Addendum: Technical Reports Volume II

2016-2017 Post-Construction Fatality Monitoring

MidAmerican Energy Company Iowa Wind Energy Portfolio:

Adams
May 2016 – May 2017

Prepared for:

MidAmerican Energy Company

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INTRODUCTION

MidAmerican Energy Company (MidAmerican Energy) has developed and currently operates a fleet of wind energy projects in Iowa with a combined 4,048 megawatts (MW) of nameplate capacity. Western EcoSystems Technology, Inc. (WEST) was retained to conduct standardized post-construction fatality monitoring at MidAmerican Energy's Iowa wind energy facilities consistent with Tier 4 of the U.S. Fish and Wildlife Service (USFWS) Land-Based Wind Energy Guidelines (USFWS 2012) and Stage 5 of the Eagle Conservation Plan Guidance (USFWS 2013). Standardized field studies were conducted to assess impacts to wildlife from operation of MidAmerican Energy's Iowa wind energy portfolio (WEST 2015).

This memo provides site-specific data that were collected using the bat-focused and eagle-focused study design at the Adams Wind Energy Facility (Adams). Bat-focused data were collected between May 16, 2016, and May 15, 2017, and eagle-focused data were collected between November 15, 2016, and May 15, 2017. Detailed methods and facility description were included in Bay et al. 2017a, 2017b.

METHODS

The primary objective of the post-construction fatality monitoring was to determine fatality estimates for bats and eagles at Adams. A secondary objective was to quantify fatality estimates for other birds in general. The monitoring protocol, which includes separate bat-focused and eagle-focused study designs, was developed in consultation with, and approved by, the USFWS Rock Island Field Office (see WEST 2015).

Bat-focused Searches

Bat-focused searches began May 16, 2016, and continued through May 15, 2017. From May 16 through November 15, 2016, searches were conducted on road and pads at approximately 80% of turbines (51 turbines; Figure 1). The remaining 13 turbines were searched using 10-meter (m; 33 feet [ft]) transects on square plots. Six of the square plots were 60 x 60 m (197 x 197 ft) in size, and the remaining seven were 100 x 100 m (328 x 328 ft; Figure 1). During this period, searches were conducted every three days.

Between November 15, 2016, and May 15, 2017, road and pad searches were conducted at all turbines, with searches occurring approximately every two weeks during winter (November 15 – March 14) and weekly during spring (March 15 – May 14). Detailed methods can be found in Bay et al. 2017b.

Eagle-focused Searches

Visual scans for eagles within 100-m (328 ft) of turbines were conducted every two weeks at all turbines from November 16, 2016, to May 14, 2017. Detailed methods are available in Bay et al. 2017a.

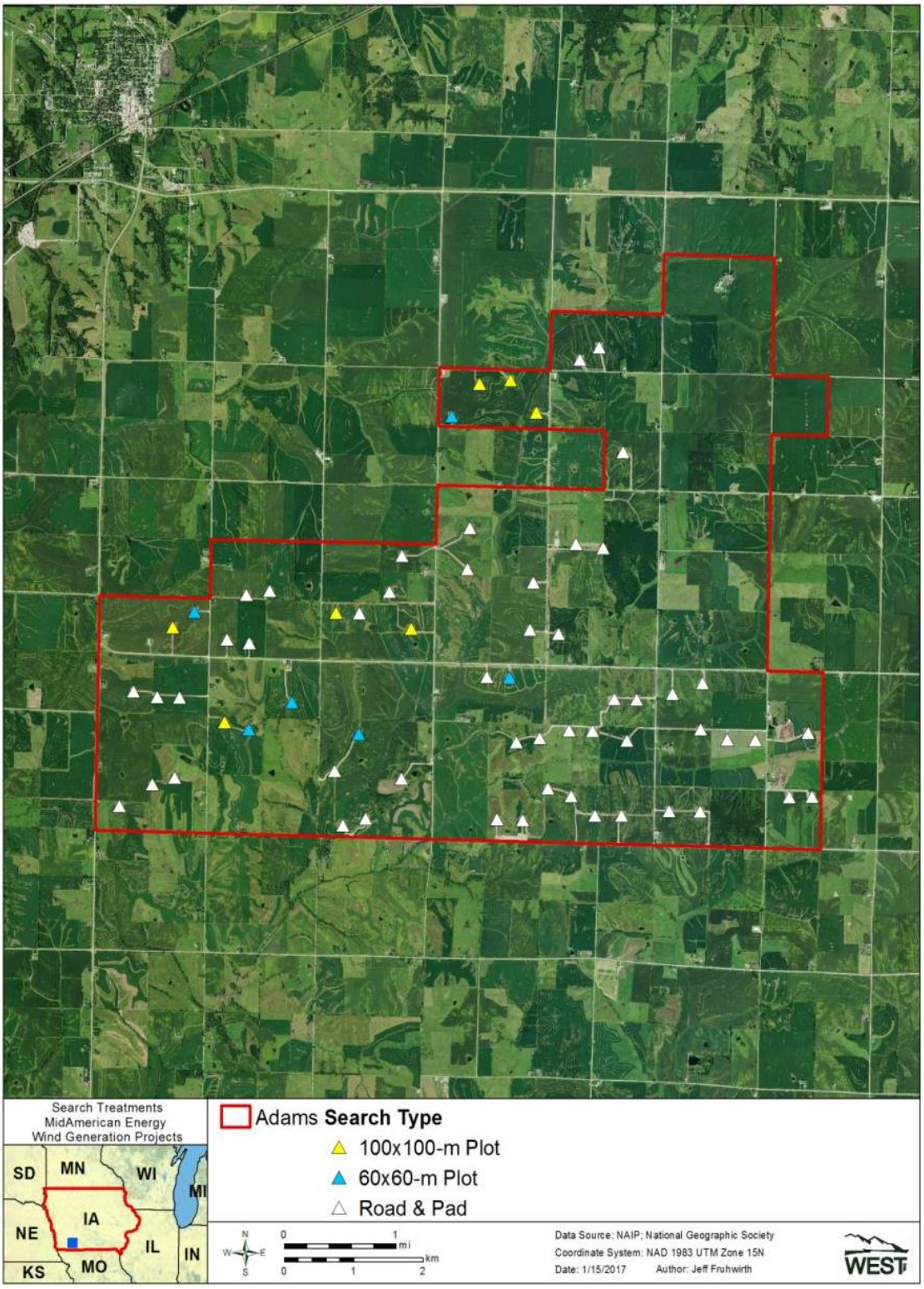


Figure 1. Search Treatments at the Adams Wind Energy Facility in Adams County, Iowa, from May 16, 2016, to November 16, 2016.

RESULTS

Bat-focused Searches

A total of 4,544 bat-focused searches were conducted at Adams during 76 visits between May 16, 2016, and May 15, 2017. Among these, 3,797 searches were on road/pad plots, 339 were on 60-m full plots, and 408 were on 100-m full plots (Table 1).

Table 1. Survey Effort, by Season and Plot Type, during the 2016-2017 Bat-focused Fatality Monitoring at the Adams Wind Energy Facility, Adams County, Iowa.

Plot Type	Summer		Fall		Winter		Spring	
	Visits	Surveys	Visits	Surveys	Visits	Surveys	Visits	Surveys
Road/Pad	21	965	41	1,949	5	309	9	574
60-m Full	21	117	41	222	0	0	0	0
100-m Full	21	144	41	264	0	0	0	0

Description of Observed Carcasses

A total of 194 bats were found during standardized searches or incidentally (Table 2). Three of the six bat species found accounted for 91.2% of all bat carcasses: eastern red bat (*Lasiurus borealis*; 81 carcasses), hoary bat (*Lasiurus cinereus*; 54 carcasses), and big brown bat (*Eptesicus fuscus*; 42 carcasses). Four tricolored bats (*Perimyotis subflavus*) were found. No federally or state-listed bat species and no *Myotis* bats were found.

Approximately 85% of bat carcasses included in the analysis were found within 30 m (98 ft) of a turbine (Figure 2). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features (Figure 3). Bat carcasses were primarily found at Adams from mid-May to mid-October, but at slightly higher rates between mid-July and late August (Figure 4).

Twenty-six bird carcasses representing 15 unique bird species were found during standardized searches or incidentally (Table 2). Four or fewer bird carcasses were found for any given species. The only raptor species found (red-tailed hawk [*Buteo jamaicensis*]; one carcass) was found outside of the search area and therefore not included in fatality estimation. No federally or state-listed bird species were found.

Of the bird carcasses included in the analysis, approximately 83% were found within 30 m of a turbine (Figure 5). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at Adams (Figure 6). Bird carcasses were found from mid-May to late July, and from early October through early December (Figure 7).

Table 2. Total Number of Carcasses and the Composition of Carcasses Discovered at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Species	Casualties Included		Casualties Off Plot		Clearing Search Casualties		Casualties Censored		Total	
	Total	% Comp	Total	% Comp	Total	% Comp	Total	% Comp	Total	% Comp
Bat										
eastern red bat	58	40.6	2	50.0	0	0	21	45.7	81	41.8
hoary bat	39	27.3	2	50.0	1	100.0	12	26.1	54	27.8
big brown bat	34	23.8	0	0	0	0	8	17.4	42	21.6
silver-haired bat	5	3.5	0	0	0	0	1	2.2	6	3.1
evening bat	4	2.8	0	0	0	0	3	6.5	7	3.6
tricolored bat	3	2.1	0	0	0	0	1	2.2	4	2.1
Overall Bats	**143**	**100**	**4**	**100**	**1**	**100**	**46**	**100**	**194**	**100**
Bird										
northern bobwhite	2	16.7	0	0	2	100	0	0	4	15.4
ring-necked pheasant	2	16.7	0	0	0	0	1	16.7	3	11.5
European starling	1	8.3	1	16.7	0	0	1	16.7	3	11.5
golden-crowned kinglet	1	8.3	0	0	0	0	0	0	1	3.8
horned lark	1	8.3	1	16.7	0	0	0	0	2	7.7
killdeer	1	8.3	0	0	0	0	0	0	1	3.8
ruby-crowned kinglet	1	8.3	0	0	0	0	1	16.7	2	7.7
red-eyed vireo	1	8.3	0	0	0	0	0	0	1	3.8
unidentified passerine	1	8.3	0	0	0	0	0	0	1	3.8
yellow warbler	1	8.3	0	0	0	0	0	0	1	3.8
blue jay	0	0	1	16.7	0	0	0	0	1	3.8
red-tailed hawk	0	0	1	16.7	0	0	0	0	1	3.8
turkey vulture	0	0	2	33.3	0	0	0	0	2	7.7
unidentified swallow	0	0	0	0	0	0	1	16.7	1	3.8
unidentified wren	0	0	0	0	0	0	1	16.7	1	3.8
yellow-billed cuckoo	0	0	0	0	0	0	1	16.7	1	3.8
Overall Birds	**12**	**100**	**6**	**100**	**2**	**100**	**6**	**100**	**26**	**100**

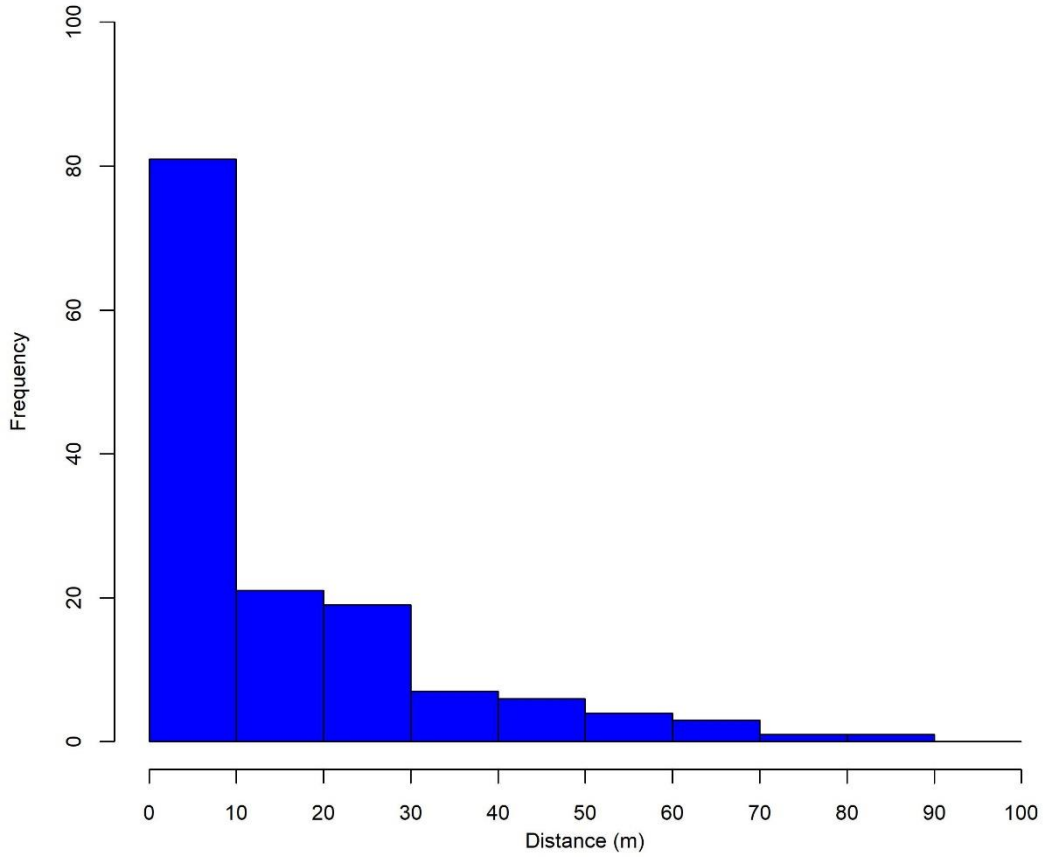


Figure 2. Distance of Bat Carcasses Included in the Analysis from each given Search Turbine at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

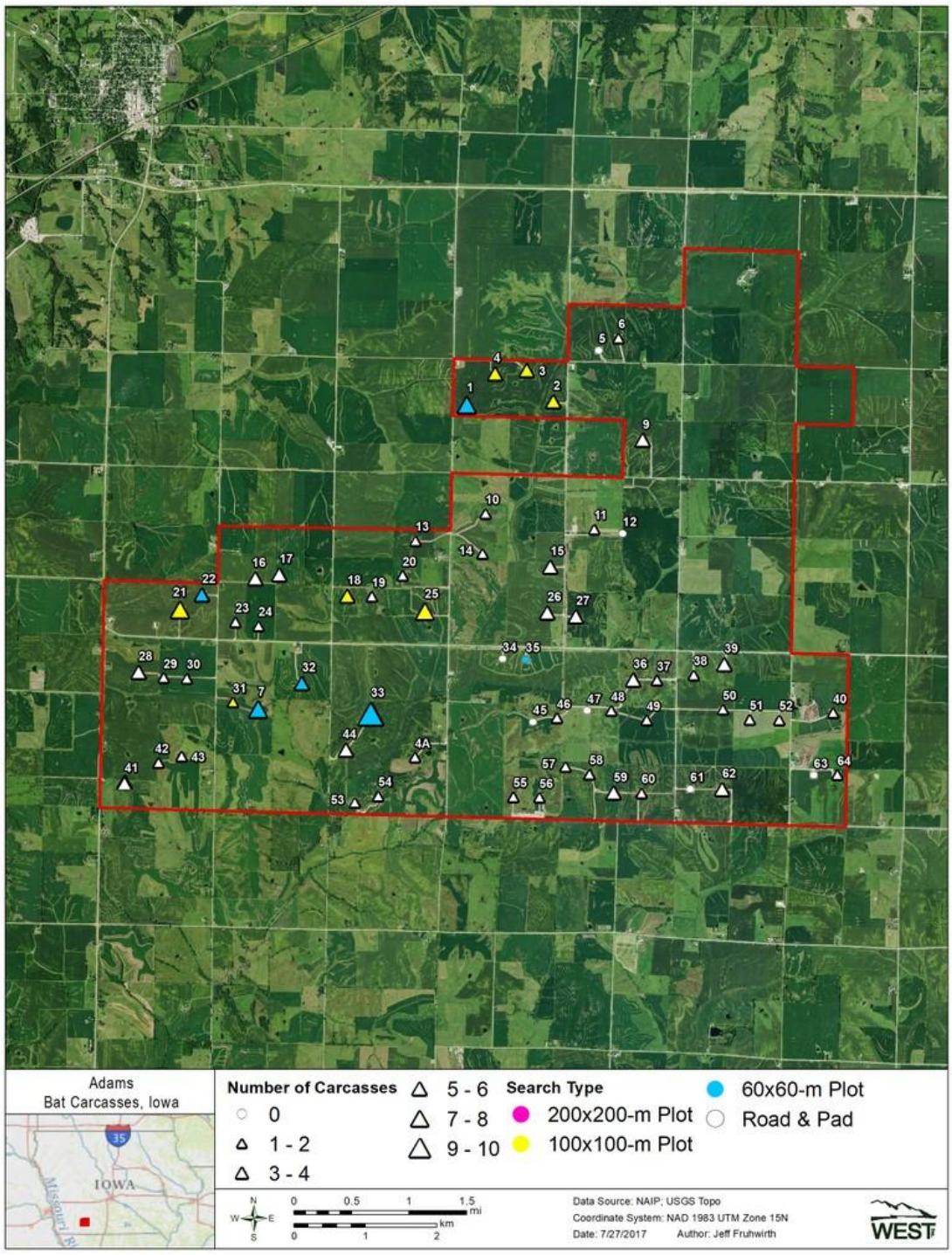


Figure 3. Locations of All Bat Carcasses Found and Included in Analysis at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

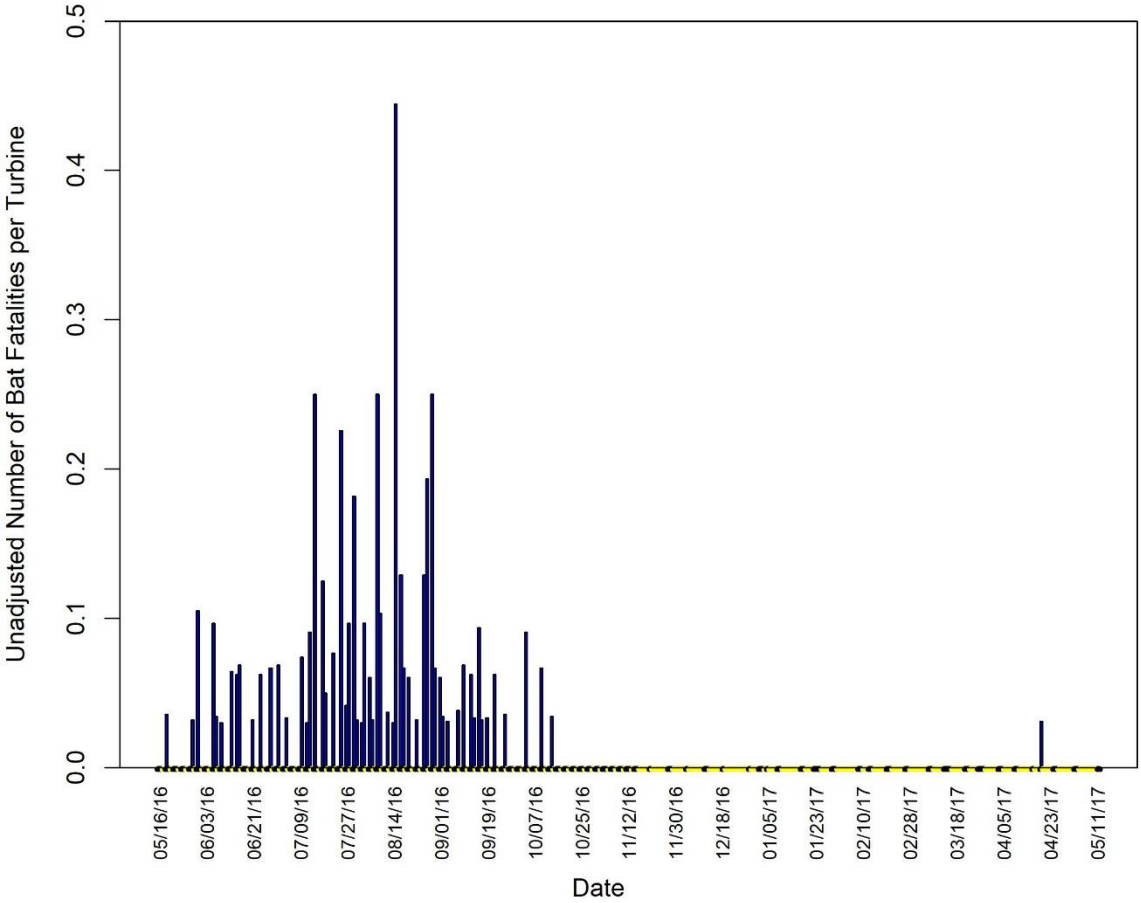


Figure 4. The Unadjusted Number of Bat Carcasses Included in the Analysis per Search for the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017. Yellow Marks on the X-Axis Indicate Days When No Searches Were Conducted.

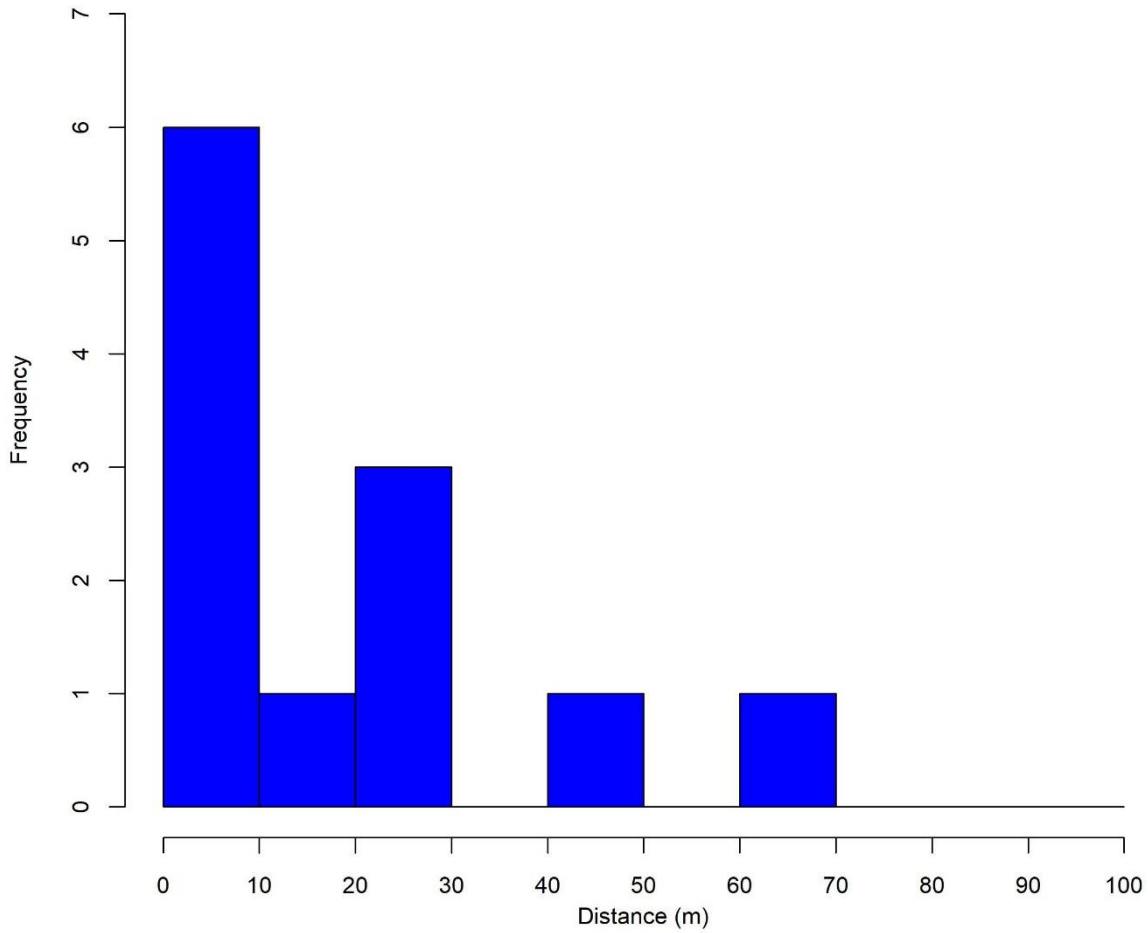
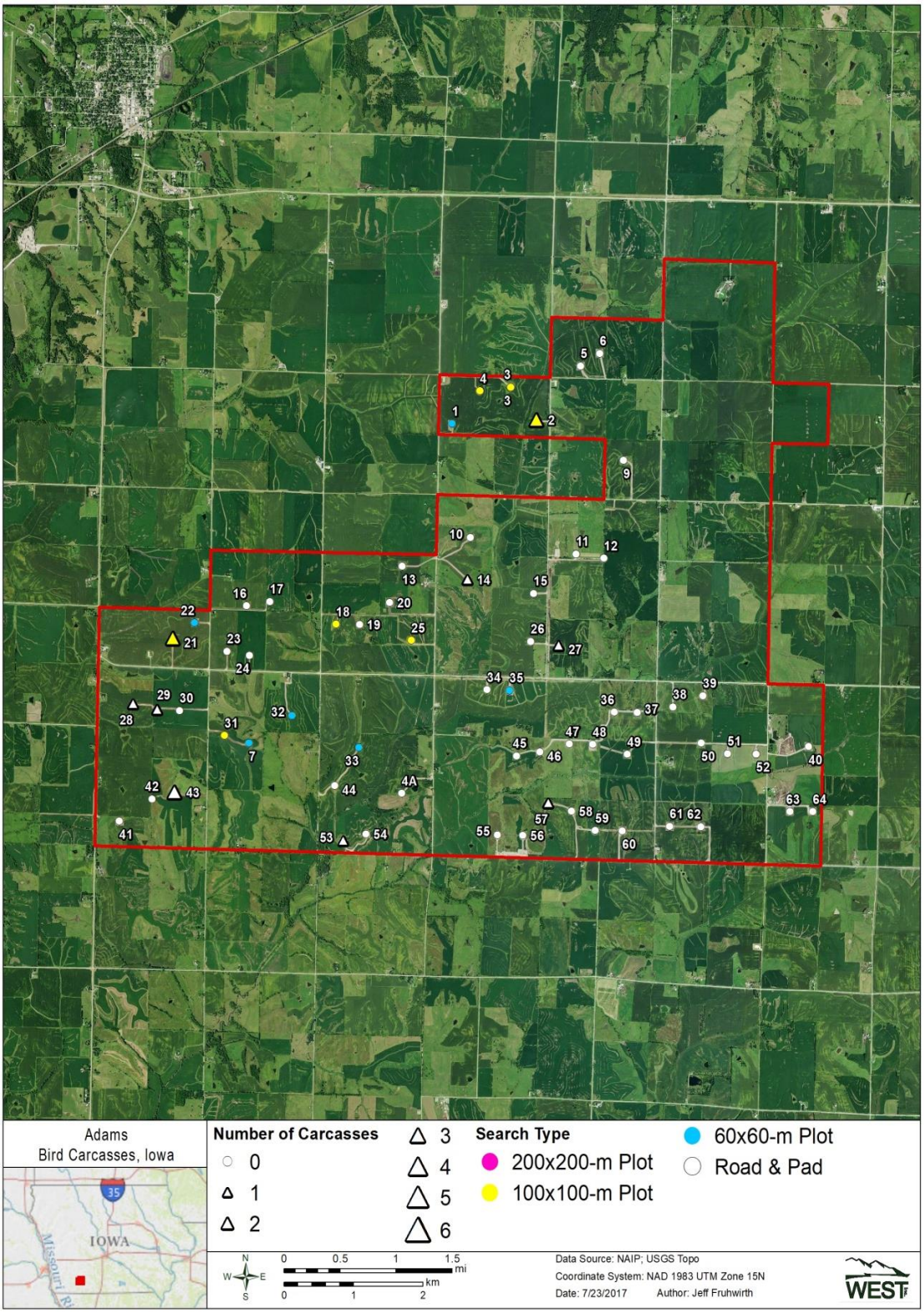


Figure 5. Distance of Bird Carcasses Included in the Analysis from Each Given Search Turbine at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.



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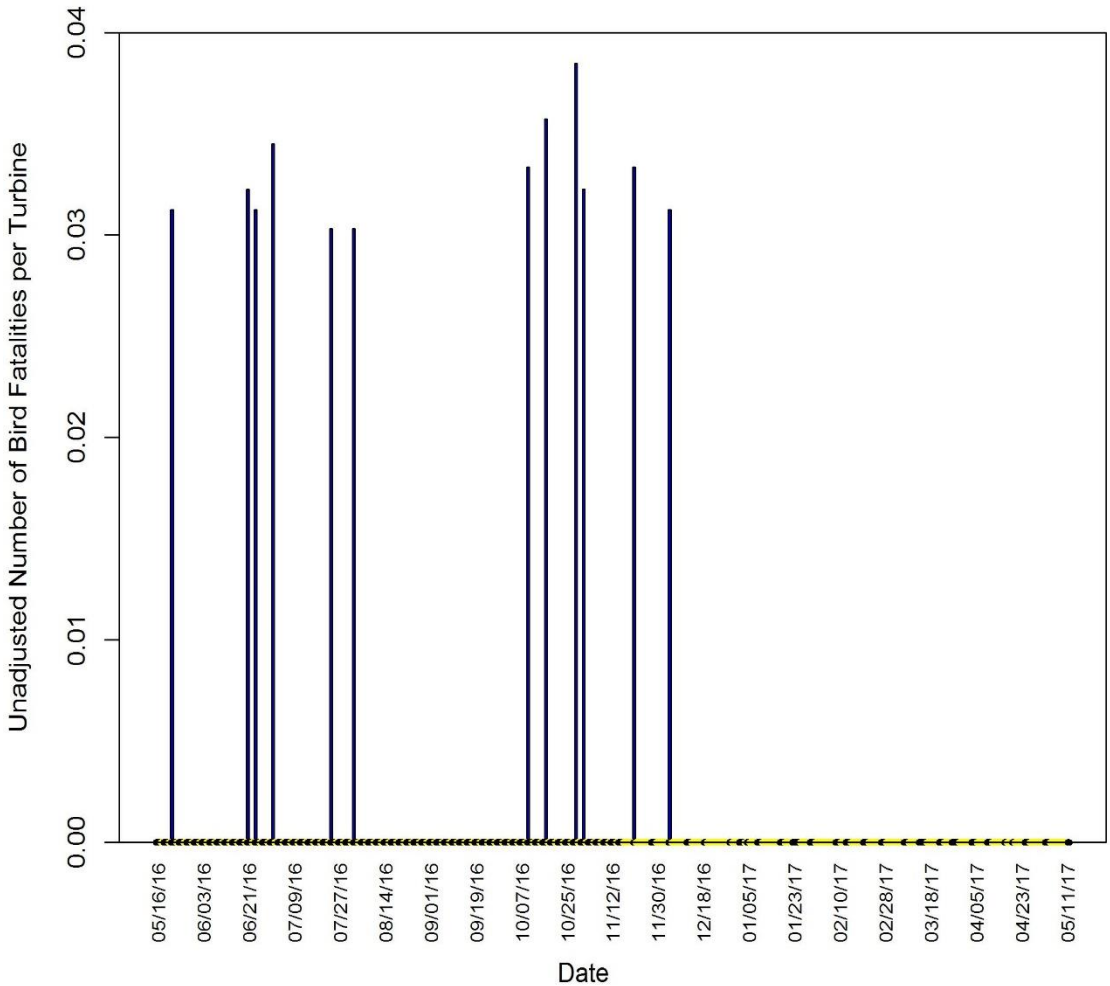

Figure 7. The Unadjusted Number of Bird Carcasses Included in the Analysis per Search for the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2015, to May 15, 2017. Yellow Marks on the X-Axis Indicate Days When No Searches Were Conducted.

Fatality Estimation

Censored Carcasses

Of the 194 bat carcasses found, 51 were excluded from the fatality rate estimation (Table 2). Four were excluded from fatality rate estimation because they were not on search plots, and one was found during the clearing search (Table 2). Among the remaining 189 bat carcasses, 91.1% of bats had an estimated time of death within seven days (Table 3). Forty-six bat carcasses had an estimated time of death outside the search interval and were censored from the analysis (Table 2). The remaining 143 bat carcasses were included in the fatality rate estimation (Table 2).

Of the 26 bird carcasses found, six bird carcasses were removed from the analysis because they were found outside the search plots, and an additional two were found during the clearing searches (Table 2). Among the remaining 18 bird carcasses, more

than 85% had an estimated time of death within seven days (Table 3). Six bird carcasses had an estimated time of death outside the search interval and were censored from the analysis (Table 2). The remaining 12 bird carcasses were included in the fatality rate estimation (Table 2).

Table 3. Estimated Time Since Death for Carcasses Found on Search Plots at the Adams Wind Energy Facility from May 16, 2016, to May 15, 2017.

Size Class	Estimated Time Since Death	# of Carcasses	% Composition
Bat	last night	89	47.1
	2-3 days	50	26.5
	4-7 days	33	17.5
	7-14 days	12	6.3
	> 2 weeks	5	2.6
	> 1 month	0	0
	unknown	0	0
Large Bird	last night	1	14.3
	2-3 days	4	57.1
	4-7 days	1	14.3
	7-14 days	0	0
	> 2 weeks	0	0
	> 1 month	1	14.3
	unknown	0	0
Small Bird	last night	3	27.3
	2-3 days	4	36.3
	4-7 days	3	27.3
	7-14 days	1	9.1
	> 2 weeks	0	0
	> 1 month	0	0
	unknown	0	0

Searcher Efficiency

A total of 245 carcasses (120 bats, 65 large birds, and 60 small birds) were placed in the search area for searcher efficiency trials between May 16, 2016, and May 15, 2017 (Tables 4 and 5). Logistic regression was used to model searcher efficiency, and model selection was based on corrected Akaike Information Criterion (AICc; Burnham and Anderson 2002; Table 6). Estimates were presented by season and plot type only if those variables were included in the selected model. For both bats and small birds, the selected model included plot type (Table 6). The searcher efficiency rate for bats was 0.84 on road/pad plots and 0.41 on full plots (Table 7). For small birds, the searcher efficiency rate was 0.81 on road/pad plots and 0.29 on full plots. No response variables were included in the selected model for large birds (Table 6), resulting in an overall searcher efficiency rate of 0.93 (Tables 6 and 7).

Table 4. Searcher Efficiency Results at the Adams Wind Energy Facility as a Function of Season and Carcass Size.

Size Class	Season	# Placed	# Available	# Found	% Found
Bat	Summer	50	49	33	67.4
	Fall	50	47	31	66.0
	Spring	20	19	16	84.2
	Overall	**120**	**115**	**80**	**69.6**
Large Bird	Summer	20	20	18	90.0
	Fall	20	20	19	95.0
	Winter	10	10	10	100
	Spring	15	15	12	90.0
	Overall	**65**	**65**	**59**	**90.8**
Small Bird	Summer	20	19	10	52.6
	Fall	20	18	12	66.7
	Winter	10	10	9	90.0
	Spring	10	10	8	80.0
	Overall	**60**	**57**	**39**	**68.4**

Table 5. Searcher Efficiency Sample Size by Size Class, Plot Type, and Season, at the Adams Wind Energy Facility, Adams County, Iowa, From May 16, 2016, to May 15, 2017.

Size Class	Plot Type	Summer	Fall	Winter	Spring
Bat	Road/Pad	33	24	-	19
	Full Plot	16	23	-	-
Large Bird	Road/Pad	14	10	10	10
	Full Plot	6	10	-	-
Small Bird	Road/Pad	13	10	10	10
	Full Plot	6	8	-	-

Table 6. Model Selection for Searcher Efficiency Data Collected at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016 to May 15, 2017 (Selected Models are Represented by Bold AICc Values).

Covariate	AICc Value		
	Bat	Large Bird	Small Bird
No Covariate	143.4	**31.5**	73.2
Plot Type	**123.2**	32.5	**62.3**
Season	145.0	36.2	74.5
Plot Type + Season	127.0	37.3	66.3
Plot Type + Season + (Plot Type * Season)	129.2	-	-

Table 7. Searcher Efficiency Rates for Each Size Class Based on Bias Trials Conducted at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Size Class	Searcher Efficiency Rate		
	Road/Pad Plots	Full Plots	Combined
Bat	0.84	0.41	-
Large Bird	-	-	0.93
Small Bird	0.81	0.29	-

Carcass Removal

A total of 253 carcasses (116 bats, 77 large birds, and 60 small birds) were placed in the project area for carcass removal trials during the monitoring period (Table 8). The Huso method (Huso 2011, Huso et al. 2012) was used for calculating carcass removal rates and the average probability of persistence. As with searcher efficiency, model selection was based on AICc; however, multiple distributions were tested in addition to the variables

(Table 9). The selected model included no covariates for bats and used a Weibull distribution. The model included no covariates and used an exponential distribution for both large and small birds (Table 9). The average carcass removal times were 3.3 days for bats, 4.3 days for large birds, and 2.9 days for small birds (Table 10).

Table 8. Carcass Removal Sample Size by Size Class, Plot Type, and Season at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Size Class	Plot Type	Summer	Fall	Winter	Spring
Bat	Road/Pad	29	27	-	10
	Full Plot	21	29	-	-
Large Bird	Road/Pad	11	11	18	13
	Full Plot	12	12	-	-
Small Bird	Road/Pad	10	10	10	10
	Full Plot	10	10	-	-

Table 9. Model and Distribution Selection for Carcass Removal Data Collected at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017 (Selected Models are in Bold Font).

Bat			Large Bird			Small Bird		
Covariates	**Distribution**	**AICc**	**Covariates**	**Distribution**	**AICc**	**Covariates**	**Distribution**	**AICc**
season	Weibull	442.3	**no covariates**	**Exponential**	**300.1**	no covariates	Lognormal	214.8
no covariates	**Weibull**	**443.2**	plot type	Exponential	300.8	**no covariates**	**Exponential**	**215.2**
plot type + season	Weibull	443.7	no covariates	Lognormal	301.6	no covariates	Loglogistic	215.6
plot type	Weibull	445.2	no covariates	Weibull	302.2	no covariates	Weibull	215.9
plot type + season + plot type*season	Weibull	448.2	plot type	Weibull	303.0	plot type	Exponential	216.2
season	Exponential	449.3	no covariates	Loglogistic	303.3	plot type	Lognormal	216.9
no covariates	Lognormal	449.8	plot type	Lognormal	303.6	plot type	Weibull	217.3
season	Lognormal	450.1	plot type + season	Exponential	305.1	season	Lognormal	217.5
plot type + season	Exponential	450.1	plot type	Loglogistic	305.3	plot type	Loglogistic	217.8
plot type + season	Lognormal	451.6	season	Lognormal	305.5	season	Loglogistic	217.9
plot type	Lognormal	451.7	season	Exponential	305.5	season	Exponential	218.7
no covariates	Loglogistic	453.3	plot type + season	Lognormal	306.3	plot type + season	Lognormal	219.9
no covariates	Exponential	453.5	season	Loglogistic	307.0	plot type + season	Loglogistic	220
season	Loglogistic	453.9	plot type + season	Weibull	307.4	season	Weibull	220.1
plot type + season + plot type*season	Exponential	454.5	season	Weibull	307.8	plot type + season	Exponential	220.5
plot type	Exponential	455.3	plot type + season	Loglogistic	307.9	plot type + season	Weibull	222.2
plot type	Loglogistic	455.3						
plot type + season	Loglogistic	455.5						
plot type + season + plot type*season	Lognormal	456.1						
plot type + season + plot type*season	Loglogistic	460.0						

Table 10. Carcass Removal Top Models With Covariates, Distributions, and Model Parameters for the Adams Wind Energy Facility, Adams County, Iowa.

Size	No Covariates	Distribution	Predicted Values	Scale
Bat	Yes	Weibull	3.3	1.3
Large Bird	Yes	Exponential	4.3	1.0
Small Bird	Yes	Exponential	2.9	1.0

Search Area Adjustment

Sufficient numbers of bat carcasses were found to fit distributions separately for each facility, and these distributions were combined with the proportion of area searched to produce an area correction for bats. A Weibull distribution was selected for bats (Table 11). There were insufficient numbers of small or large birds found at Adams to fit facility-specific bird distributions; therefore, area corrections for birds were produced on a fleet-wide basis, combining data collected at Adams from May 16 to November 16, 2016, and the nine facilities searched between November 16, 2015, and November 16, 2016 (*see* Bay et al. 2017b).

Table 11. Distribution Selection for the Search Area Adjustment for Bats at the Adams Wind Energy Facility, Adams County, Iowa.

Distribution	Parameter1	Parameter2	DeltaAIC
Weibull	1.20	38.56	0
Gompertz	0.01	0.02	4.12
Gamma	1.28	0.03	4.52
Normal	(-)5.28	44.89	12.44
Rayleigh	28.34	NA	2092.27

The area correction value for each plot type is listed in Appendix A. The search area adjustment was largest on road/pad plots and smallest for 100-m full plots for all size classes. Bat search area adjustment values ranged from 0.17 on road/pad plots to 0.77 on 100-m full plots. Small bird search area adjustments ranged from 0.08 to 0.58, while large bird adjustments ranged from 0.05 to 0.52 (Appendix A).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, and all birds, with 90% confidence intervals calculated when at least five carcasses were found (Appendix A). Separate estimates were calculated for each plot type based on plot-specific parameters (e.g., area correction, searcher efficiency, carcass removal, and observed number of carcasses; Appendix A). Each plot-specific estimate was then combined to produce an overall estimate. Table 12 provides a per-turbine fatality estimate. The overall adjusted per-MW bat fatality rate was 9.40 bats/MW/year. The adjusted all bird fatality rate was 4.59 birds/MW/year, of which the small bird estimate was 2.47 small birds/MW/year and the large bird estimate was 2.12 large birds/MW/year (Table 13). A complete list of carcasses discovered at Adams can be found in Appendix B.

Table 12. Overall Fatality Rates per Turbine, by Plot Type and Overall, for Studies Conducted at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Plot Type	Overall	
	Estimate	90% CI
Bat - Road/Pad_100	17.16	14.02 - 21.10
Bat - Full Plot_60	36.12	19.54 - 59.75
Bat - Full Plot_100	19.68	13.19 - 32.01
Bat - Overall	**22.69**	**18.99 - 28.04**
Small Bird - Road/Pad_100	5.67	0.47 - 14.57
Small Bird - Full Plot_60	0	-
Small Bird - Full Plot_100	2.76	-
Small Bird - Overall	**5.97**	**0.85 - 15.07**
Large Bird - Road/Pad_100	5.03	-
Large Bird - Full Plot_60	0	-
Large Bird - Full Plot_100	0.82	-
Large Bird - Overall	**5.12**	**0.40 - 14.96**
All Birds - Road/Pad_100	10.70	2.23 - 22.98
All Birds - Full Plot_60	0	-
All Birds - Full Plot_100	3.58	-
All Birds - Overall	**11.09**	**2.65 - 23.41**

Table 13. Overall Fatality Rates per Megawatt, by Plot Type and Overall, for Studies Conducted at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Plot Type	Overall	
	Estimate	90% CI
Bat - Road/Pad_100	7.10	5.80 - 8.74
Bat - Full Plot_60	14.95	8.09 - 24.74
Bat - Full Plot_100	8.15	5.46 - 13.25
Bat - Overall	**9.40**	**7.86 - 11.61**
Small Bird - Road/Pad_100	2.35	0.20 - 6.03
Small Bird - Full Plot_60	0	-
Small Bird - Full Plot_100	1.14	-
Small Bird - Overall	**2.47**	**0.35 - 6.24**
Large Bird - Road/Pad_100	2.08	-
Large Bird - Full Plot_60	0	-
Large Bird - Full Plot_100	0.34	-
Large Bird - Overall	**2.12**	**0.17 - 6.19**
All Birds - Road/Pad_100	4.43	0.92 - 9.52
All Birds - Full Plot_60	0	-
All Birds - Full Plot_100	1.48	-
All Birds - Overall	**4.59**	**1.10 - 9.69**

Eagle-focused Searches

A total of 756 eagle-focused searches were conducted during 12 visits between November 16, 2016, and May 15, 2017. No eagle carcasses were found during searches.

Searcher Efficiency

A total of 30 carcasses (25 turkey decoys and five red-tailed hawks) were placed in the search area for searcher efficiency trials (Table 14). Red-tailed hawks were placed only in the spring of 2017. The selected model included season as a covariate (Table 15). Searcher efficiency was 0.95 during the winter season and 0.60 during the spring season (Table 14).

Table 14. Searcher Efficiency Results at the Adams Wind Energy Facility as a Function of Season at the Adams Wind Energy Facility, Adams County, Iowa, from November 16, 2016 to May 15, 2017.

Surrogate Type	Season	# Placed	# Available	# Found	Searcher Efficiency Rate
Turkey Decoy and Raptors	Winter	20	20	19	0.95
	Spring	10	10	6	0.60

Table 15. Model Selection for Searcher Efficiency Data Collected at the Adams Wind Energy Facility, Adams County, Iowa, from November 16, 2016 to May 15, 2017 (Selected Models are Represented by Bold AICc Values).

Covariate	AICc Value
	Eagle Surrogate
No Covariate	29.2
Season	**25.8**

Carcass Removal

Upon analysis of carcass removal trials, it was determined that there was no significant difference between carcass removal rates of large birds surrogate carcasses (rock pigeons [*Columba livia*] and common quails [*Coturnix coturnix*]) and the eagle surrogate carcasses (ring-necked pheasants [*Colchicus phasianus*] and mallards [*Anas platyrhynchos*]; see Bay et al. 2016). Therefore, large bird data were pooled with the surrogate species to provide a larger sample size for calculating carcass removal rates. The number and type of species used are presented in Table 16.

Table 16. The Species[1] and Number used for the Carcass Removal Trials at the Adams Wind Energy Facility, Adams County, Iowa, from November 16, 2016, to May 15, 2017.

COQU	MALL	RNPH	ROPI	Total
3	1	10	17	31

[1]COQU = common quail (*Coturnix coturnix*); MALL = mallard (*Anas platyrhynchos*); RNPH = ring-necked pheasant (*Colchicus phasianus*); ROPI = rock pigeon (*Columba livia*);

The selected model included no covariates and used a loglogistic distribution (Table 17). The average carcass removal time for eagle surrogates was 3.2 days (Table 18).

Table 17. Model and Distribution Selection for Carcass Removal Data Collected at the Adams Wind Energy Facility, Adams County, Iowa, from November 16, 2016, to May 15, 2017 (Selected Models are in Bold Font).

Covariates	Distribution	AICc	Delta.AICc
no covariate	**Loglogistic**	**121.1**	**0**
no covariate	Lognormal	121.2	0.15
no covariate	Exponential	122.6	1.51
Season	Loglogistic	123.0	1.95
Season	Lognormal	123.6	2.52
no covariate	weibull	124.0	2.94
Season	exponential	124.9	3.79
Season	weibull	126.4	5.34

Table 18. Carcass Removal Top Models With Covariates, Distributions, and Model Parameters for the Adams Wind Energy Facility, Adams County, Iowa.

No Covariates	Distribution	Predicted Values	Scale
Yes	loglogistic	3.2	0.5

Area Correction

An area correction was calculated for the 100-m visual scan carcass searches to account for the proportion of the total area within 100 m of each turbine that was visible. Area correction values represent a proportion and therefore do not have associated units. The area correction estimates the probability that a carcass will land in searched area, which was 0.71 at Adams.

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Appendix A: Estimated Fatality Rates and Correction Factors, with 90% Confidence Intervals, for Studies Conducted at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017

Appendix A. Estimated Fatality Rates and Correction Factors, with 90% Confidence Intervals, for Studies Conducted at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Parameter	Summer		Fall		Winter		Spring	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Search Area Adjustment								
A (Bat - Road/Pad_100)	0.17	0.11 - 0.22	0.17	0.11 - 0.22	0.17	0.11 - 0.22	0.17	0.11 - 0.22
A (Bat - Full Plot_60)	0.55	0.40 - 0.69	0.55	0.40 - 0.69				
A (Bat - Full Plot_100)	0.77	0.60 - 0.90	0.77	0.60 - 0.90				
A (Small Bird - Road/Pad_100)	0.08	0.07 - 0.10	0.08	0.07 - 0.10	0.08	0.07 - 0.10	0.08	0.07 - 0.10
A (Small Bird - Full Plot_60)	0.30	0.26 - 0.36	0.30	0.26 - 0.36				
A (Small Bird - Full Plot_100)	0.58	0.54 - 0.65	0.58	0.54 - 0.65				
A (Large Bird - Road/Pad_100)	0.05	0.04 - 0.07	0.05	0.04 - 0.07	0.05	0.04 - 0.07	0.05	0.04 - 0.07
A (Large Bird - Full Plot_60)	0.22	0.17 - 0.28	0.22	0.17 - 0.28				
A (Large Bird - Full Plot_100)	0.52	0.44 - 0.62	0.52	0.44 - 0.62				
Observer Detection Rate								
P (Bat - Road/Pad_100)	0.84	0.77 - 0.91	0.84	0.77 - 0.91	0.84	0.77 - 0.91	0.84	0.77 - 0.91
P (Bat - Full Plot_60)	0.41	0.28 - 0.54	0.41	0.28 - 0.54				
P (Bat - Full Plot_100)	0.41	0.28 - 0.54	0.41	0.28 - 0.54				
P (Small Bird - Road/Pad_100)	0.81	0.71 - 0.91	0.81	0.71 - 0.91	0.81	0.71 - 0.91	0.81	0.71 - 0.91
P (Small Bird - Full Plot_60)	0.29	0.09 - 0.50	0.29	0.09 - 0.50				
P (Small Bird - Full Plot_100)	0.29	0.09 - 0.50	0.29	0.09 - 0.50				
P (Large Bird - Road/Pad_100)	0.93	0.87 - 0.98	0.93	0.87 - 0.98	0.93	0.87 - 0.98	0.93	0.87 - 0.98
P (Large Bird - Full Plot_60)	0.93	0.87 - 0.98	0.93	0.87 - 0.98				
P (Large Bird - Full Plot_100)	0.93	0.87 - 0.98	0.93	0.87 - 0.98				
Probability of a Carcass Persisting Through the Search Interval								
Bat - Road/Pad_100	0.59	0.52 - 0.65	0.59	0.52 - 0.66	0.27	0.23 - 0.31	0.41	0.36 - 0.47
Bat - Full Plot_60	0.59	0.52 - 0.65	0.59	0.52 - 0.66				
Bat - Full Plot_100	0.59	0.52 - 0.65	0.59	0.52 - 0.66				
Small Bird - Road/Pad_100	0.60	0.53 - 0.66	0.61	0.53 - 0.67	0.22	0.17 - 0.27	0.38	0.31 - 0.45
Small Bird - Full Plot_60	0.60	0.53 - 0.66	0.61	0.53 - 0.67				
Small Bird - Full Plot_100	0.60	0.53 - 0.66	0.61	0.53 - 0.67				
Large Bird - Road/Pad_100	0.70	0.65 - 0.74	0.70	0.65 - 0.74	0.31	0.26 - 0.36	0.49	0.43 - 0.55
Large Bird - Full Plot_60	0.70	0.65 - 0.74	0.70	0.65 - 0.74				
Large Bird - Full Plot_100	0.70	0.65 - 0.74	0.70	0.65 - 0.74				
Probability of Available and Detected								
Bat - Road/Pad_100	0.49	0.43 - 0.56	0.50	0.43 - 0.56	0.23	0.19 - 0.27	0.35	0.29 - 0.40
Bat - Full Plot_60	0.24	0.16 - 0.32	0.24	0.16 - 0.32				
Bat - Full Plot_100	0.24	0.16 - 0.32	0.24	0.16 - 0.32				
Small Bird - Road/Pad_100	0.49	0.41 - 0.56	0.49	0.41 - 0.57	0.18	0.14 - 0.23	0.31	0.24 - 0.38
Small Bird - Full Plot_60	0.17	0.05 - 0.30	0.17	0.06 - 0.30				
Small Bird - Full Plot_100	0.17	0.05 - 0.30	0.17	0.06 - 0.30				
Large Bird - Road/Pad_100	0.65	0.59 - 0.71	0.66	0.60 - 0.71	0.29	0.24 - 0.34	0.46	0.40 - 0.52
Large Bird - Full Plot_60	0.65	0.59 - 0.71	0.66	0.60 - 0.71				
Large Bird - Full Plot_100	0.65	0.59 - 0.71	0.66	0.60 - 0.71				
Unadjusted Number of Fatalities								
Bat - Road/Pad_100	24.0	15.0 - 34.0	65.0	54.0 - 76.0	0.0	-	1.0	-
Bat - Full Plot_60	7.0	4.0 - 11.0	21.0	11.0 - 33.0				
Bat - Full Plot_100	4.0	-	21.0	16.0 - 28.0				
Bat - Overall	**35.0**	**26.0 - 45.0**	**107.0**	**91.0 - 124.0**	**0.0**	**-**	**1.0**	**-**
Small Bird - Road/Pad_100	2.0	-	2.0	-	1.0	-	0.0	-
Small Bird - Full Plot_60	0.0	-	0.0	-				
Small Bird - Full Plot_100	1.0	-	1.0	-				
Small Bird - Overall	**3.0**	**-**	**3.0**	**-**	**1.0**	**-**	**0.0**	**-**
Large Bird - Road/Pad_100	0.0	-	2.0	-	1.0	-	0.0	-
Large Bird - Full Plot_60	0.0	-	0.0	-				
Large Bird - Full Plot_100	1.0	-	1.0	-				
Large Bird - Overall	**1.0**	**-**	**3.0**	**-**	**1.0**	**-**	**0.0**	**-**

Appendix A. Estimated Fatality Rates and Correction Factors, with 90% Confidence Intervals, for Studies Conducted at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Parameter	Summer		Fall		Winter		Spring	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
All Birds - Road/Pad_100	2.0	-	4.0	-	2.0	-	0.0	-
All Birds - Full Plot_60	0.0	-	0.0	-				
All Birds - Full Plot_100	2.0	-	2.0	-				
All Birds - Overall	**4.0**	**-**	**6.0**	**3.0 - 10.0**	**2.0**	**-**	**0.0**	**-**
Observed Fatality Rates (Fatalities/Turbine/Season(s))								
Bat - Road/Pad_100	0.45	0.28 - 0.64	1.25	1.04 - 1.46	0.00	-	0.02	-
Bat - Full Plot_60	1.17	0.67 - 1.83	3.50	1.83 - 5.50				
Bat - Full Plot_100	0.80	-	3.00	2.29 - 4.0				
Bat - Overall	**0.55**	**0.41 - 0.70**	**1.67**	**1.42 - 1.94**	**0.00**	**-**	**0.02**	**-**
Small Bird - Road/Pad_100	0.04	-	0.04	-	0.02	-	0.00	-
Small Bird - Full Plot_60	0.00	-	0.00	-				
Small Bird - Full Plot_100	0.20	-	0.14	-				
Small Bird - Overall	**0.05**	**-**	**0.05**	**-**	**0.02**	**-**	**0.00**	**-**
Large Bird - Road/Pad_100	0.00	-	0.04	-	0.02	-	0.00	-
Large Bird - Full Plot_60	0.00	-	0.00	-				
Large Bird - Full Plot_100	0.20	-	0.14	-				
Large Bird - Overall	**0.02**	**-**	**0.05**	**-**	**0.02**	**-**	**0.00**	**-**
All Birds - Road/Pad_100	0.04	-	0.08	-	0.03	-	0.00	-
All Birds - Full Plot_60	0.00	-	0.00	-				
All Birds - Full Plot_100	0.40	-	0.29	-				
All Birds - Overall	**0.06**	**-**	**0.09**	**0.05 - 0.16**	**0.03**	**-**	**0.00**	**-**
Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))								
Bat - Road/Pad_100	5.43	3.37 - 7.93	15.19	12.10 - 18.76	0.00	-	0.32	-
Bat - Full Plot_60	9.03	4.42 - 16.65	27.09	12.94 - 48.51				
Bat - Full Plot_100	4.17	-	16.70	11.04 - 27.56				
Bat - Overall	**5.67**	**4.04 - 7.97**	**16.71**	**13.67 - 20.69**	**0.00**	**-**	**0.32**	**-**
Small Bird - Road/Pad_100	0.91	-	0.93	-	4.16	-	0.00	-
Small Bird - Full Plot_60	0.00	-	0.00	-				
Small Bird - Full Plot_100	1.93	-	1.38	-				
Small Bird - Overall	**0.91**	**-**	**0.91**	**-**	**4.16**	**-**	**0.00**	**-**
Large Bird - Road/Pad_100	0.00	-	1.16	-	4.09	-	0.00	-
Large Bird - Full Plot_60	0.00	-	0.00	-				
Large Bird - Full Plot_100	0.57	-	0.41	-				
Large Bird - Overall	**0.04**	**-**	**0.99**	**-**	**4.09**	**-**	**0.00**	**-**
All Birds - Road/Pad_100	0.91	-	2.09	-	8.25	-	0.00	-
All Birds - Full Plot_60	0.00	-	0.00	-				
All Birds - Full Plot_100	2.50	-	1.79	-				
All Birds - Overall	**0.95**	**-**	**1.90**	**0.68 - 3.63**	**8.25**	**-**	**0.00**	**-**
Adjusted Fatality Rates (Fatalities/MW/Seasons(s))								
Bat - Road/Pad_100	2.25	1.40 - 3.29	6.29	5.01 - 7.77	0.00	-	0.13	-
Bat - Full Plot_60	3.74	1.83 - 6.90	11.22	5.36 - 20.09				
Bat - Full Plot_100	1.73	-	6.91	4.57 - 11.41				
Bat - Overall	**2.35**	**1.67 - 3.30**	**6.92**	**5.66 - 8.57**	**0.00**	**-**	**0.13**	**-**
Small Bird - Road/Pad_100	0.38	-	0.38	-	1.72	-	0.00	-
Small Bird - Full Plot_60	0.00	-	0.00	-				
Small Bird - Full Plot_100	0.80	-	0.57	-				
Small Bird - Overall	**0.38**	**-**	**0.38**	**-**	**1.72**	**-**	**0.00**	**-**
Large Bird - Road/Pad_100	0.00	-	0.48	-	1.69	-	0.00	-
Large Bird - Full Plot_60	0.00	-	0.00	-				
Large Bird - Full Plot_100	0.24	-	0.17	-				
Large Bird - Overall	**0.02**	**-**	**0.41**	**-**	**1.69**	**-**	**0.00**	**-**

Appendix A. Estimated Fatality Rates and Correction Factors, with 90% Confidence Intervals, for Studies Conducted at the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Parameter	Summer		Fall		Winter		Spring	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
All Birds - Road/Pad_100	0.38	-	0.87	-	3.41	-	0.00	-
All Birds - Full Plot_60	0.00	-	0.00	-				
All Birds - Full Plot_100	1.04	-	0.74	-				
All Birds - Overall	**0.39**	**-**	**0.79**	**0.28 - 1.50**	**3.41**	**-**	**0.00**	**-**

Appendix B: Complete Carcass Listing for the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017

Appendix B. Complete Carcass Listing for the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
			Bats			
5/17/2016	hoary bat	36	7	incidental	road/pad	intact
5/19/2016	silver-haired bat	6	25	carcass search	road/pad	intact
5/25/2016	evening bat	30	46	carcass search	road/pad	intact
5/25/2016	evening bat	44	45	carcass search	road/pad	intact
5/29/2016	eastern red bat	48	9	carcass search	road/pad	intact
5/29/2016	hoary bat	25	65	carcass search	full plot	intact
5/31/2016	eastern red bat	16	8	carcass search	road/pad	intact
5/31/2016	evening bat	43	23	carcass search	road/pad	intact
6/6/2016	hoary bat	24	12	carcass search	road/pad	intact
6/6/2016	hoary bat	1	2	carcass search	full plot	intact
6/6/2016	hoary bat	7	15	carcass search	full plot	intact
6/7/2016	hoary bat	2	16	carcass search	full plot	intact
6/9/2016	hoary bat	1	28	carcass search	full plot	intact
6/13/2016	eastern red bat	64	30	carcass search	road/pad	intact
6/13/2016	silver-haired bat	3	42	carcass search	road/pad	intact
6/15/2016	hoary bat	22	29	carcass search	full plot	intact
6/15/2016	hoary bat	21	27	carcass search	full plot	intact
6/16/2016	big brown bat	59	36	carcass search	road/pad	intact
6/16/2016	big brown bat	36	5	carcass search	road/pad	intact
6/21/2016	hoary bat	54	18	carcass search	road/pad	intact
6/24/2016	big brown bat	24	4	carcass search	road/pad	intact
6/24/2016	hoary bat	23	2	carcass search	road/pad	dismembered
6/25/2016	big brown bat	2	15	carcass search	full plot	scavenged
6/28/2016	big brown bat	3	5	carcass search	road/pad	intact
6/28/2016	eastern red bat	18	1	carcass search	full plot	scavenged
7/1/2016	eastern red bat	62	7	carcass search	road/pad	intact
7/1/2016	hoary bat	64	25	carcass search	road/pad	intact
7/4/2016	hoary bat	3	23	carcass search	road/pad	intact
7/10/2016	eastern red bat	3	1	carcass search	road/pad	intact
7/10/2016	eastern red bat	3	28	carcass search	road/pad	intact
7/10/2016	eastern red bat	3	15	carcass search	road/pad	scavenged
7/10/2016	hoary bat	52	3	carcass search	road/pad	intact
7/12/2016	eastern red bat	22	25	carcass search	full plot	scavenged
7/12/2016	hoary bat	41	61	carcass search	road/pad	intact
7/13/2016	big brown bat	4	19	carcass search	road/pad	scavenged
7/13/2016	hoary bat	40	6	incidental	road/pad	intact
7/15/2016	big brown bat	17	4	carcass search	road/pad	intact
7/15/2016	big brown bat	15	6	carcass search	road/pad	intact
7/15/2016	big brown bat	32	15	carcass search	full plot	scavenged
7/15/2016	eastern red bat	33	24	carcass search	full plot	intact
7/15/2016	eastern red bat	44	10	carcass search	road/pad	intact
7/15/2016	eastern red bat	16	60	carcass search	road/pad	scavenged
7/15/2016	hoary bat	15	2	carcass search	road/pad	dismembered
7/15/2016	hoary bat	21	28	carcass search	full plot	intact
7/15/2016	silver-haired bat	1	12	carcass search	full plot	intact
7/16/2016	eastern red bat	25	3	carcass search	full plot	scavenged
7/18/2016	big brown bat	6	1	carcass search	road/pad	injured
7/18/2016	big brown bat	23	47	carcass search	road/pad	intact
7/18/2016	eastern red bat	16	58	carcass search	road/pad	intact
7/18/2016	eastern red bat	17	1	carcass search	road/pad	intact
7/19/2016	hoary bat	38	6	carcass search	road/pad	intact
7/21/2016	big brown bat	6	7	carcass search	road/pad	scavenged
7/21/2016	eastern red bat	42	6	carcass search	road/pad	scavenged
7/21/2016	hoary bat	7	31	carcass search	full plot	scavenged
7/22/2016	eastern red bat	48	66	carcass search	road/pad	intact
7/22/2016	hoary bat	25	49	carcass search	full plot	intact
7/24/2016	eastern red bat	21	38	carcass search	full plot	intact
7/24/2016	eastern red bat	41	38	carcass search	road/pad	scavenged
7/24/2016	eastern red bat	41	8	carcass search	road/pad	scavenged
7/24/2016	evening bat	35	30	carcass search	full plot	scavenged
7/25/2016	big brown bat	46	17	carcass search	road/pad	intact

Appendix B. Complete Carcass Listing for the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
7/25/2016	eastern red bat	11	52	incidental	road/pad	intact
7/25/2016	eastern red bat	3	7	carcass search	full plot	intact
7/25/2016	eastern red bat	3	25	carcass search	full plot	dismembered
7/25/2016	eastern red bat	49	1	carcass search	road/pad	injured
7/25/2016	hoary bat	36	4	carcass search	road/pad	intact
7/25/2016	hoary bat	19	13	carcass search	road/pad	NA
7/25/2016	hoary bat	26	8	carcass search	road/pad	NA
7/27/2016	big brown bat	42	13	carcass search	road/pad	dismembered
7/28/2016	big brown bat	59	6	carcass search	road/pad	intact
7/28/2016	big brown bat	10	6	incidental	road/pad	intact
7/28/2016	hoary bat	57	10	carcass search	road/pad	intact
7/28/2016	silver-haired bat	40	7	carcass search	road/pad	intact
7/30/2016	big brown bat	22	15	carcass search	full plot	intact
7/30/2016	big brown bat	33	8	carcass search	full plot	scavenged
7/30/2016	eastern red bat	33	15	carcass search	full plot	intact
7/30/2016	eastern red bat	33	27	carcass search	full plot	scavenged
7/30/2016	eastern red bat	33	7	carcass search	full plot	scavenged
7/30/2016	eastern red bat	17	15	carcass search	road/pad	intact
7/31/2016	big brown bat	3	31	carcass search	full plot	dismembered
7/31/2016	eastern red bat	61	39	carcass search	road/pad	dismembered
7/31/2016	hoary bat	3	9	carcass search	full plot	intact
8/2/2016	big brown bat	13	9	carcass search	road/pad	intact
8/2/2016	eastern red bat	15	6	carcass search	road/pad	intact
8/3/2016	big brown bat	52	5	carcass search	road/pad	intact
8/3/2016	eastern red bat	58	6	carcass search	road/pad	dismembered
8/3/2016	hoary bat	50	20	carcass search	road/pad	intact
8/5/2016	big brown bat	21	48	carcass search	full plot	intact
8/5/2016	eastern red bat	44	58	carcass search	road/pad	intact
8/5/2016	eastern red bat	44	7	carcass search	road/pad	intact
8/5/2016	eastern red bat	32	16	carcass search	full plot	intact
8/6/2016	big brown bat	4	25	carcass search	full plot	intact
8/8/2016	big brown bat	29	1	carcass search	road/pad	intact
8/8/2016	big brown bat	7	27	carcass search	full plot	scavenged
8/8/2016	big brown bat	53	1	carcass search	road/pad	dismembered
8/8/2016	eastern red bat	43	3	carcass search	road/pad	scavenged
8/8/2016	eastern red bat	33	2	carcass search	full plot	intact
8/8/2016	eastern red bat	7	1	carcass search	full plot	intact
8/8/2016	eastern red bat	1	10	carcass search	full plot	intact
8/8/2016	eastern red bat	7	26	carcass search	full plot	scavenged
8/8/2016	eastern red bat	31	42	carcass search	full plot	intact
8/8/2016	hoary bat	33	29	carcass search	full plot	scavenged
8/8/2016	hoary bat	33	21	carcass search	full plot	intact
8/8/2016	hoary bat	32	33	carcass search	full plot	intact
8/9/2016	big brown bat	39	5	carcass search	road/pad	intact
8/9/2016	eastern red bat	4	6	carcass search	full plot	intact
8/9/2016	eastern red bat	25	10	carcass search	full plot	intact
8/9/2016	hoary bat	4	38	carcass search	full plot	intact
8/9/2016	hoary bat	47	6	carcass search	road/pad	intact
8/12/2016	eastern red bat	62	14	carcass search	road/pad	intact
8/12/2016	eastern red bat	4	39	carcass search	full plot	scavenged
8/12/2016	eastern red bat	52	28	carcass search	road/pad	scavenged
8/12/2016	hoary bat	35	8	incidental	full plot	scavenged
8/14/2016	big brown bat	11	3	carcass search	road/pad	dismembered
8/15/2016	big brown bat	37	3	carcass search	road/pad	dismembered
8/15/2016	big brown bat	27	2	carcass search	road/pad	intact
8/15/2016	eastern red bat	25	3	carcass search	full plot	intact
8/15/2016	eastern red bat	39	5	carcass search	road/pad	intact
8/15/2016	eastern red bat	18	22	carcass search	full plot	intact
8/15/2016	eastern red bat	18	33	carcass search	full plot	intact
8/15/2016	eastern red bat	27	5	carcass search	road/pad	intact
8/15/2016	evening bat	36	2	carcass search	road/pad	intact
8/15/2016	evening bat	25	2	carcass search	full plot	intact

Appendix B. Complete Carcass Listing for the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
8/15/2016	hoary bat	26	0	carcass search	road/pad	intact
8/15/2016	hoary bat	59	1	carcass search	road/pad	intact
8/15/2016	hoary bat	37	2	carcass search	road/pad	intact
8/15/2016	hoary bat	4	24	carcass search	full plot	scavenged
8/15/2016	hoary bat	4	36	carcass search	full plot	scavenged
8/16/2016	big brown bat	18	8	incidental	full plot	intact
8/16/2016	big brown bat	33	15	incidental	full plot	intact
8/17/2016	big brown bat	22	17	carcass search	full plot	scavenged
8/17/2016	big brown bat	13	3	carcass search	road/pad	scavenged
8/17/2016	eastern red bat	43	4	carcass search	road/pad	intact
8/17/2016	hoary bat	4A	90	carcass search	road/pad	scavenged
8/18/2016	big brown bat	39	4	carcass search	road/pad	intact
8/18/2016	tricolored bat	60	8	carcass search	road/pad	intact
8/20/2016	eastern red bat	10	8	carcass search	road/pad	scavenged
8/20/2016	eastern red bat	9	5	carcass search	road/pad	scavenged
8/20/2016	hoary bat	16	5	carcass search	road/pad	intact
8/20/2016	tricolored bat	33	19	carcass search	full plot	scavenged
8/23/2016	big brown bat	21	50	carcass search	full plot	scavenged
8/23/2016	hoary bat	44	32	carcass search	road/pad	intact
8/26/2016	eastern red bat	16	2	carcass search	road/pad	intact
8/26/2016	eastern red bat	22	30	carcass search	full plot	scavenged
8/26/2016	eastern red bat	33	12	carcass search	full plot	intact
8/26/2016	hoary bat	7	20	carcass search	full plot	intact
8/27/2016	big brown bat	56	4	carcass search	road/pad	intact
8/27/2016	big brown bat	25	25	carcass search	full plot	scavenged
8/27/2016	eastern red bat	2	45	carcass search	full plot	intact
8/27/2016	eastern red bat	55	3	carcass search	road/pad	scavenged
8/27/2016	hoary bat	25	3	carcass search	full plot	intact
8/27/2016	hoary bat	55	86	carcass search	road/pad	scavenged
8/27/2016	tricolored bat	2	8	carcass search	full plot	dismembered
8/29/2016	big brown bat	15	2	carcass search	road/pad	intact
8/29/2016	big brown bat	25	5	incidental	full plot	intact
8/29/2016	eastern red bat	9	10	carcass search	road/pad	intact
8/29/2016	eastern red bat	51	1	incidental	road/pad	intact
8/30/2016	eastern red bat	26	10	carcass search	road/pad	intact
8/30/2016	tricolored bat	3	64	carcass search	full plot	intact
9/1/2016	eastern red bat	7	5	carcass search	full plot	intact
9/1/2016	eastern red bat	33	5	carcass search	full plot	intact
9/1/2016	eastern red bat	31	2	carcass search	full plot	scavenged
9/1/2016	hoary bat	32	3	carcass search	full plot	scavenged
9/1/2016	hoary bat	5	5	carcass search	road/pad	scavenged
9/1/2016	hoary bat	13	1	carcass search	road/pad	scavenged
9/2/2016	eastern red bat	27	7	carcass search	road/pad	intact
9/4/2016	big brown bat	20	12	carcass search	road/pad	dismembered
9/4/2016	eastern red bat	29	29	carcass search	road/pad	scavenged
9/8/2016	hoary bat	27	8	carcass search	road/pad	scavenged
9/10/2016	evening bat	9	51	carcass search	road/pad	intact
9/10/2016	hoary bat	1	26	carcass search	full plot	intact
9/13/2016	eastern red bat	28	10	carcass search	road/pad	intact
9/13/2016	hoary bat	28	24	carcass search	road/pad	intact
9/14/2016	eastern red bat	62	10	carcass search	road/pad	dismembered
9/16/2016	eastern red bat	14	8	carcass search	road/pad	scavenged
9/16/2016	hoary bat	32	8	carcass search	full plot	scavenged
9/16/2016	hoary bat	28	10	carcass search	road/pad	intact
9/17/2016	eastern red bat	62	6	carcass search	road/pad	scavenged
9/17/2016	eastern red bat	60	6	carcass search	road/pad	intact
9/19/2016	eastern red bat	21	40	carcass search	full plot	scavenged
9/22/2016	eastern red bat	10	6	carcass search	road/pad	intact
9/22/2016	eastern red bat	13	16	carcass search	road/pad	scavenged
9/22/2016	hoary bat	21	49	carcass search	full plot	scavenged
9/26/2016	eastern red bat	51	1	carcass search	road/pad	injured
9/28/2016	eastern red bat	23	8	carcass search	road/pad	scavenged

Appendix B. Complete Carcass Listing for the Adams Wind Energy Facility, Adams County, Iowa, from May 16, 2016, to May 15, 2017.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
10/4/2016	eastern red bat	30	2	carcass search	road/pad	intact
10/4/2016	eastern red bat	32	32	carcass search	full plot	scavenged
10/4/2016	hoary bat	32	30	carcass search	full plot	scavenged
10/10/2016	eastern red bat	22	31	carcass search	full plot	scavenged
10/10/2016	eastern red bat	21	14	carcass search	full plot	intact
10/10/2016	silver-haired bat	21	31	carcass search	full plot	scavenged
10/10/2016	silver-haired bat	21	44	carcass search	full plot	intact
10/14/2016	big brow n bat	40	4	carcass search	road/pad	intact
4/20/2017	eastern red bat	41	74	carcass search	road/pad	intact
Birds						
4/21/2016	northern bobw hite	11	1	incidental	road/pad	intact
4/21/2016	northern bobw hite	11	1	incidental	road/pad	intact
5/16/2016	horned lark	29	25	incidental	road/pad	intact
5/22/2016	yellow warbler	43	69	carcass search	road/pad	intact
6/4/2016	turkey vulture	15	75	incidental	road/pad	scavenged
6/12/2016	turkey vulture	28	50	incidental	road/pad	dismembered
6/13/2016	yellow -billed cuckoo	52	81	carcass search	road/pad	dismembered
6/21/2016	horned lark	21	12	carcass search	full plot	intact
6/24/2016	red-eyed vireo	43	4	carcass search	road/pad	intact
7/1/2016	ring-necked pheasant	2	47	carcass search	full plot	feather spot
7/1/2016	ring-necked pheasant	2	45	carcass search	full plot	dismembered
7/24/2016	killdeer	21	27	carcass search	full plot	feather spot
8/2/2016	ring-necked pheasant	14	1	carcass search	road/pad	intact
10/10/2016	unidentified passerine	29	27	carcass search	road/pad	dismembered
10/14/2016	unidentified sw allow	25	25	carcass search	full plot	dismembered
10/16/2016	ruby-crow ned kinglet	11	34	carcass search	road/pad	dismembered
10/16/2016	unidentified w ren	35	29	carcass search	full plot	scavenged
10/17/2016	ruby-crow ned kinglet	2	3	carcass search	full plot	intact
10/29/2016	golden-crow ned kinglet	27	27	carcass search	road/pad	scavenged
11/1/2016	northern bobw hite	57	1	carcass search	road/pad	scavenged
11/3/2016	European starling	6	20	carcass search	road/pad	dismembered
11/16/2016	red-tailed haw k	48	25	incidental	road/pad	intact
11/21/2016	northern bobw hite	53	3	incidental	road/pad	intact
12/05/2016	European starling	28	3	incidental	road/pad	intact
2/28/2017	European starling	44	14	incidental	road/pad	intact
4/25/2017	blue jay	23	232	incidental	road/pad	intact

2017-2018 Post-Construction Fatality Monitoring: Bat-Focused Surveys

MidAmerican Energy Company Iowa Wind Energy Portfolio: Ida Grove and O'Brien

March 2017 – March 2018

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INTRODUCTION

MidAmerican Energy Company (MidAmerican Energy or MidAmerican) has developed and operated a fleet of wind energy projects in Iowa with a combined 4,048 megawatts (MW) of nameplate capacity (Table 1, Figure 1). Western EcoSystems Technology, Inc. (WEST) was retained to conduct standardized post-construction fatality monitoring at MidAmercan's Iowa wind energy facilities consistent with Tier 4 of the U.S. Fish and Wildlife Service (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and Stage 5 of the *Eagle Conservation Plan Guidance* (USFWS 2013). These standardized field studies were conducted to assess impacts to wildlife from operation of MidAmerican's Iowa wind energy portfolio (WEST 2015), and to help inform development of MidAmerican's Habitat Conservation Plan (HCP) for Indiana bat (*Myotis sodalis*), northern long-eared bat (*M. septentrionalis*), little brown bat (*M. lucifugus*), and tricolored bat (*Perimyotis subflavus*) under the Endangered Species Act (ESA) of 1973.

The primary objective of the post-construction fatality monitoring was to determine fatality estimates for bats and eagles at normally operating wind projects. A secondary objective was to quantify fatality estimates for other birds in general to inform the National Environmental Policy Act (1969) process associated with the development of MidAmerican's HCP. The monitoring protocol, which includes separate eagle-focused and bat-focused study designs, was developed in consultation with, and approved by, the USFWS Rock Island Field Office (see WEST 2015) consistent with USFWS permitting requirements.

During the 2017-2018 study year, post-construction fatality monitoring was conducted at two MidAmerican Energy facilities: Ida Grove and O'Brien (Table 1, Figure 1). This report provides site-specific data that were collected using the bat-focused study design with the purpose of estimating fatality rates for bats and general avian species (i.e., all birds) at these two facilities between March 16, 2017, and March 15, 2018. Eagle-focused study design survey data for 2017-2018 are presented in a separate report.

Table 1. MidAmerican Energy Company's Iowa Wind I-X Energy Portfolio, Including Facility Specifications.

Facility Name	County	Project Area (Square Miles)	Project Area (Acres)	Number of Turbines	Turbine Size (MW)	Total Project (MW)
2014-2015 Fatality Monitoring Study						
Adair	Adair/Cass	26	16,640	76	2.3	174.8
Carroll	Carroll	25	16,000	100	1.5	150.0
Eclipse	Audubon/Guthrie	31	19,840	87	2.3	200.1
Lundgren*	Webster	52	33,280	107	2.3	251
Macksburg*	Madison	22	14,080	51	2.3	119.6
Morning Light	Adair	13	8,320	44	2.3	101.2
Rolling Hills*	Adair/Adams/Cass	69	44,160	193	2.3	443.9
Victory	Carroll/Crawford	28	17,920	66	1.5	99.0
Walnut	Pottawattamie	32	20,480	102	1.5	153.0
2015-2016 Fatality Monitoring Study						
Adams	Adams	16	10,126	64	2.3/2.4	154.3
Century	Hamilton/Wright	28	17,920	145	1.5/1.0	200.0
Charles City	Floyd	18	11,520	50	1.5	75.0
Highland	O'Brien	92	58,880	214	2.3	502
Intrepid	Sac/Buena Vista	43	27,520	122	1.5/1.0	175.5
Laurel	Marshall	16	10,240	52	2.3	119.6
Pomeroy	Pocahontas	33	21,120	184	1.5/2.3	286.4
Vienna	Marshall/Tama	15	9,600	45	2.3	105.6
Vienna II	Marshall	11	7,040	19	2.3	44.6
Wellsburg	Grundy	36	23,040	60	2.3	140.8
2017-2018 Fatality Monitoring Study (This Report)						
Ida Grove	Ida	184	117,800	134	1.8/2.3	301.0
O'Brien	O'Brien	94	60,454	104	2.3/2.4	250.3

* Surveyed for a second year in 2015-2016
MW = megawatt

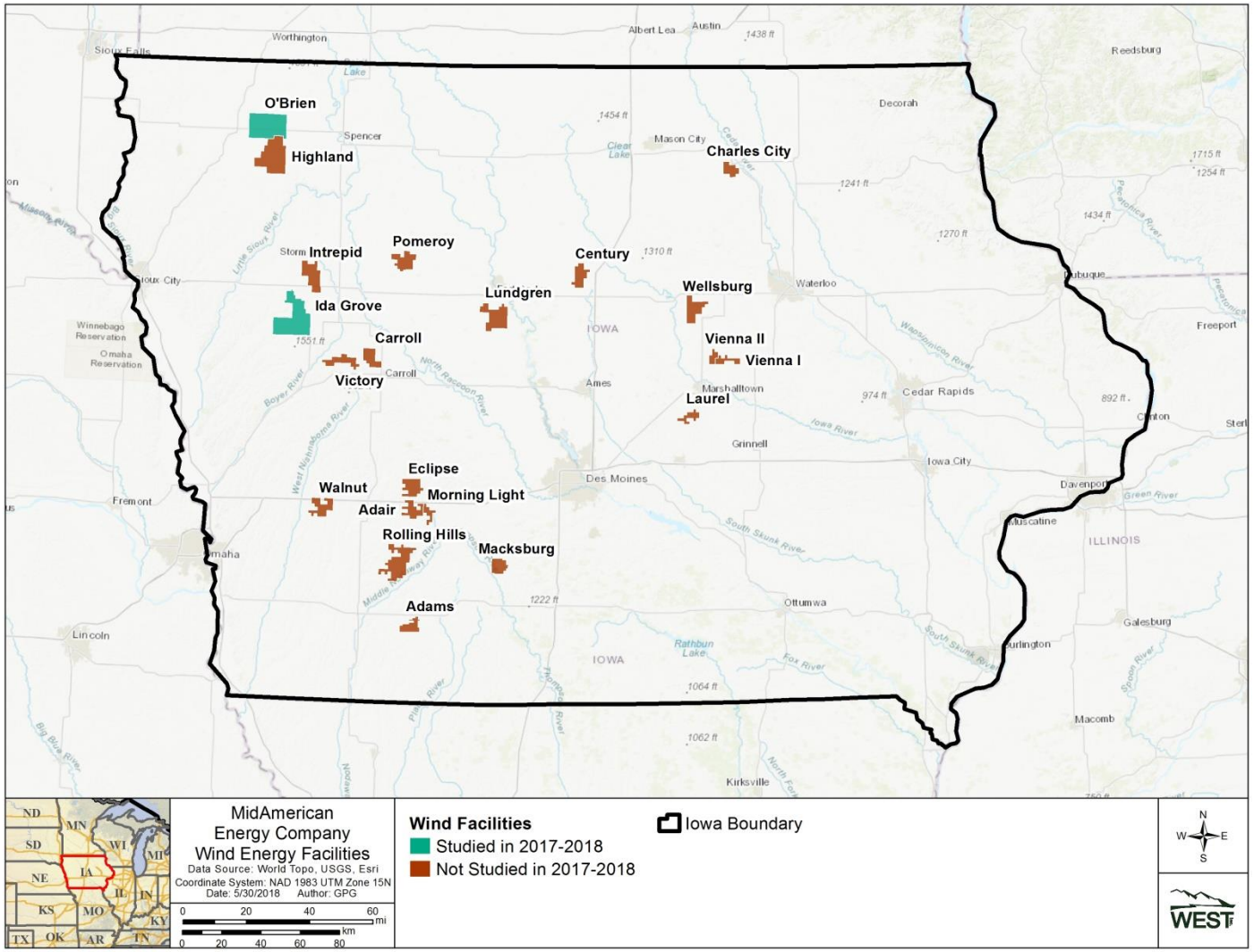

Figure 1. Locations of MidAmerican Energy Company's Iowa Wind I-X Energy Projects.

STUDY AREA

The Ida Grove facility is located in both the Steeply Rolling Loess Prairies and the Western Loess Hills Level 4 Ecoregion. The O'Brien facility is located in the Northwest Iowa Loess Prairies Level 4 Ecoregion (U.S. Environmental Protection Agency [USEPA] 2016). Ida Grove and O'Brien landcover predominately consists of cropland (i.e., corn [*Zea mays*] and soybeans [*Glycine max*]), according to the U.S. Geological Survey (USGS) National Land Cover Database (NLCD; USGS NLCD 2011, Homer et al. 2015).

METHODS

The purpose of this document is to report and discuss post-construction monitoring fatality estimates for bats, with a secondary objective to report and discuss general bird fatality estimates. The methods of the post-construction monitoring study are organized into four primary components: (1) standardized carcass searches, (2) searcher efficiency trials, (3) carcass persistence trials, and (4) statistical analysis.

Standardized Carcass Searches

Standardized carcass searches were conducted at all turbines in each of the two facilities to determine the observed number of bat and bird carcasses. A combination of road and pad surveys and transect surveys at cleared plots were conducted at the Ida Grove facility, and only road and pad surveys were used at O'Brien. Trained field technicians conducted searches at each facility from March 16, 2017, through March 15, 2018. Searches were conducted approximately every other week at both facilities during winter (November 17 to March 15). At Ida Grove, surveys were conducted approximately twice per week in the spring (March 16 to May 14), summer (May 15 to July 14), and fall (July 15 to November 16). At O'Brien, surveys were conducted once per week in the spring, summer, and fall.

All Ida Grove turbines were searched using road and pad plots in winter. During the rest of the year, standardized searches were conducted; plots included a combination of approximately 80% road and pad plots (107 turbines), and transect searches were conducted within cleared square plots (full plots) at the remaining 20% of turbines (27 turbines). All O'Brien turbines were searched using roads and pad plots throughout the year. Searchers walked at a rate of approximately 40-60 meters (m; 131-197 feet [ft]) per minute, regardless of plot type.

Road and Pad Searches

Road and pad plots included the entire gravel turbine pad and all gravel access roads within a 100-m (328-ft) radius of the turbine (Figure 2). To conduct the road and pad surveys, a searcher walked the perimeter of the road around the turbine pad while focusing search efforts for carcasses only on roads and pads. This methodology is consistent with the surveys conducted in 2014-2015 and 2015-2016 (Bay et al. 2016, 2017).

Figure 2. Example of a Road and Pad Search Plot Used for Bat-focused Surveys at the MidAmerican Energy Company's Ida Grove and O'Brien Wind Energy Facilities.

Transect Searches

Transect carcass searches were conducted only at Ida Grove during the spring, summer, and fall of 2018. Transect searches were conducted within square cleared plots centered on the turbine (Figure 3) at approximately 20% of turbines (27 turbines): 14 cleared plots were 100 m x 100 m and 13 were 60 m x 60 m. Plot selection was based on landowner participation and randomized within the subset of suitable plots with landowner consent.

Searchers walked transects while scanning the area on both sides of each transect for carcasses. The planned transect width was 10 m (33 ft); however, transect width was decreased in the event of low visibility due to vegetation growth on the plots. MidAmerican maintained a vegetation height of approximately six to eight inches (15 to 20 centimeters) on cleared plots, to the extent practicable; factors such as weather and field conditions at times prohibited plot maintenance.

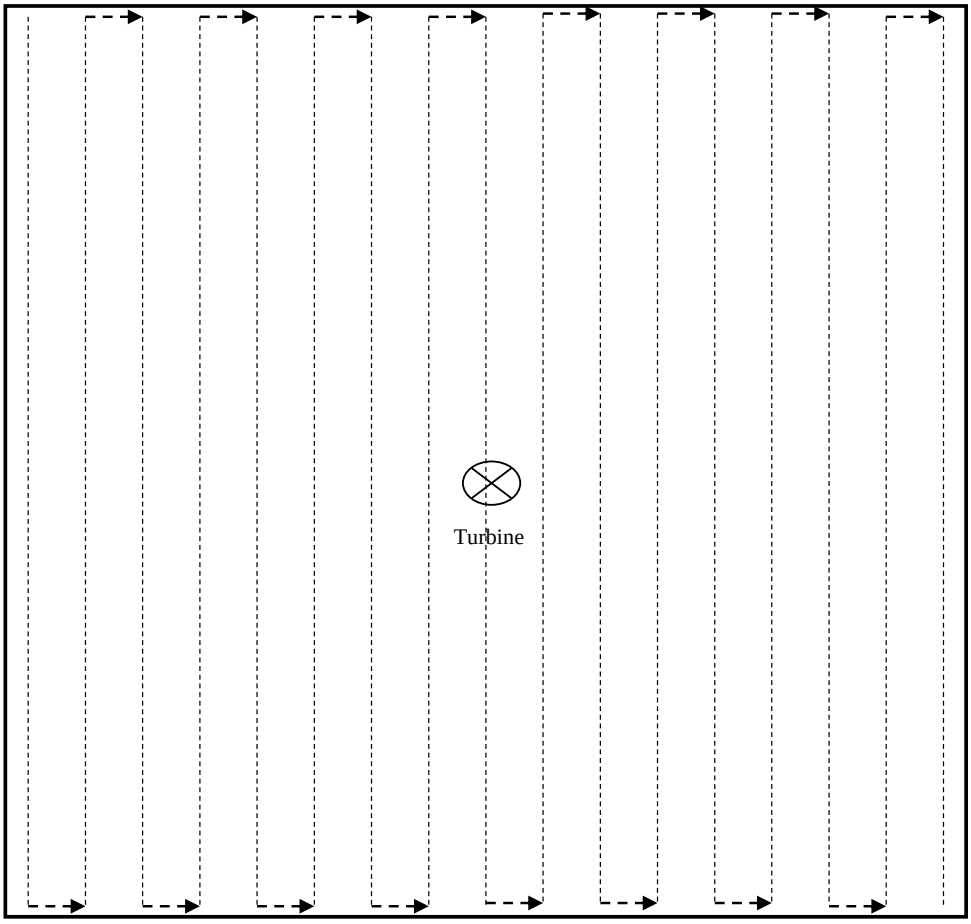

Figure 3. Schematic of a Full Plot Search Area (Not to Scale). Transects were Typically Spaced 10 Meters Apart.

Data Collected

During each turbine search, the following data were recorded: date, start time, end time, observer initials, type of search (i.e., road and pad or full plot), and if any carcasses were

found. If a bat or bird carcass was found during a search, the searcher marked the carcass (e.g., using a pin flag or flagging) and finished the standardized search. After the search was completed, the searcher returned to the carcass and recorded the date and time the carcass was found, species or best possible identification, sex and age (when possible), observer initials, turbine number, distance from turbine in meters, azimuth from turbine, Universal Transverse Mercator coordinates, habitat surrounding carcass, condition of carcass (e.g., intact, partial, scavenged), and estimated time of death (e.g., last night, two to three days). For carcasses where the cause of death was not apparent, it was assumed the fatality was associated with the operations of the wind energy facility. Digital photographs were taken of the carcass, any visible injuries (e.g., broken wing), and surrounding habitat.

Carcasses found outside the search area were documented in a similar fashion as those found within standardized search areas, but were not included in the calculation of fatality estimates. All fatalities found in the road and pad search area and within the turbine-specific search interval were included in the analysis, whether found during standardized searches or incidentally.

WEST staff biologists confirmed all bird and bat identifications. Potential *Myotis* bat species were verified in-hand by a staff bat biologist and unambiguously confirmed via DNA analysis. Bat carcasses that were not identifiable based on photographs or in-hand examinations were identified using DNA analysis.

Disposition of Carcasses

Bird carcasses were not collected but were marked with spray paint to avoid duplicate counting. Intact diurnal raptors[1], owls, and vultures were not marked with spray paint, and instead left in place for carcass persistence trials. Bat carcasses were collected, placed in a freezer bag, labeled with a freezer tag, and placed in a freezer on-site. Wildlife salvage/collection permits held by WEST for the collection of bats were reissued by the Iowa Department of Natural Resources (IDNR), and dissemination of data collected under this permit occurred as described in the permit conditions.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of carcasses found by searchers. Searcher efficiency trials were conducted during all seasons in the same areas carcass searches occurred. Searcher efficiency was estimated by size of carcass (large bird, small bird, or bat), and, when appropriate, by season (i.e., spring, summer, fall, or winter) and/or plot type (i.e., road and pad, or full plot). Searcher efficiency estimates were used to adjust the total number of carcasses found for carcasses missed by searchers, correcting for detection bias.

Separate searcher efficiency trials were conducted for bats and birds. Searcher efficiency trials for large and small birds were conducted throughout the study period, and searcher

[1] Diurnal raptors include kites, accipiters, buteos, eagles, falcons, northern harriers (*Circus cyaneus*), and osprey (*Pandion haliaetus*).

efficiency trials for bats were conducted in spring, summer, and fall. At the Ida Grove facility, approximately 20 bat carcasses or surrogate mice (*Mus musculus*) were placed for searcher efficiency trials in spring, and approximately 50 bats or surrogate mice were used in each summer and fall search periods, for a total of approximately 120 bat carcasses. Half of the bat carcasses were placed on the road and pads and half were placed on full plots. At the O'Brien facility, approximately 20 bat carcasses or surrogate mice were placed for searcher efficiency trials in spring, and approximately 40 bats or surrogate mice were used in each summer and fall search periods, for a total of approximately 100 bat carcasses. When bat carcasses were unavailable, or available in low numbers, brown or black mice were used as surrogates. Only non-*Myotis* bat species were used for searcher efficiency trials.

At the Ida Grove facility, approximately 10 small bird and 10 large bird carcasses were placed during the spring and winter seasons, and 20 small bird and 20 large bird carcasses were placed during the summer and fall seasons, for a total of approximately 120 bird carcasses. During spring, summer, and fall, half the small bird and half the large bird carcasses were placed on roads and pads, and the other half were placed on cleared plots. At the O'Brien facility, approximately 10 small bird and 10 large bird carcasses were placed during each season, for a total of approximately 80 bird carcasses. Bird carcasses consisted of non-native/non-protected or commercially available species, with house sparrows (*Passer domesticus*) and juvenile Coturnix quail (*Coturnix coturnix*) representing small birds, and rock pigeons (*Columba livia*) and adult Coturnix quail representing large birds.

All searcher efficiency trial carcasses were placed at random locations within the search area prior to scheduled carcass searches for that day. The person placing the carcasses did not inform the searcher when the trial was being conducted or where trial carcasses were placed. Each trial carcass was discreetly marked so that it could be identified as a study carcass after it was found. The number and location of the searcher efficiency carcasses found during the carcass survey was recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses.

Carcass Persistence Trials

The objective of carcass persistence trials was to estimate the average length of time a carcass remained in the search area before being removed by scavengers or by other means, such as being plowed into a field. Carcass persistence trials were conducted every one to two weeks to cover all seasons and distribute carcasses evenly across the study period. Estimates of carcass persistence were used to adjust the total number of carcasses found for those removed from the search area prior to searches, thereby correcting for removal bias.

To estimate carcass persistence rates at the Ida Grove facility, approximately 10 bat carcasses were placed during the spring season and approximately 50 bat carcasses during each summer and fall seasons, for approximately 110 total bat carcasses. In summer and fall, half of the carcass persistence trials were conducted on road and pad

plots and the remaining half were placed on full plots. At the O'Brien facility, we placed approximately 10 bat carcasses or surrogates during the spring season and approximately 20 during each the summer and fall seasons, for a total of 50 bat carcasses or surrogate carcasses. Carcass persistence trials were conducted using the same bat species and bat surrogate species used for searcher efficiency trials.

At Ida Grove, approximately 10 small bird and 10 large bird carcasses were placed during the spring and winter seasons, and 20 small bird and 20 large bird carcasses were placed during each the summer and fall seasons for approximately 120 total bird carcasses. During the spring, summer, and fall seasons, half the trials were placed on roads and pads and the other half were placed on full plots. At O'Brien, approximately 10 small bird carcasses and 10 large bird carcasses were placed within the search areas during each season, for a total of approximately 80 bird carcasses. Carcass persistence trials were conducted using the same bird species used for searcher efficiency trials. Remains of intact diurnal raptors, owls, or vultures found during scheduled searches and used for carcass persistence trials were marked and left in the field for carcass persistence trials.

Carcasses were dropped from shoulder height and allowed to land in a natural posture. Each trial carcass was marked discreetly with a black zip-tie around the leg to identify it as a trial carcass. Personnel conducting carcass searches monitored the trial birds over a 30-day period, checking carcasses every day for the first four days, then on day seven, day 10, day 14, day 21, and day 30. While maintained to the extent possible, the schedule varied depending on weather and coordination with other survey work. At the end of the 30-day period, any evidence of trial carcasses that remained was removed. Remains of diurnal raptors, owls, or vultures used for carcass persistence trials were spray-painted at the end of the trial.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers and crew leaders were responsible for inspecting data forms for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

A Microsoft® SQL database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent quality assurance, quality control, and data analysis. All data forms, field notebooks, and electronic data files were retained for reference.

Fatality Rate Estimation

Fatality rate estimation is complex due to variables present in every study. To determine the rate at which bird and bat fatalities occur, the number of carcasses found in each search area is tallied; however, carcasses persist for variable amounts of time and can be detected with varying levels of success based on carcass characteristics and season. In addition, only the designated search area for each turbine was searched. To account for these variables, statistical analyses have been developed to adjust the observed count of carcasses based on the project-specific rate of carcass persistence, the ability of searchers to detect carcasses, and the proportion of carcasses likely to have fallen in searched areas.

Estimates of facility-related carcasses are based on:

1. Observed number of carcasses found during standardized searches during the monitoring year for which the cause of death is either unknown or attributed to the facility;
2. Searcher efficiency, expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials;
3. Persistence rates expressed as an average probability a carcass is expected to remain in the study area and be available for detection by the searchers as estimated from persistence trials; and
4. Search area adjustment based on the road and pad search area and carcass density.

Annual, plot search type-specific, and, if necessary based on bias trial results, seasonal fatality estimates are provided for the following groups: (1) bats, (2) all birds, (3) small birds, (4) large birds, and (5) diurnal raptors. The total number of carcasses in each group listed above was estimated by adjusting for carcass persistence and searcher efficiency bias via a fatality estimator model. The Huso estimator (Huso 2011, Huso et al. 2015) was used and is described below.

Definition of Variables

The following variables are used in the equations below for the Huso estimator:

N total number of turbines at the facility

n number of turbines sampled at the facility

k number of carcass categories (e.g., combinations of size, season, search interval, etc.)

$\widehat{a}_i$ truncated weighted likelihood area correction for category i

I_i time interval between the previous search and discovery for category i

$\hat{\tilde{I}}_i$ effective search interval for carcasses in category i

$\hat{r}_i$ average probability of persistence for carcass in category i

$\hat{p}_i$ probability of detection for carcass in category i

c_i total number of carcasses in category i

Observed Number of Carcasses

All carcasses found in the standardized search areas and within the turbine-specific search interval were included in the analysis, whether found during standardized searches or incidentally. Any injured bats or birds were recorded and, when appropriate, treated as fatalities in the final analysis. All carcasses were documented in the same manner (as described above); however, carcasses were excluded from the analyses when they met one of the following criteria:

1. carcass was found outside the search area;
2. carcass was found during the clearing search (i.e., the initial search of the study period); or
3. carcass with estimated time of death longer than time between searches.

The Huso method requires that carcasses are censored, or excluded from the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). The search interval is specific to the turbine where the carcass was found. If the estimated time since death was greater than the most recent search, it was assumed that the carcass was missed on the first opportunity to have been found, and was therefore excluded from the fatality estimate (i.e., censored). The adjustment for the "missed" carcass occurs when incorporating the searcher efficiency rates into fatality estimation.

Estimation of Searcher Efficiency Rates

Searcher efficiency rates were estimated using logistic regression modeling, with separate modeling efforts for each size class (i.e., bat, small bird, and large bird). Potential covariates for logistic regression models included season, plot search type, and, when appropriate, interactions between these variables. Logistic regression models the natural logarithm of the odds of finding an available carcass as a function of the above covariates. The best model was selected using a combination of Akaike information criterion with a correction for finite sample sizes, hereafter referred to as AICc, and model parsimony (Burnham and Anderson 2002).

Estimation of Carcass Persistence Rates

Estimates of carcass persistence rates were used to adjust carcass counts for removal bias. Carcass persistence can be modeled as a function of a variety of variables including season, plot search type, and, when appropriate, the interactions between these variables. The average probability of persistence of a carcass ($\hat{r}$) was estimated from an interval censored carcass persistence model. Within each size class (i.e., bat, small bird, and large bird), exponential, log-logistic, lognormal, and Weibull distributions were fit and

parameterized according to Therneau (Therneau and Grambsch 2000, Therneau 2015), and the best model was selected using a combination of AICc and model parsimony.

Search Area Adjustment

The area surveyed within road and pad plots represented a sample of the area where carcasses could land; therefore, an estimate of the proportion of fatalities expected to land within searched areas was calculated to account for the unsearched area beneath turbines as a result of plot shape as well as carcasses that could have fallen beyond the plot boundaries. The area near turbines has been found to have higher densities of carcasses than areas farther from turbines (Huso and Dalthorp 2014), and these distributions vary by size class. Therefore, search area adjustments were calculated by size class. Two methods were used to calculate search area adjustments: truncated weighted maximum likelihood was used for bats and the physics-based Hull and Muir (2010) method was used for birds.

The search area adjustment for bats was calculated by estimating the proportion of carcasses expected to fall within searched areas:

$$a = \sum_{j=1}^{r} F(j) \times p(j)$$

where a is the area correction factor, j indexes a series of 1.0-m (3.3-ft) wide annuli centered on the turbine, r is the maximum search radius, $p(j)$ is the fraction of the jth annulus that was searched (calculated in geographical information system [GIS]), and $F(j)$ is the proportion of all carcasses expected within the jth annulus. $F(j)$ was calculated from $f(j)$, the estimated density distribution of carcasses with respect to distance from turbines. The density distribution of carcasses is determined by fitting truncated Weibull, truncated Rayleigh, truncated Normal, truncated Gamma, or truncated Gompertz density distributions (parameterized according to 2010 R Development Core Team 2016, Thomas et al. 2010) to carcass distances (from turbines) and choosing the best-supported distribution through AICc. Truncation bounds for the density distributions are set at zero m (zero ft; carcasses cannot be a negative distance from turbines) and at the maximum search radius from the turbine (to account for carcasses that may fall beyond the plot boundary). For example, the maximum search radius for square plots 160 m x 160 m (525 ft x 525 ft) in size is 113 m (371 ft; i.e., the distance from the turbine to the corner of a square plot). 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 of detection ($\hat{\pi}$) for that carcass. Weighted maximum likelihood accounted for carcass detection probabilities that varied systematically with distance from turbines.

Due to low small and large bird carcass counts in some strata for turbine type, the Hull and Muir method was used to calculate area correction for road and pad searches. Using this method, a physics-based model was developed to predict the maximum fall distance

of animal carcasses around turbines. The model uses turbine hub height, rotor diameter, and size of the carcass (small and large birds) to determine the maximum theoretical fall distance relative to the turbine base. A linear density was assumed from the turbine base out to the maximum fall distance. The density-weighted proportion of area searched was estimated based on the linear density and the proportion of area searched in each 1.0-m annulus from the turbine base out to the maximum predicted fall distance.

Adjusted Facility-related Fatality Rates

The estimated probability that a carcass in category *i* was available and detected is:

$$\widehat{\pi_i} = \widehat{a_i} \cdot \widehat{p_i} \cdot \widehat{r_i} \cdot \hat{v}_i$$

where $\widehat{v_i}$ = min(1, $\hat{\hat{I}}_i/I_i$). Thus, the total number of carcasses in category *i*, based on the number of carcasses found in category *i* is given by

$$\widehat{m_i} = \frac{c_i}{\widehat{\pi_i}}.$$

To obtain annual estimates of the total per-turbine carcass rate for a given carcass size, seasonal estimates, if applicable, are combined by summing across seasons within a size class and plot type. Estimates across plot types are obtained by calculating a weighted average of the plot-specific estimates in which the weight is determined by the number of turbines under that specific plot treatment.

The total per turbine carcass rate (*m*) is estimated by

$$\hat{F} = \frac{\sum_{i=1}^{k} \widehat{m}_i}{n}$$

The per-turbine fatality estimates, standard errors and 90% confidence intervals (CIs) were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating point estimates, variances, and CIs for complicated test statistics. A total of 1,000 bootstrap samples were used. The lower 5th and upper 95th percentiles of the 1,000 bootstrap samples were estimates of the lower limit and upper limit of 90% CIs.

RESULTS

A total of 11,934 bat-focused searches were conducted at Ida Grove during 90 visits. Among these, 9,743 searches were on road/pad plots and 2,191 were on full plots. At O'Brien, a total of 4,414 road and pad searches were completed during 44 visits. At both facilities combined, a total of 577 bats were discovered between March 16, 2017, and March 15, 2018 (Tables 2 and 3). No state or federally-listed endangered or threatened bat species were found. A total of 154 bird carcasses were discovered at both facilities combined, none of which were state or federally listed as endangered or threatened (Tables 2 and 3).

Ida Grove

Description of Observed Carcasses

A total of 492 bat carcasses representing five unique species were found at Ida Grove between March 16, 2017, and March 15, 2018, of which 450 were included in the analysis (Table 2). Three of the five bat species found accounted for 88.0% of all bat carcasses found: eastern red bat (*Lasiurus borealis*; 189 carcasses), hoary bat (*L. cinereus*; 122 carcasses), and big brown bat (*Eptesicus fuscus*; 122 carcasses). No *Myotis* species or tricolored bats were found (Table 2).

Approximately 80% of bats included in the analysis were found within 30 m (98 ft) of turbines, and nearly all bats (97.6%) were within 60 m (197 ft; Figure 4). Bat carcasses were found throughout the entire Ida Grove facility, with finds at 95.5% of turbines (Figure 5). Among all finds, there appear to be clusters of turbines with a higher number of carcasses; however, the landscape features surrounding these turbines are inconsistent (Figure 5). Some turbines with higher carcass counts are near creeks or other water sources; however, some are located in upland areas with few trees or water sources that might attract bats (Figure 5). All bats were found between April 10 and October 24, 2017, with the majority of fatalities occurring between mid-July and mid-August (Figure 6).

A total of 125 bird carcasses representing 47 identifiable species were found during the 2017-2018 fatality monitoring. Eighty-three bird carcasses were included in the analysis. Among all finds, the most commonly found species were turkey vulture (*Cathartes aura*; 10 carcasses), Nashville warbler (*Oreothlypis ruficapilla;* eight carcasses), and ruby-crowned kinglet (*Regulus calendula;* seven carcasses), accounting for 8.0%, 6.4%, and 5.6% of bird carcasses, respectively. Each of the remaining species accounted for less than 5% of bird carcasses found. No state or federally listed bird species were found. Six diurnal raptors were found, five red-tailed hawks (*Buteo jamaicensis*) and one sharp-shinned hawk (*Accipiter striatus*), of which two were included in the analysis.

Of the bird carcasses included in analysis, 82% were found within 60 m (197 ft) of a turbine (Figure 7). Bird carcasses were found throughout the Ida Grove facilities, with no discernable association with landscape features (Figure 8). Bird carcasses were found primarily in spring, summer and fall, with slight increases from mid-July to early-September (Figure 9).

Table 2. Total Number of Carcasses and the Composition of Carcasses Discovered during Bat-Focused Fatality Monitoring at the MidAmerican Energy Company's Ida Grove Wind Energy Facility between March 16, 2017, and March 15, 2018.

	Casualties Included		Casualties Off Plot		Clearing Search Casualties		Casualties Censored		Total	
Species	**Total**	**% Composition**	**Total**	**% Composition**	**Total**	**% Composition**	**Total**	**% Composition**	**Total**	**% Composition**
eastern red bat	174	38.7	6	35.3	0	0	9	36	189	38.4
big brown bat	116	25.8	3	17.6	0	0	3	12	122	24.8
hoary bat	107	23.8	5	29.4	0	0	10	40	122	24.8
silver-haired bat	46	10.2	3	17.6	0	0	3	12	52	10.6
evening bat	7	1.6	0	0	0	0	0	0	7	1.4
Overall Bats	**450**	**100**	**17**	**100**	**0**	**0**	**25**	**100**	**492**	**100**
turkey vulture	3	3.6	7	24.1	0	0	0	0	10	8.0
Nashville warbler	7	8.4	1	3.4	0	0	0	0	8	6.4
ruby-crowned kinglet	6	7.2	0	0	0	0	1	7.7	7	5.6
European starling	3	3.6	0	0	0	0	3	23.1	6	4.8
house wren	4	4.8	0	0	0	0	1	7.7	5	4.0
sedge wren	4	4.8	0	0	0	0	1	7.7	5	4.0
golden-crowned kinglet	3	3.6	1	3.4	0	0	1	7.7	5	4.0
red-tailed hawk	2	2.4	3	10.3	0	0	0	0	5	4.0
song sparrow	1	1.2	3	10.3	0	0	0	0	4	3.2
common yellowthroat	3	3.6	0	0	0	0	0	0	3	2.4
indigo bunting	2	2.4	1	3.4	0	0	0	0	3	2.4
marsh wren	2	2.4	1	3.4	0	0	0	0	3	2.4
red-winged blackbird	2	2.4	1	3.4	0	0	0	0	3	2.4
swamp sparrow	2	2.4	1	3.4	0	0	0	0	3	2.4
yellow-billed cuckoo	1	1.2	2	6.9	0	0	0	0	3	2.4
American robin	2	2.4	0	0	0	0	0	0	2	1.6
American tree sparrow	2	2.4	0	0	0	0	0	0	2	1.6
cliff swallow	2	2.4	0	0	0	0	0	0	2	1.6
dark-eyed junco	2	2.4	0	0	0	0	0	0	2	1.6
Lapland longspur	2	2.4	0	0	0	0	0	0	2	1.6
Le Conte's sparrow	2	2.4	0	0	0	0	0	0	2	1.6
mourning dove	2	2.4	0	0	0	0	0	0	2	1.6
tree swallow	2	2.4	0	0	0	0	0	0	2	1.6
house sparrow	1	1.2	1	3.4	0	0	0	0	2	1.6
red-eyed vireo	1	1.2	1	3.4	0	0	0	0	2	1.6
unidentified small bird	1	1.2	0	0	0	0	1	7.7	2	1.6
unidentified large bird	1	1.2	0	0	0	0	1	7.7	2	1.6
unidentified wren	1	1.2	0	0	0	0	1	7.7	2	1.6
Acadian flycatcher	1	1.2	0	0	0	0	0	0	1	0.8
barn swallow	1	1.2	0	0	0	0	0	0	1	0.8
black-and-white warbler	1	1.2	0	0	0	0	0	0	1	0.8
black-billed cuckoo	1	1.2	0	0	0	0	0	0	1	0.8
blue-headed vireo	1	1.2	0	0	0	0	0	0	1	0.8
brown creeper	1	1.2	0	0	0	0	0	0	1	0.8
horned lark	1	1.2	0	0	0	0	0	0	1	0.8
Lincoln's sparrow	1	1.2	0	0	0	0	0	0	1	0.8
mourning warbler	1	1.2	0	0	0	0	0	0	1	0.8

Table 2. Total Number of Carcasses and the Composition of Carcasses Discovered during Bat-Focused Fatality Monitoring at the MidAmerican Energy Company's Ida Grove Wind Energy Facility between March 16, 2017, and March 15, 2018.

	Casualties Included		Casualties Off Plot		Clearing Search Casualties		Casualties Censored		Total	
Species	**Total**	**% Composition**	**Total**	**% Composition**	**Total**	**% Composition**	**Total**	**% Composition**	**Total**	**% Composition**
Philadelphia vireo	1	1.2	0	0	0	0	0	0	1	0.8
Savannah sparrow	1	1.2	0	0	0	0	0	0	1	0.8
Tennessee warbler	1	1.2	0	0	0	0	0	0	1	0.8
unidentified flycatcher	1	1.2	0	0	0	0	0	0	1	0.8
unidentified passerine	1	1.2	0	0	0	0	0	0	1	0.8
unidentified sparrow	1	1.2	0	0	0	0	0	0	1	0.8
wild turkey	1	1.2	0	0	0	0	0	0	1	0.8
yellow rail	1	1.2	0	0	0	0	0	0	1	0.8
Baltimore oriole	0	0	1	3.4	0	0	0	0	1	0.8
dickcissel	0	0	0	0	0	0	1	7.7	1	0.8
gray partridge	0	0	1	3.4	0	0	0	0	1	0.8
gray catbird	0	0	0	0	0	0	1	7.7	1	0.8
ring-necked pheasant	0	0	1	3.4	0	0	0	0	1	0.8
sora	0	0	1	3.4	0	0	0	0	1	0.8
sharp-shinned hawk	0	0	1	3.4	0	0	0	0	1	0.8
unidentified icterid	0	0	0	0	0	0	1	7.7	1	0.8
white-throated sparrow	0	0	1	3.4	0	0	0	0	1	0.8
Overall Birds	**83**	**100**	**29**	**100**	**0**	**0**	**13**	**100**	**125**	**100**

Table 3. Total Number of Carcasses and the Composition of Carcasses Discovered during Bat-focused Fatality Monitoring at the MidAmerican Energy Company's O'Brien Wind Energy Facility between March 16, 2017, and March 15, 2018.

Species	Casualties Included		Casualties Off Plot		Clearing Search Casualties		Casualties Censored		Total	
	Total	% Composition	Total	% Composition	Total	% Composition	Total	% Composition	Total	% Composition
Bats										
eastern red bat	34	43.0	2	66.7	0	0	2	66.7	38	44.7
hoary bat	29	36.7	0	0	0	0	0	0	29	34.1
big brown bat	9	11.4	0	0	0	0	0	0	9	10.6
silver-haired bat	6	7.6	1	33.3	0	0	0	0	7	8.2
tricolored bat	1	1.3	0	0	0	0	0	0	1	1.2
evening bat	0	0	0	0	0	0	1	33.3	1	1.2
Overall Bats	**79**	**100**	**3**	**100**	**0**	**0**	**3**	**100**	**85**	**100**
Bird										
killdeer	3	13.0	0	0	0	0	0	0	3	10.3
unidentified passerine	1	4.3	0	0	0	0	2	100	3	10.3
cliff swallow	2	8.7	0	0	0	0	0	0	2	6.9
ruby-crowned kinglet	2	8.7	0	0	0	0	0	0	2	6.9
common grackle	1	4.3	1	25.0	0	0	0	0	2	6.9
red-tailed hawk	1	4.3	1	25.0	0	0	0	0	2	6.9
sedge wren	1	4.3	1	25.0	0	0	0	0	2	6.9
brown-headed cowbird	1	4.3	0	0	0	0	0	0	1	3.4
European starling	1	4.3	0	0	0	0	0	0	1	3.4
house wren	1	4.3	0	0	0	0	0	0	1	3.4
Nashville warbler	1	4.3	0	0	0	0	0	0	1	3.4
Philadelphia vireo	1	4.3	0	0	0	0	0	0	1	3.4
ring-necked pheasant	1	4.3	0	0	0	0	0	0	1	3.4
rock pigeon	1	4.3	0	0	0	0	0	0	1	3.4
ruby-throated hummingbird	1	4.3	0	0	0	0	0	0	1	3.4
tree swallow	1	4.3	0	0	0	0	0	0	1	3.4
unidentified small bird	1	4.3	0	0	0	0	0	0	1	3.4
yellow warbler	1	4.3	0	0	0	0	0	0	1	3.4
yellow-billed cuckoo	1	4.3	0	0	0	0	0	0	1	3.4
Harris' sparrow	0	0	1	25.0	0	0	0	0	1	3.4
Overall Birds	**23**	**100**	**4**	**100**	**0**	**0**	**2**	**100**	**29**	**100**

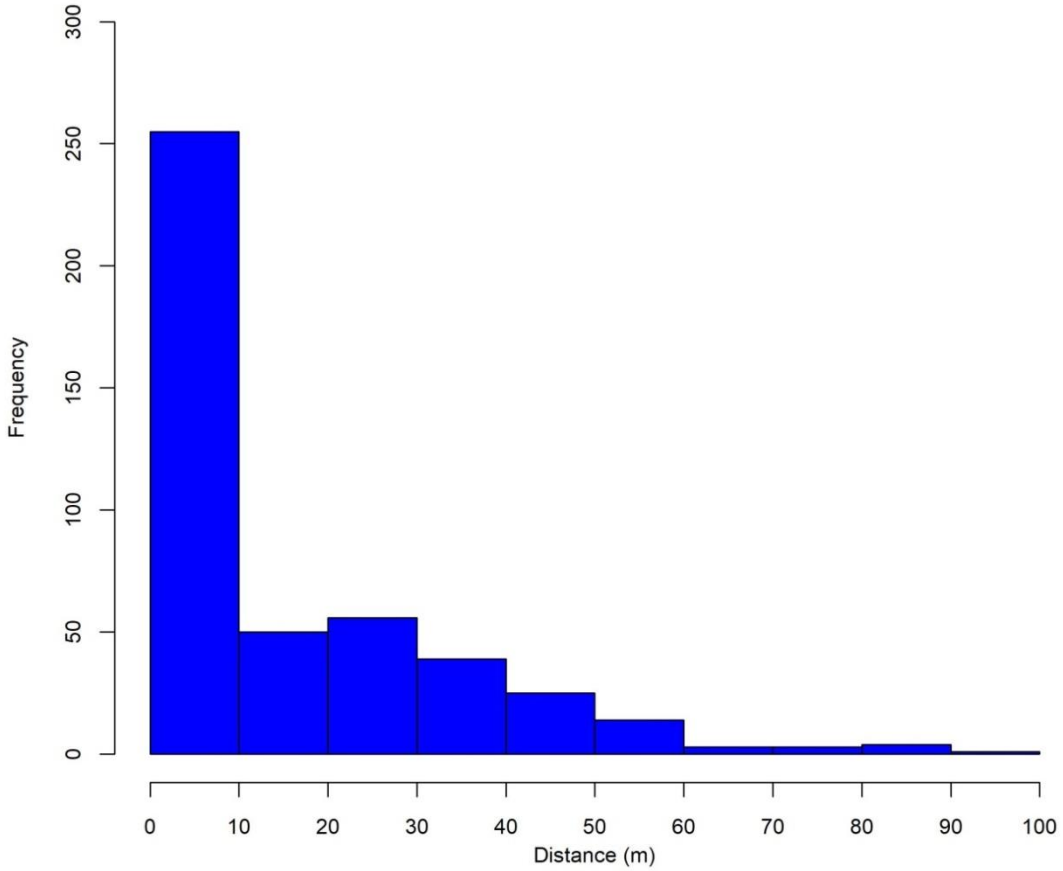

Figure 4. Distance from the Turbine of Bat Carcasses Included in the Analysis for the Ida Grove Wind Energy Facility Found between March 16, 2017, and March 15, 2018.

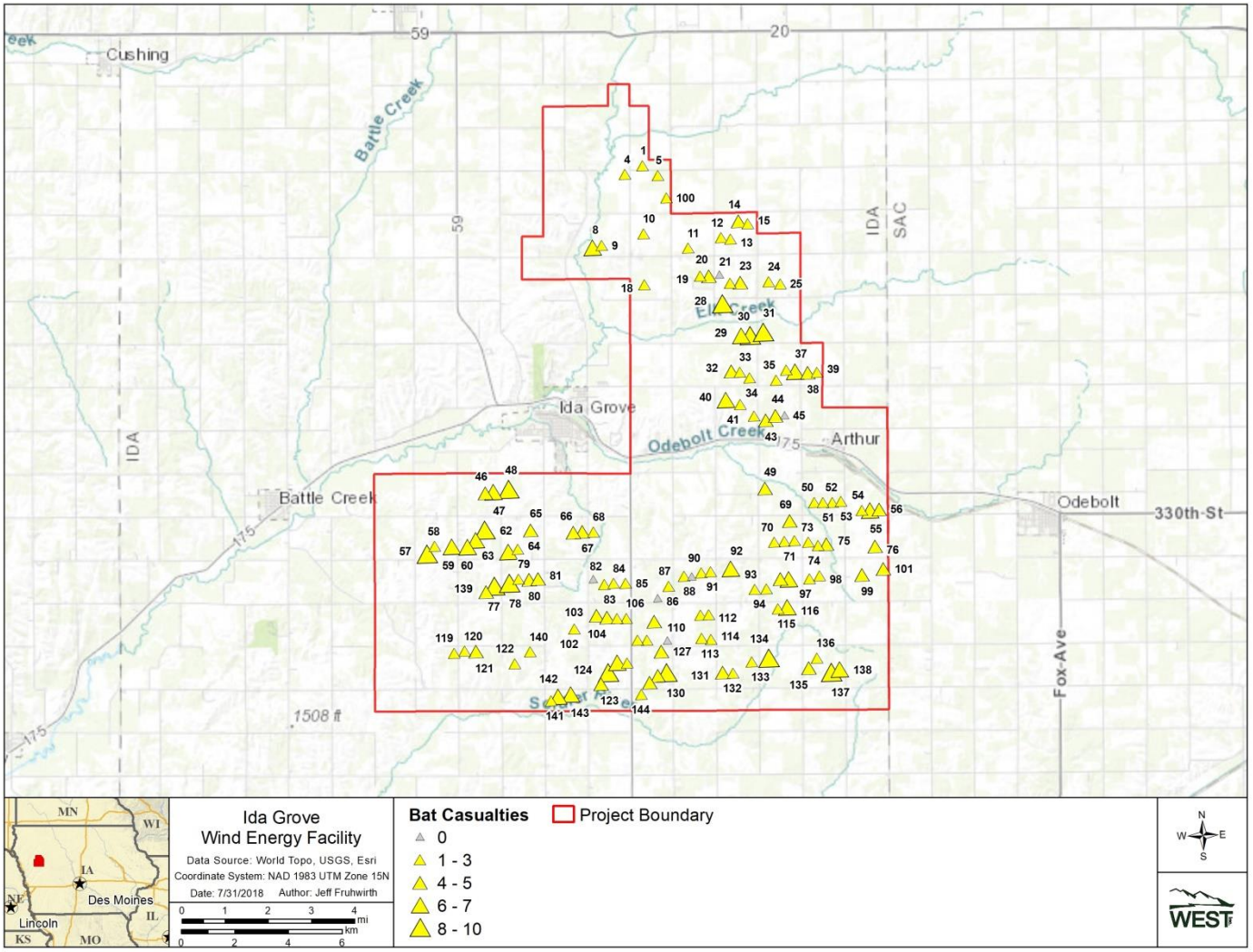

Figure 5. Bat Carcasses per Turbine found at the Ida Grove Wind Energy Facility between March 16, 2017, and March 15, 2018.

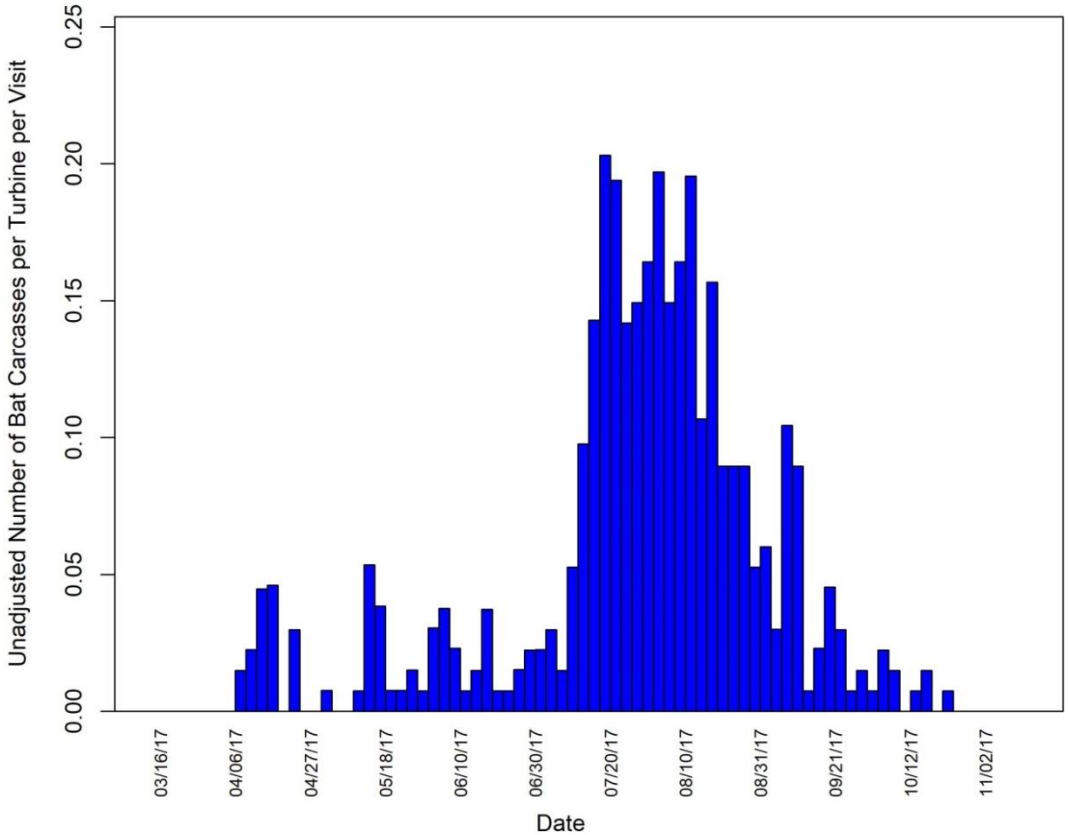

Figure 6. Frequency of Bat Carcasses per Turbine at the Ida Grove Wind Energy Facility during each Visit between March 16, 2017, and March 15, 2018.

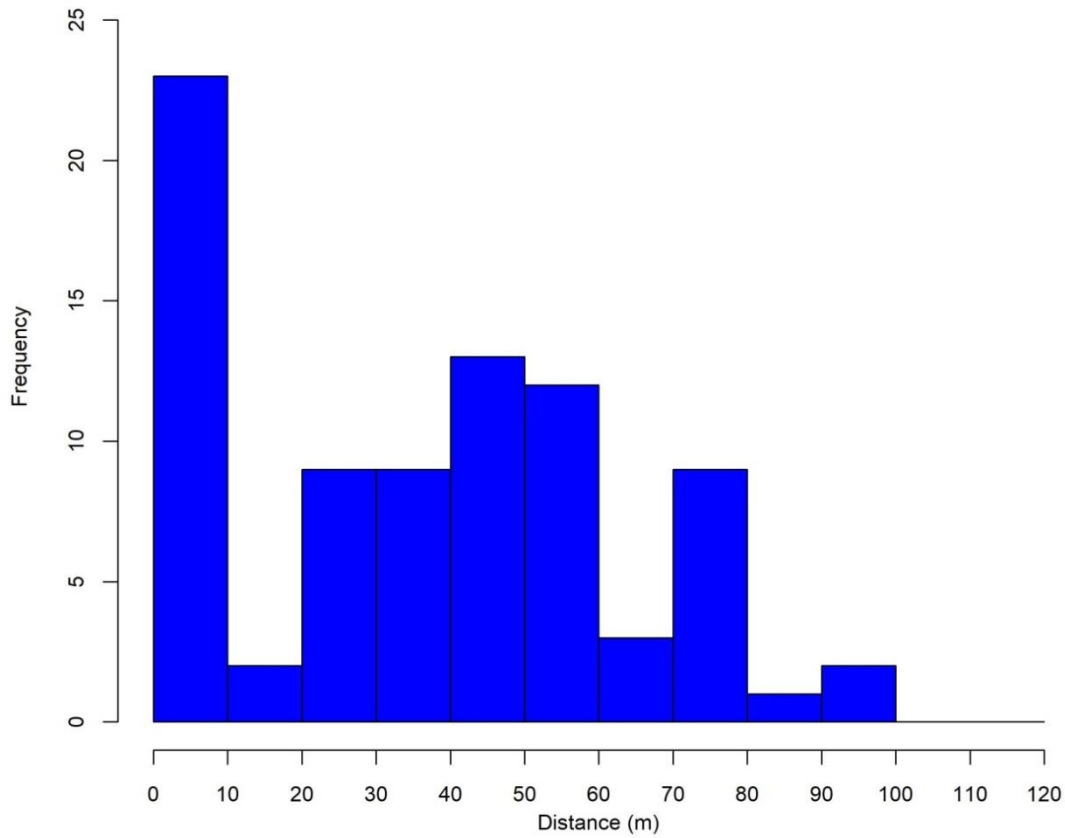

Figure 7. Distance from the Turbine of Bird Carcasses Included in the Analysis for the Ida Grove Wind Energy Facility Found between March 16, 2017, and March 15, 2018.

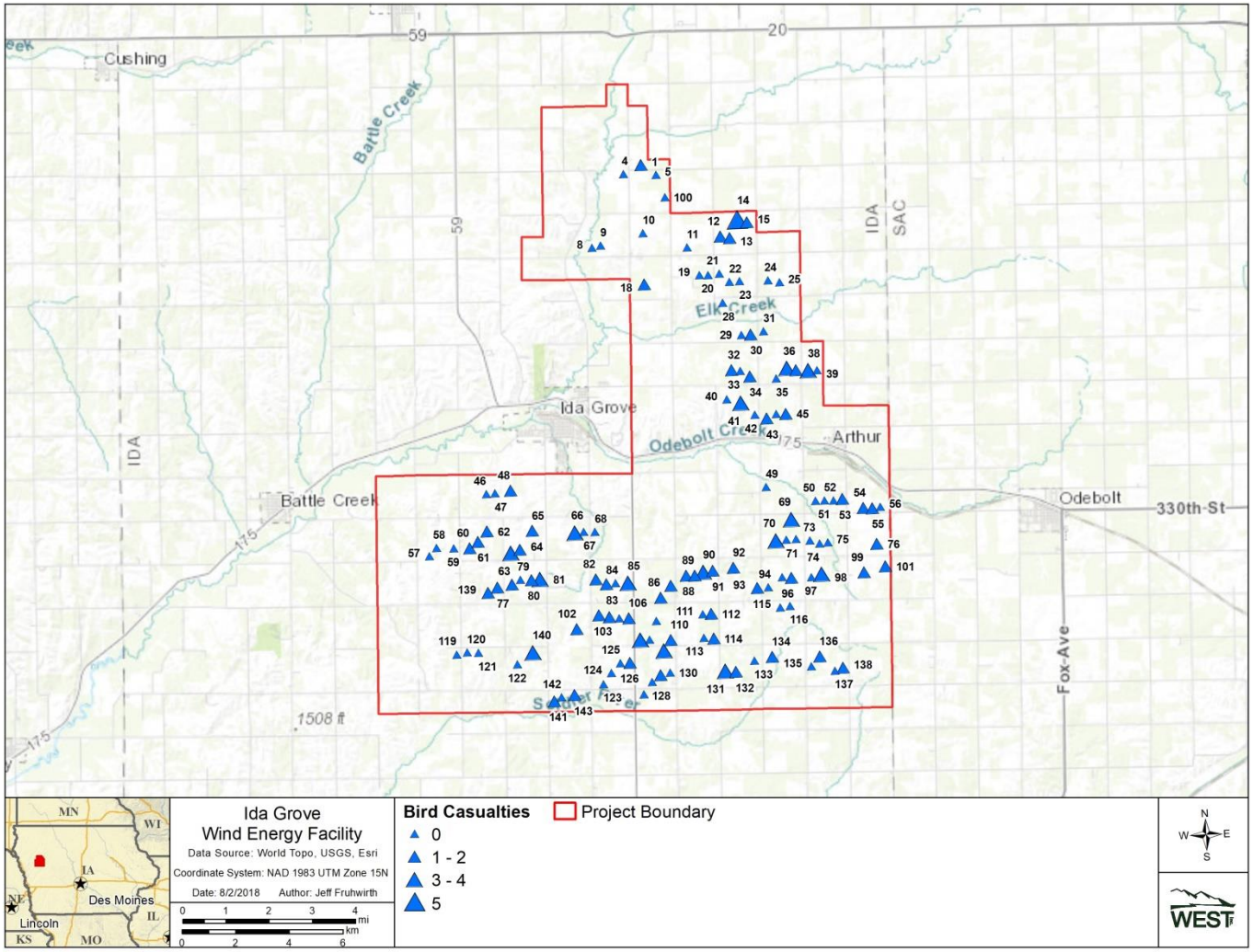

Figure 8. Bird Carcasses per Turbine found at the Ida Grove Wind Energy Facility between March 16, 2017, and March 15, 2018.

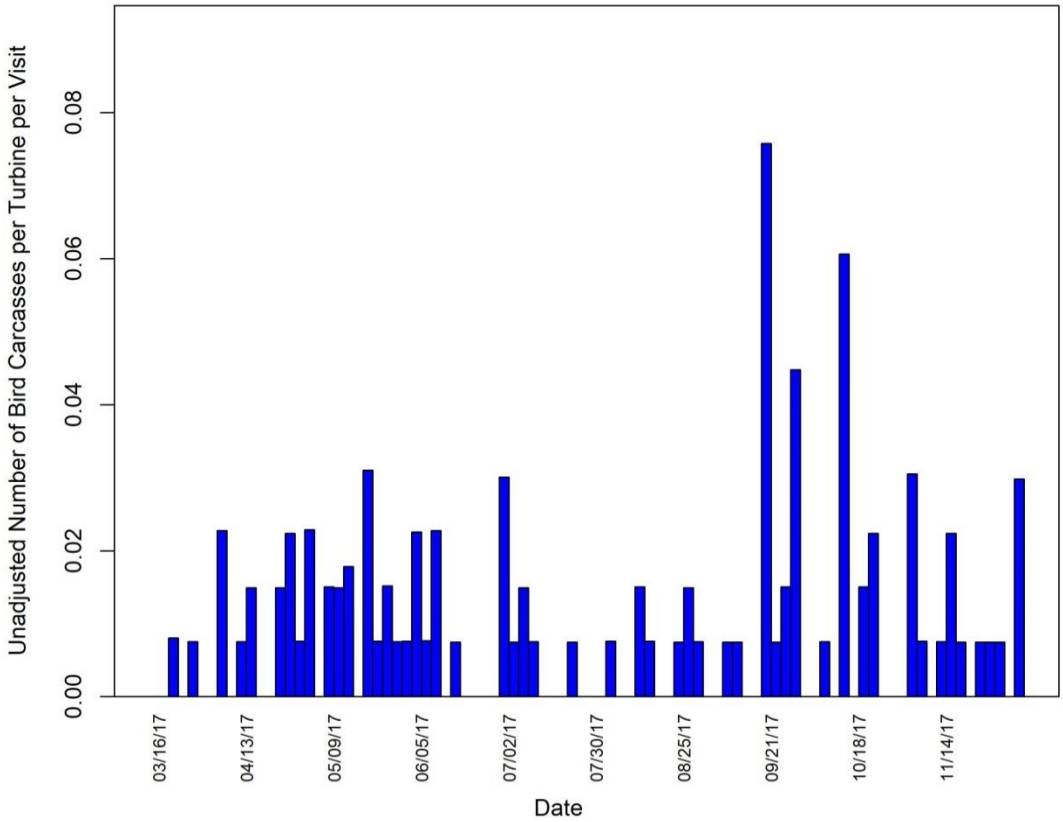

Figure 9. Frequency of Bird Carcasses per Turbine at the Ida Grove Wind Energy Facility during each Visit between March 16, 2017, and March 15, 2018.

Censored Carcasses

Of the 492 bat carcasses found, 17 were excluded from fatality rate estimation because they were not on search plots (Table 2). Among the remaining 475 bat carcasses, 95.4% of bats had an estimated time of death within three days (Table 4). Twenty-five bat carcasses had an estimated time of death longer than the previous turbine-specific search interval and were censored from the analysis (Table 2). The remaining 450 bat carcasses were included in the fatality rate estimation (Table 2).

Of the 125 bird carcasses found, 29 were found outside designated search areas and were excluded from the analyses (Table 2). Among the 96 remaining bird carcasses, 86.5% of birds had an estimated time of death within three days (Table 4). Thirteen bird carcasses had an estimated time of death longer than the previous turbine-specific search interval and were censored from the analysis (Tables 2 and 3).The remaining 83 bird carcasses were included in the fatality rate estimation (Table 2).

Table 4. Estimated Time Since Death for Carcasses Found on Search Plots at the Ida Grove Wind Energy Facility from March 16, 2017, to March 15, 2018.

Size Class	Estimated Time Since Death	Ida Grove	
		# of Carcasses	% Composition
Bat	Last Night	339	71.4
	2-3 Days	114	24.0
	4-7 Days	17	3.6
	7-14 Days	5	1.0
	> 2 Weeks	0	0
	> 1 Month	0	0
	Unknown	0	0
Large Bird	Last Night	5	41.7
	2-3 Days	4	33.3
	4-7 Days	0	0
	7-14 Days	0	0
	> 2 Weeks	0	0
	> 1 Month	0	0
	Unknown	3	25.0
Small Bird	Last Night	52	61.9
	2-3 Days	22	26.2
	4-7 Days	5	5.9
	7-14 Days	2	2.4
	> 2 Weeks	0	0
	> 1 Month	0	0
	Unknown	3	3.6

Searcher Efficiency

Searcher efficiency was modeled using the Huso method. Logistic regression was used to model searcher efficiency and model selection was based on AICc. Estimates were presented by season and plot type only if those variables were included in the selected model, based on the lowest AICc and model parsimony.

A total of 235 carcasses (116 bats, 60 large birds, and 59 small birds) were available to be found for searcher efficiency trials between March 16, 2017, and March 15, 2018 (Table 5). For bat searcher efficiency, the selected model included season and plot type (Table 6). On road and pad plots, searcher efficiency for bats was lowest in fall (0.77) and higher in spring and summer (0.95 and 0.96, respectively; Table 7). On full plots, searcher efficiency for bats was lowest in fall (0.19) and highest in summer (0.64; Table 7). No response variables were included in the selected model for large or small birds (Table 6), resulting in an overall searcher efficiency rate of 1.00 for large birds and 0.78 for small birds (Table 7).

Table 5. Searcher Efficiency Trial Results at the Ida Grove Wind Energy Facility as a Function of Season, Plot Type, and Carcass Size.

Size Class	Season	Plot Type	# Placed	# Available	# Found	% Found
Bat	Spring	Full Plot	10	10	6	60.0
	Spring	Road/Pad	10	10	9	90.0
	Summer	Full Plot	26	25	17	68.0
	Summer	Road/Pad	25	25	23	92.0
	Fall	Full Plot	23	18	2	11.1
	Fall	Road/Pad	30	28	23	82.1
Large Bird	Spring	Full Plot	5	5	5	100
	Spring	Road/Pad	5	5	5	100
	Summer	Full Plot	10	10	10	100
	Summer	Road/Pad	10	10	10	100
	Fall	Full Plot	10	9	9	100
	Fall	Road/Pad	11	11	11	100
	Winter	Road/Pad	10	10	10	100

Table 5. Searcher Efficiency Trial Results at the Ida Grove Wind Energy Facility as a Function of Season, Plot Type, and Carcass Size.

Size Class	Season	Plot Type	# Placed	# Available	# Found	% Found
Small Bird	Spring	Full Plot	5	5	4	80.0
	Spring	Road/Pad	5	5	5	100
	Summer	Full Plot	10	10	8	80.0
	Summer	Road/Pad	10	10	9	90.0
	Fall	Full Plot	12	10	5	50.0
	Fall	Road/Pad	10	10	8	80.0
	Winter	Road/Pad	10	9	7	77.8

Table 6. Searcher Efficiency Logistic Regression Models from the Ida Grove Wind Energy Facility Search Efficiency Trials. Selected Models are Denoted by an Asterisk in the 'DeltaAICc' Column.

Size Class	Covariate	AICc	DeltaAICc
Bat	Season + Plot Type	115.25	0*
	Season + Plot Type + Season* Plot Type	116.85	1.60
	Plot Type	125.37	10.12
	Season	142.17	26.92
	Null Model	145.73	30.49
Large Bird	Null Model	2.07	0*
	Plot Type	4.21	2.14
	Season	8.73	6.66
	Season + Plot Type	11.11	9.04
Small Bird	Plot Type	63.95	0
	Null Model	64.30	0.34*
	Season + Plot Type	66.75	2.80
	Season	67.58	3.63

Table 7. Searcher Efficiency Rates for the Ida Grove Wind Energy Facility from March 16, 2017, to March 15, 2018.

Size Class	Plot Type	Spring	Summer	Fall	Winter
Bat	Road/Pad	0.95	0.96	0.77	-
	Full Plot	0.55	0.64	0.19	-
Large Bird	Road/Pad	1.0	1.0	1.0	1.0
	Full Plot	1.0	1.0	1.0	-
Small Bird	Road/Pad	0.78	0.78	0.78	0.78
	Full Plot	0.78	0.78	0.78	-

Carcass Persistence Time

The Huso method was used for calculating carcass persistence rates and the average probability of persistence. As with searcher efficiency, model selection was based on AICc; however, multiple distributions were tested, in addition to the different variables. Seasonal estimates were calculated when the model with the lowest AICc included season.

A total of 231 carcasses (110 bats, 60 large birds, and 61 small birds) were placed in the project area for carcass persistence trials. The selected model for bats and large birds included season as a covariate. Season and plot type were selected covariates for small birds. For bats and small birds, the selected model used an exponential distribution, and loglogistic distribution was used for large birds (Table 8). The average bat carcass persistence time was much longer in spring (22.96 days) compared to summer and fall (6.39 and 5.31 days, respectively; Table 9). The average large bird carcass persistence time was longest in winter (25.32 days), followed by spring (13.55 days), summer (8.07 days), and fall (2.69 days; Table 9). On full plots, the average small bird carcass

persistence time was longer in summer (17.00 days) than in spring and fall (6.30 and 6.59 days, respectively). On roads and pads, the average small bird carcass persistence was also longer in summer (7.75 days) than in spring and fall (2.87 and 3.00 days, respectively), but small bird carcass persistence was much longer in winter (16.70 days; Table 9).

Table 8. Carcass Persistence Models and Parameters at the Ida Grove Wind Energy Facility. Selected Models are Denoted by an Asterisk in the 'DeltaAICc' Column.

Size Class	Covariate	Distribution	AICc	Delta AICc
Bat	Season	Weibull	474.10	0
	Season	Exponential	474.19	0.09*
	Season	Lognormal	474.25	0.15
	Season + Plot Type	Weibull	476.25	2.15
	Season + Plot Type	Exponential	476.26	2.16
	Season + Plot Type	Lognormal	476.43	2.33
	Season	Loglogistic	476.90	2.80
	Season + Plot Type	Loglogistic	479.08	4.98
	Null Model	Lognormal	481.52	7.42
	Null Model	Loglogistic	482.93	8.83
	Plot Type	Lognormal	483.63	9.53
	Null Model	Weibull	484.71	10.61
	Plot Type	Loglogistic	485.04	10.94
	Plot Type	Weibull	486.62	12.52
	Null Model	Exponential	488.53	14.43
	Plot Type	Exponential	490.26	16.16
Large Bird	Season	Loglogistic	257.83	0*
	Season	Lognormal	258.41	0.59
	Season + Plot Type	Lognormal	259.31	1.48
	Season + Plot Type	Loglogistic	259.37	1.54
	Season + Plot Type	Exponential	261.91	4.09
	Season	Exponential	264.07	6.24
	Season + Plot Type	Weibull	264.29	6.46
	Season	Weibull	265.85	8.02
	Null Model	Lognormal	272.39	14.57
	Null Model	Weibull	273.62	15.79
	Null Model	Exponential	273.94	16.12
	Null Model	Loglogistic	273.95	16.12
	Plot Type	Lognormal	274.59	16.77
	Plot Type	Weibull	275.84	18.01
	Plot Type	Exponential	276.08	18.26
	Plot Type	Loglogistic	276.11	18.29
Small Bird	Season + Plot Type	Exponential	258.96	0*
	Season + Plot Type	Weibull	261.41	2.46
	Season	Exponential	263.70	4.74
	Season + Plot Type	Lognormal	265.29	6.33
	Season	Weibull	265.57	6.62
	Season + Plot Type	Loglogistic	267.45	8.49
	Season	Lognormal	267.89	8.94
	Season	Loglogistic	270.03	11.07
	Null Model	Weibull	273.50	14.55
	Null Model	Exponential	274.69	15.73
	Plot Type	Weibull	274.87	15.91
	Plot Type	Exponential	275.62	16.66
	Null Model	Lognormal	280.07	21.11
	Plot Type	Lognormal	281.94	22.98
	Null Model	Loglogistic	282.33	23.38
	Plot Type	Loglogistic	284.07	25.12

Table 9. Carcass Persistence Top Models with Covariates, Distributions, and Model Parameters for the Ida Grove Wind Energy Facility.

Size Class	Season	Plot Type	Distribution	Mean Removal Time	Scale
Bat	Spring	-	Exponential	22.96	1.00
	Summer	-	Exponential	6.39	1.00
	Fall	-	Exponential	5.31	1.00
Large Bird	Spring	-	Loglogistic	13.55	0.68

Table 9. Carcass Persistence Top Models with Covariates, Distributions, and Model Parameters for the Ida Grove Wind Energy Facility.

Size Class	Season	Plot Type	Distribution	Mean Removal Time	Scale
	Summer	-	Loglogistic	8.07	0.68
	Fall	-	Loglogistic	2.69	0.68
	Winter	-	Loglogistic	25.32	0.68
Small Bird	Spring	Road/Pad	Exponential	2.87	1.00
		Full	Exponential	6.30	1.00
	Summer	Road/Pad	Exponential	7.75	1.00
		Full	Exponential	17.00	1.00
	Fall	Road/Pad	Exponential	3.00	1.00
		Full	Exponential	6.59	1.00
	winter	Road/Pad	Exponential	16.70	1.00

Search Area Adjustment

Sufficient numbers of bat carcasses were found to fit distributions separately and these distributions were combined with the proportion of area searched to produce an area correction for bats. A Weibull distribution was selected for bats. There were not sufficient numbers of small or large birds found in every turbine type strata to fit facility-specific bird distributions; therefore, the physics-based Hull and Muir model was used. Two turbine types were used at Ida Grove; therefore, the Hull and Muir area correction varied slightly between turbine models. Search area adjustments are listed in Table 10.

Table 10. Search Area Adjustment Values for Ida Grove Wind Energy Facility Studied from March 16, 2017, to March 15, 2018.

Size Class	Turbine MW*	Plot Type	Area Correction
Ida Grove			
Bat	2.3	Road/Pad 100	0.13
	2.3	60-m Plot	0.50
	2.3	100-m Plot	0.79
	1.79	Road/Pad 100	0.10
	1.79	100-m Plot	0.65
Large Bird	2.3	Road/Pad 100	0.17
	2.3	60-m Plot	0.50
	2.3	100-m Plot	0.72
	1.79	Road/Pad 100	0.17
	1.79	60-m Plot	0.50
	1.79	100-m Plot	0.73
Small Bird	2.3	Road/Pad 100	0.23
	2.3	60-m Plot	0.66
	2.3	100-m Plot	0.89
	1.79	Road/Pad 100	0.23
	1.79	60-m Plot	0.67
	1.79	100-m Plot	0.90

* Variation in turbine blade radius at Ida Grove resulted in slightly different Hull and Muir area adjustments.

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, raptors, and all birds (Table 11). When at least five carcasses were included in the analysis, 90% CIs were calculated.

Bats

Bat estimated fatality rates were the highest in the fall, with 31.39 bats/MW (Table 11, Appendix B). Estimated fatality rates in the summer (1.91 bats/MW) and spring (0.51 bat/MW) were much lower (Table 11, Appendix B). The overall estimated bat fatality rate across all seasons was 33.80 bats/MW/year (Table 12).

Large Birds

While all large bird fatality rates were generally low, fall had the highest large bird estimated fatality rate (0.09 large birds/MW), followed by summer and winter (0.04 large birds/MW per season) and spring (0.03 large birds/MW; Table 11). The overall large bird fatality estimate was 0.20 large birds/MW/year.

Raptors

Raptors carcasses were only found on search plots and within the search interval during the winter. The estimated raptor fatality rate was 0.04 raptors/MW/year (Table 12).

Small Birds

The estimated fatality rates for small birds was highest in fall (0.76 small birds/MW), followed by spring (0.31 small birds/MW), summer (0.24 small birds/MW), and winter (0.16 small birds/MW; Table 11, Appendix B). The overall small bird estimate was 1.46 birds/MW/year (Table 12).

All Birds

The estimated all bird fatality rate was 0.84 birds/MW in fall, 0.33 birds/MW in spring, 0.28 birds/MW in summer, and 0.20 birds/MW in winter (Table 11). The overall estimated bird fatality rate was 1.66 birds/MW/year (Table 12).

Table 11. Adjusted Fatality Rate Estimate (Fatalities/Megawatt/Year) and 90% Confidence Intervals (CIs)[1] at the Ida Grove Wind Energy Facility from March 16, 2017, to March 15, 2018.

Size Class	Spring		Summer		Fall		Winter	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Bat	0.51	0.31 - 0.78	1.91	1.38 - 2.56	31.39	24.33 - 40.10	-	-
Large Bird	0.03	-	0.04	-	0.09	-	0.04	-
Raptor	-	-	-	-	-	-	0.04	-
Small Bird	0.31	0.16-0.57	0.24	0.14-0.36	0.76	0.52-1.19	0.16	0.06-0.28
All Bird	0.33	0.17-0.61	0.28	0.17-0.40	0.84	0.59-1.29	0.20	0.10-0.33

[1] 90% CIs were not calculated when fewer than five carcasses were included in the analysis

Table 12. Overall Fatality Rates per Turbine and per Megawatt (MW) for Studies Conducted at the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Size Class	Per Turbine		Per MW	
	Estimate	90% Confidence Interval	Estimate	90% Confidence Interval
Bat	69.40	55.86 – 87.30	33.80	26.77 - 42.81
Large Bird	0.43	0.18 – 0.74	0.20	0.08 – 0.33
Raptor	0.10	0 – 0.24	0.04	0 – 0.10
Small Bird	3.32	2.58 – 4.62	1.46	1.14 – 2.03
All Bird	3.75	2.98 – 5.14	1.66	1.32 – 2.26

O'Brien

Description of Observed Carcasses

A total of 85 bat carcasses were found at O'Brien between March 16, 2017, and March 15, 2018, of which 79 were included in analysis (Table 3, Appendix C). Six unique bat species were found. Among all bat finds, eastern red bat was most common (44.7%), followed by hoary bat (34.1%; Table 3). No *Myotis* and one tricolored bat (1.2%) were found (Table 3).

All bats were found within 70 m (230 ft) of the turbine (Figure 10). Bat carcasses were found throughout the facility, with no association to landscape features (Figure 11). All bats were found between April 17 and October 10, 2017, with the majority of carcasses found between mid-July and the mid-August (Figure 12).

A total of 29 bird carcasses representing 18 identifiable species were found; 23 bird carcasses were included in the analysis (Table 3, Appendix C). Three or fewer carcasses were found of each identifiable species. Two red-tailed hawks were the only diurnal raptor species found. No state or federally listed bird species were found.

All the bird carcasses included in the analysis were found within 90 m (295 ft) of turbines (Figure 13). There was no apparent spatial pattern of bird carcass finds relative to landscape features (Figure 14). Bird carcasses were found primarily in spring, summer, and fall (Figure 15).

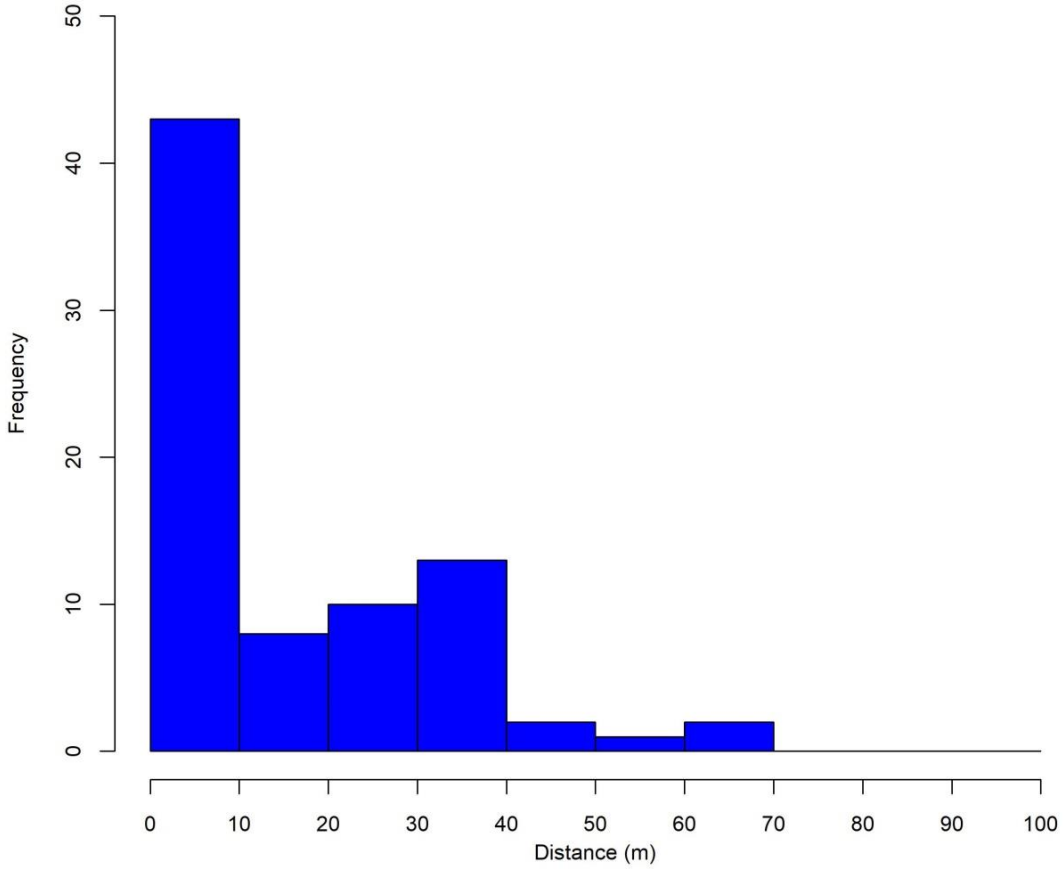

Figure 10. Distance from the Turbine of Bat Carcasses Included in the Analysis for MidAmerican Energy Company O'Brien Wind Energy Facility Found between March 16, 2017, and March 15, 2018.

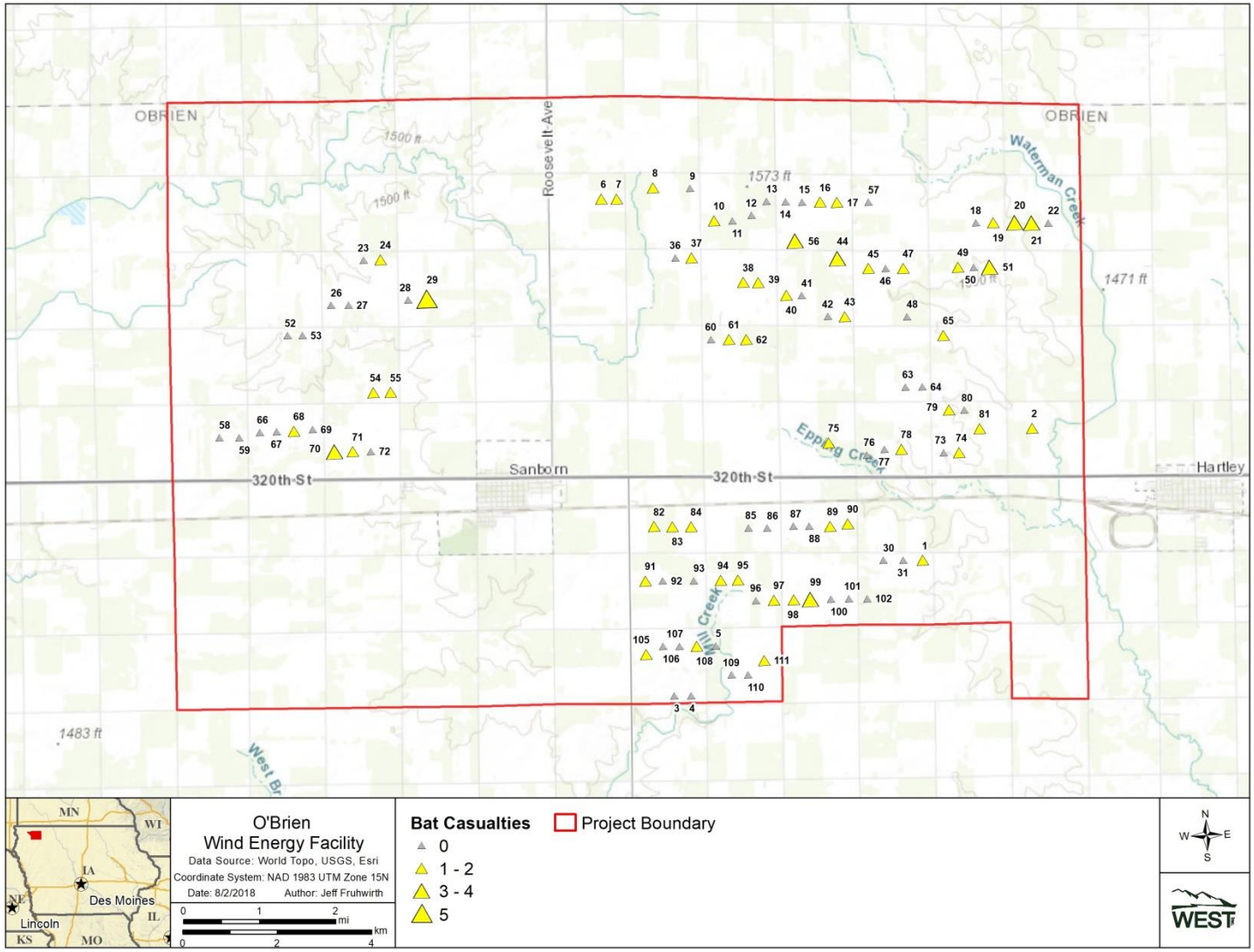

Figure 11. Bat Carcasses per Turbine found at the O'Brien Wind Energy Facility between March 16, 2017, and March 15, 2018.

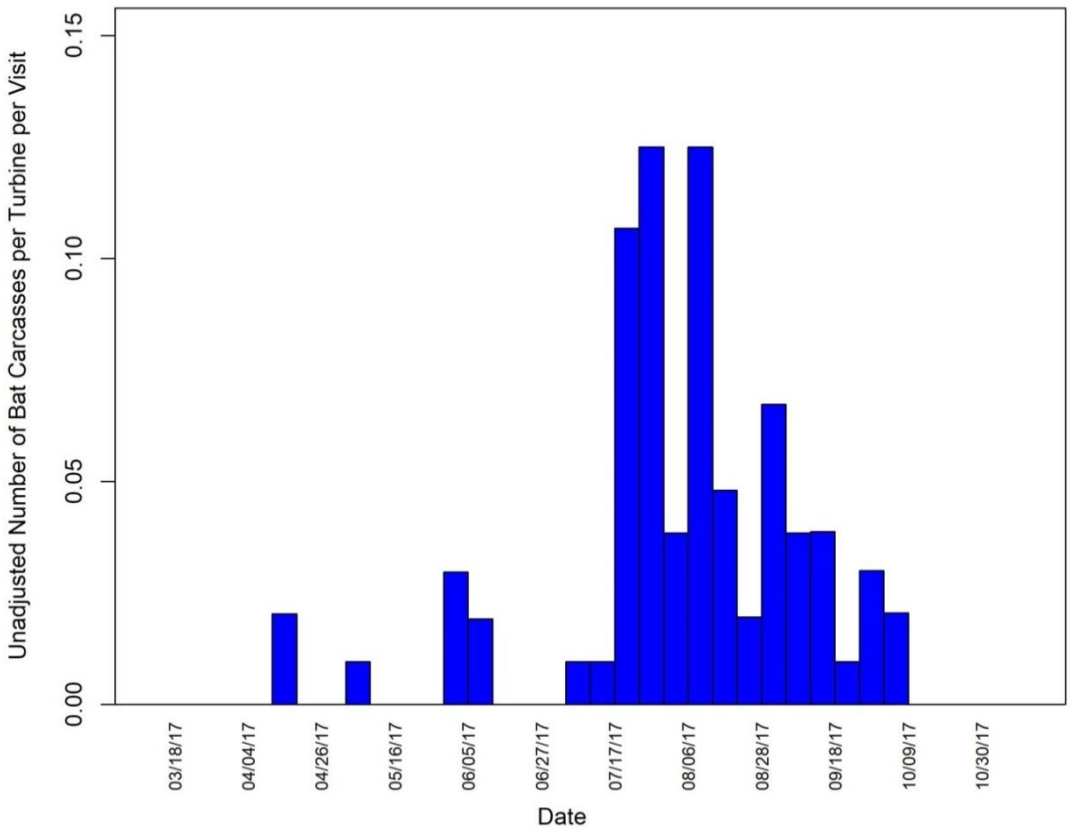

Figure 12. Frequency of Bats per Turbine at the O'Brien Wind Energy Facility during each Visit between March 16, 2017, and March 15, 2018.

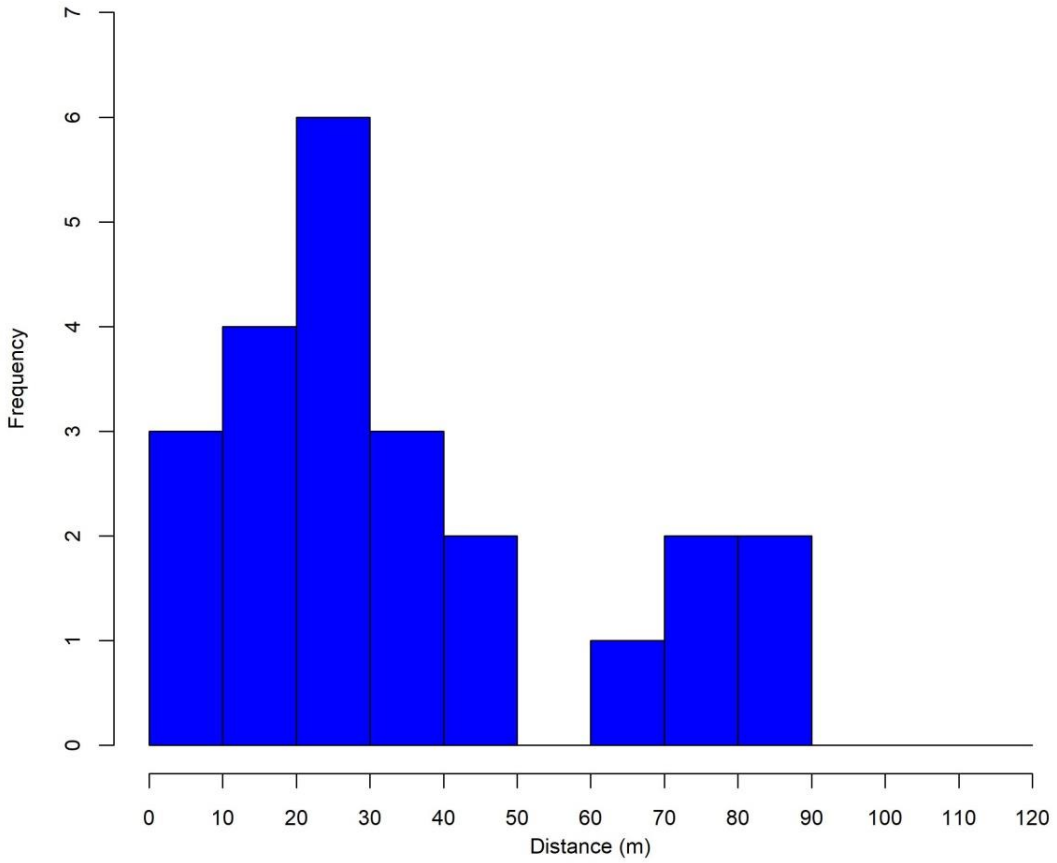

Figure 13. Distance from the Turbine of Bird Carcasses Included in the Analysis for the O'Brien Wind Energy Facility Found between March 16, 2017, and March 15, 2018.

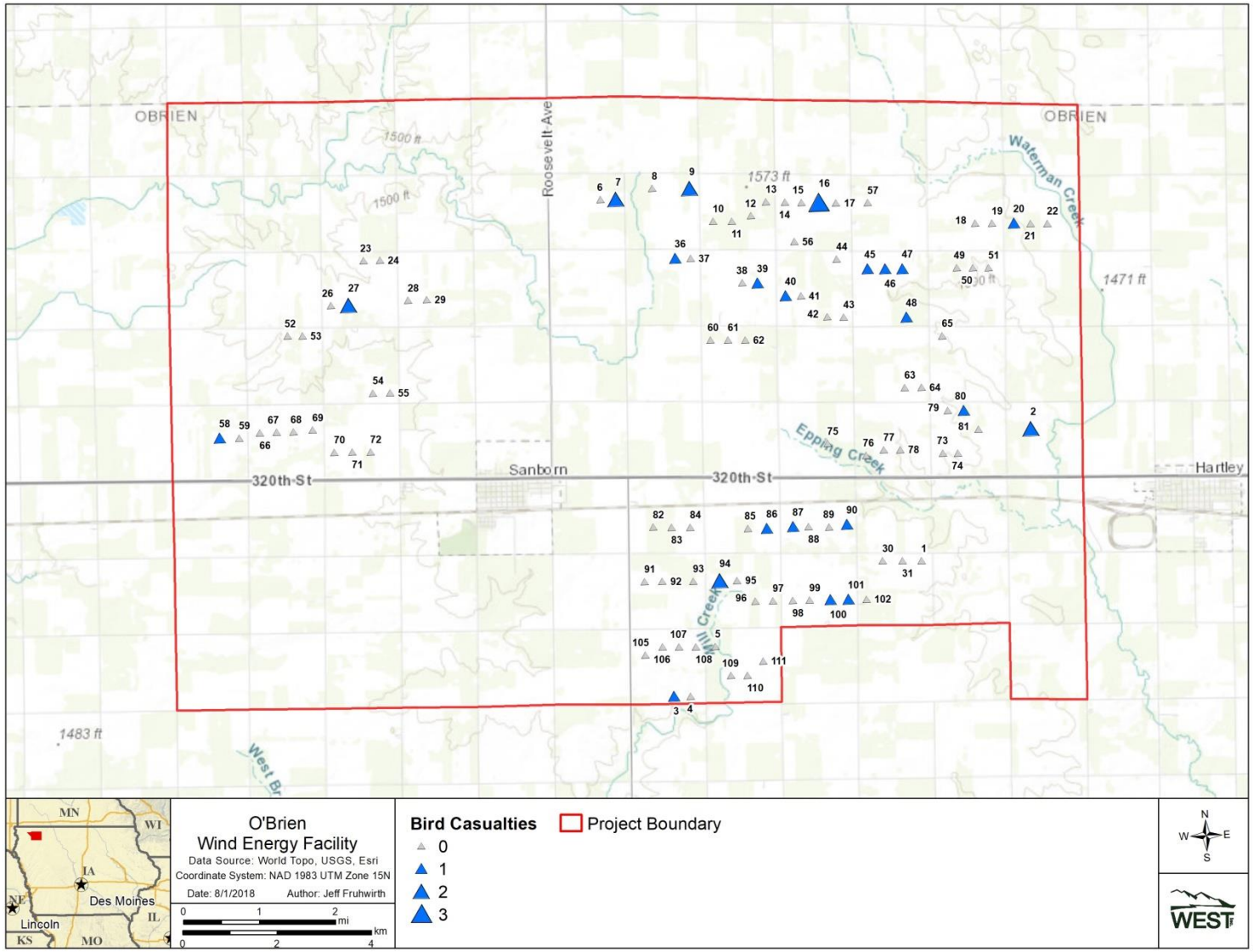

Figure 14. Bird Carcasses per Turbine found at the O'Brien Wind Energy Facility between March 16, 2017, and March 15, 2018.

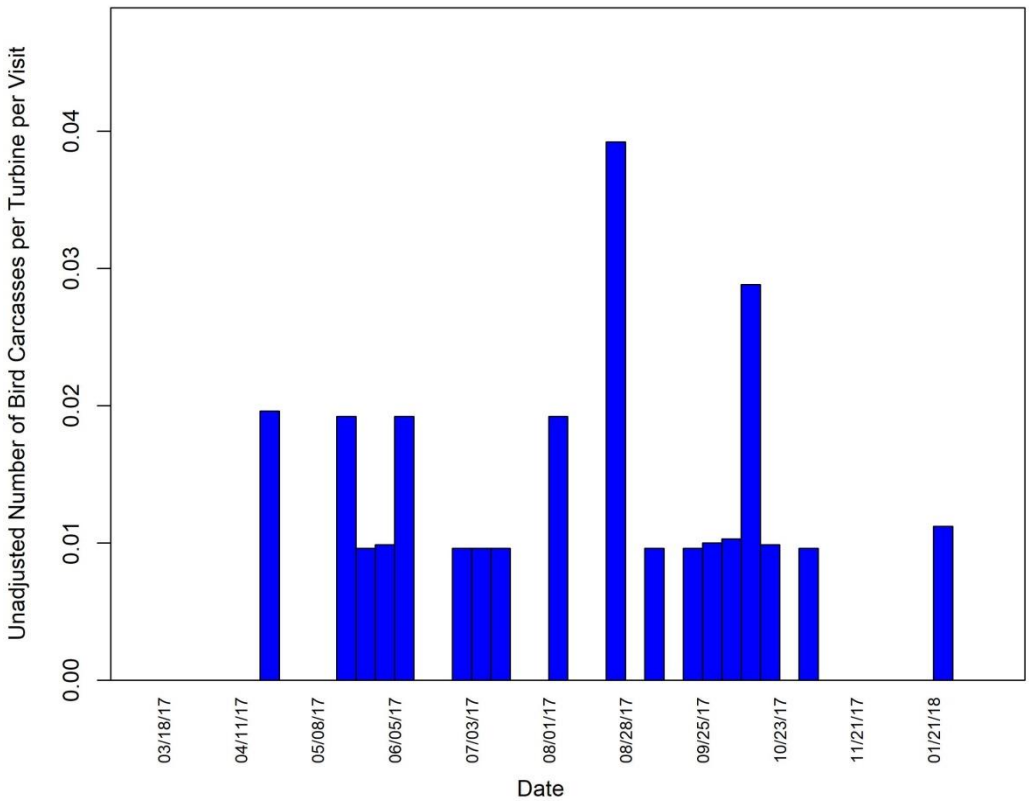

Figure 15. Frequency of Bird Carcasses per Turbine at the O'Brien Wind Energy Facility during each Visit between March 16, 2017, and March 15, 2018.

Censored Carcasses

Of the 85 bat carcasses found, three were carcasses were excluded from analysis because they were not on search plots (Table 3). Among the remaining 82 bat carcasses, 97.5% were estimated to have died within seven days (Table 13). Three bat carcasses had an estimated time of death longer than the previous turbine-specific search interval and were censored from the analysis (Table 3). A total of 79 bat carcasses were included in the fatality estimate (Table 3).

Of the 29 bird carcasses found, four were found outside designated search areas and were excluded from the analyses (Table 3). All but two bird carcasses were estimated to have fallen within the previous turbine-specific search interval (Table 3). A total of 23 bird carcasses were included in fatality estimation (Table 3).

Table 13. Estimated Time Since Death for Carcasses Found on Search Plots at the O'Brien Wind Energy Facility from March 16, 2017, to March 15, 2018.

Size Class	Estimated Time Since Death	O'Brien	
		# of Carcasses	% Composition
Bat	Last Night	42	51.2
	2-3 Days	16	19.5
	4-7 Days	22	26.8
	7-14 Days	2	2.4
	> 2 Weeks	0	0
	> 1 Month	0	0
	Unknown	0	0
Large Bird	Last Night	2	25.0
	2-3 Days	1	12.5
	4-7 Days	3	37.5
	7-14 Days	0	0
	> 2 Weeks	0	0
	> 1 Month	0	0
	Unknown	2	25.0
Small Bird	Last Night	9	52.9
	2-3 Days	2	11.8
	4-7 Days	5	29.4
	7-14 Days	1	5.9
	> 2 Weeks	0	0
	> 1 Month	0	0
	Unknown	0	0

Searcher Efficiency

A total of 190 carcasses (106 bats, 40 large birds, and 44 small birds) were available to be found for searcher efficiency trials between March 16, 2017, and March 15, 2018 (Table 14). For bats, the selected model included season (Table 15). The bat searcher efficiency rate was 0.42 in spring, 0.76 in summer, and 0.87 in fall (Table 16). No response variables were included in the selected model for large or small birds, resulting in an overall searcher efficiency rate of 0.95 and 0.80, respectively (Tables 15 and 16).

Table 14. Searcher efficiency results at the O'Brien Wind Energy Facility as a Function of Season and Carcass Size.

Size Class	Season	# Placed	# Available	# Found	% Found
Bat	Spring	20	19	8	42.1
	Summer	43	41	31	75.6
	Fall	47	46	40	87.0
	Overall	**110**	**106**	**79**	**74.5**
Large Bird	Spring	10	9	8	88.9
	Summer	10	10	10	100
	Fall	10	10	9	90.0
	Winter	11	11	11	100
	Overall	**41**	**40**	**38**	**95.0**
Small Bird	Spring	12	12	10	83.3
	Summer	10	10	10	100
	Fall	11	11	9	81.8
	Winter	12	11	6	54.5
	Overall	**45**	**44**	**35**	**79.6**

Table 15. Searcher Efficiency Logistic Regression Models for Bats from the O'Brien Wind Energy Facility Search Efficiency Trials. Selected Models are Denoted by an Asterisk in the 'DeltaAICc' Column.

Size Class	Covariate	AICc	DeltaAICc
Bat	Season	113.28	0*
	Null	122.34	9.06
Large Bird	Null	17.99	0*
	Season	21.92	3.94
Small Bird	Season	45.43	0
	Null	46.68	1.25*

Table 16. Searcher Efficiency Rates for the O'Brien Wind Energy Facility from March 16, 2017, to March 15, 2018.

Size Class	Spring	Summer	Fall	Winter
Bat	0.42	0.76	0.87	-
Large Bird	0.95	0.95	0.95	0.95
Small Bird	0.80	0.80	0.80	0.80

Carcass Persistence Time

A total of 120 carcasses (54 bats, 34 large birds, and 32 small birds) were placed in the project area for carcass persistence trials during the monitoring period. The selected model included season as a covariate for bats and used a loglogistic distribution (Table 17). The average carcass persistence time for bats ranged from 0.94 days in the fall to 4.69 days in the spring (Table 18). For large birds, the model included season as a covariate and used an exponential distribution (Table 17). For large birds, the average persistence time was shortest in fall (2.99 days) followed by spring (12.43 days), summer (13.15 days), and longest in winter (25.75 days; Table 18). For small birds, the model included no covariates and used a Weibull distribution (Table 17). The overall average carcass persistence time for small birds was 7.24 days (Table 18).

Table 17. Carcass Persistence Models and Parameters at the O'Brien Wind Energy Facility. Selected Models are Denoted by an Asterisk in the 'DeltaAICc' Column.

Size Class	Covariate	Distribution	AICc	Delta AICc
Bat	Season	Loglogistic	205.93	0*
	Season	Lognormal	207.25	1.31
	Season	Weibull	208.59	2.65
	Season	Exponential	208.63	2.69
	Null Model	Loglogistic	216.83	10.90
	Null Model	Lognormal	217.29	11.35
	Null Model	Weibull	217.85	11.92
	Null Model	Exponential	225.21	19.27
Large Bird	Season	Exponential	143.84	0*
	Season	Loglogistic	144.90	1.06
	Season	Lognormal	145.73	1.89
	Season	Weibull	146.22	2.38
	Null Model	Exponential	151.23	7.39
	Null Model	Weibull	152.77	8.93
	Null Model	Loglogistic	153.95	10.11
	Null Model	Lognormal	154.85	11.01

Table 17. Carcass Persistence Models and Parameters at the O'Brien Wind Energy Facility. Selected Models are Denoted by an Asterisk in the 'DeltaAICc' Column.

Size Class	Covariate	Distribution	AICc	Delta AICc
Small Bird	Season	Exponential	145.78	0
	Season	Weibull	147.27	1.49
	Null Model	Weibull	147.30	1.52*
	Null Model	Lognormal	149.19	3.41
	Null Model	Loglogistic	149.69	3.92
	Null Model	Exponential	149.99	4.21
	Season	Loglogistic	151.30	5.52
	Season	Lognormal	151.63	5.85

Table 18. Carcass Persistence Top Models with Covariates, Distributions, and Model Parameters for the O'Brien Wind Energy Facility.

Size	Season	Distribution	Mean Removal Time	Scale
Bat	Spring	Loglogistic	4.69	0.68
	Summer	Loglogistic	3.54	0.68
	Fall	Loglogistic	0.94	0.68
Large Bird	Spring	Exponential	12.43	1.00
	Summer	Exponential	13.15	1.00
	Fall	Exponential	2.99	1.00
	Winter	Exponential	25.75	1.00
Small Bird	All	Weibull	7.24	1.41

Search Area Adjustment

Sufficient numbers of bat carcasses were found to fit distributions separately and these distributions were combined with the proportion of area searched to produce an area correction for bats. A Weibull distribution was selected for bats. There were not sufficient numbers of small or large birds found to fit facility-specific bird distributions; therefore, the physics-based Hull and Muir model was used. Search area adjustments are listed in Table 19.

Table 19. Search Area Adjustment Values for O'Brien Wind Energy Facility Studied from March 16, 2017, to March 15, 2018.

Size Class	Area Correction
Bat	0.08
Large Bird	0.16
Small Bird	0.21

Adjusted Fatality Estimate

Bats

The estimated fatality rate for bats was much higher in fall (18.41 bats/MW/season) than in summer (0.75 bats/MW) and spring (0.56 bats/MW; Table 20, Appendix D). The overall estimated fatality rate across all seasons was 19.72 bats/MW/year (Table 21).

Large Birds

The estimated fatality rate for large birds was calculated for summer and fall; no large bird carcasses were found on search plots in winter and spring. The estimated large bird fatality rate was 0.34 large birds/MW in fall and 0.11 large birds/MW in summer (Table 20).

Raptors

Estimated fatality rates for raptors were calculated for fall, the only season when raptors were found on search plots. The raptor fatality estimate was 0.06 raptors/MW/year (Table 20).

Small Birds

The estimated fatality rates for small birds was highest in fall (0.39 small birds/MW/season). Summer (0.11 small birds/MW/season), spring (0.08), and winter (0.04) had similar estimated fatality rates. The overall small bird estimate was 0.62 small birds/MW/year (Table 21).

All Birds

The estimated fatality rate for all birds was highest in fall (0.72 birds/MW/season) followed by summer (0.22 birds/MW/season). Spring and winter had similar estimated fatality rates with 0.08 and 0.04 birds/MW/season, respectively (Table 20). Across all seasons, the estimated fatality rate was 1.07 birds/MW/year (Table 21, Appendix D).

Table 20. Adjusted Fatality Rate Estimate (Fatalities/MW/Year) and 90% Confidence Intervals (CIs)[1] at the O'Brien Wind Energy Facility, O'Brien County, from March 16, 2017, to March 15, 2018.

Size Class	Spring		Summer		Fall		Winter	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Bat	0.56	0.12 - 1.51	0.75	0.3 - 1.39	18.41	12.40 - 31.04	-	-
Large Bird	0		0.11	0.03 - 0.24	0.34	0.11 - 0.76	0	
Raptor	0		0		0.06	0 - 0.22	0	
Small Bird	0.08	0 - 0.19	0.11	0.03 - 0.23	0.39	0.18 - 0.65	0.04	0 - 0.13
All Bird	0.08	0 - 0.19	0.22	0.08 - 0.39	0.72	0.41 - 1.23	0.04	0 - 0.13

[1.] 90% confidence intervals (Cis) were not calculated when fewer than five carcasses were included in the analysis

Table 21. Overall Fatality Rates per Turbine and per Megawatt (MW) for Studies Conducted at the O'Brien Wind Energy Facility, O'Brien County, Iowa, from March 16, 2017, to March 15, 2018.

Size Class	Per Turbine		Per MW	
	Estimate	90% Confidence Interval	Estimate	90% Confidence Interval
Bat	47.47	32.73 - 78.29	19.72	13.60 - 32.52
Large Bird	1.08	0.49 - 2.18	0.45	0.20 - 0.90
Raptor	0.15	0 - 0.52	0.06	0 - 0.22
Small Bird	1.49	0.85 - 2.28	0.62	0.35 - 0.95
All Bird	2.57	1.63 - 4.03	1.07	0.68 - 1.67

DISCUSSION

The approach outlined by the Huso method was used for calculating adjusted fatality estimates and has been frequently used to calculate fatality estimates in recent post-construction monitoring studies at wind projects throughout the U.S. The method accounts for search interval, searcher efficiency rates, carcass persistence rates, and search area. Fatality estimates calculated using the Huso estimator are comparable to post-construction monitoring work conducted at the other facilities in MidAmerican's Wind I-X Energy portfolio between December 2014 and November 2017.

Given the primary objective of this survey effort, the generally low bird mortality, and the lack of bird species listed under the ESA, by the IDNR, or protected under the Bald and Golden Eagle Protection Act of 1940 found, there will be no discussion of bird mortality. No bat species listed under the ESA or by the IDNR were found; therefore, the discussion will focus on all-bat carcasses and ongoing research that incorporates data collected at the Ida Grove and O'Brien facilities.

Bat Carcasses

Landscape and habitat context have long been hypotheses to explain bat carcasses at wind energy facilities; however the risk profile for bats at wind energy facilities appears to be more complex than initially thought. For example, clear cutting into the forested ridges on which some wind energy facilities are built in the eastern U.S. was thought to contribute to the relatively high numbers of bat carcasses at these sites, as clearings create potential foraging habitat and ridges may serve as attractive linear features during foraging, commuting, or migration (Kunz et al. 2007). However, relatively large numbers of bat carcasses found at some Midwestern wind facilities indicate that facilities in open landscapes may also pose risk to bats (Gruver et al. 2009; BHE Environmental 2010, 2011, Good et al. 2013a, 2013b, Bay et al. 2016, 2017). Anecdotal information indicates that insects differentially use habitats and that bat mortalities are high in croplands where insect use is high. Data collected at Ida Grove and O'Brien will be used, along with the large dataset collected at the remaining facilities in MidAmerican's Wind I-X fleet to evaluate whether the habitat surrounding turbines influences bat mortalities.

All-bat fatality rates at Ida Grove and O'Brien were among the higher rates in MidAmerican's Wind I-X fleet (Table 22). Post-construction fatality monitoring at Ida Grove and O'Brien began approximately three months after the facilities became operational, and similarly high fatality rates had previously been recorded at other facilities that were surveyed shortly after the became operational, such as Macksburg and Lundgren. MidAmerican has funded research to explore if a relationship exists between bat fatality rates at a facility and time since the facility became operational. Such research will potentially increase understanding of how the direct impact (take) of an operational wind energy facility changes over time, if such a pattern exists.

Data collected at Ida Grove and O'Brien are being used in other research, such as understanding the effects of weather of bat fatality timing, improvement of take

estimation, and improvement of minimization measures. The MidAmerican dataset is large and provides a useful case study to increase understanding of the covariates that influence bat mortality on a spatial and temporal scale, as well as quantifying the effectiveness of minimization strategies. Understanding these covariates will enable MidAmerican to develop more effective and more efficient minimization strategies.

Table 22. Facility-specific All Bat Fatality Estimates by Year and Observed Number of Carcass from the Monitoring Studies of the MidAmerican Energy Company's Fleet of Wind Energy Projects in Iowa.

Facility	Year	Number of Turbines	Fatality Estimates (per MW)	Number of INBA	Number of NLEB	Number of LBBA	Number of TRBA	Number of Other Bats
Adair	2015	76	14.05	0	0	0	0	54
Adams	2016	64	10.08	0	0	0	4	189
Carroll	2015	100	11.71	0	0	0	0	56
Century	2016	145	9.07	0	0	1	2	185
Charles City	2016	50	10.41	0	0	13	0	88
Eclipse	2015	87	10.01	0	0	0	1	71
Highland	2016	214	8.63	0	0	1	7	367
Intrepid	2016	122	18.37	0	0	0	0	188
Laurel	2016	52	14.22	0	0	1	0	95
Lundgren	2015	107	28.74	0	0	26	7	264
Lundgren	2016	107	8.80	0	0	4	2	241
Macksburg	2015	51	73.08	0	0	8	7	136
Macksburg	2016	51	10.79	1	0	6	3	180
Morning Light	2015	44	20.19	0	0	0	1	48
Pomeroy	2016	184	6.25	0	0	0	1	124
Rolling Hills	2015	193	6.13	0	0	0	2	126
Rolling Hills	2016	193	6.30	0	0	1	5	247
Victory	2015	66	6.48	0	0	0	0	21
Vienna I	2016	45	9.09	0	0	3	1	119
Vienna II	2016	19	10.28	0	0	2	1	50
Walnut	2015	102	21.69	0	0	0	0	79
Wellsburg	2016	60	12.30	0	0	7	1	161
O'Brien	**2017**	**104**	**19.72**	**0**	**0**	**0**	**1**	**84**
Ida Grove	**2017**	**134**	**38.80**	**0**	**0**	**0**	**0**	**492**

MW = megawatt; INBA = Indiana bat, NLEB = northern long-eared bat; LBBA = little brown bat, TRBA = tricolored bat
Source: Bay et al. 2016, 2017; MidAmerican Energy Company 2018

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Appendix A: Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
			Bats			
4/10/2017	silver-haired bat	144	7	carcass search	road/pad	injured
4/10/2017	silver-haired bat	116	37	incidental	road/pad	intact
4/10/2017	silver-haired bat	113	7	carcass search	road/pad	intact
4/11/2017	silver-haired bat	144	0	incidental	road/pad	injured
4/13/2017	silver-haired bat	123	7	carcass search	full plot	scavenged
4/15/2017	silver-haired bat	47	5	carcass search	road/pad	scavenged
4/15/2017	silver-haired bat	32	0	carcass search	road/pad	intact
4/16/2017	silver-haired bat	57	7	carcass search	road/pad	intact
4/16/2017	silver-haired bat	142	86	carcass search	road/pad	intact
4/16/2017	silver-haired bat	129	26	carcass search	full plot	injured
4/16/2017	silver-haired bat	130	43	carcass search	full plot	intact
4/16/2017	silver-haired bat	130	58	carcass search	full plot	scavenged
4/18/2017	silver-haired bat	37	10	carcass search	full plot	dismembered
4/19/2017	silver-haired bat	57	21	carcass search	road/pad	scavenged
4/19/2017	silver-haired bat	140	22	carcass search	road/pad	intact
4/19/2017	silver-haired bat	103	17	carcass search	full plot	scavenged
4/20/2017	silver-haired bat	123	1	carcass search	full plot	scavenged
4/20/2017	silver-haired bat	130	32	carcass search	full plot	intact
4/23/2017	silver-haired bat	72	11	incidental	full plot	feather spot
4/24/2017	silver-haired bat	116	26	carcass search	road/pad	intact
4/24/2017	silver-haired bat	44	7	carcass search	road/pad	intact
4/25/2017	silver-haired bat	129	11	carcass search	full plot	intact
5/3/2017	eastern red bat	101	89	carcass search	road/pad	dismembered
5/12/2017	big brown bat	54	6	carcass search	road/pad	intact
5/15/2017	big brown bat	47	9	carcass search	road/pad	scavenged
5/15/2017	eastern red bat	33	7	carcass search	road/pad	intact
5/15/2017	silver-haired bat	10	6	carcass search	road/pad	intact
5/16/2017	eastern red bat	138	24	carcass search	full plot	intact
5/16/2017	silver-haired bat	62	49	carcass search	full plot	intact
5/16/2017	silver-haired bat	93	6	carcass search	road/pad	intact
5/16/2017	silver-haired bat	138	21	carcass search	full plot	intact
5/18/2017	hoary bat	29	13	carcass search	full plot	scavenged
5/18/2017	hoary bat	35	14	carcass search	full plot	intact
5/19/2017	evening bat	96	31	carcass search	full plot	intact
5/19/2017	hoary bat	58	86	carcass search	road/pad	intact
5/19/2017	hoary bat	81	36	carcass search	full plot	intact
5/22/2017	hoary bat	130	6	carcass search	full plot	scavenged
5/25/2017	eastern red bat	37	34	incidental	full plot	injured
5/25/2017	silver-haired bat	129	15	carcass search	full plot	intact
5/27/2017	big brown bat	31	5	carcass search	full plot	intact
5/30/2017	hoary bat	1	5	carcass search	road/pad	intact
6/3/2017	eastern red bat	121	3	carcass search	road/pad	intact
6/3/2017	evening bat	77	28	incidental	full plot	scavenged
6/3/2017	hoary bat	77	39	carcass search	full plot	injured
6/3/2017	hoary bat	96	55	carcass search	full plot	scavenged
6/5/2017	eastern red bat	69	18	carcass search	road/pad	intact
6/5/2017	eastern red bat	138	23	incidental	full plot	intact
6/5/2017	eastern red bat	124	30	incidental	full plot	intact
6/6/2017	evening bat	102	20	carcass search	road/pad	intact
6/6/2017	evening bat	80	18	carcass search	full plot	intact
6/8/2017	silver-haired bat	29	26	carcass search	full plot	intact
6/9/2017	big brown bat	109	2	carcass search	road/pad	intact
6/9/2017	eastern red bat	67	26	carcass search	road/pad	intact
6/10/2017	eastern red bat	18	34	carcass search	road/pad	intact
6/12/2017	eastern red bat	132	45	carcass search	road/pad	intact
6/15/2017	big brown bat	61	29	incidental	full plot	intact
6/15/2017	eastern red bat	128	4	carcass search	road/pad	intact
6/15/2017	hoary bat	60	40	carcass search	full plot	scavenged
6/17/2017	big brown bat	48	10	carcass search	road/pad	intact
6/17/2017	hoary bat	92	2	carcass search	road/pad	intact
6/17/2017	hoary bat	76	0	carcass search	road/pad	intact
6/17/2017	hoary bat	61	30	carcass search	full plot	intact
6/18/2017	big brown bat	135	6	carcass search	road/pad	intact
6/20/2017	eastern red bat	61	39	carcass search	full plot	scavenged

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
6/21/2017	big brown bat	103	1	carcass search	full plot	intact
6/21/2017	eastern red bat	128	98	carcass search	road/pad	intact
6/23/2017	big brown bat	75	4	carcass search	road/pad	scavenged
6/26/2017	big brown bat	48	4	carcass search	road/pad	intact
6/26/2017	hoary bat	47	2	carcass search	road/pad	intact
6/29/2017	eastern red bat	43	2	carcass search	road/pad	intact
6/29/2017	evening bat	99	17	carcass search	road/pad	dismembered
6/30/2017	big brown bat	58	38	carcass search	road/pad	intact
7/2/2017	hoary bat	20	7	carcass search	road/pad	intact
7/3/2017	big brown bat	81	22	carcass search	full plot	intact
7/3/2017	hoary bat	108	4	carcass search	road/pad	scavenged
7/5/2017	eastern red bat	46	11	carcass search	road/pad	intact
7/5/2017	hoary bat	62	41	carcass search	full plot	intact
7/5/2017	hoary bat	92	2	carcass search	road/pad	intact
7/6/2017	eastern red bat	136	43	carcass search	road/pad	intact
7/8/2017	big brown bat	70	6	carcass search	road/pad	intact
7/8/2017	eastern red bat	28	5	carcass search	road/pad	scavenged
7/8/2017	hoary bat	39	9	carcass search	road/pad	intact
7/9/2017	hoary bat	95	37	carcass search	full plot	dismembered
7/11/2017	big brown bat	48	0	carcass search	road/pad	injured
7/11/2017	eastern red bat	116	7	carcass search	road/pad	intact
7/11/2017	eastern red bat	62	55	carcass search	full plot	injured
7/11/2017	hoary bat	62	43	carcass search	full plot	scavenged
7/11/2017	hoary bat	39	8	carcass search	road/pad	scavenged
7/12/2017	big brown bat	142	15	carcass search	road/pad	intact
7/12/2017	hoary bat	138	31	carcass search	full plot	scavenged
7/13/2017	big brown bat	101	1	carcass search	road/pad	intact
7/14/2017	big brown bat	30	11	carcass search	full plot	intact
7/14/2017	eastern red bat	70	3	carcass search	road/pad	scavenged
7/14/2017	hoary bat	30	58	carcass search	full plot	intact
7/15/2017	big brown bat	120	4	carcass search	road/pad	injured
7/15/2017	eastern red bat	137	43	carcass search	full plot	intact
7/15/2017	eastern red bat	138	40	carcass search	full plot	intact
7/15/2017	eastern red bat	143	59	carcass search	road/pad	intact
7/15/2017	hoary bat	80	11	carcass search	full plot	intact
7/15/2017	hoary bat	80	4	carcass search	full plot	intact
7/16/2017	big brown bat	131	5	carcass search	road/pad	scavenged
7/16/2017	eastern red bat	109	5	carcass search	road/pad	scavenged
7/16/2017	eastern red bat	108	52	carcass search	road/pad	scavenged
7/16/2017	hoary bat	134	36	carcass search	road/pad	scavenged
7/17/2017	big brown bat	99	5	carcass search	road/pad	dismembered
7/17/2017	big brown bat	40	6	carcass search	road/pad	intact
7/17/2017	big brown bat	23	9	carcass search	road/pad	scavenged
7/17/2017	eastern red bat	56	25	carcass search	road/pad	intact
7/17/2017	eastern red bat	76	17	carcass search	road/pad	intact
7/17/2017	hoary bat	69	6	carcass search	road/pad	intact
7/17/2017	hoary bat	52	9	carcass search	road/pad	intact
7/17/2017	hoary bat	37	9	carcass search	full plot	intact
7/18/2017	big brown bat	57	7	carcass search	road/pad	intact
7/18/2017	big brown bat	60	21	carcass search	full plot	intact
7/18/2017	eastern red bat	67	6	carcass search	road/pad	intact
7/18/2017	eastern red bat	77	38	carcass search	full plot	intact
7/18/2017	eastern red bat	60	10	carcass search	full plot	dismembered
7/18/2017	evening bat	122	8	carcass search	road/pad	scavenged
7/18/2017	hoary bat	65	27	carcass search	road/pad	intact
7/18/2017	hoary bat	66	8	carcass search	road/pad	intact
7/18/2017	hoary bat	127	9	carcass search	road/pad	intact
7/18/2017	hoary bat	40	50	incidental	road/pad	intact
7/18/2017	hoary bat	127	10	carcass search	road/pad	intact
7/18/2017	hoary bat	119	5	carcass search	road/pad	injured
7/19/2017	big brown bat	43	7	carcass search	road/pad	intact
7/19/2017	big brown bat	48	17	incidental	road/pad	intact
7/20/2017	eastern red bat	63	5	carcass search	full plot	intact
7/20/2017	eastern red bat	15	12	carcass search	full plot	scavenged
7/20/2017	eastern red bat	25	5	carcass search	road/pad	scavenged

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
7/20/2017	hoary bat	71	2	carcass search	road/pad	intact
7/20/2017	hoary bat	72	32	carcass search	full plot	scavenged
7/20/2017	hoary bat	20	2	carcass search	road/pad	intact
7/20/2017	hoary bat	48	8	carcass search	road/pad	intact
7/20/2017	hoary bat	51	14	carcass search	road/pad	scavenged
7/21/2017	big brown bat	48	8	incidental	road/pad	intact
7/21/2017	eastern red bat	135	2	carcass search	road/pad	dismembered
7/21/2017	eastern red bat	83	8	carcass search	road/pad	scavenged
7/21/2017	eastern red bat	57	10	carcass search	road/pad	intact
7/21/2017	eastern red bat	60	3	carcass search	full plot	intact
7/21/2017	eastern red bat	109	6	carcass search	road/pad	scavenged
7/21/2017	hoary bat	87	7	carcass search	road/pad	scavenged
7/21/2017	hoary bat	59	52	carcass search	road/pad	intact
7/21/2017	hoary bat	135	49	carcass search	road/pad	scavenged
7/21/2017	hoary bat	135	10	carcass search	road/pad	intact
7/21/2017	hoary bat	112	6	carcass search	road/pad	intact
7/21/2017	hoary bat	60	18	carcass search	full plot	intact
7/22/2017	big brown bat	132	7	carcass search	road/pad	scavenged
7/22/2017	big brown bat	126	19	carcass search	road/pad	scavenged
7/22/2017	big brown bat	28	3	incidental	road/pad	scavenged
7/22/2017	eastern red bat	103	25	carcass search	full plot	scavenged
7/22/2017	eastern red bat	121	33	carcass search	road/pad	scavenged
7/22/2017	eastern red bat	100	6	carcass search	road/pad	intact
7/22/2017	hoary bat	95	23	carcass search	full plot	scavenged
7/23/2017	big brown bat	116	39	carcass search	road/pad	intact
7/23/2017	big brown bat	99	8	carcass search	road/pad	intact
7/23/2017	big brown bat	101	6	carcass search	road/pad	scavenged
7/23/2017	big brown bat	23	3	carcass search	road/pad	intact
7/23/2017	big brown bat	8	0	carcass search	road/pad	intact
7/23/2017	eastern red bat	23	15	carcass search	road/pad	intact
7/23/2017	eastern red bat	44	27	carcass search	road/pad	intact
7/23/2017	eastern red bat	32	38	carcass search	road/pad	intact
7/23/2017	eastern red bat	25	6	carcass search	road/pad	intact
7/23/2017	eastern red bat	31	1	carcass search	full plot	scavenged
7/23/2017	hoary bat	43	8	carcass search	road/pad	scavenged
7/23/2017	hoary bat	34	3	carcass search	road/pad	scavenged
7/23/2017	hoary bat	40	12	carcass search	road/pad	scavenged
7/23/2017	silver-haired bat	28	12	carcass search	road/pad	intact
7/24/2017	big brown bat	98	2	carcass search	road/pad	scavenged
7/24/2017	big brown bat	94	11	carcass search	road/pad	scavenged
7/24/2017	big brown bat	106	7	carcass search	road/pad	scavenged
7/24/2017	big brown bat	65	45	carcass search	road/pad	scavenged
7/24/2017	big brown bat	68	6	carcass search	road/pad	dismembered
7/24/2017	big brown bat	119	5	carcass search	road/pad	scavenged
7/24/2017	eastern red bat	77	5	carcass search	full plot	intact
7/24/2017	eastern red bat	95	30	carcass search	full plot	scavenged
7/24/2017	hoary bat	104	22	carcass search	full plot	scavenged
7/24/2017	hoary bat	142	8	carcass search	road/pad	scavenged
7/26/2017	big brown bat	62	15	carcass search	full plot	intact
7/26/2017	big brown bat	53	10	carcass search	road/pad	scavenged
7/26/2017	eastern red bat	52	6	carcass search	road/pad	intact
7/26/2017	eastern red bat	71	17	carcass search	road/pad	dismembered
7/26/2017	eastern red bat	92	18	carcass search	road/pad	intact
7/26/2017	eastern red bat	69	2	carcass search	road/pad	scavenged
7/26/2017	eastern red bat	32	5	carcass search	road/pad	injured
7/26/2017	eastern red bat	31	44	carcass search	full plot	intact
7/26/2017	hoary bat	61	46	carcass search	full plot	dismembered
7/26/2017	hoary bat	12	32	carcass search	road/pad	scavenged
7/27/2017	big brown bat	125	8	carcass search	road/pad	scavenged
7/27/2017	big brown bat	66	36	carcass search	road/pad	scavenged
7/27/2017	big brown bat	57	0	carcass search	road/pad	scavenged
7/27/2017	eastern red bat	123	41	carcass search	full plot	injured
7/27/2017	eastern red bat	91	31	carcass search	road/pad	scavenged
7/27/2017	eastern red bat	91	10	carcass search	road/pad	scavenged
7/27/2017	hoary bat	57	0	carcass search	road/pad	dismembered

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
7/27/2017	hoary bat	85	46	carcass search	road/pad	scavenged
7/27/2017	hoary bat	96	1	carcass search	full plot	intact
7/28/2017	big brown bat	97	38	carcass search	road/pad	intact
7/28/2017	big brown bat	56	7	carcass search	road/pad	intact
7/28/2017	eastern red bat	112	1	carcass search	road/pad	intact
7/29/2017	big brown bat	15	4	carcass search	full plot	scavenged
7/29/2017	big brown bat	31	3	carcass search	full plot	intact
7/29/2017	eastern red bat	33	3	carcass search	road/pad	scavenged
7/29/2017	eastern red bat	63	9	carcass search	full plot	intact
7/29/2017	eastern red bat	40	3	carcass search	road/pad	scavenged
7/29/2017	eastern red bat	38	41	carcass search	road/pad	intact
7/29/2017	hoary bat	76	6	carcass search	road/pad	scavenged
7/29/2017	hoary bat	12	40	carcass search	road/pad	scavenged
7/29/2017	hoary bat	71	6	carcass search	road/pad	intact
7/29/2017	silver-haired bat	28	47	carcass search	road/pad	intact
7/30/2017	big brown bat	77	23	carcass search	full plot	scavenged
7/30/2017	eastern red bat	93	6	carcass search	road/pad	scavenged
7/30/2017	eastern red bat	111	21	carcass search	road/pad	scavenged
7/30/2017	eastern red bat	109	8	carcass search	road/pad	scavenged
7/30/2017	eastern red bat	127	78	carcass search	road/pad	scavenged
7/30/2017	eastern red bat	125	3	carcass search	road/pad	scavenged
7/30/2017	eastern red bat	87	35	carcass search	road/pad	scavenged
7/30/2017	hoary bat	130	31	carcass search	full plot	scavenged
7/30/2017	hoary bat	144	7	carcass search	road/pad	scavenged
7/30/2017	hoary bat	67	7	carcass search	road/pad	scavenged
7/30/2017	hoary bat	77	27	carcass search	full plot	scavenged
7/30/2017	hoary bat	124	12	carcass search	full plot	intact
8/1/2017	big brown bat	48	7	carcass search	road/pad	injured
8/1/2017	big brown bat	48	9	carcass search	road/pad	intact
8/1/2017	big brown bat	101	7	carcass search	road/pad	intact
8/1/2017	big brown bat	9	7	carcass search	road/pad	scavenged
8/1/2017	big brown bat	9	6	carcass search	road/pad	scavenged
8/1/2017	big brown bat	49	3	carcass search	road/pad	intact
8/1/2017	eastern red bat	14	26	carcass search	full plot	scavenged
8/1/2017	eastern red bat	5	2	carcass search	road/pad	scavenged
8/1/2017	hoary bat	48	5	carcass search	road/pad	intact
8/1/2017	hoary bat	74	9	carcass search	road/pad	intact
8/2/2017	big brown bat	29	4	incidental	full plot	intact
8/2/2017	big brown bat	57	6	carcass search	road/pad	intact
8/2/2017	eastern red bat	59	7	carcass search	road/pad	intact
8/2/2017	eastern red bat	88	6	carcass search	road/pad	intact
8/2/2017	eastern red bat	65	7	carcass search	road/pad	intact
8/2/2017	eastern red bat	107	27	carcass search	road/pad	intact
8/2/2017	eastern red bat	143	13	carcass search	road/pad	scavenged
8/2/2017	hoary bat	84	2	carcass search	road/pad	intact
8/2/2017	hoary bat	88	8	carcass search	road/pad	intact
8/2/2017	hoary bat	127	19	carcass search	road/pad	scavenged
8/2/2017	hoary bat	127	0	carcass search	road/pad	scavenged
8/3/2017	big brown bat	29	1	incidental	full plot	intact
8/3/2017	big brown bat	139	7	incidental	full plot	intact
8/3/2017	eastern red bat	28	3	carcass search	road/pad	intact
8/3/2017	hoary bat	93	6	carcass search	road/pad	intact
8/4/2017	big brown bat	54	1	carcass search	road/pad	scavenged
8/4/2017	big brown bat	37	61	carcass search	full plot	intact
8/4/2017	eastern red bat	55	8	carcass search	road/pad	scavenged
8/4/2017	eastern red bat	38	5	carcass search	road/pad	intact
8/4/2017	eastern red bat	31	29	carcass search	full plot	scavenged
8/5/2017	eastern red bat	137	1	carcass search	full plot	intact
8/5/2017	eastern red bat	137	2	carcass search	full plot	intact
8/5/2017	eastern red bat	137	16	carcass search	full plot	scavenged
8/5/2017	eastern red bat	141	2	carcass search	road/pad	intact
8/5/2017	eastern red bat	143	50	carcass search	road/pad	intact
8/5/2017	eastern red bat	143	3	carcass search	road/pad	intact
8/5/2017	eastern red bat	65	24	carcass search	road/pad	intact
8/5/2017	eastern red bat	59	5	carcass search	road/pad	intact

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
8/5/2017	eastern red bat	138	7	carcass search	full plot	scavenged
8/5/2017	eastern red bat	78	6	carcass search	road/pad	scavenged
8/5/2017	hoary bat	81	18	carcass search	full plot	intact
8/5/2017	hoary bat	124	36	carcass search	full plot	scavenged
8/5/2017	hoary bat	104	35	carcass search	full plot	intact
8/5/2017	hoary bat	79	10	carcass search	road/pad	intact
8/5/2017	hoary bat	98	45	carcass search	road/pad	dismembered
8/5/2017	hoary bat	103	28	carcass search	full plot	scavenged
8/6/2017	eastern red bat	105	6	carcass search	road/pad	intact
8/6/2017	eastern red bat	75	39	carcass search	road/pad	scavenged
8/7/2017	big brown bat	62	25	carcass search	full plot	intact
8/7/2017	big brown bat	49	8	carcass search	road/pad	intact
8/7/2017	eastern red bat	62	58	carcass search	full plot	scavenged
8/7/2017	eastern red bat	64	46	carcass search	full plot	intact
8/7/2017	eastern red bat	115	3	carcass search	road/pad	intact
8/7/2017	eastern red bat	37	1	carcass search	full plot	intact
8/7/2017	hoary bat	61	29	carcass search	full plot	scavenged
8/7/2017	hoary bat	61	17	carcass search	full plot	dismembered
8/7/2017	hoary bat	4	14	carcass search	road/pad	scavenged
8/8/2017	big brown bat	134	8	carcass search	road/pad	intact
8/8/2017	big brown bat	77	5	carcass search	full plot	scavenged
8/8/2017	eastern red bat	142	27	carcass search	road/pad	scavenged
8/8/2017	eastern red bat	83	6	carcass search	road/pad	intact
8/8/2017	eastern red bat	137	24	carcass search	full plot	intact
8/8/2017	eastern red bat	138	6	carcass search	full plot	scavenged
8/8/2017	eastern red bat	124	11	carcass search	full plot	scavenged
8/8/2017	eastern red bat	104	38	carcass search	full plot	scavenged
8/8/2017	hoary bat	125	42	carcass search	road/pad	scavenged
8/8/2017	hoary bat	128	5	carcass search	road/pad	scavenged
8/8/2017	hoary bat	96	11	carcass search	full plot	scavenged
8/9/2017	eastern red bat	130	14	carcass search	full plot	intact
8/9/2017	eastern red bat	130	23	carcass search	full plot	intact
8/10/2017	big brown bat	28	2	carcass search	road/pad	intact
8/10/2017	big brown bat	101	10	carcass search	road/pad	scavenged
8/10/2017	eastern red bat	46	23	carcass search	road/pad	intact
8/10/2017	eastern red bat	63	29	carcass search	full plot	intact
8/10/2017	eastern red bat	46	21	carcass search	road/pad	intact
8/10/2017	eastern red bat	54	6	carcass search	road/pad	scavenged
8/10/2017	eastern red bat	56	0	carcass search	road/pad	scavenged
8/10/2017	eastern red bat	35	36	carcass search	full plot	dismembered
8/10/2017	hoary bat	22	7	carcass search	road/pad	scavenged
8/10/2017	hoary bat	24	5	carcass search	road/pad	scavenged
8/10/2017	hoary bat	35	28	carcass search	full plot	dismembered
8/11/2017	big brown bat	137	5	carcass search	full plot	intact
8/11/2017	big brown bat	96	6	carcass search	full plot	intact
8/11/2017	big brown bat	79	4	carcass search	road/pad	intact
8/11/2017	big brown bat	131	33	carcass search	road/pad	scavenged
8/11/2017	eastern red bat	137	8	carcass search	full plot	intact
8/11/2017	eastern red bat	90	9	carcass search	road/pad	intact
8/11/2017	eastern red bat	134	8	carcass search	road/pad	intact
8/11/2017	eastern red bat	143	7	carcass search	road/pad	intact
8/11/2017	eastern red bat	141	15	carcass search	road/pad	intact
8/11/2017	hoary bat	136	4	carcass search	road/pad	intact
8/12/2017	eastern red bat	66	24	carcass search	road/pad	intact
8/12/2017	hoary bat	30	40	carcass search	full plot	intact
8/13/2017	big brown bat	49	6	carcass search	road/pad	scavenged
8/13/2017	big brown bat	8	15	carcass search	road/pad	scavenged
8/13/2017	big brown bat	8	1	carcass search	road/pad	intact
8/13/2017	big brown bat	63	27	carcass search	full plot	intact
8/13/2017	big brown bat	19	1	carcass search	road/pad	scavenged
8/13/2017	eastern red bat	34	9	carcass search	road/pad	scavenged
8/13/2017	eastern red bat	43	27	carcass search	road/pad	scavenged
8/13/2017	eastern red bat	11	18	carcass search	road/pad	scavenged
8/13/2017	eastern red bat	31	34	carcass search	full plot	intact
8/13/2017	eastern red bat	52	6	carcass search	road/pad	intact

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
8/13/2017	eastern red bat	46	5	carcass search	road/pad	scavenged
8/13/2017	eastern red bat	36	7	carcass search	road/pad	intact
8/13/2017	eastern red bat	29	21	carcass search	full plot	scavenged
8/13/2017	eastern red bat	28	1	carcass search	road/pad	scavenged
8/13/2017	hoary bat	11	1	carcass search	road/pad	scavenged
8/13/2017	hoary bat	12	33	carcass search	road/pad	scavenged
8/13/2017	silver-haired bat	41	7	carcass search	road/pad	intact
8/14/2017	big brown bat	81	27	carcass search	full plot	scavenged
8/14/2017	big brown bat	59	9	carcass search	road/pad	intact
8/14/2017	big brown bat	124	14	carcass search	full plot	intact
8/14/2017	eastern red bat	78	36	carcass search	road/pad	intact
8/14/2017	eastern red bat	114	2	carcass search	road/pad	intact
8/14/2017	eastern red bat	77	36	carcass search	full plot	intact
8/14/2017	eastern red bat	57	56	carcass search	road/pad	intact
8/14/2017	eastern red bat	123	21	carcass search	full plot	intact
8/14/2017	hoary bat	142	7	carcass search	road/pad	scavenged
8/14/2017	silver-haired bat	106	1	carcass search	road/pad	scavenged
8/16/2017	big brown bat	30	50	carcass search	full plot	intact
8/16/2017	eastern red bat	20	8	carcass search	road/pad	intact
8/16/2017	eastern red bat	23	5	carcass search	road/pad	intact
8/16/2017	hoary bat	67	44	incidental	road/pad	scavenged
8/16/2017	hoary bat	30	19	carcass search	full plot	intact
8/17/2017	big brown bat	59	7	carcass search	road/pad	intact
8/17/2017	big brown bat	66	7	carcass search	road/pad	scavenged
8/17/2017	eastern red bat	94	7	carcass search	road/pad	scavenged
8/17/2017	hoary bat	126	14	carcass search	road/pad	intact
8/18/2017	big brown bat	32	6	carcass search	road/pad	intact
8/18/2017	big brown bat	87	9	incidental	road/pad	intact
8/18/2017	big brown bat	75	5	carcass search	road/pad	intact
8/18/2017	eastern red bat	55	42	carcass search	road/pad	scavenged
8/18/2017	hoary bat	56	27	carcass search	road/pad	scavenged
8/18/2017	hoary bat	69	6	carcass search	road/pad	scavenged
8/19/2017	big brown bat	61	6	carcass search	full plot	intact
8/19/2017	big brown bat	23	2	carcass search	road/pad	scavenged
8/19/2017	big brown bat	20	4	carcass search	road/pad	intact
8/19/2017	big brown bat	92	7	carcass search	road/pad	scavenged
8/19/2017	big brown bat	8	5	carcass search	road/pad	scavenged
8/19/2017	eastern red bat	63	23	carcass search	full plot	scavenged
8/19/2017	eastern red bat	19	8	carcass search	road/pad	scavenged
8/19/2017	eastern red bat	28	1	carcass search	road/pad	injured
8/19/2017	evening bat	99	25	carcass search	road/pad	scavenged
8/20/2017	big brown bat	57	0	carcass search	road/pad	injured
8/20/2017	big brown bat	78	0	carcass search	road/pad	scavenged
8/20/2017	big brown bat	134	7	carcass search	road/pad	scavenged
8/20/2017	big brown bat	114	1	carcass search	road/pad	scavenged
8/20/2017	big brown bat	139	4	carcass search	full plot	scavenged
8/20/2017	eastern red bat	59	8	carcass search	road/pad	scavenged
8/20/2017	eastern red bat	106	0	carcass search	road/pad	scavenged
8/20/2017	eastern red bat	80	6	carcass search	full plot	scavenged
8/20/2017	eastern red bat	122	3	carcass search	road/pad	scavenged
8/20/2017	hoary bat	142	6	carcass search	road/pad	scavenged
8/21/2017	big brown bat	47	10	carcass search	road/pad	intact
8/22/2017	big brown bat	63	5	carcass search	full plot	intact
8/22/2017	big brown bat	42	10	carcass search	road/pad	intact
8/22/2017	big brown bat	25	0	carcass search	road/pad	injured
8/22/2017	eastern red bat	40	30	carcass search	road/pad	scavenged
8/22/2017	eastern red bat	22	14	carcass search	road/pad	scavenged
8/22/2017	eastern red bat	50	67	carcass search	road/pad	intact
8/23/2017	big brown bat	143	7	carcass search	road/pad	intact
8/23/2017	big brown bat	78	3	carcass search	road/pad	scavenged
8/23/2017	eastern red bat	112	4	carcass search	road/pad	scavenged
8/23/2017	eastern red bat	143	8	carcass search	road/pad	intact
8/23/2017	hoary bat	81	22	carcass search	full plot	intact
8/23/2017	silver-haired bat	137	25	carcass search	full plot	intact
8/25/2017	big brown bat	8	8	carcass search	road/pad	intact

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
8/25/2017	eastern red bat	55	9	carcass search	road/pad	intact
8/25/2017	eastern red bat	55	7	carcass search	road/pad	intact
8/25/2017	eastern red bat	73	1	carcass search	road/pad	intact
8/25/2017	eastern red bat	116	5	carcass search	road/pad	intact
8/25/2017	eastern red bat	38	61	carcass search	road/pad	scavenged
8/26/2017	big brown bat	96	4	carcass search	full plot	scavenged
8/26/2017	eastern red bat	125	7	carcass search	road/pad	intact
8/26/2017	hoary bat	125	12	carcass search	road/pad	dismembered
8/27/2017	big brown bat	104	21	carcass search	full plot	intact
8/27/2017	hoary bat	124	6	carcass search	full plot	intact
8/27/2017	hoary bat	60	25	carcass search	full plot	intact
8/28/2017	big brown bat	18	1	carcass search	road/pad	intact
8/28/2017	big brown bat	30	8	carcass search	full plot	intact
8/28/2017	big brown bat	47	7	carcass search	road/pad	intact
8/28/2017	big brown bat	48	13	carcass search	road/pad	intact
8/28/2017	eastern red bat	29	3	carcass search	full plot	intact
8/28/2017	eastern red bat	36	46	carcass search	road/pad	intact
8/28/2017	hoary bat	41	4	carcass search	road/pad	scavenged
8/29/2017	big brown bat	131	6	carcass search	road/pad	intact
8/29/2017	big brown bat	124	30	carcass search	full plot	intact
8/29/2017	eastern red bat	134	8	carcass search	road/pad	intact
8/29/2017	hoary bat	111	15	carcass search	road/pad	scavenged
8/29/2017	hoary bat	130	1	carcass search	full plot	intact
8/31/2017	big brown bat	37	25	carcass search	full plot	scavenged
8/31/2017	hoary bat	14	32	carcass search	full plot	scavenged
8/31/2017	silver-haired bat	74	1	carcass search	road/pad	scavenged
9/1/2017	big brown bat	78	13	carcass search	road/pad	scavenged
9/1/2017	eastern red bat	139	5	carcass search	full plot	scavenged
9/1/2017	silver-haired bat	78	5	carcass search	road/pad	scavenged
9/1/2017	silver-haired bat	125	6	carcass search	road/pad	intact
9/1/2017	silver-haired bat	104	0	carcass search	full plot	intact
9/3/2017	big brown bat	31	41	carcass search	full plot	scavenged
9/3/2017	big brown bat	28	6	carcass search	road/pad	intact
9/3/2017	eastern red bat	92	7	carcass search	road/pad	intact
9/3/2017	hoary bat	31	19	carcass search	full plot	intact
9/4/2017	eastern red bat	109	87	carcass search	road/pad	dismembered
9/4/2017	eastern red bat	131	4	carcass search	road/pad	intact
9/4/2017	eastern red bat	129	38	carcass search	full plot	intact
9/4/2017	silver-haired bat	80	30	carcass search	full plot	intact
9/4/2017	silver-haired bat	137	46	carcass search	full plot	scavenged
9/4/2017	silver-haired bat	129	14	carcass search	full plot	dismembered
9/6/2017	big brown bat	92	2	carcass search	road/pad	dismembered
9/6/2017	eastern red bat	44	27	carcass search	road/pad	intact
9/7/2017	hoary bat	130	15	carcass search	full plot	intact
9/7/2017	silver-haired bat	139	14	carcass search	full plot	intact
9/7/2017	silver-haired bat	111	5	carcass search	road/pad	intact
9/9/2017	eastern red bat	5	29	carcass search	road/pad	intact
9/9/2017	eastern red bat	76	56	carcass search	road/pad	scavenged
9/9/2017	eastern red bat	55	34	carcass search	road/pad	intact
9/9/2017	eastern red bat	14	59	carcass search	full plot	intact
9/9/2017	hoary bat	43	58	carcass search	road/pad	scavenged
9/10/2017	big brown bat	78	60	carcass search	road/pad	scavenged
9/10/2017	eastern red bat	128	2	carcass search	road/pad	intact
9/10/2017	eastern red bat	121	7	carcass search	road/pad	intact
9/10/2017	eastern red bat	122	1	carcass search	road/pad	intact
9/10/2017	eastern red bat	134	19	carcass search	road/pad	scavenged
9/10/2017	eastern red bat	96	31	carcass search	full plot	dismembered
9/10/2017	eastern red bat	98	0	carcass search	road/pad	scavenged
9/10/2017	hoary bat	78	33	carcass search	road/pad	scavenged
9/10/2017	silver-haired bat	141	13	carcass search	road/pad	intact
9/10/2017	silver-haired bat	135	9	carcass search	road/pad	dismembered
9/12/2017	eastern red bat	42	3	carcass search	road/pad	scavenged
9/12/2017	hoary bat	10	7	carcass search	road/pad	intact
9/12/2017	hoary bat	40	7	carcass search	road/pad	intact
9/12/2017	hoary bat	30	35	carcass search	full plot	intact

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
9/12/2017	silver-haired bat	5	26	carcass search	road/pad	intact
9/13/2017	big brown bat	67	27	carcass search	road/pad	scavenged
9/13/2017	eastern red bat	140	75	carcass search	road/pad	scavenged
9/13/2017	eastern red bat	108	19	carcass search	road/pad	intact
9/13/2017	eastern red bat	134	2	carcass search	road/pad	intact
9/13/2017	eastern red bat	124	33	carcass search	full plot	scavenged
9/13/2017	hoary bat	90	5	carcass search	road/pad	intact
9/13/2017	hoary bat	140	79	carcass search	road/pad	scavenged
9/13/2017	silver-haired bat	95	11	carcass search	full plot	dismembered
9/16/2017	eastern red bat	133	5	carcass search	road/pad	intact
9/18/2017	eastern red bat	49	5	carcass search	road/pad	intact
9/18/2017	hoary bat	53	10	carcass search	road/pad	scavenged
9/19/2017	big brown bat	77	22	carcass search	full plot	intact
9/21/2017	eastern red bat	14	28	carcass search	full plot	dismembered
9/21/2017	eastern red bat	13	99	carcass search	road/pad	intact
9/21/2017	eastern red bat	24	41	carcass search	road/pad	scavenged
9/21/2017	eastern red bat	62	7	carcass search	full plot	intact
9/21/2017	silver-haired bat	38	30	carcass search	road/pad	intact
9/22/2017	eastern red bat	102	43	carcass search	road/pad	scavenged
9/22/2017	hoary bat	121	82	carcass search	road/pad	scavenged
9/22/2017	hoary bat	136	33	carcass search	road/pad	scavenged
9/25/2017	eastern red bat	68	5	carcass search	road/pad	intact
9/25/2017	hoary bat	139	9	carcass search	full plot	scavenged
9/26/2017	eastern red bat	134	5	carcass search	road/pad	intact
9/26/2017	hoary bat	92	7	carcass search	road/pad	scavenged
9/27/2017	silver-haired bat	30	10	carcass search	full plot	injured
9/30/2017	eastern red bat	55	64	carcass search	road/pad	intact
9/30/2017	silver-haired bat	44	17	carcass search	road/pad	intact
10/3/2017	eastern red bat	8	7	carcass search	road/pad	intact
10/6/2017	hoary bat	47	56	carcass search	road/pad	intact
10/6/2017	silver-haired bat	75	2	carcass search	road/pad	intact
10/6/2017	silver-haired bat	64	58	carcass search	full plot	intact
10/9/2017	eastern red bat	116	3	carcass search	road/pad	intact
10/10/2017	hoary bat	103	30	carcass search	full plot	intact
10/15/2017	silver-haired bat	24	3	carcass search	road/pad	intact
10/19/2017	big brown bat	94	1	carcass search	road/pad	dismembered
10/19/2017	eastern red bat	121	6	carcass search	road/pad	intact
10/24/2017	big brown bat	64	5	carcass search	full plot	intact
			Birds			
3/22/2017	European starling	40	11	incidental	road/pad	dismembered
3/23/2017	song sparrow	60	86	carcass search	full plot	intact
3/26/2017	American robin	131	55	incidental	road/pad	scavenged
4/3/2017	red-winged blackbird	8	27	incidental	road/pad	injured
4/3/2017	wild turkey	12	39	incidental	road/pad	scavenged
4/4/2017	European starling	9	6	incidental	road/pad	intact
4/8/2017	song sparrow	81	33	carcass search	full plot	intact
4/11/2017	tree swallow	74	78	incidental	road/pad	intact
4/13/2017	European starling	86	16	incidental	road/pad	scavenged
4/15/2017	turkey vulture	133	43	incidental	road/pad	scavenged
4/16/2017	golden-crowned kinglet	96	51	carcass search	full plot	scavenged
4/16/2017	ruby-crowned kinglet	68	78	carcass search	road/pad	intact
4/25/2017	ruby-crowned kinglet	67	3	carcass search	road/pad	dismembered
4/25/2017	ruby-crowned kinglet	96	47	carcass search	full plot	intact
4/27/2017	house wren	35	51	carcass search	full plot	scavenged
4/28/2017	European starling	59	6	carcass search	road/pad	intact
4/29/2017	marsh wren	139	50	carcass search	full plot	scavenged
5/1/2017	house wren	139	56	carcass search	full plot	scavenged
5/1/2017	sora	80	112	incidental	full plot	intact
5/4/2017	marsh wren	129	52	carcass search	full plot	intact
5/4/2017	red-tailed hawk	87	51	carcass search	road/pad	dismembered
5/4/2017	tree swallow	107	3	carcass search	road/pad	scavenged
5/7/2017	ruby-crowned kinglet	89	25	carcass search	road/pad	scavenged
5/9/2017	house wren	12	87	carcass search	road/pad	intact
5/10/2017	unidentified flycatcher	89	60	carcass search	road/pad	scavenged
5/12/2017	Baltimore oriole	99	20	carcass search	road/pad	feather spot

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
5/13/2017	unidentified passerine	67	25	carcass search	road/pad	dismembered
5/15/2017	house wren	8	66	carcass search	road/pad	intact
5/15/2017	Tennessee warbler	138	26	incidental	full plot	injured
5/21/2017	golden-crowned kinglet	14	62	carcass search	full plot	intact
5/21/2017	yellow-billed cuckoo	14	68	carcass search	full plot	intact
5/22/2017	common yellowthroat	96	45	carcass search	full plot	intact
5/22/2017	European starling	144	0	carcass search	road/pad	intact
5/25/2017	savannah sparrow	107	6	carcass search	road/pad	intact
5/27/2017	American robin	33	6	carcass search	road/pad	intact
5/27/2017	cliff swallow	15	35	carcass search	full plot	intact
5/29/2017	common yellowthroat	42	14	incidental	road/pad	intact
5/30/2017	unidentified wren	31	41	carcass search	full plot	dismembered
6/3/2017	indigo bunting	85	6	carcass search	road/pad	intact
6/5/2017	common yellowthroat	37	23	carcass search	full plot	injured
6/5/2017	dickcissel	63	22	carcass search	full plot	feather spot
6/5/2017	turkey vulture	64	38	carcass search	full plot	intact
6/6/2017	yellow-billed cuckoo	144	47	carcass search	road/pad	intact
6/8/2017	red-winged blackbird	36	21	carcass search	road/pad	intact
6/11/2017	turkey vulture	8	37	carcass search	road/pad	scavenged
6/12/2017	unidentified large bird	104	25	carcass search	full plot	feather spot
6/13/2017	house wren	102	73	carcass search	road/pad	dismembered
6/17/2017	yellow-billed cuckoo	29	29	carcass search	full plot	scavenged
7/2/2017	red-tailed hawk	61	62	carcass search	full plot	intact
7/3/2017	horned lark	139	46	carcass search	full plot	intact
7/3/2017	turkey vulture	142	53	carcass search	road/pad	dismembered
7/3/2017	turkey vulture	83	6	carcass search	road/pad	intact
7/6/2017	turkey vulture	83	22	carcass search	road/pad	scavenged
7/8/2017	red-winged blackbird	101	6	carcass search	road/pad	dismembered
7/9/2017	indigo bunting	130	3	carcass search	full plot	intact
7/12/2017	sedge wren	140	93	carcass search	road/pad	intact
7/24/2017	sedge wren	104	36	carcass search	full plot	intact
8/5/2017	indigo bunting	68	10	carcass search	road/pad	intact
8/13/2017	barn swallow	8	1	carcass search	road/pad	scavenged
8/14/2017	cliff swallow	83	2	carcass search	road/pad	intact
8/17/2017	Nashville warbler	127	24	carcass search	road/pad	intact
8/26/2017	black-billed cuckoo	90	43	carcass search	road/pad	scavenged
8/29/2017	Acadian flycatcher	86	0	carcass search	road/pad	dismembered
8/29/2017	red-eyed vireo	97	43	carcass search	road/pad	intact
8/31/2017	mourning dove	75	1	carcass search	road/pad	scavenged
9/9/2017	red-eyed vireo	62	90	incidental	full plot	dismembered
9/10/2017	gray catbird	130	28	carcass search	full plot	dismembered
9/10/2017	house sparrow	126	17	carcass search	road/pad	scavenged
9/21/2017	blue-headed vireo	76	30	carcass search	road/pad	scavenged
9/21/2017	Nashville warbler	40	33	carcass search	road/pad	intact
9/21/2017	Nashville warbler	64	9	carcass search	full plot	intact
9/21/2017	Nashville warbler	47	48	carcass search	road/pad	intact
9/21/2017	Nashville warbler	37	51	carcass search	full plot	intact
9/21/2017	ruby-crowned kinglet	40	32	carcass search	road/pad	intact
9/22/2017	black-and-white warbler	139	50	carcass search	full plot	intact
9/22/2017	Le Conte's sparrow	96	4	carcass search	full plot	scavenged
9/22/2017	Philadelphia Vireo	137	37	carcass search	full plot	scavenged
9/22/2017	swamp sparrow	126	60	carcass search	road/pad	intact
9/24/2017	Nashville warbler	64	23	carcass search	full plot	dismembered
9/28/2017	Nashville warbler	110	9	carcass search	road/pad	intact
9/28/2017	yellow rail	127	8	carcass search	road/pad	intact
9/30/2017	Le Conte's sparrow	37	54	carcass search	full plot	intact
9/30/2017	mourning warbler	53	4	carcass search	road/pad	intact
9/30/2017	swamp sparrow	14	42	carcass search	full plot	intact
10/1/2017	ruby-crowned kinglet	84	72	carcass search	road/pad	dismembered
10/2/2017	sedge wren	91	73	carcass search	road/pad	intact
10/2/2017	unidentified small bird	135	41	carcass search	road/pad	scavenged
10/2/2017	unidentified icterid	130	49	carcass search	full plot	scavenged
10/3/2017	sedge wren	64	37	carcass search	full plot	scavenged
10/7/2017	unidentified small bird	138	29	carcass search	full plot	scavenged
10/10/2017	unidentified wren	94	76	carcass search	road/pad	scavenged

Appendix A. Complete Carcass Listing for the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
10/15/2017	Lincoln's sparrow	74	94	carcass search	road/pad	intact
10/15/2017	marsh wren	44	72	carcass search	road/pad	dismembered
10/15/2017	red-tailed hawk	35	88	carcass search	full plot	injured
10/15/2017	ruby-crowned kinglet	35	53	carcass search	full plot	scavenged
10/16/2017	brown creeper	127	26	carcass search	road/pad	intact
10/16/2017	dark-eyed junco	137	42	carcass search	full plot	feather spot
10/16/2017	golden-crowned kinglet	80	37	carcass search	full plot	intact
10/17/2017	golden-crowned kinglet	114	32	carcass search	road/pad	intact
10/18/2017	sharp-shinned hawk	35	247	incidental	full plot	intact
10/21/2017	turkey vulture	15	50	carcass search	full plot	scavenged
10/21/2017	unidentified large bird	61	50	carcass search	full plot	feather spot
10/24/2017	Nashville warbler	37	67	carcass search	full plot	intact
10/24/2017	sedge wren	54	60	carcass search	road/pad	dismembered
10/24/2017	song sparrow	52	55	carcass search	road/pad	intact
10/24/2017	turkey vulture	1	16	carcass search	road/pad	dismembered
10/25/2017	turkey vulture	67	76	carcass search	road/pad	dismembered
10/28/2017	turkey vulture	89	36	carcass search	road/pad	scavenged
11/5/2017	golden-crowned kinglet	42	9	carcass search	road/pad	intact
11/5/2017	unidentified sparrow	61	58	carcass search	full plot	feather spot
11/6/2017	swamp sparrow	139	64	carcass search	full plot	intact
11/7/2017	white-throated sparrow	106	141	carcass search	road/pad	intact
11/8/2017	mourning dove	75	1	carcass search	road/pad	intact
11/14/2017	house sparrow	53	20	carcass search	road/pad	scavenged
11/27/2017	American tree sparrow	68	8	carcass search	road/pad	intact
11/27/2017	ring-necked pheasant	60	1200	incidental	road/pad	intact
11/29/2017	red-tailed hawk	110	50	carcass search	road/pad	dismembered
12/12/2017	European starling	79	9	carcass search	road/pad	intact
1/16/2018	red-tailed hawk	101	4	incidental	road/pad	intact
1/25/2018	song sparrow	98	148	incidental	road/pad	dismembered
1/26/2018	gray partridge	103	283	incidental	road/pad	intact
3/8/2018	American tree sparrow	112	76	carcass search	road/pad	intact
3/8/2018	dark-eyed junco	129	78	carcass search	road/pad	intact
3/8/2018	Lapland longspur	107	59	carcass search	road/pad	intact
3/8/2018	Lapland longspur	106	53	carcass search	road/pad	intact

Appendix B: Estimated Fatality Rates and Correction Factors, with 90% Confidence Intervals, for Studies Conducted at the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018

Appendix B. Estimated fatality rates and correction factors, with 90% confidence intervals (CIs), for post-construction monitoring conducted at the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Parameter	Spring		Summer		Fall		Winter	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Search Area Adjustment								
A (Bat 100-m Full Plot, 1.79MW)	0.65	0.47 - 0.98	0.65	0.47 - 0.98	0.65	0.47 - 0.98	-	-
A (Bat 100-m Full Plot, 2.3MW)	0.79	0.74 - 0.87	0.79	0.74 - 0.87	0.79	0.74 - 0.87	-	-
A (Bat 60-m Full Plot, 2.3 MW)	0.50	0.45 - 0.58	0.50	0.45 - 0.58	0.50	0.45 - 0.58	-	-
A (Bat 100m Road/Pad, 1.79MW)	0.10	0.05 - 0.15	0.10	0.05 - 0.15	0.10	0.05 - 0.15	-	-
A (Bat 100m Road/Pad, 2.3MW)	0.13	0.11 - 0.16	0.13	0.11 - 0.16	0.13	0.11 - 0.16	-	-
A (Large Bird 100-m Full Plot, 1.79MW)	0.73	-	0.73	-	0.73	-	0.73	-
A (Large Bird 100-m Full Plot, 2.3MW)	0.72	-	0.72	-	0.72	-	0.72	-
A (Large Bird 60-m Full Plot, 2.3MW)	0.50	-	0.50	-	0.50	-	0.50	-
A (Large Bird 100-m Road/Pad, 1.79MW)	0.17	-	0.17	-	0.17	-	0.17	-
A (Large Bird 100-m Road/Pad, 2.3MW)	0.17	-	0.17	-	0.17	-	0.17	-
A (Small Bird 100-m Full Plot, 1.79MW)	0.90	-	0.90	-	0.90	-	0.90	-
A (Small Bird 100-m Full Plot, 2.3MW)	0.90	-	0.90	-	0.90	-	0.90	-
A (Small Bird 60-m Full Plot, 2.3MW)	0.66	-	0.66	-	0.66	-	0.66	-
A (Small Bird 100-m Road/Pad, 1.79MW)	0.24	-	0.24	-	0.24	-	0.24	-
A (Small Bird 100-m Road/Pad, 2.3MW)	0.23	-	0.23	-	0.23	-	0.23	-
Observer Detection Rate								
P (Bat 100-m Full Plot)	0.55	0.31 - 0.82	0.64	0.48 - 0.79	0.19	0.07 - 0.33	-	-
P (Bat 60-m Full Plot)	0.55	0.31 - 0.82	0.64	0.48 - 0.79	0.19	0.07 - 0.33	-	-
P (Bat 100-m Road/Pad)	0.95	0.84 - 0.99	0.96	0.91 - 0.99	0.77	0.65 - 0.89	-	-
P (Large Bird 100-m Full Plot)	1	1-1	1	1-1	1	1-1	1	1-1
P (Large Bird 60-m Full Plot)	1	1-1	1	1-1	1	1-1	1	1-1
P (Large Bird 100-m Road/Pad)	1	1-1	1	1-1	1	1-1	1	1-1
P (Small Bird 100-m Full Plot)	0.78	0.69-0.86	0.78	0.69-0.86	0.78	0.69-0.86	0.78	0.69-0.86
P (Small Bird 60-m Full Plot)	0.78	0.69-0.86	0.78	0.69-0.86	0.78	0.69-0.86	0.78	0.69-0.86
P (Small Bird 100-m Road/Pad)	0.78	0.69-0.86	0.78	0.69-0.86	0.78	0.69-0.86	0.78	0.69-0.86
Probability of a Carcass Persisting Through the Search Interval								
Bat (100-m Full Plot)	0.94	0.88 - 0.97	0.80	0.75 - 0.83	0.76	0.69 - 0.82	-	-
Bat (60-m Full Plot)	0.94	0.88 - 0.97	0.80	0.75 - 0.83	0.76	0.69 - 0.82	-	-
Bat (100-m Road/Pad)	0.94	0.88 - 0.97	0.80	0.75 - 0.83	0.76	0.69 - 0.82	-	-
Large Bird (100-m Full Plot)	0.96	0.90-0.99	0.92	0.84-0.97	0.71	0.60-0.82	-	-
Large Bird (60-m Full Plot)	0.96	0.90-0.99	0.92	0.84-0.97	0.71	0.60-0.82	-	-
Large Bird (100-m Road/Pad)	0.96	0.90 – 0.99	0.92	0.84 – 0.97	0.71	0.60 – 0.82	0.87	0.81 – 0.93
Small Bird (100-m Full Plot)	0.79	0.65 – 0.87	0.92	0.88 – 0.94	0.80	0.68 – 0.87	-	-
Small Bird (60-m Full Plot)	0.79	0.65 – 0.87	0.92	0.88 – 0.94	0.80	0.68 – 0.87	-	-
Small Bird (100-m Road/Pad)	0.63	0.41 – 0.72	0.83	0.74 – 0.88	0.63	0.46 – 0.73	0.68	0.58 – 0.76

Appendix B. Estimated fatality rates and correction factors, with 90% confidence intervals (CIs), for post-construction monitoring conducted at the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Parameter	Spring		Summer		Fall		Winter	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Probability of Available and Detected								
Bat (100-m Full Plot)	0.52	0.29 - 0.77	0.51	0.38 - 0.63	0.15	0.05 - 0.25	-	-
Bat (60-m Full Plot)	0.52	0.29 - 0.77	0.51	0.38 - 0.63	0.15	0.05 - 0.25	-	-
Bat (100-m Road/Pad)	0.89	0.78 - 0.95	0.77	0.70 - 0.81	0.59	0.48 - 0.69	-	-
Large Bird (100-m Full Plot)	0.96	0.90 – 0.99	0.92	0.84 – 0.97	0.71	0.60 – 0.82	-	-
Large Bird (60-m Full Plot)	0.96	0.90 – 0.99	0.92	0.84 – 0.97	0.71	0.60 – 0.82	-	-
Large Bird (100-m Road/Pad)	0.96	0.90 – 0.99	0.92	0.84 – 0.97	0.71	0.60 – 0.82	0.87	0.81 – 0.93
Small Bird (100-m Full Plot)	0.62	0.49 – 0.71	0.71	0.63 – 0.79	0.63	0.51 – 0.72	-	-
Small Bird (60-m Full Plot)	0.62	0.49 – 0.71	0.71	0.63 – 0.79	0.63	0.51 – 0.72	-	-
Small Bird (100-m Road/Pad)	0.48	0.30 – 0.58	0.65	0.55 – 0.73	0.49	0.35 – 0.59	0.53	0.44 – 0.62
Unadjusted Number of Fatalities								
Bat (100-m Full Plot)	3	-	12	7 – 17	59	46.95 - 73	-	-
Bat (60-m Full Plot)	6	2 – 11	12	7 – 18	42	31 - 53	-	-
Bat (100-m Road/Pad)	14	7 – 21	34	25 - 44	268	237 - 299	-	-
Large Bird (100-m Full Plot)	0	-	1	-	1	-	0	-
Large Bird (60-m Full Plot)	0	-	2	-	0	-	0	-
Large Bird (100-m Road/Pad)	1	-	1	-	3	-	2	-
Raptor (100-m Road/Pad)	0	-	0	-	0	-	2	-
Small Bird (100-m Full Plot)	3	-	6	3 – 9	12	7 - 18	0	-
Small Bird (60-m Full Plot)	0	-	1	-	2	-	0	-
Small Bird (100-m Road/Pad)	10	5 – 16	9	5 – 14	23	15 – 31	6	2 - 10
Observed Fatality Rates (Fatalities/Turbine/Season(s))								
Bat (100-m Full Plot)	0.25	0 - 0.58	1	0.58 - 1.42	6.58	5.58 - 7.75	-	-
Bat (60-m Full Plot)	0.46	0.15 - 0.85	0.92	0.54 - 1.38	3.23	2.38 - 4.08	-	-
Bat (100-m Road/Pad)	0.15	0.07 - 0.22	0.65	0.42 - 0.89	4.28	3.62 - 4.86	-	-
Large bird (100-m Full Plot)	0	-	0.07	-	0.07	-	0	-
Large bird (60-m Full Plot)	0	-	0.15	-	0	-	0	-
Large bird (100-m Road/Pad)	0.01	-	0.01	-	0.03	-	0.02	-
Raptor (100-m Road/Pad)	0	-	0	-	0	-	0.01	0 – 0.04
Small Bird (100-m Full Plot)	0.21	-	0.43	0.21-0.64	0.86	0.50-1.29	0	-
Small Bird (60-m Full Plot)	0	-	0.08	-	0.15	-	0	-
Small bird (100-m Road/Pad)	0.09	0.05 – 0.15	0.08	0.05 – 0.13	0.21	0.14 – 0.29	0.04	0.01 – 0.07
Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))								
Bat (100-m Full Plot)	0.61	0 - 1.62	2.58	1.42 - 4.04	60.4	33.95 - 175.71	-	-
Bat (60-m Full Plot)	1.78	0.47 - 4.04	3.55	1.99 - 5.61	43.55	24.01 - 128.26	-	-
Bat (100-m Road/Pad)	1.29	0.69 - 2.01	7.61	4.65 - 10.91	63.94	50.37 - 80.41	-	-
Bat Overall	**1.16**	**0.72 - 1.80**	**4.29**	**3.16 - 5.70**	**63.94**	**50.46 - 80.83**	-	-

Appendix B. Estimated fatality rates and correction factors, with 90% confidence intervals (CIs), for post-construction monitoring conducted at the Ida Grove Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Parameter	Spring		Summer		Fall		Winter	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Large Bird (100-m Full Plot)	0	-	0.11	-	0.14	-	0	-
Large Bird (60-m Full Plot)	0	-	0.34	-	0	-	0	-
Large Bird (100-m Road/Pad)	0.06	-	0.06	-	0.23	-	0.10	-
Large Bird Overall	**0.04**	**-**	**0.09**	**-**	**0.20**	**-**	**0.10**	**-**
Raptor (100-m Road/Pad)	-	-	-	-	-	-	0.10	-
Raptor Overall	**-**	**-**	**-**	**-**	**-**	**-**	**0.10**	**-**
Small Bird (100-m Full Plot)	0.39	-	0.67	0.37-1.02	1.52	0.85-2.30	0	-
Small Bird (60-m Full Plot)	0	-	0.16	-	0.36	-	0	-
Small Bird (100-m Road/Pad)	0.82	0.41-1.55	0.56	0.29-0.90	1.91	1.26-3.13	0.37	0.15-0.64
Small Bird Overall	**0.69**	**0.36-1.28**	**0.54**	**0.31-0.82**	**1.72**	**1.17-2.70**	**0.37**	**0.15-0.64**
All Bird (100-m Full Plot)	0.39	-	0.78	0.46-1.11	1.66	1.01-2.46	0	-
All Bird (60-m Full Plot)	0	-	0.50	-	0.36	-	0	-
All Bird (100-m Road/Pad)	0.87	0.43-1.62	0.62	0.33-0.96	2.14	1.46-3.37	0.47	0.23-0.75
All Bird Overall	**0.74**	**0.38-1.34**	**0.63**	**0.39-0.91**	**1.91**	**1.33-2.93**	**0.47**	**0.23-0.75**
Adjusted Fatality Rates (Fatalities/MW/Seasons(s))								
Bat (100-m Full Plot)	0.27	0 - 0.71	1.12	0.62 - 1.76	28.83	16.43 - 83.33	-	-
Bat (60-m Full Plot)	0.77	0.20 - 1.76	1.55	0.87 - 2.44	18.94	10.44 - 55.76	-	-
Bat (100-m Road/Pad)	0.56	0.30 - 0.87	3.85	2.26 - 5.65	31.39	24.25 - 39.75	-	-
Bat Overall	**0.51**	**0.31 - 0.78**	**1.91**	**1.38 - 2.56**	**31.39**	**24.33 - 40.10**	-	-
Large Bird (100-m Full Plot)	0	-	0.05	-	0.08	-	0	-
Large Bird (60-m Full Plot)	0	-	0.15	-	0	-	0	-
Large Bird (100-m Road/Pad)	0.03	-	0.03	-	0.10	-	0.04	-
Large Bird Overall	**0.03**	**-**	**0.04**	**-**	**0.09**	**-**	**0.04**	**-**
Raptor (100-m Road/Pad)	-	-	-	-	-	-	0.04	-
Raptor Overall	-	-	-	-	-	-	**0.04**	**-**
Small Bird (100-m Full Plot)	0.17	-	0.32	0.19-0.47	0.68	0.39-1.01	0	-
Small Bird (60-m Full Plot)	0	-	0.07	-	0.16	-	0	-
Small Bird (100-m Road/Pad)	0.37	0.18-0.69	0.24	0.13-0.39	0.84	0.56-1.39	0.16	0.06-0.28
Small Bird Overall	**0.31**	**0.16-0.57**	**0.24**	**0.14-0.36**	**0.76**	**0.52-1.19**	**0.16**	**0.06-0.28**
All Bird (100-m Full Plot)	0.17	-	0.37	0.23-0.51	0.75	0.47-1.10	-	-
All Bird (60-m Full Plot)	0	-	0.22	-	0.16	-	0	-
All Bird (100-m Road/Pad)	0.40	0.20-0.74	0.27	0.14-0.42	0.94	0.64-1.48	0.20	0.10-0.33
All Bird Overall	**0.33**	**0.17-0.61**	**0.28**	**0.17-0.40**	**0.84**	**0.59-1.29**	**0.20**	**0.10-0.33**

Appendix C: Complete Carcass Listing for the O'Brien Wind Energy Facility, O'Brien County, Iowa, from March 16, 2017, to March 15, 2018

Appendix C. Complete Carcass Listing for the O'Brien Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
			Bats			
4/17/2017	silver-haired bat	21	20	carcass search	road/pad	intact
4/18/2017	silver-haired bat	17	54	carcass search	road/pad	intact
5/1/2017	evening bat	10	18	carcass search	road/pad	scavenged
5/9/2017	tricolored bat	51	45	carcass search	road/pad	intact
6/5/2017	hoary bat	20	36	carcass search	road/pad	dismembered
6/7/2017	eastern red bat	65	16	incidental	inc	intact
6/8/2017	eastern red bat	99	62	carcass search	road/pad	scavenged
6/13/2017	big brown bat	19	8	carcass search	road/pad	dismembered
6/16/2017	eastern red bat	56	9	carcass search	road/pad	Injured
7/12/2017	hoary bat	83	39	carcass search	road/pad	intact
7/17/2017	eastern red bat	51	2	carcass search	road/pad	scavenged
7/24/2017	big brown bat	79	7	carcass search	road/pad	intact
7/24/2017	hoary bat	55	38	carcass search	road/pad	scavenged
7/24/2017	hoary bat	29	34	carcass search	road/pad	scavenged
7/25/2017	eastern red bat	20	5	carcass search	road/pad	intact
7/25/2017	hoary bat	16	2	carcass search	road/pad	intact
7/25/2017	hoary bat	47	22	carcass search	road/pad	scavenged
7/26/2017	eastern red bat	89	21	carcass search	road/pad	scavenged
7/26/2017	eastern red bat	82	32	carcass search	road/pad	scavenged
7/26/2017	hoary bat	98	35	carcass search	road/pad	scavenged
7/26/2017	hoary bat	105	8	carcass search	road/pad	scavenged
7/26/2017	silver-haired bat	111	6	carcass search	road/pad	scavenged
7/31/2017	big brown bat	29	63	carcass search	road/pad	scavenged
7/31/2017	eastern red bat	29	7	carcass search	road/pad	scavenged
7/31/2017	eastern red bat	54	3	carcass search	road/pad	intact
7/31/2017	hoary bat	7	37	carcass search	road/pad	scavenged
7/31/2017	hoary bat	29	39	carcass search	road/pad	scavenged
7/31/2017	hoary bat	8	3	carcass search	road/pad	scavenged
8/1/2017	eastern red bat	20	24	carcass search	road/pad	scavenged
8/1/2017	eastern red bat	19	10	carcass search	road/pad	scavenged
8/1/2017	hoary bat	17	3	carcass search	road/pad	scavenged
8/1/2017	hoary bat	56	5	carcass search	road/pad	scavenged
8/2/2017	hoary bat	38	1	carcass search	road/pad	scavenged
8/3/2017	hoary bat	81	5	carcass search	road/pad	dismembered
8/4/2017	hoary bat	47	31	carcass search	road/pad	intact
8/6/2017	eastern red bat	29	5	carcass search	road/pad	scavenged
8/10/2017	big brown bat	43	1	carcass search	road/pad	scavenged
8/10/2017	eastern red bat	44	38	carcass search	road/pad	scavenged
8/12/2017	eastern red bat	20	46	carcass search	road/pad	intact
8/14/2017	big brown bat	39	6	carcass search	road/pad	intact
8/14/2017	big brown bat	75	26	carcass search	road/pad	scavenged
8/14/2017	hoary bat	70	10	carcass search	road/pad	scavenged
8/15/2017	eastern red bat	62	5	carcass search	road/pad	scavenged
8/16/2017	eastern red bat	44	2	incidental	inc	intact
8/16/2017	eastern red bat	21	1	carcass search	road/pad	intact
8/16/2017	eastern red bat	74	4	carcass search	road/pad	scavenged
8/16/2017	eastern red bat	1	3	carcass search	road/pad	scavenged
8/16/2017	hoary bat	1	4	carcass search	road/pad	intact
8/17/2017	big brown bat	94	24	carcass search	road/pad	scavenged
8/17/2017	eastern red bat	95	25	carcass search	road/pad	dismembered
8/17/2017	eastern red bat	99	3	carcass search	road/pad	scavenged
8/17/2017	eastern red bat	97	13	carcass search	road/pad	scavenged
8/17/2017	hoary bat	108	5	carcass search	road/pad	dismembered
8/22/2017	big brown bat	55	14	carcass search	road/pad	scavenged
8/22/2017	hoary bat	56	2	carcass search	road/pad	scavenged
8/23/2017	eastern red bat	61	8	carcass search	road/pad	scavenged
8/24/2017	hoary bat	99	9	carcass search	road/pad	scavenged
8/24/2017	hoary bat	97	18	carcass search	road/pad	intact
8/28/2017	eastern red bat	8	4	carcass search	road/pad	scavenged
8/28/2017	eastern red bat	51	18	carcass search	road/pad	scavenged
8/29/2017	eastern red bat	21	5	carcass search	road/pad	scavenged
8/30/2017	eastern red bat	84	10	carcass search	road/pad	dismembered
8/30/2017	hoary bat	2	32	incidental	inc	Injured
8/31/2017	eastern red bat	91	34	incidental	inc	intact

Appendix C. Complete Carcass Listing for the O'Brien Wind Energy Facility, Ida County, Iowa, from March 16, 2017, to March 15, 2018.

Date	Common Name	Turbine Number	Distance from Turbine (m)	Type of Find	Search Type	Condition
9/4/2017	eastern red bat	70	13	carcass search	road/pad	scavenged
9/4/2017	eastern red bat	68	102	carcass search	road/pad	scavenged
9/4/2017	hoary bat	10	4	carcass search	road/pad	intact
9/4/2017	silver-haired bat	71	11	carcass search	road/pad	intact
9/5/2017	eastern red bat	44	6	carcass search	road/pad	scavenged
9/5/2017	eastern red bat	45	26	carcass search	road/pad	scavenged
9/5/2017	hoary bat	44	37	carcass search	road/pad	scavenged
9/11/2017	eastern red bat	24	6	carcass search	road/pad	scavenged
9/12/2017	big brown bat	2	2	carcass search	road/pad	scavenged
9/12/2017	hoary bat	40	28	carcass search	road/pad	intact
9/13/2017	eastern red bat	74	20	carcass search	road/pad	scavenged
9/19/2017	eastern red bat	62	4	carcass search	road/pad	scavenged
9/19/2017	silver-haired bat	37	8	carcass search	road/pad	intact
9/20/2017	hoary bat	99	19	carcass search	road/pad	scavenged
9/20/2017	silver-haired bat	83	18	carcass search	road/pad	scavenged
9/26/2017	hoary bat	49	6	carcass search	road/pad	dismembered
10/3/2017	eastern red bat	70	24	carcass search	road/pad	intact
10/3/2017	eastern red bat	6	5	carcass search	road/pad	scavenged
10/4/2017	eastern red bat	90	3	carcass search	road/pad	intact
10/9/2017	hoary bat	78	26	carcass search	road/pad	dismembered
10/10/2017	silver-haired bat	45	4	carcass search	road/pad	intact
Birds						
5/29/2017	red-tailed hawk	40	159	carcass search	road/pad	scavenged
6/13/2017	yellow-billed cuckoo	27	86	carcass search	road/pad	scavenged
6/14/2017	killdeer	101	44	carcass search	road/pad	intact
7/4/2017	common grackle	2	165	carcass search	road/pad	scavenged
7/12/2017	killdeer	86	81	carcass search	road/pad	scavenged
7/19/2017	rock pigeon	94	17	carcass search	road/pad	feather spot
8/10/2017	red-tailed hawk	46	33	carcass search	road/pad	scavenged
8/29/2017	ring-necked pheasant	16	25	carcass search	road/pad	feather spot
8/30/2017	killdeer	100	32	carcass search	road/pad	feather spot
9/26/2017	common grackle	45	79	carcass search	road/pad	feather spot
4/24/2017	house wren	3	20	carcass search	road/pad	Injured
4/25/2017	tree swallow	47	15	carcass search	road/pad	intact
5/18/2017	unidentified passerine	39	5	carcass search	road/pad	dismembered
5/22/2017	sedge wren	7	37	carcass search	road/pad	intact
5/22/2017	unidentified passerine	90	22	carcass search	road/pad	dismembered
5/29/2017	unidentified passerine	16	44	carcass search	road/pad	dismembered
6/5/2017	yellow warbler	94	24	carcass search	road/pad	intact
8/10/2017	Cliff swallow	16	26	carcass search	road/pad	scavenged
8/28/2017	Philadelphia vireo	27	62	carcass search	road/pad	scavenged
8/29/2017	Cliff swallow	2	5	carcass search	road/pad	intact
9/11/2017	ruby-throated hummingbird	58	29	carcass search	road/pad	intact
10/4/2017	brown-headed cowbird	20	25	carcass search	road/pad	scavenged
10/9/2017	sedge wren	9	107	carcass search	road/pad	intact
10/17/2017	ruby-crowned kinglet	7	80	carcass search	road/pad	scavenged
10/17/2017	Unidentified bird (small)	36	9	carcass search	road/pad	dismembered
10/19/2017	ruby-crowned kinglet	87	48	carcass search	road/pad	intact
10/24/2017	Harris' sparrow	48	31	carcass search	road/pad	scavenged
11/7/2017	Nashville warbler	80	15	carcass search	road/pad	scavenged
1/29/2018	European starling	9	7	carcass search	road/pad	dismembered

Appendix D: Estimated Fatality Rates and Correction Factors, with 90% Confidence Intervals, for Studies Conducted at the O'Brien Wind Energy Facility, O'Brien County, Iowa, from March 16, 2017, to March 15, 2018

Appendix D. Estimated Fatality Rates and Correction Factors, with 90% Confidence Intervals (CIs), for Post-Construction Monitoring Conducted at the O'Brien Wind Energy Facility, O'Brien County, Iowa, from March 16, 2017, to March 15, 2018.

Parameter	Spring		Summer		Fall		Winter	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Search Area Adjustment								
A (Bat)	0.08	0.06 - 0.11	0.08	0.06 - 0.11	0.08	0.06 - 0.11	-	-
A (Large Bird)	0.16	-	0.16	-	0.16	-	0.16	-
A (Small Bird)	0.21	-	0.21	-	0.21	-	0.21	-
Observer Detection Rate								
P (Bat)	0.42	0.22 - 0.6	0.76	0.64 - 0.85	0.87	0.78 - 0.94	-	-
P (Large Bird)	0.95	0.90 - 1.00	0.95	0.90 – 1.00	0.95	0.90 – 1	0.95	0.90 - 1.00
P (Small Bird)	0.80	0.70 - 0.89	0.80	0.70 - 0.89	0.80	0.70 - 0.89	0.80	0.70 - 0.89
Probability of a Carcass Persisting Through the Search Interval								
Bat	0.64	0.45 - 0.79	0.56	0.45 - 0.67	0.23	0.15 - 0.31	-	-
Large Bird	0.77	0.59 - 0.87	0.78	0.67 - 0.86	0.39	0.22 - 0.52	0.75	0.55 - 0.87
Small Bird	0.59	0.48 - 0.69	0.59	0.48 - 0.69	0.59	0.48 - 0.69	0.40	0.31 - 0.49
Probability of Available and Detected								
Bat	0.02	0.01 - 0.04	0.03	0.02 - 0.05	0.02	0.01 - 0.02	-	-
Large Bird	0.11	0.09 - 0.13	0.11	0.10 - 0.13	0.06	0.03 - 0.08	0.11	0.08 - 0.13
Small Bird	0.10	0.08 - 0.12	0.10	0.08 - 0.12	0.10	0.08 - 0.12	0.07	0.05 - 0.09
Unadjusted Number of Fatalities								
Bat	3.0	1 - 6	6.0	2 - 10	70.0	55 - 86	-	-
Large Bird	0.0	-	3.0	1 - 6	5.0	2 - 9	-	-
Raptor	0.0	-	0.0	-	1.0	0 - 3	0.0	-
Small Bird	2.0	0 - 5	3.0	1 - 6	9.0	5 - 14	1.0	0 - 3
Observed Fatality Rates (Fatalities/Turbine/Season(s))								
Bat	0.03	0.01 - 0.06	0.06	0.02 - 0.1	0.67	0.53 - 0.83	-	-
Large Bird	-	-	0.03	0.01 - 0.06	0.05	0.02 - 0.09	-	-
Raptor	-	-	-	-	0.01	0 - 0.03	-	-
Small Bird	0.02	0 - 0.05	0.03	0.01 - 0.06	0.09	0.05 - 0.13	0.01	0 - 0.03
Adjusted Fatality Rates (Fatalities/Turbine/Seasons(s))								
Bat	1.35	0.30 - 3.64	1.81	0.71 - 3.34	44.31	29.85 - 74.72	-	-
Large Bird	-	-	0.27	0.07 - 0.57	0.81	0.27 - 1.83	-	-
Raptor	-	-	-	-	0.15	0 - 0.52	-	-
Small Bird	0.19	0 - 0.47	0.26	0.07 - 0.56	0.93	0.44 - 1.56	0.11	0 - 0.31
All Bird	0.19	0 - 0.47	0.53	0.20 - 0.94	1.74	0.99 - 2.95	0.11	0 - 0.31
Adjusted Fatality Rates (Fatalities/MW/Seasons(s))								
Bat	0.56	0.12 - 1.51	0.75	0.3 - 1.39	18.41	12.4 - 31.04	-	-
Large Bird	-	-	0.11	0.03 - 0.24	0.34	0.11 - 0.76	-	-
Raptor	-	-	-	-	0.06	0 - 0.22	-	-
Small Bird	0.08	0 - 0.19	0.11	0.03 - 0.23	0.39	0.18 - 0.65	0.04	0 - 0.13
All Bird	0.08	0 - 0.19	0.22	0.08 - 0.39	0.72	0.41 - 1.23	0.04	0 - 0.13

2017-2018 Post-Construction Fatality Monitoring: Eagle-Focused Surveys

MidAmerican Energy Company Iowa Wind Energy Portfolio: Ida Grove and O'Brien Wind Energy Facilities

March 2017 – March 2018

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INTRODUCTION

MidAmerican Energy Company (MidAmerican Energy or MidAmerican) has developed and operates a fleet of wind energy projects in Iowa with a combined 4,048 megawatts (MW) of nameplate capacity (Table 1, Figure 1). Western EcoSystems Technology, Inc. (WEST) was retained to conduct standardized post-construction fatality monitoring at MidAmerican's Iowa wind energy facilities consistent with Tier 4 of the U.S. Fish and Wildlife Service *Land-based Wind Energy Guidelines* (USFWS 2012) and Stage 5 of the *Eagle Conservation Plan Guidance* (USFWS 2013). These standardized field studies were conducted to assess impacts to wildlife from operation of MidAmerican's Wind I-X Iowa wind energy portfolio (WEST 2015).

The primary objective of the eagle specific post-construction monitoring presented in this report is to gather data useful in quantifying fatality estimates for eagles, specifically focused on improving the accuracy of searcher efficiency and carcass persistence trial estimation. A secondary objective is to gather data to support the HCP and National Environmental Policy Act (NEPA) process in application for an Incidental Take Permit. For the HCP, this study will also be used to help evaluate and determine an effective and economically feasible method of long-term monitoring for permit compliance.

Study components to support these objectives include:

1. Determine the searcher efficiency rates for eagle searches;
2. Determine and compare carcass persistence rates for frozen and thawed red-tailed hawks (*Buteo jamaicensis*);
3. Compare the searcher efficiency rates for frozen and thawed raptor carcasses, large feather spots, and eagle surrogates; and
4. Determine the area viewable from the visual scan searches.

During the 2017-2018 study period, post-construction fatality monitoring was conducted at Ida Grove and O'Brien facilities (Table 1, Figure 1). This report provides site-specific data collected using the eagle-focused study design at these two facilities between March 2017 and March 2018.

Table 1. MidAmerican Energy Company's Iowa Wind Energy Portfolio, Including Facility Specifications.

Facility Name	County	Project Area		Number of Turbines	Turbine Size (MW)	Total Project (MW)
		(Square Miles)	(Acres)			
2014-2016 Fatality Monitoring Study						
Adair	Adair/Cass	26	16,640	76	2.3	174.8
Carroll	Carroll	25	16,000	100	1.5	150.0
Eclipse	Audubon/Guthrie	31	19,840	87	2.3	200.1
Lundgren	Webster	52	33,280	107	2.3	251
Macksburg	Madison	22	14,080	51	2.3	119.6
Morning Light	Adair	13	8,320	44	2.3	101.2
Rolling Hills	Adair/Adams/Cass	69	44,160	193	2.3	443.9
Victory	Carroll/Crawford	28	17,920	66	1.5	99.0
Walnut	Pottawattamie	32	20,480	102	1.5	153.0
2015-2017 Fatality Monitoring Study						
Adams	Adams	16	10,126	64	2.3/2.4	154.3
Century	Hamilton/Wright	28	17,920	145	1.5/1.0	200.0
Charles City	Floyd	18	11,520	50	1.5	75.0
Highland	O'Brien	92	58,880	214	2.3	502
Intrepid	Sac/Buena Vista	43	27,520	122	1.5/1.0	175.5
Laurel	Marshall	16	10,240	52	2.3	119.6
Pomeroy	Pocahontas	33	21,120	184	1.5/2.3	286.4
Vienna	Marshall/Tama	15	9,600	45	2.3	105.6
Vienna II	Marshall	11	7,040	19	2.3	44.6
Wellsburg	Grundy	36	23,040	60	2.3	140.8
2017-2018 Fatality Monitoring Study (This Report)						
Ida Grove	Ida	184	117,800	134	1.8/2.3	301.0
O'Brien	O'Brien	94	60,454	104	2.3/2.4	250.3

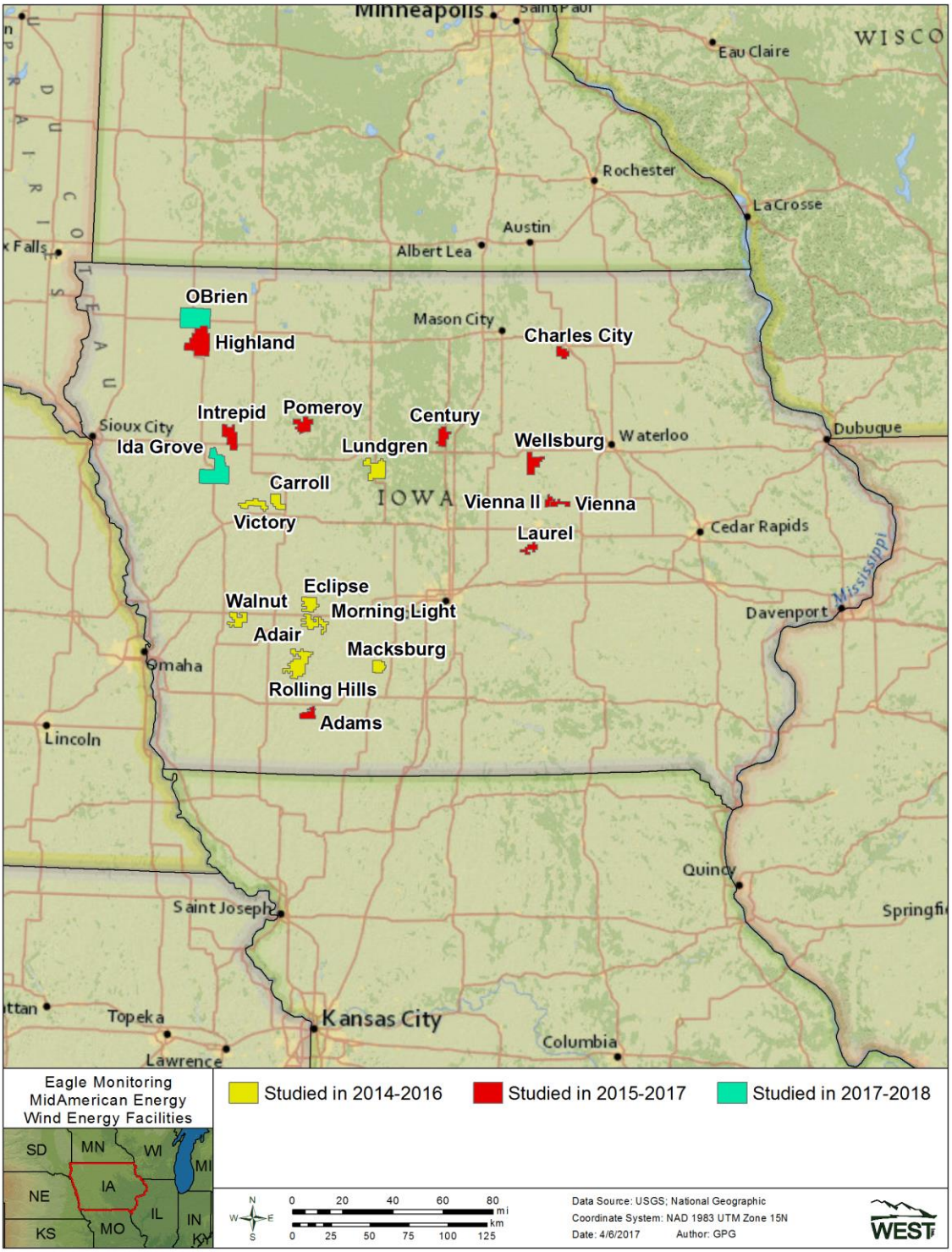

Figure 1. Locations of MidAmerican Energy Company's Iowa Wind Energy Facilities in the Wind I-X portfolio.

STUDY AREA

The Ida Grove facility is located in both the Northwest Iowa Loess Prairies and the Steeply Rolling Loess Prairies Level 4 Ecoregion (Chapman et al. 2001). The O'Brien facility is located in the Northwest Iowa Loess Prairies Level 4 Ecoregion. The land cover at both facilities predominately consists of cropland (i.e., corn [*Zea mays*] and soybeans [*Glycine max*]), according to the U.S. Geological Survey (USGS) National Land Cover Database (NLCD; USGS NLCD 2011, Homer et al. 2015).

METHODS

The methods are organized into five primary components: (1) standardized carcass searches, (2) searcher efficiency trials, (3) carcass persistence trials, (4) visible area delineations, and (5) statistical analysis.

Standardized Carcass Searches

To determine the observed number of eagle carcasses, standardized carcass searches (i.e., visual scans) were conducted from March 16, 2017, to May 15, 2017 (spring 2017), and from November 16, 2017, to March 15, 2018 (winter 2017/2018). This timeframe (i.e., November to May) corresponds with the period of highest eagle use at the MidAmerican facilities (Simon et al. 2016). Biologists trained in proper search techniques conducted all carcass searches. Standardized eagle searches, described below, were conducted immediately before road and pad searches for fatalities of bats and other bird species (WEST 2015).

Eagle carcass searches were completed using visual scans of the area within a 100-meter (m; 328-foot) radius plot centered on the turbine. The distance from turbine was determined using landmarks and a rangefinder. Searchers stood at the edge of the turbine pad at each of the four cardinal directions and scanned the ground for carcasses using binoculars. Eagle carcass searches were conducted once per month at 100% of turbines. All carcasses found during searches were documented in the manner described below, regardless of the distance from turbine.

Data Collected

During each carcass search, the following data were recorded: date, start time, end time, observer initials, type of search (i.e., eagle scan), and if any carcasses were found. If a bat or bird carcass was found during a search, the searcher marked the carcass (e.g., using a pin flag or flagging) and finished searching the plot. After the search was completed, the searcher returned to the carcass and recorded additional data on a casualty form including the date and time the carcass was found, species or best possible identification, sex and age (when possible), observer initials, turbine number, distance from turbine in meters, azimuth from turbine, Universal Transverse Mercator coordinates, vegetation surrounding carcass, condition of carcass (e.g., intact, partial, scavenged), and estimated

time of death (e.g., last night, two or three days). Digital photographs were taken of the carcass, any visible injuries (e.g., broken wing), and surrounding habitat.

Carcass Handling

If an eagle carcass was found, the USFWS was to be notified for further collection and handling instruction. If other sensitive species (i.e. federally endangered or threatened, state endangered, threatened, or species of special concern) were found the USFWS or Iowa Department of Natural Resources were to be notified for further final disposition instructions. This process was consistent with the Collection and Reporting Protocol found in Appendix B of MidAmerican's Bird and Bat Conservation Strategy. Carcasses found outside the search area were documented in a similar fashion as those found within standardized search areas. All non-eagle and non-sensitive species carcasses were to be processed and collected or spray painted as described in Bay et al. (2016, 2017a).

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of carcasses found by searchers. Searcher efficiency trials were conducted concurrently with and in the same area as eagle carcass searches. Trials were distributed temporally across the survey period to provide measurements of searcher efficiency in varying field conditions. Searcher efficiency estimates are used to adjust the total number of carcasses found for carcasses missed by searchers, thereby correcting for detection bias.

Searcher efficiency trials were to be conducted using fully-feathered turkey (*Meleagris gallopavo*) decoy surrogates (decoys) in spring 2017. Decoys and red-tailed hawk carcasses were used in winter 2017/2018. Trials were conducted using four treatments for placement condition:

1. Fully-feathered turkey decoys;
2. Frozen, compacted red-tailed hawk carcasses (as provided by USFWS);
3. Thawed, unfolded, and outstretched red-tailed hawk carcasses; and
4. Red-tailed hawk feather spots.

Five decoys were placed in spring 2017. During winter 2017/2018, approximately, 30 trials were planned for each treatment, for a total of approximately 120 trials at each Project. Frozen, compacted red-tailed hawk carcasses were left in the state in which received from the USFWS. Thawed, unfolded, and outstretched red-tailed hawk carcasses were thawed, having their wings extended in various positions, simulating the natural posture of a fallen carcass. Turkey decoys each consisted of a plastic decoy body covered in fully-feathered Turkey Skinz™. Feather spots included a minimum of 10 red-tailed hawk flight feathers with additional body feathers from red-tailed hawk and ring-necked pheasant; enough feathers were placed to cover a two by two foot area. Prior to placing the feather spot trial carcasses, trial administrators searched an area approximately six by six meters centered on the predetermined placement coordinates to ensure no feather

spots were located in the area; any carcasses or feather spots found were to be documented as a casualty using standard protocol (WEST 2015). Feather spots were marked discreetly in a manner that identified the feather spot but did not make it more visible to searchers. The frozen and thawed carcasses were then left in the field to complete carcass persistence trials as described below.

Searcher efficiency trial carcasses were placed at random locations within the visible portion of the search area prior to scheduled carcass searches for that day. Red-tailed hawk trial carcasses were discreetly marked using a dark zip-tie around the leg. Searchers were not informed when searcher efficiency trials were being conducted, nor where trial decoys or carcasses were placed. The number and location of the searcher efficiency decoys and carcasses found during the carcass survey was recorded. The number of decoys and carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the decoys and carcasses.

Carcass Persistence Trials

The objective of carcass persistence trials is to estimate the likelihood a carcass is removed by scavengers as a function of the number of days since the trial carcasses were placed in the field. Carcass removal includes removal by predation/scavenging or removal by other means such as being plowed into a field. Estimates of carcass persistence are used to adjust the total number of carcasses found for those removed from the search area prior to searches, thereby correcting for persistence bias.

Surrogates for eagle carcasses consisted of adult ring-necked pheasants (*Phasianus colchicus*), and red-tailed hawk carcasses as provided by the USFWS. In spring 2017 ten ring-necked pheasants were to be placed at each Project and in Winter 2017/2018 the same frozen and thawed carcasses that were placed during searcher efficiency trails were used. If recent fatalities of large birds in good condition were found during standardized searches, they could be left in place to be monitored for the carcass persistence trials.

All carcass persistence trial carcasses, except those found during standardized searches, were discreetly marked using a dark zip-tie around the leg and dropped from shoulder height and allowed to land in a random posture to simulate a true turbine-related fatality; carcasses found during scheduled searches and observed for carcass persistence trials were marked and left undisturbed in the field. Personnel conducting carcass searches monitored the ring-necked pheasant carcasses over a 30-day period by checking them every day for the first four days, then on day seven, day 10, day 14, day 20, and day 30. Raptor carcasses were monitored for a 60-day period and followed the same monitoring schedule but were also checked on day 40, day 50, and day 60. This schedule occasionally varied depending on weather and coordination with other survey work but was followed as closely as possible. At the end of the trial period, any evidence of the placed trial carcasses that remained was removed.

Visible Area Delineations

An area correction was calculated to account for the area of the 100-m circular plots that were not visible during the visual scan carcass searches. Technicians delineated the area of each 100-m plot that was not visible from the turbine pad on turbine-specific paper maps which were then scanned and imported to ArcGIS (version 10.3) and georeferenced at each turbine site. The areas that were considered not visible were digitized and stored in a geodatabase. A 100-m circular plot around the turbine was developed and combined with the visibility layer in order to make search area correction calculations.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field carcass searches, observers and crew leaders were responsible for inspecting data forms for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. 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 in all steps were made.

Data Compilation and Storage

A Microsoft® SQL database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent quality assurance, quality control, and data analysis. All data forms, field notebooks, and electronic data files were retained for reference.

Fatality Rate Estimation

Fatality rate estimation is a complex task due to variables present in every study. To determine the rate at which fatalities occur, the number of carcasses found in each search area is tallied; however, carcasses persist for variable amounts of time and can be detected with varying levels of success based on carcass characteristics and season. In addition, the visible area within the 100-m visual scan plots varied at each turbine. To account for these variables, statistical analyses have been developed to adjust the observed count of carcasses based on the project-specific rate of carcass persistence, the ability of searchers to detect carcasses, and the proportion of carcasses likely to have fallen in visible areas.

Estimation of Searcher Efficiency Rates

Searcher efficiency rates were summarized for both Projects using the ratio of trial carcasses found over the total number of trial carcasses available to be found, including both the decoys and raptor surrogates. For the red-tailed hawk bias trial study component, we only considered models that included placement condition as a covariate. Model selection compared using a logistic regression (McCullagh and Nelder 1989) to

determine whether additional covariates (i.e., distance from turbine and facility) should be included in the model. The best model was selected using a combination of Akaike information criterion with a correction for finite sample sizes, hereafter referred to as AICc, and model parsimony (Burnham and Anderson 2002). We tested multiple comparison hypotheses by comparing interesting combinations of placement condition within the logistic regression context. The comparisons of interest were frozen vs thawed, turkey decoy vs thawed and frozen combined (hereafter referred to as whole RTHA), feather spot vs whole RTHA, and turkey decoy vs feather spot. We used a Bonferroni correction of the p values to account for the multiple tests conducted (Dunn 1958).

Estimation of Carcass Persistence Rates

Estimates of carcass persistence rates were calculated using interval censored mean. For the red-tailed hawk bias trial study carcass persistence rates were modeled using an interval censored survival regression (Therneau and Lumley 2015, Therneau and Grambsch 2000). AICc and model parsimony (Burnham and Anderson 2002) were used to determine distribution (Exponential, log-logistic, lognormal, or Weibull) and whether to include a facility covariate. All models included a placement condition covariate. The selected model is used to test for difference is persistent times between frozen and thawed carcasses.

Area Correction Calculation

An area correction was used to account for area within the 100-meter plots used for visual scans that was not viewable from the turbine pads. The carcass density distribution was estimated using a triangular distribution approached based on Hull and Muir (2010). The carcass density distribution used in connection with the proportion of area searched, averaged across all turbines within each facility, provides an estimate of the proportion of fatalities expected to land within searched areas.

RESULTS

All 134 turbines at Ida Grove were searched four times in spring (531 searches) and eight times in winter (1,072 searches), for a total of 1,603 searches (Table 2). All 104 turbines at O'Brien were searched four times in spring (395 searches) and eight times in winter (759 searches) for a total of 1,154 searches (Table 2). No eagle fatalities were found at either Project during this study period.

Table 2. Eagle Carcass Search Effort for Ida Grove and O'Brien Wind Energy Facilities Studied from March 16 – May 15, 2017 and November 16, 2017 - March 15, 2018.

Facility	Spring	Winter
Ida Grove	531	1,072
O'Brien	395	759
All Facilities	**926**	**1,831**

Searcher Efficiency

A total of 131 searcher efficiency trial carcasses were monitored at Ida Grove and 132 at O'Brien between March 16, 2017, and March 15, 2018 (Table 3). At Ida Grove, we

placed 36 turkey, 61 red-tailed hawk carcasses, and 30 large feather spots. At O'Brien, we placed 35 turkey decoys, 66 red-tailed hawk carcass, and 31 large feather spots. Searcher efficiency ranged from 0.54 for large feather spots to 0.94 for turkey decoys. Searcher efficiency at O'Brien ranged from 0.63 for large feather spots to 0.89 for turkey decoys (Table 3).

Table 3. Searcher Efficiency Results for Ida Grove and O'Brien Wind Energy Facilities Studied Between March 16 – May 15, 2017 and November 16, 2017 – March 15, 2018.

Surrogate Type	Season	# Placed	#Available	Found	Searcher Efficiency Rate
Turkey Decoys	Ida Grove	36	35	33	0.94
	O'Brien	35	35	31	0.89
	Total	**71**	**70**	**64**	**0.91**
Frozen Red-tailed Hawks	Ida Grove	34	34	23	0.68
	O'Brien	36	36	27	0.75
	Total	**70**	**70**	**50**	**0.71**
Thawed Red-tailed Hawks	Ida Grove	31	30	22	0.73
	O'Brien	30	29	23	0.79
	Total	**61**	**59**	**45**	**0.76**
Large Feather Spots	Ida Grove	30	28	15	0.54
	O'Brien	31	30	19	0.63
	Total	**61**	**58**	**34**	**0.59**

Carcass Persistence

Sixty-eight carcass persistence trials were monitored at Ida Grove, which included 61 red-tailed hawks and seven ring-necked pheasant surrogates (Table 4). Sixty-two carcass persistence trials were monitored at O'Brien, which included 58 red-tailed hawk and four ring-necked pheasant surrogates. The mean carcass persistence time for ring-necked pheasants was 6.96 days at Ida Grove, compared to 31.32 days for red-tailed hawks. At O'Brien, the mean persistence time was 17.03 days for ring-necked pheasants and 43.58 days for red-tailed hawks (Table 5).

Table 4. The Species[a] and Counts of Carcass Persistence Trial Surrogates Placed at Ida Grove and O'Brien Wind Energy Facilities Between March 16 – May 15, 2017 and November 16, 2017 – March 15, 2018.

Facility	RNPH	RTHA	Total
Ida Grove	7	61	68
O'Brien	4	58	62

[a] RNPH = ring-necked pheasant (*Colchicus phasianus*); RTHA = red-tailed hawk (*Buteo jamaicensis*)

Table 5. Persistence Time, in Days, for each Species at the Ida Grove and O'Brien Wind Energy Facilities Studied Between March 16 – May 15, 2017 and November 16, 2017- March 15, 2018.

Facility	Species	Persistence Rate
Ida Grove	RNPH	6.96
	RTHA	31.32
O'Brien	RNPH	17.03
	RTHA	43.58

Search Area Adjustment

An area correction was calculated to account for the proportion of the total area within 100 m of each turbine that was not visible. We calculated separate area correction values for each turbine type at Ida Grove. The area correction value for 1.79 MW turbines at Ida

Grove was 0.85 and for 2.3 MW turbines was 0.77. At O'Brien, the area correction value was 0.93 (Table 6).

Table 6. Area Corrections Values for 100-meter Scan Plots at Ida Grove and O'Brien Wind Energy Facilities Studied from March 16 – May 15, 2017 and November 16, 2017 – March 15, 2018.

Facility	Turbine MW	Area Correction
Ida Grove	1.79	0.85
	2.3	0.77
O'Brien	2.4	0.93

Red-tailed Hawk Bias Trial Study

Searcher Efficiency

To test the difference in searcher efficiency based on placement condition, we used 117 surrogates at Ida Grove and 120 at O'Brien, for a total of 137 searcher efficiency trials (Table 7). At either facility, large feather spot had the lowest proportion found and turkey decoys had the highest proportion found. The searcher efficiency rate for thawed red-tailed hawks was slightly higher than frozen red-tailed hawks at both facilities (Table 7).

Table 7. The Results of Searcher Efficiency Trials during the Red-tailed Hawk Bias Trial Study at the Ida Grove and O'Brien Wind Energy Facilities from November 16, 2017, to March 15, 2018.

Facility	Placement Condition	Sample Size	Searcher Efficiency
Ida Grove	Turkey Decoy	30	0.93
	Frozen RTHA	29	0.69
	Thawed RTHA	30	0.73
	Large feather spot	28	0.54
O'Brien	Turkey Decoy	30	0.93
	Frozen RTHA	31	0.71
	Thawed RTHA	29	0.79
	Large feather spot	30	0.63

The most parsimonious model with the lowest AICc value included only placement condition as a covariate, indicating that little additional information is gained by additional covariates considered (Table 8). Placement condition is a single covariate, but since it is a categorical covariate with multiple values, it has multiple coefficients (Table 8). The z-test indicates that three of the four categories (turkey decoys, frozen red-tailed hawks, and thawed red-tailed hawks) had coefficients that were not equal to zero (Table 9). To determine if categories could be collapsed, we further examined four comparisons of interest and found a significant difference between turkey decoys and feather spots, and turkey decoys and whole red-tailed hawk carcass (i.e., frozen and thawed combined; Table 10). We did not find a significant difference between thawed or frozen red-tailed hawk carcasses, nor did we find a significant difference between feather spots and whole red-tailed hawk carcasses (Table 10).

Table 8. Model Selection Results to Determine if Additional Covariates Should be Included when Modelling Searcher Efficiency by Placement Condition.

Covariates	AICc Values	Delta AICc Values
Placement Condition	**254.18**	**0**
Placement Condition + Distance	255.36	1.16
Placement Condition + Facility	255.63	1.43
Placement Condition + Facility + Distance	256.75	2.56
Placement Condition + Facility + Placement Condition by Facility	261.77	7.57
Placement Condition + Facility + Distance + Placement Condition by Facility	262.96	8.77

Table 9. Details of the Selected Model by Placement Condition and a Test for Differences among Each Placement Condition.

Placement Condition	Coefficient Estimate	Standard Error	z Value	Pr (>|z|)
Frozen RTHA	0.85	0.28	3.01	<0.01
Thawed RTHA	1.17	0.31	3.82	<0.01
Turkey Decoy	2.64	0.52	5.10	<0.01
Large feather spot	0.35	0.27	1.31	0.19

Table 10. Comparisons of Interest to Test for a Difference in Searcher Efficiency Rates.

	Estimate	Standard Error	z Value	p	Adjusted P-value*
Turkey Decoy vs Feather Spot	2.29	0.58	3.93	<0.01	<0.01
Thawed vs. Frozen Red-tailed Hawk	0.32	0.42	0.77	0.44	1.00
Turkey Decoy vs Whole Red-tailed Hawk**	1.63	0.56	2.93	<0.01	0.01
Feather Spot vs Whole Red-tailed Hawk**	0.66	0.34	1.95	0.05	0.21

*Bonferroni correction applied

** Combined Frozen and Thawed Red-tailed Hawks

Carcass Persistence

The modelling results indicated that no additional covariates should be included in carcass persistence with placement condition, and that carcass persistence follows an exponential distribution (Table 11). Therefore, the sample size for both facilities was combined (Table 12). Frozen red-tailed hawk carcasses remained available to be found for a shorter duration than thawed red-tailed hawk carcasses (Table 12). However, the coefficient estimates, standard errors, and p-value indicate there is little evidence of a statistical difference in persistence times between frozen and thawed carcasses (Table 13).

Table 11. Model Selection Results to Determine if Additional Covariates Should be Included when Modelling Carcass Efficiency by Placement Condition.

Covariate	Distribution	AICc	Delta AICc
Placement Condition	**exponential**	**456.59**	**0**
Placement Condition + Facility	exponential	456.59	<0.01
Placement Condition + Facility	weibull	458.61	2.02
Placement Condition	weibull	458.65	2.06
Placement Condition + Facility	loglogistic	462.30	5.71
Placement Condition	loglogistic	462.98	6.39
Placement Condition	lognormal	468.03	11.44
Placement Condition + Facility	lognormal	469.67	13.08

Table 12. Summary Mean Removal Time for Frozen and Thawed Red-tailed Hawks at the Ida Grove and O'Brien Wind Energy Facilities Between March 16 – May 15, 2017, and November 16, 2017 - March 15, 2018.

Placement Condition	Sample Size	Mean Removal Time
Frozen Red-tailed Hawk	59	35.51
Thawed Red-tailed Hawk	60	39.58

Table 13. Test to Determine Whether Placement Condition Should be included in the Carcass Persistence Model.

	Value	Standard Error	z Value	p Value
(Intercept)	3.54	0.14	25.00	<0.01
Placed Condition (Thawed Red-tailed Hawk)	0.10	0.21	0.51	0.61

DISCUSSION

The results of the eagle focused surveys at Ida Grove and O'Brien contribute data to inform ongoing Habitat Conservation Plan development for MidAmerican's wind energy portfolio. While we did not find any casualties, the searcher efficiency, carcass persistence, and search area adjustment results indicate that the study design was adequate for collecting data to estimate eagle fatality rates. Searcher efficiency estimates indicated that the majority of eagle carcasses would be found during eagle carcass searches. Carcass persistence values indicate that eagle carcasses would likely remain to be found through the search interval. Lastly, the majority of all eagle carcass search plots were visible, again suggesting likely high detection rate for eagles – a relatively large carcass.

While the study design presented here was adequate for eagle fatality estimation, we also conducted research to examine two adjustments for bias included in fatality estimation: searcher efficiency and carcass removal. These data will enable MidAmerican to make informed adjustments in how these biases are measured to achieve increased accuracy in eagle fatality estimation.

Searcher Efficiency

We examined the difference in searcher efficiency rates for fully-feathered turkey decoys, a common eagle surrogate, and red-tailed hawk carcasses in various placement conditions (i.e., frozen, thawed, and feather spots) in an attempt to improve searcher efficiency

accuracy for eagle studies. We found that searcher efficiency rates for turkey decoys were higher than red-tailed hawks, regardless of placement condition. Among the red-tailed hawk placement types, we found no statistically significant difference between frozen, compacted carcasses and thawed, outstretched carcasses. We also found no difference between whole red-tailed carcasses and red-tailed hawk feather spots.

The important question for improving eagle fatality estimation, however, is which surrogate best represent an eagle carcass. Several traits suggest that turkey decoys may be easier to find on a landscape relative to a real raptor carcasses. First, a turkey decoy carcass must be weighted down with rocks to ensure it does not blow away prior to searches; the rocks often stand the decoy up vertically making it higher profile than a raptor carcass. Secondly, care must be taken to ensure no unfeathered portion of the decoy is visible during trials, as the un-feathered decoy body looks unnatural on the landscape. Further, any red or blue coloration of the turkey decoy head can make the decoy easy to see in the natural landscape. However, when care is taken to ensure that the turkey decoy does not stand up vertically and that no un-feathered portion of the body is showing, turkey decoys likely represent an eagle carcass well, particularly when considering that they can be easily manipulated to match the size of an eagle carcass.

Red-tailed hawks have several traits that suggest they may bias searcher efficiency results as well. As mentioned above, red-tailed hawks are much smaller than eagle carcasses, making them a smaller target on the landscape. The largest red-tailed hawks are considerably smaller than the smallest bald or golden eagles, particularly in wingspan and wing chord, suggesting that red-tailed hawks may be too small to be a suitable surrogate for eagle carcasses.

The best fit for representing searcher efficiency for eagle carcasses may be a combination of red-tailed hawk carcasses and decoys. The combination of both surrogates would presumably correct for the high bias of the decoys and low bias of the red-tailed hawk. Regardless of which surrogate used, a sufficient sample of large feather spots should be placed as well.

Carcass Persistence

This study was not designed to address the question of whether game birds (ring-necked pheasants) or red-tailed hawks persisted on the landscape longer. Red-tailed hawk carcass persisted longer in the field than ring-necked pheasants; however, placements did not occur concurrently, nor were sample sizes balanced between red-tailed hawk and ring-necked pheasant carcasses. In spring 2017, we placed standard surrogates (ring-necked pheasants) at Ida Grove and O'Brien. We only placed raptor carcasses in winter 2017-2018, as results from research at MidAmerican's Century facility in winter 2016-2017

suggested that ring-necked pheasants were not a sufficient surrogate for raptor species. During that study, red-tailed hawk carcasses persisted nearly twice as long as ring-necked pheasants (Bay et al. 2017b). Results are consistent with other research indicating raptor carcasses last longer than the standard surrogates, particularly gamebirds such as pheasants (Urquhart et al. 2015, Hallingstad et al. in prep).

We tested whether there was a difference in persistence rates based on initial placement state (i.e., frozen or thawed), as a thawed carcass may better represent a freshly fallen carcass. That is, we wanted to measure if there was an unintentional bias associated with placing frozen carcasses. We did not find evidence that initial placement condition of the red-tailed hawk carcass affected carcass persistence time.

CONCLUSION

MidAmerican capitalized on a rare opportunity of access to frozen raptor carcasses for furthering the state of science concerning searcher efficiency and carcass persistence adjustments in fatality estimation for eagles. Eagle fatality estimation research conducted to date typically used easily-obtained surrogates; such as fully feathered turkey decoys, mallards, ring-necked pheasants, and rock pigeon; to measure adjustments for searcher efficiency and carcass persistence. Our research suggests that fully feathered turkey decoys are likely suitable surrogates for searcher efficiency; however, the effectiveness of searchers finding feather spots should also be measured. Concerning carcass persistence, our study anecdotally reinforced that raptor carcass persistence is not adequately represented by persistence of gamebird carcasses, and that thawing frozen carcasses does not produce measurable change in carcass persistence. The data collected during this study suggests that when buteo-sized raptor carcasses are available for use in eagle-focused post-construction monitoring, it is prudent to use those carcasses to measure carcass persistence, as turkey decoys are likely more effective surrogates for eagle-sized carcasses.

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