Post-construction Monitoring Studies for the Hog Creek Wind Farm
Hardin County, Ohio

Year 2 Final Report

April 1 – May 15 and August 1 – October 15, 2021

Prepared for:

EDP Renewables

Attn: Erin O'Shea

1501 McKinney Street
Suite 1300, Houston, Texas 77010

Prepared by:

Ashley Matteson, Daniel Riser-Espinoza, Andrew Telander, and Rachel Katz

Western EcoSystems Technology, Inc.
408 West 6th Street
Bloomington, Indiana 47404

January 28, 2022

EXECUTIVE SUMMARY

Hog Creek Wind Project, LLC, a subsidiary of EDP Renewables North American is operating the Hog Creek Wind Farm (HCWF or Project) in Hardin County, Ohio. This report details the second year of post-construction monitoring studies conducted in 2021, consistent with Section 5.4.1 of the Project's Habitat Conservation Plan (HCP) and Incidental Take Permit (ITP; TE80697D-0) for Indiana bats and northern long-eared bats (hereafter, Covered Species). The HCWF ITP was issued on August 13, 2020. Turbines were feathered when wind speeds were below 3.0 meters (m) per second (m/s; 11.5 feet [ft] per second [ft/s]) per second in the spring, and 5.0 m/s (16.4 ft/s) in the fall to minimize impacts to Covered Species, per the HCP.

Post-construction monitoring was completed in accordance with the study plan, which was designed to achieve a probability of detection, or *g*, of 0.25 and approved by US Fish and Wildlife Service on March 29, 2021. The overall goal of this post-construction fatality monitoring study was to generate reliable fatality estimates for the Covered Species and to evaluate compliance with the incidental take authorization granted under the Project's ITP. More specifically, the objectives of this study were to estimate Covered Species take using the Evidence of Absence framework as outlined in the HCP and provide the necessary data to determine if adaptive management was necessary to further reduce mortality.

Standardized carcass searches were completed for bat carcasses at three plot types: cleared plots, uncleared plots, and roads and pads. During the spring (April 1 – May 15), a technician searched all 30 turbines as road and pad areas to a distance of 100 m (328 ft) from the turbine, weekly. During the fall (August 1 – October 15), a technician searched 14 turbines as road and pad plots to a distance of 100 m from the turbine and dog-handler teams searched eight turbines as cleared plots with a 70-m (230-ft) radius and eight turbines as uncleared plots with a 70 m-radius twice weekly. Searcher efficiency and carcass persistence trials were also conducted during each season to correct for detection and scavenger bias.

No Covered Species were found at HCWF. During the study, 194 bats were found. The most commonly found bat species were silver-haired bat (42.3%), followed by eastern red bat (28.9%), hoary bat (19.6%) and big brown bat (8.3%). The mean annual take rates at HCWF were 1.04 Indiana bats and 1.04 northern long-eared bats. The probability that the estimated annual take rate was greater than the expected take rate was 0.08 for Indiana bat and 0.33 for northern long-eared bat. The cumulative take estimates through 2021 for HCWF were zero Indiana bat and zero northern long-eared bat fatalities. The cumulative take estimates were below levels authorized by the ITP. No adaptive management actions are necessary at this time.

STUDY PARTICIPANTS

Ashley Matteson	Project Manager, Permitted Bat Biologist
Rhett Good	Senior Reviewer
Daniel Kramer	Field Supervisor
Anna Ciecka	Detection Dog Coordinator
Daniel Riser-Espinoza	Lead Client Analyst
Andrew Telander	Evidence of Absence Analyst
Guy DiDonato	Statistician
Rachel Katz	Report Compiler
Wes Conway	GIS Technician
Valerie Woelfel	GIS Technician
Jolie Blevins	Report Tracking and Data Manager
Julia Preston-Fulton	Technical Editor
Kyle Proxmire	Field Crew Lead
Robert Miller	Field Technician
Kristen VanNess and Tonks and Viktor	Dog-Handler Team

REPORT REFERENCE

Matteson, A., D. Riser-Espinoza, A. Telander, and R. Katz. 2021 Post-construction Monitoring Studies for the Hog Creek Wind Farm, Hardin County, Ohio. Year 2 Final Report: April 1 – May 15 and August 1 – October 15, 2021. Prepared for EDP Renewables, Houston, Texas. Prepared by Western EcoSystems Technology, Inc. (WEST). Bloomington, Indiana. January 28, 2022.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Hog Creek Wind Project, LLC, a subsidiary of EDP Renewables North America, is operating the Hog Creek Wind Farm (HCWF or Project) in Hardin County, Ohio. Hog Creek obtained an Incidental Take Permit (ITP; TE80697D-0) for the federally listed endangered Indiana bat (*Myotis sodalis*) and the federally listed threatened northern long-eared bat (*M. septentrionalis*; hereafter, Covered Species) from the US Fish and Wildlife Service (USFWS) dated August 13, 2020. Compliance monitoring is required by the ITP to determine if the level of take complies with the authorized take and to evaluate the need for adaptive management measures.

As specified in the Habitat Conservation Plan (HCP), Western EcoSystems Technology, Inc. (WEST) designed the monitoring effort for the HCWF to achieve a probability of detection, or *g*, of 0.25. The objectives of this study were to estimate Covered Species take using the Evidence of Absence (EoA) framework as outlined in the HCP and provide the necessary data to determine if adaptive management is triggered. This report presents the results of the second year of monitoring within the Project from April 1 – May 15 and August 1 – October 15, 2021.

STUDY AREA

According to the National Land Cover Database (2019), 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 96.5% of 92.1 hectares (227.6 acres), followed by patches of deciduous forest, which make up 2.7%, and open space, which makes up 0.8% (Table 1, Figure 1).

Hog Creek Wind Farm became operational in the fall of 2017 and consists of 30, 2.2-megawatt Vestas V110 wind turbines that have a 95-m (312-ft) hub height, and a 55-m (180-ft) blade length. All turbines are within the spring and fall migratory range of Covered Species; to minimize impacts to the Covered Species during migration, HCWF adjusted turbine operations during the spring and fall migration periods. HCWF committed to feathering blades on nights when temperatures were above 10 degrees (°) Celsius (C; 50° Fahrenheit [F])[1] and wind speeds were below 3.0 m per second (m/s; 11.5 ft per second [ft/s]) during spring migration (April 1 – May 15), and when wind speeds were below 5.0 m/s (16.4 ft/s) during fall migration (August 1 – October 15).

---

[1] In practice, HCWF feathered turbine blades on all nights, regardless of temperature.
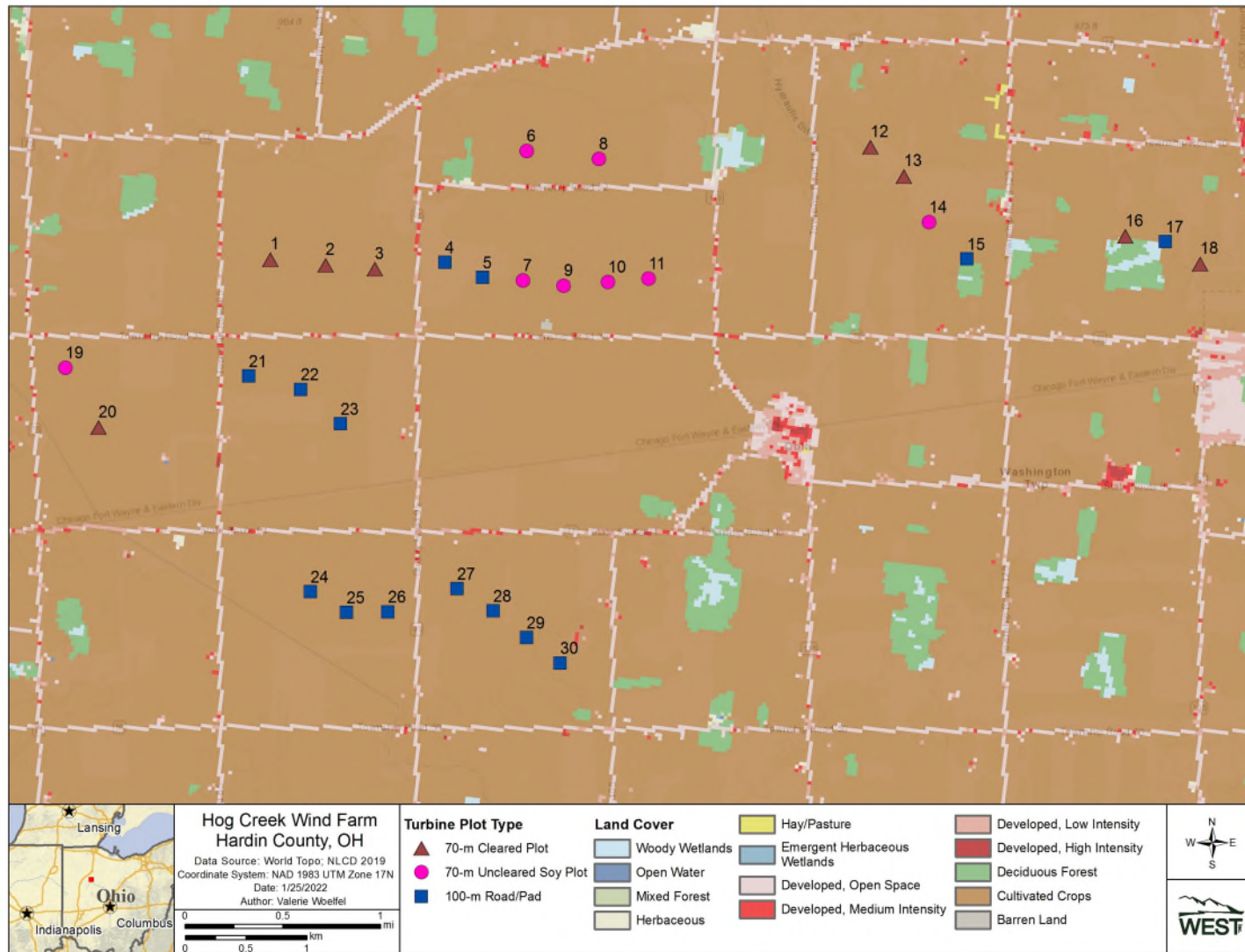
Figure 1. Turbine locations by search type[1] and surrounding land cover at the Hog Creek Wind Farm in Hardin County, Ohio, from August 18 – October 15, 2021.

[1]. From April 1 – May 15 all turbines were searched as 100-m roads and pads. From August 1 – August 17 cleared plots were searched as roads and pads, with the exception of turbine 20 which was searched as a 70-m uncleared plot.

Table 1. National Land Cover Database land cover types, acreages, and percent compositions at the Hog Creek Wind Project, by Permit Area and within 1.0 kilometer (km) of turbines.

Land Cover Class	Permit Area Hectares (Acres)	Permit Area Percent	Within 1.0 km Hectares (Acres)	Within 1.0 km Percent
Cultivated Crops	92.1 (227.6)	96.5	3,145.4 (7,772.5)	91.2
Developed, Open Space	0.8 (1.9)	0.8	182.1 (450.1)	5.3
Deciduous Forest	2.6 (6.4)	2.7	66.6 (164.6)	1.9
Developed, Low-High Intensity	–	–	37.0 (91.4)	1.1
Herbaceous	–	–	14.5 (35.8)	0.4
Hay/Pasture	–	–	2.6 (6.4)	0.1
Total	**95.5 (235.9)**	**100**	**3,448.2 (8,520.8)**	**100**

Data from National Land Cover Database (2019).

METHODS

WEST used Project-specific data from previous post-construction monitoring studies to develop a study plan that targeted a *g* of 0.25 to meet the monitoring commitments in the HCP. WEST submitted a study plan the USFWS on January 29, 2021 and received approval on March 29, 2021 (K. Lott, USFWS, pers. comm.).

Standardized Carcass Searches

Number of Turbines Sampled, Search Frequency, and Plot Size

Technicians and dog-handler teams conducted standardized carcass searches from April 1 – May 15, 2021 (spring) and August 1 – October 15, 2021 (fall). Search effort varied by season, and was designed to maximize effort when the greatest number of Covered Species were expected to occur (Table 2). Logistical constraints delayed mowing of cleared plots. Thus, the fall season was split into Fall 1 (August 1 – 17, 2021) and Fall 2 (August 18 – October 15, 2021; Tables 2 and 3). Mowing occurred on August 17, 20, and 31, and once plots were mowed the planned cleared plot searches began (Table 3). Table 3 shows date when cleared plots were mowed and plot type assignments for Fall 1 and Fall 2 at each turbine.

Table 2. Search effort by season and plot type at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Season	Plot Type	Plot Size (meter)	Number of Turbines	Search Interval	Searcher Type
Spring	Roads and pads	100	30	weekly	Human
Fall 1 (August 1 – 17)	Roads and pads	100	22	twice weekly	Human
	Uncleared	70	8	twice weekly	Dog-Handler
Fall 2 (August 18 – October 15)	Roads and pad	100	14	twice weekly	Human
	Cleared	70	8	twice weekly	Dog-Handler
	Uncleared	70	8	twice weekly	Dog-Handler

Table 3. Date cleared plots were mowed and plot type assignments for Fall 1 (August 1 – 31) and Fall 2 (August 18 – October 15) at all turbines at the Hog Creek Wind Farm, Hardin County, Ohio.

Turbine Number	Mowing Date	Fall 1 (August 1 – 17) Plot Type	Fall 2 (August 18 – October 15) Plot Type
1	August 17	100-m road/pad	70-m cleared
2	August 31	100-m road/pad[1]	70-m cleared
3	August 31	100-m road/pad[1]	70-m cleared
4	-	100-m road/pad	100-m road/pad
5	-	100-m road/pad	100-m road/pad
6	-	70-m uncleared	70-m uncleared
7	August 20	100-m road/pad[1]	70-m uncleared
8	-	70-m uncleared	70-m uncleared
9	-	70-m uncleared	70-m uncleared
10	-	70-m uncleared	70-m uncleared
11	-	70-m uncleared	70-m uncleared
12	August 17	100-m road/pad	70-m cleared
13	August 17	100-m road/pad	70-m cleared
14	-	70-m uncleared	70-m uncleared
15	-	100-m road/pad	100-m road/pad
16	August 31	100-m road/pad[1]	70-m cleared
17	-	100-m road/pad	100-m road/pad
18	August 17	100-m road/pad	70-m cleared
19	-	70-m uncleared	70-m uncleared
20	August 17	70-m uncleared	70-m cleared
21	-	100-m road/pad	100-m road/pad
22	-	100-m road/pad	100-m road/pad
23	-	100-m road/pad	100-m road/pad
24	-	100-m road/pad	100-m road/pad
25	-	100-m road/pad	100-m road/pad
26	-	100-m road/pad	100-m road/pad
27	-	100-m road/pad	100-m road/pad
28	-	100-m road/pad	100-m road/pad
29	-	100-m road/pad	100-m road/pad
30	-	100-m road/pad	100-m road/pad

[1]. searches were considered to be missed, even though the 100-m road/pad area was searched, during the time period between the start of Fall 2 and the mowing date. Any carcasses found during those searches were considered to be incidental.

A technician searched the gravel road and pad areas (roads and pads; Figure 2) under all 30 turbines to a distance of 100 m from the turbine once per week in the spring, 22 turbines to a distance of 100 m from the turbine twice per week during Fall 1, and 14 turbines to a distance of 100 m from the turbine twice per week in the Fall 2 (Tables 2 and 3). Dog-handler teams searched the remaining eight turbines as cleared plots (cleared) twice per week in the Fall 2, where crops were regularly mowed within a 70-m (230-ft) radius and eight turbines as uncleared soy (*Glycine max*) plots (uncleared) with a 70-m radius twice per week in the fall (Tables 2 and 3).

A representative photo showing the condition of road and pad plots is in Figure 2. During the fall, vegetation at 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 (Figure 3). Uncleared plots were vegetated with soybeans (Figure 4). A cross pattern 1.5 m (4.9 ft) wide was mowed into the uncleared plots to assist with plot access.

Figure 2. Representative photo of a 100-meter road and pad.

Figure 3. Representative photo of a 70-meter cleared plot.

Figure 4. Representative photo of a 70-meter uncleared plot.

Search Methods

All personnel were trained to follow the HCWF search protocol, including proper handling and reporting of carcasses. Carcass searches began as early as first light, and ended by 1700 hours.

Human Searchers

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

Dog-handler Teams

Detection dog handler teams searched cleared and uncleared plots for bat carcasses. Detection dogs were considered candidates for carcass searches if they met temperament, basic obedience, ability to detect bird and/or bat carcasses requirements. Temperament characteristics sought after are high-energy dogs, with a high food or toy drive, and eagerness to please their handler. Prior to conducting searches at HCWF, handlers trained their detection dogs on the scent of bat carcasses using methods derived from search and rescue programs and drug detection (Kay 2012, Helfers 2017). Dogs were initially trained on cotton scent swabs that had been rubbed on or stored in a container with bat carcasses and progressed to bat carcasses at increasing distances over a period of three to four weeks. The detection dog coordinator conducted a 2-day field evaluation of each dog-handler team; after teams achieved a searcher efficiency of 75% or greater for 30 bats during evaluation trials, they were approved to conduct standardized carcass searches. Because the objective of the study was to document bat carcasses, dogs were not explicitly trained on native bird carcasses; however, all detection dogs alerted on birds in the field, and handlers rewarded bird finds in the field to encourage future alerts to bird carcasses. Detection dogs used at HCWF included two golden retrievers.

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 dogs to start searches perpendicular to the wind to maximize scent detection. Both windspeed and crop density can affect scent dispersal across the search area. Transect width varied by plot type to maximize detection and was approximately 5–10 m (16–33 ft) apart on uncleared plots, and 10–15 m (33–49 ft) on cleared plots. Dog handlers rewarded detection dogs with either a food reward or a short play session when dogs alerted to a bird or bat carcass.

Data Collection

For each scheduled search, technicians recorded the date, start and end times, technician name, turbine number, type of search and if any fatalities were found. When a fatality 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 fatality on a fatality 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 as Universal Transverse Mercator coordinates, habitat surrounding carcass, condition of carcass (i.e., intact, scavenged, dismembered, feather spot [for birds only], injured), and estimated time of death (e.g., less than one day, two days). Technicians took digital photographs of each fatality, including any visible injuries, and surrounding habitat. The technician also plotted the location of each fatality on a map of the search area. 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, but were not included in analysis.

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

- Intact—a complete carcass, 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—an entire 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

Bat carcasses were collected under the Project's ITP (TE80697D-0), WEST's Federal Native Endangered and Threatened Species Recovery Permit (TE234121-9), and WEST's State Scientific Collection Permit (SC210040). Technicians placed all bat carcasses in a re-sealable plastic bag labeled with the unique carcass identification number, turbine number, and date, for storage in a freezer on site. Leather and rubber gloves were used to handle all bat carcasses to eliminate possible transmission of rabies or other diseases. Bird carcasses were recorded, but left in place.

Carcass Identification and Agency Notification

Identification of bird carcasses were verified by biologists with significant field experience in identification of birds and their feathers. A federally permitted bat biologist (TE19208C-0) verified the identifications of all bat carcasses in hand at the end of the surveys. In the event any species listed as endangered or threatened under the Endangered Species Act, birds protected under the Bald and Golden Eagle Protection Act, or any state-listed threatened or endangered species had been discovered, WEST would have notified the USFWS and the ODNR within 24 hours of positive identification.

Tissue samples were collected from heavily scavenged or decomposed carcasses that could not be positively identified and had potential to be a Covered Species (i.e., forearm less than 41 millimeters [mm; 1.6 inches] and no fur on inner wing membrane) and were submitted to a USFWS-approved laboratory, Northern Arizona University School of Forestry and Center for Microbial Genetics and Genomics, 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 inner wing membrane or forearms measured over 41 mm) were identified to the closest genus (i.e., unidentified *Lasiurus*) or group (i.e., unidentified non-Myotis) possible and were not sent to the laboratory for further identification.

All bat carcasses found during searches were delivered to the ODNR Division of Wildlife Office in Columbus, Ohio, on November 15, 2021.

Bias Trials

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the probability searchers found a carcass. Searcher efficiency trials were conducted in the same areas where carcass searches occurred. Personnel conducting carcass surveys did not know when searcher efficiency trials were being conducted or the location of the trial carcasses. Trial carcasses consisted of carcasses provided by ODNR and included: eastern red bats (*Lasiurus borealis*), hoary bats (*L. cinereus*), big brown bats (*Eptesicus fuscus*), and silver haired bats (*Lasionycteris noctivagans*). A minimum of 20 bat carcasses were placed and confirmed available per plot type and per season. 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 around the upper forelimb for identification as a study carcass after it is found. Carcasses were dropped from waist-height or higher and allowed to land in a random posture. The number and location of trial carcasses found during the subsequent search were recorded, and the number of trial carcasses available for detection during each search was determined immediately after each trial by the person responsible for distributing the carcasses. Searchers had one chance to locate trial carcasses during the first search after carcass placement. The trial administrator walked in a meandering path and dropped trials for detection dogs the night prior to the next search to allow time for the scent to pool and disperse prior to scheduled searches. Following searches, any carcasses that were not detected were checked to confirm availability. Sixty-one trial carcasses were left in place and used for carcass persistence trials.

Carcass Persistence Trials

The objective of carcass persistence trials was to estimate the length of time (in days) a carcass persisted and was available for detection. Carcasses could be removed by scavenging or rendered undetectable by typical farming activities. Fifteen trial carcasses were placed in each season and plot type to incorporate the effects of varying weather and climatic conditions on carcass persistence. Trials were conducted across all plot types to incorporate the effects of varying weather and scavenger densities. 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 day 7, 10, 14, 21, and 30. Trial carcasses were monitored until they were completely removed or the trial period ended. Detection dogs determined when carcasses were removed on cleared and uncleared plots, while human technicians verified the status of carcasses placed on roads and pads.

Search Area Mapping

Technicians recorded the boundaries of all plots using the ArcGIS Field Maps program on a tablet computer paired to a Trimble® R1 submeter global positioning satellite unit. 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 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 Evidence of Absence (EoA; Dalthorp et al. 2017) modeling framework was used to estimate take of Covered Species. To estimate take, EoA used data collected in the field to estimate the overall probability of detecting a bat fatality, the arrival distribution of bats (described below), and the number of Covered Species detections. Data used in the EoA model included number of Covered Species fatalities, fatality spatial data from all bats found during surveys, and the results of searcher efficiency and carcass persistence trials.

Searcher Efficiency Estimation

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, while accounting for the detection reduction factor *k* (Dalthorp et al. 2018). Models included plot type and season as potential covariates, and searcher efficiency was modeled separately for humans and dog handler teams to account for different modes of detection (i.e., humans use sight, dogs use scent). For both sets of models, selection was completed using an information theoretic approach known as AICc, or corrected Akaike Information Criterion (Burnham and Anderson 2002). The best-fit model was selected as the most parsimonious model within two AICc units of the model with the lowest AICc value. Searcher efficiency values 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 amount of time, in days, carcasses remained available to be located by the searcher. The average probability a carcass persisted through the search interval (i.e., the time between scheduled searches) 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). Persistence was modeled separately for humans and dog handler teams to account for different modes of detection and the dogs' ability to detect small remnants of carcasses that would not be considered discoverable by a human. Season and plot type were fit to all parameters of the candidate distributions. 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 90% Confidence Interval [CI] of β) were used as inputs in the EoA Single Class module, which is used to estimate stratum-specific detection probabilities.

Area Adjustment

The search area adjustment accounted for unsearched areas beneath turbines, and was calculated as a probability that ranged from zero to one. The area adjustment was estimated as the product of the searched area around each turbine and a carcass-density distribution. A truncated weighted maximum likelihood (TWL) modeling approach (Khokan et al. 2013) was used to estimate the carcass-density distribution using site-specific fatality locations. The TWL approach uses weight based probability of detection and the proportion of area searched in each 1.0-m annulus around the turbine. Distributions considered were normal, gamma, Gompertz, Rayleigh and Weibull (parameterized according to R Development Core Team [2016] and Yee [2015]). The best-fit model was selected using AICc. 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 1.0-m annulus around the turbine. A single carcass-density model was fit using site specific data; however, due to changes in searchable area during the fall monitoring period (Fall 1 and Fall 2, described above) different area adjustment values were calculated for each sub-season.

Carcasses Excluded from Area Correction Calculations

Fatalities were excluded from the area correction calculation 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 area adjustment accounts for the carcass by adjusting for unsearched areas. Carcasses found prior to the start of surveys (e.g., a carcass found on a plot in the summer that is not searched until the fall) were also excluded because the carcass occurred outside of the study period. Note that carcasses found on a plot incidentally were included in the analysis if that plot had a scheduled search in the future. 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 area correction estimate, but would be included in the EoA fatality estimate following Dalthorp et al. (2020).

Indiana Bat and Northern Long-eared Bat Take and Detection Probability Estimates

Evidence of Absence

EoA was used to estimate the median cumulative take to-date (M^*), mean annual take rate (λ), and the probability that the estimated take rate (λ) exceeded the expected take rate (τ) for 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 probability of detection (*g*) was estimated using the bias corrections for searcher efficiency, carcass persistence, and area searched, as well as the assumed seasonality of risk for Covered Species, which, per the HCP, was 11% in spring and 89% in fall. The EoA Single Class module was used to estimate the distribution of detection probability in each search stratum. This resulted in alpha and beta parameters that defined the Beta distribution of detection probability in each stratum. The area adjustment for each search stratum was included as the "Spatial coverage (a)" parameter in EoA. The EoA Multiple Class module was then used to combine detection probability distributions across plot types within each season (cleared plots searched by dog-handler teams, cleared plots searched by technicians, uncleared plots, and roads and pads), with weights for each class defined by the within-season sampling fraction. Then, the Multiple Class module was used again to combine detection probability parameters across seasons, with weights for each season defined by the expected arrival proportions specified in the HCP (0.11 in spring; 0.89 in fall). The fall arrival proportion was adjusted to account for mowing delays (and thus unplanned changes in searchable area) at the HCWF. This was accounted for by splitting the fall monitoring season into two fall seasons, with Fall 1, occurring prior to mowing (August 1 – 17), and Fall 2 occurring after mowing (August 18 – October 15). The fall arrival proportion of 0.89 was rescaled according to the proportion of the total number of days in the fall monitoring period that fell within each fall sub-season, assuming uniform carcass arrival within the fall season (Table 4). This procedure produced an overall, site-wide estimate of detection probability for the Project in 2021.

Table 4. Rescaled arrival proportions for the fall season at Hog Creek Wind Farm in Hardin County, Ohio, from August 1 – October 15, 2021.

Season	Rescaled Arrival Proportion
Fall 1 (August 1 – August 17)	0.211
Fall 2 (August 18 – October 15)	0.678

The EoA Multiple Years module was used to estimate the detection probability to date over the two years of monitoring conducted at the Project. Detection probability parameters (Ba and Bb parameters in EoA) for 2020 and 2021 were combined using year-specific weights (ρ in EoA). ρ was set to 0.70 for 2020 because curtailment (as per the HCP) was implemented 17 days after August 1, meaning that potential take of the Covered Species only occurred after that date in fall of 2020[2]. ρ for 2020 was calculated by multiplying the fall arrival proportion by the proportion of

---

[2] Prior to the receipt of the ITP all turbines at the HCWF were curtailed when windspeeds were less than 6.9 m/s, which is considered to be avoidance for take of the Covered Species.

days in the fall season that were available for searching (e.g., accounting for the 17-day gap between the start of the fall season and when searches began). Following the expected arrival proportions, fall represents 70% of the total risk period. ρ was set to 1 in 2021 because the permit was in effect for the entire risk period (spring and fall).

The total number of Covered Species' carcasses found to date and the results from the Multiple Years module (Ba and Bb parameters for the detection probability to date) were used to estimate M^*, mean take rate λ and its 95% CI, and the probability that λ > τ. Appendix C shows how the compliance metrics were calculated using the EoA Graphical User Interface[3].

<u>Adaptive Management Triggers</u>

The estimates from the EoA analysis were used to test two adaptive management triggers: a short-term test of whether the estimated take rate exceeded the expected take rate 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 Covered Species.

Evidence of Absence Short-term Trigger

The EoA short-term trigger is designed as an early warning signal that the Project may exceed permitted take (T) by the end of the permit term. The short-term trigger is designed to determine if an adaptive management response is needed to prevent the cumulative take estimate from actuating a response to the long-term trigger test. The short-term trigger tests if the estimated annual take rate (λ) exceeded the expected take rate (τ = T ÷ years in permit) at a confidence level of α = 0.1, per the HCP. The HCWF 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 90% confidence, the short-term trigger would be met, indicating the minimization plan in the HCP may need to be adjusted to ensure the median cumulative take estimate (M^*) remains within the permitted limit over the ITP term. Two years of data were used in this analysis, 2020 and 2021.

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) under the HCP (i.e., test whether cumulative take has met permitted take). Per the HCP, cumulative take to date (M^*) was estimated at a confidence level of α = 0.5 (using the median, or 50th credible bound, of the posterior distribution of estimated mortality). If the cumulative take to date at α = 0.5 is less than the total permitted take (M^* < T), then the HCWF complies with the ITP. If the cumulative take to date at α = 0.5 is greater than or equal to the total permitted take ($M^* \geq$ T), then the take limit has been met and the HCWF must enact avoidance measures.

---

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

RESULTS

Standardized Carcass Searches

In the spring, 207 searches were completed, 141 searches were completed in Fall 1, and 489 searches were completed in Fall 2 (Table 5). Thirty-one searches (3.7%) were missed, of which nineteen (2.3%) were missed due to turbine maintenance, weather constraints, and/or safety hazards, and twelve searches (1.4%) of cleared plots (turbines 2, 3, and 16) were completed as roads and pads due to delayed mowing at those three turbines, and thus were considered to be missed searches. There were 194 bat carcasses and 40 bird carcasses found during surveys and incidentally (Appendix A).

Table 5. Number of searches per plot type at the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15, 2021, and August 1 – October 15, 2021.

Season	Plot Type	Search Interval	Number of Searches
Spring (April 1 – May 15)	100-m roads and pads	weekly	207
Fall 1 (August 1 – August 17)	100-m roads and pads	twice weekly	102
	70-m uncleared plot	twice weekly	39
Fall 2 (August 18 – October 15)	100-m roads and pads	twice weekly	232
	70-m cleared plot	twice weekly	122
	70-m uncleared plot	twice weekly	135
Overall			**837**

m = meter.

Species Composition

No Covered Species or federally or state-listed species were found. Three bats were found in the spring and 191 bats were found in the fall (Appendix A). The most commonly found bat species were silver-haired bat (82 carcasses; 42.27%) and eastern red bat (56; 28.87%), followed by hoary bat (38; 19.59%) and big brown bat (16; 8.25%). Two Seminole bats (*L. seminolus*; 1.08%) were also found (Table 6, Appendix A). Eight heavily scavenged bats (e.g., wing membrane only, bones, or partial carcasses) were sent off for genetic testing. Genetic testing determined the previously unidentified bats were common species, including three eastern red bats, two silver-haired bats, two hoary bats, and one big brown bat. The majority of bat carcasses were recorded on plots searched by dog handler teams (Table 7).

Table 6. Number and percent (%) of bat carcasses found at the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Species	Included in Area Correction		Outside Search Area*		Outside Study Period*		Total	
	Total	%	Total	%	Total	%	Total	%
silver-haired bat	81	43.78	1	33.33	0	0	82	42.27
eastern red bat	54	29.19	2	66.67	0	0	56	28.87
hoary bat	35	18.92	0	0	3	50.00	38	19.59
big brown bat	13	7.03	0	0	3	50.00	16	8.25
Seminole bat	2	1.08	0	0	0	0	2	1.03
Total	**185**	**100**	**3**	**100**	**6**	**100**	**194**	**100**

* Carcasses not included in analysis.

Table 7. Species composition by plot type for bat carcasses[1] found at the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

	Spring		Fall[2]					
	100-m Road/Pad		100-m Road/Pad		70-m Cleared Plot		70-m Uncleared Plot	
Species	# of Carcasses	%	# of Carcasses	%	# of Carcasses	%	# of Carcasses	%
silver-haired bat	1	50.00	20	48.78	29	40.28	31	44.29
eastern red bat	1	50.00	15	36.59	19	26.39	19	27.14
hoary bat	0	0	3	7.32	18	25.00	14	20.00
big brown bat	0	0	3	7.32	4	5.56	6	8.57
Seminole bat	0	0	0	0	2	2.78	0	0
Total	**2**	**100**	**41**	**100**	**72**	**100**	**70**	**100**

1. This table only includes bat carcasses included in the area correction calculation.

2. Fall includes Fall 1 and Fall 2.

Sums may not equal total values shown due to rounding.

m = meter.

Carcasses for Area Correction Analysis

Nine of the 194 bats found during the 2021 monitoring season were excluded from modeling the area correction for EoA; three bat carcasses were excluded from analysis because they were found off plot, and six bats were excluded because their estimated time of death was prior to the start of surveys (Table 6).

Bias Trials

Searcher Efficiency Trials

One hundred thirty-two bats were placed for searcher efficiency trials, and 96 were available for search teams to find across all plot types and seasons. Overall searcher efficiency rates were 91.8% on roads and pads and 74.5% on 70-m cleared and uncleared plots searched by dog handler teams (Table 8).

The best-fit model for searcher efficiency on roads and pads did not support the inclusion of season as a covariate (Appendix B1). The best-fit model for searcher efficiency on 70-m plots did not support the inclusion of plot type as a covariate. These results meant there was not a substantial difference between searcher efficiency rates on uncleared and cleared plots or between seasons (Appendix B2).

Table 8. Searcher efficiency results by plot type at the Hog Creek Wind Farm, Hardin County, Ohio from April 1 – May 15 and August 1 – October 15, 2021.

Season	Plot Type	Number Placed	Number Available	Number Found	% Found
Spring	100-m roads and pads	26	22	21	95.45
	100-m roads and pads	39	27	24	88.89
Fall[1]	70-m cleared plot	30	21	16	76.19
	70-m uncleared plot	37	26	19	73.08
Overall 100-m roads and pads		**65**	**49**	**45**	**91.84**
Overall 70-m cleared and uncleared plots		**67**	**47**	**35**	**74.47**
Overall		**132**	**96**	**80**	**83.33**

[1.] Fall includes Fall 1 and Fall 2.

m = meter.

Carcass Persistence Trials

Thirty-two carcasses were placed to estimate carcass persistence on roads and pads. The best-fit model for carcass persistence included season as a shape and scale covariate with a log-logistic distribution, which suggests that carcass persistence rates varied by season (Appendix B3). Twenty-nine carcasses were placed to estimate carcass persistence on 70-m cleared and uncleared plots. The best-fit model for carcass persistence had no covariates with a lognormal distribution, which suggests carcass persistence rates did not vary by plot type (Appendix B4).

The estimated median carcass persistence times on roads and pads were 11.90 days in the spring and 4.54 days in the fall and 4.17 days on 70-m cleared and uncleared plots (Table 9). In the spring, the average probability a carcass persisted through the 7.0-day search interval on roads and pads was 0.94 (90% CI: 0.87–0.99; Figure 5). In the fall, the average probability a carcass persisted through the 3.5-day search interval on roads and pads was 0.79 (90% CI: 0.66–0.89) and 0.76 (90% CI: 0.66–0.86) on cleared and uncleared plots (Figures 5 and 6).

Table 9. Bat carcass persistence top models with covariates, distributions, and model parameters for the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021

Plot Type	Season	Distribution	Predicted Median Removal Times (days)	Parameter 1	Parameter 2
100-m roads and pads	Spring	log-logistic**	11.90	shape = 0.365	scale = 2.477
100-m roads and pads	Fall	log-logistic**	4.54	shape = 0.883	scale = 1.513
70-m cleared/ uncleared	Fall	lognormal*	4.17	meanlog = 1.428	sdlog = 1.614

* Parameterization follows the base R parameterization for this distribution.

** Parameterization follows the FAdist parameterization for this distribution.
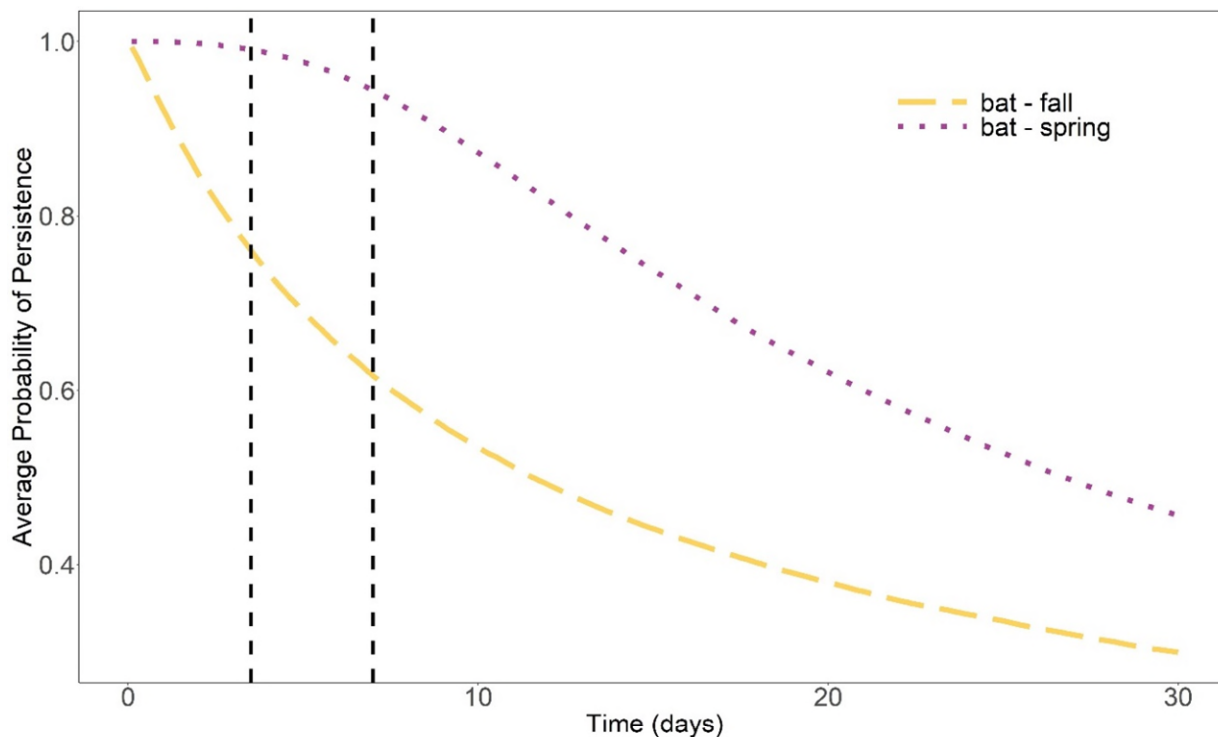
Figure 5. The average probability of carcass persistence, in days, on roads and pads at the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 –October 15, 2021. Vertical dashed lines represents a 7.0-day search interval in spring and 3.5-day search interval in fall.
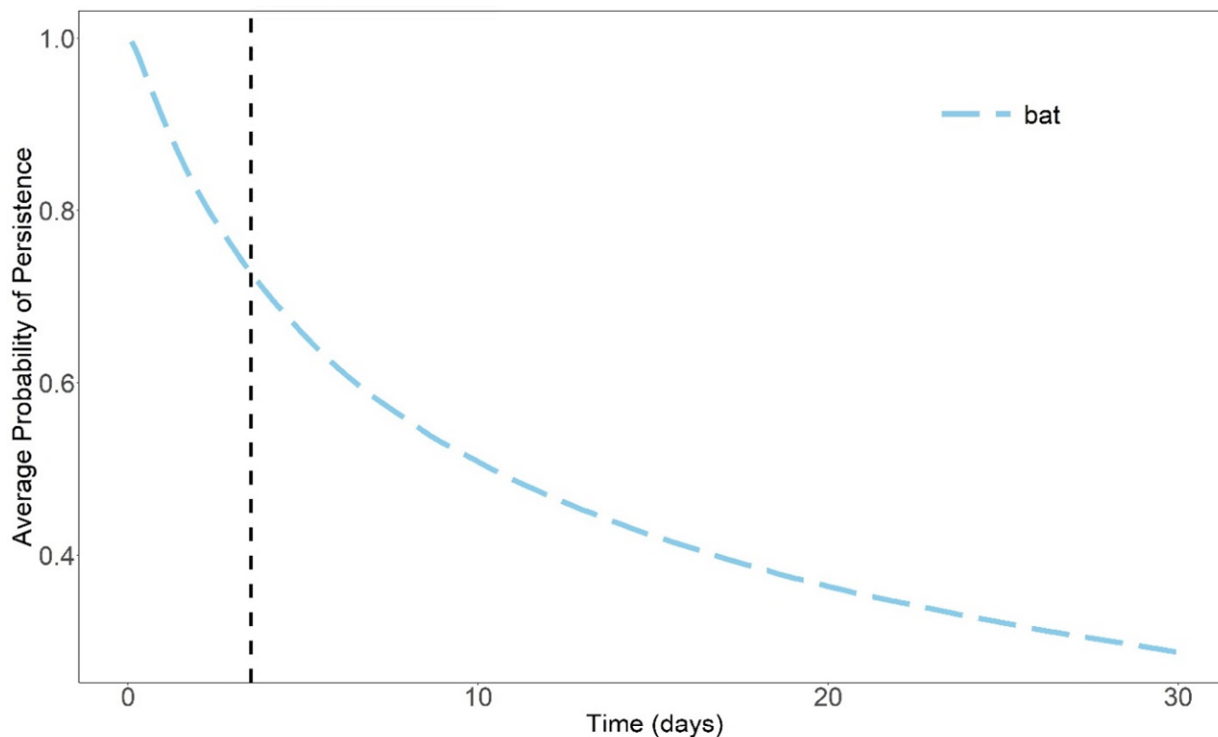
Figure 6. The average probability of carcass persistence, in days, on 70-meter cleared and uncleared plots at the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021. Vertical dashed line represents a 3.5-day search interval.

Statistical Analysis

Area Adjustment

The best-fit model for the distribution of bats with respect to distance from turbine base was a Gompertz distribution (Appendix B5). The TWL area adjustment for bats at 100-m roads and pads was 0.11. The TWL area adjustment for bats at 70-m cleared plots was 0.77 and at 70-m uncleared plots was 0.95 (Appendices B6 and B7).

Indiana Bat and Northern Long-eared Bat Take Estimates

Evidence of Absence Framework

Zero Indiana bat and zero northern long-eared bat carcasses were found during the study. The site-wide *g* distribution for the 2021 monitoring period had a mean of 0.27 (95% CI: 0.24–0.31; Table 10). 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 C.

Table 10. Annual and overall probabilities of detection (*g*), Ba, Bb, and p for Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Year	Ba[1]	Bb[1]	ρ[2]	g	95% Confidence Intervals
2020	65.52	274.61	0.70	0.19	0.15–0.24
2021	218.39	575.95	1.00	0.27	0.24–0.31
Short-term Trigger (Last 3 Years)	268.59	845.72	NA	0.24	0.22–0.27
Long-term Trigger (Cumulative)	268.59	845.72	NA	0.24	0.22–0.27

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

[2]. ρ is the weight in the weighted average that is used to combine the probability of detection distributions across years**.**

Mean estimated annual take rates for the Covered Species were lower than the expected average annual take rates reported in the HCP. The mean was estimated to be 1.040 (95% CI = 0.001–5.240) Indiana bats per year and 1.040 (95% CI = 0.001–5.240) northern long-eared bat per year from April 1 – May 15 and August 1 – October 15, 2021 (Table 11). The expected average annual take rate reported in the HCP is 3.3 Indiana bats per year and 1.0 northern long-eared bat per year.

Adaptive Management—Evidence of Absence Short-term Trigger

The short-term trigger assesses the probability the estimated take rate exceeded the expected take rate, $Pr(\lambda > \tau)$. At a 95% confidence level, (α = 0.05, $Pr(\lambda > \tau)$ must be greater than or equal to 0.95 for the short-term trigger to fire. For Indiana bat, $Pr(\lambda > \tau) = 0.08$, and for northern long-eared bat, $Pr(\lambda > \tau) = 0.33$ (Table 11). Neither probability meets or exceeds 0.95, indicating the short-term trigger was not met and no adaptive management actions are necessary (Table 11, Figure 7).

Table 11. Probability the estimated take rates exceeded the expected take rates of 3.3 Indiana bats per year and 1.0 northern long-eared bat per year at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Species	Mean λ (95% CI)	Expected Take Rate (τ)	Pr(λ > τ)*	Short-term trigger fires at α = 0.05?
Indiana bat	1.04 (0.001, 5.24)	3.30	0.08	No
Northern long-eared bat	1.04 (0.001, 5.24)	1.00	0.33	No

* Pr(λ > τ) reads, "the probability that λ (the annual take rate) is greater than τ (the expected annual take rate based on the total permitted take, used as a threshold for adaptive management)." If this probability is less than 0.90 (e.g., α = 0.1 for a one-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.

 Adaptive Management—Evidence of Absence Long-term Trigger

Cumulative take to-date, *M** at α = 0.5 (50th credible bound), is estimated to be zero Indiana bats and zero northern long-eared bat (Table 12). These values fall below the total permitted take for each species (97 Indiana bats and 30 northern long-eared bats over the 30-year permit term). The long-term trigger was not met and HCWF is in compliance for both species because *M** < T for both species. Therefore, an avoidance response is not necessary.

Table 12. Cumulative take estimate to date using Evidence of Absence for studies conducted at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Species	Cumulative take (M*)	Permitted take (T)	Long-term trigger fires at α = 0.5?
Indiana bat (50th credible bound)	0	97	No
northern long-eared bat (50th credible bound)	0	30	No

CONCLUSIONS

The post-construction monitoring effort completed in 2021 was consistent with the HCP's monitoring requirement and the HCWF 2021 study plan. No Covered Species carcasses were found despite a high probability of detection in 2021. Estimates of potential take for the Covered Species were below the levels authorized by the ITP and no adaptive management was necessary.

Indiana bat

Northern long-eared bat
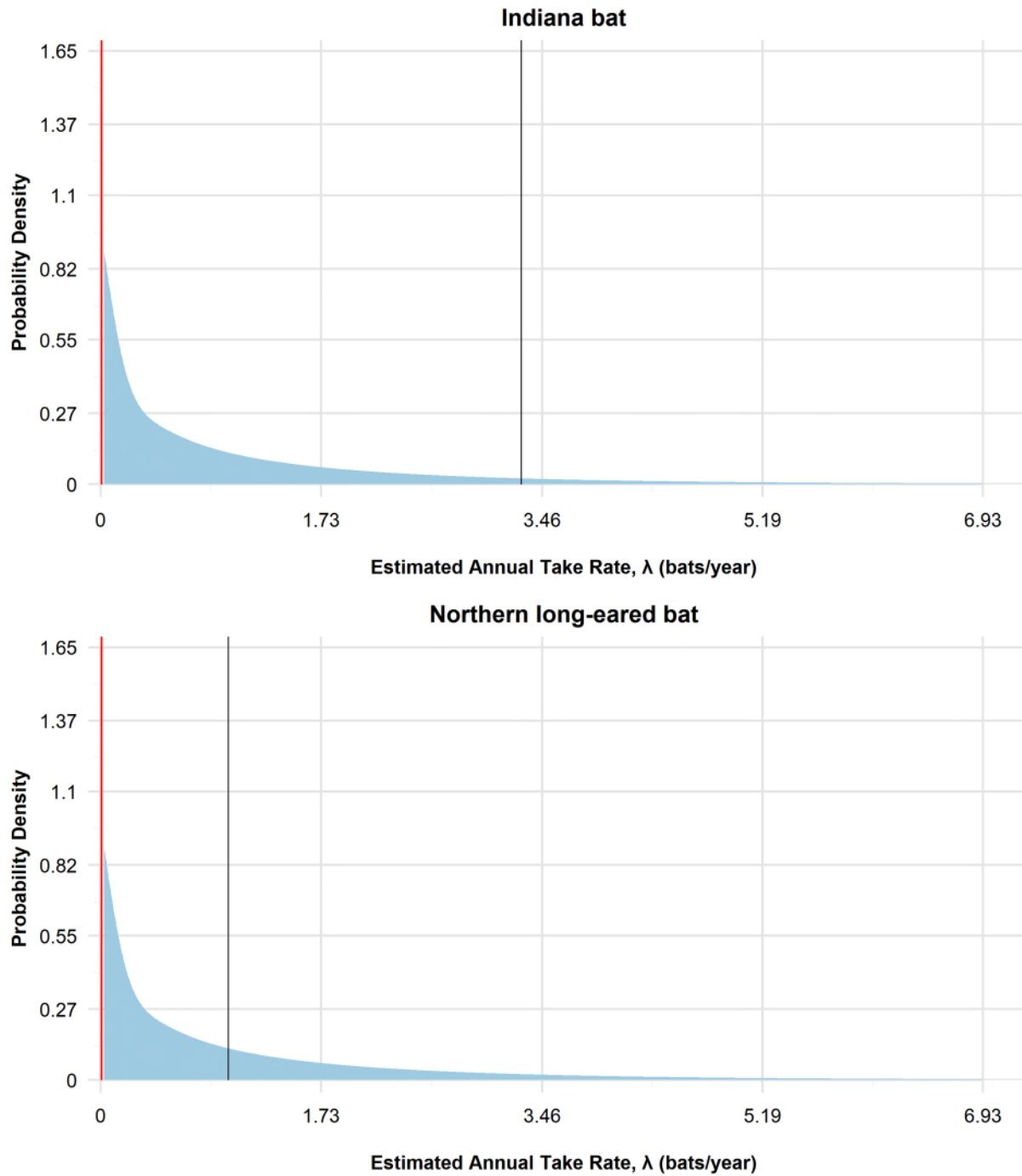
Figure 7. Estimated annual take rate (λ) bats per year at the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Note: The red region of the posterior distributions shows the region of the lower 10% quantile of the distributions (red region may not be visible when the posterior distribution is skewed heavily toward zero). The vertical line marks the expected take rate. The short-term trigger evaluates whether the vertical line falls within or to the left of the red region of the posterior distributions. For both species, the short-term trigger is not met because the vertical line (expected take rate) is not within or to the left of the red regions. In other words, the probability that estimated take rate is greater than the expected take rate does not exceed 95%.

REFERENCES

Burnham, K. P. and D. R. Anderson. 2002. Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach. Second Edition. Springer, New York, New York.

Dalthorp, D. and M. Huso. 2015. A Framework for Decision Points to Trigger Adaptive Management Actions in Long-Term Incidental Take Permits. US Geological Survey Open-File Report 2015-1227. 88 pp. doi: 10.3133/ofr20151227. Available online: https://pubs.usgs.gov/of/2015/1227/ofr20151227.pdf

Dalthorp, D., M. M. P. Huso, and D. Dail. 2017. Evidence of Absence (V2.0) Software User Guide. US Geological Survey (USGS) Data Series 1055. USGS, Reston, Virginia. 109 pp. doi: 10.3133/ds1055. Available online: https://pubs.usgs.gov/ds/1055/ds1055.pdf

Dalthorp, D., P. Rabie, M. Huso, and A. T. Tredennick. 2020. Some Approaches to Accounting for Incidental Carcass Discoveries in Non-Monitored Years Using the Evidence of Absence Model. US Geological Survey (USGS) Open-File Report 2020-1027, 24 pp. doi: 10.3133/ofr20201027. Available online: https://pubs.er.usgs.gov/publication/ofr20201027

Dalthorp, D. H., L. Madsen, M. M. Huso, P. Rabie, R. Wolpert, J. Studyvin, J. Simonis, and J. M. Mintz. 2018. GenEst Statistical Models—a Generalized Estimator of Mortality. US Geological Survey Techniques and Methods, Volume 7, Chapter A2. 13 pp. doi: 10.3133/tm7A2. Available online: https://pubs.usgs.gov/tm/7a2/tm7a2.pdf

Esri. 2022. World Imagery and Aerial Photos (World Topo). ArcGIS Resource Center. Environmental Systems Research Institute (Esri), producers of ArcGIS software, Redlands, California. Accessed January 2022. Available online: https://www.arcgis.com/home/webmap/viewer.html?useExisting= &layers=10df2279f9684e4a9f6a7f08febac2a9

Helfers, F. 2017. The Nose Work Handler - Foundation to Finesse. Dogwise Publishing, Wenatchee, WA. 144 pp.

Huso, M., D. Dalthorp, and F. Korner-Nievergelt. 2017. Statistical Principles of Post-Construction Fatality Monitoring Design. Pp. *In*: M. Perrow, ed. Wildlife and Wind Farms, Conflicts and Solutions. Pelagic Publishing, Exeter, United Kingdom. Vol. 2, Onshore: Monitoring and Mitigation.

Kalbfleisch, J. D. and R. L. Prentice. 2002. The Statistical Analysis of Failure Time Data. John Wiley & Sons, Hoboken, New Jersey.

Kay, D. 2012. Super Sniffer Drill Book - a Workbook for Training Detector Dogs. Coveran Publishing House, 86 pp.

Khokan, M. R., W. Bari, and J. A. Khan. 2013. Weighted Maximum Likelihood Approach for Robust Estimation: Weibull Model. Dhaka University Journal of Science 61(2): 153-156.

National Land Cover Database (NLCD). 2019. National Land Cover Database 2019 - Landcover & Imperviousness (NLCD2019). Available online: https://www.mrlc.gov/data. *As cited* includes:

Homer, C., J. Dewitz, S. Jin, G. Xian, C. Costello, P. Danielson, L. Gass, M. Funk, J. Wickham, S. Stehman, R. Auch, and K. Riitters. 2020. Conterminous United States Land Cover Change Patterns 2001–2016 from the 2016 National Land Cover Database. ISPRS Journal of Photogrammetry and Remote Sensing 162(5): 184-199. doi: 10.1016/j.isprsjprs.2020.02.019.

Jin, S., C. Homer, L. Yang, P. Danielson, J. Dewitz, C. Li, Z. Zhu, G. Xian, and D. Howard. 2019. Overall Methodology Design for the United States National Land Cover Database 2016 Products. Remote Sensing. 2971. doi: 10.3390/rs11242971.

Wickham, J., S. V. Stehman, D. G. Sorenson, L. Gass, and J. A. Dewitz. 2021, Thematic Accuracy Assessment of the NLCD 2016 Land Cover for the Conterminous United States: Remote Sensing of Environment 257: 112357. doi: 10.1016/j.rse.2021.112357

and

Yang, L., S. Jin, P. Danielson, C. Homer, L. Gass, S. M. Bender, A. Case, C. Costello, J. Dewitz, J. Fry, M. Funk, B. Granneman, G. C. Liknes, M. Rigge, and G. Xian. 2018. A New Generation of the United States National Land Cover Database: Requirements, Research Priorities, Design, and Implementation Strategies. ISPRS Journal of Photogrammetry and Remote Sensing 146: 108-123. doi: 10.1016/j.isprsjprs.2018.09.006.

North American Datum (NAD). 1983. NAD83 Geodetic Datum.

R Development Core Team. 2016. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. Available online: http://www.R-project.org/

Yee, T. W. 2015. Vector Generalized Linear and Additive Models: With an Implementation in R. Springer, New York.

Appendix A. Carcasses found during the 2021 Post-construction Monitoring Surveys at the Hog Creek Wind Farm

Appendix A. Carcasses found at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Dog Aided Search
Bat Carcasses							
04/15/2021	eastern red bat	22	12	carcass search**	100-m road and pad	intact	no
04/15/2021	silver-haired bat	11	1	carcass search	100-m road and pad	intact	no
05/13/2021	eastern red bat	0	8	carcass search	100-m road and pad	intact	no
08/02/2021	big brown bat	10	15	carcass search	100-m road and pad	scavenged	no
08/02/2021	big brown bat	57	6	carcass search	70-m uncleared	dismembered	yes
08/03/2021	big brown bat	49	14	carcass search	70-m uncleared	scavenged	yes
08/03/2021	hoary bat	31	20	carcass search	70-m cleared	scavenged	yes
08/03/2021	hoary bat	17	28	carcass search	100-m road and pad	scavenged	no
08/03/2021	hoary bat	4	29	carcass search	100-m road and pad	scavenged	no
08/05/2021	eastern red bat	106	3	carcass search**	100-m road and pad	scavenged	no
08/05/2021	hoary bat	9	3	carcass search	100-m road and pad	dismembered	no
08/05/2021	hoary bat	19	6	carcass search	70-m uncleared	scavenged	yes
08/06/2021	big brown bat	28	30	carcass search	100-m road and pad	scavenged	no
08/06/2021	hoary bat	5	20	carcass search	70-m cleared	intact	yes
08/09/2021	big brown bat	0	6	carcass search	70-m uncleared	intact	yes
08/10/2021	big brown bat	35	11	carcass search	70-m uncleared	scavenged	yes
08/10/2021	big brown bat	9	26	carcass search	100-m road and pad	intact	no
08/10/2021	eastern red bat	3	1	carcass search	100-m road and pad	intact	no
08/10/2021	hoary bat	34	19	carcass search	70-m uncleared	scavenged	yes
08/12/2021	eastern red bat	66	10	carcass search	70-m uncleared	scavenged	yes
08/12/2021	eastern red bat	16	16	carcass search	100-m road and pad	scavenged	no
08/12/2021	hoary bat	3	8	carcass search	70-m uncleared	intact	yes
08/12/2021	hoary bat	23	9	carcass search	70-m uncleared	scavenged	yes
08/13/2021	big brown bat	42	14	carcass search	70-m uncleared	intact	yes
08/13/2021	big brown bat	27	28	carcass search	100-m road and pad	intact	no
08/13/2021	eastern red bat	16	28	carcass search	100-m road and pad	intact	no
08/13/2021	eastern red bat	11	29	carcass search	100-m road and pad	dismembered	no
08/16/2021	eastern red bat	13	3	carcass search	100-m road and pad	scavenged	no
08/16/2021	eastern red bat	41	6	carcass search	70-m uncleared	scavenged	yes
08/16/2021	eastern red bat	6	8	carcass search	70-m uncleared	scavenged	yes
08/16/2021	hoary bat	49	6	carcass search	70-m uncleared	scavenged	yes
08/17/2021	eastern red bat	49	18	carcass search	100-m road and pad	intact	no
08/17/2021	eastern red bat	8	30	carcass search	100-m road and pad	scavenged	no
08/19/2021	eastern red bat	35	13	carcass search	70-m cleared	scavenged	yes
08/19/2021	hoary bat	27	1	carcass search	70-m cleared	intact	yes
08/19/2021	hoary bat	35	13	carcass search	70-m cleared	scavenged	yes

Appendix A. Carcasses found at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Dog Aided Search
08/23/2021	hoary bat	13	12	carcass search	70-m cleared	scavenged	yes
08/24/2021	eastern red bat	32	3	carcass search	70-m cleared	intact	yes
08/26/2021	big brown bat	32	10	carcass search	70-m uncleared	intact	yes
08/26/2021	big brown bat	30	6	carcass search	70-m uncleared	scavenged	yes
08/26/2021	eastern red bat	37	10	carcass search	70-m uncleared	scavenged	yes
08/26/2021	eastern red bat	7	17	carcass search	100-m road and pad	scavenged	no
08/27/2021	eastern red bat	38	20	carcass search	70-m uncleared	dismembered	yes
08/27/2021	eastern red bat	9	27	carcass search	100-m road and pad	intact	no
08/27/2021	eastern red bat	34	14	carcass search	70-m uncleared	dismembered	yes
08/30/2021	eastern red bat	19	10	carcass search	70-m uncleared	intact	yes
08/30/2021	eastern red bat	19	13	carcass search	cleared	scavenged	yes
08/30/2021	eastern red bat	27	22	carcass search	100-m road and pad	scavenged	no
08/30/2021	eastern red bat	16	7	carcass search	70-m uncleared	scavenged	yes
08/30/2021	eastern red bat	19	8	carcass search	70-m uncleared	scavenged	yes
08/30/2021	hoary bat	25	5	carcass search	100-m road and pad	scavenged	no
08/30/2021	eastern red bat	5	16	carcass search	70-m cleared	scavenged	yes
08/31/2021	eastern red bat	44	18	carcass search	70-m cleared	scavenged	yes
08/31/2021	eastern red bat	26	26	carcass search	100-m road and pad	scavenged	no
08/31/2021	hoary bat	52	1	carcass search	70-m cleared	scavenged	yes
08/31/2021	hoary bat	34	1	carcass search	70-m cleared	scavenged	yes
08/31/2021	eastern red bat	38	20	carcass search	70-m cleared	scavenged	yes
09/02/2021	big brown bat	18	12	carcass search	70-m cleared	scavenged	yes
09/02/2021	eastern red bat	20	13	carcass search	70-m cleared	scavenged	yes
09/02/2021	eastern red bat	29	9	carcass search	70-m uncleared	scavenged	yes
09/02/2021	Seminole bat	43	12	carcass search	70-m cleared	scavenged	yes
09/02/2021	silver-haired bat	9	13	carcass search	70-m cleared	intact	yes
09/03/2021	eastern red bat	22	11	carcass search	70-m uncleared	scavenged	yes
09/03/2021	eastern red bat	6	2	carcass search	70-m cleared	scavenged	yes
09/03/2021	hoary bat	24	19	carcass search	70-m uncleared	scavenged	yes
09/03/2021	hoary bat	41	6	incidental	70-m uncleared	scavenged	yes
09/03/2021	hoary bat	4	19	carcass search	70-m uncleared	scavenged	yes
09/06/2021	eastern red bat	19	12	carcass search	70-m cleared	intact	yes
09/06/2021	eastern red bat	40	22	carcass search	100-m road and pad	intact	no
09/06/2021	hoary bat	42	6	carcass search	70-m uncleared	intact	yes
09/06/2021	silver-haired bat	38	15	carcass search	100-m road and pad	intact	no
09/06/2021	silver-haired bat	24	16	carcass search	70-m cleared	intact	yes
09/07/2021	eastern red bat	6	1	carcass search	70-m cleared	scavenged	yes

Appendix A. Carcasses found at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Dog Aided Search
09/07/2021	silver-haired bat	57	1	carcass search	70-m cleared	intact	yes
09/07/2021	silver-haired bat	18	27	carcass search	100-m road and pad	intact	no
09/09/2021	hoary bat	4	7	carcass search	70-m uncleared	intact	yes
09/09/2021	silver-haired bat	43	12	carcass search	70-m cleared	scavenged	yes
09/09/2021	silver-haired bat	35	13	carcass search	70-m cleared	scavenged	yes
09/09/2021	silver-haired bat	11	15	carcass search	100-m road and pad	intact	no
09/09/2021	silver-haired bat	38	16	carcass search	70-m cleared	scavenged	yes
09/10/2021	eastern red bat	14	3	carcass search	70-m cleared	intact	yes
09/10/2021	hoary bat	44	11	carcass search	70-m uncleared	scavenged	yes
09/10/2021	hoary bat	37	3	carcass search	70-m cleared	scavenged	yes
09/10/2021	silver-haired bat	43	14	carcass search	70-m uncleared	scavenged	yes
09/10/2021	silver-haired bat	54	19	carcass search	70-m uncleared	scavenged	yes
09/10/2021	silver-haired bat	32	19	carcass search	70-m uncleared	scavenged	yes
09/10/2021	silver-haired bat	34	20	carcass search	70-m cleared	intact	yes
09/10/2021	silver-haired bat	5	11	carcass search	70-m uncleared	scavenged	yes
09/13/2021	eastern red bat	47	16	carcass search	70-m cleared	scavenged	yes
09/14/2021	eastern red bat	50	20	carcass search	70-m cleared	scavenged	yes
09/14/2021	hoary bat	64	3	carcass search	70-m cleared	scavenged	yes
09/17/2021	eastern red bat	0	10	carcass search	70-m uncleared	scavenged	yes
09/17/2021	eastern red bat	25	13	carcass search	cleared	intact	yes
09/17/2021	eastern red bat	19	25	carcass search	100-m road and pad	intact	no
09/17/2021	eastern red bat	59	9	carcass search	70-m uncleared	scavenged	yes
09/17/2021	hoary bat	20	12	carcass search	cleared	intact	yes
09/17/2021	silver-haired bat	7	15	carcass search**	100-m road and pad	intact	no
09/17/2021	silver-haired bat	21	17	carcass search	100-m road and pad	intact	no
09/17/2021	silver-haired bat	19	27	carcass search	100-m road and pad	intact	no
09/17/2021	silver-haired bat	30	27	carcass search	100-m road and pad	intact	no
09/17/2021	silver-haired bat	52	7	carcass search	70-m uncleared	intact	yes
09/17/2021	silver-haired bat	10	7	carcass search	70-m uncleared	intact	yes
09/18/2021	eastern red bat	43	11	carcass search	70-m uncleared	intact	yes
09/18/2021	hoary bat	27	3	carcass search	70-m cleared	intact	yes
09/18/2021	silver-haired bat	44	11	carcass search	70-m uncleared	intact	yes
09/18/2021	silver-haired bat	20	11	carcass search	70-m uncleared	intact	yes
09/18/2021	silver-haired bat	36	14	carcass search	70-m uncleared	scavenged	yes
09/18/2021	silver-haired bat	25	2	carcass search	70-m cleared	scavenged	yes
09/18/2021	silver-haired bat	38	20	carcass search	70-m cleared	scavenged	yes
09/18/2021	silver-haired bat	58	20	carcass search	70-m cleared	intact	yes

Appendix A. Carcasses found at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Dog Aided Search
09/20/2021	eastern red bat	49	8	carcass search	70-m uncleared	scavenged	yes
09/20/2021	silver-haired bat	46	10	carcass search	70-m uncleared	scavenged	yes
09/20/2021	silver-haired bat	35	12	carcass search	70-m cleared	intact	yes
09/20/2021	silver-haired bat	22	17	carcass search	100-m road and pad	intact	no
09/20/2021	silver-haired bat	33	17	carcass search	100-m road and pad	intact	no
09/20/2021	silver-haired bat	11	17	carcass search	100-m road and pad	intact	no
09/20/2021	silver-haired bat	9	21	carcass search	100-m road and pad	intact	no
09/20/2021	silver-haired bat	31	7	carcass search	70-m uncleared	scavenged	yes
09/20/2021	silver-haired bat	13	8	carcass search	70-m uncleared	scavenged	yes
09/20/2021	silver-haired bat	22	8	carcass search	70-m uncleared	scavenged	yes
09/21/2021	big brown bat	63	14	carcass search	70-m uncleared	scavenged	yes
09/21/2021	eastern red bat	38	2	carcass search	70-m cleared	intact	yes
09/21/2021	eastern red bat	49	20	carcass search	70-m cleared	intact	yes
09/21/2021	eastern red bat	12	27	carcass search	100-m road and pad	intact	no
09/21/2021	hoary bat	36	18	carcass search	cleared	scavenged	yes
09/21/2021	hoary bat	6	28	carcass search	100-m road and pad	intact	no
09/21/2021	silver-haired bat	35	1	carcass search	70-m cleared	scavenged	yes
09/21/2021	silver-haired bat	65	1	carcass search	70-m cleared	scavenged	yes
09/21/2021	silver-haired bat	43	1	carcass search	70-m cleared	intact	yes
09/21/2021	silver-haired bat	20	11	carcass search	70-m uncleared	intact	yes
09/21/2021	silver-haired bat	31	11	carcass search	70-m uncleared	intact	yes
09/21/2021	silver-haired bat	14	11	carcass search	70-m uncleared	intact	yes
09/21/2021	silver-haired bat	34	11	carcass search	70-m uncleared	intact	yes
09/21/2021	silver-haired bat	34	18	carcass search	70-m cleared	scavenged	yes
09/21/2021	silver-haired bat	30	18	carcass search	70-m cleared	scavenged	yes
09/21/2021	silver-haired bat	16	2	carcass search	70-m cleared	intact	yes
09/21/2021	silver-haired bat	20	20	carcass search	70-m cleared	intact	yes
09/21/2021	silver-haired bat	42	26	carcass search	100-m road and pad	intact	no
09/21/2021	silver-haired bat	20	26	carcass search	100-m road and pad	intact	no
09/21/2021	silver-haired bat	5	27	carcass search	100-m road and pad	intact	no
09/21/2021	silver-haired bat	6	30	carcass search	100-m road and pad	intact	no
09/21/2021	big brown bat	23	2	carcass search	70-m cleared	scavenged	yes
09/21/2021	hoary bat	58	3	carcass search	70-m cleared	scavenged	yes
09/23/2021	big brown bat	27	12	carcass search	70-m cleared	intact	yes
09/23/2021	hoary bat	53	13	carcass search	70-m cleared	scavenged	yes
09/23/2021	hoary bat	67	16	carcass search	70-m cleared	scavenged	yes
09/23/2021	silver-haired bat	30	10	carcass search	70-m uncleared	scavenged	yes

Appendix A. Carcasses found at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Dog Aided Search
09/23/2021	silver-haired bat	41	13	carcass search	70-m cleared	scavenged	yes
09/23/2021	silver-haired bat	34	13	carcass search	70-m cleared	intact	yes
09/23/2021	silver-haired bat	37	22	carcass search	100-m road and pad	intact	no
09/23/2021	silver-haired bat	68	23	carcass search	100-m road and pad	intact	no
09/23/2021	silver-haired bat	26	7	carcass search	70-m uncleared	intact	yes
09/23/2021	silver-haired bat	20	8	carcass search	70-m uncleared	scavenged	yes
09/23/2021	silver-haired bat	52	9	carcass search	70-m uncleared	scavenged	yes
09/24/2021	eastern red bat	56	14	carcass search	70-m uncleared	scavenged	yes
09/24/2021	silver-haired bat	30	1	carcass search	70-m cleared	scavenged	yes
09/24/2021	silver-haired bat	0	24	carcass search	100-m road and pad	intact	no
09/27/2021	hoary bat	49	12	carcass search	70-m cleared	scavenged	yes
09/27/2021	hoary bat	45	7	carcass search	70-m uncleared	scavenged	yes
09/27/2021	silver-haired bat	52	16	carcass search	70-m cleared	scavenged	yes
09/28/2021	silver-haired bat	53	1	carcass search	70-m cleared	scavenged	yes
09/28/2021	silver-haired bat	52	30	carcass search	100-m road and pad	intact	no
09/30/2021	hoary bat	14	12	carcass search	70-m cleared	scavenged	yes
09/30/2021	hoary bat	45	8	carcass search	70-m uncleared	scavenged	yes
09/30/2021	silver-haired bat	24	13	carcass search	70-m cleared	scavenged	yes
09/30/2021	silver-haired bat	31	16	carcass search	70-m cleared	scavenged	yes
10/01/2021	eastern red bat	69	20	carcass search	70-m cleared	intact	yes
10/01/2021	eastern red bat	45	25	carcass search	100-m road and pad	intact	no
10/01/2021	silver-haired bat	26	11	carcass search	70-m uncleared	scavenged	yes
10/01/2021	silver-haired bat	57	19	carcass search	70-m uncleared	scavenged	yes
10/04/2021	eastern red bat	31	13	carcass search	70-m cleared	scavenged	yes
10/04/2021	eastern red bat	9	6	carcass search	70-m uncleared	scavenged	yes
10/04/2021	hoary bat	37	13	carcass search	70-m cleared	scavenged	yes
10/04/2021	hoary bat	44	8	carcass search	70-m uncleared	scavenged	yes
10/04/2021	silver-haired bat	38	13	carcass search	70-m cleared	scavenged	yes
10/04/2021	silver-haired bat	58	13	carcass search	70-m cleared	scavenged	yes
10/04/2021	silver-haired bat	62	8	carcass search	70-m uncleared	scavenged	yes
10/04/2021	silver-haired bat	59	9	carcass search	70-m uncleared	scavenged	yes
10/05/2021	Seminole bat	37	20	carcass search	70-m cleared	scavenged	yes
10/05/2021	silver-haired bat	57	19	carcass search	70-m uncleared	scavenged	yes
10/07/2021	eastern red bat	43	10	carcass search	70-m uncleared	scavenged	yes
10/07/2021	silver-haired bat	28	12	carcass search	70-m cleared	scavenged	yes
10/07/2021	silver-haired bat	38	16	carcass search	70-m cleared	scavenged	yes
10/07/2021	silver-haired bat	29	23	carcass search	100-m road and pad	intact	no

Appendix A. Carcasses found at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Dog Aided Search
10/07/2021	silver-haired bat	9	5	carcass search	100-m road and pad	intact	no
10/08/2021	big brown bat	24	18	carcass search	70-m cleared	scavenged	yes
10/08/2021	eastern red bat	56	19	carcass search	70-m uncleared	scavenged	yes
10/08/2021	silver-haired bat	61	11	carcass search	70-m uncleared	scavenged	yes
10/11/2021	eastern red bat	53	13	carcass search	70-m cleared	scavenged	yes
10/11/2021	silver-haired bat	20	10	carcass search	70-m uncleared	scavenged	yes
10/11/2021	silver-haired bat	29	8	carcass search	70-m uncleared	scavenged	yes
10/12/2021	silver-haired bat	40	14	carcass search	70-m uncleared	intact	yes
10/12/2021	silver-haired bat	30	7	carcass search	70-m uncleared	scavenged	yes
10/15/2021	hoary bat	60	20	carcass search	70-m cleared	intact	yes
Bird Carcasses							
08/02/2021	horned lark	56	9	carcass search	70-m uncleared	scavenged	yes
08/03/2021	horned lark	3	24	carcass search	100-m road and pad	scavenged	no
08/03/2021	unidentified large bird	53	11	carcass search	70-m uncleared	scavenged	yes
08/03/2021	unidentified small bird	51	11	carcass search	70-m uncleared	scavenged	yes
08/03/2021	unidentified small bird	56	11	carcass search	70-m uncleared	feather spot	yes
08/03/2021	unidentified small bird	5	29	carcass search	100-m road and pad	scavenged	no
08/05/2021	unidentified small bird	41	2	carcass search	100-m road and pad	feather spot	no
08/05/2021	unidentified small bird	37	9	carcass search	70-m uncleared	feather spot	yes
08/06/2021	brown-headed cowbird	15	20	carcass search	70-m cleared	intact	yes
08/06/2021	unidentified small bird	32	20	carcass search	70-m cleared	scavenged	yes
08/06/2021	unidentified small bird	24	22	carcass search	100-m road and pad	feather spot	no
08/10/2021	unidentified small bird	35	19	carcass search	70-m uncleared	feather spot	yes
08/23/2021	horned lark	12	9	carcass search	70-m uncleared	intact	yes
08/24/2021	purple martin	22	1	carcass search	70-m cleared	scavenged	yes
08/26/2021	horned lark	40	9	carcass search	70-m uncleared	scavenged	yes
08/27/2021	unidentified sparrow	48	11	carcass search	70-m uncleared	scavenged	yes
09/03/2021	European starling	41	3	carcass search	70-m cleared	scavenged	yes
09/03/2021	European starling	20	3	carcass search	70-m cleared	scavenged	yes
09/03/2021	European starling	22	3	carcass search	70-m cleared	scavenged	yes
09/03/2021	unidentified blackbird	46	3	carcass search	70-m cleared	feather spot	yes
09/03/2021	unidentified small bird	53	3	carcass search	70-m cleared	feather spot	yes
09/06/2021	red-eyed vireo	50	12	carcass search	70-m cleared	scavenged	yes
09/07/2021	European starling	29	3	carcass search	70-m cleared	intact	yes
09/07/2021	European starling	17	3	carcass search	70-m cleared	intact	yes
09/07/2021	European starling	28	3	carcass search	70-m cleared	dismembered	yes
09/09/2021	horned lark	60	12	carcass search	70-m cleared	scavenged	yes

Appendix A. Carcasses found at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Found Date	Species	Distance from Turbine (m)	Turbine	Search Type	Search Area Type	Physical Condition	Dog Aided Search
09/14/2021	European starling	55	3	carcass search	70-m cleared	scavenged	yes
09/17/2021	Cape May warbler	32	17	carcass search	100-m road and pad	intact	no
09/17/2021	unidentified warbler	33	27	carcass search	100-m road and pad	scavenged	no
09/20/2021	eastern phoebe	41	12	carcass search	70-m cleared	scavenged	yes
09/20/2021	unidentified kinglet	55	16	carcass search	70-m cleared	scavenged	yes
09/21/2021	unidentified warbler	25	2	carcass search	70-m cleared	scavenged	yes
09/24/2021	eastern phoebe	64	3	carcass search	70-m cleared	scavenged	yes
09/24/2021	European starling	29	3	carcass search	70-m cleared	scavenged	yes
09/28/2021	unidentified warbler	64	20	carcass search	70-m cleared	scavenged	yes
10/05/2021	yellow-billed cuckoo	40	11	carcass search	70-m uncleared	dismembered	yes
10/07/2021	unidentified warbler	13	6	carcass search	70-m uncleared	scavenged	yes
10/11/2021	horned lark	17	12	carcass search	70-m cleared	scavenged	yes
10/12/2021	horned lark	0	7	carcass search	70-m uncleared	scavenged	yes
10/14/2021	horned lark	50	12	carcass search	70-m cleared	feather spot	yes

** Carcass found outside the search area.

m = meter.

Appendix B. Searcher Efficiency, Carcass Persistence, and Truncated Weighted Likelihood Area Adjustment Estimate Model Fitting Results

Appendix B1. Searcher efficiency models for bats placed on 100-meter road and pad from the Hog Creek Wind Farm, Hardin County, Ohio from April 1 – May 15 and August 1 – October 15, 2021 (n = 49).

Covariates	k Value	AICc	Delta AICc
No Covariates	k fixed at 0.67	29.79	0*
Season	k fixed at 0.67	31.23	1.44

* Selected model.

AICc = corrected Akaike Information Criterion.

Appendix B2. Searcher efficiency models for bats placed on 70-meter cleared and uncleared plots from the Hog Creek Wind Farm, Hardin County, Ohio from August 1 – October 15, 2021 (n = 47).

Covariates	k Value	AICc	Delta AICc
No Covariates	k fixed at 0.67	55.49	0*
Plot Search Type	k fixed at 0.67	57.62	2.13

* Selected model.

AICc = corrected Akaike Information Criterion.

Appendix B3. Carcass persistence models with covariates and distributions for bats placed on road and pad plots at the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021 (n = 32).

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
Season	Season	loglogistic	141.97	0*
Season	Season	lognormal	142.09	0.12
No Covariates	Season	lognormal	144.10	2.13
No Covariates	Season	loglogistic	144.12	2.15
No Covariates	Season	Weibull	145.28	3.31
Season	Season	Weibull	145.94	3.97
Season	No Covariates	loglogistic	146.13	4.16
Season	No Covariates	lognormal	146.60	4.63
No Covariates	–	exponential	146.85	4.88
Season	–	exponential	147.86	5.89
No Covariates	No Covariates	Weibull	149.11	7.14
No Covariates	No Covariates	loglogistic	149.38	7.41
No Covariates	No Covariates	lognormal	149.52	7.55
Season	No Covariates	Weibull	150.29	8.32

*Selected model.

AICc = corrected Akaike Information Criterion.

Appendix B4. Carcass persistence models with covariates and distributions for bats placed on 70-meter plots at the Hog Creek Wind Farm, Hardin County, Ohio, from August 1 – October 15, 2021 (n = 29).

Location Covariates	Scale Covariates	Distribution	AICc	Delta AICc
No Covariates	No Covariates	lognormal	126.01	0*
No Covariates	No Covariates	loglogistic	126.09	0.08
No Covariates	PlotSearchType	lognormal	128.23	2.22
No Covariates	PlotSearchType	loglogistic	128.39	2.38
PlotSearchType	No Covariates	loglogistic	128.40	2.39
PlotSearchType	No Covariates	lognormal	128.41	2.40
No Covariates	No Covariates	Weibull	129.85	3.84
PlotSearchType	PlotSearchType	lognormal	130.85	4.84
PlotSearchType	PlotSearchType	loglogistic	130.94	4.93
No Covariates	PlotSearchType	Weibull	131.90	5.89
PlotSearchType	No Covariates	Weibull	132.35	6.34
PlotSearchType	PlotSearchType	Weibull	134.59	8.58
No Covariates	–	exponential	136.10	10.09
PlotSearchType	–	exponential	138.40	12.39

*Selected model.

AICc = corrected Akaike Information Criterion.

Appendix B5. Search area adjustment models for bats from the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Distribution	AICc	Delta AICc
Gompertz	8,115.49	0*
normal	8,202.70	87.21
Weibull	8,277.40	161.91
Rayleigh	8,310.91	195.42
gamma	8,408.28	292.79

* Selected model.

Appendix B6. Truncated weighted maximum likelihood search area adjustment estimates for the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021 (Bat n = 185).

Size Class	Search Area Type	Distribution	Parameter 1	Parameter 2	Area Adjustment
	spring road and pad	Gompertz	0.0555	0.0035	0.11
	Fall 1 road and pad	Gompertz	0.0555	0.0035	0.11
	Fall 1 uncleared	Gompertz	0.0555	0.0035	0.95
Bat	Fall 2 road and pad	Gompertz	0.0555	0.0035	0.11
	Fall 2 cleared	Gompertz	0.0555	0.0035	0.77
	Fall 2 uncleared	Gompertz	0.0555	0.0035	0.95
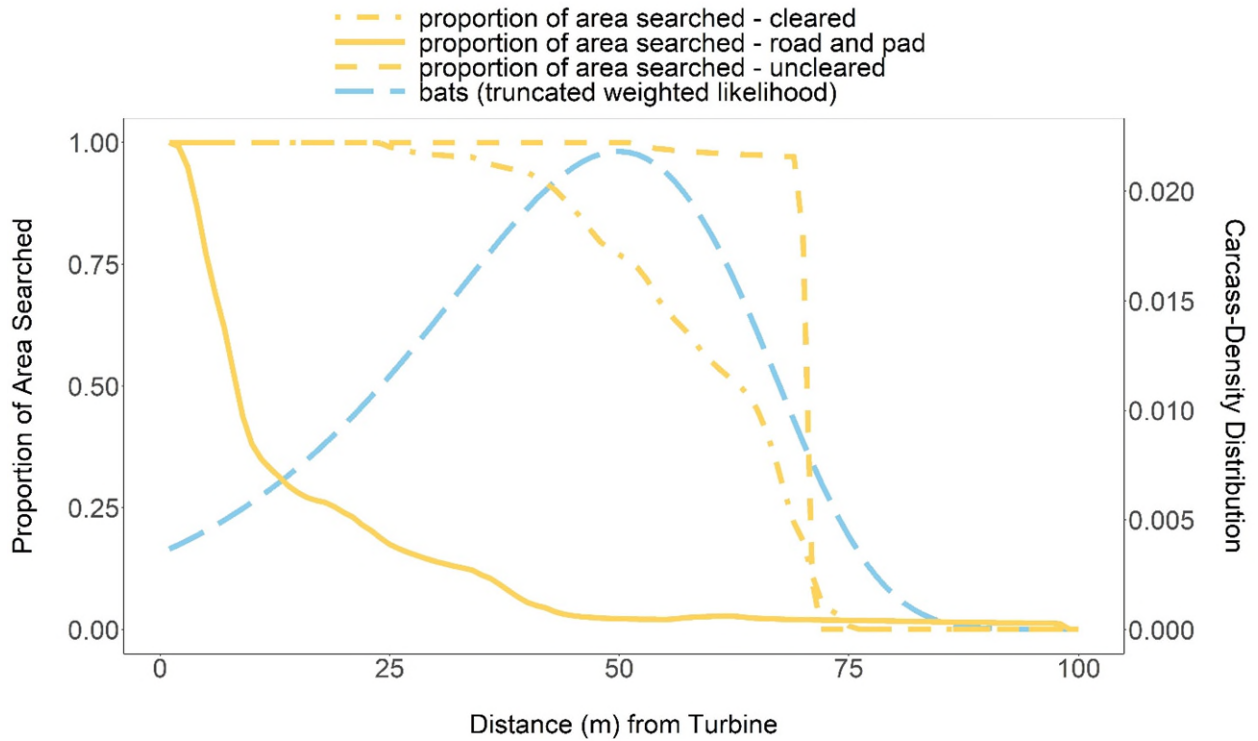
Appendix B7. Density of bat carcasses per area searched at all roads and pads, cleared plots, and uncleared plots at Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Appendix C. Inputs for Single Class and Multiple Class Modules in Evidence of Absence and Screenshots of the Inputs and Outputs for the Single Class and Multiple Class Modules

Appendix C1. Inputs needed to run Evidence of Absence: Single Class Module for the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Season	Plot Type	Search interval (I)	Number of searches[1]	Spatial Coverage (a)	Searcher Efficiency		Carcass Persistence[2]			
					Carcasses Available	Carcasses Found	Shape (α)	Scale (β)	Scale Lower Limit (β)	Scale Upper Limit (β)
spring	100-m road and pad	7	7	0.1059	49	45	2.740	11.905	8.611	16.445
Fall 1	100-m road and pad	3.5	5	0.0804	49	45	1.133	4.540	2.173	9.478
Fall 1	70-m uncleared	3.5	5	0.2533	47	35	2.605	1.428	0.821	2.036
Fall 2	100-m road and pad	3.5	17	0.0505	49	45	1.133	4.540	2.173	9.478
Fall 2	70-m uncleared	3.5	16	0.2533	47	35	2.605	1.428	0.821	2.036
Fall 2	70-m cleared	3.5	15	0.2065	47	35	2.605	1.428	0.821	2.036

[1]. The Evidence of Absence Graphical User Interface requires adding an additional search, which is automatically excluded as a clearing search. Therefore, to use the GUI, the user must add 1 to each of these reported numbers of searches.

[2]. A log-logistic distribution was used for carcass persistence distribution on roads and pads and a lognormal distribution was used for carcass persistence distribution on cleared and uncleared plots.

Appendix C2. Inputs needed to run Evidence of Absence: Multiple Class Module for the Hog Creek Wind Farm, Hardin County, Ohio, from April 1 – May 15 and August 1 – October 15, 2021.

Season	Plot Type	Ba	Bb	Sampling Fraction	Temporal coverage (v)[1]	Weights (dwp)
spring	100-m roads and pads	469.516	4536.559	1	0.110	0.110
Fall 1	100-m roads and pads	88.457	1043.613	0.733	0.211	0.113
Fall 1	70-m uncleared	38.799	29.868	0.267	0.211	0.041
Fall 2	100-m road and pad	82.449	981.686	0.467	0.678	0.344
Fall 2	70-m uncleared	37.291	27.352	0.267	0.678	0.196
Fall 2	70-m cleared	48.703	54.418	0.267	0.678	0.196

[1] Temopral coverage adjusted for fall sub-seasons based on the relative length of each respective sub-season.

v = temporal coverage; dwp = stratum weight

Appendix C3. Inputs needed to run Evidence of Absence: Multiple Year Module for the Hog Creek Wind Farm Hardin County, Ohio, from 2020 – 2021

Year	Ba	Bb	Weights (ρ)
2020	65.52	274.61	0.7
2021	218.39	575.95	1.0

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): 2021-04-01

◉ Formula
Search interval (I): 7
Number of searches: 8

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

Spatial coverage (a): 0.106
Temporal coverage (v): 0.11

Searcher Efficiency

○ Carcasses available for several searches
95% CIs: p ∈ [0.529, 0.676], k ∈ [0.653, 0.813]
p̂ = 0.62, k̂ = 0.735   View   Edit

◉ Carcasses removed after one search
Carcasses available: 49
Carcasses found: 45
p̂ = 0.918, with 95% CI = [0.818, 0.972]
Factor by which searcher efficiency changes with each search (k): 0.67

Persistence Distribution

○ Use field trials to estimate parameters   View/Edit
Distribution: Lognormal with shape (α) = 4.078 and scale (β) = 1.171
r = 0.531 for Ir = 7, with 95% CIs: r = [0.411, 0.66], β = [0.488, 1.854]

◉ Enter parameter estimates manually   View

Parameters
Exponential
Weibull
Log-Logistic
Lognormal

shape (α): 2.740
scale (β): 11.905   lwr 8.611   upr 16.445
r = 0.945 for Ir = 7, with 95% CI: r ∈ [0.884, 0.976]

Estimate g

Fatality estimation (M, λ)

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

Close

R Estimated detection probability (g)

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

Full site for full year
    Estimated g = 0.0103, 95% CI = [0.00949, 0.0112]
    Fitted beta distribution parameters for estimated g: Ba = 541.0316, Bb = 51764.2953


Full site for monitored period, 01-Apr-2021 through 27-May-2021
    Estimated g = 0.094, 95% CI = [0.0863, 0.102]
    Fitted beta distribution parameters for estimated g: Ba = 495.1842, Bb = 4770.9477
    Temporal coverage (within year) = 0.11


Searched area for monitored period, 01-Apr-2021 through 27-May-2021
    Estimated g = 0.887, 95% CI = [0.803, 0.95]
    Fitted beta distribution parameters for estimated g: Ba = 61.6335, Bb = 7.8436

================================================================================
Input:
Search parameters
    trial carcasses placed = 49, carcasses found = 45
    estimated searcher efficiency: p = 0.918, 95% CI = [0.818, 0.972]
    k = 0.67
    Search schedule: Search interval (I) = 7, number of searches = 8, span = 56
        spatial coverage: 0.106    temporal coverage: 0.11

Carcass persistence:
    Log-Logistic persistence distribution
        shape (a) = 2.74 and scale (ß) = 11.905
        95% CI ß = [8.611, 16.445]
        r = 0.945 for Ir = 7 with 95% CI = [0.884, 0.976]
        Parameters entered manually
    Uniform arrivals
```

Appendix C4. Spring 100-m road/pad, 30 turbines searched weekly, inputs and outputs from the Evidence of Absence Graphical User Interface Single Class Module for Indiana bat and northern long-eared bat. Inputs are based on values reported in Appendix C1.

Appendix C5. Fall 1 100-m road/pad, 22 turbines searched twice weekly, inputs and outputs from the Evidence of Absence Graphical User Interface Single Class Module for Indiana bat and northern long-eared bat. Inputs are based on values reported in Appendix C1.

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): 2021-08-01

⦿ Formula

Search interval (I): 3.5

Number of searches: 18

◯ Custom   Edit/View

span = 182, I (mean) = 7

Spatial coverage (a): 0.0505

Temporal coverage (v): 0.678

Estimate g

Searcher Efficiency

◯ Carcasses available for several searches

95% CIs: p ∈ [0.526, 0.676], k ∈ [0.647, 0.819]

p̂ = 0.62, k̂ = 0.735   View   Edit

⦿ Carcasses removed after one search

Carcasses available: 49

Carcasses found: 45

p̂ = 0.918, with 95% CI = [0.818, 0.972]

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 = 0.653 for Ir = 3.5, with 95% CIs: r = [0.528, 0.774], β = [0.488, 1.854]

⦿ Enter parameter estimates manually   View

Exponential	Parameters		
Weibull	shape (α)	1.133	
Log-Logistic	scale (β)	4.540 lwr	2.173 upr
Lognormal			9.478

r = 0.761 for Ir = 3.5, with 95% CI: r ∈ [0.603, 0.874]

Fatality estimation (M, λ)

Carcass Count (X): 2   Estimate M   ⦿ One-sided CI (M*)   ◯ Two-sided CI

Credibility level (1 - α): 0.9   Estimate λ

Close

Estimated detection probability (g)

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

Full site for full year
    Estimated g = 0.0246, 95% CI = [0.0201, 0.0295]
    Fitted beta distribution parameters for estimated g: Ba = 103.0945, Bb = 4087.627


Full site for monitored period, 01-Aug-2021 through 03-Oct-2021
    Estimated g = 0.0363, 95% CI = [0.0296, 0.0436]
    Fitted beta distribution parameters for estimated g: Ba = 98.1071, Bb = 2605.769
    Temporal coverage (within year) = 0.678


Searched area for monitored period, 01-Aug-2021 through 03-Oct-2021
    Estimated g = 0.718, 95% CI = [0.573, 0.843]
    Fitted beta distribution parameters for estimated g: Ba = 29.438, Bb = 11.5376


================================================================================
Input:
Search parameters
    trial carcasses placed = 49, carcasses found = 45
    estimated searcher efficiency: p = 0.918, 95% CI = [0.818, 0.972]
    k = 0.67
    Search schedule: Search interval (I) = 3.5, number of searches = 18, span = 63
        spatial coverage: 0.0505     temporal coverage: 0.678
_____
Carcass persistence:
    Log-Logistic persistence distribution
        shape (a) = 1.133 and scale (B) = 4.54
        95% CI B = [2.173, 9.478]
        r = 0.761 for Ir = 3.5 with 95% CI = [0.603, 0.874]
    Parameters entered manually
    Uniform arrivals
_____
```

Appendix C6. Fall 2 100-m road/pad, 14 turbines searched twice weekly, inputs and outputs from the Evidence of Absence Graphical User Interface Single Class Module for Indiana bat and northern long-eared bat. Inputs are based on values reported in Appendix C1.

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): 2021-08-01

● Formula
Search interval (I): 3.5
Number of searches: 18

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

Spatial coverage (a): 0.2533
Temporal coverage (v): 0.211

[Estimate g]

Searcher Efficiency

○ Carcasses available for several searches
95% CIs: p ∈ [0.526, 0.676], k ∈ [0.647, 0.819]
$\hat{p}$ = 0.62, $\hat{k}$ = 0.735   [View] [Edit]

● Carcasses removed after one search
Carcasses available: 47
Carcasses found: 35
$\hat{p}$ = 0.745, with 95% CI = [0.608, 0.852]
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 = 0.653 for Ir = 3.5, with 95% CIs: r = [0.528, 0.774], β = [0.488, 1.854]

● Enter parameter estimates manually   [View]

	Parameters
Exponential	shape (α): 2.605
Weibull	scale (β): 1.428 lwr 0.821 upr 2.036
Log-Logistic	r = 0.729 for Ir = 3.5, with 95% CI: r ∈ [0.607, 0.83]
Lognormal	

Fatality estimation (M, λ)

Carcass Count (X): 2   [Estimate M]   ● One-sided CI (M*)   ○ Two-sided CI   [Close]
Credibility level (1 - α): 0.9   [Estimate λ]

R Estimated detection probability (g)

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

Full site for full year
    Estimated g = 0.0327, 95% CI = [0.0263, 0.0397]
    Fitted beta distribution parameters for estimated g: Ba = 88.569, Bb = 2622.2818


Full site for monitored period, 01-Aug-2021 through 03-Oct-2021
    Estimated g = 0.155, 95% CI = [0.125, 0.188]
    Fitted beta distribution parameters for estimated g: Ba = 77.6752, Bb = 423.9698
    Temporal coverage (within year) = 0.211


Searched area for monitored period, 01-Aug-2021 through 03-Oct-2021
    Estimated g = 0.611, 95% CI = [0.484, 0.731]
    Fitted beta distribution parameters for estimated g: Ba = 35.8197, Bb = 22.7821

================================================================================
Input:
Search parameters
    trial carcasses placed = 47, carcasses found = 35
    estimated searcher efficiency: p = 0.745, 95% CI = [0.608, 0.852]
    k = 0.67
    Search schedule: Search interval (I) = 3.5, number of searches = 18, span = 63
      spatial coverage: 0.2533    temporal coverage: 0.211
    _____
Carcass persistence:
    Lognormal persistence distribution
      shape (a) = 2.605 and scale (ß) = 1.428
      95% CI ß = [0.821, 2.036]
      r = 0.729 for Ir = 3.5 with 95% CI = [0.607, 0.83]
    Parameters entered manually
    Uniform arrivals
    _____
```

Appendix C7. Fall 1 70-m uncleared plot, eight turbines searched twice weekly, inputs and outputs from the Evidence of Absence Graphical User Interface Single Class Module for Indiana bat and northern long-eared bat. Inputs are based on values reported in Appendix C1.

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd)   2021-08-01

☉ Formula

Search interval (I)   3.5
Number of searches   17

○ Custom   Edit/View

span = 182, I (mean) = 7

Spatial coverage (a)   0.2533
Temporal coverage (v)   0.678

Estimate g

Searcher Efficiency

○ Carcasses available for several searches

95% CIs: p ∈ [0.526, 0.676], k ∈ [0.647, 0.819]
p̂ = 0.62, k̂ = 0.735   View   Edit

☉ Carcasses removed after one search

Carcasses available   47
Carcasses found   35
p̂ = 0.745, with 95% CI = [0.608, 0.852]

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 = 0.653 for Ir = 3.5, with 95% CIs: r = [0.528, 0.774], β = [0.488, 1.854]

☉ Enter parameter estimates manually   View

Exponential
Weibull
Log-Logistic
Lognormal

Parameters

shape (α)   2.605
scale (β)   1.428   lwr   0.821   upr   2.036
r = 0.729 for Ir = 3.5, with 95% CI: r ∈ [0.607, 0.83]

Fatality estimation (M, λ)

Carcass Count (X)   2   Estimate M   ☉ One-sided CI (M*)   ○ Two-sided CI   Close
Credibility level (1 - α)   0.9   Estimate λ

R Estimated detection probability (g)

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

Full site for full year
    Estimated g = 0.105, 95% CI = [0.084, 0.128]
    Fitted beta distribution parameters for estimated g: Ba = 77.9803, Bb = 665.0539


Full site for monitored period, 01-Aug-2021 through 29-Sep-2021
    Estimated g = 0.155, 95% CI = [0.124, 0.189]
    Fitted beta distribution parameters for estimated g: Ba = 73.7982, Bb = 402.9664
    Temporal coverage (within year) = 0.678


Searched area for monitored period, 01-Aug-2021 through 29-Sep-2021
    Estimated g = 0.611, 95% CI = [0.482, 0.733]
    Fitted beta distribution parameters for estimated g: Ba = 34.4903, Bb = 21.9535

================================================================
Input:
Search parameters
    trial carcasses placed = 47, carcasses found = 35
    estimated searcher efficiency: p = 0.745, 95% CI = [0.608, 0.852]
    k = 0.67
    Search schedule: Search interval (I) = 3.5, number of searches = 17, span = 59.5
      spatial coverage: 0.2533    temporal coverage: 0.678

Carcass persistence:
    Lognormal persistence distribution
      shape (a) = 2.605 and scale (B) = 1.428
      95% CI B = [0.821, 2.036]
      r = 0.729 for Ir = 3.5 with 95% CI = [0.607, 0.83]
    Parameters entered manually
    Uniform arrivals
```

Appendix C8. Fall 2, 70-m uncleared plot, eight turbines searched twice weekly, inputs and outputs from the Evidence of Absence Graphical User Interface Single Class Module for Indiana bat and northern long-eared bat. Inputs are based on values reported in Appendix C1.

EoA, v2.0.7 - Single Class Module

Edit   Help

Detection Probability (g)

Search Schedule

Start of monitoring (yyyy-mm-dd): `2021-08-01`

○ Formula

Search interval (I): `3.5`

Number of searches: `16`

○ Custom   Edit/View

span = 182, I (mean) = 7

Spatial coverage (a): `0.2065`

Temporal coverage (v): `0.678`

[Estimate g]

Searcher Efficiency

○ Carcasses available for several searches

95% CIs: p ∈ [0.526, 0.676], k ∈ [0.647, 0.819]

p̂ = 0.62, k̂ = 0.735   [View] [Edit]

● Carcasses removed after one search

Carcasses available: `47`

Carcasses found: `35`

p̂ = 0.745, with 95% CI = [0.608, 0.852]

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 = 0.653 for Ir = 3.5, with 95% CIs: r = [0.528, 0.774], β = [0.488, 1.854]

● Enter parameter estimates manually   [View]

Exponential	Parameters			
Weibull	shape (α)	2.605		
Log-Logistic	scale (β)	1.428	lwr 0.821	upr 2.036
Lognormal	r = 0.729 for Ir = 3.5, with 95% CI: r ∈ [0.607, 0.83]			

Fatality estimation (M, λ)

Carcass Count (X): `2`   [Estimate M]   ● One-sided CI (M*)   ○ Two-sided CI

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

[Close]

R Estimated detection probability (g)

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

Full site for full year
    Estimated g = 0.085, 95% CI = [0.0679, 0.104]
    Fitted beta distribution parameters for estimated g: Ba = 78.1742, Bb = 841.4948


Full site for monitored period, 01-Aug-2021 through 26-Sep-2021
    Estimated g = 0.125, 95% CI = [0.1, 0.153]
    Fitted beta distribution parameters for estimated g: Ba = 74.8305, Bb = 522.0388
    Temporal coverage (within year) = 0.678


Searched area for monitored period, 01-Aug-2021 through 26-Sep-2021
    Estimated g = 0.607, 95% CI = [0.477, 0.73]
    Fitted beta distribution parameters for estimated g: Ba = 33.7909, Bb = 21.8739


=================================================================================
Input:
Search parameters
    trial carcasses placed = 47, carcasses found = 35
    estimated searcher efficiency: p = 0.745, 95% CI = [0.608, 0.852]
    k = 0.67
    Search schedule: Search interval (I) = 3.5, number of searches = 16, span = 56
      spatial coverage: 0.2065     temporal coverage: 0.678
_____
Carcass persistence:
    Lognormal persistence distribution
      shape (a) = 2.605 and scale (ß) = 1.428
      95% CI ß = [0.821, 2.036]
      r = 0.729 for Ir = 3.5 with 95% CI = [0.607, 0.83]
      Parameters entered manually
    Uniform arrivals
_____
```

Appendix C9. Fall 2 70-m cleared plot, eight turbines searched twice weekly, inputs and outputs from the Evidence of Absence Graphical User Interface Single Class Module for Indiana bat and northern long-eared bat. Inputs are based on values reported in Appendix C1.

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

Edit   Help

Options

Overall

◉ Estimate total mortality (M)

Credibility level (1 - α) [0.8]

◉ One-sided CI (M*)
○ Two-sided CI

○ Estimate overall detection probability (g)

Individual classes

○ Calculate g parameters from monitoring data
◉ Enter g parameters manually

Actions

[Add class] [Calculate]   [Clear] [Close]

Class	dwp	X	Ba	Bb	ĝ	95% CI
unsearched	0	0	---	---	0	[0, 0]
spring road/pad	0.11	0	469.516	4536.559	0.09379	[0.0859, 0.102]
fall 1 road/pad	0.113	0	88.457	1043.613	0.07814	[0.0632, 0.0945]
fall 1 uncleared	0.041	0	38.799	29.868	0.565	[0.447, 0.679]
fall 2 road/pad	0.344	0	82.449	981.686	0.07748	[0.0622, 0.0943]
fall 2 uncleared	0.196	0	37.291	27.352	0.5769	[0.456, 0.694]
fall 2 cleared	0.196	0	48.703	54.418	0.4723	[0.377, 0.568]

R Estimated mortality (M) & 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 road/pad    0.11    0   469.5  4537  0.094  [0.086, 0.102]
  fall 1 road/pad    0.113   0    88.46  1044  0.078  [0.063, 0.094]
  fall 1 uncleared   0.041   0    38.8  29.87  0.565  [0.447, 0.679]
  fall 2 road/pad    0.344   0    82.45  981.7  0.077  [0.062, 0.094]
  fall 2 uncleared   0.196   0    37.29  27.35  0.577  [0.456, 0.694]
  fall 2 cleared     0.196   0    48.7  54.42  0.472  [0.377, 0.568]
===============================================================
Results for full site
_____

Detection probability
  Estimated g = 0.275, 95% CI = [0.244, 0.306]
  Fitted beta distribution parameters for estimated g: Ba = 218.7939, Bb = 577.$

Mortality
  M* = 2 for credibility 1 - alpha = 0.8, i.e., P(M <= 2) >= 80%
  Estimated annual fatality rate: lambda = 1.83, 95% CI = [ 0.0018, 9.207]

Test of assumed relative weights (rho)
  Class              Assumed   Fitted (95% CI)
  unsearched          0.000      NA
  spring road/pad     0.110    [0.001, 0.788]
  fall 1 road/pad     0.113    [0.002, 0.882]
  fall 1 uncleared    0.041    [0.000, 0.348]
  fall 2 road/pad     0.344    [0.002, 0.845]
  fall 2 uncleared    0.196    [0.000, 0.353]
  fall 2 cleared      0.196    [0.000, 0.406]
  p = 1 for likelihood ratio test of H0: assumed rho = true rho

Mortality rates (lambda) by class
  Class              Median        IQR          95% CI
  unsearched          ---          ---           ---
  spring road/pad     2.43    [ 0.54,  7.07]  [ 0.01, 26.88]
  fall 1 road/pad     2.94    [ 0.65,  8.56]  [ 0.01, 32.83]
  fall 1 uncleared    0.41    [ 0.09,  1.19]  [ 0.00,  4.55]
  fall 2 road/pad     2.96    [ 0.66,  8.64]  [ 0.01, 33.16]
  fall 2 uncleared    0.40    [ 0.09,  1.16]  [ 0.00,  4.46]
  fall 2 cleared      0.49    [ 0.11,  1.42]  [ 0.00,  5.44]
```

Appendix C10. Spring, Fall 1, and Fall 2, 100-m roads/pads, 70-m uncleared plots, and 70-m cleared plots searched weekly in the spring and twice weekly in the Fall 1 and Fall 2, inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Class Module for Indiana bat and northern long-eared bat. Inputs are based on values reported in the main text and Appendices C2.

Appendix C11. Inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Years Module for the M* calculation for northern long-eared bat, and inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Years Module for the short-term trigger test for northern long-eared bat.

```
R Mortality over 2 years                                          [ _ ][ □ ][ X ]

Summary statistics for total mortality through 2 years
----------------------------------------
Results
M* = 0 for 1 - a = 0.5, i.e., P(M <= 0) >= 50%

Estimated overall detection probability: g = 0.241, 95% CI = [0.216, 0.267]
   Ba = 268.6, Bb = 845.72

Estimated baseline fatality rate: lambda = 1.225, 95% CI = [0.00121, 6.16]


Test of assumed relative weights (rho) and potential bias           Fitted rho
Assumed rho      95% CI
     0.7     [0.012, 1.695]
       1     [0.005, 1.688]

p = 1 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 0.938

Posterior distribution of M
m      p(M = m) p(M > m)
0        0.5315   0.4685
1        0.1671   0.3014
2        0.0973   0.2040
3        0.0623   0.1417
4        0.0417   0.1000
5        0.0286   0.0713
6        0.0200   0.0513
7        0.0142   0.0372
8        0.0101   0.0270
9        0.0073   0.0198
10       0.0053   0.0145
11       0.0038   0.0107
12       0.0028   0.0079
13       0.0021   0.0058
14       0.0015   0.0043
15       0.0011   0.0032
16       0.0008   0.0024
17       0.0006   0.0018
18       0.0005   0.0013
19       0.0003   0.0010
20       0.0002   0.0007
21       0.0002   0.0005
22       0.0001   0.0004
23       0.0001   0.0003
24       0.0001   0.0002
25       0.0001   0.0002
26       0.0000   0.0001
27       0.0000   0.0001
28       0.0000   0.0001
29       0.0000   0.0000
30       0.0000   0.0000
31       0.0000   0.0000
32       0.0000   0.0000
33       0.0000   0.0000
```

Appendix C11 continued. Inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Years Module for the M* calculation for northern long-eared bat, and inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Years Module for the short-term trigger test for northern long-eared bat.

EoA, v2.0.7 - Multiple Years Module

Edit   Help

Past monitoring and operations data

Year	ρ	X	Ba	Bb	ĝ	95% CI
2020	0.7	0	65.52	274.61	0.1926	[0.153, 0.236]
2021	1	0	218.39	575.95	0.2749	[0.244, 0.306]

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)   60

○ 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 theshold (τ)   3.3
○ Credibility level for CI (1-α)   0.9
⊙ Short-term rate (λ > τ)   Term: 2   α   0.05
○ Reversion test (λ < ρ τ)   ρ   0.6   α   0.1

Actions

Calculate   Close

R Short-term Trigger

```
Short-term trigger: Test of average fatality rate (lambda) over 2 years
Years: 2020 - 2021
============================================================================
Results
Estimated overall detection probability: g = 0.241, 95% CI = [0.216, 0.267]
   Ba = 268.6, Bb = 845.72

Estimated annual fatality rate over the past 2 years: lambda = 1.041, 95% CI = [0.00103, 5.24]
   P(lambda > 3.3) = 0.0750999999999999
   Compliance: Cannot infer lambda > 3.3 with 95% credibility
_____
Input
Threshold for short-term rate (tau) =   3.3  per year

Period        rel_wt  X    Ba     Bb   ghat      95% CI
2020          0.700   0  65.52  274.6 0.193 [0.153, 0.236]
2021          1.000   0  218.4    576 0.275 [0.244, 0.306]
```

Appendix C12. Inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Years Module for the M* calculation for Indiana bat, and inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Years Module for the short-term trigger test for Indiana bat.

```
R Mortality over 2 years                                              _  □  ✕

Summary statistics for total mortality through 2 years
---------------------------------------
Results
M* = 0 for 1 - a = 0.5, i.e., P(M <= 0) >= 50%

Estimated overall detection probability: g = 0.241, 95% CI = [0.216, 0.267]
   Ba = 268.6, Bb = 845.72

Estimated baseline fatality rate: lambda = 1.225, 95% CI = [0.00121, 6.16]


Test of assumed relative weights (rho) and potential bias          Fitted rho
Assumed rho      95% CI
     0.7      [0.013, 1.695]
       1      [0.005, 1.687]

p = 1 for likelihood ratio test of H0: assumed rho = true rho
Quick test of relative bias: 0.938

Posterior distribution of M
m      p(M = m)  p(M > m)
0       0.5315    0.4685
1       0.1671    0.3014
2       0.0973    0.2040
3       0.0623    0.1417
4       0.0417    0.1000
5       0.0286    0.0713
6       0.0200    0.0513
7       0.0142    0.0372
8       0.0101    0.0270
9       0.0073    0.0198
10      0.0053    0.0145
11      0.0038    0.0107
12      0.0028    0.0079
13      0.0021    0.0058
14      0.0015    0.0043
15      0.0011    0.0032
16      0.0008    0.0024
17      0.0006    0.0018
18      0.0005    0.0013
19      0.0003    0.0010
20      0.0002    0.0007
21      0.0002    0.0005
22      0.0001    0.0004
23      0.0001    0.0003
24      0.0001    0.0002
25      0.0001    0.0002
26      0.0000    0.0001
27      0.0000    0.0001
28      0.0000    0.0001
29      0.0000    0.0000
30      0.0000    0.0000
31      0.0000    0.0000
32      0.0000    0.0000
33      0.0000    0.0000
```

Appendix C12 continued. Inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Years Module for the M* calculation for Indiana bat, and inputs and outputs from the Evidence of Absence Graphical User Interface Multiple Years Module for the short-term trigger test for Indiana bat.