09/14/2023	silver-haired bat	7	207	carcass search	road and pad	scavenged
09/14/2023	silver-haired bat	75	227	carcass search ²	full plot	scavenged
09/15/2023	Indiana bat	47	233	carcass search	full plot	scavenged
09/15/2023	big brown bat	44	240	carcass search	full plot	scavenged
09/15/2023	eastern red bat	69	232	carcass search	full plot	intact
09/15/2023	eastern red bat	54	233	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
09/15/2023	eastern red bat	26	241	carcass search	full plot	scavenged
09/15/2023	hoary bat	6	241	carcass search	full plot	intact
09/18/2023	big brown bat	7	245	carcass search	road and pad	scavenged
09/18/2023	eastern red bat	4	246	carcass search	road and pad	intact
09/20/2023	big brown bat	54	215	carcass search	full plot	scavenged
09/20/2023	hoary bat	30	215	carcass search	full plot	intact
09/20/2023	silver-haired bat	24	215	carcass search	full plot	scavenged
09/21/2023	eastern red bat	14	223	carcass search	full plot	intact
09/21/2023	eastern red bat	53	223	carcass search	full plot	scavenged
09/21/2023	hoary bat	11	243	carcass search	road and pad	scavenged
09/21/2023	silver-haired bat	53	238	carcass search	road and pad	scavenged
09/22/2023	big brown bat	48	227	carcass search	full plot	scavenged
09/22/2023	big brown bat	56	241	carcass search	full plot	scavenged
09/22/2023	eastern red bat	28	224	carcass search	full plot	scavenged
09/22/2023	eastern red bat	32	224	carcass search	full plot	scavenged
09/22/2023	eastern red bat	18	225	carcass search	full plot	scavenged
09/22/2023	eastern red bat	43	241	carcass search	full plot	scavenged
09/22/2023	hoary bat	43	227	carcass search	full plot	intact
09/22/2023	silver-haired bat	68	224	carcass search	full plot	scavenged
09/22/2023	silver-haired bat	43	241	carcass search	full plot	scavenged
09/23/2023	Indiana bat	41	233	carcass search	full plot	intact
09/23/2023	Indiana bat	14	240	carcass search	full plot	scavenged
09/23/2023	hoary bat	7	240	carcass search	full plot	scavenged
09/23/2023	hoary bat	20	240	carcass search	full plot	scavenged
09/23/2023	hoary bat	30	240	carcass search	full plot	scavenged
09/23/2023	silver-haired bat	56	240	carcass search	full plot	scavenged
09/23/2023	silver-haired bat	43	240	carcass search	full plot	intact
09/25/2023	big brown bat	36	202	carcass search	full plot	scavenged
09/25/2023	big brown bat	29	211	carcass search	full plot	scavenged
09/25/2023	big brown bat	59	215	carcass search	full plot	scavenged
09/25/2023	big brown bat	24	226	carcass search	road and pad	scavenged
09/25/2023	big brown bat	14	226	carcass search ²	road and pad	scavenged
09/25/2023	eastern red bat	30	215	carcass search	full plot	scavenged
09/25/2023	eastern red bat	17	228	carcass search	road and pad	intact
09/25/2023	hoary bat	72	215	carcass search	full plot	scavenged
09/26/2023	big brown bat	17	203	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
09/26/2023	big brown bat	58	249	carcass search	full plot	scavenged
09/26/2023	big brown bat	56	249	carcass search	full plot	scavenged
09/26/2023	eastern red bat	39	249	carcass search	full plot	scavenged
09/26/2023	hoary bat	47	249	carcass search	full plot	scavenged
09/28/2023	big brown bat	56	227	carcass search	full plot	scavenged
09/28/2023	eastern red bat	35	224	carcass search	full plot	scavenged
09/28/2023	eastern red bat	69	225	carcass search	full plot	scavenged
09/28/2023	eastern red bat	17	225	carcass search	full plot	scavenged
09/28/2023	hoary bat	41	224	carcass search	full plot	scavenged
09/28/2023	hoary bat	20	235	carcass search	road and pad	intact
09/28/2023	silver-haired bat	6	214	carcass search	full plot	scavenged
09/28/2023	silver-haired bat	11	228	carcass search	road and pad	intact
09/29/2023	eastern red bat	32	230	carcass search	full plot	scavenged
09/29/2023	eastern red bat	23	230	carcass search	full plot	scavenged
09/29/2023	eastern red bat	40	240	carcass search	full plot	scavenged
09/29/2023	eastern red bat	0	246	carcass search	road and pad	scavenged
10/02/2023	big brown bat	20	236	carcass search	road and pad	scavenged
10/02/2023	silver-haired bat	10	207	carcass search	road and pad	intact
10/03/2023	eastern red bat	36	203	carcass search	full plot	scavenged
10/03/2023	eastern red bat	14	203	carcass search	full plot	scavenged
10/03/2023	eastern red bat	47	210	carcass search	full plot	scavenged
10/03/2023	eastern red bat	71	212	carcass search	full plot	scavenged
10/03/2023	eastern red bat	59	215	carcass search	full plot	scavenged
10/03/2023	silver-haired bat	14	203	carcass search	full plot	scavenged
10/04/2023	eastern red bat	51	224	carcass search	full plot	scavenged
10/04/2023	eastern red bat	33	224	carcass search	full plot	scavenged
10/05/2023	big brown bat	20	227	carcass search	full plot	scavenged
10/05/2023	silver-haired bat	17	205	carcass search	road and pad	intact
10/06/2023	silver-haired bat	12	232	carcass search	full plot	scavenged
10/06/2023	silver-haired bat	8	232	carcass search	full plot	intact
10/06/2023	silver-haired bat	36	232	carcass search	full plot	intact
10/06/2023	silver-haired bat	30	240	carcass search	full plot	scavenged
10/09/2023	eastern red bat	51	212	carcass search	full plot	scavenged
10/09/2023	silver-haired bat	26	202	carcass search	full plot	intact
10/09/2023	silver-haired bat	50	202	carcass search	full plot	scavenged
10/09/2023	silver-haired bat	56	210	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
10/09/2023	silver-haired bat	29	215	carcass search	full plot	intact
10/09/2023	silver-haired bat	33	215	carcass search	full plot	intact
10/09/2023	silver-haired bat	18	215	carcass search	full plot	scavenged
10/09/2023	silver-haired bat	13	246	carcass search	road and pad	intact
10/10/2023	eastern red bat	60	203	carcass search	full plot	scavenged
10/10/2023	eastern red bat	32	203	carcass search	full plot	intact
10/10/2023	silver-haired bat	58	201	carcass search	full plot	intact
10/10/2023	silver-haired bat	9	203	carcass search	full plot	scavenged
10/10/2023	silver-haired bat	48	223	carcass search	full plot	scavenged
10/10/2023	silver-haired bat	53	223	carcass search	full plot	scavenged
10/10/2023	silver-haired bat	26	244	carcass search	full plot	intact
10/10/2023	silver-haired bat	8	244	carcass search	full plot	intact
10/10/2023	silver-haired bat	5	249	carcass search	full plot	intact
10/10/2023	silver-haired bat	44	249	carcass search	full plot	intact
10/12/2023	silver-haired bat	65	224	carcass search	full plot	scavenged
10/13/2023	eastern red bat	21	225	carcass search	full plot	intact
10/13/2023	eastern red bat	50	240	carcass search	full plot	scavenged
10/13/2023	silver-haired bat	69	225	carcass search	full plot	intact
10/13/2023	silver-haired bat	44	232	carcass search	full plot	scavenged
10/13/2023	silver-haired bat	43	241	carcass search	full plot	scavenged
04/13/2023	turkey vulture	11	217	carcass search ²	road and pad	scavenged
04/19/2023	ruby-crowned kinglet	20	216	carcass search	road and pad	scavenged
04/26/2023	horned lark	4	214	carcass search	road and pad	intact
04/26/2023	red-tailed hawk	51	205	carcass search ³	road and pad	intact
05/10/2023	turkey vulture	2	203	carcass search	road and pad	scavenged
05/15/2023	red-tailed hawk	74	202	incidental	full plot	scavenged
05/15/2023	unidentified passerine	65	202	incidental	full plot	intact
05/15/2023	unidentified passerine	83	210	Incidental ²	full plot	feather spot
05/16/2023	brown-headed cowbird	68	225	carcass search	full plot	scavenged
05/16/2023	turkey vulture	32	222	carcass search	full plot	dismembered
05/17/2023	killdeer	35	214	carcass search	full plot	dismembered
05/17/2023	red-tailed hawk	21	227	carcass search	full plot	scavenged
05/18/2023	red-winged blackbird	43	203	carcass search ³	road and pad	dismembered
05/19/2023	magnolia warbler	41	233	carcass search	full plot	dismembered
05/19/2023	red-eyed vireo	44	233	carcass search	full plot	scavenged
05/23/2023	indigo bunting	45	225	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
05/29/2023	yellow-billed cuckoo	74	211	carcass search	full plot	scavenged
06/01/2023	horned lark	42	231	carcass search	full plot	scavenged
06/01/2023	red-tailed hawk	53	231	carcass search	full plot	scavenged
06/09/2023	red-eyed vireo	42	233	carcass search	full plot	intact
06/09/2023	red-tailed hawk	33	233	carcass search	full plot	intact
06/09/2023	red-tailed hawk	40	233	carcass search	full plot	scavenged
06/12/2023	red-tailed hawk	54	202	carcass search	full plot	scavenged
06/14/2023	unidentified buteo	44	225	carcass search	full plot	dismembered
06/14/2023	unidentified warbler	48	225	carcass search	full plot	intact
06/15/2023	red-tailed hawk	59	218	carcass search	full plot	scavenged
06/26/2023	unidentified large bird	23	210	carcass search	full plot	feather spot
07/07/2023	red-tailed hawk	54	249	carcass search	full plot	scavenged
07/19/2023	red-winged blackbird	38	210	carcass search	full plot	scavenged
07/20/2023	red-tailed hawk	76	227	carcass search ²	full plot	scavenged
07/20/2023	turkey vulture	60	227	carcass search	full plot	scavenged
07/21/2023	unidentified blackbird	59	240	carcass search	full plot	feather spot
07/25/2023	cliff swallow	38	249	carcass search	full plot	scavenged
07/25/2023	horned lark	62	223	carcass search	full plot	scavenged
07/25/2023	horned lark	60	249	carcass search	full plot	scavenged
07/25/2023	turkey vulture	18	225	carcass search	full plot	scavenged
07/27/2023	purple martin	59	231	carcass search	full plot	scavenged
07/29/2023	purple martin	53	232	carcass search	full plot	scavenged
08/01/2023	horned lark	23	249	carcass search	full plot	scavenged
08/01/2023	horned lark	27	249	carcass search	full plot	scavenged
08/01/2023	horned lark	29	249	carcass search	full plot	scavenged
08/02/2023	horned lark	23	215	carcass search	full plot	intact
08/02/2023	turkey vulture	72	240	carcass search	full plot	scavenged
08/05/2023	killdeer	77	212	carcass search	full plot	feather spot
08/05/2023	killdeer	83	231	carcass search ³	full plot	feather spot
08/05/2023	mourning dove	8	233	carcass search	full plot	scavenged
08/07/2023	killdeer	81	212	carcass search ³	full plot	feather spot
08/07/2023	red-tailed hawk	29	215	carcass search	full plot	scavenged
08/08/2023	horned lark	78	249	carcass search	full plot	scavenged
08/08/2023	killdeer	56	212	incidental	full plot	feather spot
08/11/2023	horned lark	36	233	carcass search	full plot	scavenged
08/11/2023	purple martin	39	231	carcass search	full plot	scavenged

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
08/15/2023	American goldfinch	51	249	carcass search	full plot	scavenged
08/18/2023	Blackburnian warbler	15	213	carcass search	road and pad	scavenged
08/18/2023	mourning dove	12	230	carcass search	full plot	feather spot
08/20/2023	horned lark	23	212	carcass search	full plot	scavenged
08/20/2023	unidentified blackbird	27	211	carcass search	full plot	feather spot
08/23/2023	horned lark	59	249	carcass search	full plot	feather spot
08/24/2023	Blackburnian warbler	38	246	carcass search	road and pad	scavenged
08/24/2023	killdeer	11	224	carcass search	full plot	scavenged
08/26/2023	horned lark	32	233	carcass search	full plot	scavenged
08/26/2023	mourning dove	26	230	carcass search	full plot	feather spot
08/28/2023	ruby-throated hummingbird	37	213	carcass search	road and pad	scavenged
08/29/2023	horned lark	57	210	carcass search	full plot	feather spot
08/29/2023	purple martin	63	212	carcass search	full plot	scavenged
08/30/2023	purple martin	63	249	carcass search	full plot	scavenged
08/31/2023	horned lark	26	224	carcass search	full plot	feather spot
08/31/2023	turkey vulture	51	227	carcass search	full plot	intact
09/01/2023	mourning dove	29	230	carcass search	full plot	feather spot
09/01/2023	mourning dove	87	232	carcass search ³	full plot	feather spot
09/01/2023	turkey vulture	44	232	carcass search	full plot	scavenged
09/01/2023	turkey vulture	20	233	carcass search	full plot	dismembered
09/01/2023	turkey vulture	41	233	carcass search	full plot	scavenged
09/04/2023	black-and-white warbler	23	238	carcass search	road and pad	scavenged
09/04/2023	horned lark	63	210	carcass search	full plot	feather spot
09/04/2023	magnolia warbler	54	202	carcass search	full plot	scavenged
09/04/2023	red-headed woodpecker	10	207	carcass search ²	road and pad	scavenged
09/05/2023	cliff swallow	30	223	carcass search	full plot	scavenged
09/06/2023	ruby-throated hummingbird	35	249	carcass search	full plot	scavenged
09/07/2023	Blackburnian warbler	43	227	carcass search	full plot	scavenged
09/07/2023	horned lark	14	225	carcass search	full plot	scavenged
09/07/2023	turkey vulture	41	227	carcass search	full plot	scavenged
09/10/2023	horned lark	15	212	carcass search	full plot	feather spot
09/10/2023	killdeer	77	212	carcass search	full plot	intact
09/10/2023	unidentified swallow	50	212	carcass search	full plot	feather spot
09/11/2023	Tennessee warbler	53	249	carcass search	full plot	intact
09/11/2023	unidentified warbler	46	201	carcass search	full plot	feather spot
09/13/2023	magnolia warbler	114	232	Incidental ²	full plot	intact

Appendix A1. Carcasses found at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Found Date	Species¹	Distance from Turbine (m)	Turbine	Search Type	Plot Type	Physical Condition
09/14/2023	horned lark	4	224	carcass search	full plot	intact
09/14/2023	horned lark	56	224	carcass search	full plot	feather spot
09/14/2023	ruby-throated hummingbird	43	227	carcass search	full plot	scavenged
09/18/2023	chimney swift	55	239	carcass search ²	road and pad	scavenged
09/20/2023	northern bobwhite	20	202	carcass search	full plot	scavenged
09/20/2023	unidentified passerine	15	202	carcass search	full plot	scavenged
09/20/2023	unidentified passerine	32	212	carcass search	full plot	scavenged
09/20/2023	unidentified warbler	59	202	carcass search	full plot	scavenged
09/21/2023	horned lark	77	249	carcass search	full plot	feather spot
09/21/2023	palm warbler	60	201	carcass search	full plot	scavenged
09/21/2023	unidentified passerine	17	201	carcass search	full plot	feather spot
09/22/2023	horned lark	33	224	carcass search	full plot	scavenged
09/22/2023	turkey vulture	49	224	incidental	full plot	intact
09/23/2023	horned lark	39	230	carcass search	full plot	scavenged
09/23/2023	horned lark	30	233	carcass search	full plot	scavenged
09/23/2023	magnolia warbler	56	233	carcass search	full plot	scavenged
09/23/2023	pine warbler	76	240	carcass search	full plot	intact
09/23/2023	red-tailed hawk	53	232	carcass search	full plot	intact
09/25/2023	turkey vulture	2	225	incidental	full plot	intact
09/26/2023	Tennessee warbler	42	201	carcass search	full plot	scavenged
09/28/2023	horned lark	15	227	carcass search	full plot	dismembered
09/28/2023	magnolia warbler	69	207	carcass search	road and pad	intact
09/28/2023	turkey vulture	48	225	carcass search	full plot	scavenged
09/28/2023	unidentified passerine	9	224	carcass search	full plot	feather spot
09/29/2023	purple martin	51	240	carcass search	full plot	scavenged
09/29/2023	ruby-throated hummingbird	3	230	carcass search	full plot	scavenged
10/04/2023	chimney swift	59	244	carcass search	full plot	scavenged
10/04/2023	horned lark	27	223	carcass search	full plot	dismembered
10/05/2023	ruby-throated hummingbird	27	249	carcass search	full plot	scavenged
10/10/2023	European starling	44	201	carcass search	full plot	intact
10/12/2023	horned lark	80	224	carcass search	full plot	scavenged
10/12/2023	turkey vulture	54	233	carcass search	full plot	scavenged
10/13/2023	mourning dove	1	232	carcass search	full plot	intact

¹ Birds found during the study period were not included in analysis.

² Carcass was found outside the search area and was not included in analysis.

Appendix A2. Summary of searches and bat fatalities recorded by season and search area type at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Season	Search Area Type¹	Number of Searched Turbines	Number of Searches	Total Number of Bats Recorded²
Spring	100-m road and pad	49	291	12
	100-m road and pad	14	299	13
Summer	80-m cleared plot (1*; 1**)	13	141	45
	80-m uncleared plot	2	22	2
	100-m road and pad	28	607	66
Fall	80-m cleared plot (4*)	15	160	184
	80-m uncleared plot (1*; 2**)	5	55	69
Overall		49	1,575	391

¹ All 80-meter (m) plots were searched by detection-dog teams, and road and pads were searched by technicians.

² Four hundred sixteen bats in total were found. Twenty-five bats were excluded from analysis.

* Number of Indiana bats collected at each plot type by season.

** Number of evening bats collected at each plot type by season

Appendix B. Searcher Efficiency and Carcass Persistence Model Fitting Results

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Appendix B1. Searcher efficiency results by season and plot type at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Season	Plot Type	Number Placed	Number Available	Number Found	% Found
Spring	100-m road and pad	16	15	14	93.33
Summer	100-m road and pad	18	15	12	80.00
	80-m cleared plot	15	15	15	100
Fall	80-m uncleared plot	11	10	8	80.00
	100-m road and pad	15	15	14	93.33
	80-m cleared plot	17	15	12	80.00
	80-m uncleared plot	16	14	11	78.57
Overall Full Plots (Cleared and Uncleared)		59	54	46	85.19
Overall Roads and Pads		49	45	40	88.89
Overall		108	99	86	86.87

¹. Uncleared and cleared plots were combined for analysis.

m = meter

Appendix B2. Searcher efficiency models for detection-dog teams at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Covariates	k Value	AICc	Delta AICc
No Covariates	0.67	47.38	0*
Season	0.67	47.74	0.36
Plot Search Type Both Turbines	0.67	48.30	0.92
Plot Search Type + Season Both Turbines	0.67	48.95	1.57
Season * Plot Search Type Both Turbines	0.67	49.40	2.02

* Selected model.

k =- detection reduction factor; AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix B3. Searcher efficiency models for technicians at the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Covariates	k Value	AICc	Delta AICc
No Covariates	0.67	33.49	0*
Season	0.67	36.29	2.80

* Selected model.

k = detection reduction factor; AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix B4. Number of carcass persistence trial carcasses placed by season and plot type at the Headwaters II Wind Farm, Randolph County, Indiana from April 3 – October 15, 2023.

Season	Search Area Type¹	Number of Carcasses Placed
Spring	100-m road and pad	15
Summer	100-m road and pad	15
	80-m cleared plot	15
Fall	80-m uncleared plot	5
	100-m road and pad	15
	80-m cleared plot	15
Overall 100-m Road and Pads		45
Overall 80-m Full Plots		50
Overall		95

¹. Uncleared and cleared plots were combined for analysis.

Appendix B5. Carcass persistence models with covariates and distributions for bats at 80-meter full plots at the Headwaters II Wind Farm, Randolph County, Indiana from April 3 – October 15, 2023.

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
No Covariates	No Covariates	lognormal	200.32	0*
Season	No Covariates	lognormal	200.61	0.29
No Covariates	No Covariates	loglogistic	200.73	0.41
Season	No Covariates	loglogistic	201.13	0.81
No Covariates	Season	lognormal	202.43	2.11
Season	Season	lognormal	202.91	2.59
No Covariates	Season	loglogistic	202.93	2.61
Season	Season	loglogistic	203.47	3.15
No Covariates	No Covariates	Weibull	203.52	3.2
Season	No Covariates	Weibull	204.15	3.83
No Covariates	Season	Weibull	205.38	5.06
Season	Season	Weibull	206.27	5.95
Season	–	exponential	229.22	28.9
No Covariates	–	exponential	229.69	29.37

* Selected model.

AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix B6. Carcass persistence models with covariates and distributions for road and pads at the Headwaters II Wind Farm, Randolph County, Indiana from April 3 – October 15, 2023.

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
Season	No Covariates	lognormal	185.41	0
No Covariates	No Covariates	lognormal	186.21	0.8*
Season	No Covariates	loglogistic	186.28	0.87
No Covariates	No Covariates	loglogistic	186.55	1.14
Season	No Covariates	Weibull	187.95	2.54
No Covariates	No Covariates	Weibull	188.81	3.4
Season	Season	lognormal	190.24	4.83
No Covariates	Season	lognormal	190.28	4.87
No Covariates	Season	loglogistic	190.71	5.3
Season	Season	loglogistic	191.17	5.76
Season	Season	Weibull	192.86	7.45
No Covariates	Season	Weibull	193.19	7.78
Season	–	exponential	210.24	24.83
No Covariates	–	exponential	213.69	28.28

* Selected model.

AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

Appendix B7. Carcass persistence top model with covariates, distributions, and model parameters for the Headwaters II Wind Farm, Randolph County, Indiana from April 3 – October 15, 2023.

Plot Search Type	Distribution	Estimated Median		
		Removal Times (days)	Parameter 1	Parameter 2
Road and pad	lognormal ¹	5.34	shape = 1.675	scale = 2.347
Full plot	lognormal ¹	8.06	shape = 2.087	scale = 2.501

¹: Parameterization follows the base R parameterization for this distribution.

**Appendix C. Truncated Weighted Maximum Likelihood Search Area Adjustment Model
Fitting Results**

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Appendix C1. Number and percent (%) of bat carcasses found and total included in the search area adjustment calculation for the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Species	Included in Search Area Adjustment		Outside Search Area ¹		Outside Study Period ¹		Total	
	Total	%	Total	%	Total	%	Total	%
eastern red bat	169	43.22	3	30.0	9	60.0	181	43.5
silver-haired bat	103	26.34	2	20.0	3	20.0	108	26.0
big brown bat	65	16.62	3	30.0	3	20.0	71	17.1
hoary bat	42	10.74	2	20.0	0	0	44	10.6
Indiana bat	6	1.53	0	0	0	0	6	1.4
evening bat	3	0.77	0	0	0	0	3	0.7
unidentified <i>Lasiurus</i> spp.	2	0.51	0	0	0	0	2	0.5
unidentified bat ²	1	0.26	0	0	0	0	1	0.2
Total	391	100	10	100	15	100	416	100

¹ Carcasses not included in analysis

² Unidentified bat was scavenged (removed from plot) prior to species confirmation due to a safety standdown in the field. Carcass did not exhibit characteristics resembling a *Myotis* spp.

Sums of values may not equal totals shown due to rounding.

Appendix C2. Search area adjustment models for bats from the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

3.6-MW Distribution	4.3-MW Distribution	Pooled Distribution	AICc	DeltaAICc
gamma	Gompertz	–	14,374.56	0
Weibull	Gompertz	–	14,374.56	0
Gompertz	Gompertz	–	14,375.74	1.17
normal	Gompertz	–	14,375.74	1.18
gamma	normal	–	14,439.20	64.63
Weibull	normal	–	14,439.20	64.63
Gompertz	normal	–	14,440.37	65.81
normal	normal	–	14,440.38	65.81
gamma	Weibull	–	14,508.94	134.37
Weibull	Weibull	–	14,508.94	134.37
Gompertz	Weibull	–	14,510.11	135.55
normal	Weibull	–	14,510.11	135.55
gamma	gamma	–	14,596.02	221.46
Weibull	gamma	–	14,596.03	221.46
Gompertz	gamma	–	14,597.20	222.63
normal	gamma	–	14,597.20	222.64
–	–	Weibull	14,746.07	371.51*
–	–	normal	14,752.61	378.05
–	–	gamma	14,763.98	389.42
–	–	Gompertz	14,765.56	390.99

* Selected model.

AICc = corrected Akaike Information Criterion; Delta AICc = change in AICc.

All of the 3.6-megawatt (MW) models failed validity checks due to issues with negative variance, infinite variance, and failure to meet standards for minimum cumulative probability within 100 meters of the turbine. The selected model, the pooled Weibull distribution, had the lowest AICc among the pooled models.

Appendix C3. Truncated weighted maximum (TWL) likelihood search area adjustment estimates by turbine and plot type for the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023 (Bat n = 391).

Sample Size ¹	Turbine Size (MW) ²	Number of Searches	Area Adjustment	Search Area Type	Distribution	Parameter 1	Parameter 2
47	3.6	117	0.81	full plot	Weibull	1.6820	56.9782
253	4.3	261	0.81	full plot	Weibull	1.6820	56.9782
16	3.6	274	0.11	road and pad	Weibull	1.6820	56.9782
75	4.3	923	0.11	road and pad	Weibull	1.6820	56.9782

¹ Bat carcasses input for the TWL.

² Due to 3.6-megawatt (MW) turbine models for failing validity checks due to issues with negative variance, infinite variance, and failure to meet standards for minimum cumulative probability within 100 meters of the turbine. Turbine types were combined for TWL analysis (see Appendix C4).

Appendix C4. Truncated weighted maximum likelihood search area estimates for the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Search Area Type	Distribution	Parameter 1	Parameter 2	Search Area Adjustment
Full plot	Weibull	1.68	56.98	0.81
Road and pad	Weibull	1.68	56.98	0.11

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

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Appendix D1. Inputs needed to run Evidence of Absence (EoA): Single Class Module for the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.¹

Season ⁵	Plot Type ⁴	Aided Search	Search Interval (I; in days)	Number of Searches	Spatial Coverage (a)	Searcher Efficiency		Carcass Persistence ²	
						Carcasses Available	Carcasses Found	Shape (α)	Scale (β)
Spring (April 1 – May 15)	Road and pad	none	7	7	0.114	45	40	5.51	1.68
Summer 1 (May 16 – July 6)	Full plot	dog ³	7	9	0.809	54	46	6.26	2.09
	Road and pad	none	3.5	17	0.114	45	40	5.51	1.68
Summer 2 (July 7 – 29)	Full plot	dog ³	7	4	0.809	54	46	6.26	2.09
	Road and pad	none	3	7	0.114	45	40	5.51	1.68
Fall 1 (August 1 – 17)	Full plot	dog ³	6.5	4	0.809	54	46	6.26	2.09
	Road and pad	none	3	7	0.114	45	40	5.51	1.68
Fall 2 (August 18 – October 15)	Full plot	dog ³	7	9	0.809	54	46	6.26	2.09
	Road and pad	none	3.5	17	0.114	45	40	5.51	1.68

¹ The detection reduction factor k was assumed to equal 0.67 for all strata, per Huso et al. (2017).

² A lognormal distribution was used for carcass persistence on technician-searched 100-m road and pad plots. The 95% upper and lower confidence intervals (CIs) on β for technician searches were set to 0.95 and 2.4, respectively.

³ A lognormal distribution was used for carcass persistence on all dog-aided full plot searches. The 95% upper and lower CIs on β for dog-aided searches were set to 1.34 and 2.84, respectively.

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.

⁵ Summer and fall were split into separate seasons to account for changes in searched turbines. In summer 1 there were 15 full plots and 14 road and pad plots. In summer 2 there were 15 full plots and 13 road and pad plots. Fall 1 and fall 2 both had 20 full plots and 28 road and pad plots; however, Turbine 222 was unsearched and was only operational during the last two weeks of fall 2.

m = meter.

Appendix D2. Inputs needed to run Evidence of Absence (EoA) model to combine across plot types within each season: Multiple Class Module for the Headwaters II Wind Farm, Randolph County, Indiana, from April 3 – October 15, 2023.

Season ²	Plot Type ¹	Ba	Bb	Within-Season Sampling Fraction	Within-Season Relative Operations	Weights (DWP)
Spring (April 1 – May 15)	road and pad	87.53	1,274.94	1	1	1
Summer 1 (May 16 – July 6)	road and pad	139.62	1,697.53	0.48	1	0.25
	full plot	62.03	64.99	0.52	1	0.26
Summer 2 (July 7 – 29)	road and pad	157.36	1,864.5	0.45	1	0.23
	full plot	60.63	66.06	0.52	1	0.26
	unsearched	0.01	1,000	0.03	0.04	0
Fall 1 (August 1 – 17)	road and pad	157.36	1,864.5	0.58	1	0.29
	full plot	64.83	68.62	0.42	1	0.21
	road and pad	139.62	1,697.53	0.57	1	0.29
Fall 2 (August 18 – October 15)	full plot	62.03	64.99	0.41	1	0.21
	unsearched	0.01	1,000	0.02	0.32	0

¹ 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.

² Summer and fall were split into separate seasons to account for changes in searched turbines. In summer 1 there were 15 full plots and 14 road and pad plots. In summer 2 there were 15 full plots and 13 road and pad plots. Fall 1 and fall 2 both had 20 full plots and 28 road and pad plots; however, Turbine 222 was unsearched and was only operational during the last two weeks of fall 2.

m = meter; DWP = density-weighted proportion.

Appendix D3. Inputs needed to run Evidence of Absence model to combine across seasons: Multiple Class Module for the Headwaters II Wind Farm, Indiana, from April 3 – October 15, 2023.

Season	Ba	Bb	Weights (DWP)
Spring (April 1 – May 15)	87.53	1,274.94	0.082
Summer 1 (May 16 – July 6)	111.70	274.43	0.169
Summer 2 (July 7 – 29)	106.25	257.49	0.081
Fall 1 (August 1 – 17)	137.80	418.24	0.147
Fall 2 (August 18 – October 15)	131.33	402.18	0.520

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, from 2022 – 2023.

Year	Ba	Bb	Weights (ρ)
2022	293.12	660.05	0.92
2023	369.9751	1,155.9061	1.0

Appendix D5. Inputs needed to run Evidence of Absence model to combine across years for the summer trigger: Multiple Years Module for the Headwaters II Wind Farm in Randolph County, Indiana, from 2022 – 2023.

Year	Ba	Bb	Weights (ρ)
2022	359.2813	769.3605	0.94
2023	196.0188	479.4881	1.0

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

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EoA, v2.0.7 - Single Class Module

Edit Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd)

Formula

Search interval (I)

Number of searches

Custom

span = 182, I (mean) = 7

Spatial coverage (a)

Temporal coverage (v)

Searcher Efficiency

Carcasses available for several searches

95% CI: $p \in [0.533, 0.673]$, $k \in [0.652, 0.819]$

$\hat{p} = 0.62$, $\hat{k} = 0.736$

Carcasses removed after one search

Carcasses available

Carcasses found

$\hat{p} = 0.889$, with 95% CI = [0.773, 0.956]

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

Persistence Distribution

Use field trials to estimate parameters

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

$r = 0.531$ for $I_r = 7$, with 95% CI: $r \in [0.421, 0.658]$, $\beta \in [0.488, 1.854]$

Enter parameter estimates manually

Parameters

shape (α)

scale (β) lwr upr

$r = 0.608$ for $I_r = 7$, with 95% CI: $r \in [0.493, 0.714]$

Fatality estimation (M, λ)

Carcass Count (X) One-sided CI (M*) Two-sided CI

Credibility level (1 - α)

Estimated detection probability (g)

Summary statistics for estimation of detection probability (g)

Results:

Full site for full year

Estimated $g = 0.0645$, 95% CI = [0.0523, 0.0778]

Fitted beta distribution parameters for estimated g : $B_a = 92.0324$, $B_b = 1335.429$

Full site for monitored period, 05-Apr-2023 through 24-May-2023

Estimated $g = 0.0645$, 95% CI = [0.0523, 0.0778]

Fitted beta distribution parameters for estimated g : $B_a = 92.0324$, $B_b = 1335.429$

Temporal coverage (within year) = 1

Searched area for monitored period, 05-Apr-2023 through 24-May-2023

Estimated $g = 0.566$, 95% CI = [0.454, 0.674]

Fitted beta distribution parameters for estimated g : $B_a = 43.1241$, $B_b = 33.1294$

Input:

Search parameters

trial carcasses placed = 45, carcasses found = 40

estimated searcher efficiency: $p = 0.889$, 95% CI = [0.773, 0.956]

$k = 0.67$

Search schedule: Search interval (I) = 7, number of searches = 7, span = 49

spatial coverage: 0.114 temporal coverage: 1

Carcass persistence:

Lognormal persistence distribution

shape (α) = 5.508 and scale (β) = 1.675

95% CI β = [0.946, 2.403]

$r = 0.608$ for $I_r = 7$ with 95% CI = [0.493, 0.714]

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 2023, 100-meter road and pad searches at 13 3.6-megawatt turbines with a blade length of 67 meters, and 36 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)

Formula

Search interval (I)

Number of searches

Custom

span = 182, I (mean) = 7

Spatial coverage (a)

Temporal coverage (v)

Searcher Efficiency

Carcasses available for several searches

95% CIs: $p \in [0.533, 0.673]$, $k \in [0.652, 0.819]$

$\hat{p} = 0.62$, $\hat{k} = 0.736$

Carcasses removed after one search

Carcasses available

Carcasses found

$\hat{p} = 0.889$, with 95% CI = [0.773, 0.956]

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

Persistence Distribution

Use field trials to estimate parameters

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

$r = 0.653$ for $I_r = 3.5$, with 95% CIs: $r \in [0.532, 0.775]$, $\beta \in [0.488, 1.854]$

Enter parameter estimates manually

Parameters

shape (α)

scale (β) lwr upr

$r = 0.709$ for $I_r = 3.5$, with 95% CI: $r \in [0.602, 0.801]$

Fatality estimation (M, λ)

Carcass Count (X) One-sided CI (M*) Two-sided CI

Credibility level (1 - α)

Estimated detection probability (g)

Summary statistics for estimation of detection probability (g)

Results:

Full site for full year

Estimated $g = 0.076$, 95% CI = [0.064, 0.089]

Fitted beta distribution parameters for estimated g : $B_a = 131.5852$, $B_b = 1599.1581$

Full site for monitored period, 16-May-2023 through 14-Jul-2023

Estimated $g = 0.076$, 95% CI = [0.064, 0.089]

Fitted beta distribution parameters for estimated g : $B_a = 131.5852$, $B_b = 1599.1581$

Temporal coverage (within year) = 1

Searched area for monitored period, 16-May-2023 through 14-Jul-2023

Estimated $g = 0.667$, 95% CI = [0.556, 0.769]

Fitted beta distribution parameters for estimated g : $B_a = 48.8549$, $B_b = 24.4067$

Input:

Search parameters

trial carcasses placed = 45, carcasses found = 40

estimated searcher efficiency: $p = 0.889$, 95% CI = [0.773, 0.956]

$k = 0.67$

Search schedule: Search interval (I) = 3.5, number of searches = 17, span = 59.5

spatial coverage: 0.114 temporal coverage: 1

Carcass persistence:

Lognormal persistence distribution

shape (α) = 5.508 and scale (β) = 1.675

95% CI β = [0.946, 2.403]

$r = 0.709$ for $I_r = 3.5$ with 95% CI = [0.602, 0.801]

Parameters entered manually

Uniform arrivals

Appendix E2. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer1 2023, road and pad searches at two 3.6-megawatt turbines with a blade length of 67 meters, and 12 4.2-megawatt turbines with a blade length of 74 meters searched at a 3.5-day interval.

EoA, v2.0.7 - Single Class Module

Edit Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd)

Formula

Search interval (I)

Number of searches

Custom

span = 182, I (mean) = 7

Spatial coverage (a)

Temporal coverage (v)

Searcher Efficiency

Carcasses available for several searches

95% CI: $p \in [0.533, 0.673]$, $k \in [0.652, 0.819]$

$\hat{p} = 0.62$, $\hat{k} = 0.736$

Carcasses removed after one search

Carcasses available

Carcasses found

$\hat{p} = 0.889$, with 95% CI = [0.773, 0.956]

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

Persistence Distribution

Use field trials to estimate parameters

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

$r = 0.679$ for $l_r = 3$, with 95% CI: $r \in [0.564, 0.79]$, $\beta \in [0.488, 1.854]$

Enter parameter estimates manually

Parameters

shape (α)

scale (β) lwr upr

$r = 0.73$ for $l_r = 3$, with 95% CI: $r \in [0.626, 0.818]$

Fatality estimation (M, λ)

Carcass Count (X) One-sided CI (M*) Two-sided CI

Credibility level (1 - α)

Estimated detection probability (g)

Summary statistics for estimation of detection probability (g)

Results:

Full site for full year

Estimated $g = 0.0779$, 95% CI = [0.0665, 0.0901]

Fitted beta distribution parameters for estimated g : $B_a = 154.3786$, $B_b = 1826.6348$

Full site for monitored period, 07-Jul-2023 through 28-Jul-2023

Estimated $g = 0.0779$, 95% CI = [0.0665, 0.0901]

Fitted beta distribution parameters for estimated g : $B_a = 154.3786$, $B_b = 1826.6348$

Temporal coverage (within year) = 1

Searched area for monitored period, 07-Jul-2023 through 28-Jul-2023

Estimated $g = 0.684$, 95% CI = [0.576, 0.782]

Fitted beta distribution parameters for estimated g : $B_a = 52.8031$, $B_b = 24.4392$

Input:

Search parameters

trial carcasses placed = 45, carcasses found = 40

estimated searcher efficiency: $p = 0.889$, 95% CI = [0.773, 0.956]

$k = 0.67$

Search schedule: Search interval (I) = 3, number of searches = 7, span = 21

spatial coverage: 0.114 temporal coverage: 1

Carcass persistence:

Lognormal persistence distribution

shape (α) = 5.508 and scale (β) = 1.675

95% CI β = [0.946, 2.403]

$r = 0.73$ for $l_r = 3$ with 95% CI = [0.626, 0.818]

Parameters entered manually

Uniform arrivals

Appendix E3. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer2 2023, road and pad searches at two 3.6-megawatt turbines with a blade length of 67 meters, and 12 4.2-megawatt turbines with a blade length of 74 meters searched at a 3.5-day interval.

EoA, v2.0.7 - Single Class Module

Edit Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd)

Formula

Search interval (I)

Number of searches

Custom

span = 182, I (mean) = 7

Spatial coverage (a)

Temporal coverage (v)

Searcher Efficiency

Carcasses available for several searches

95% CIs: p e [0.533, 0.673], k e [0.652, 0.819]

$\hat{p} = 0.62, \hat{k} = 0.736$

Carcasses removed after one search

Carcasses available

Carcasses found

$\hat{p} = 0.852$, with 95% CI = [0.74, 0.927]

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

Persistence Distribution

Use field trials to estimate parameters

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

r = 0.531 for Ir = 7, with 95% CIs: r = [0.412, 0.655], β = [0.488, 1.854]

Enter parameter estimates manually

Parameters

Exponential

Weibull

Log-Logistic

Lognormal

shape (α)

scale (β) lwr upr

r = 0.661 for Ir = 7, with 95% CI: r e [0.553, 0.758]

Fatality estimation (M, λ)

Carcass Count (X) One-sided CI (M*) Two-sided CI

Credibility level (1 - α)

Estimated detection probability (g)

Summary statistics for estimation of detection probability (g)

Results:

Full site for full year

Estimated g = 0.487, 95% CI = [0.399, 0.576]

Fitted beta distribution parameters for estimated g: Ba = 59.5108, Bb = 62.6185

Full site for monitored period, 16-May-2023 through 18-Jul-2023

Estimated g = 0.487, 95% CI = [0.399, 0.576]

Fitted beta distribution parameters for estimated g: Ba = 59.5108, Bb = 62.6185

Temporal coverage (within year) = 1

Searched area for monitored period, 16-May-2023 through 18-Jul-2023

Estimated g = 0.602, 95% CI = [0.491, 0.709]

Fitted beta distribution parameters for estimated g: Ba = 45.9916, Bb = 30.3641

Input:

Search parameters

trial carcasses placed = 54, carcasses found = 46

estimated searcher efficiency: p = 0.852, 95% CI = [0.74, 0.927]

k = 0.67

Search schedule: Search interval (I) = 7, number of searches = 9, span = 63

spatial coverage: 0.809 temporal coverage: 1

Carcass persistence:

Lognormal persistence distribution

shape (α) = 6.255 and scale (β) = 2.087

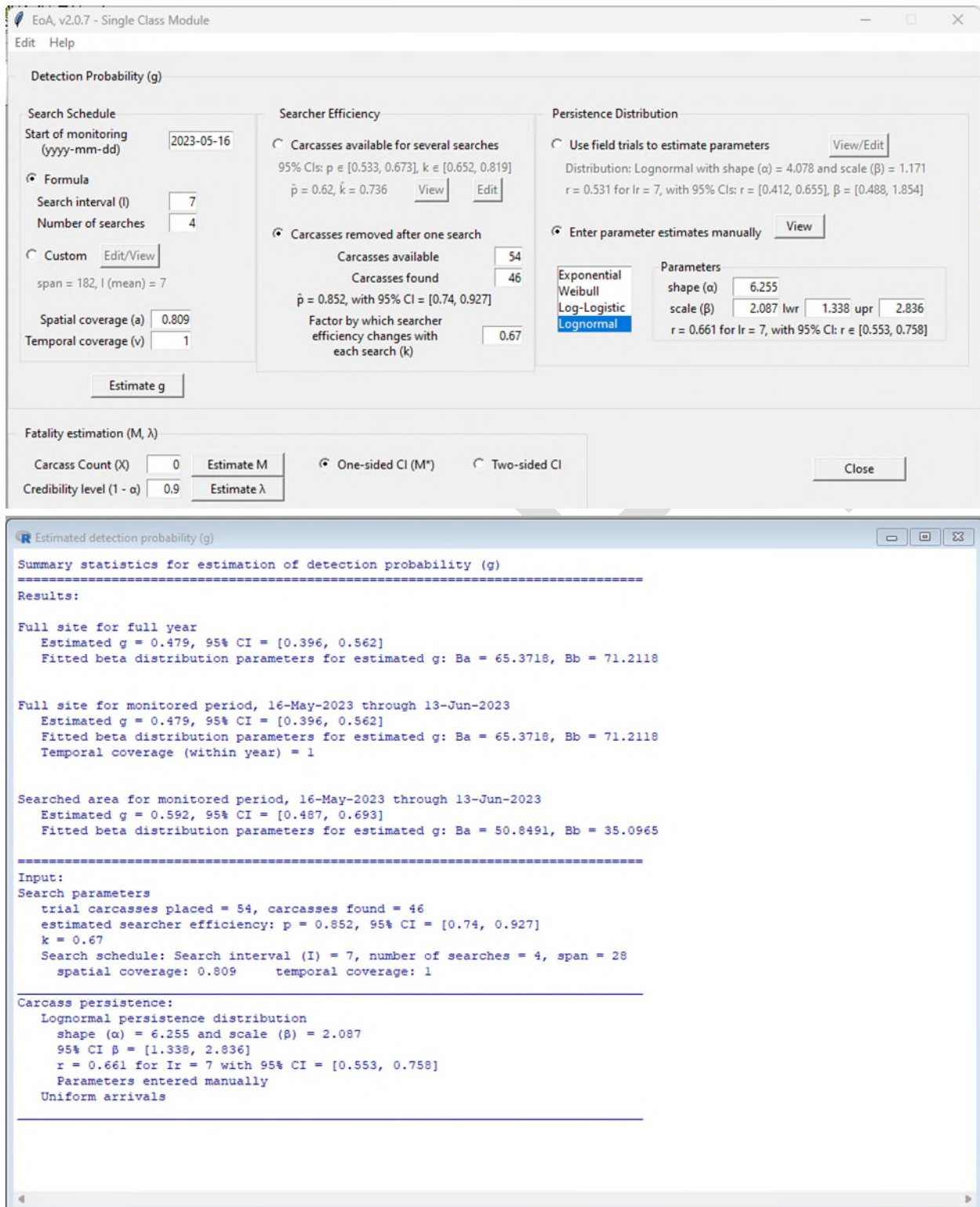
95% CI β = [1.338, 2.836]

r = 0.661 for Ir = 7 with 95% CI = [0.553, 0.758]

Parameters entered manually

Uniform arrivals

Appendix E4. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Summer1 2023, 80-meter full plot, dog-aided searches at five 3.6-megawatt turbines, and 10 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 Summer2 2023, 80-meter full plot, dog-aided searches at five 3.6-megawatt turbines, and 10 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)

Formula

Search interval (I)

Number of searches

Custom

span = 182, I (mean) = 7

Spatial coverage (a)

Temporal coverage (v)

Searcher Efficiency

Carcasses available for several searches

95% CI: $p \in [0.533, 0.673]$, $k \in [0.652, 0.819]$

$\hat{p} = 0.62$, $\hat{k} = 0.736$

Carcasses removed after one search

Carcasses available

Carcasses found

$\hat{p} = 0.889$, with 95% CI = [0.773, 0.956]

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

Persistence Distribution

Use field trials to estimate parameters

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

$r = 0.679$ for $l_r = 3$, with 95% CI: $r \in [0.558, 0.796]$, $\beta \in [0.488, 1.854]$

Enter parameter estimates manually

Parameters

shape (α)

scale (β) lwr upr

$r = 0.73$ for $l_r = 3$, with 95% CI: $r \in [0.626, 0.818]$

Fatality estimation (M, λ)

Carcass Count (X) One-sided CI (M*) Two-sided CI

Credibility level (1 - α)

Estimated detection probability (g)

Summary statistics for estimation of detection probability (g)

Results:

Full site for full year

Estimated $g = 0.0772$, 95% CI = [0.0661, 0.089]

Fitted beta distribution parameters for estimated g : $B_a = 160.1317$, $B_b = 1914.6014$

Full site for monitored period, 01-Aug-2023 through 22-Aug-2023

Estimated $g = 0.0772$, 95% CI = [0.0661, 0.089]

Fitted beta distribution parameters for estimated g : $B_a = 160.1317$, $B_b = 1914.6014$

Temporal coverage (within year) = 1

Searched area for monitored period, 01-Aug-2023 through 22-Aug-2023

Estimated $g = 0.677$, 95% CI = [0.573, 0.773]

Fitted beta distribution parameters for estimated g : $B_a = 56.3504$, $B_b = 26.8813$

Input:

Search parameters

trial carcasses placed = 45, carcasses found = 40

estimated searcher efficiency: $p = 0.889$, 95% CI = [0.773, 0.956]

$k = 0.67$

Search schedule: Search interval (I) = 3, number of searches = 7, span = 21

spatial coverage: 0.114 temporal coverage: 1

Carcass persistence:

Lognormal persistence distribution

shape (α) = 5.508 and scale (β) = 1.675

95% CI $\beta = [0.946, 2.403]$

$r = 0.73$ for $l_r = 3$ with 95% CI = [0.626, 0.818]

Parameters entered manually

Uniform arrivals

Appendix E6. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Fall1 2023, 100-meter road and pad searches at seven 3.6-megawatt turbines with a blade length of 67 meters, and 21 4.2-megawatt turbines with a blade length of 74 meters, searched at a 3.5-day interval.

EoA, v2.0.7 - Single Class Module

Edit Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd)

Formula

Search interval (I)

Number of searches

Custom

span = 182, l (mean) = 7

Spatial coverage (a)

Temporal coverage (v)

Searcher Efficiency

Carcasses available for several searches

95% CIs: $p \in [0.533, 0.673]$, $k \in [0.652, 0.819]$

$\hat{p} = 0.62$, $\hat{k} = 0.736$

Carcasses removed after one search

Carcasses available

Carcasses found

$\hat{p} = 0.889$, with 95% CI = [0.773, 0.956]

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

Persistence Distribution

Use field trials to estimate parameters

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

$r = 0.653$ for $l_r = 3.5$, with 95% CIs: $r \in [0.541, 0.772]$, $\beta \in [0.488, 1.854]$

Enter parameter estimates manually

Parameters

shape (α)

scale (β) lwr upr

$r = 0.709$ for $l_r = 3.5$, with 95% CI: $r \in [0.602, 0.801]$

Fatality estimation (M, λ)

Carcass Count (X) One-sided CI (M*) Two-sided CI

Credibility level (1 - α)

Estimated detection probability (g)

Summary statistics for estimation of detection probability (g)

Results:

Full site for full year

Estimated $g = 0.0757$, 95% CI = [0.064, 0.0883]

Fitted beta distribution parameters for estimated g : $B_a = 137.5131$, $B_b = 1677.9237$

Full site for monitored period, 18-Aug-2023 through 16-Oct-2023

Estimated $g = 0.0757$, 95% CI = [0.064, 0.0883]

Fitted beta distribution parameters for estimated g : $B_a = 137.5131$, $B_b = 1677.9237$

Temporal coverage (within year) = 1

Searched area for monitored period, 18-Aug-2023 through 16-Oct-2023

Estimated $g = 0.664$, 95% CI = [0.555, 0.766]

Fitted beta distribution parameters for estimated g : $B_a = 50.0173$, $B_b = 25.2583$

Input:

Search parameters

trial carcasses placed = 45, carcasses found = 40

estimated searcher efficiency: $p = 0.889$, 95% CI = [0.773, 0.956]

$k = 0.67$

Search schedule: Search interval (I) = 3.5, number of searches = 17, span = 59.5

spatial coverage: 0.114 temporal coverage: 1

Carcass persistence:

Lognormal persistence distribution

shape (α) = 5.508 and scale (β) = 1.675

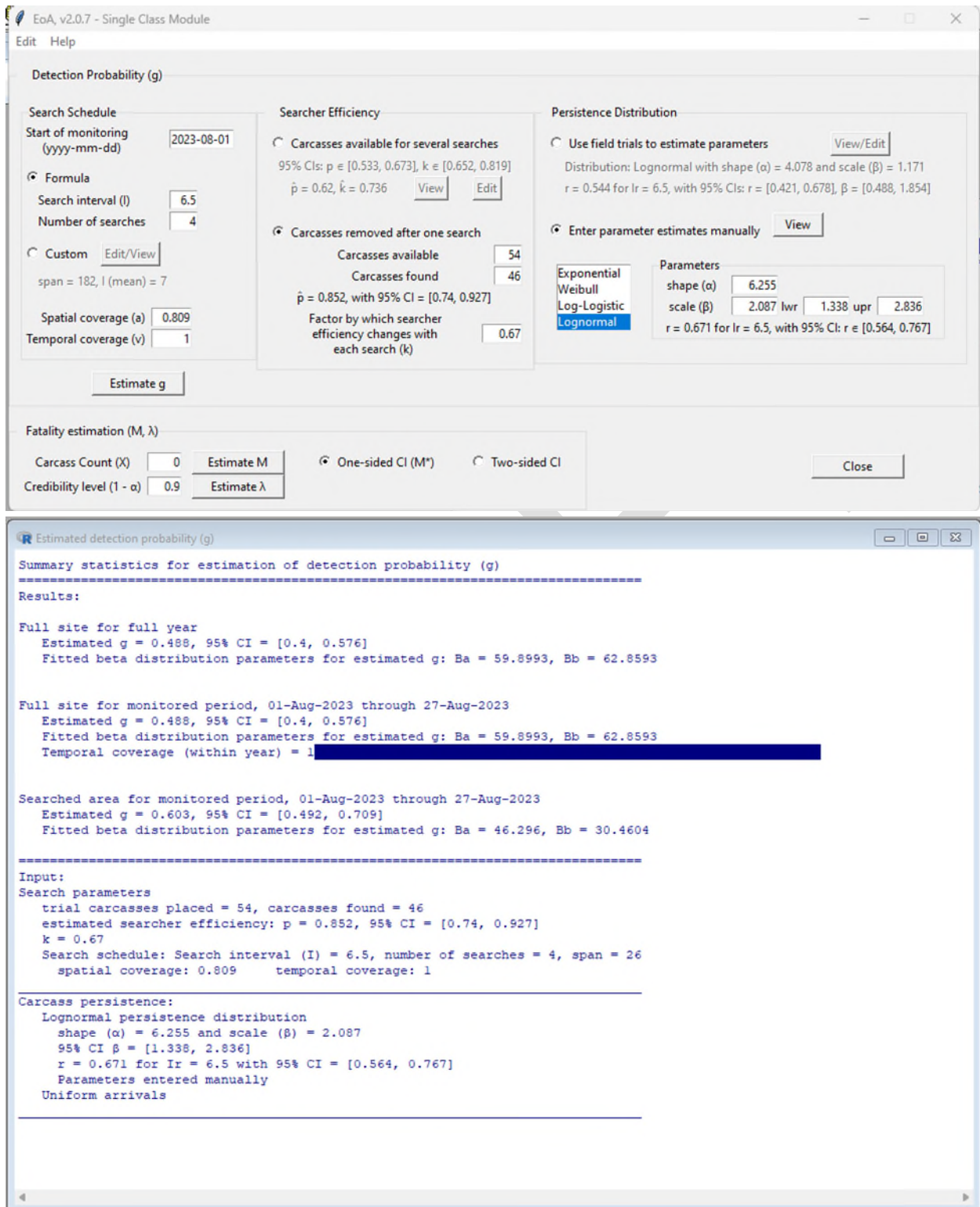
95% CI β = [0.946, 2.403]

$r = 0.709$ for $l_r = 3.5$ with 95% CI = [0.602, 0.801]

Parameters entered manually

Uniform arrivals

Appendix E7. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Fall2 2023, 100-meter road and pad searches at seven 3.6-megawatt turbines with a blade length of 67 meters, and 21 4.2-megawatt turbines with a blade length of 74 meters searched at a 3.5-day interval.



Appendix E8. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Fall1 2023, 80-meter full plot, dog-aided searches at six 3.6-megawatt turbines, and 14 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) 2023-08-01

Formula

Search interval (I) 7

Number of searches 9

Custom Edit/View

span = 182, I (mean) = 7

Spatial coverage (a) 0.809

Temporal coverage (v) 1

Estimate g

Searcher Efficiency

Carcasses available for several searches

95% CI: $p \in [0.533, 0.673]$, $k \in [0.652, 0.819]$

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

Carcasses removed after one search

Carcasses available 54

Carcasses found 46

$\hat{p} = 0.852$, with 95% CI = [0.74, 0.927]

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 $I_r = 7$, with 95% CI: $r \in [0.412, 0.655]$, $\beta \in [0.488, 1.854]$

Enter parameter estimates manually View

Parameters

shape (α) 6.255

scale (β) 2.087 lwr 1.338 upr 2.836

$r = 0.661$ for $I_r = 7$, with 95% CI: $r \in [0.553, 0.758]$

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 $g = 0.492$, 95% CI = [0.407, 0.578]

Fitted beta distribution parameters for estimated g : $B_a = 63.7206$, $B_b = 65.7792$

Full site for monitored period, 01-Aug-2023 through 03-Oct-2023

Estimated $g = 0.492$, 95% CI = [0.407, 0.578]

Fitted beta distribution parameters for estimated g : $B_a = 63.7206$, $B_b = 65.7792$

Temporal coverage (within year) = 1

Searched area for monitored period, 01-Aug-2023 through 03-Oct-2023

Estimated $g = 0.608$, 95% CI = [0.5, 0.712]

Fitted beta distribution parameters for estimated g : $B_a = 48.6751$, $B_b = 31.3493$

Input:

Search parameters

trial carcasses placed = 54, carcasses found = 46

estimated searcher efficiency: $p = 0.852$, 95% CI = [0.74, 0.927]

$k = 0.67$

Search schedule: Search interval (I) = 7, number of searches = 9, span = 63

spatial coverage: 0.809 temporal coverage: 1

Carcass persistence:

Lognormal persistence distribution

shape (α) = 6.255 and scale (β) = 2.087

95% CI β = [1.338, 2.836]

$r = 0.661$ for $I_r = 7$ with 95% CI = [0.553, 0.758]

Parameters entered manually

Uniform arrivals

Appendix E9. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Single Class Module inputs for Fall2 2023, 80-meter full plot, dog-aided searches at six 3.6-megawatt turbines, and 14 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)

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	\hat{g}	95% CI
unsearched	0	0	---	---	0	[0, 0]
spring	0.08	0	87.53	1274.94	0.06424	[0.0518, 0.0779]
summer.1	0.17	0	111.7	274.43	0.2893	[0.245, 0.335]
summer.2	0.08	0	106.25	257.49	0.2921	[0.247, 0.34]
fall.1	0.15	0	137.8	418.24	0.2478	[0.213, 0.285]
fall.2	0.52	0	131.33	402.18	0.2462	[0.211, 0.284]

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	0.08	0	87.53	1275	0.064	[0.052, 0.078]
summer.1	0.17	0	111.7	274.4	0.289	[0.245, 0.335]
summer.2	0.08	0	106.2	257.5	0.292	[0.247, 0.340]
fall.1	0.15	0	137.8	418.2	0.248	[0.213, 0.285]
fall.2	0.52	0	131.3	402.2	0.246	[0.211, 0.284]

Results for full site

Detection probability

Estimated g = 0.243, 95% CI = [0.222, 0.265]

Fitted beta distribution parameters for estimated g: Ba = 369.8614, Bb = 1153.0573

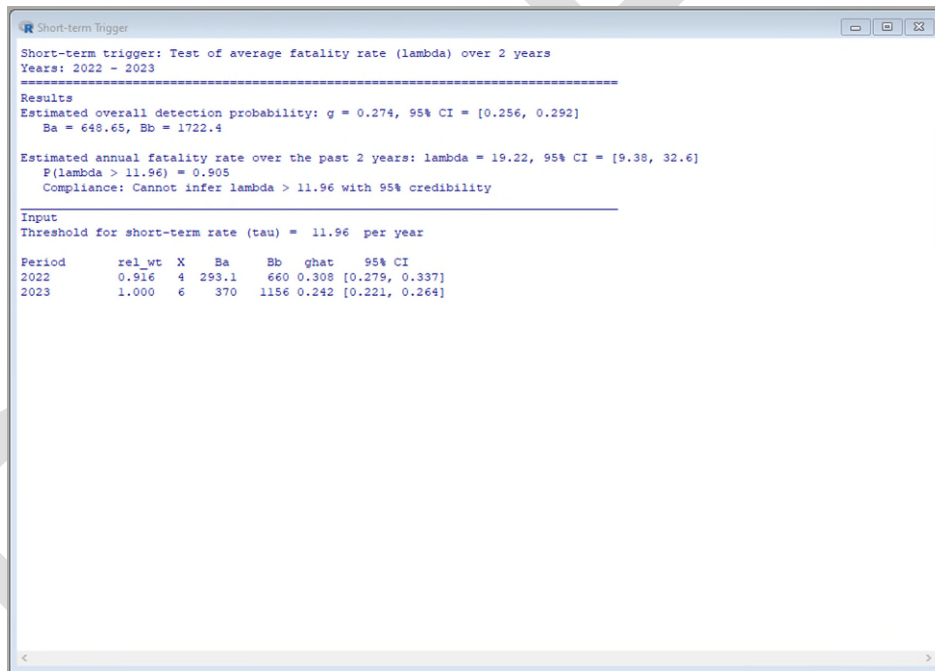
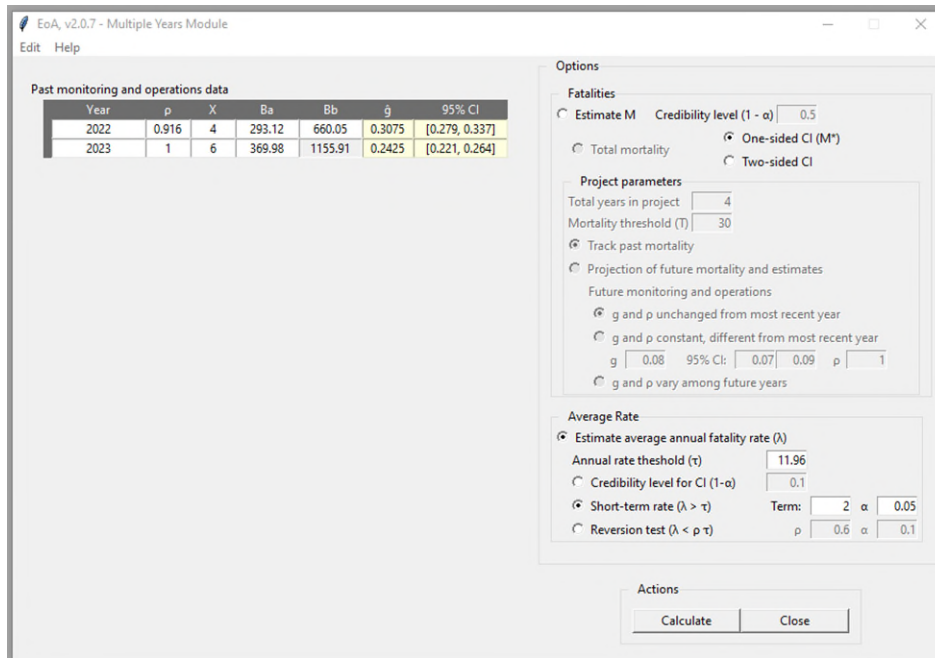
Mortality

Test of assumed relative weights (rho)

Class	Assumed	Fitted (95% CI)
unsearched	0.000	NA
spring	0.080	[0.005, 0.936]
summer.1	0.170	[0.000, 0.690]
summer.2	0.080	[0.001, 0.594]
fall.1	0.150	[0.001, 0.712]
fall.2	0.520	[0.001, 0.667]

p = 1 for likelihood ratio test of H0: assumed rho = true rho

Appendix E10. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Class Module inputs and output for Spring, Summer and Fall 2023, (n = 49 in spring, n = 48 in fall, and n = 29 in summer), searched at a 7-day interval in the spring and a 7-day and 3.5-day interval in summer and fall.



Appendix E11. Screen shot of Evidence of Absence (v2.0.7) graphical user interface (GUI), 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 sums to 1.92, 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), it is preferred to calculate the “ ρ -adjusted λ ”. The GUI does not accommodate that calculation. The “ ρ -adjusted λ ,” 20.07, is equivalent to the “year-adjusted λ ” (19.22 as seen in the output above) multiplied by two years and divided by the sum of ρ (1.92).

EoA, v2.0.7 - Multiple Years Module

Edit Help

Past monitoring and operations data

Year	ρ	X	Ba	Bb	\hat{g}	95% CI
2022	0.916	4	293.12	660.05	0.3075	[0.279, 0.337]
2023	1	6	369.98	1155.91	0.2425	[0.221, 0.264]

Options

Fatalities

Estimate M Credibility level (1 - α) 0.5

Total mortality One-sided CI (M^*)
 Two-sided CI

Project parameters

Total years in project 30
Mortality threshold (T) 35

Track past mortality

Projection of future mortality and estimates

Future monitoring and operations

g and ρ unchanged from most recent year
 g and ρ constant, different from most recent year
 g 0.08 95% CI: 0.07 0.09 ρ 1
 g and ρ vary among future years

Average Rate

Estimate average annual fatality rate (λ)

Annual rate threshold (τ) 11.96
 Credibility level for CI (1 - α) 0.1
 Short-term rate ($\lambda > \tau$) Term: 2 α 0.05
 Reversion test ($\lambda < \rho \tau$) ρ 0.6 α 0.1

Actions

Calculate Close

Mortality over 2 years

Summary statistics for mortality estimates through 2 years

Results

$M^* = 37$ for $1 - \alpha = 0.5$, i.e., $P(M \leq 37) \geq 50\%$
Estimated overall detection probability: $g = 0.274$, 95% CI = [0.256, 0.292]
Ba = 648.65, Bb = 1722.4
Estimated baseline fatality rate (for $\rho = 1$): $\lambda = 20.06$, 95% CI = [9.79, 34]

Cumulative Mortality Estimates

Year	X	g	M^*	median	95% CI	mean	lambda	95% CI
2022	4	0.308	13	13	[6, 27]	14.68		[4.385, 31.18]
2023	10	0.274	37	37	[21, 59]	38.44		[18.76, 65.17]

Annual Mortality Estimates

Year	X	g	M^*	median	95% CI	mean	lambda	95% CI
2022	4	0.308	13	13	[6, 27]	14.6800		[4.3850, 31.1800]
2023	6	0.242	25	25	[12, 47]	26.8900		[10.3100, 51.4100]

Test of assumed relative weights (ρ) and potential bias

Fitted ρ

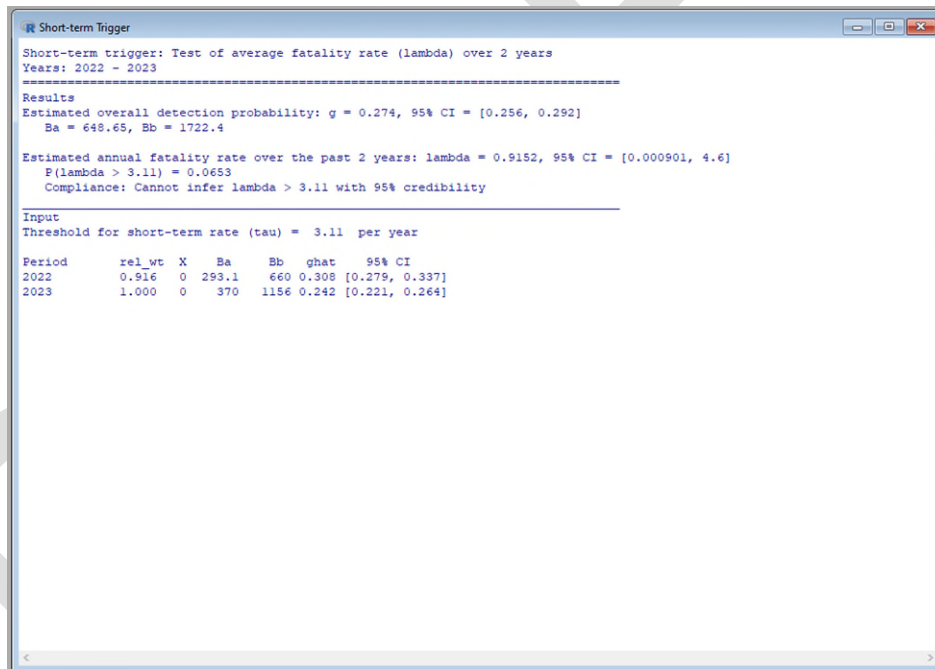
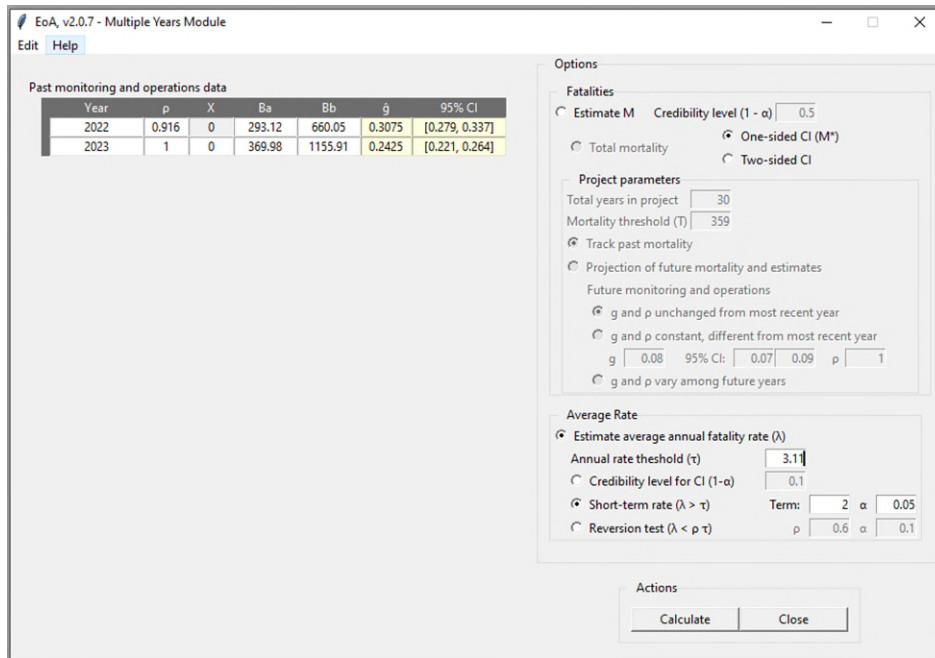
Assumed ρ	95% CI
0.916	[0.226, 1.204]
1	[0.710, 1.689]

$p = 0.38632$ for likelihood ratio test of H_0 : assumed $\rho =$ true ρ
Quick test of relative bias: 0.969

Input

Year (or period)	ρ	X	Ba	Bb	\hat{g}	95% CI
2022	0.916	4	293.1	660	0.308	[0.279, 0.337]
2023	1.000	6	370	1156	0.242	[0.221, 0.264]

Appendix E12. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Year Module for Indiana bat Incidental Take Permit term-to-date detection probability and cumulative take estimate (M^*). Inputs are based on values reported in the main text.



Appendix E13. Appendix E13. Screen shot of Evidence of Absence (v2.0.7) graphical user interface (GUI), 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 sum of the weight (ρ) column of the Multiple Years Module is equal to 1.92, 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), it is preferred to calculate the “ ρ -adjusted λ ”. The GUI does not accommodate that calculation. The “ ρ -adjusted λ ,” 0.96, is equivalent to the “year-adjusted λ ” (0.92 as seen in the output above) multiplied by two years and divided by the sum of ρ (1.87).

EoA, v2.0.7 - Multiple Years Module

Edit Help

Past monitoring and operations data

Year	ρ	X	Ba	Bb	\hat{g}	95% CI
2022	0.916	0	293.12	660.05	0.3075	[0.279, 0.337]
2023	1	0	369.98	1155.91	0.2425	[0.221, 0.264]

Options

Fatalities

Estimate M Credibility level (1 - α)

Total mortality One-sided CI (M*)

Two-sided CI

Project parameters

Total years in project

Mortality threshold (T)

Track past mortality

Projection of future mortality and estimates

Future monitoring and operations

g and ρ unchanged from most recent year

g and ρ constant, different from most recent year

g 95% CI: ρ

g and ρ vary among future years

Average Rate

Estimate average annual fatality rate (λ)

Annual rate threshold (τ)

Credibility level for CI (1 - α)

Short-term rate ($\lambda > \tau$) Term: α

Reversion test ($\lambda < \rho \tau$) ρ α

Actions

Mortality over 2 years

Summary statistics for mortality estimates through 2 years

Results

$M^* = 0$ for $1 - \alpha = 0.5$, i.e., $P(M \leq 0) \geq 50\%$
 Estimated overall detection probability: $g = 0.274$, 95% CI = [0.256, 0.292]
 Ba = 648.65, Bb = 1722.4
 Estimated baseline fatality rate (for $\rho = 1$): $\lambda = 0.9553$, 95% CI = [0.00094, 4.8]

Cumulative Mortality Estimates

Year	X	g	M*	median	95% CI	mean	lambda	95% CI
2022	0	0.308	0	0	[0, 5]	1.631	1.631	[0.001591, 8.206]
2023	0	0.274	0	0	[0, 6]	1.83	1.83	[0.001801, 9.202]

Annual Mortality Estimates

Year	X	g	M*	median	95% CI	mean	lambda	95% CI
2022	0	0.308	0	0	[0, 5]	1.6310	1.6310	[0.0016, 8.2060]
2023	0	0.242	0	0	[0, 7]	2.0680	2.0680	[0.0020, 10.4000]

Test of assumed relative weights (ρ) and potential bias

Fitted ρ

Assumed ρ	95% CI
0.916	[0.008, 1.903]
1	[0.011, 1.908]

$p = 1$ for likelihood ratio test of H_0 : assumed $\rho =$ true ρ
 Quick test of relative bias: 0.991

Input

Year (or period)	ρ	X	Ba	Bb	\hat{g}	95% CI
2022	0.916	0	293.1	660	0.308	[0.279, 0.337]
2023	1.000	0	370	1156	0.242	[0.221, 0.264]

Appendix E14. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Year Module for northern long-eared bat Incidental Take Permit term-to-date detection probability and cumulative take estimate (M^*). Inputs are based on values reported in the main text.

EoA, v2.0.7 - Multiple Class Module

Edit Help

Options

Overall

Estimate total mortality (M)

Credibility level (1 - α)

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	\hat{g}	95% CI
unsearched	0.0007	0	---	---	0	[0, 0]
summer.1_fp	0.2630	0	62.03	64.99	0.4883	[0.402, 0.575]
summer.1_rp	0.2454	0	139.62	1697.53	0.076	[0.0643, 0.0885]
summer.2_fp	0.2630	0	60.63	66.06	0.4786	[0.392, 0.565]
summer.2_rp	0.2279	0	157.36	1864.3	0.07783	[0.0666, 0.0899]

Estimated detection probability (g) for multiple classes

Summary statistics for multiple class estimate

Input: Detection probability, by search class

Search coverage = 0.9993

Class	DWP	X	Ba	Bb	ghat	95% CI
unsearched	0.0007	0	---	---	0	[0, 0]
summer.1_fp	0.263	0	62.03	64.99	0.488	[0.402, 0.575]
summer.1_rp	0.245	0	139.6	1698	0.076	[0.064, 0.089]
summer.2_fp	0.263	0	60.63	66.06	0.479	[0.392, 0.565]
summer.2_rp	0.228	0	157.4	1864	0.078	[0.067, 0.090]

Results for full site

Detection probability

Estimated g = 0.291, 95% CI = [0.259, 0.324]

Fitted beta distribution parameters for estimated g: Ba = 218.1993, Bb = 532.4348

Mortality

Test of assumed relative weights (rho)

Class	Assumed	Fitted (95% CI)
unsearched	0.001	NA
summer.1_fp	0.263	[0.000, 0.650]
summer.1_rp	0.245	[0.004, 0.952]
summer.2_fp	0.263	[0.000, 0.541]
summer.2_rp	0.228	[0.003, 0.938]

p = 1 for likelihood ratio test of H0: assumed rho = true rho

Appendix E15. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Class Module inputs and output for Summer 2023, (n = 29), searched at a 7-day and 3.5-day interval in summer and fall.

EoA, v2.0.7 - Multiple Years Module

Edit Help

Past monitoring and operations data

Year	p	X	Ba	Bb	\hat{g}	95% CI
2022	0.942	0	359.28	769.361	0.3183	[0.291, 0.346]
2023	1	1	196.019	479.488	0.2902	[0.257, 0.325]

Options

Fatalities

Estimate M Credibility level (1 - α)

One-sided CI (M*)

Total mortality Two-sided CI

Project parameters

Total years in project

Mortality threshold (T)

Track past mortality

Projection of future mortality and estimates

Future monitoring and operations

g and p unchanged from most recent year

g and p constant, different from most recent year

g 95% CI: p

g and p vary among future years

Average Rate

Estimate average annual fatality rate (λ)

Annual rate threshold (τ)

Credibility level for CI (1 - α)

Short-term rate ($\lambda > \tau$) Term: α

Reversion test ($\lambda < \rho \tau$) ρ α

Actions

Short-term Trigger

Short-term trigger: Test of average fatality rate (λ) over 2 years

Years: 2022 - 2023

Results

Estimated overall detection probability: $g = 0.304$, 95% CI = [0.282, 0.326]

Ba = 510.04, Bb = 1168.6

Estimated annual fatality rate over the past 2 years: $\lambda = 2.473$, 95% CI = [0.178, 7.72]

$P(\lambda > 0.78) = 0.814$

Compliance: Cannot infer $\lambda > 0.78$ with 95% credibility

Input

Threshold for short-term rate (τ) = 0.78 per year

Period	rel_wt	X	Ba	Bb	ghat	95% CI
2022	0.942	0	359.3	769.4	0.318	[0.291, 0.346]
2023	1.000	1	196	479.5	0.290	[0.257, 0.325]

Appendix E16. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Year Module for Indiana bat summer detection probability and summer short-term adaptive management trigger test. Inputs are based on values reported in the main text.

EoA, v2.0.7 - Multiple Years Module

Edit Help

Past monitoring and operations data

Year	ρ	X	Ba	Bb	\hat{g}	95% CI
2022	0.942	0	359.28	769.361	0.3183	[0.291, 0.346]
2023	1	0	196.019	479.488	0.2902	[0.257, 0.325]

Options

Fatalities

Estimate M Credibility level (1 - α)

One-sided CI (M*)

Total mortality Two-sided CI

Project parameters

Total years in project

Mortality threshold (T)

Track past mortality

Projection of future mortality and estimates

Future monitoring and operations

g and ρ unchanged from most recent year

g and ρ constant, different from most recent year

g 95% CI: ρ

g and ρ vary among future years

Average Rate

Estimate average annual fatality rate (λ)

Annual rate threshold (τ)

Credibility level for CI (1 - α)

Short-term rate ($\lambda > \tau$) Term: α

Reversion test ($\lambda < \rho \tau$) ρ α

Actions

Short-term Trigger

Short-term trigger: Test of average fatality rate (λ) over 2 years

Years: 2022 - 2023

Results

Estimated overall detection probability: $g = 0.304$, 95% CI = [0.282, 0.326]

Ba = 510.04, Bb = 1168.6

Estimated annual fatality rate over the past 2 years: $\lambda = 0.8243$, 95% CI = [0.000811, 4.14]

$P(\lambda > 0.78) = 0.3306$

Compliance: Cannot infer $\lambda > 0.78$ with 95% credibility

Input

Threshold for short-term rate (τ) = 0.78 per year

Period	rel_wt	X	Ba	Bb	ghat	95% CI
2022	0.942	0	359.3	769.4	0.318	[0.291, 0.346]
2023	1.000	0	196	479.5	0.290	[0.257, 0.325]

Appendix E17. Screen shot of Evidence of Absence (v2.0.7) graphical user interface, Multiple Year Module for northern long-eared bat summer detection probability and summer short-term adaptive management trigger test. Inputs are based on values reported in the main text.