Operational Monitoring at the Hoopeston Wind Project Vermilion County, Illinois

April – October 2019

Prepared for:

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EXECUTIVE SUMMARY

Western EcoSystems Technology, Inc. completed operational post-construction fatality monitoring during the spring, summer, and fall of 2019 at the Hoopeston Wind Project (Project) located in Vermilion County, Illinois. This report details the post-construction fatality monitoring studies conducted in accordance with the Hoopeston Habitat Conservation Plan (HCP) and Incidental Take Permit (ITP) TE54252C-0 for Indiana bats and northern long-eared bats for the second year after the issuance of an ITP. The study objectives were to: 1) determine overall bat fatality rates, 2) estimate Indiana bat and northern long-eared bat take using the Species Composition approach and Evidence of Absence (EoA) framework outlined in the HCP, and 3) provide the necessary data to determine if adaptive management is triggered.

The Project HCP outlines fixed spring and summer monitoring plans, and, per Section 6.4.2.3, states that the fall season is the only potentially risky season to the federally listed Indiana and northern long-eared bat. The HCP also dictates that the level of monitoring during the fall season for the first three years after receiving an ITP will strive to reach a *g* of 0.29, or have a 29% probability of detecting a single bat carcass, such as an Indiana or northern long-eared bat. A modeling approach using data collected in 2018 was used to determine monitoring effort for fall 2019 to reach a *g* of 0.29.

During the spring (April 1 – May 15), searches were completed weekly at five turbines within a 40-m (131-ft) radius cleared plot, and road and pad searches were completed weekly at the remaining 44 turbines on gravel areas within 95 m (312 ft) of the turbine. During the summer (May 16 – July 31), road and pad searches within 95 m were completed weekly at all 49 turbines. All spring and summer searches were conducted by human searchers. During the fall (August 1 – October 15), turbines were searched twice weekly, with 15 turbines searched as 40-m radius cleared plots, 14 turbines searched as 70-m (229-ft) radius un-cleared plots, and 20 turbines were searched as 95-m road and pad searches. In the fall, human searchers completed the road and pad searches and dog-handler teams completed the 40-m and 70-m radius plot searches. Searcher efficiency and carcass persistence trials were completed to estimate bat carcass detectability and persistence rates during each season and for each survey type. Overall bat fatality and Indiana bat and northern long-eared bat take estimates were calculated using searcher efficiency, carcass persistence and area adjustment estimates. Area adjustment estimates were calculated using Project-specific data from this study to determine the proportion of bats estimated to fall within search areas. Fatality estimates for bats were calculated using GenEst, Huso, and Shoenfeld fatality estimators, per U.S. Fish and Wildlife Service request. However, only the overall fatality estimates from the GenEst were used to determine take estimates for Indiana and northern-long eared bats. Bird carcasses were recorded and identified if found during searches or incidentally, but fatality estimates were not calculated.

A total of 633 plot searches and 1,213 road and pad searches were completed during the 2019 monitoring period. The estimated searcher efficiency rates for dog-handler teams ranged from 23% for 70-m un-cleared plots in grasslands to 88% for cleared plots. Searcher efficiency for

human searchers ranged from 70% on cleared plots in the spring to 100% on roads and pads in the summer. The median time bat carcasses were estimated to persist was 8.9 days, and rates did not differ by season.

No Indiana bats or northern long-eared bats, or any other federally or state-listed species, were found during the post-construction fatality monitoring studies. A total of 473 non-listed bats were found during scheduled carcass searches and incidentally. Species found included eastern red bat (59%), followed by silver-haired bat (18%), hoary bat (16%), big brown bat (3%), evening bat (1%) and Seminole bat (0.8%). The bat species composition recorded at the Project was similar to previous studies at the Project and other wind energy facilities in the Midwest. Bats were mainly found in the fall season and were not concentrated within a specific area of the Project.

Overall bat fatality estimates for the 2019 monitoring period were 17.86 bats per MW using GenEst (90% confidence intervals: 13.02–36.50), 15.77 bats per MW using the Huso estimator (90% confidence intervals: 10.81–29.09), and 13.77 bats per MW using the Shoenfeld estimator (90% confidence intervals: 10.02–23.06). The use of dogs increased searcher efficiency rates approximately 44% in 2019 relative to rates achieved by humans on cleared plots in the fall of 2018. The use of dogs to increase searcher efficiency rates, in combination with searching more and larger plots, resulted in an increased probability of detecting a single carcass in 2019 (g = 0.26) relative to 2018 (g = 0.13) when using the Project-specific area correction.

The EoA framework estimated that zero Indiana bats and zero northern long-eared bats were killed during 2019, using the 50% credible estimate. Take estimates for 2019 using the Species Composition approach and based on the GenEst estimator were 4.0 Indiana bat and 4.0 northern long-eared bat. EoA estimates are a direct measure of Indiana and northern long-eared take, while Species Composition estimates rely on the assumption that migratory tree bat mortality is a good surrogate for Indiana and northern long-eared bat mortality, and that Indiana and northern long-eared bat populations have not declined relative to tree bat populations since the inception of the HCP.

The estimated levels of Indiana bat and northern long-eared bat take during 2019 were below levels authorized within the ITP, using EoA estimates. The projected level of take for the remainder of the Project operation was also estimated to be lower than limits authorized by the HCP and ITP assuming similar levels of mortality in future years.

STUDY PARTICIPANTS

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REPORT REFERENCE

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INTRODUCTION

Western EcoSystems Technology, Inc. (WEST) completed operational post-construction fatality monitoring during the spring, summer, and fall of 2019 at the Hoopeston Wind Project (Project) located in Vermilion County, Illinois. The purpose of the study was to conduct monitoring in accordance with the Hoopeston Habitat Conservation Plan (HCP) and Incidental Take Permit (ITP) TE54252C-0 for Indiana bats (*Myotis sodalis*) and northern long-eared bats (*Myotis septentrionalis*). This was the second year of monitoring post-receipt of Project ITP.

The Project is composed of 49 2.0-megawatt (MW) wind turbines capable of generating 98 MW. All turbines are V 100 Vestas turbines with a 100-meter (m; 328-feet [ft]) hub height and 49-m (161-ft) blade length. As required in the HCP, the Project feathered turbines below manufacturer cut-in speed (3.0 meters per second [mps]; 6.7 miles per hour) from sunset to sunrise each night from April 1 through October 15 to minimize impacts to Indiana bats and northern long-eared bats. The overall goal of this post-construction fatality monitoring study was to generate reliable fatality estimates for the covered species as specified in the HCP and to evaluate compliance with the incidental take authorization granted under ITP TE54252C-0. The objectives of this study were to: 1) determine overall bat fatality rates, 2) estimate Indiana bat and northern long-eared bat take using the Species Composition approach and Evidence of Absence (EoA) framework outlined in the HCP, and 3) provide the necessary data to determine if adaptive management is triggered (see Tables 7-2, 7-3 and 8-1 of the HCP; Hoopeston Wind 2017).

STUDY AREA

The Project is in the Central Corn Belt Plains Ecoregion, which encompasses a large portion of central Illinois (Woods et al. 2007). This ecoregion is composed of primarily of vast glaciated plains. Tall-grass prairie originally dominated much of the region, and scattered groves of trees and marshes occurred on level uplands. Today, the dominant land use within the Project is tilled agriculture, consisting primarily of corn (*Zea mays*), soybeans (*Glycine max*), and winter wheat (*Triticum sp.).* In addition, there are scattered residences, and small areas of pasture, grasslands, and shelterbelts (Figure 1; Multi-Resolution Land Characteristics 2019, Yang et al. 2018). Fatality monitoring was completed at 100% of the turbines as shown in Figure 1 and as described in the Methods section below.

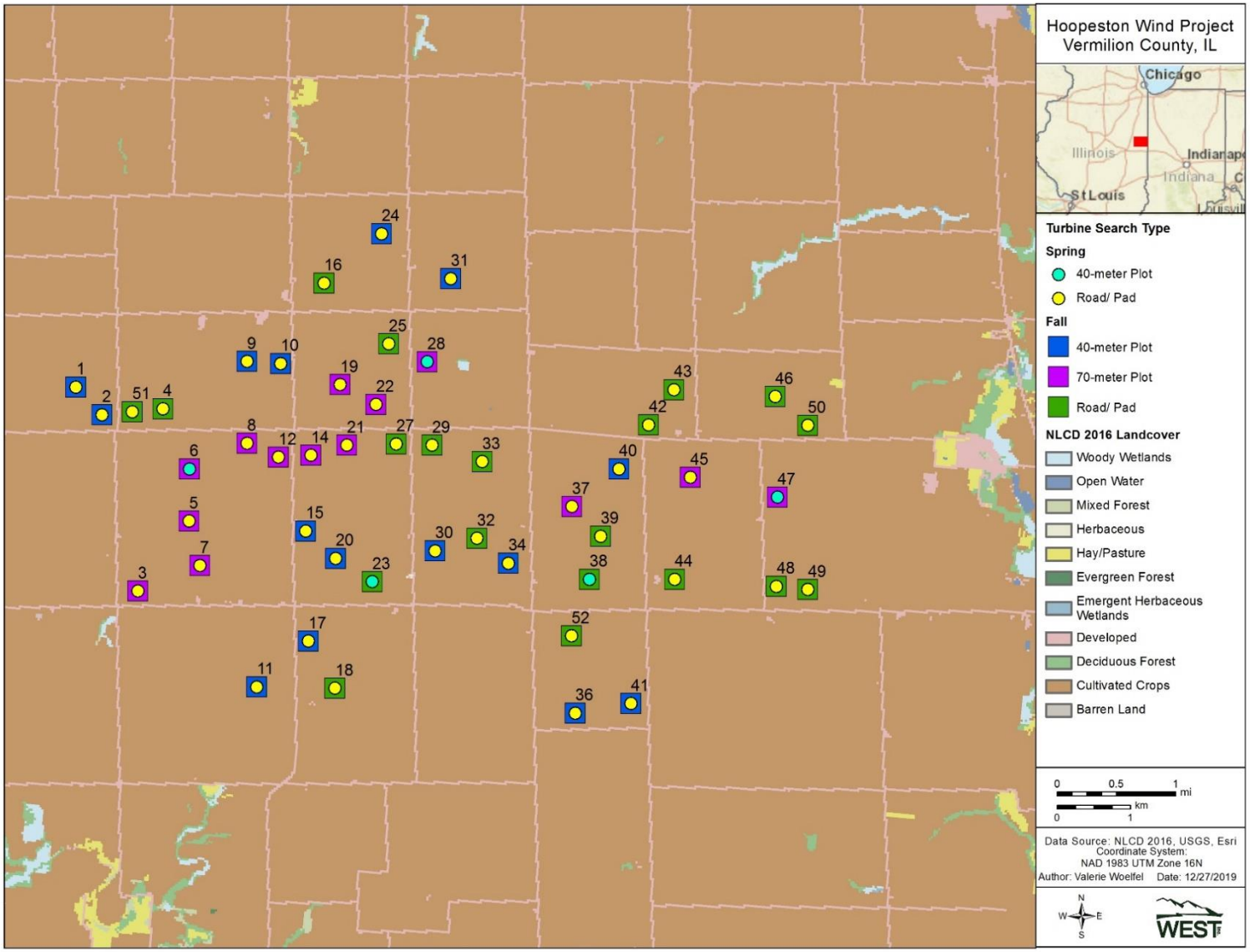

Figure 1. Land cover, turbine layout, and search plot types during the 2019 monitoring period at the Hoopeston Wind Project in Vermilion County, Illinois.

METHODS

The study contained two components: 1) standardized carcass searches, and 2) searcher efficiency and carcass persistence trials using bat carcasses. Carcasses were found under two possible scenarios: 1) during standardized carcass surveys on survey plots or, 2) incidentally (i.e., outside of the search area or survey time or by operations personnel).

Field Methods

Spring and summer monitoring was completed in accordance with the fixed monitoring described in the HCP. A modeling approach using data collected in 2018 was used to determine the necessary monitoring effort for fall 2019 to reach a *g* of 0.29. WEST outlined the methods proposed for the fall monitoring with USFWS via email on July 22, 2019 and received approval for the study design on July 30, 2019 (Amber Schorg, USFWS, pers.comm.).

Standardized Carcass Searches

All carcass searches were conducted by WEST technicians trained to follow the Project's carcass search protocols, including proper handling and reporting of carcasses. Technicians collected bat carcasses in accordance with WEST's Illinois Department of Natural Resources (IDNR) Scientific Permit (2019; NH19.5223-1), WEST's IDNR Endangered and Threatened Species Permit (2514), WEST's US Fish and Wildlife Service (USFWS) Native Endangered and Threatened Species Recovery Permit (TE234121-9), and the Project's ITP (TE54252C-0). A USFWS-permitted bat biologist (TE19208C-0) verified the identification of all bats in person. In the event that heavily scavenged or decomposed bat carcasses were discovered that could not be positively identified and had potential to be a covered species, a 1-cm by 1-cm tissue sample was collected and sent to the Northern Arizona University School of Forestry and Center for Microbial Genetics and Genomics for further analysis. Bird carcasses were recorded but left in place, and all bird carcasses were verified by WEST biologists experienced with bird identification.

Survey methods in spring and summer were consistent with the Project HCP. During the spring (April 1 – May 15), a technician conducted weekly searches at five turbines within a cleared 40-m (131-ft) radius of the turbine (40-m plot), and at the remaining 44 turbines on just the gravel areas within 95 m (312 ft) of turbines (road and pad; Figure 1). During the summer (May 16 – July 31), a technician conducted searches of road and pads at all 49 turbines on a weekly basis.

Survey methods in the fall (August 1 – October 15) exceeded the level of effort described within the HCP in order to reach a *g* of 0.29. A technician searched 20 turbines as road and pads to a distance of 95 m. Dog-handler teams searched 15 turbines as cleared plots within 40 m (131-ft) of the turbine (40-m plots), and searched 14 turbines as 70-m (230-ft) radius un-cleared plots (70 m plots; Figure 1). Vegetation cover within the 70-m plots mainly consisted of soybeans (n= 9), but also included two plots vegetated with hemp (*Cannabis sativa*), and three plots vegetated with native grasses (Appendix A). All turbines were searched twice per week in the fall.

Technicians delineated the perimeter of each 40-m and 70-m plot using a Global Positioning System, and road-and-pad areas were digitized from aerial photography with Geographic Information System (GIS) software. Due to difficulties in marking and maintaining a set distance from turbines in vegetated fields, the boundaries of some of the plots exceeded 70 m. The plot boundaries were used to verify if carcasses were found inside the search areas, and to estimate the number of carcasses that fell outside of search areas; where plot boundaries exceeded 70m, these areas were included in analysis and the increased search areas were accounted for. During the spring and fall study periods, vegetation at 40-m plots was mowed and maintained by Project staff within 10 to 15 centimeters (four to six inches) in height to enhance detectability of carcasses.

In all seasons, technicians searched gravel road and pads by starting 95 m from the turbine, walking towards and around the turbine, and then back towards their vehicle. Human searchers searched 40-m plots in the spring by walking transects spaced five m apart, starting at one side of the plot and systematically searching in a north-south or east-west direction. Technicians alternated the direction of the search pattern on each visit to a plot. Technicians walked at a rate of approximately 45–60 m (148–197 ft) per minute and scanned the ground out to 2.5 m (8.2 ft) on either side of the transect.

In the fall, dog-handler teams searched all 40-m and 70-m plots at the Project. Handlers trained their detection dogs on the scent of bat carcasses using methods derived from search and rescue and drug detection programs (Kay 2012, Helfers 2017). Dogs were initially trained on cotton scent swabs from bat carcasses, and progressed to bat carcasses at increasing distances. The detection dog coordinator conducted a two-day evaluation of each dog-handler team; after teams achieved a searcher efficiency of 75% or greater on cleared plots 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 certified to perform searches at the Project included the following breeds: border collie, border collie mix, and Labrador/golden retriever mix.

Both wind speed and vegetation density can affect scent dispersal across the search area and therefore affects optimal transect width and starting locations for the dog-handler teams. Dog-handlers oriented their detection dog to start searches perpendicular to the wind to maximize scent detection and ensure the search area was adequately covered by searching transects spaced approximately 10 m (32 ft) apart in vegetated plots and transects spaced approximately 15 m (49 ft) apart in cleared plots, depending on wind speed and vegetation density. The handler placed a marker by the carcass and rewarded the dog with either a food reward or a short play session when a detection dog correctly alerted to a bird or bat carcass.

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

- Live/Injured— a live or injured bat or bird
- Intact— a carcass that was completely intact, was not badly decomposed, and showed no sign of being fed upon by a predator or scavenger

- Scavenged— an entire carcass, which showed 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 was heavily infested by insects
- Feather Spot (for bird carcasses only)—10 or more feathers (not including down) at one location indicating predation or scavenging

The following information was recorded for each carcass found during standardized surveys:

- Date and time
- Initial species identification
- Sex, age, and reproductive condition (if identifiable)
- Geographic coordinate
- Distance and bearing to turbine
- Substrate/ground cover conditions
- Condition (intact, scavenged)
- Estimated time since death (number of days)

Searcher Efficiency Trials

Searcher efficiency trials were conducted at a subset of 40-m and 70-m plots and road-and-pad turbines. The objective of the searcher efficiency trials was to estimate the probability that a bat carcass was found by human or dog searchers for each plot type. Between 10 to 15 bats were used for searcher efficiency trials per plot type and per season. The number of trials dropped per plot was restricted to two or less per survey. Searcher efficiency was estimated by plot type and season, and was used to adjust the total number of carcasses found by searchers, correcting for detection bias.

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 big brown bat (*Eptesicus fuscus*) carcasses provided by Illinois Natural History Survey, and of eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*) and silver-haired bat (*Lasionycteris noctivagans*) carcasses that were found at the Project.

All trial carcasses were placed at random locations within the search area prior to the survey that day. Trial carcasses were dropped from waist height and allowed to land in a random posture. Each trial carcass was discreetly marked with a black zip-tie around the bat's upper arm prior to placement so that the carcass could be identified as a trial carcass after it was found. The number and location of trial carcasses found during each carcass search were recorded. The number of carcasses available for detection during each trial was determined after the carcass search, and any carcasses determined to be unavailable during the survey time were excluded from the searcher efficiency estimates. Personnel conducting carcass surveys had one chance to locate trial carcasses, during the first search after carcass placement. A random path was taken to and from carcass locations to avoid the possibility of detection dogs following a human scent trail to trial carcasses.

Carcass Persistence Trials

Carcass persistence trials were conducted using a subset of the carcasses placed for searcher efficiency trials. The objective of carcass persistence trials was to estimate the average length of time a bat carcass remained in the field. Nine carcass persistence trials were completed with start dates between April 8 and September 24, 2019. Estimates of carcass persistence were used to adjust the total number of carcasses found by searchers, correcting for removal bias. Between 10-20 trial carcasses were placed in each season to incorporate the effects of varying weather and climatic conditions on carcass persistence. Trials were conducted in all plot types, but plot type was not used as a variable in analysis. Bats used for carcass persistence trials were previously frozen, but with little to no visible decomposition.

Personnel monitored the trial carcasses over a 28-day period, checking the carcasses on days 1, 2, 3, 4, 7, 10, 14, 21, and 28 after placement. Carcasses were left at the location until the carcass was completely removed or the trial period ended. Any remaining evidence of the carcass was removed at the end of the 28-day monitoring period.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers 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 observer 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 were made in all affected steps.

Data Compilation and Storage

A Microsoft SQL server database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined protocol to facilitate subsequent QA/QC and data analysis. All data forms and electronic data files were retained for reference.

Fatality Estimates

Fatality estimates were calculated for bats using the GenEst (a generalized estimator of fatality; Dalthorp et al. 2018, Simonis et al. 2018), Huso, and Shoenfeld fatality estimators (Huso 2011; Huso et al. 2015; Shoenfeld 2004). However, only the overall fatality estimates from the GenEst, the most updated estimator, were used to determine take estimates for Indiana and northern-long eared bats. The Huso and Shoenfeld estimators (Huso 2011; Huso et al. 2015; Shoenfeld 2004) were requested by the USFWS for comparison purposes in 2019. Descriptions of the variables used to calculate the fatality estimates are described in Appendix D.

Fatality estimates for bats were based on:

- Observed number of carcasses found within standardized search plots during the monitoring period.
- Searcher efficiency, expressed as the probability that a carcass was found by searchers during searcher efficiency trials.
- Persistence rates, expressed as the estimated average probability a carcass was expected to persist in the search area and be available for detection by the searchers during persistence trials.
- Area adjustment estimates, expressed as the carcass-density weighted adjustment for carcasses that fell outside of the search areas.

Each carcass included in the analysis was adjusted for searcher efficiency, carcass persistence, a detection reduction factor (also referred to as "*k*"; see below), and a search area adjustment to obtain an overall fatality estimate. Differences in methods used to determine the number of carcasses included in the analysis and to estimate searcher efficiency, carcass persistence, and area adjustment for the three estimators (GenEst, Huso, and Shoenfeld) are outlined below.

Confidence intervals surrounding estimates for each season and plot type were calculated, assuming more than five fatalities were detected. Estimates and 90% confidence intervals were calculated using a parametric bootstrap for GenEst (Dalthorp et al. 2018) and a non-parametric bootstrap for Huso and Shoenfeld. Bootstrapping is a computer simulation technique that is useful for calculating variances and confidence intervals for complicated test statistics. One thousand bootstrap samples were used. The lower 5^{th} and upper 95^{th} percentiles of the 1,000 bootstrap estimates were estimates of the lower limit and upper limit of 90% confidence intervals. For Huso and Shoenfeld, a weighted average was calculated across plot types. Seasonal estimates were summed to obtain overall fatality estimates. The number of turbines sampled per search plot type was used as a weight for the seasonal fatality estimates. For Gen-Est, estimates and confidence intervals were calculated using a parametric bootstrap (Dalthorp et al. 2018) by season and plot type, as well as overall.

Carcasses Excluded from Fatality Estimation

All carcasses found within the mapped plot boundaries were considered for inclusion in the fatality rate estimation if they had an estimated time of death within the study period and the area where they were found was monitored during their estimated time of death (i.e., carcasses found outside of plots were omitted from the analysis).

One of the underlying assumptions of the Huso estimator is that searchers have a single opportunity to discover a carcass (k=0; Huso 2011). In practice, particularly when carcass persistence times are long, carcasses may be discovered that have been available for more than one search. To meet the assumptions of the Huso estimator, a carcass was included in the Huso fatality estimates only if the estimated time since death was less than the search interval associated with that carcass.

The GenEst and Shoenfeld estimators do not require the assumption that searchers have a single opportunity to discover a carcass. GenEst accounts for multiple opportunities for finding a carcass through *k*; therefore, carcasses with an estimated time since death older than the search interval were not excluded from the fatality estimates calculated using GenEst, or Shoenfeld (which inherently assumes *k*=1).

Estimation of Searcher Efficiency

Estimates of searcher efficiency were used to adjust carcass counts for detection bias. Searcher efficiency estimated the probability of a carcass being detected by a searcher given the carcass was available to be found.

For GenEst, a logit regression model (Dalthorp et al. 2018) was used to obtain estimates of searcher efficiency while accounting for *k*. Potential covariates, or explanatory variables of interest, for the searcher efficiency models included plot type and season for human teams. Because dog-handler teams were only used at the Project in the fall, plot type was the only potential variable used for dog-handler teams. Within the 70-m plots, vegetation cover and density was variable. Therefore, searcher efficiency was estimated separately for soy and grassland plots. Hemp plots were sparsely vegetated, and of the two searcher efficiency carcasses dropped in hemp plots, both were detected; therefore, for the purposes of modeling searcher efficiency, hemp plots were grouped with cleared plots. Dogs were only used in one season; therefore, due to the uneven sampling design, searcher efficiency was modeled separately for the two types of teams. Models were selected using an information theoretic approach known as AICc, or corrected Akaike Information Criteria (Burnham and Anderson 2002). The selected model was the most parsimonious model within two AICc units of the model with the lowest AICc value.

Detection Reduction Factor

The change in searcher efficiency between successive searches was defined by a parameter called the detection reduction factor (*k*) that ranged from zero to one. When *k* is estimated or assumed to be zero, it implies that 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. The detection reduction factor was a required parameter for GenEst; however, data were not collected to estimate *k*. A value of *k*=0.8 was used for GenEst, in accordance with the HCP. As mentioned above, the Huso estimator inherently assumes the value of *k* is zero, and the Shoenfeld estimator inherently assumes the value of *k* is one.

Estimation of Carcass Persistence Rates

Estimates of carcass persistence were used to adjust carcass counts for removal bias for all estimators. The carcass persistence adjustment for the GenEst and Huso estimators estimated the average probability a carcass persisted through the search interval (i.e., the time between scheduled searches) using an interval-censored survival regression model using exponential, log-logistic, lognormal, and Weibull distributions (Dalthorp et al. 2018, Kalbfleisch and Prentice 2002). In the case of the Shoenfeld estimator, the carcass persistence rates were assumed to follow an exponential distribution and the average carcass persistence time for bats was generated using

predictions from these models. Season was the only potential covariate considered in carcass persistence models. The most parsimonious model within two AICc units of the model with the lowest AICc value was selected as the best model.

Area Adjustment

The search area adjustment accounted for carcasses falling within unsearched areas and was calculated as a probability that ranged from zero to one. The area adjustment was estimated as the product of the unsearched area around each turbine and a carcass-density distribution. A likelihood modeling approach was used to estimate the carcass-distance density distribution based on the distances at which bat carcasses were found from turbines during this study. A Truncated Weighted Likelihood (TWL) was used to estimate the carcass-distance density distribution using Project-specific data collected on the distance bat carcasses fell from the turbines. The density distribution of carcasses was estimated by fitting truncated Weibull, truncated Rayleigh, truncated Normal, truncated Gamma, or truncated Gompertz density distributions (parameterized according to R Core Team [2016] and Thomas et al. [2010]) to carcass distances from turbines and choosing the best-supported distribution through AICc. Fits were obtained using a weighted maximum likelihood approach (Khokan et al. 2013), where the weight for each observed carcass distance was the inverse of the fraction of area searched at the distance where the carcass was found, multiplied by the inverse of the probability the carcass was available to be found and detected by searchers. This approach results in weighted maximum likelihood estimates of carcass detection probabilities that vary systematically with distance from turbines. Areas near the turbine tend to have a higher density of bat carcasses than areas farther from the turbine (Huso and Dalthorp 2014) and, therefore, the search area was combined with the carcass-density distribution to estimate the area adjustment. The result was an estimate of the proportion of bat carcasses expected to land within searched and unsearched areas around the turbines. This approach was used for all three estimators based on the probability the carcass was available to be found and detected by searchers and variance estimation (bootstrap) methods for each respective estimator outlined above.

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

The fall season was the only season with potential risk to covered species per the HCP; therefore, species-specific fatality estimates were calculated for Indiana bats and northern long-eared bats using fall bat fatality estimates only.

Species Composition Approach

Indiana bat and northern long-eared bat fatalities were estimated for the year using the Species Composition approach by assuming that Indiana bat fatalities comprised 0.29% of all bat fatalities and northern long-eared bat fatalities comprised 0.24% of all bat fatalities, as specified in the HCP. Species Composition estimates were calculated in the 2018 report using the Huso estimator (Iskali and Pham 2019). Therefore, for the purposes of comparison, take estimates using this approach were calculated for both the GenEst and Huso all bat fatality estimates and the species composition percentages outlined above. For the purposes of comparing 2018 to 2019 take

estimates from the Species Composition approach, a rolling average was calculated using Huso estimates from both years and also using an average of Huso and GenEst[1] estimates.

Evidence of Absence

The EoA framework (Dalthorp et al. 2014; Dalthorp et al. 2017) used a statistical hierarchical model to estimate the actual number of fatalities from the number found, *g* (the site-wide probability that a carcass was available to be found and detected by searchers), the estimated mortality rate (λ), and the cumulative 30-year projected mortality based on λ.

The site-wide probability that a carcass was available to be found and detected by searchers was based on:

- Searcher efficiency expressed as the proportion of placed carcasses found by searchers during searcher efficiency trials (see Estimation of Searcher Efficiency Rates on page 11).
- Carcass persistence rates expressed as the estimated average probability a carcass was expected to remain in the study area and be available for detection by the searchers during persistence trials (see Estimation of Carcass Persistence Rates on page 11).
- Search area adjustment based on the estimated carcass-density within search areas and outside of search areas (see Area Adjustment section on page 12).
- Detection reduction factor (*k*), expressed as the fraction to which searcher efficiency was reduced with each successive search (see Detection Reduction Factor section on page 9). The factor *k* was assumed to equal 0.8, as outlined in the HCP.

Because the HCP specifies that the fall season was the only season with potential risk to covered species, the site-wide probability of detection (*g)* was estimated for five unique strata within the fall season; each stratum representing a unique combination of plot type and searcher efficiency class. Specifically, 1,000 bootstrap samples from each stratum were simulated from the fitted searcher efficiency models, carcass persistence models, and from area adjustment models fitted using the TWL for the GenEst analysis. These values were then used to calculate a value for *g* for each of the 1,000 bootstrap samples. These samples, along with an adjustment factor that accounted for sampling fraction for each stratum, were used to develop a distribution of overall fall *g* from which the median, upper and lower 90% confidence intervals were calculated. These values were used to compute parameters (Ba and Bb) for a beta distribution describing the distribution of g for the fall season. Species-specific fatality estimates were calculated for Indiana bats and northern long-eared bats using the beta distribution parameters from fall 2019. Parameters from both 2018 and 2019 were used with the EoA Multiple Year module to estimate the mortality rate and cumulative 30-year projected mortality.

The EoA estimator assumed the number of fatalities found during searches followed a binomial distribution

$$X \sim binomial(M, g)$$

[1] GenEst is a new fatality estimator that was not available in 2018.

where *X* was the count of Indiana bat or northern long-eared bat fatalities found during standardized carcass searches and *M* was the (unknown) number of actual bat fatalities. The statistical hierarchy of models inherent in EoA used an integrated reference prior distribution (Dalthorp et al. 2017) for Indiana bat or northern long-eared bat fatalities (*M*).

The Project HCP specified that a projection of take over 30 years of operation should be calculated to evaluate if the long-term permitted level of take may be exceeded. The EoA model estimated total mortality (*M*) during the 2019 study period, which was always a whole number of bats. In addition, EoA produced an estimate of the underlying average annual fatality rate based on both 2018 and 2019 data, (λ), which was not necessarily a whole number. For example, a facility may have an *average* λ (over a large number of years) of 0.2 bats per facility per year. The estimated take for a given year cannot be 0.2 bats because it is nonsensical to take a fifth of a bat. However, during a given year, the actual take at a facility with a take rate of 0.2 bats per year may be zero, one, or in rare years, even two or three bats. To evaluate cumulative 30-year projected mortality based on the estimated rate, λ was used to estimate the life of Project mortality by drawing a sample of potential take rates from the posterior distribution of the estimated take rate, and then simulated take in each year based on that take rate. *M* was summed over the permit duration (30 years), and the median overall *M* was calculated based on the distribution of projected *M*. For the take projections, it was assumed that there were no changes in operations in future years, and no reason to suspect mortality rates (ρ) varied systematically from year to year.

RESULTS

Standardized Carcass Searches

A total of 633 plot searches and 1,213 road and pad searches were completed from April 2 to October 15, 2019. Sixty-five searches (3%) were missed over the course of the survey period due to turbine maintenance and weather constraints. Details of all carcasses found during the study are presented in Appendix B. No Indiana bat or northern long-eared bat carcasses were found during the study. The searcher efficiency and carcass persistence results presented below focus on the GenEst analysis. Additional results for Huso and Shoenfeld estimators are presented in Appendix D.

Overall Fatalities

A total of 473 non-listed bat carcasses belonging to six species were found during scheduled carcass searches and incidentally. Eastern red bat (n=281, 59.4%) was the most common species fatality, followed by silver-haired bat (n=89, 18.8%), hoary bat (n=76, 16.1%), big brown bat (n=15, 3.2%), evening bat (*Nycticeius humeralis*) (n=6, 1.3%) and Seminole bat (*Lasiurus seminolus*) (n=4, 0.8%).

Five heavily scavenged bats (e.g., wing membrane only, bones, or partial carcasses) were sent off for DNA analysis; none were identified as state or federally listed species. One sample had

poor polymerase chain reaction amplification and a high quality DNA sequence was not able to be extracted; therefore, one of the unknown bats could not be further identified to species (Dr. Faith Walker, Northern Arizona University, pers.comm). The remaining four samples that were sent off for analysis were identified to common species, including eastern red bat (n=1) and silver-haired bat (n=3). One additional bat wing was confirmed to not be an Indiana bat or northern long-eared bat based on physical characteristics (e.g., the forearm measurement was 45 millimeters; the forearms of Indiana and northern long-eared bats do not exceed 41 millimeters [Whitaker and Mumford 2009]).

Forty-one bird carcasses of 13 known species were found during the study (Table 1). Killdeer (*Charadrius vociferous)* and horned lark (*Eremophila alpestris*) were the most common bird species found (n=16), accounting for 39% of the total carcasses found. Seven birds could not be identified to species due to scavenging and decomposition. No state or federally listed bird species were recorded.

Table 1. Total number of carcasses and percent composition of carcasses discovered at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

	Included in GenEst Fatality Estimate		Outside Plot		Outside Study Period		Total	
Species	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
eastern red bat	254	60.8	21	51.2	6	42.9	281	59.4
silver-haired bat	79	18.9	10	24.4	0	0	89	18.8
hoary bat	62	14.8	7	17.1	7	50	76	16.1
big brown bat	13	3.1	2	4.9	0	0	15	3.2
evening bat	5	1.2	1	2.4	0	0	6	1.3
Seminole bat	4	1	0	0	0	0	4	0.8
unidentified bat	1	0.2	0	0	1	7.1	2	0.4
Overall Bats	**418**	**100**	**41**	**100**	**14**	**100**	**473**	**100**
horned lark	0	0	0	0	0	0	8	19.5
killdeer	0	0	0	0	0	0	8	19.5
unidentified passerine	0	0	1	20.0	0	0	6	14.6
mourning dove	0	0	1	20.0	0	0	5	12.2
ring-necked pheasant	0	0	0	0	0	0	2	4.9
ruby-crowned kinglet	0	0	0	0	0	0	2	4.9
turkey vulture	0	0	2	40.0	0	0	2	4.9
American redstart	0	0	0	0	0	0	1	2.4
purple martin	0	0	0	0	0	0	1	2.4
red-eyed vireo	0	0	0	0	0	0	1	2.4
red-winged blackbird	0	0	1	20.0	0	0	1	2.4
unidentified warbler	0	0	0	0	0	0	1	2.4
yellow-billed cuckoo	0	0	0	0	0	0	1	2.4
yellow-bellied flycatcher	0	0	0	0	0	0	1	2.4
yellow-rumped warbler	0	0	0	0	0	0	1	2.4
Overall Birds*	**0**	**0**	**5**	**100**	**0**	**0**	**41**	**100**

*Birds were not included in fatality estimates.

Carcasses for Analysis

Fourteen bat carcasses were estimated to have occurred outside the monitoring period, and forty-one bat carcasses were found outside of search plot boundaries. All of these carcasses were

excluded from the analysis of all three estimators (GenEst, Huso, and Shoenfeld). One hundred bat carcasses were excluded from the Huso fatality estimate because they did not meet the model assumption of the searcher having a single opportunity to find each carcass (i.e., the estimated time of death was greater than the search interval; Table 1), but were included in both the GenEst and Shoenfeld fatality estimates. Bird fatality rates were not estimated.

Timing and Distribution of Bat Fatalities

The vast majority of bat carcasses were found after August 6, 2019 (Figure 2). The number of bat carcasses peaked early August, and was predominantly composed of eastern red bats and a smaller number of hoary bats (Appendix B). Bat carcasses were found at 41 of the 49 study turbines. Bats were found mainly on uncleared 70-m plots, which were the largest areas searched (Figure 2), and no concentrations of bats were found at a certain area of the Project.

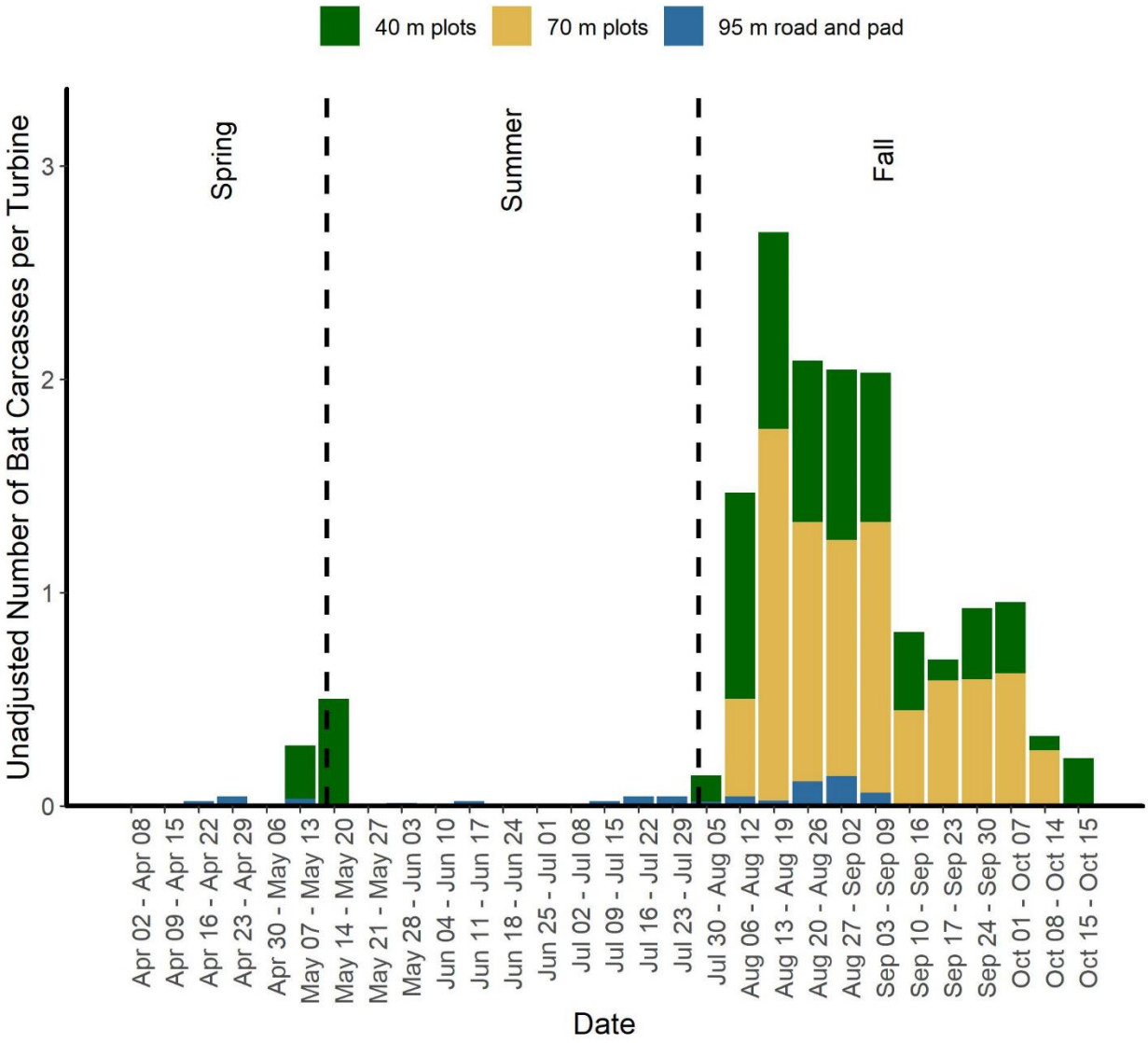

Figure 2. Timing of bat carcasses at the Hoopeston Wind Project from April 2 – October 15, 2019 for carcasses included in the GenEst fatality estimates.

Searcher Efficiency Trials

Eighty-six bat carcasses were used during 10 searcher efficiency trials conducted between April 8 and October 7, 2019. Raw searcher efficiency ranged from 23.1% to 100% depending on plot type and season (Table 2). Different searcher efficiency models were fit for human searchers and dog-handler teams because dog-handler teams were only used in fall. Plot type was included in the best fit model for dog-handler teams, suggesting that searcher efficiency varied substantially across plot types (Table 3). Plot type was not included in the best fit model for human searchers, suggesting that searcher efficiency did not vary substantially across plot types (Table 4). Estimated searcher efficiency, which was used in determining fatality and take estimates, is presented in Table 5.

Table 2. Searcher efficiency results at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019 as a function of season and plot search type for bats.

Plot Search Type	Season	# Placed	# Available	# Found	% Found
Human searchers: cleared	Spring	10	10	7	70.0
Human searchers: road and pad	Spring	10	10	9	90.0
Human searchers: road and pad	Summer*	12	12	12	100
Dog-handler team: cleared	Fall	16	16	14	87.5
Dog-handler team: grassland	Fall	13	13	3	23.1
Dog-handler team: soy	Fall	15	15	11	73.3
Human searchers: road and pad	Fall	10	10	8	80.0
Overall		**86**	**86**	**64**	**74.4**

*Only roads and pads were searched during the summer.

Table 3. Searcher efficiency logistic regression models for bats (dog-handler teams) from the Hoopeston Wind Project, Vermilion County, Illinois search efficiency trials from August 1, 2019 to October 15, 2019 (n=44). Selected model is denoted by an asterisk in the 'Delta AICc' column.

Covariate	AICc	Delta AICc
Plot Type	50.10	0*
No Covariates (Intercept)	59.78	9.68

AICc = Akaike Information Criteria

Table 4. Searcher efficiency logistic regression models for bats (human searchers) from the Hoopeston Wind Project, Vermilion County, Illinois search efficiency trials from April 2, 2019 to October 15, 2019 (n=42). Selected model is denoted by an asterisk in the 'Delta AICc' column.

Covariate	AICc	Delta AICc
Plot Type	36.44	0
No Covariates (Intercept)	36.55	0.11*

AICc = Akaike Information Criteria

Table 5. Overall searcher efficiency probabilities and 90% confidence intervals for bats calculated using a logistic regression model for GenEst estimators at the Hoopeston Wind Project, from April 2, 2019 to October 15, 2019.

Search Team and Plot Type	Estimated Searcher Efficiency Rate
Dog-handler: Cleared and Hemp	0.88 (0.65 – 0.96)
Dog-handler: Grassland	0.23 (0.01 – 0.47)
Dog-handler: Soy	0.73 (0.52 – 0.87)
Human searchers: Road and pad and cleared plot	0.85 (0.74 – 0.92)

Carcass Persistence Trials

Fifty-four bat carcasses were placed for carcass persistence trials and were used to estimate carcass persistence rates. The best-fit model was a lognormal distribution with no covariates, suggesting that carcass persistence did not vary substantially across seasons (Table 6). The estimated median carcass persistence time was 8.91 days (Table 7). Approximately 50% of bat carcasses remained after 10 days (Figure 3). The average probability that a bat carcass persisted through a 7-day search interval (spring and summer) was 0.73 (90% confidence interval [CI]: 0.65, 0.80), and the average probability of bat carcass persistence through a 3.5-day search interval (fall) was 0.84 (90% CI: 0.77, 0.90).

Table 6. Carcass persistence models and covariates for bats at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019 (n = 54).

Shape Covariates	Scale Covariates	Distribution	AICc	Delta AICc
Season	No Covariates	lognormal	218.34	0
Season	No Covariates	loglogistic	219.09	0.75
No Covariates	No Covariates	lognormal	220.09	1.75*
No Covariates	No Covariates	loglogistic	221.02	2.68
Season	Season	lognormal	221.69	3.35
No Covariates	Season	lognormal	222.04	3.70
Season	Season	loglogistic	222.36	4.02
No Covariates	No Covariates	Weibull	222.47	4.13
No Covariates	Season	Weibull	222.98	4.64
Season	No Covariates	Weibull	223.23	4.89
No Covariates	Season	loglogistic	223.32	4.98
Season	Season	Weibull	224.69	6.35
Season	-	exponential	226.60	8.26
No Covariates	-	exponential	227.40	9.06

* Selected model

Table 7. Carcass persistence top model with covariates, distributions, and model parameters for the Hoopeston Wind Project, Vermilion County, Illinois, from April 2, 2019 to October 15, 2019.

Size	Distribution	Estimated Removal Time (days)	Predicted Scale
Bat	lognormal	8.91	1.74

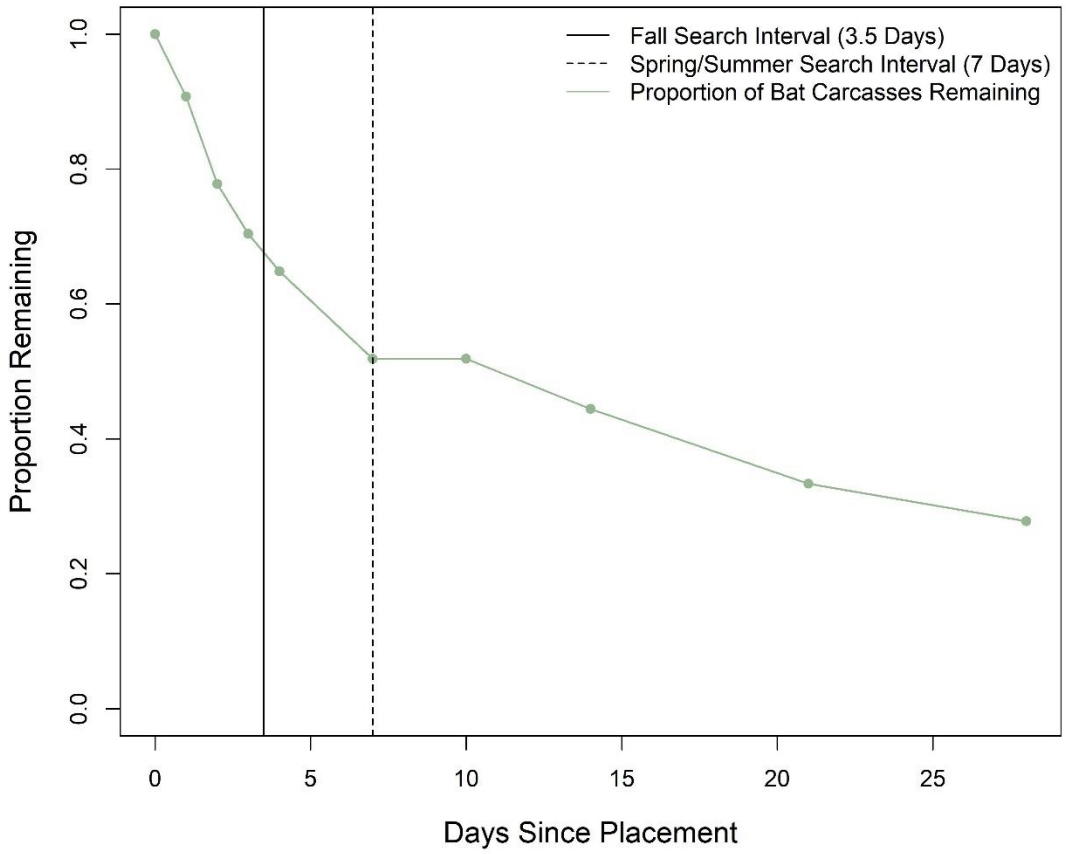

Figure 3. The proportion of carcasses remaining during carcass persistence trials at the Hoopeston Wind Project, Vermilion County Illinois, from April 2, 2019 to October 15, 2019.

Area Adjustment Using Project-Specific Data

The search area was delineated at all plots in the spring, fall, and summer. One 40-m cleared plot searched during the fall was approximately 20% vegetated with corn, and the corn portion of the plot was unable to be searched by dog-handler teams; no other plots had unsearchable areas. The boundaries of some un-cleared plots exceeded 70 m, and these areas were included in the analysis and the increased search areas accounted for. The best-fit model was a gamma distribution (Appendix C) and was used to calculate the area adjustment. The TWL model estimated that approximately 41% of bats fell within the search area of 40-m plot turbines, 78% within the search area of 70-m plot turbines and 4% within the search area of 95-m road and pads (Figure 4).

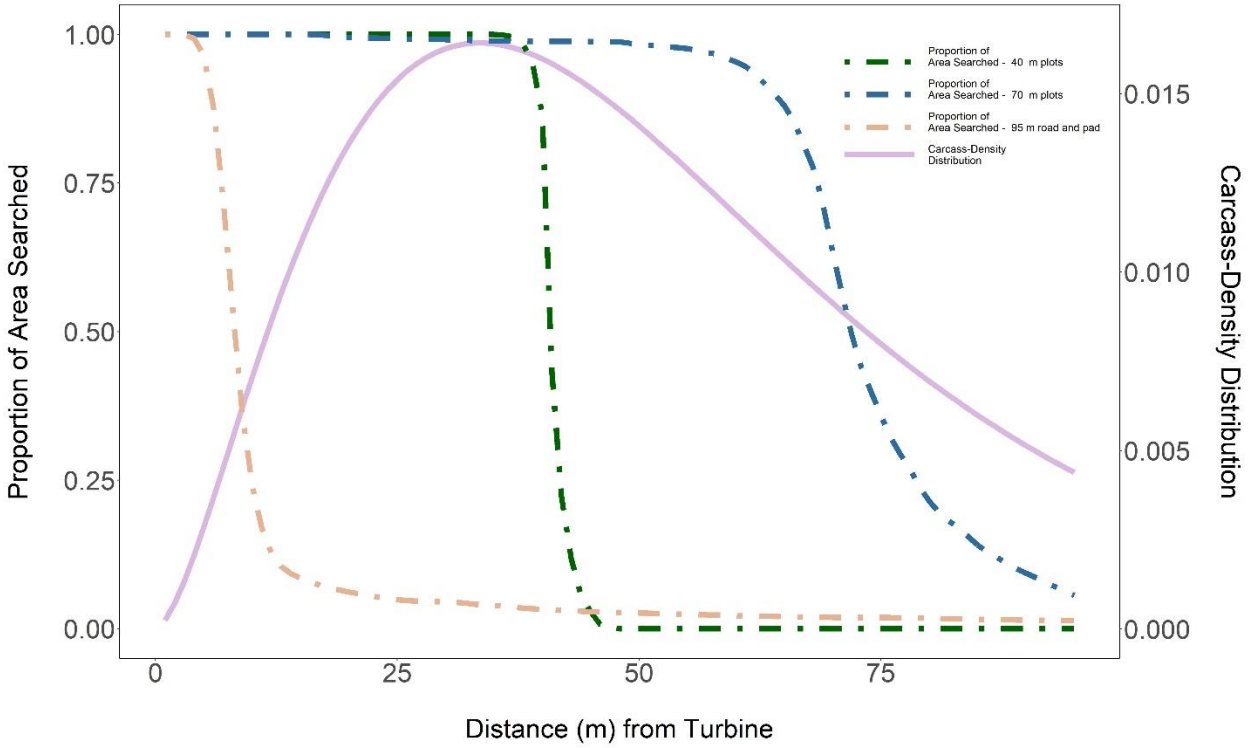

Figure 4. Proportion of area searched by search plot type and estimated carcass density (pink) using truncated weighted likelihood methods.

Adjusted Overall Bat Fatality Estimates

Fatality estimates were calculated for the year to enable comparison with other operating wind projects, per the HCP. Fatality estimates from GenEst were used to calculate Indiana bat and northern long-eared bat take estimates; fatality estimates calculated using the Shoenfeld and Huso estimators were calculated for comparison purposes only. Fall fatality estimates at cleared and un-cleared plots were consistently higher than rates estimated from roads and pads using all three estimators (Appendix D). Overall fatality estimates, which were calculated using weighted averages based on the number of each plot type sampled, were slightly higher using GenEst, although the confidence intervals for all three estimators overlapped (Tables 8a-c).

Table 8a. Overall bat fatality rates per turbine and megawatt using GenEst for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois, from April 2 – October 15, 2019.

Season	Bat Fatality Estimate per Turbine	90% Confidence Limits	Bat Fatality Estimate per Megawatt	90% Confidence Limits
Spring	3.09	1.01 - 7.81	1.55	0.50 - 3.91
Summer	4.98	2.01 - 11.11	2.49	1.00 - 5.56
Fall	27.20	20.08 - 59.73	13.60	10.04 - 29.86
Overall	**35.72**	**26.03 - 72.99**	**17.86**	**13.02 - 36.50**

Table 8b. Overall bat fatality rates per turbine and megawatt using the Huso Estimator for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois, from April 2 – October 15, 2019.

Season	Bat Fatality Estimate per Turbine	90% Confidence Limits	Bat Fatality Estimate per Megawatt	90% Confidence Limits
Spring	2.86	0.88 - 5.81	1.43	0.44 - 2.91
Summer	4.57	1.66 - 9.12	2.29	0.83 - 4.56
Fall	24.11	16.78 - 44.85	12.05	8.39 - 22.43
Overall	**31.53**	**21.61 - 58.18**	**15.77**	**10.81 - 29.09**

Table 8c. Overall bat fatality rates per turbine and megawatt using the Shoenfeld Estimator for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois, from April 2 – October 15, 2019.

Season	Bat Fatality Estimate per Turbine	90% Confidence Limits	Bat Fatality Estimate per Megawatt	90% Confidence Limits
Spring	2.19	0.65 - 4.40	1.09	0.32 - 2.20
Summer	3.49	1.27 – 6.58	1.75	0.63 - 3.29
Fall	21.86	16.36 - 36.54	10.93	8.18 - 18.27
Overall	**27.53**	**20.05 - 46.12**	**13.77**	**10.02 - 23.06**

Indiana Bat and Northern Long-Eared Bat Take Estimates

EoA Framework

The overall probability of detecting a single bat carcass (*g*), such as an Indiana bat or northern long-eared bat, during the fall was 0.26 (90% CI: 0.12, 0.34). The fall *g* estimate was used to determine EoA take estimates because risk to Indiana bats and northern long-eared bats only occurs during the fall, as described within the Project HCP. Variables used to calculate g are presented in Table 9.

Table 9. Variables used to estimate the detection probability for Indiana bats and northern long-eared bats using EoA framework during 2019 fall searches at Hoopeston Wind Project, Vermilion County, Illinois.

Number of Searches per Turbine	21
Search Interval	3.54
40-m plot Turbines Searched	15
70-m plot (Hemp) Turbines Searched	2
70-m plot (Soy) Turbines Searched	9
70-m plot (Grass) Turbines Searched	3
Roads and Pad Turbines Searched	20
Probability of Detection - 40-m plot Cleared and 70-m plot (Hemp)	0.88 (95% CI: 0.65, 0.96)
Probability of Detection – 70-m plot (Soy)	0.73 (95% CI: 0.01, 0.47)
Probability of Detection – 70-m plot (Grass)	0.23 (95% CI: 0.52, 0.87)
Probability of Detection - Road and Pad	0.85 (95% CI: 0.74, 0.92)
Probability a Carcass Was Available for Detection (rHat)	0.84 (95% CI: 0.77, 0.90)
Area Adjustment– 40-m Plot	0.41 (95% CI: 0.17, 0.61)
Area Adjustment – 70-m Plot	0.76 (95% CI: 0.34, 0.93)
Area Adjustment - Road and Pad	0.05 (95% CI: 0.03, 0.06)
k (as defined in HCP)	0.80

The EoA mortality estimates with 50% credibility (which is equivalent to the median value) were zero Indiana bat and zero northern long-eared bat fatalities occurred during the 2019 study period (Table 10). The cumulative take estimate for both years was one Indiana bat and one northern long-eared bat, as the median take estimate for each species was equal to one in 2018 (Iskali et al. 2019).

Table 10. Median take estimates per year using EoA and Project-specific area correction for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois, from April 2, 2019 to October 15, 2019.

Estimate Type	Bat Fatality Estimate per Year
Evidence of Absence - Indiana bat (50% credible bound)	0
Evidence of Absence - Northern long-eared bat (50% credible bound)	0

Projected Mortality for Remainder of the Project ITP

Using the Multiple Years Module in the EoA software, the estimated fatality rates (λ) for Indiana bat and northern long-eared bat were calculated based on the *g* values from the fall seasons of both 2018 and 2019 (Tables 11 and 12). The cumulative median 30-year mortality projection at 50% credible interval for both Indiana bat and northern long-eared bat was also calculated using this method and was estimated to be 40 fatalities (Table 13), which is below the life of project

permitted take described within the Project HCP. The Project ITP authorized the take of 60 individuals of each species over the life of the permit.

Table 11. Fall g distribution parameter inputs for EoA Multiple Years Module for the estimation of lambda and projected bat fatalities.

Year	Fall g	95% CI	Weight (ρ)	Fatalities (X)	Ba	Bb
2018	0.13	(0.11, 0.15)	1	0	181.13	1208.60
2019	0.26	(0.15, 0.37)	1	0	10.06	29.23

Table 12. Estimated annual fatality rate (λ) of Indiana and northern long-eared bats using EoA and the Project-specific area correction for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois, from April 2, 2018 to October 15, 2019.

Estimate Type	Annual Bat Fatality Rates
Evidence of Absence - Indiana bat (50th credible bound)	1.36
Evidence of Absence - Northern long-eared bat (50th credible bound)	1.36

Table 13. Cumulative median 30-year projected bat fatalities using EoA and the Project-specific area correction for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois, from April 2, 2018 to October 15, 2019.

Estimate Type	Cumulative median projected mortalities (30 years)
Evidence of Absence - Indiana bat (α = 0.5)	41
Evidence of Absence - Northern long-eared bat (α = 0.5)	41

Species Composition Approach

Take estimates for Indiana bat and northern long-eared bat were also calculated using the Species Composition approach for the potential risky fall season, as outlined in the HCP. Bat fatality rates included fractions of bats; however, a fraction of a bat cannot be taken in a given year. Therefore, the rates calculated in Tables 14 and 15 were rounded to whole integers to calculate take estimates for 2019. Four Indiana and three northern long-eared bats were estimated to be taken using the GenEst estimator, and three of each species were estimated to be taken using the Huso estimator using 2019 fatality estimates (Tables 14 and 15).The rolling average of 2018 and 2019 Species Composition approach take estimates determined that approximately three Indiana bats and between two and three northern long-eared bats were taken per year, depending on the estimator used for the 2019 take estimate (Table 16).

Table 14. Bat fatality estimates using the GenEst estimator, Project-specific area correction, and Species Composition approach for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois, from April 2, 2019 to October 15, 2019.

Bat Species	Bats per Megawatt	Total Bats*	Species Composition	Bats per Year	Take Estimate
Indiana bats	13.6	1,332.80	0.0029	**3.87**	**4**
Northern long-eared bats	13.6	1,332.80	0.0024	**3.20**	**3**

* 13.6 bats/megawatt x 98 megawatts = 1332.80 total bats.

Table 15. Bat fatality estimates using the Huso estimator, Project-specific area correction, and Species Composition approach for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois, from April 2, 2019 to October 15, 2019.

Bat Species	Bats per Megawatt	Total Bats*	Species Composition	Bats per Year	Take Estimate
Indiana bats	12.1	1,181.39	0.0029	**3.43**	**3**
Northern long-eared bats	12.1	1,181.39	0.0024	**2.84**	**3**

* 12.1 bats/megawatt x 98 megawatts = 1181.39 total bats.

Table 16. Rolling average of bat fatality estimates using the Species Composition approach for studies conducted at the Hoopeston Wind Project, Vermilion County, Illinois in 2018 and 2019.

Estimators Used	Indiana Bats Per Year	Indiana bat Take Estimate	Northern Long-eared Bats Per Year	Northern Long-eared Bat Take Estimate
2018 Huso and 2019 GenEst	3.15	3	2.61	3
2018 Huso and 2019 Huso	2.93	3	2.43	2

The estimates of take using the Species Composition approach were higher than EoA-based estimates; the lack of any Indiana bat and northern long-eared bat carcasses found during 2018 or 2019 suggests that the species composition estimates were biased high. This is likely because the ratios used for the Species Composition Approach calculation were derived from data collected prior to 2013, the year when White Nose Syndrome (WNS) was confirmed in Illinois (Illinois Natural History Survey 2019). WNS has been detected in 13 species of bats, including the Indiana and northern long-eared bat, and has decimated populations of bats in eastern regions of the US, especially populations of little brown (*Myotis lucifugus*), tricolored (*Perimyotis subflavus*) and northern long-eared bats (White-nose Syndrome Response Team 2019, Center for Biological Diversity 2019). Indiana bat populations have declined by 15% since 2013 in the Midwest Recovery Unit and northern long-eared bat populations have declined by over 90% in part of its range (USFWS 2019, 2020). Therefore, the ratios used for Species Composition and the take estimates predicted by this method are likely lower than what is presented here.

We also quantified the probability that zero Indiana or northern long-eared bats would be found if the annual take rates calculated using Species Composition methods were true (3.15 for Indiana bat and 2.61 for northern long-eared bat were used; Table 16) over two years. Using methods consistent with EoA's Scenario Explorer, 10,000 simulations of carcass searches over two years were conducted assuming the Species Composition take rates. Carcass searches were modeled using a detection probability of 0.195 (the average of 2018 and 2019's estimated *g* values of 0.13 and 0.26). The simulations showed that the probability of finding zero carcasses over two years was 0.30 for Indiana bat and 0.36 for northern long-eared bat. The combined probability of finding zero carcasses of both species over both years, given g = 0.195 and the rolling average take for both species, was 0.30 * 0.36 = 0.11.

DISCUSSION

No federally or state-listed bats were found during the first two years of intensive monitoring at the Project. The species of bats found during the 2019 study were commonly found fatalities at other wind projects in the region (Ellison 2012; Arnett et al. 2008). The majority of the bats were found in fall, which is the seasonal pattern observed at other wind projects in the Midwest.

The Project HCP specifies that the need for adaptive management will be evaluated after the initial three years of intensive monitoring. Two methods are described within the HCP for estimating potential take estimates: an EoA based approach, and a Species Composition approach. EoA based take estimates for both covered species were below the authorized and expected level of take in 2019. Estimates of Indiana bat and northern long-eared take using EoA decreased from 2018 to 2019 due to the increased monitoring effort in 2019. The use of dogs to increase searcher efficiency rates, in combination with searching more and larger plots, resulted in an increased probability of detecting a single carcass in 2019 (g = 0.26) relative to 2018 (g = 0.13) using the Project-specific area correction. Searcher efficiency rates on fall cleared plots in 2019 using dog-handler teams were twice as high (87.5%) as rates achieved by humans (44.4%) on fall cleared plots in 2018 (Iskali et al. 2019). Relatively high searcher efficiency rates were also recorded in un-cleared soybean and hemp fields in 2019. The results achieved at the Project mirror the results of other studies that have used dog-handlers where searcher efficiency rates as high as 86% have been documented, depending on carcass size and vegetation cover (Arnett 2006; Reyes et al. 2016), and supports the continued use of dog-handlers as a cost efficient method to increase g while minimizing crop damage.

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Appendix A. Representative Photos of Vegetation in Cleared and Un-cleared Plots Searched at the Hoopeston Wind Project during 2019

Appendix A1. Representative photo of vegetation conditions in a 40-m clear plot.

Appendix A2. Representative photo of vegetation conditions in a 70-m hemp plot.

Appendix A3. Representative photo of vegetation conditions in a 70-m soy plot.

Appendix A4. Representative photo of vegetation conditions in a 70-m grassland plot.

Appendix B. Complete List of Carcasses Found at the Hoopeston Wind Project during 2019

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
04/16/2019	33	silver-haired bat	95 m	68	2-3 days	No	No
04/23/2019	27	silver-haired bat	95 m	65	last night	No	No
05/01/2019	8	red-winged blackbird	95 m	61	15-30 days	Yes	Yes
05/01/2019	20	yellow-rumped warbler	95 m	41	last night	Yes	Yes
05/09/2019	23	eastern red bat	40 m	2	4-7 days	No	No
05/09/2019	6	silver-haired bat	40 m	39	2-3 days	No	No
05/09/2019	15	silver-haired bat	95 m	66	2-3 days	Yes	Yes
05/09/2019	15	silver-haired bat	95 m	104	2-3 days	Yes	Yes
05/09/2019	16	silver-haired bat	95 m	87	2-3 days	No	No
05/09/2019	29	silver-haired bat	95 m	7	2-3 days	No	No
05/14/2019	38	silver-haired bat	40 m	40	2-3 days	No	No
05/28/2019	12	ring-necked pheasant	95 m	1	last night	Yes	Yes
05/28/2019	25	evening bat	95 m	25	2-3 days	No	No
06/11/2019	47	silver-haired bat	95 m	47	last night	No	No
06/18/2019	49	turkey vulture	95 m	15	last night	Yes	Yes
07/15/2019	1	eastern red bat	95 m	42	2-3 days	No	No
07/16/2019	27	eastern red bat	95 m	23	4-7 days	No	No
07/22/2019	17	hoary bat	95 m	15	4-7 days	No	No
07/23/2019	38	hoary bat	95 m	4	4-7 days	No	No
07/30/2019	27	hoary bat	95 m	32	2-3 days	No	No
08/05/2019	24	killdeer	40 m	13	2-3 days	Yes	Yes
08/05/2019	24	killdeer	40 m	10	2-3 days	Yes	Yes
08/05/2019	20	unidentified bat	40 m	35	15-30 days	Yes	Yes
08/05/2019	24	killdeer	40 m	20	2-3 days	Yes	Yes
08/05/2019	24	killdeer	40 m	24	2-3 days	Yes	Yes
08/05/2019	11	eastern red bat	40 m	6	2-3 days	No	No
08/05/2019	34	hoary bat	40 m	10	8-14 days	No	No
08/05/2019	34	eastern red bat	40 m	21	8-14 days	Yes	Yes
08/06/2019	17	eastern red bat	40 m	30	4-7 days	Yes	Yes
08/06/2019	2	eastern red bat	40 m	52	last night	Yes	Yes
08/06/2019	7	hoary bat	70 m	11	15-30 days	Yes	Yes
08/06/2019	19	eastern red bat	70 m	56	15-30 days	Yes	Yes
08/07/2019	47	eastern red bat	70 m	59	4-7 days	Yes	Yes
08/07/2019	22	eastern red bat	70 m	16	2-3 days	No	No
08/07/2019	22	hoary bat	70 m	20	4-7 days	Yes	Yes
08/07/2019	22	hoary bat	70 m	17	4-7 days	Yes	Yes
08/09/2019	36	eastern red bat	40 m	38	last night	No	No
08/09/2019	2	eastern red bat	40 m	33	8-14 days	Yes	No
08/09/2019	2	eastern red bat	40 m	45	15-30 days	Yes	Yes

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
08/09/2019	2	eastern red bat	40 m	106	4-7 days	Yes	Yes
08/09/2019	40	big brown bat	40 m	23	last night	No	No
08/09/2019	40	eastern red bat	40 m	14	last night	No	No
08/09/2019	34	hoary bat	40 m	19	last night	No	No
08/09/2019	30	hoary bat	40 m	14	2-3 days	Yes	Yes
08/09/2019	36	eastern red bat	40 m	32	4-7 days	No	No
08/09/2019	36	eastern red bat	40 m	21	8-14 days	Yes	No
08/09/2019	41	eastern red bat	40 m	35	last night	No	No
08/09/2019	7	eastern red bat	70 m	46	2-3 days	No	No
08/09/2019	5	purple martin	70 m	30	8-14 days	Yes	Yes
08/09/2019	6	killdeer	70 m	21	4-7 days	Yes	Yes
08/09/2019	6	eastern red bat	70 m	59	2-3 days	No	No
08/09/2019	6	eastern red bat	70 m	69	2-3 days	No	No
08/09/2019	5	eastern red bat	70 m	10	8-14 days	Yes	Yes
08/09/2019	5	hoary bat	70 m	31	8-14 days	Yes	Yes
08/09/2019	5	hoary bat	70 m	41	8-14 days	Yes	Yes
08/10/2019	31	big brown bat	40 m	19	last night	No	No
08/10/2019	9	eastern red bat	40 m	35	2-3 days	No	No
08/10/2019	24	eastern red bat	40 m	34	last night	No	No
08/10/2019	31	eastern red bat	40 m	39	2-3 days	No	No
08/10/2019	17	eastern red bat	40 m	28	last night	No	No
08/10/2019	11	eastern red bat	40 m	31	31-60 days	Yes	Yes
08/10/2019	11	hoary bat	40 m	16	4-7 days	Yes	Yes
08/10/2019	9	eastern red bat	40 m	26	2-3 days	No	No
08/10/2019	20	eastern red bat	40 m	40	2-3 days	No	No
08/10/2019	20	eastern red bat	40 m	30	2-3 days	No	No
08/10/2019	17	eastern red bat	40 m	31	2-3 days	No	No
08/10/2019	15	hoary bat	40 m	33	4-7 days	No	No
08/10/2019	15	Seminole bat	40 m	28	2-3 days	No	No
08/10/2019	19	eastern red bat	70 m	53	8-14 days	Yes	No
08/10/2019	22	eastern red bat	70 m	29	4-7 days	Yes	No
08/10/2019	14	killdeer	70 m	6	8-14 days	Yes	Yes
08/10/2019	12	ring-necked pheasant	70 m	10	unknown	Yes	Yes
08/10/2019	21	eastern red bat	70 m	25	4-7 days	Yes	No
08/10/2019	14	evening bat	70 m	27	2-3 days	No	No
08/10/2019	21	eastern red bat	70 m	24	4-7 days	Yes	No
08/10/2019	12	eastern red bat	70 m	40	2-3 days	No	No
08/12/2019	30	eastern red bat	40 m	31	last night	No	No
08/12/2019	2	eastern red bat	40 m	23	4-7 days	Yes	No
08/12/2019	41	big brown bat	40 m	24	2-3 days	No	No
08/12/2019	41	eastern red bat	40 m	32	2-3 days	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
08/12/2019	36	eastern red bat	40 m	34	2-3 days	No	No
08/12/2019	34	silver-haired bat	40 m	22	2-3 days	Yes	No
08/12/2019	9	eastern red bat	40 m	29	4-7 days	Yes	No
08/12/2019	10	eastern red bat	40 m	49	2-3 days	Yes	Yes
08/12/2019	34	eastern red bat	40 m	27	4-7 days	Yes	No
08/12/2019	34	hoary bat	40 m	37	last night	No	No
08/12/2019	6	eastern red bat	70 m	59	4-7 days	Yes	No
08/12/2019	7	eastern red bat	70 m	52	2-3 days	No	No
08/12/2019	6	silver-haired bat	70 m	41	4-7 days	Yes	No
08/12/2019	6	hoary bat	70 m	34	8-14 days	Yes	No
08/12/2019	45	eastern red bat	70 m	25	2-3 days	No	No
08/12/2019	7	eastern red bat	70 m	15	last night	No	No
08/12/2019	48	eastern red bat	95 m	4	last night	No	No
08/12/2019	16	eastern red bat	95 m	1	last night	No	No
08/13/2019	31	eastern red bat	40 m	23	2-3 days	No	No
08/13/2019	31	eastern red bat	40 m	41	2-3 days	Yes	Yes
08/13/2019	31	eastern red bat	40 m	28	last night	No	No
08/13/2019	24	eastern red bat	40 m	9	last night	No	No
08/13/2019	17	eastern red bat	40 m	12	2-3 days	No	No
08/13/2019	17	eastern red bat	40 m	5	2-3 days	No	No
08/13/2019	21	eastern red bat	70 m	38	4-7 days	Yes	No
08/13/2019	22	eastern red bat	70 m	14	2-3 days	No	No
08/13/2019	22	eastern red bat	70 m		unknown	No	No
08/13/2019	21	eastern red bat	70 m	25	4-7 days	Yes	No
08/13/2019	21	eastern red bat	70 m	26	last night	No	No
08/13/2019	22	eastern red bat	70 m	60	4-7 days	Yes	No
08/13/2019	28	eastern red bat	70 m	59	4-7 days	Yes	No
08/13/2019	22	eastern red bat	70 m	15	8-14 days	Yes	No
08/13/2019	19	eastern red bat	70 m	52	last night	No	No
08/13/2019	21	hoary bat	70 m	52	4-7 days	Yes	No
08/13/2019	28	eastern red bat	70 m	26	last night	No	No
08/14/2019	20	eastern red bat	40 m	36	2-3 days	No	No
08/14/2019	20	eastern red bat	40 m	27	4-7 days	No	No
08/14/2019	14	eastern red bat	70 m	32	last night	No	No
08/14/2019	14	hoary bat	70 m	28	2-3 days	No	No
08/15/2019	41	eastern red bat	40 m	30	4-7 days	Yes	No
08/15/2019	41	big brown bat	40 m	41	last night	Yes	Yes
08/15/2019	40	eastern red bat	40 m	73	4-7 days	Yes	Yes
08/15/2019	34	eastern red bat	40 m	19	4-7 days	Yes	No
08/15/2019	30	eastern red bat	40 m	34	last night	No	No
08/15/2019	36	hoary bat	40 m	9	15-30 days	Yes	No
08/15/2019	2	hoary bat	40 m	38	last night	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
08/15/2019	47	hoary bat	70 m	49	8-14 days	Yes	No
08/15/2019	7	eastern red bat	70 m	26	4-7 days	Yes	No
08/15/2019	7	eastern red bat	70 m	37	2-3 days	No	No
08/15/2019	7	hoary bat	70 m	74	4-7 days	Yes	Yes
08/15/2019	3	eastern red bat	70 m	33	8-14 days	Yes	No
08/15/2019	45	eastern red bat	70 m	64	4-7 days	Yes	No
08/15/2019	6	eastern red bat	70 m	51	8-14 days	Yes	No
08/15/2019	3	eastern red bat	70 m	21	4-7 days	Yes	No
08/15/2019	6	eastern red bat	70 m	51	4-7 days	Yes	No
08/16/2019	24	hoary bat	40 m	8	live	No	No
08/16/2019	9	eastern red bat	40 m	44	4-7 days	Yes	Yes
08/16/2019	10	eastern red bat	40 m	15	2-3 days	No	No
08/16/2019	10	eastern red bat	40 m	27	2-3 days	No	No
08/16/2019	28	eastern red bat	70 m	32	4-7 days	Yes	No
08/16/2019	14	eastern red bat	70 m	60	15-30 days	Yes	No
08/16/2019	21	eastern red bat	70 m	41	last night	No	No
08/16/2019	22	eastern red bat	70 m	70	2-3 days	No	No
08/16/2019	19	eastern red bat	70 m	41	last night	No	No
08/16/2019	28	eastern red bat	70 m	60	last night	No	No
08/16/2019	14	eastern red bat	70 m	54	15-30 days	Yes	No
08/16/2019	22	hoary bat	70 m	28	2-3 days	No	No
08/16/2019	14	eastern red bat	70 m	42	2-3 days	No	No
08/16/2019	14	eastern red bat	70 m	54	8-14 days	Yes	No
08/16/2019	19	eastern red bat	70 m	41	4-7 days	Yes	No
08/16/2019	21	eastern red bat	70 m	1	2-3 days	No	No
08/16/2019	21	eastern red bat	70 m	28	4-7 days	Yes	No
08/16/2019	14	eastern red bat	70 m	32	8-14 days	Yes	No
08/16/2019	21	eastern red bat	70 m	44	8-14 days	Yes	No
08/17/2019	11	hoary bat	40 m	23	last night	No	No
08/17/2019	17	eastern red bat	40 m	41	2-3 days	No	No
08/17/2019	17	hoary bat	40 m	40	last night	No	No
08/17/2019	11	eastern red bat	40 m	25	2-3 days	No	No
08/19/2019	36	eastern red bat	40 m	36	unknown	No	No
08/19/2019	40	hoary bat	40 m	25	last night	No	No
08/19/2019	2	eastern red bat	40 m	38	4-7 days	No	No
08/19/2019	1	eastern red bat	40 m	24	2-3 days	No	No
08/19/2019	45	eastern red bat	70 m	23	2-3 days	No	No
08/19/2019	5	eastern red bat	70 m	37	2-3 days	No	No
08/19/2019	5	eastern red bat	70 m	40	8-14 days	Yes	No
08/19/2019	3	eastern red bat	70 m	42	4-7 days	Yes	No
08/19/2019	5	eastern red bat	70 m	51	2-3 days	No	No
08/19/2019	47	evening bat	70 m	25	2-3 days	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
08/19/2019	5	eastern red bat	70 m	46	4-7 days	Yes	No
08/19/2019	5	eastern red bat	70 m	10	4-7 days	Yes	No
08/19/2019	5	eastern red bat	70 m	47	8-14 days	Yes	No
08/19/2019	7	eastern red bat	70 m	34	2-3 days	No	No
08/19/2019	47	big brown bat	70 m	4	2-3 days	No	No
08/19/2019	25	eastern red bat	95 m	24	2-3 days	No	No
08/20/2019	14	big brown bat	70 m	4	2-3 days	No	No
08/20/2019	14	hoary bat	70 m	64	4-7 days	Yes	No
08/20/2019	14	eastern red bat	70 m	39	2-3 days	No	No
08/20/2019	12	eastern red bat	70 m	29	4-7 days	No	No
08/20/2019	12	eastern red bat	70 m	60	8-14 days	Yes	No
08/21/2019	15	eastern red bat	40 m	27	2-3 days	No	No
08/21/2019	11	eastern red bat	40 m	28	2-3 days	No	No
08/21/2019	24	eastern red bat	40 m	26	2-3 days	No	No
08/21/2019	31	eastern red bat	40 m	20	2-3 days	No	No
08/21/2019	31	eastern red bat	40 m	17	2-3 days	No	No
08/21/2019	15	eastern red bat	40 m	16	8-14 days	Yes	No
08/21/2019	15	eastern red bat	40 m	35	2-3 days	No	No
08/21/2019	20	eastern red bat	40 m	10	2-3 days	No	No
08/21/2019	20	eastern red bat	40 m	32	2-3 days	No	No
08/21/2019	28	hoary bat	70 m	32	2-3 days	No	No
08/21/2019	21	eastern red bat	70 m	12	2-3 days	No	No
08/21/2019	21	eastern red bat	70 m	50	4-7 days	No	No
08/21/2019	22	eastern red bat	70 m	14	8-14 days	Yes	No
08/22/2019	40	eastern red bat	40 m	34	2-3 days	No	No
08/22/2019	40	hoary bat	40 m	44	4-7 days	Yes	Yes
08/22/2019	2	big brown bat	40 m	31	2-3 days	No	No
08/22/2019	36	eastern red bat	40 m	23	2-3 days	No	No
08/22/2019	47	eastern red bat	70 m	35	2-3 days	No	No
08/22/2019	6	eastern red bat	70 m	29	2-3 days	No	No
08/22/2019	7	hoary bat	70 m	41	2-3 days	No	No
08/22/2019	45	eastern red bat	70 m	44	last night	No	No
08/22/2019	5	eastern red bat	70 m	51	8-14 days	Yes	No
08/22/2019	3	eastern red bat	70 m	34	8-14 days	Yes	No
08/22/2019	37	evening bat	70 m	32	2-3 days	No	No
08/22/2019	3	eastern red bat	70 m	19	2-3 days	No	No
08/22/2019	33	eastern red bat	95 m	9	last night	Yes	Yes
08/22/2019	46	hoary bat	95 m	9	4-7 days	Yes	Yes
08/23/2019	24	eastern red bat	40 m	19	4-7 days	Yes	No
08/23/2019	9	eastern red bat	40 m	42	4-7 days	Yes	Yes
08/23/2019	20	eastern red bat	40 m	22	2-3 days	No	No
08/23/2019	9	evening bat	40 m	42	4-7 days	Yes	Yes

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
08/23/2019	9	mourning dove	40 m	42	2-3 days	Yes	Yes
08/23/2019	24	eastern red bat	40 m	26	4-7 days	Yes	No
08/23/2019	31	eastern red bat	40 m	23	last night	No	No
08/23/2019	10	eastern red bat	40 m	17	2-3 days	No	No
08/23/2019	10	eastern red bat	40 m	36	4-7 days	Yes	No
08/23/2019	11	big brown bat	40 m	36	2-3 days	No	No
08/23/2019	31	eastern red bat	40 m	21	last night	No	No
08/23/2019	19	eastern red bat	70 m	57	2-3 days	No	No
08/23/2019	19	hoary bat	70 m	49	4-7 days	Yes	No
08/23/2019	21	eastern red bat	70 m	51	2-3 days	Yes	No
08/23/2019	14	eastern red bat	70 m	37	2-3 days	No	No
08/23/2019	28	eastern red bat	70 m	52	2-3 days	No	No
08/23/2019	28	eastern red bat	70 m	59	2-3 days	No	No
08/23/2019	28	eastern red bat	70 m	22	2-3 days	No	No
08/23/2019	28	hoary bat	70 m	12	last night	No	No
08/23/2019	14	eastern red bat	70 m	55	8-14 days	Yes	No
08/26/2019	34	eastern red bat	40 m	31	last night	No	No
08/26/2019	36	eastern red bat	40 m	25	8-14 days	Yes	No
08/26/2019	7	eastern red bat	70 m	33	2-3 days	No	No
08/26/2019	8	unidentified passerine	70 m	69	4-7 days	Yes	Yes
08/26/2019	45	big brown bat	70 m	20	4-7 days	No	No
08/26/2019	6	eastern red bat	70 m	45	4-7 days	No	No
08/26/2019	3	hoary bat	70 m	43	last night	No	No
08/26/2019	7	eastern red bat	70 m	74	last night	Yes	Yes
08/26/2019	45	eastern red bat	70 m	46	2-3 days	No	No
08/26/2019	6	eastern red bat	70 m	33	4-7 days	No	No
08/26/2019	6	eastern red bat	70 m	22	8-14 days	Yes	No
08/26/2019	6	eastern red bat	70 m	61	4-7 days	No	No
08/26/2019	7	horned lark	70 m	9	4-7 days	Yes	Yes
08/26/2019	50	eastern red bat	95 m	40	last night	No	No
08/26/2019	50	eastern red bat	95 m	62	last night	No	No
08/26/2019	33	eastern red bat	95 m	79	2-3 days	No	No
08/26/2019	50	eastern red bat	95 m	49	2-3 days	No	No
08/27/2019	20	eastern red bat	40 m	36	last night	No	No
08/27/2019	24	eastern red bat	40 m	16	2-3 days	No	No
08/27/2019	24	eastern red bat	40 m	42	2-3 days	Yes	Yes
08/27/2019	15	eastern red bat	40 m	19	unknown	No	No
08/27/2019	31	eastern red bat	40 m	20	2-3 days	No	No
08/27/2019	10	eastern red bat	40 m	28	4-7 days	Yes	No
08/27/2019	10	eastern red bat	40 m	28	2-3 days	No	No
08/27/2019	31	eastern red bat	40 m	26	2-3 days	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
08/27/2019	28	eastern red bat	70 m	17	2-3 days	No	No
08/27/2019	19	eastern red bat	70 m	70	8-14 days	Yes	No
08/27/2019	22	eastern red bat	70 m	50	15-30 days	Yes	No
08/27/2019	19	eastern red bat	70 m	51	8-14 days	Yes	No
08/27/2019	22	eastern red bat	70 m	25	8-14 days	Yes	No
08/27/2019	14	eastern red bat	70 m	73	2-3 days	Yes	Yes
08/27/2019	21	eastern red bat	70 m	27	8-14 days	Yes	No
08/27/2019	14	eastern red bat	70 m	55	2-3 days	No	No
08/27/2019	14	eastern red bat	70 m	61	2-3 days	No	No
08/28/2019	7	eastern red bat	70 m	43	2-3 days	No	No
08/28/2019	7	silver-haired bat	70 m	47	2-3 days	Yes	No
08/29/2019	2	eastern red bat	40 m	32	8-14 days	Yes	No
08/29/2019	2	eastern red bat	40 m	51	last night	Yes	Yes
08/29/2019	30	eastern red bat	40 m	45	last night	Yes	Yes
08/29/2019	30	eastern red bat	40 m	33	last night	No	No
08/29/2019	40	silver-haired bat	40 m	43	2-3 days	No	No
08/29/2019	40	eastern red bat	40 m	42	last night	Yes	Yes
08/29/2019	41	big brown bat	40 m	33	last night	No	No
08/29/2019	2	eastern red bat	40 m	42	8-14 days	Yes	Yes
08/29/2019	1	big brown bat	40 m	20	last night	No	No
08/29/2019	36	eastern red bat	40 m	30	last night	No	No
08/29/2019	34	eastern red bat	40 m	23	2-3 days	No	No
08/29/2019	36	eastern red bat	40 m	24	4-7 days	Yes	No
08/29/2019	6	hoary bat	70 m	33	8-14 days	Yes	No
08/29/2019	47	unidentified passerine	70 m	60	8-14 days	Yes	Yes
08/29/2019	37	silver-haired bat	70 m	55	2-3 days	No	No
08/29/2019	38	hoary bat	95 m	9	last night	Yes	Yes
08/29/2019	25	hoary bat	95 m	25	2-3 days	No	No
08/29/2019	23	eastern red bat	95 m	15	last night	No	No
08/30/2019	17	hoary bat	40 m	43	2-3 days	Yes	Yes
08/30/2019	17	eastern red bat	40 m	68	2-3 days	Yes	Yes
08/30/2019	31	hoary bat	40 m	39	last night	No	No
08/30/2019	21	eastern red bat	70 m	42	2-3 days	No	No
08/30/2019	21	hoary bat	70 m	25	last night	No	No
08/30/2019	21	eastern red bat	70 m	5	last night	No	No
09/02/2019	34	silver-haired bat	40 m	64	4-7 days	Yes	Yes
09/02/2019	30	eastern red bat	40 m	41	last night	No	No
09/02/2019	30	eastern red bat	40 m	22	last night	No	No
09/02/2019	2	hoary bat	40 m	31	last night	No	No
09/02/2019	1	eastern red bat	40 m	33	15-30 days	Yes	No
09/02/2019	36	eastern red bat	40 m	21	last night	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
09/02/2019	40	hoary bat	40 m	23	last night	No	No
09/02/2019	34	hoary bat	40 m	46	8-14 days	Yes	Yes
09/02/2019	2	eastern red bat	40 m	35	last night	No	No
09/02/2019	41	eastern red bat	40 m	38	2-3 days	No	No
09/02/2019	7	eastern red bat	70 m	21	last night	No	No
09/02/2019	3	eastern red bat	70 m	28	4-7 days	Yes	No
09/02/2019	3	eastern red bat	70 m	55	2-3 days	No	No
09/02/2019	6	eastern red bat	70 m	39	2-3 days	No	No
09/02/2019	6	eastern red bat	70 m	38	last night	No	No
09/02/2019	45	eastern red bat	70 m	7	2-3 days	No	No
09/02/2019	3	silver-haired bat	70 m	20	2-3 days	No	No
09/02/2019	3	eastern red bat	70 m	48	4-7 days	Yes	No
09/02/2019	3	eastern red bat	70 m	45	2-3 days	No	No
09/02/2019	6	killdeer	70 m	55	4-7 days	Yes	Yes
09/02/2019	45	silver-haired bat	70 m	38	2-3 days	No	No
09/02/2019	7	eastern red bat	70 m	18	2-3 days	No	No
09/02/2019	3	silver-haired bat	70 m	54	2-3 days	No	No
09/02/2019	5	eastern red bat	70 m	53	4-7 days	Yes	No
09/02/2019	37	hoary bat	70 m	46	last night	No	No
09/02/2019	37	hoary bat	70 m	68	2-3 days	No	No
09/02/2019	37	hoary bat	70 m	64	4-7 days	No	No
09/02/2019	32	eastern red bat	95 m	5	last night	No	No
09/02/2019	29	silver-haired bat	95 m	5	last night	No	No
09/03/2019	17	eastern red bat	40 m	35	2-3 days	No	No
09/03/2019	11	hoary bat	40 m	38	4-7 days	No	No
09/03/2019	11	hoary bat	40 m	28	2-3 days	No	No
09/03/2019	10	eastern red bat	40 m	48	2-3 days	Yes	Yes
09/03/2019	9	mourning dove	40 m	34	2-3 days	Yes	Yes
09/03/2019	19	eastern red bat	70 m	23	2-3 days	No	No
09/03/2019	28	hoary bat	70 m	38	8-14 days	Yes	No
09/03/2019	28	silver-haired bat	70 m	39	2-3 days	No	No
09/03/2019	28	eastern red bat	70 m	43	2-3 days	No	No
09/03/2019	28	eastern red bat	70 m	47	8-14 days	Yes	No
09/03/2019	22	silver-haired bat	70 m	29	2-3 days	No	No
09/03/2019	19	hoary bat	70 m	59	4-7 days	No	No
09/03/2019	28	eastern red bat	70 m	57	2-3 days	No	No
09/03/2019	28	eastern red bat	70 m	28	2-3 days	No	No
09/03/2019	28	eastern red bat	70 m	25	last night	No	No
09/03/2019	28	silver-haired bat	70 m	55	2-3 days	No	No
09/03/2019	21	eastern red bat	70 m	48	2-3 days	No	No
09/03/2019	14	eastern red bat	70 m	29	2-3 days	No	No
09/03/2019	14	hoary bat	70 m	44	2-3 days	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
09/04/2019	24	silver-haired bat	40 m	26	2-3 days	No	No
09/04/2019	31	silver-haired bat	40 m	25	4-7 days	No	No
09/04/2019	15	eastern red bat	40 m	14	4-7 days	No	No
09/05/2019	2	unidentified passerine	40 m	20	2-3 days	Yes	Yes
09/05/2019	2	eastern red bat	40 m	20	2-3 days	No	No
09/05/2019	2	eastern red bat	40 m	34	2-3 days	No	No
09/05/2019	2	eastern red bat	40 m	29	4-7 days	Yes	No
09/05/2019	34	hoary bat	40 m	15	4-7 days	Yes	No
09/05/2019	41	big brown bat	40 m	24	2-3 days	No	No
09/05/2019	34	horned lark	40 m	27	2-3 days	Yes	Yes
09/05/2019	36	silver-haired bat	40 m	36	4-7 days	Yes	No
09/05/2019	36	hoary bat	40 m	37	last night	No	No
09/05/2019	3	eastern red bat	70 m	60	last night	No	No
09/05/2019	7	eastern red bat	70 m	16	2-3 days	No	No
09/05/2019	7	hoary bat	70 m	49	2-3 days	No	No
09/05/2019	45	horned lark	70 m	55	2-3 days	Yes	Yes
09/05/2019	7	eastern red bat	70 m	58	4-7 days	Yes	No
09/05/2019	7	eastern red bat	70 m	31	4-7 days	Yes	No
09/05/2019	7	silver-haired bat	70 m	44	last night	No	No
09/05/2019	5	hoary bat	70 m	23	2-3 days	No	No
09/05/2019	47	eastern red bat	70 m	37	4-7 days	Yes	No
09/06/2019	15	unidentified passerine	40 m	38	2-3 days	Yes	Yes
09/06/2019	11	silver-haired bat	40 m	51	4-7 days	Yes	Yes
09/06/2019	11	hoary bat	40 m	60	2-3 days	Yes	Yes
09/06/2019	11	eastern red bat	40 m	22	2-3 days	No	No
09/06/2019	21	hoary bat	70 m	61	2-3 days	No	No
09/06/2019	21	hoary bat	70 m	41	2-3 days	No	No
09/06/2019	28	hoary bat	70 m	15	8-14 days	Yes	No
09/06/2019	14	Seminole bat	70 m	46	4-7 days	Yes	No
09/06/2019	19	silver-haired bat	70 m	87	2-3 days	Yes	Yes
09/06/2019	19	eastern red bat	70 m	28	2-3 days	No	No
09/06/2019	19	eastern red bat	70 m	87	4-7 days	Yes	Yes
09/06/2019	14	hoary bat	70 m	46	8-14 days	Yes	No
09/06/2019	39	hoary bat	95 m	5	8-14 days	Yes	No
09/06/2019	46	eastern red bat	95 m	43	2-3 days	No	No
09/09/2019	1	silver-haired bat	40 m	24	2-3 days	No	No
09/09/2019	1	eastern red bat	40 m	39	4-7 days	No	No
09/09/2019	30	eastern red bat	40 m	22	last night	No	No
09/09/2019	30	silver-haired bat	40 m	50	4-7 days	Yes	Yes
09/09/2019	36	eastern red bat	40 m	33	2-3 days	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
09/09/2019	2	killdeer	40 m	35	2-3 days	Yes	Yes
09/09/2019	1	silver-haired bat	40 m	17	2-3 days	No	No
09/09/2019	41	eastern red bat	40 m	27	2-3 days	No	No
09/09/2019	40	eastern red bat	40 m	45	8-14 days	Yes	Yes
09/09/2019	40	silver-haired bat	40 m	30	4-7 days	Yes	No
09/09/2019	45	silver-haired bat	70 m	68	2-3 days	No	No
09/09/2019	45	eastern red bat	70 m	5	last night	No	No
09/09/2019	6	silver-haired bat	70 m	59	4-7 days	No	No
09/09/2019	6	silver-haired bat	70 m	49	4-7 days	No	No
09/09/2019	47	hoary bat	70 m	39	8-14 days	Yes	No
09/09/2019	45	hoary bat	70 m	40	2-3 days	No	No
09/09/2019	25	eastern red bat	95 m	0	4-7 days	No	No
09/10/2019	24	silver-haired bat	40 m	34	4-7 days	No	No
09/10/2019	31	silver-haired bat	40 m	23	last night	No	No
09/10/2019	15	eastern red bat	40 m	10	2-3 days	No	No
09/10/2019	20	eastern red bat	40 m	22	2-3 days	No	No
09/10/2019	11	silver-haired bat	40 m	35	2-3 days	No	No
09/10/2019	11	hoary bat	40 m	31	last night	No	No
09/10/2019	28	silver-haired bat	70 m	30	2-3 days	No	No
09/10/2019	28	eastern red bat	70 m	51	8-14 days	Yes	No
09/10/2019	21	silver-haired bat	70 m	36	2-3 days	No	No
09/10/2019	5	eastern red bat	70 m	38	2-3 days	No	No
09/10/2019	21	Seminole bat	70 m	21	4-7 days	No	No
09/11/2019	14	silver-haired bat	70 m	26	last night	No	No
09/12/2019	28	eastern red bat	70 m	42	4-7 days	Yes	No
09/12/2019	28	eastern red bat	70 m	24	2-3 days	No	No
09/13/2019	1	big brown bat	40 m	6	last night	No	No
09/13/2019	36	silver-haired bat	40 m	29	4-7 days	No	No
09/13/2019	41	eastern red bat	40 m	13	2-3 days	No	No
09/13/2019	7	eastern red bat	70 m	43	4-7 days	No	No
09/13/2019	7	big brown bat	70 m	25	2-3 days	No	No
09/13/2019	45	eastern red bat	70 m	28	2-3 days	No	No
09/16/2019	1	eastern red bat	40 m	8	2-3 days	No	No
09/16/2019	30	hoary bat	40 m	16	2-3 days	No	No
09/16/2019	6	silver-haired bat	70 m	50	2-3 days	No	No
09/16/2019	37	eastern red bat	70 m	22	last night	No	No
09/17/2019	9	hoary bat	40 m	36	last night	No	No
09/17/2019	31	yellow-bellied flycatcher	40 m	27	last night	Yes	Yes
09/17/2019	17	horned lark	40 m	33	last night	Yes	Yes
09/17/2019	11	eastern red bat	40 m	28	last night	No	No
09/17/2019	15	hoary bat	40 m	35	4-7 days	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
09/17/2019	21	eastern red bat	70 m	43	live	No	No
09/17/2019	28	horned lark	70 m	10	2-3 days	Yes	Yes
09/18/2019	5	big brown bat	70 m	64	8-14 days	Yes	Yes
09/18/2019	5	eastern red bat	70 m	54	4-7 days	No	No
09/19/2019	6	eastern red bat	70 m	23	2-3 days	No	No
09/19/2019	47	silver-haired bat	70 m	35	4-7 days	Yes	No
09/19/2019	45	eastern red bat	70 m	42	2-3 days	No	No
09/19/2019	45	silver-haired bat	70 m	31	2-3 days	No	No
09/19/2019	45	eastern red bat	70 m	23	4-7 days	Yes	No
09/19/2019	45	eastern red bat	70 m	19	8-14 days	Yes	No
09/19/2019	7	silver-haired bat	70 m	50	2-3 days	No	No
09/20/2019	9	red-eyed vireo	40 m	30	2-3 days	Yes	Yes
09/20/2019	28	silver-haired bat	70 m	36	2-3 days	No	No
09/20/2019	19	eastern red bat	70 m	46	2-3 days	No	No
09/23/2019	2	mourning dove	40 m	38	4-7 days	Yes	Yes
09/23/2019	6	silver-haired bat	70 m	21	4-7 days	No	No
09/23/2019	7	yellow-billed cuckoo	70 m	33	last night	Yes	Yes
09/23/2019	7	silver-haired bat	70 m	45	4-7 days	Yes	No
09/23/2019	47	hoary bat	70 m	48	2-3 days	No	No
09/23/2019	45	silver-haired bat	70 m	70	4-7 days	No	No
09/23/2019	37	silver-haired bat	70 m	40	8-14 days	Yes	No
09/24/2019	24	hoary bat	40 m	22	last night	No	No
09/24/2019	20	silver-haired bat	40 m	23	last night	No	No
09/24/2019	9	silver-haired bat	40 m	35	unknown	No	No
09/24/2019	14	eastern red bat	70 m	34	4-7 days	No	No
09/24/2019	19	hoary bat	70 m	37	last night	No	No
09/24/2019	19	Seminole bat	70 m	25	2-3 days	No	No
09/24/2019	21	silver-haired bat	70 m	45	2-3 days	No	No
09/24/2019	22	silver-haired bat	70 m	20	last night	No	No
09/24/2019	22	hoary bat	70 m	17	last night	No	No
09/26/2019	36	silver-haired bat	40 m	22	2-3 days	No	No
09/26/2019	30	horned lark	40 m	40	last night	Yes	Yes
09/26/2019	41	silver-haired bat	40 m	6	last night	No	No
09/26/2019	1	silver-haired bat	40 m	23	2-3 days	No	No
09/26/2019	41	eastern red bat	40 m	23	last night	No	No
09/26/2019	47	silver-haired bat	70 m	66	2-3 days	No	No
09/26/2019	45	eastern red bat	70 m	60	last night	No	No
09/26/2019	8	silver-haired bat	70 m	27	8-14 days	Yes	No
09/27/2019	20	horned lark	40 m	23	2-3 days	Yes	Yes
09/27/2019	20	eastern red bat	40 m	12	2-3 days	No	No
09/27/2019	10	silver-haired bat	40 m	20	2-3 days	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
09/27/2019	20	silver-haired bat	40 m	37	last night	No	No
09/28/2019	9	mourning dove	40 m	22	last night	Yes	Yes
09/28/2019	9	mourning dove	40 m	13	last night	Yes	Yes
09/28/2019	21	silver-haired bat	70 m	48	4-7 days	No	No
09/28/2019	19	silver-haired bat	70 m	24	2-3 days	No	No
09/28/2019	19	silver-haired bat	70 m	54	2-3 days	No	No
09/30/2019	5	American redstart	70 m	30	2-3 days	Yes	Yes
09/30/2019	7	eastern red bat	70 m	59	2-3 days	No	No
09/30/2019	7	silver-haired bat	70 m	60	2-3 days	No	No
09/30/2019	7	eastern red bat	70 m	65	last night	No	No
09/30/2019	45	eastern red bat	70 m	52	8-14 days	Yes	No
10/01/2019	20	horned lark	40 m	25	last night	Yes	Yes
10/01/2019	11	hoary bat	40 m	32	2-3 days	No	No
10/01/2019	11	silver-haired bat	40 m	36	2-3 days	No	No
10/01/2019	14	silver-haired bat	70 m	34	2-3 days	No	No
10/01/2019	6	silver-haired bat	70 m	38	8-14 days	Yes	No
10/01/2019	22	eastern red bat	70 m	64	2-3 days	No	No
10/01/2019	22	unidentified passerine	70 m	78	2-3 days	Yes	Yes
10/01/2019	22	eastern red bat	70 m	69	4-7 days	Yes	No
10/01/2019	28	hoary bat	70 m	36	2-3 days	No	No
10/01/2019	28	silver-haired bat	70 m	42	2-3 days	No	No
10/03/2019	1	silver-haired bat	40 m	35	2-3 days	No	No
10/03/2019	41	eastern red bat	40 m	43	4-7 days	Yes	Yes
10/03/2019	36	eastern red bat	40 m	23	2-3 days	No	No
10/03/2019	37	eastern red bat	70 m	60	last night	No	No
10/03/2019	45	unidentified warbler	70 m	44	2-3 days	Yes	Yes
10/03/2019	5	eastern red bat	70 m	67	last night	No	No
10/03/2019	3	silver-haired bat	70 m	46	8-14 days	Yes	No
10/04/2019	9	hoary bat	40 m	28	4-7 days	Yes	No
10/04/2019	15	silver-haired bat	40 m	29	last night	No	No
10/04/2019	19	eastern red bat	70 m	45	4-7 days	Yes	No
10/04/2019	12	silver-haired bat	70 m	24	last night	No	No
10/07/2019	36	eastern red bat	40 m	19	2-3 days	No	No
10/07/2019	36	silver-haired bat	40 m	27	2-3 days	No	No
10/07/2019	1	eastern red bat	40 m	35	last night	No	No
10/07/2019	1	silver-haired bat	40 m	44	8-14 days	Yes	Yes
10/07/2019	1	eastern red bat	40 m	37	2-3 days	No	No
10/07/2019	5	eastern red bat	70 m	38	4-7 days	No	No
10/07/2019	5	unidentified bat	70 m	59	4-7 days	No	No

Appendix B1. Complete listing of carcasses found at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Found Date	Search Location	Common Name	Plot Type*	Distance from Turbine (m)	Estimated Time of Death	Excluded from Huso?	Excluded from GenEst and Shoenfeld?
10/07/2019	6	ruby-crowned kinglet	70 m	68	2-3 days	Yes	Yes
10/07/2019	3	silver-haired bat	70 m	52	2-3 days	No	No
10/07/2019	3	silver-haired bat	70 m	41	2-3 days	No	No
10/07/2019	7	silver-haired bat	70 m	63	8-14 days	Yes	No
10/07/2019	47	silver-haired bat	70 m	31	last night	No	No
10/07/2019	37	silver-haired bat	70 m	51	last night	No	No
10/08/2019	31	silver-haired bat	40 m	53	2-3 days	Yes	Yes
10/08/2019	11	silver-haired bat	40 m	24	2-3 days	No	No
10/08/2019	28	eastern red bat	70 m	64	last night	No	No
10/08/2019	28	silver-haired bat	70 m	75	2-3 days	Yes	Yes
10/08/2019	19	unidentified passerine	70 m	55	4-7 days	Yes	Yes
10/08/2019	22	silver-haired bat	70 m	69	2-3 days	No	No
10/08/2019	14	silver-haired bat	70 m	15	last night	No	No
10/10/2019	40	silver-haired bat	40 m	53	2-3 days	Yes	Yes
10/10/2019	3	evening bat	70 m	32	8-14 days	Yes	No
10/10/2019	8	hoary bat	70 m	14	2-3 days	No	No
10/10/2019	8	ruby-crowned kinglet	70 m	55	2-3 days	Yes	Yes
10/11/2019	10	silver-haired bat	40 m	37	2-3 days	No	No
10/11/2019	14	hoary bat	70 m	63	2-3 days	No	No
10/11/2019	22	eastern red bat	70 m	46	last night	No	No
10/15/2019	9	silver-haired bat	40 m	34	last night	No	No
10/15/2019	11	turkey vulture	40 m	50	last night	Yes	Yes
10/15/2019	11	eastern red bat	40 m	39	2-3 days	No	No

*Cleared plots are denoted as 40 –m plots in this table, and un-cleared plots are denoted as 70-m plots. Roads and pads are denoted as 95-m plots.

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

Appendix C1. Truncated weighted maximum likelihood search area adjustment estimates for the GenEst fatality estimator for the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Plot Type	Distribution	Parameter 1	Parameter 2	Area Adjustment
40 m	gamma	2.67	0.05	0.41
70 m	gamma	2.67	0.05	0.78
95 m	gamma	2.67	0.05	0.04

Appendix C2. Search area adjustment models for the GenEst fatality estimator from the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Distribution	AICc	Delta AICc
gamma	12,003.45	0*
Weibull	12,016.45	13.01
Rayleigh	12,016.70	13.26
normal	12,077.37	73.93
Gompertz	12,135.45	132.00

* selected model

Appendix C3. Truncated weighted maximum likelihood area adjustment estimates for the Huso fatality estimator from the Hoopeston Wind Project, Vermilion County, Illinois, from April 2, 2019 to October 15, 2019.

Plot Type	Distribution	Parameter	Area Adjustment
40 m	Rayleigh	39.90	0.41
70 m	Rayleigh	39.90	0.81
95 m	Rayleigh	39.90	0.05

Appendix C4. Area adjustment models for the Huso fatality estimator from the Hoopeston Wind Project, Vermilion County, Illinois, from April 2, 2019 to October 15, 2019.

Distribution	AICc	Delta AICc
Rayleigh	12,292.85	0*
Weibull	12,294.85	2.00
gamma	12,298.91	6.06
normal	12,332.47	39.62
Gompertz	12,387.74	94.88

* selected model

Appendix C5. Truncated weighted maximum likelihood search area adjustment estimates for the Shoenfeld fatality estimator from the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Plot Type	Distribution	Parameter	Area Adjustment
40 m	Rayleigh	38.99	0.42
70 m	Rayleigh	38.99	0.83
95 m	Rayleigh	38.99	0.05

Appendix C6. Search area adjustment models for the Shoenfeld fatality estimator from the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

Distribution	AICc	Delta AICc
Rayleigh	10,517.60	0*
Weibull	10,518.83	1.24
gamma	10,521.08	3.49
normal	10,554.26	36.66
Gompertz	10,608.89	91.29

*selected model

Appendix D. Bat Fatality Rates at the Hoopeston Wind Project Using the GenEst, Huso, and Shoenfeld Estimators

Appendix D1. Estimated bat fatality rates and adjustment factors, with 90% confidence intervals, using GenEst, for studies conducted at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

	Spring		Summer		Fall	
	Estimate	**90% CI**	**Estimate**	**90% CI**	**Estimate**	**90% CI**
Search Area Adjustment						
40-m plot	0.41	0.17 - 0.61			0.41	0.17 - 0.61
70-m plot: grass					0.78	0.38 - 0.93
70-m plot: hemp					0.78	0.38 - 0.93
70-m plot: soy					0.78	0.38 - 0.93
95-m road and pad	0.04	0.03 - 0.06	0.04	0.03 - 0.06	0.04	0.03 - 0.06
Searcher Efficiency						
40-m plot	0.85	0.74 – 0.92			0.88	0.65 – 0.96
70-m plot: grass					0.23	0.01 - 0.47
70-m plot: hemp					0.88	0.65 – 0.96
70-m plot: soy					0.73	0.52 - 0.87
95-m road and pad	0.85	0.74 - 0.92	0.85	0.74 - 0.92	0.85	0.74 - 0.92
Average Probability of a Carcass Persisting Through the Search Interval						
40-m plot	0.72	0.65 - 0.80			0.84	0.77 - 0.90
70-m plot: grass					0.84	0.77 - 0.90
70-m plot: hemp					0.84	0.77 - 0.90
70-m plot: soy					0.84	0.77 - 0.90
95-m road and pad	0.72	0.65 - 0.80	0.72	0.65 - 0.80	0.84	0.77 - 0.90
Probability of Available and Detected						
40-m plot	0.66	0.57 - 0.74			0.79	0.69 - 0.87
70-m plot: grass					0.38	0.18 - 0.60
70-m plot: hemp					0.79	0.69 - 0.87
70-m plot: soy					0.74	0.61 - 0.82
95-m road and pad	0.66	0.57 - 0.74	0.66	0.57 - 0.74	0.79	0.70 - 0.85
Observed Fatality Rates (Fatalities/Turbine/Season(s))						
40-m plot	0.60	n/a*			10.37	10.37 - 10.37
70-m plot: grass					7.26	7.26 - 7.26
70-m plot: hemp					17.20	17.20 - 17.20
70-m plot: soy					19.07	19.07 - 19.07
95-m road and pad	0.09	n/a*	0.14	0.14 - 0.14	0.70	0.70 - 0.70
Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))						
40-m plot	2.31	n/a*			32.59	21.44 - 83.57
70-m plot					32.51	24.31 - 69.58
70-m plot: grass					27.64	13.91 - 80.17
70-m plot: hemp					29.39	22.11 - 62.99

Appendix D1. Estimated bat fatality rates and adjustment factors, with 90% confidence intervals, using GenEst, for studies conducted at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

	Spring		Summer		Fall	
	Estimate	**90% CI**	**Estimate**	**90% CI**	**Estimate**	**90% CI**
70-m plot: soy					34.51	26.32 - 72.06
95-m road and pad	3.21	n/a*	4.98	2.01 - 11.11	19.61	10.66 - 39.47
All Search Plots	**3.09**	**1.01 - 7.81**	**4.98**	**2.01 - 11.11**	**27.20**	**20.08 - 59.73**
Overall Fatalities/Turbine (All Seasons)					**35.72**	**26.03 – 72.99**
Adjusted Fatality Rates (Fatalities/MW/Seasons(s))						
40-m plot	1.16	n/a*			16.29	10.72 - 41.78
70-m plot					16.25	12.16 - 34.79
70-m plot: grass					13.82	6.96 - 40.09
70-m plot: hemp					14.70	11.05 - 31.49
70-m plot: soy					17.25	13.16 - 36.03
95-m road and pad	1.61	n/a*	2.49	1.00 - 5.56	9.81	5.33 - 19.74
All Search Plots	**1.55**	**0.50 - 3.91**	**2.49**	**1.00 - 5.56**	**13.60**	**10.04 - 29.86**
Overall Fatalities/MW (All Seasons)					**17.86**	**13.02 – 36.50**

Appendix D2. Estimated bat fatality rates and adjustment factors, with 90% confidence intervals, using the Huso estimator, for studies conducted at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

	Spring		Summer		Fall	
	Estimate	**90% CI**	**Estimate**	**90% CI**	**Estimate**	**90% CI**
Search Area Adjustment						
40-m plot	0.41	0.26 - 0.61			0.41	0.26 - 0.61
70-m plot: grass					0.81	0.63 - 0.94
70-m plot: hemp					0.81	0.63 - 0.94
70-m plot: soy					0.81	0.63 - 0.94
95-m road and pad	0.05	0.04 - 0.08	0.05	0.04 - 0.08	0.05	0.04 - 0.08
Searcher Efficiency						
40-m plot	0.86	0.76 - 0.95			0.87	0.75 - 1.00
70-m plot: grass					0.23	0.08 - 0.46
70-m plot: hemp					0.87	0.75 - 1.00
70-m plot: soy					0.73	0.53 - 0.93
95-m road and pad	0.86	0.76 - 0.95	0.86	0.76 - 0.95	0.86	0.76 - 0.95
Average Probability of a Carcass Persisting Through the Search Interval						
40-m plot	0.72	0.65 - 0.80			0.84	0.77 - 0.90
70-m plot: grass					0.84	0.77 - 0.90

Appendix D2. Estimated bat fatality rates and adjustment factors, with 90% confidence intervals, using the Huso estimator, for studies conducted at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

	Spring		Summer		Fall	
	Estimate	**90% CI**	**Estimate**	**90% CI**	**Estimate**	**90% CI**
70-m plot: hemp					0.84	0.77 - 0.90
70-m plot: soy					0.84	0.77 - 0.90
95-m road and pad	0.72	0.65 - 0.80	0.72	0.65 - 0.80	0.84	0.77 - 0.90
Probability of Available and Detected						
40-m plot	0.62	0.54 - 0.71			0.73	0.60 - 0.85
70-m plot: grass					0.19	0.06 - 0.37
70-m plot: hemp					0.73	0.60 - 0.85
70-m plot: soy					0.61	0.44 - 0.76
95-m road and pad	0.62	0.54 - 0.71	0.62	0.54 - 0.72	0.72	0.63 - 0.81
Observed Fatality Rates (Fatalities/Turbine/Season(s))						
40-m plot	0.60	n/a*			9.00	5.53 - 12.47
70-m plot: grass					4.33	0 - 10.33
70-m plot: hemp					10.50	0 - 23.50
70-m plot: soy					13.56	7.11 - 21.01
95-m road and pad	0.09	n/a*	0.14	0.06 - 0.24	0.65	0.30 - 1.05
Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))						
40-m plot	2.53	n/a*			30.68	16.08 - 53.78
70-m plot					26.05	14.45 - 58.01
70-m plot: grass					27.98	0 - 157.91
70-m plot: hemp					17.82	0 - 42.37
70-m plot: soy					27.23	14.11 - 49.07
95-m road and pad	2.89	n/a*	4.57	1.66 - 9.12	17.81	7.27 - 33.25
All Search Plots	**2.86**	**0.88 - 5.81**	**4.57**	**1.66 - 9.12**	**24.11**	**16.78 - 44.85**
Overall Fatalities/Turbine (All Seasons)					**31.53**	**21.61 – 58.18**
Adjusted Fatality Rates (Fatalities/MW/Seasons(s))						
40-m plot	1.26	n/a*			15.34	8.04 - 26.89
70-m plot					13.02	7.22 - 29.00
70-m plot: grass					13.99	0 - 78.96
70-m plot: hemp					8.91	0 - 21.19
70-m plot: soy					13.62	7.06 - 24.54
95-m road and pad	1.45	n/a*	2.29	0.83 - 4.56	8.91	3.63 - 16.63
All Search Plots	**1.43**	**0.44 - 2.91**	**2.29**	**0.83 - 4.56**	**12.05**	**8.39 - 22.43**
Overall Fatalities/MW (All Seasons)					**15.77**	**10.81 – 29.09**

Appendix D3. Estimated bat fatality rates and adjustment factors, with 90% confidence intervals, using the Shoenfeld estimator, for studies conducted at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

	Spring		Summer		Fall	
	Estimate	**90% CI**	**Estimate**	**90% CI**	**Estimate**	**90% CI**
Search Area Adjustment						
40-m plot	0.42	0.28 - 0.61			0.42	0.28 - 0.61
70-m plot: grass					0.83	0.66 - 0.94
70-m plot: hemp					0.83	0.66 - 0.94
70-m plot: soy					0.83	0.66 - 0.94
95-m road and pad	0.05	0.04 - 0.07	0.05	0.04 - 0.07	0.05	0.04 - 0.07
Searcher Efficiency						
40-m plot	0.86	0.76 - 0.93			0.87	0.75 - 1.00
70-m plot: grass					0.23	0.08 - 0.46
70-m plot: hemp					0.87	0.75 - 1.00
70-m plot: soy					0.73	0.53 - 0.93
95-m road and pad	0.86	0.76 - 0.93	0.86	0.76 - 0.93	0.86	0.76 - 0.93
Mean Carcass Removal Time (Days)						
40-m plot	17.22	12.34 - 23.50			17.22	12.34 - 23.50
70-m plot: grass					17.22	12.34 - 23.50
70-m plot: hemp					17.22	12.34 - 23.50
70-m plot: soy					17.22	12.34 - 23.50
95-m road and pad	17.22	12.34 - 23.50	17.22	12.34 - 23.50	17.22	12.34 - 23.50
Probability of Available and Detected						
40-m plot	0.77	0.69 - 0.83			0.88	0.83 - 0.92
70-m plot: grass					0.56	0.24 - 0.74
70-m plot: hemp					0.88	0.83 - 0.92
70-m plot: soy					0.85	0.76 - 0.90
95-m road and pad	0.77	0.69 - 0.83	0.77	0.69 - 0.83	0.88	0.83 - 0.91
Observed Fatality Rates (Fatalities/Turbine/Season(s))						
40-m plot	0.60	n/a*			10.53	6.60 - 14.54
70-m plot: grass					7.67	0.67 - 18.33
70-m plot: hemp					17.50	0 - 38.50
70-m plot: soy					19.33	9.67 - 29.56
95-m road and pad	0.09	n/a*	0.14	0.06 - 0.24	0.70	0.35 - 1.10
Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))						

Appendix D3. Estimated bat fatality rates and adjustment factors, with 90% confidence intervals, using the Shoenfeld estimator, for studies conducted at the Hoopeston Wind Project, Vermillion County, Illinois, from April 2, 2019 to October 15, 2019.

	Spring		Summer		Fall	
	Estimate	**90% CI**	**Estimate**	**90% CI**	**Estimate**	**90% CI**
40-m plot	1.84	n/a*			28.25	15.80 - 49.27
70-m plot					24.74	15.23 - 43.96
70-m plot: grass					16.60	1.24 - 64.79
70-m plot: hemp					24.03	0 - 57.13
70-m plot: soy					27.61	13.98 - 44.23
95-m road and pad	2.22	n/a*	3.49	1.27 - 6.58	15.05	6.61 - 26.83
All Search Plots	**2.19**	**0.65 - 4.40**	**3.49**	**1.27 - 6.58**	**21.86**	**16.36 - 36.54**
Overall Fatalities/Turbine (All Seasons)					**27.53**	**20.05 – 46.12**
Adjusted Fatality Rates (Fatalities/MW/Seasons(s))						
40-m plot	0.92	n/a*			14.13	7.90 - 24.64
70-m plot					12.37	7.62 - 21.98
70-m plot: grass					8.30	0.62 - 32.39
70-m plot: hemp					12.01	0 - 28.57
70-m plot: soy					13.80	6.99 - 22.11
95-m road and pad	1.11	n/a*	1.75	0.63 - 3.29	7.52	3.31 - 13.42
All Search Plots	**1.09**	**0.32 - 2.20**	**1.75**	**0.63 - 3.29**	**10.93**	**8.18 - 18.27**
Overall Fatalities/MW (All Seasons)					**13.77**	**10.02 – 23.06**