2023 Annual Post-Construction Bat Mortality Monitoring Report

High Prairie Renewable Energy Center

Schuyler and Adair Counties, Missouri

Incidental Take Permit (ITP) Level Monitoring (April 1 – October 31)

Project #193709495

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1.0 Introduction

1.1 PROJECT DESCRIPTION AND HISTORY

Ameren Missouri's (Ameren) High Prairie Renewable Energy Center (Project or High Prairie) consists of 175 turbines (163 V120 2.2-MW and 12 V112 3.45-MW) with an approximate 400-megawatt (MW) operating capacity in Schuyler and Adair Counties, Missouri.

Due to the risk of take of the federally endangered Indiana bat (*Myotis sodalis*) and federally-endangered northern long-eared bat (*Myotis septentrionalis*) during operations, Ameren applied for and received an Incidental Take Permit (ITP) for these species, as well as for the little brown bat (*Myotis lucifugus*).

During much of the 2023 bat active season, Ameren voluntarily implemented avoidance measures and wind turbines ceased operation on a nightly basis from 45 minutes before sunset until 45 minutes after sunrise. In consultation with the United States Fish and Wildlife Service (USFWS) and the Missouri Department of Conservation (MDC), it was agreed that post-construction monitoring for bats need not occur during such curtailment periods (i.e., nighttime shutdown).

During the 2023 monitoring period, 20-50 of the turbines operated on select nights under limited nighttime operations, which is summarized below in Table 1-1. The turbines that operated under limited nighttime operations had a cut-in speed of 8 meters/second (m/s) along with the EchoSense smart curtailment technology, which Ameren is voluntarily phasing in to further reduce bat mortality. On the night of September 26, Ameren voluntarily ceased all operations at night until October 31.

Table 1-1. Summary of nighttime operations from April 1 through October 31, 2023, at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri.

Date(s)	Number of Turbines Operating	Number of Turbines Not Operating at Night	Curtailment
April 1 – April 23	20	155	8.0 m/s + EchoSense
April 24 – September 17	32	143	8.0 m/s + EchoSense
September 18 – September 25	50	125	8.0 m/s + EchoSense
September 26 - October 31	0	175	No nighttime operations

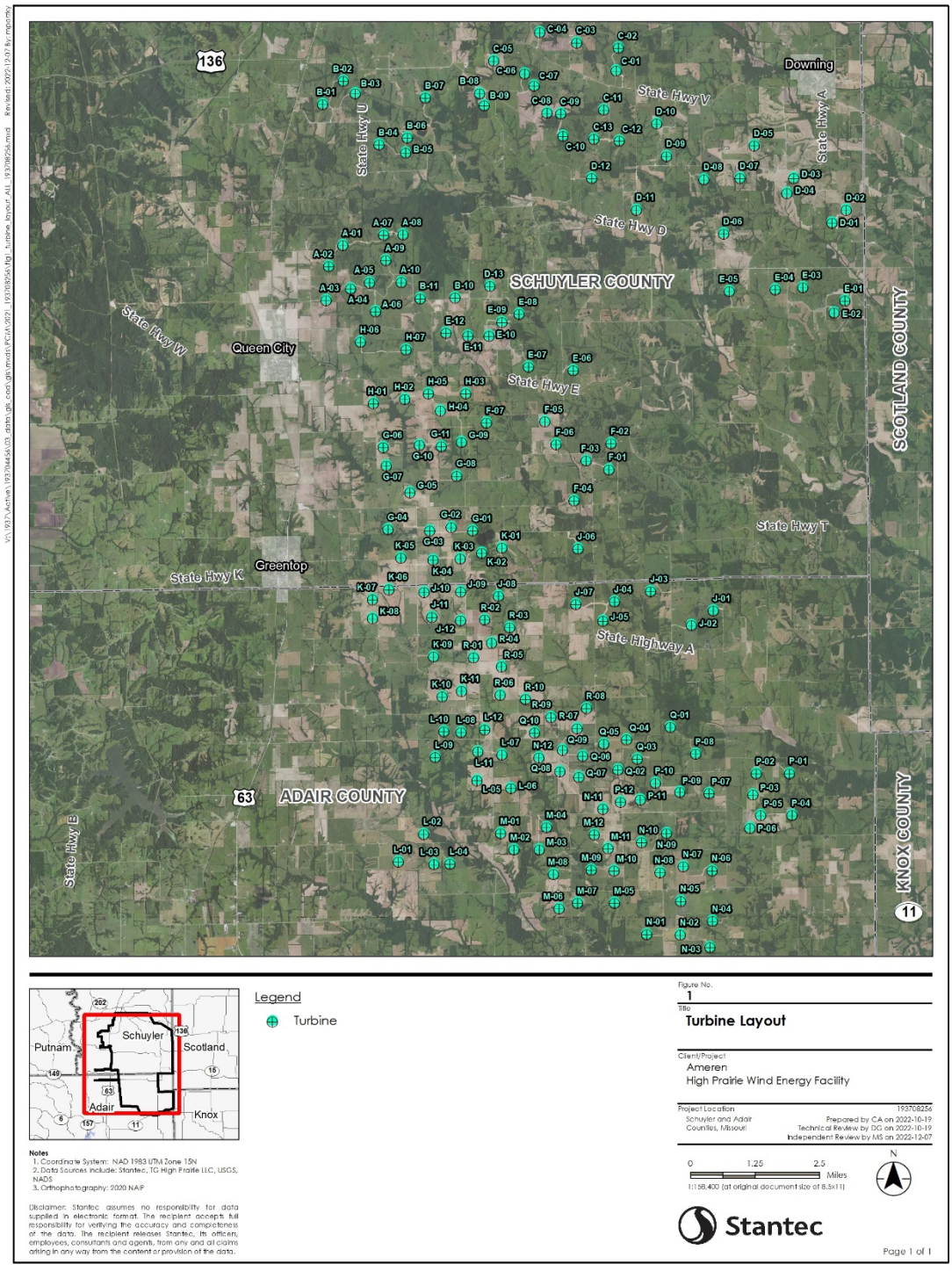

Figure 1. Turbine Layout

1.2 PURPOSE AND OBJECTIVES OF THE MONITORING

Post-construction mortality monitoring activities at turbines operating at night adhered to the goals and objectives outlined in the Project's HCP, specifically to evaluate the effectiveness of the minimization measures and ensure that take of the Covered Species remains within the take limits set forth in the ITP.

2.0 Methods

Post-construction monitoring included the following components:

1. Standardized carcass searches to systematically search plots at all turbines operating at night from April 1 to October 31 for bat casualties attributable to the turbines.
2. Searcher efficiency trials to estimate the percentage of bat casualties that were found by the searcher(s).
3. Carcass removal trials to estimate the persistence time of carcasses on-site before scavengers removed them.

2.1 FIELD METHODS

2.1.1 Standardized Carcass Searches

Post-construction monitoring was conducted at 100% of the turbines that operated at night between April 1 and October 31, 2023. Standardized carcass searches consisted of searching the turbine pads and the roads out to 312 feet (ft; 95 meters [m]) and full plots out to 197 ft (60 m), though the proportion of roads and pads to full plots varied based on the number of operational turbines (Table 2-1). The search interval also varied by season due to changes in the monitoring protocol (Table 2-1).

Table 2-1. Summary of post-construction monitoring protocols by season between April 1 and October 31, 2023, at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri.

Season	Dates	Number of Operational Nights	Number of Full Plots	Number of Roads and Pads	Search Interval
Spring	April 1 – April 23	23	20 (100%)	0 (0%)	Five times weekly (~1.5 days)
	April 24 – May 14	21	27 (84%)	5 (16%)	Three times weekly (~2.5 days)
Summer	May 15 – August 14	92	27 (84%)	5 (16%)	Two to three times weekly (~2.5-3.5 days)

Season	Dates	Number of Operational Nights	Number of Full Plots	Number of Roads and Pads	Search Interval
Fall	August 15 – September 18	35	27 (84%)	5 (16%)	Two to three times weekly (~2.5-3.5 days)
	September 19 – September 27[1]	7	37 (74%)	13 (26%)	Three times weekly (~2.5 days)

[1]No turbine searches were completed after September 27 because operations had ceased at all turbines beginning the night of September 26

Standardized carcass searches were conducted by qualified searchers trained in mortality search methods, including proper handling and reporting of carcasses. Searchers were familiar with and able to accurately identify bat species likely to be found in the Project area. Preliminary bat species identifications were made in the field by qualified staff. When carcass condition allowed, sex and age of the carcass were recorded. For bat carcasses, forearm length was recorded to facilitate species identification. In addition to the carcass, photographs and data collected for each carcass were used to verify the species identification. Photos of any unknown bats discovered were sent to a Stantec USFWS permitted bat biologist for positive identification, and carcasses were kept on-site. A Stantec senior bat biologist who holds a USFWS permit for threatened and endangered bats, reviewed any unknown or suspected *Myotis* identifications to confirm the identification and, if necessary, a tissue sample was sent to the Northern Arizona University's Bat Ecology and Genetics Lab[1] for genetic testing.

During searches, searchers walked at a rate of approximately 2 miles per hour (mph; 45 to 60 m per minute) while searching 10 ft (3 m) on either side. For each carcass found (for the purposes of this analysis, live or injured bats were considered a carcass), the following data were recorded digitally within Survey123 (ESRI, Redlands, CA):

- Date and time.
- Initial species identification [this information was updated as needed based on photos, dentition, or results of genetic testing].
- Sex, age, and reproductive condition (when possible) [sex was updated based on genetic testing, if applicable].
- Global positioning system (GPS) location.
- Distance and bearing to turbine.
- Condition (intact, scavenged, decomposed).
- Any notes on presumed cause of death.

[1] https://in.nau.edu/bat-ecology-genetics/

A digital photograph of each carcass found was taken before the carcass was handled and removed. Bat carcasses were labeled, bagged, and stored in a freezer at the Project Operations and Maintenance Building.

Bat carcasses found in non-search areas were coded as incidental finds and documented in a similar fashion to those found in standardized surveys when possible. These included carcasses found during non-search times or outside the monitoring plot. Incidental bat carcasses were collected and stored in the freezer with the carcasses found during standardized surveys. As per industry standard, incidental finds were not included in the fatality estimates.

2.1.2 Searcher Efficiency Trials

Searcher efficiency trials were used to estimate the probability of bat carcass detection by the searchers. The searchers did not know when during the monitoring periods the trials were being conducted, at which turbines trial carcasses were placed, or the location or number of trial carcasses placed in any given search plot. Commercially available brown mouse carcasses were used as trial carcasses to represent bats.

All searcher efficiency trial carcasses were randomly placed by a field lead within the search plots. These were placed either the evening before monitoring, or in the morning prior to the planned carcass surveys for that day and checked after the searcher efficiency trial to ensure they had not been scavenged. The number of trial carcasses found by the searcher during the mortality surveys in each plot was recorded and compared to the total number of trial carcasses placed in the plot and not scavenged prior to the mortality search.

2.1.3 Carcass Persistence Trials

A carcass removal trial was conducted to estimate the average length of time carcasses remained in the search plots (i.e., were available to find) before being removed by scavengers. Mouse carcasses used during the searcher efficiency trials were left in place, and their locations were discretely marked. Alternatively, sometimes separate mouse carcasses were placed for carcass removal trials alone. Searchers monitored the trial carcasses over a period of up to 30 days. During the carcass removal trial, carcasses were generally checked every day for the first week, and then regularly checked until missing or 30 days had passed.

The condition of each carcass was recorded during each trial check. The conditions recorded were defined as follows:

- Intact – complete carcass with no body parts missing
- Scavenged – carcass with some evidence or signs of scavenging
- Fur spot – no carcass, but fur spot remaining
- Missing – no carcass or fur remaining

Any carcasses remaining at the end of the 30-day trial period were removed from the field.

2.2 DATA ANALYSIS - GENEST

Results include summaries of the raw data, including counts of species, the number of searches conducted, and the average search interval (calculated as the sum of the number of visits to a turbine divided by the number of days within a season).

The Generalized Estimator (GenEst; Dalthorp et al. 2018) was used for calculating bias correction factors (searcher efficiency, carcass persistence, and area adjustment) and the overall fatality rate and fatality estimates for each bat species at the Project. Note that throughout the document some estimates may not correspond exactly with subsets of those estimates (e.g., fatality by species may not add up to total fatality). This is because GenEst generates all estimates as a result of 1,000's of iterations of a model (called "bootstraps"). As each iteration yields slightly different results, different repetitions of the analysis will yield slightly different results.

2.2.1 Searcher Efficiency (p)

Searcher efficiency (p) represents the average probability that a carcass was detected by the searcher. The searcher efficiency rate was calculated using the data collected during searcher efficiency trials (see Section 2.1.2) by dividing the number of trial carcasses the observer found by the total number which remained available during the trial (i.e., non-scavenged). Analysis includes an evaluation of whether searcher efficiency differed by searcher, season (spring, summer, fall), or plot type (roads and pads, full plots). Searcher efficiency decay (k) was fixed at 0.67. This value represents the decrease in searcher efficiency (p) on subsequent searches (i.e., if a carcass is missed the first time it is available, it is less likely to be found on subsequent searches than a "fresh" carcass).

GenEst returns numerous models depending on the number of variables included in the analysis, as well as Akaike information criterion (AIC) values for each model. The AIC value is a statistical score for the quality of a model fit, where smaller AIC values are considered better models. However, models within 3-4 ΔAIC (the difference between each model's AIC and the AIC of the "best" model) are generally considered indistinguishable by this measure (Dalthorp et al. 2018). Therefore, the best model was chosen based on a manual review of models with the lowest AIC values, and a top model was chosen from the models within 3-4 ΔAIC of the top model based on AIC and parsimoniousness. Confidence intervals were generated using 1,000 bootstrapped iterations.

2.2.2 Carcass Persistence

Carcass persistence times modeled in GenEst include using censored exponential, Weibull, lognormal, and loglogistic survival models of the data collected as part of the carcass removal trial (see Section 2.1.3). GenEst returns numerous models depending on the number of variables included in the analysis, as well as AIC values for each model. The best model was chosen based on a comparison of models with the lowest AIC values, though similar to searcher efficiency, models were also graphically evaluated to ensure that they are logical, and the top model was

chosen from the models within 3-4 ΔAIC of the top model. Confidence intervals were generated using 1,000 bootstrapped iterations.

2.2.3 Density-weighted Proportion (DWP)

Due to the small number of bat carcasses found in 2023, the 2021 density-weighted proportion (DWP) was updated using Dalthorp et al. 2022. The updated DWPs averaged 77% for full plots and 5% on roads and pads. The plot type at 18 of the searched turbines changed from road and pad plots in 2021 to full plots in 2023. Given of the small number of bat carcasses found in 2023, these turbines were assigned the average DWP for full plots (77%). See Dalthorp et al. (2022) for further explanation of methods in deriving DWP for turbines at the Project. The DWP will be reviewed annually and updated as appropriate.

2.2.4 Adjusted Fatality Estimates (GenEst)

GenEst was used to calculate overall fatality rates for the Project (per turbine, per MW, and for all 175 turbines). All estimates include 90% confidence intervals. Because the number of operating turbines sometimes changed within a season, "per turbine estimates" were calculated by dividing the GenEst estimate (and confidence intervals) by the weighted average number of turbines (175 turbines). For example, if 20 turbines operated for the first 22 days of a monitoring period and 32 turbines operated for the last 22 days of a monitoring period (42 days total in the monitoring period), then the "number of operating turbines" for that monitoring period would be calculated as follows:

((20 turbines * 22 days) + (32 turbines * 20 days)) / 42 days = 25.7 operating turbines

The "per MW estimates" were calculated by dividing the GenEst estimate (and confidence intervals) by the weighted average operating MW, based on the two turbine types (163 V120 2.2-MW and 12 V112 3.45-MW).

Fatality estimates were split by several carcass variables, including season and species.

2.3 DATA ANALYSIS – EVIDENCE OF ABSENCE

Evidence of Absence (EofA; Dalthorp et al. 2017) was used for estimating the overall detection probability (g) and the estimated take of the Covered Species (M and λ).

2.3.1 Estimation of Detection Probability (g)

For analysis of the 2023 data, the "Multiple Class Module" was used to combine data from the two search classes (roads and pads and full plots) and across the three seasons (spring, summer, and fall). Site-specific monitoring data were used to calculate the g-value for each search class, including the following inputs:

- Search interval (I), calculated as the average time between searches for that plot type.

- Number of searches, calculated as the average number of times each turbine within that plot type was visited.

- Temporal coverage (v), which is set to 1 since monitoring occurred during the entire period of risk during each season.

- Searcher efficiency, which was calculated using the "carcasses removed after one search" option and inputting the total number of carcasses available and the number of carcasses found for that plot type and season across all searchers.

- Factor by which searcher efficiency changes with each search (k) was fixed at 0.67.

- Persistence distribution, which was calculated using field trials to estimate the parameters, and the top model was selected based on results from GenEst modeling.

This input was done for both road and pad searches and for full plots to calculate the detection probability (g) within those searched areas. Within the Multiple Class Module, the fraction of total carcasses arriving within each class needs to be assigned to the DWP column. This differs from the DWP calculated in Section 2.2.3, which is the proportion of bats expected to fall within the searched area at a particular turbine, whereas this DWP is the proportion of bats expected to fall within that class. The DWP was calculated for each of the plot types, as well as for an "unsearched" class to account for carcasses that fall outside of the searched area. The DWPs of these three classes (roads and pads, full plots, and unsearched) must sum to one. The DWPs for roads and pads and full plots were calculated based on the DWPs calculated for the turbines within those plots (Section 2.2.3), using the average DWP for the plot type and multiplying it by the proportion of turbines within that plot type and the proportion of the season operating under that monitoring protocol. The unsearched class was then calculated as one minus the sum of the DWPs for the searched areas.

Once these inputs were complete, the "Estimate overall detection probability (g)" option was chosen, and the overall detection probability for that season was calculated. This detection probability is the same for all three Covered Species.

A class for each season was then entered into the Multiple Class Module to get a detection probability across the entire monitoring period. The DWPs of the four classes (spring, summer, fall, and unsearched) were calculated based on the percentage of carcasses arriving during each season. Because the monitoring period covered the entire period of risk, the unsearched class was set to 0 as all fatalities are expected to occur during the monitoring period. Once these inputs were complete, the "Estimate overall detection probability (g)" option was chosen, and the overall detection probability for 2023 was calculated. This detection probability is the same for all three Covered Species.

2.3.2 Evaluation of Fatality Estimates and Adaptive Management Triggers

For analysis of the 2023 data, the "Multiple Years Module" was used with the results of the detection probability (g) obtained as described in Section 2.3.1, along with the number of observed mortalities of each of the Covered Species. This analysis was run separately for each Covered Species to determine the total estimated mortality (M), the annual fatality rate (λ), the projected future take over the 6-year permit term if current take rate trends continue, and to evaluate whether the short-term triggers described in Table 7-3 of the HCP had been exceeded. All analysis was done at a=0.5 and included the results from 2021 and 2022 monitoring.

Selection of the "Multiple Years Module" in EofA requires the user to provide a relative mortality rate (ρ), which informs EofA whether the user believes there to be any systematic variation in mortality rates from year to year. Per the EofA user guide, "if there are no changes in operations and no reason to suspect mortality rates varied systematically from year to year, then ρ = 1 each year. However, if operations or ecological conditions change, the ρ parameter should be adjusted to reflect changes." (Dalthorp et al. 2017). At High Prairie, operations have varied in each of the three operational years; therefore, ρ was be calculated for each individual year of monitoring.

The "Multiple Years Module" was used to combine results from 2021, 2022, and 2023 incorporating detection probabilities from each year and requiring assignment of ρ for each year. A value of ρ = 1 was assigned for 2021 as the baseline year.

In 2023, a more in-depth analysis of turbine run-time and bat activity reported for 2021, 2022, and 2023 was completed. Turbine rotor speed (rpm) data recorded at 10-minute intervals for all 175 turbines between April 1 – October 31. Each 10-minute interval was categorized as operational (rpm > 1) or non-operational. Analysis was limited to the interval data collected between sunset and sunrise (i.e., nighttime operations) and when wind speeds were less than 15 meters per second (m/s). Acoustic data that characterized bat activity, collected by the EchoSense system operated by Natural Power in 2022 and 2023, were also analyzed. The number of 10-minute nighttime periods in which turbines were operational during each year on a monthly basis were summed. These sums of 10-minute intervals were then weighted by the monthly relative number of acoustic bat passes recorded at 35 turbines by the EchoSense system in 2022 and 2023. The weighted interval sums were converted to turbine-hours of operation that likely posed risks to bats. This method of combining the seasonal trend in bat activity with the amount of time turbines were operating when bat fatalities could occur (nighttime at wind speeds less than 15 m/s) provided a data-driven integrated approach to derive ρ values using site-specific data that described relevant turbine operations and bat activity.

The resulting numbers of turbine-hours, weighted by monthly bat activity levels, were 1,829 for 2021 and 128 for 2022, representing a 93% decrease in relative mortality risk from 2021 to 2022; therefore, a ρ of 0.07 was used for 2022. The 370 weighted turbine-hours for 2023 indicated an 80% reduction in relative mortality risk from 2021 to 2023; therefore, a ρ of 0.20 was used for 2023 (Table 2-2).

Table 2-2. Calculated number of hours at night when turbine rotor speed exceeded 1 rpm in 2021 – 2023, weighted by monthly rate of acoustic bat passes detected by EchoSense in 2022 and 2023

Year	Total hours with rotor speed > 1 rpm	Weighted hours with rotor speed > 1 rpm*	ρ
2021	51,326	1,829	1.00
2022	2,759	128	0.07
2023	4,983	370	0.20
*Weighted values represent the sum of the product of monthly turbine-hours with rotor speed > 1 rpm multiplied by rate of acoustic bat activity recorded by EchoSense in the corresponding month			

Projected take over the remainder of the permit term was calculated assuming a ρ value equal to 2023 (i.e., 0.20).

2.3.3 Design Protocols – Future Monitoring

The HCP denotes a desired detection probability (g) of 0.2 over the 6-year permit term. To design a protocol to target a detection probability of at least 0.2, the EofA "Design Tradeoffs" module will be used.

3.0 Results

3.1 ALL BATS

3.1.1 Carcass Searches

A total of 2,288 searches were conducted between April 1 and October 31, under HCP-level in the spring (April 1 – May 14; 20-27 full plots and 0-5 roads and pads), summer (May 15 – August 14; 60-27 full plots and 5 roads and pads), and fall (August 15 – September 27; 27-37 full plots and 5-13 roads and pads) (Table 3-1). Carcass searches ceased after September 27, 2023, due to a site-wide nighttime shutdown beginning on the night of September 26, 2023.

Table 3-1. Summary of post-construction monitoring conducted between April 1 and October 31, 2023, at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri.

Season	Dates	Number of Searches Conducted	Average Search Interval	Number of Bats Found in Standardized Searches	Number of Bats Found Incidentally
Spring	April 1 – May 14	565	2.0 days	3	2
Summer	May 15 – August 14	1,078	2.7 days	6	0
Fall	August 15 – October 31[1]	645	2.4 days	7	1
Total	**April 1 – October 31[1]**	**2,288**	**n/a**	**16**	**3**

[1] monitoring ceased after September 27 due to a site-wide nighttime shutdown beginning the night of September 26.

A total of 16 individual bat carcasses were found during standardized carcass searches, and 3 individual bat carcasses were found incidentally.

3.1.2 Species Composition

A summary of all bat carcasses found during the spring (April 1 – May 14), summer (May 15 – August 14), and fall (August 15 – September 27) standardized carcass searches is shown in Table 3-2.

Table 3-2. Summary of all bat carcasses found during standardized carcass searches between April 1 and October 31, 2023, during post-construction monitoring at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri.

Species (state/federal status)	Count (species composition)			
	Spring	Summer	Fall	Total
Big Brown Bat	0	2 (33.3%)	0	2 (12.5%)
Eastern Red Bat	0	0	5 (71.4%)	5 (31.3%)
Evening Bat	0	2 (33.3%)	1 (14.3%)	3 (18.8%)
Hoary Bat (SOCC)	0	1 (16.7%)	0	1 (6.3%)
Indiana Bat (Covered Species, SE, FE, SOCC)	0	0	1 (14.3%)	1 (6.3%)

Species (state/federal status)	Count (species composition)			
	Spring	Summer	Fall	Total
Silver-haired Bat (SOCC)	3 (100%)	0	0	3 (18.8%)
Unknown	0	1 (16.7%)	0	1 (6.3%)
Total	3 (100%)	6 (100%)	7 (100%)	16 (100%)

Key
SOCC = Species of Conservation Concern (state)
SE = state-endangered
FE= federally-endangered

A total of 16 bat carcasses were found, 15 of which were identified to the species level.

Of the 16 bat carcasses, the most common species found was the eastern red bat (*Lasiurus borealis*), followed by the evening bat (*Nycticeius humeralis*), silver-haired bat (*Lasionycteris noctivagans*), and big brown bat (*Eptesicus fuscus*); the least frequently found species (n=1 each) were the hoary bat (*Lasiurus cinereus*) and Indiana bat. No northern long-eared bats (Covered Species, state-endangered and SOCC, federally endangered) or little brown bats (Covered Species, SOCC) were found.

Incidental finds included three bat carcasses, two during the spring (eastern red bat and big brown bat) and one during the fall (eastern red bat) monitoring period.

3.1.3 Searcher Efficiency

Searcher efficiency trials were conducted during post-construction monitoring during all three seasons (spring, summer, and fall). Searcher efficiency was tested using a total of 158 trial carcasses: 43 in the spring, 75 in the summer, and 40 in the fall. Data were analyzed in GenEst, with searcher, season, and plot type as the three predictor variables. The selected model was the parsimonious model and included plot type as the predictor (Table 3-3). Selected model is shown in bold.

Table 3-3. Model comparison results from the top five models for searcher efficiency trials conducted between April 1 and October 31, 2023, at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri. Selected model shown in bold.

Formula/Model	k	AIC_c	ΔAIC_c
p ~ Season + Searcher + PlotType	0.67	156.61	0
p ~ PlotType	**0.67**	**157.89**	**1.28**

Formula/Model	k	AIC_c	ΔAIC_c
P ~ Searcher + PlotType	0.67	158.08	1.47
P ~ Season + PlotType	0.67	160.19	3.58
P ~Season + Searcher + PlotType + Season:PlotType	0.67	160.5	3.89

Based on the results of the selected model, searcher efficiency did not vary by season or searcher and was 95.1% on roads and pads and 60.8% on full plots.

Table 3-4. Searcher efficiency during 2023 post-construction monitoring at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri

Plot Type	Trial Carcasses	Searcher Efficiency (90% CI)
Full Plots	97	0.608 (0.524 – 0.686)
Roads and Pads	61	0.951 (0.879 – 0.981)

3.1.4 Carcass Persistence

The top five models for carcass persistence in GenEst included exponential and Weibull distributions, with effects of season and/or plot type (Table 3-5). Exponential models assume the probability of carcasses persisting from one day to the next (daily carcass persistence) remains constant over time; however, a decreasing probability of carcass removal through time is more biologically plausible (Bispo et al. 2012, Bernardino et al. 2013), which the Weibull distribution allows for. Therefore, the exponential model was discarded. Based on AIC and visual analysis of the remaining models, the Weibull distribution with season and plot type in the formula for location and plot type in the formula for scale was selected as the model for carcass persistence.

Table 3-5. Model comparison results from the top five models for carcass persistence trials conducted between April 1 and October 31, 2023, at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri. Selected model is shown in bold.

Distribution	Location Formula	Scale Formula	AIC_c	ΔAIC_c
Exponential	l ~ Season + PlotType	n/a	467.54	0
Weibull	**l ~ Season + PlotType**	**s ~ PlotType**	**468.54**	**1**

Distribution	Location Formula	Scale Formula	AIC_c	ΔAIC_c
Weibull	l ~ Season + PlotType	s ~ constant	469.46	1.92
Weibull	l ~ Season + PlotType	s ~ Season	472.03	4.49
Weibull	l ~ Season + Plot Type	s ~ Season + Plot Type	472.18	4.64

Carcass persistence was tested using 110 carcasses across the three seasons. The shortest carcass persistence observed was in the fall, when carcass persistence averaged 1.0 days on roads and pads and 3.2 days on full plots, compared to spring which ranged from 3.6 on roads and pads to 11.7 days on full plots and summer which ranged from 1.5 days on roads and pads to 5.0 days on full plots (Table 3-6).

Table 3-6. Carcass persistence during 2023 post-construction monitoring at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri.

Season	Full Plots		Roads and Pads	
	Trial Carcasses	Carcass Persistence (90% CI)	Trial Carcasses	Carcass Persistence (90% CI)
Spring	30	11.7 (8.1 – 16.9)	0	3.6 (1.7 – 7.3)
Summer	20	5.0 (3.3 – 7.4)	20	1.5 (0.8 – 2.8)
Fall	20	3.2 (2.1 – 4.8)	20	1.0 (0.5 – 1.8)

3.1.5 Density-weighted Proportion (DWP)

Based on data from 2021, updated based on Dalthorp et al. 2022, full plot turbines have an average DWP of 77%, and road and pad turbines have an average DWP of 5%. Turbine-specific DWPs are provided in Appendix A.

3.1.6 Adjusted Fatality Estimates

Fatality rate estimates were calculated based on the carcasses found during the standardized carcass searches and did not include any incidental finds. Observed bat mortality estimates were adjusted to account for searcher efficiency, carcass removal, search schedule, and turbine-specific DWPs.

3.1.6.1 Seasonal Fatality Estimates

A total of three bat carcasses were found during the spring monitoring period (Table 3-1, Table 3-2). Applying the searcher efficiency rates (see Section 3.1.3), carcass persistence rates (Table 3-6), turbine-specific DWPs (Appendix A), and the spring search schedule, results in an overall bat fatality estimate of 4.9 bats (90% CI: 3.0 to 7.8) across the weighted average 25.7 operating turbines between April 1 and May 14, 2023 – equivalent to 0.2 bat/turbine (90% CI: <0.1-0.3) or 0.1 bat/MW (90% CI: 0.1-0.1) (Table 3-7).

A total of six bat carcasses were found during the summer monitoring period (Table 3-1, Table 3-2). Applying the searcher efficiency rates (see Section 3.1.3), carcass persistence rates (Table 3-6), turbine-specific DWPs (Appendix A), and the summer search schedule, results in an overall bat fatality estimate of 15.5 bats (90% CI: 8.0 – 25.5) across the 32 operating turbines between May 15 and August 14, 2023 – equivalent to 0.5 bat/turbine (90% CI: 0.2 – 0.8) or 0.2 bat/MW (90% CI: 0.1 – 0.4) (Table 3-7).

A total of seven bat carcasses were found during the fall monitoring period (Table 3-1, Table 3-2). Applying the searcher efficiency rates (see Section 3.1.3), carcass persistence rates (Table 3-6), turbine-specific DWPs (Appendix A), and the fall search schedule, results in an overall bat fatality estimate of 14.2 bats (90% CI: 6.5 – 24.2) across the weighted average 35.2 operating turbines between August 15 and October 31, 2021 – equivalent to 0.4 bat/turbine (90% CI: 0.2 – 0.7) or 0.2 bat/MW (90% CI: 0.1 – 0.3) (Table 3-7).

Table 3-7. Bat fatality rates by season from 2023 post-construction monitoring at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri.

Season	Dates	Facility-wide Estimated Fatalities (90% CI)	Per Turbine Estimated Fatalities (90% CI)[1]	Per MW Estimated Fatalities (90% CI)[2]
Spring	April 1 – May 14	4.9 (3.0 – 7.9)	0.2 (0.1 – 0.3)	0.1 (0.1 – 0.1)
Summer	May 15 – August 14	15.5 (7.8 – 25.6)	0.5 (0.2 – 0.8)	0.2 (0.1 – 0.4)
Fall	August 15 – October 31[3]	14.2 (6.5 – 23.1)	0.4 (0.2 – 0.7)	0.2 (0.1 – 0.3)

[1] Calculated based on a weighted average of 25.7 operating turbines in spring, 32 operating turbines in summer, and 35 operating turbines in fall
[2] Calculated based on a weighted average of 57.9 operating MW in spring, 71.7 operating MW in summer, and 80.1 operating MW in fall
[3]Monitoring ceased after September 27 due to a site-wide nighttime operations shutdown

3.1.6.2 Fatality Estimates by Species

The fatality estimates by species are shown in Table 3-8. The eastern red bat was the most commonly found species (Table 3-2), and was also the species with the highest fatality estimate of 0.4 eastern red bat bat/turbine, followed by the evening bat and silver-haired bat (0.2 bat/turbine). The remaining bats (big brown bat, hoary bat, Indiana bat, and unknown bat ranged from 0.1 bat/turbine to less than 0.1 bat/turbine (Table 3-8).

Table 3-8. Bat fatality estimates by species from April 1 – October 31, 2023, post-construction monitoring at the High Prairie Renewable Energy Center, Schuyler and Adair Counties, Missouri.

Species	Total Found	Total Estimated Fatality (90% CI)	Per Turbine Estimated Fatalities (90% CI)[1]	Per MW Estimated Fatalities (90% CI)[2]
Big Brown Bat	2	4.3 (2.0 – 8.1)	0.1 (0.1 – 0.3)	0.1 (<0.1 – 0.1)
Eastern Red Bat	5	11.6 (5.4 – 19.7)	0.4 (0.2 – 0.6)	0.2 (0.1 – 0.3)
Evening Bat	3	7.0 (3.0 – 13.2)	0.2 (0.1 – 0.4)	0.1 (<0.1 – 0.2)
Hoary Bat	1	1.8 (1.0 – 3.9)	0.1 (<0.1 – 0.1)	<0.1 (<0.1 – 0.1)
Indiana Bat	1	2.6 (1.0 – 7.2)	0.1 (<0.1 – 0.2)	<0.1 (<0.1 – 0.1)
Silver-haired Bat	3	4.8 (3.0 – 7.3)	0.2 (0.1 – 0.2)	0.1 (<0.1 – 0.1)
Unknown	1	1.9 (1.0 – 4.3)	0.1 (<0.1 – 0.1)	<0.1 (<0.1 – 0.1)

[1] Calculated based on a weighted average 31.2 operating turbines over the entire monitoring period
[2] Calculated based on a weighted average 71.5 operating MW over the entire monitoring period

3.2 COVERED SPECIES

Among the Covered Species, one Indiana bat was found. No little brown or northern long-eared bats were found. A Stantec USFWS permitted bat biologist identified the carcass as a female Indiana bat. Further validation was obtained via a tissue sample sent for genetic testing which confirmed the species identification and sex. The fatality was found at Turbine A-01 and it is the second female fatality in the northern part of the Project.

The location of the female Indiana bat fatality and a 2.5-mile buffer around Turbine A-01 are shown in Figure 2 along with all prior Covered Species fatalities and corresponding adaptive management buffers for female fatalities.

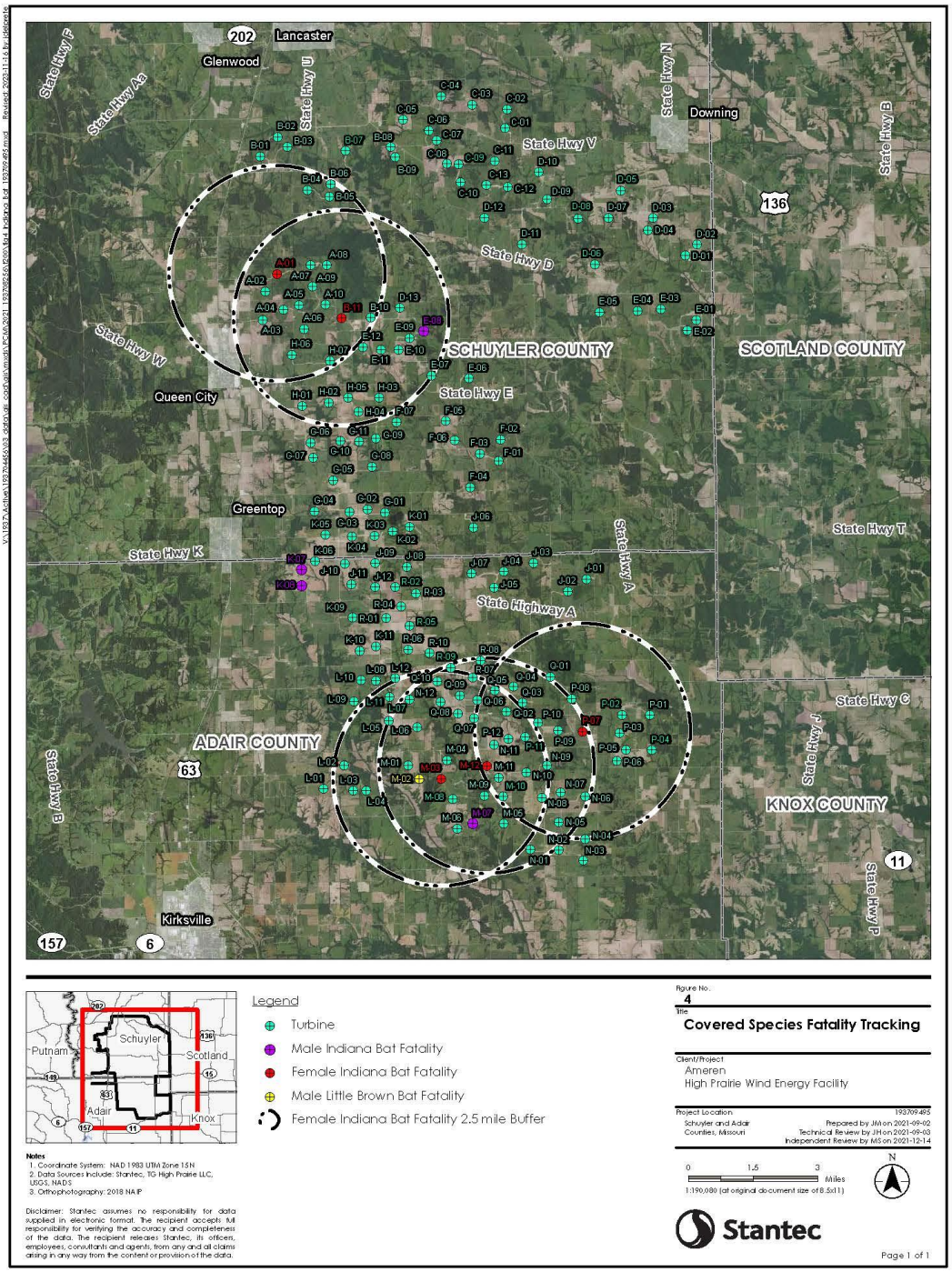

Figure 2. Covered Species Fatality Tracking

3.2.1 GenEst

As described in Section 0, GenEst estimated the total Indiana bat fatalities for 2023 at 2.6 Indiana bats (90% CI: 1.0 – 7.2). Since no northern long-eared or little brown bats were found, GenEst was unable to estimate a fatality estimate for that species.

In addition, the GenEst analysis for the Indiana bat was also conducted with a 95% confidence interval to make the results comparable to EofA. The estimated total fatalities in GenEst for 2023 with a 95% confidence interval was 2.6 Indiana bats (95% CI: 1.0 – 8.6).

3.2.2 Evidence of Absence

Screenshots of the inputs for EofA are included in Appendix B and the results are summarized in the sections below. The "Multiple Classes" module was used in EofA. Because searcher efficiency and/or carcass persistence varied by season and plot type and because search protocols changed within seasons, the module was run four times: once for each season (with separate classes for each plot type and monitoring protocol plus an unsearched proportion), and once for the entire year (with separate classes for each season, and no unsearched portion since post-construction monitoring was conducted during the entire period of risk – April 1 through October 31, while turbines were operational – April 1 through September 26).

3.2.2.1 Detection Probability (g)

The overall detection probability for the post-construction monitoring season (April 1 through October 31, 2023) was 0.411 (95% CI: 0.085 to 0.149); however, this varied by season as summarized in Table 3-9.

Table 3-9. Summary of detection probability (g) by season and overall, during 2023 post-construction monitoring at the High Prairie Renewable Energy Center in Schuyler and Adair Counties, Missouri.

Season	Detection Probability (g) and 95% CI
Spring	0.533 (0.468 – 0.598)
Summer	0.414 (0.317 – 0.516)
Fall	0.317 (0.28 – 0.467)
Total/Overall	**0.411 (0.352 – 0.471)**

3.2.2.2 Fatality Estimates (M* and λ) and Adaptive Management Triggers

Analysis in the EofA "Multiple Years Module" included calculation of the following for each of the Covered Species, per Section 7.5.2 of the HCP:

- Number of Detected Fatalities (X)
- Annual Take Estimate (M_{2023})
- Annual take rate (λ)
- Cumulative take estimate (M*; includes 2021 and 2022 data)
- Projected Take Estimate (number estimated to have been killed to-date, plus the additional take likely to occur in the remaining years of the permit if the annual take rate stays the same)

Screenshots of inputs are provided in Appendix B, and results are summarized in Table 3-10.

Table 3-10. Summary of EofA outputs for the Covered Species from 2023 post-construction monitoring at the High Prairie Renewable Energy Center in Schuyler and Adair Counties, Missouri. Analysis done with a=0.5.

Species	Number of Detected Fatalities in 2023 (X)	Annual Take Estimate (M_{2023}) (95% CI)	Annual Take Rate (λ_{2023}) (95% CI)	Cumulative Take Estimate ($M_{2021\text{-}2023}$) (95% CI)	Projected Take Estimate[1]	Short-term Trigger Met?
Indiana bat	1	3 (1 - 8)	3.68 (0.263 – 11.54)	45 (23 – 81)	67.1 (43 – 101)	No, cannot infer λ > 12
Little brown bat	0	0 (0 – 3)	1.23 (0.001 – 6.18)	6 (1 – 20)	10.2 (3 – 26)	No, cannot infer λ > 16
Northern long-eared bat	0	0 (0 – 3)	1.23 (0.001 – 6.18)	1 (0 – 9)	2.3 (0 - 12)	No, cannot infer λ > 3

[1]Projected take estimate assumes that detection probability (g) will vary in future years to achieve goal of 0.2 over the 6-year term, but assumes no operational changes that would reduce risk (i.e., this is the estimate for the Project operating under the same protocols as 2023 for the remaining 3 years of the permit)

No new adaptive management triggers were met in 2023.

3.2.3 Comparison of GenEst and EofA Estimates for the Indiana Bat

GenEst estimated the Indiana bat fatalities for 2023 at 2.6 (95% CI: 1.0 – 8.6) compared to EofA, which estimated the Indiana bat fatalities for 2023 at 3 (95% CI: 1-8).

Ameren is continuing to investigate the relationship between EofA and GenEst to determine if improvements to the take estimation can be made and will follow-up with any additional analyses or discussion as appropriate.

3.3 DESIGN PROTOCOLS – FUTURE MONITORING

The HCP denotes a desired detection probability (g) of 0.2 over the 6-year permit term. The Project detection probability (g) was greater than the 0.2 needed for 2023. In 2024, a detection probability of at least 0.2 will again be targeted.

To design this monitoring, the following assumptions will be used:

- Searcher efficiency of 0.608 on full plots
- Searcher efficiency of 0.951 on roads and pads
- Carcass persistence of 2.03 days [average of 2023 road and pad values to be conservative]
- Area adjustment of 0.77 for full plots and 0.05 for roads and pads

Monitoring under the HCP (April 1 – October 31) will be limited to turbines that operate at night (defined as 45 minutes before sunset to 45 minutes after sunset). Any turbines that remain shut down at night for all or part of the bat active season (April 1 – October 31) will not require monitoring until such time that they become operational, and non-operational turbines will not be factored into calculations of g-value (which will be applied only to turbines and time periods of risk).

Because the operational plan remains flexible at this time, the post-construction monitoring plan will also remain flexible. Table 3-11 overviews the possible combinations of full plots to roads and pads and corresponding search intervals that would achieve a detection probability ≥ 0.2. These proportions of full plots to roads and pads are valid for any number of operational turbines (i.e., the number of total turbines searched does not impact the g-value, only the proportion of full plots to roads and pads).

Table 3-11. Overview of detection probability of possible post-construction monitoring protocols for 2024 for the High Prairie Renewable Energy Center in Schuyler and Adair Counties, Missouri. Bolded and green filled cells indicate protocols that achieve a detection probability of ≥0.2.

% Full Plots	% Roads and Pads	Search Interval 2X/week (I=3.5)	Search Interval 3X/week (I=2.5)	Search Interval 5X/week (I=1.5)
100%	0%	**0.233**	**0.291**	**0.38**
90%	10%	**0.222**	**0.277**	**0.360**
80%	20%	**0.209**	**0.259**	**0.335**
70%	30%	**0.194**	**0.240**	**0.308**
60%	40%	**0.176**	**0.217**	**0.278**

% Full Plots	% Roads and Pads	Search Interval 2X/week (I=3.5)	Search Interval 3X/week (I=2.5)	Search Interval 5X/week (I=1.5)
50%	50%	**0.156**	**0.192**	**0.244**
40%	60%	**0.134**	**0.164**	**0.207**

At a minimum, post-construction monitoring will need to include 40% full plots and 60% roads and pads searched five times a week, or 80% full plots and 20% roads and pads searches twice weekly, though Ameren may voluntarily choose to monitor at a higher level of effort (and thus achieving a higher g-value).

Searcher efficiency and carcass persistence trials will take place seasonally (if monitoring is occurring), and the preliminary results of these trials will be provided to USFWS and MDC in the seasonal summaries.

Section 8.1.3.2 of the HCP requires Ameren to contract with a 3rd party contractor to conduct the post-construction monitoring. Once Ameren signs a contract with a third-party contractor, the surety will be updated accordingly.

4.0 Summary and Discussion of 2023 Post-construction Bat Mortality Monitoring and Next Steps

- Post-construction monitoring occurred at a limited number of turbines that operated at night.
- A total of one Indiana bat was found during 2023 post-construction mortality monitoring. No adaptive management triggers were exceeded.
- One female Indiana bat was found; female Indiana bat fatalities will continue to be tracked and evaluated for adaptive management triggers.
- No little brown or northern long-eared bats were found, and no adaptive management was triggered for either species.
- The overall detection probability (g) in 2023 was 0.411. Post-construction monitoring will be implemented in 2024 at operational turbines with protocols designed to achieve a goal detection probability ≥0.2.
- The cumulative take estimates for the Covered Species at the end of the 2023 season were 45 Indiana bats (95% CI: 23-81), 6 little brown bats (95% CI: 1-20), and 1 northern long-eared bat (95% CI: 0-9) from 2021-2023.

- The cumulative take estimates (M*) have decreased each year of monitoring with a substantial decrease from 2022 to 2023. The calculation of M* is based on compiled multi-year detection probabilities (g) and fatalities; therefore, each year of additional data included in the EofA analysis at a higher g-value increases the overall detection probability and increases the precision of the model. Additionally, the ρ value (assumed relative mortality) for 2022 was updated in 2023 based on a more in-depth analysis of turbine operations data and acoustic bat data. The 2021 ρ value was set at 1 as the baseline year. Therefore, 2022 and 2023 ρ values are relative to 2021. The ρ value weights probability of detection and fatality between years; therefore, the combination of increased ρ value, increased detection probability (g), and decreased number of fatalities in 2023 (compared to 2021) lowers the overall M* over the three monitored years (2021 to 2023).

5.0 Literature Cited

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Dalthorp, D., Huso, M., Dalthorp, M. and Mintz, J., 2022. Accounting for the Fraction of Carcasses outside the Searched Area and the Estimation of Bird and Bat Fatalities at Wind Energy Facilities. arXiv preprint arXiv:2201.10064.

Appendix A Turbine-specific Density-Weighted Proportions

Turbine ID	DWP
A-01	0.77
A-02	0.71
A-03	0.77
A-04	0.72
A-06	0.77
A-08	0.79
A-09	0.77
B-01	0.82
B-03	0.02
B-04	0.02
B-05	0.79
B-06	0.79
B-07	0.8
B-08	0.77
B-09	0.77
B11	0.8
C-01	0.8
C02	0.77
C-03	0.09
C-04	0.7
C05	0.77
C-06	0.02
C-07	0.81
C-08	0.77
C09	0.77
C-10	0.7
C-11	0.77
C-12	0.69
C-13	0.77
D-02	0.7
D-03	0.77
D-04	0.77
D05	0.69
D-06	0.8

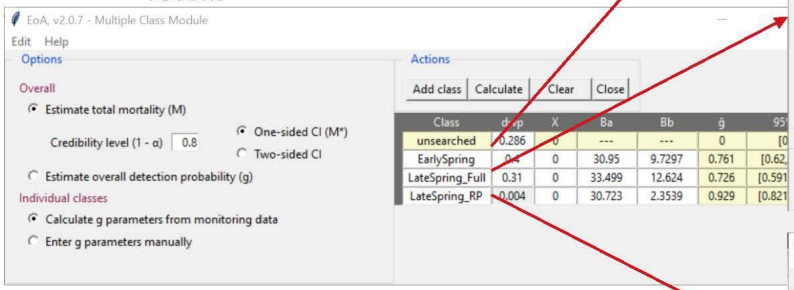
Turbine ID	DWP
D-07	0.77
D-08	0.7
D-09	0.84
D-10	0.02
D-11	0.02
D-12	0.7
D-13	0.02
E-01	0.82
E02	0.8
E-03	0.02
E-04	0.02
E-05	0.82
E-06	0.02
E-07	0.83
E-08	0.82
E-10	0.01
E-12	0.77
H-01	0.77
H-03	0.71
H-04	0.02
H-05	0.02
H-06	0.77
H-07	0.8

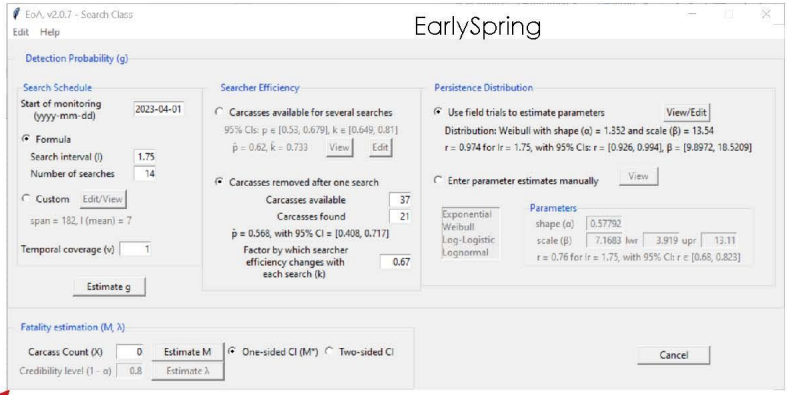
Appendix B Evidence of Absence Screenshots

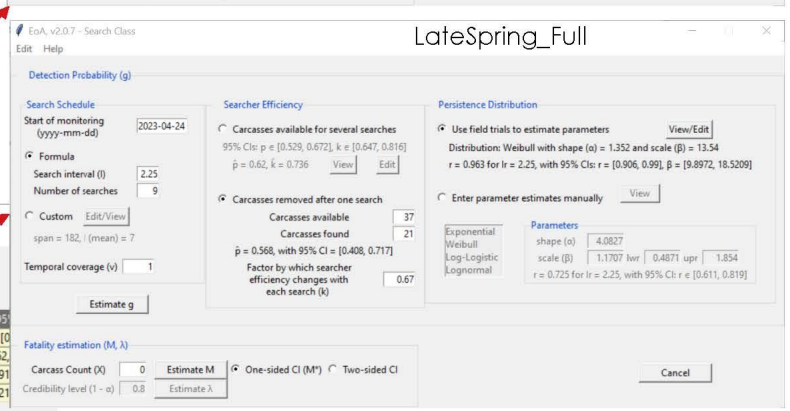
Summaries and screenshots of inputs for estimation of detection probability (g) and fatality estimates (M and λ) are provided on the following pages.

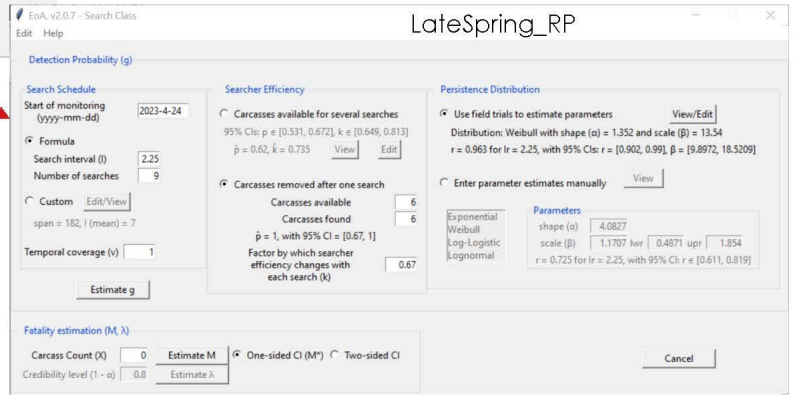
Spring 2023 Inputs

- Early spring:
  - Start date of 4/1/2023
  - Search interval of 1.68 days (rounded to 1.75)
  - Average of 14 visits per turbine
  - 21/37 SE trials found for full plots
- Late spring:
  - Start date of 4/24/2023
  - Search interval of 2.29 days (rounded to 2.25)
  - Average of 9 visits per turbine
  - 21/37 SE trials found for full plots
  - 6/6 SE trials found for roads and pads
- Same for both periods:
  - Temporal coverage of 100% of the season
  - K fixed at 0.67
  - Field trial CP data added by plot type, Weibull distribution chosen based on GenEst results









Additional information:

- 0 Covered Species found

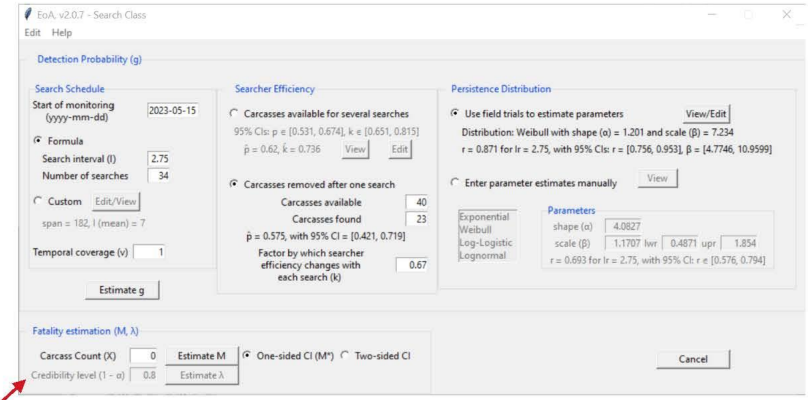
DWP assigned as follows:

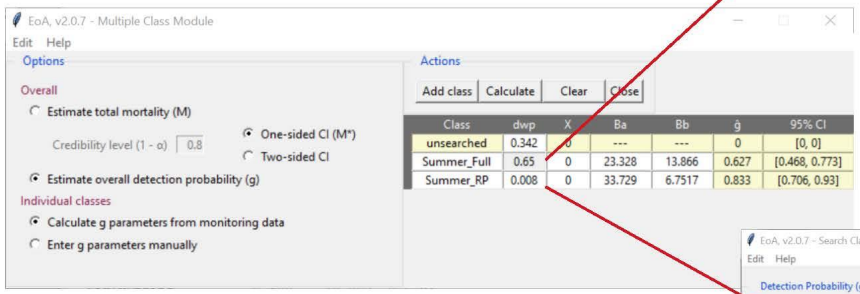
- Early spring = avg DWP for full (0.77) * 1 * 0.52 = 0.40
- Late spring Full = 0.77 * 0.84 * 0.48 = 0.31
- Late spring RP = avg DWP for RP (0.05) * 0.16 * 0.48 = 0.004
- Unsearched = 1-(0.4+0.004+0.31) = 0.286

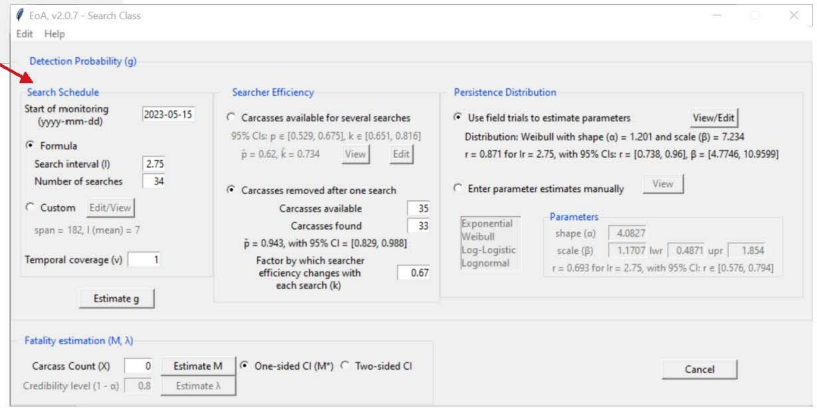
RESULTS: g = 0.533 (Ba = 119.6781, Bb = 104.7759)

Summer 2023 Inputs

- Start date of 5/15/2021
- Search interval of 2.71 days (rounded to 2.75)
- Average of 34 visits per turbine
- Temporal coverage of 100% of the season
- 33/35 SE trials found for full plots
- 23/40 SE trials found for roads and pads
- K fixed at 0.67
- Field trial CP data added by plot type, Weibull distribution chosen based on GenEst results







Additional information:

- 0 Covered Species found

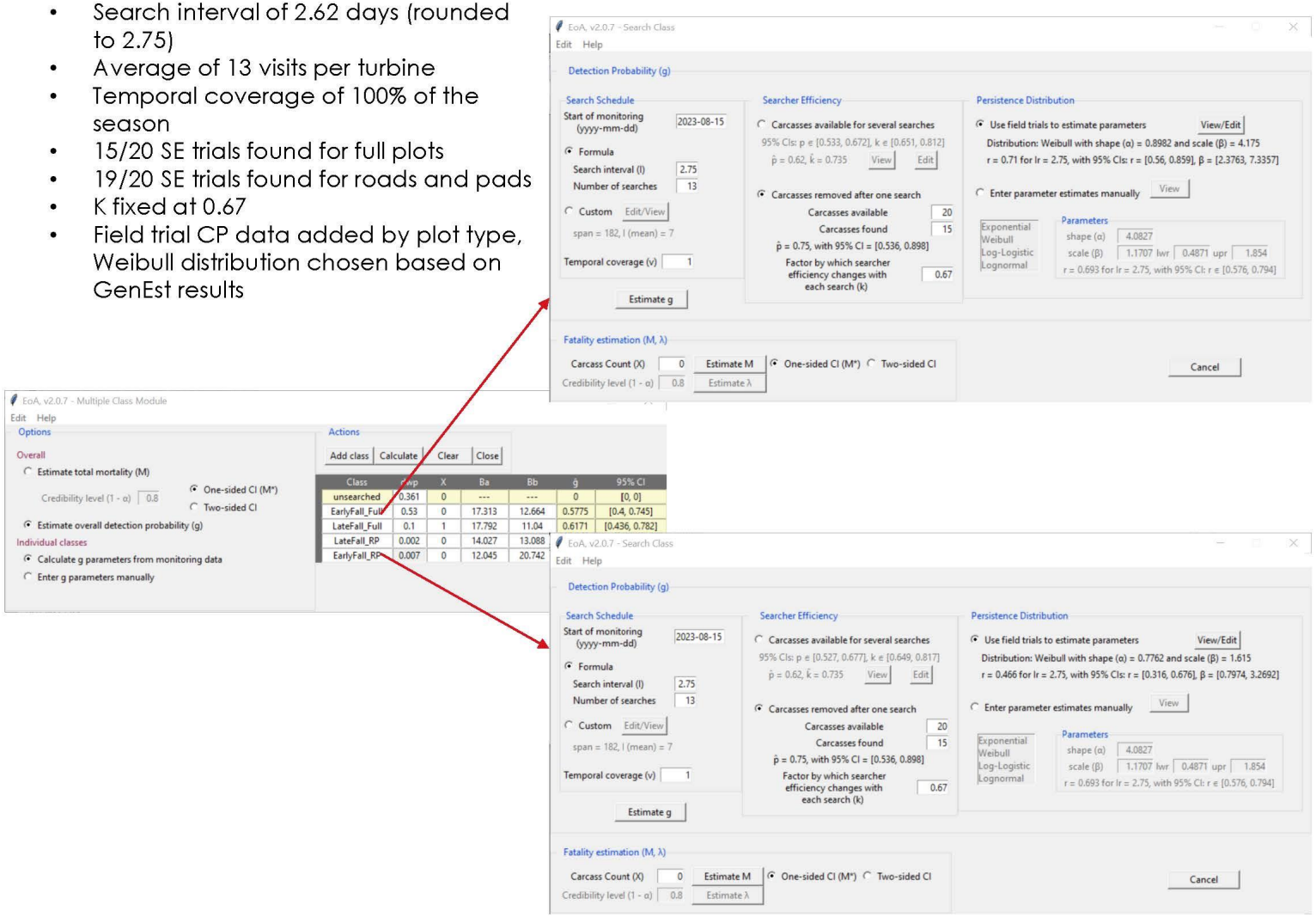
DWP assigned as follows:

- Full = avg DWP for full (0.77) * 0.84 = 0.65
- RP=avg DWP for RP (0.05) * 0.16 = 0.008
- Unsearched = 1-(0.65+0.008) = 0.342

RESULTS: g = 0.414 (Ba = 38.4557, Bb = 54.3552)

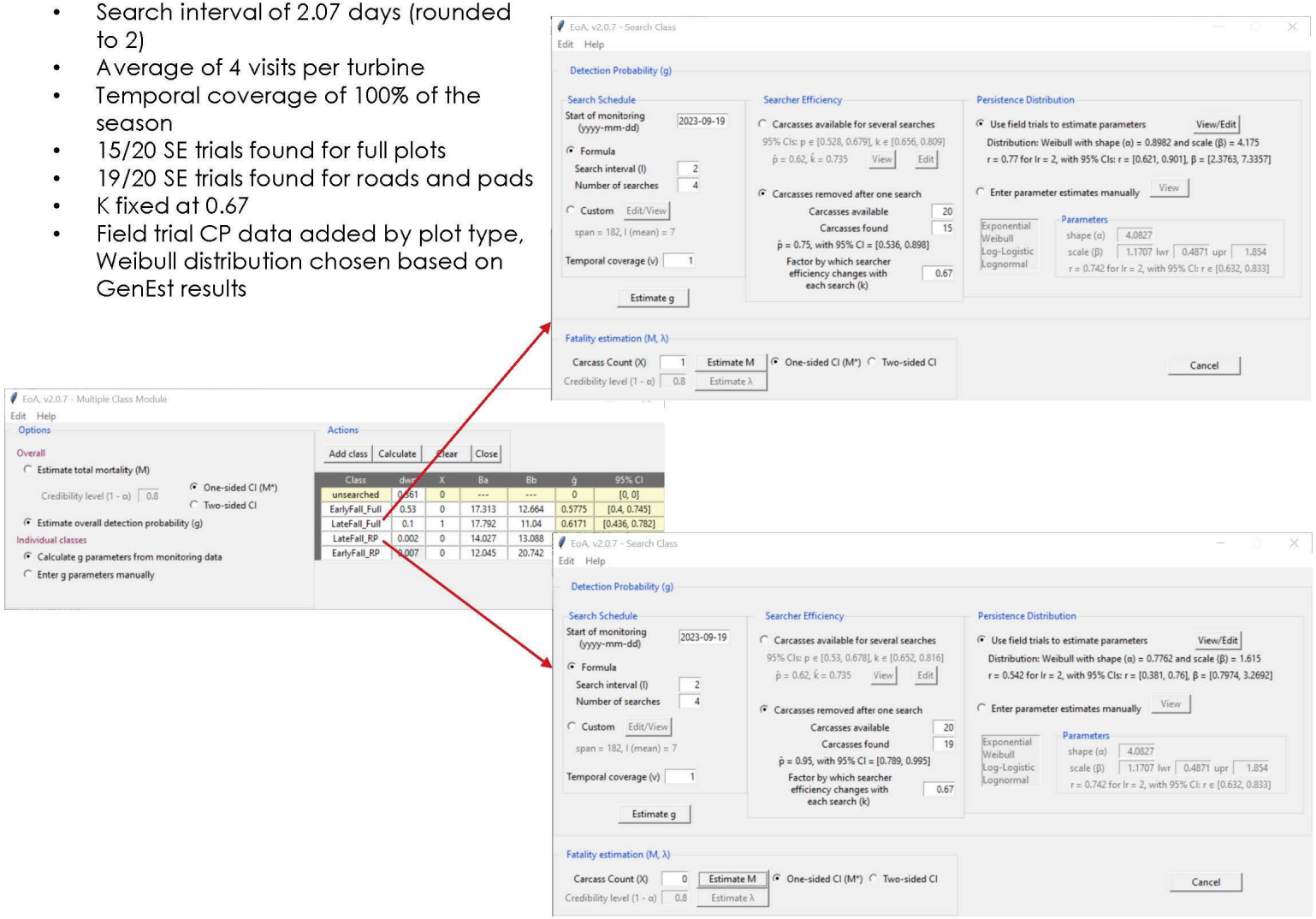
Early Fall 2023 Inputs

- Start date of 8/15/2021
- Search interval of 2.62 days (rounded to 2.75)
- Average of 13 visits per turbine
- Temporal coverage of 100% of the season
- 15/20 SE trials found for full plots
- 19/20 SE trials found for roads and pads
- K fixed at 0.67
- Field trial CP data added by plot type, Weibull distribution chosen based on GenEst results



Late Fall 2023 Inputs

- Start date of 9/19/2021
- Search interval of 2.07 days (rounded to 2)
- Average of 4 visits per turbine
- Temporal coverage of 100% of the season
- 15/20 SE trials found for full plots
- 19/20 SE trials found for roads and pads
- K fixed at 0.67
- Field trial CP data added by plot type, Weibull distribution chosen based on GenEst results



Full Fall 2023 Inputs

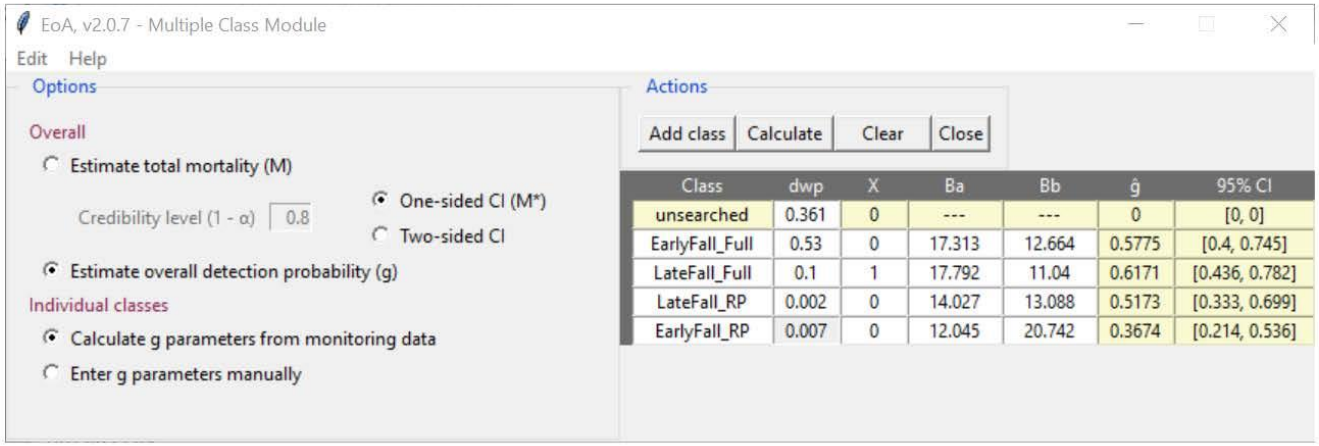
- See early and late fall pages

Additional information:

- 1 Indiana bat found in late fall at a full plot

DWP assigned as follows:

- EarlyFall_Full = avg DWP for full (0.77) * 0.84 * 0.825 = 0.53
- EarlyFall_RP=avg DWP for RP (0.05) * 0.16 * 0.825 = 0.007
- LateFall_Full = avg DWP for full (0.77) * 0.74 * 0.175= 0.1
- LateFall_RP=avg DWP for RP (0.05) * 0.26 * 0.175 = 0.002
- Unsearched = 1-(0.53+0.007+0.1+0.002) = 0.361

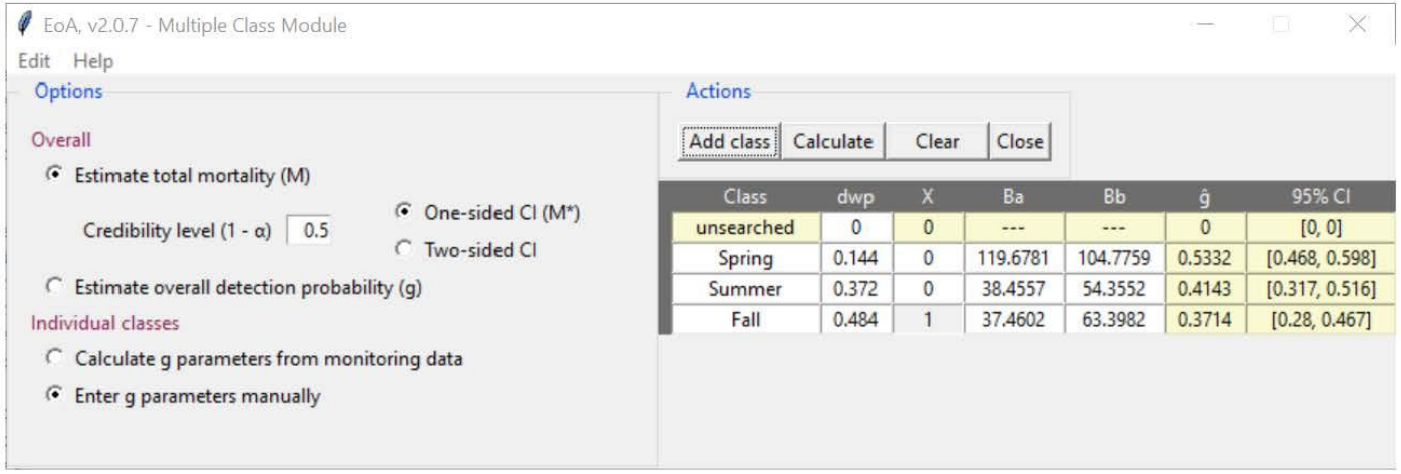


Class	dwp	X	Ba	Bb	ĝ	95% CI
unsearched	0.361	0	---	---	0	[0, 0]
EarlyFall_Full	0.53	0	17.313	12.664	0.5775	[0.4, 0.745]
LateFall_Full	0.1	1	17.792	11.04	0.6171	[0.436, 0.782]
LateFall_RP	0.002	0	14.027	13.088	0.5173	[0.333, 0.699]
EarlyFall_RP	0.007	0	12.045	20.742	0.3674	[0.214, 0.536]

RESULTS: g = 0.371 (Ba = 37.4602, Bb = 63.3982)

Full Year 2023 Inputs

- Input the beta parameters that were derived by season from the previous inputs, ran model separately for Indiana bats (shown in screenshot below), little brown bats (no fatalities) and northern long-eared bats (no fatalities)
- Assigned DWP based on the percent of total bat fatalities that occurred in each season, adjusted for search effort
    - Spring: 3 fatalities/0.533 g-value = 5.63 [DWP: 0.144]
    - Summer: 6 fatalities/0.414 g-value = 14.49 [DWP: 0.372]
    - Fall: 7 fatalities/0.371 g-value = 18.87 [DWP: 0.484]



Class	dwp	X	Ba	Bb	ĝ	95% CI
unsearched	0	0	---	---	0	[0, 0]
Spring	0.144	0	119.6781	104.7759	0.5332	[0.468, 0.598]
Summer	0.372	0	38.4557	54.3552	0.4143	[0.317, 0.516]
Fall	0.484	1	37.4602	63.3982	0.3714	[0.28, 0.467]

RESULTS: g = 0.411 (Ba = 107.8871, Bb = 154.8159)

Adaptive Management Analysis - 2023 Inputs (Multiple Years Module)

- Input the beta parameters that were derived for the entire year (Ba = 109.6041, Bb = 157.1161), as well as 2021 (Ba = 44.9804, Bb = 345.6797) and 2022 (Ba = 72.85, Bb = 81.53), ran model separately for Indiana bats (shown in screenshot below), little brown bats (1 fatality in 2021) and northern long-eared bats (no fatalities)
- Used "Estimate M" and "track past mortality" with credibility set to 0.5 to estimate M* and λ
- Used "Estimate M" and "Projection of future mortality and estimates" to estimate projected fatality, assuming the same reduction in fatality (ρ=0.2) as 2023, and a detection probability (g) of 0.2 (0.18-0.22) for a 6-year project with a mortality threshold of 72 Indiana bats, 96 little brown bats, or 18 northern long-eared bats
- Used "Estimate average annual fatality rate (λ)" and "short term rate (λ>τ)" for a term of 1 year and α=0.5 to determine if the short-term trigger had been exceeded, with an "Annual rate threshold (τ)" of 12 Indiana bats, 16 little brown bats, or 3 northern long-eared bats