Addendum: Technical Reports

2015 Northern Long-Eared Bat Fall Migration Study

MidAmerican Energy Company
Iowa Wind Energy Portfolio

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EXECUTIVE SUMMARY

MidAmerican Energy Company (MidAmerican) contracted Western EcoSystems Technology, Inc. (WEST) to conduct surveys for northern long-eared bats (*Myotis septentrionalis*; NLEBs) during late summer and fall of 2015. The survey efforts were focused on capturing NLEBs in order to affix radio-transmitters to the bats and attempt to understand key aspects of the migratory ecology of the species in southern Iowa.

Between August 17, 2015 and October 11, 2015 WEST captured 76 bats at five sites, including 17 NLEBs, 30 big brown bats (*Eptesicus fuscus*), 10 eastern red bats (*Lasiurus borealis*), 3 hoary bats (*L. cinereus*), 11 evening bats (*Nycticeius humeralis)*, 2 silver-haired bats (*Lasionycteris noctivagans*), and 3 little brown bats (*M. lucifugus*). No Indiana bats (*M. sodalis*) were captured during the surveys. Fourteen of the 17 captured NLEBs were outfitted with Lotek NanoTag transmitters, while the other three NLEBs were outfitted with traditional Lotek or Holohil transmitters. Ten of the 17 captured NLEBs were female (seven adults and three juveniles), and the other seven were male (four adults and three juveniles)

During roost telemetry surveys, WEST documented five different roost trees for three NLEBs. Four of the five roosts were in oak (*Quercus* spp.*)* trees; two in bur oaks (*Q. macrocarpa),* one in white oak (*Q. alba*), one in unidentified oak species (*Q.* spp), and one in a basswood (*Tilia americana*) tree. Three of the five roost trees found were snags, while the remaining two were living with dead branches and crevices. Average tree height of all found roosts was 13.0 meters (42.7 feet), and the average DBH was 54.8 centimeters (21.6 inches). Seven emergence counts were conducted at four of the roosts, resulting in counts ranging from 0 – 7 bats emerging from a roost tree in a night.

Fixed telemetry towers were deployed at 13 sites in Madison, Ringgold and Decatur counties. During 635 tower-days from August 18 to October 25, 2015, just over 4.4 million data observations were passively recorded, of which 699,845 were detections of active tags on NLEBs. On average, tagged bats were detected by fixed telemetry towers on 8.1 nights across 9.6 calendar nights. Two bats apparently left the area the night they were tagged and were never recorded. One bat was detected on 27 nights during a 31-day period. Analysis of weather data associated suggested that precipitation events were associated with bats leaving the study areas.

Based on analysis of telemetry headings for the last 15-minute period that bats were detected, there was no clear pattern in direction travelled, though bats did appear to be moving along or toward riparian areas. This suggests that NLEBs were following creeks during presumed migratory movements, and it is likely that bats ultimately travelled in directions other than the direction of last detection while moving to wintering areas.

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Report Reference

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INTRODUCTION

Migration is a phenomenon observed widely in the animal kingdom, and involves movements of most or all of the individuals in a given population at approximately the same time. Despite the risks, time and physiological expense associated with these large-scale movements, migration may confer selective benefits to individuals through increased survival, increased reproductive success, or a combination of these. Well known examples of migrations include those performed by blue whales that are nearly global in scale, the continental scale migrations of large African ungulates and many bird species, and salmonid and insect migrations (e.g., monarch butterflies). Seasonal bat migrations have been recognized since at least the late 1880's (Merriam 1887), yet after more than a century of research on bats, remarkably few details are available regarding bat migration.

For north temperate bat species, migrations generally coincide with changes in reproductive condition and/or seasonal resource constraints. For example, many species of bats mate in the fall after migration but before the onset of hibernation, and give birth the following summer following spring migration (Cockrum 1955). Similarly, the onset of cold winter temperatures is associated with a reduction in or elimination of bats' energy supply (i.e., insect prey) along with a substantial increase in the energy required to defend body temperature (Speakman and Thomas 2003). Bats have evolved two mechanisms to deal with the seasonal shortfall between energy consumption and energy expenditure. Some species of bats migrate to areas that allow them to remain relatively active, whereas others migrate to areas that allow them to safely spend the winter in hibernation. Bats that do the former are typically referred to as long-distance migrants, and bats that do the latter are referred to as either regional or short distance migrants, depending on the typical distance of migration (Fleming and Eby 2003). Regional or short distance (hereafter, "local") migrating bats typically do not move far enough from summer areas to avoid the harsh temperatures and food shortage of winter. Instead, they enter a deep physiological torpor (hibernation), and survive the winter by very slowly using the fat reserves accumulated during the previous summer to maintain metabolic function. While local migrants hibernate in areas that experience sub-freezing surface temperatures until spring, long-distance migrants appear to overwinter in coastal and more southern areas (Findley and Jones 1964, Cryan 2003), which presumably means that they do not experience sub-freezing temperatures and are able to forage during nights with favorable conditions.

As with small birds, much of what is known about bat migration has been learned through the practice of wing banding, which allows repeated observations of individuals at their summer and subsequently their winter areas. Wing banding involves placing a small plastic or aluminum band on a bat's forearm. The bands are coded with a unique identifier that allows researchers to trace the date and location of the original application of the band, and data provided by banding has provided a disproportionate share of our knowledge of the extent and seasonality of bat movements (Griffin 1936, 1945; Albright 1959; Glass 1982; Kurta and Murray 2002; and Rockey et al. 2013). For example, records of an Indiana bat banded in northern Michigan and re-sighted in a hibernaculum in Kentucky (Rockey et al. 2013) expanded our understanding of the maximum distance that Indiana bats may migrate, and re-sightings of banded Indiana and little brown bats in hibernacula and on summer grounds provide an indication of the direction of migratory movements (e.g., Davis and Hitchcock 1965). As a research method, banding has worked relatively well for species that tend to aggregate in large numbers during the winter and that are therefore easily visible to researches (e.g., little brown bat and Indiana bat). For other species of bats, however, banding has not yielded much information. This may be because these bats remain relatively hidden to researchers within known hibernacula, or because the bats are hibernating in locations that researchers are not monitoring or are not aware of. For example, despite the fact that the northern long-eared bat (NLEB; *Myotis septentrionalis*) is known to overwinter in underground refugia such as caves and abandoned mines as do other species in the genus *Myotis*, NLEB are notoriously difficult to observe in hibernacula (USFWS 2014). Thus, specific management activities like cave gating that have worked well to benefit species such as the Indiana bat (*M. sodalis*) may not be available to resource managers for more cryptic species like NLEB. Whereas species such as little brown bat and Indiana bat tend to cluster in large aggregations on the walls and ceilings of hibernacula, NLEBs tend to roost in smaller numbers and to squeeze into cracks and crevices in hibernacula, making them harder to see during hibernacula surveys (Caceres and Barclay 2000; USFWS 2014, 2015). It is also possible that NLEB do not utilize to the same extent the caves and mines that appear to be favored by little brown and Indiana bats, but instead overwinter in less obvious locations and in smaller groups. If so, this likely means that they are more dispersed across the landscape in winter than are little brown and Indiana bats. The apparent difficulty in observing NLEB during hibernacula counts (and/or the possibility that they hibernate elsewhere) means that it is likely underrepresented numerically when estimating species population sizes and trends through time (USFWS 2015). It also means that banding, the traditional method of determining the origin of bats that are observed in hibernacula (and vice-versa), may be largely ineffective to determine movement patterns for NLEB.

Despite having a general sense of where bats spend the winter, the routes that bats use to migrate between summer and winter areas are largely unknown and this is true for long distance migrants as well as local migrants. This is perhaps not surprising given that bats are small, nocturnal and highly mobile, which means that, unlike other migratory phenomena that can be documented through visual observation (e.g., raptor migrations), bat migration occurs largely outside of the natural perceptual capacity of humans. And while banding provides an indication of a starting and ending point in migration, it generally cannot provide information about the route taken between the two points. Thus, although the fall migration period for bats is known to pose greater mortality risks to bats (e.g., Timm 1989, Arnett et al. 2008), the current lack of understanding of where migration corridors are (and if they even exist), the precise time of migration and the duration of migration all make more difficult the task of estimating risks to migrating bats that may be posed by specific wind turbines or wind energy facilities.

Advances in technology have accelerated both the quantity and quality of our knowledge of bat biology and ecology. The development of commercially available devices capable of detecting and recording bat vocalizations has allowed researchers, managers and others to assess bat activity and bat communities at local, regional and national scales (Ahlen and Baagøe 1999, Rodhouse et al. 2012, and Loeb et al. 2015). Similarly, the advent and availability of miniaturized radio transmitters in the late 1980's that were capable of being carried by small insectivorous bats (Amelon et al. 2009) led to a much greater understanding of the types of structures bats used for day-roosts, the locations of those roosts on the landscape, and the nightly foraging patterns and home range sizes of bats (e.g., Waldien 1998, Henry et al. 2002, and Owen et al. 2003). While acoustic detection of bats does not allow for individual identification of bats and therefore likely cannot be used to effectively track migration through space, radiotelemetry does allow individuals to be tracked. While the small size of transmitters has created opportunities to better understand the ecology of bats, their small size is also a shortcoming. Typically, transmitters must not exceed 5% of a bat's mass (Aldridge and Brigham 1988). For a typical *Myotis* bat that might weigh 8-12 g, the transmitter would need to weigh between 0.4 and 0.6 grams. Transmitters can achieve this by reducing battery size (and therefore battery weight) and output signal strength. These constraints mean that typical transmitters for bats have small detection distances and relatively short battery life. Thus, while radio transmitters would seem to provide a useful tool for tracking bats during migration, it has proven difficult to successfully track a highly volant animal traveling long distances. As well, affixing a radio transmitter to a bat does not necessarily mean that it will begin to migrate during the period that the battery remains viable. Nonetheless, there are several examples of researchers using transmitters to track bats during migration.

To date, all of the studies for which we are aware that have successfully tracked radio-tagged bats during migration have occurred during the spring (South Penn Tunnel 2000, Chenger 2003, 2005; NYDEC 2004, 2005, 2006, 2007, Bat Conservation and Management 2006, Bat Conservation and Management and Sanders Environmental 2007; Sanders et al. 2001; Hicks et al. 2012). Undertaking such a study during spring migration is effective because a bat captured exiting a hibernaculum in spring is very likely beginning its migration. To be able to keep track of as many of the tagged migrating bats as possible, these studies used small fixed-wing aircraft outfitted with telemetry tracking equipment to follow that bats, and several coordinated aerial telemetry with mobile or fixed stations telemetry crews on the ground. Of the spring migration studies referenced here, only one (Hicks et al. 2012) was conducted in the Midwest and in habitat similar to that in our Iowa study area, and none were conducted on NLEBs. In an attempt to produce preliminary information about the patterns associated with fall migration of NLEBs in Iowa, a period during which bat fatalities at wind farms has been shown to be highest (Arnett and Baerwald 2013), WEST, in conjunction with MidAmerican and the U.S. Fish and Wildlife Service (USFWS), undertook a study intended to identify the timing and direction of NLEB migratory movements. This involved preliminary acoustics surveys to identify areas with NLEB presence (WEST 2015), mist-net surveys at one MidAmerican wind project area and two Iowa Department of Natural Resources (DNR) properties, and active and passive telemetry in the same areas.

METHODS

Species and Study Areas

This study was focused on the NLEB (*Myotis septentrionalis*). The NLEB was listed as Threatened under the Endangered Species Act in April 2015 (USFWS 2015), largely as a result of population declines associated with white-nose syndrome (WNS). The NLEB shares many physical and ecological characteristics with other North American bats in the genus *Myotis*, such as the little brown bat (*M. lucifugus*) and the Indiana bat (*M. sodalis*). These species occur most commonly in the northeastern and midwestern parts of the continent, though the little brown bat and NLEB occur as far west as the Pacific Northwest and British Columbia (Harvey et al. 1999).

Like other *Myotis* bats, NLEB is a nocturnal insectivore that spends the day roosting singly or in small groups in cracks, crevices and cavities, often utilizing live or dead trees as roosting structures. However, they may also take advantage of roosting opportunities in human-built structures such as barns, garages, attics and bridges. While the NLEB shares many general characteristics with its congeners, the species differs in some ways. For example, relative to the little brown bat, NLEB is found less often in human-built structures and more often in trees (Caceres and Barclay 2000). Relative to the Indiana bat, NLEB are more often found roosting in cracks and cavities, often in areas with greater canopy cover and appear to use live trees and those with smaller diameters more often than Indiana bats (Foster and Kurta 1999, Carter and Feldhamer 2005, Timpone et al. 2010). In addition, as mentioned above, NLEB does not appear to form large clusters of hibernating individuals, instead roosting in small groups or singly in cracks and crevices within hibernacula or perhaps in non-typical hibernacula such as rock outcrops. As a result, NLEB overwintering areas are largely unknown to researchers and managers, as are the likely paths that the species follows between summer and winter habitats.

Based on results of acoustic surveys that occurred during summer of 2015 (WEST 2015), WEST proposed to focus capture and telemetry efforts at MidAmerican's Macksburg Wind Project (MWP), located in Madison County (Figure 1). The habitat and topography within the MWP is typical of areas in south-central and southwest Iowa, and is characterized by rolling terrain and dominated by tilled cereal agricultural interspersed with remnant patches of forest. Many of the forest cover and patches are associated with and located along riparian corridors. In addition, WEST conducted surveys and telemetry at two Iowa DNR properties in Ringgold and Decatur Counties to the south of MWP (Figure 1). Topography on the DNR properties is similar to the MWP, but the DNR properties were more forested than the MWP.

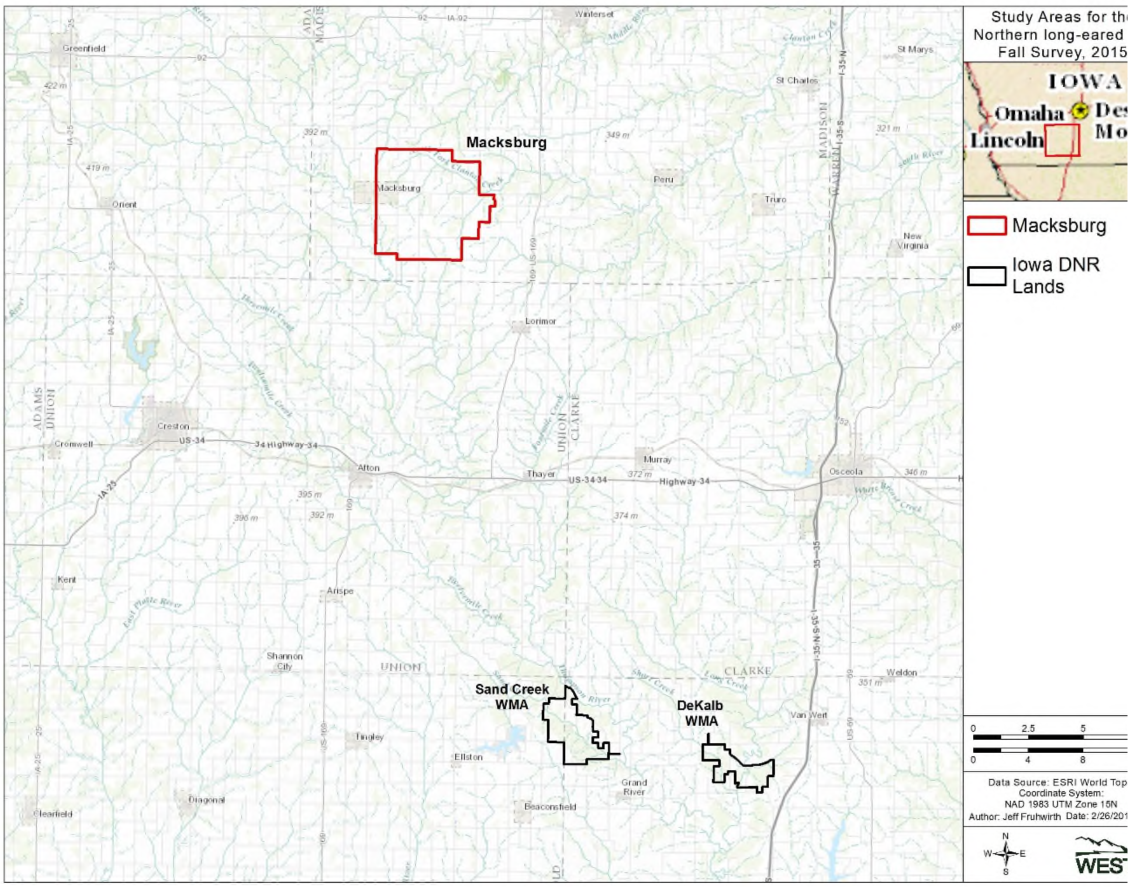

Figure 1. Study areas used for the 2015 northern long-eared bat fall migration study.

Mist-net Surveys

Based on their experience capturing NLEB, WEST's permitted bat biologists selected mist-net sites over streams or ponds and/or along travel corridors in forested habitats (Figure 2). If weather conditions, such as persistent rain (more than 30 minutes) or strong winds (greater than nine miles (mi) per hour for more than 30 minutes), occurred during the netting period, then the survey night was ended. All mist-net surveys were performed by staff permitted and approved by USFWS (Permit # TE234121-7), and Iowa DNR Scientific Collector Permit (Permit # SC1079) to capture and handle NLEB.

For each mist-net survey we recorded the date, start and end time, site description, site coordinates, mist-net specifics, and weather data (temperature, cloud cover, wind speed, precipitation, and moon phase). WEST identified all captured bats to species. WEST also recorded the sex, age, reproductive condition, body mass (grams), forearm length (mm), and capture status (recapture/new) Reichard Index score (0-3) for all captured bats. To prevent potential cross contamination of captured bats with *Pd (Pseudogymnoascus destructans)*, the fungal cause of WNS, WEST followed the USFWS WNS decontamination protocols for all mist-netting efforts (whitenosesyndrome.org 2015). Captured bats were measured and processed immediately, and were usually released within 15 minutes. Captured NLEB that had transmitters attached were released within 30 minutes of capture. Captured bats were photo-documented. In addition, WEST took voucher photographs of species-specific identifiable features (e.g., head, body, calcar, foot, toe hairs etc.) for captured NLEB and little brown bats. Numbered metal forearm bands were attached to NLEB before release.

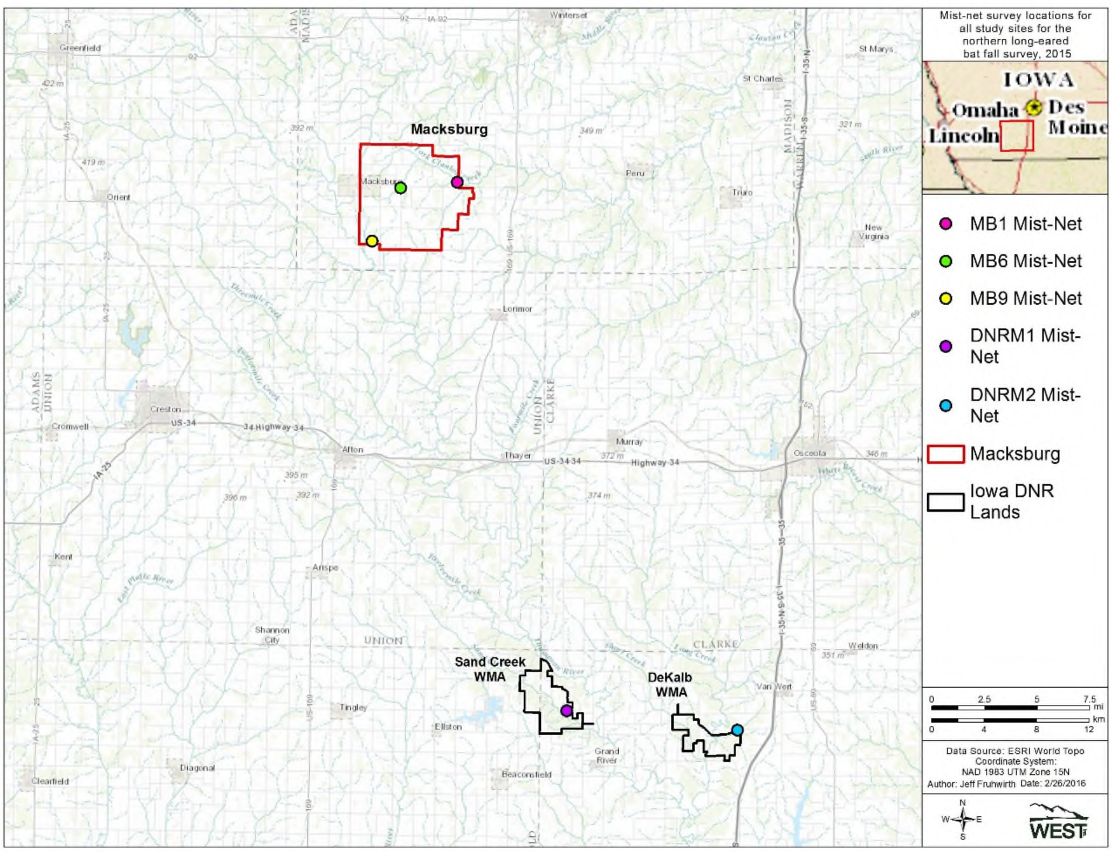

Figure 2. Mist-net survey locations, 2015 northern long-eared bat fall migration study.

Telemetry

Telemetry surveys were conducted to learn more about the fall behavior of NLEB around the MWP, SCWMA, and DWMA. Captured NLEB were outfitted with a coded VHF radio-transmitter (NanoTag NTQ, Lotek Wireless, Ontario, Canada) or a 0.23 to 0.35 gram radio-transmitter (model no. LB-2X; Holohil Systems Ltd., Ontario, Canada) and tracked for the life of the transmitter (7 – 30 days). Lotek transmitters were used for unique transmitter identification when activated and to survey fall movement and behavior of NLEB in the area. The Lotek transmitters were programmed to emit a signal every 5.3 seconds, in order to prolong the battery life of the transmitter up to 21 days. Holohil transmitters were used to better locate roosts and initial foraging areas. Transmitter signals were followed during daylight hours to find potential roosts and foraging areas. Bats were tracked to roost trees on land where landowner access had been granted. If bats were located on inaccessible land tracts, the day roost location was triangulated from public roads. For each roost tree found, photographs, Global Positioning System (GPS) coordinates, roost type (tree, building, etc.), tree species, tree type (live, snag), tree diameter at breast height (DBH), approximate roost height (m), and roost location (cavity, crevice, bark, etc.) were recorded. When possible, up to two exit counts were performed at known roost trees to determine the number of bats in the roost and to confirm the specific roost type and location.

WEST performed day-time and limited foraging telemetry on initial captured NLEB at each mist-net site. This in depth telemetry effort was done to determine general habitat use patterns of the first captured NLEB in the area and as telemetry towers were being placed (see below). Holohil transmitters were placed on three NLEB due to the transmitter's higher pulse rate and more audible signal, which helped locate areas of importance to NLEB in new areas. The remaining captured NLEB were outfitted with Lotek radio-transmitters. Foraging telemetry effort ranged from the first few hours after the bat was released to sunrise to locate potential roosts and foraging areas. As telemetry towers were installed around the net locations, less effort was focused on active telemetry in favor of passive telemetry.

Telemetry Towers

WEST placed 12 fixed telemetry towers throughout the study areas surrounding mist-net locations (Figure 3). Each tower comprised of one SRX 800-D receiver (Lotek Wireless Inc., Ontario, Canada) connected to four 5-element Yagi antennas pointed in the four cardinal directions. Antennas were raised between 5.5 and 9.1 m (18 and 30 ft). Tower placement was chosen to surround mist-net locations at high points on the landscape to increase detection, or in areas of potential flight corridors based on foraging telemetry results (Appendix F). During installation the GPS location, date, receiver serial number, a general description of the surrounding habitat, and pictures of each antenna view and of the tower were recorded. Receivers were programmed as data loggers that would scan for the coded Lotek transmitters, all of which had the same radio frequency (166.380 megahertz; MHz), each with a unique identifying code (ID tags 6 – 18 and 467). Tower antennas were configured to face the cardinal direction based on their attachment to the receiver (i.e., antenna 1 faced north, antenna 2 faced east, antenna 3 faced south, and antenna 4 faced west; see Appendix F). Receivers recorded date and time, tag ID, antenna number, and signal strength of detected tags. Data from the receivers were downloaded and reviewed every 2 – 3 days when the battery was exchanged. The date for all data-downloads and battery-exchanges were recorded on a data log, and antenna arrays were checked for directional fidelity. Deviations from initial tower setup, if any, were recorded and corrected.

In order to avoid false positive identification of unique ID tags, WEST developed protocol to correctly identify true signals from active transmitters. True positive detection was defined as being detected only from transmitters that were physically activated and that recorded five or more detections of a tag ID within a five minute period from the same tower.

Days NLEB with attached transmitters were present at towers and met the above threshold for detection were recorded to show presence of NLEB within the landscape. To better define the final movement patterns of NLEB present near towers, data from the last fifteen minutes for each NLEB present near towers was analyzed. By analyzing these data, the final directions of movements away from fixed towers can provide indications as to when and in which direction NLEB may have been leaving the area. Maps for each tagged bat were created using the last fifteen minutes of movement data. The maps show the fixed towers that last detected each bat within the last fifteen minutes of recorded activity. In instances where there was overlap between towers detecting a bat in the last fifteen minutes, the most likely area of activity was highlighted.

Scouting and Testing

Telemetry towers were field tested with an activated Lotek transmitter around a fixed telemetry tower at set distances. Field testing concluded that the telemetry towers were able to detect the Lotek transmitters reliably at a distance of 1.2 kilometers (km; 0.75 mi). Telemetry towers were set near known roosts or capture sites using the testing distance as the outer limits of detection. Once telemetry towers were deployed, topography and altitude of bat flight height could affect detection distance either greater or less than the estimated 1.2 km.

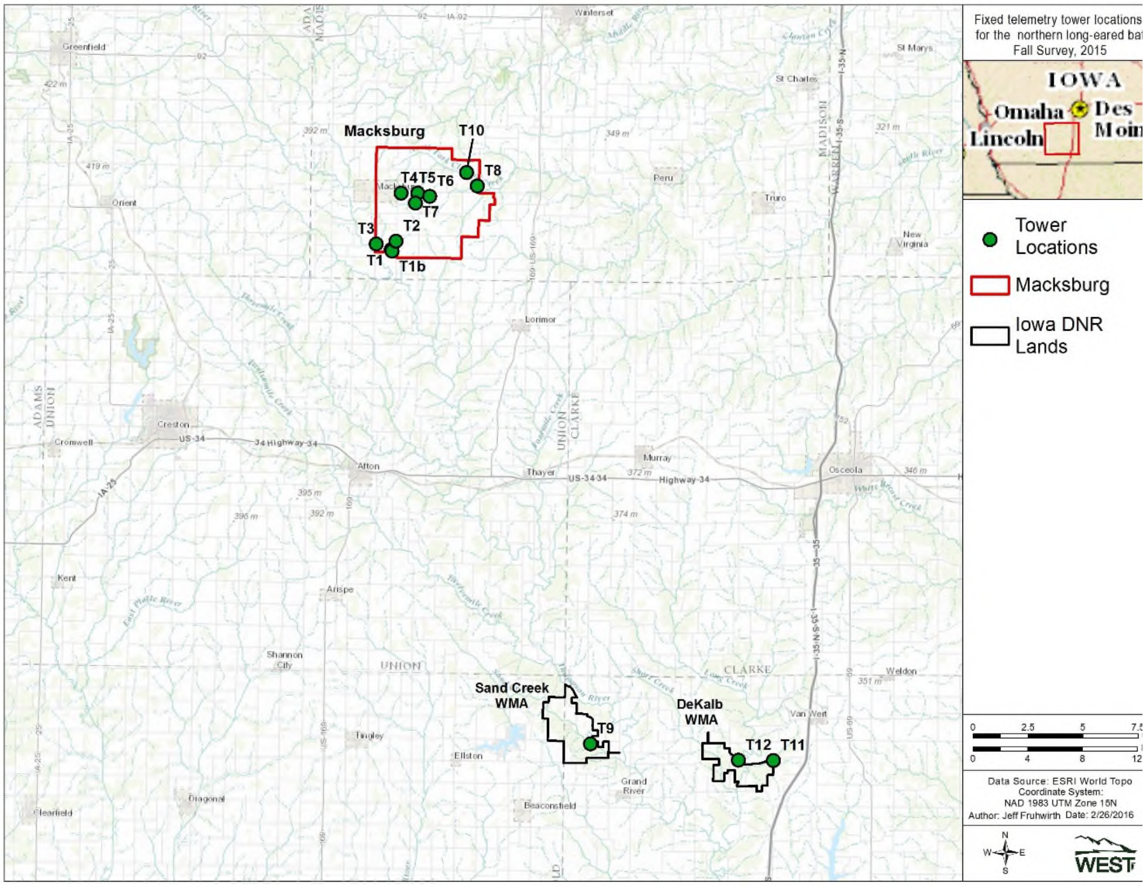

Figure 3. Locations of fixed telemetry towers during the 2015 northern long-eared bat fall migration study.

A Holohil transmitter and Lotek NanoTag transmitter were tested and compared on August 19, 2015. Testing was conducted to evaluate signal strength relative to distance and variable topography within the study area. Both transmitters were attached to a tree with the antenna pointed down at 1.5 m (4.9 ft) above the ground in a creek bottom west of mist-net site MB-9 to mimic a bat roosting. Transmitter signals were searched for from a barn at MB-9, roughly 200 m (656.2 ft) to the east, with a 5 element Yagi on a painter's pole with the Lotek SRX800-M receiver and a Communication Specialist R1000 (Communication Specialists, Inc., California) with a 3-element Yagi. Both transmitters were detected, however, as wind speed increased the Lotek receiver ceased being able to identify the tag ID, but was still able to audibly detect the transmitter. The R1000 had an audible beep for both transmitters, even as the wind speed increased. Due to the slower pulse rate of the Lotek transmitter, scanning had to be at a slower rate to not miss sign of detection. Various readings were tested at gradually increasing distances in a circular pattern outward from the transmitters, some points from high locations, others from slightly lower with some topography interference from 350 m to 750 m (1,148 ft to 2,460 ft) away. Overall, the R1000 receiver seemed to outperform the SRX800-M receiver in detecting an audible signal for the Lotek transmitter. However, the R1000 was not capable of identifying the unique coded tags of the associated with the transmitter. Factors such as topography and weather potentially impacted the ability of the SRX800-M to receive a signal from the transmitter. In comparison, the traditional Holohil "beep" transmitter provided a better audible signal for both transmitters, and was also less affected by factors such as wind or topography.

Once bats began to move out of the survey areas and out of telemetry tower detection ranges, field scouting of other potential high bat areas occurred. Active searching using telemetry was conducted at tunnels, covered bridges, and quarries adjacent to the survey areas. In addition to telemetry, these areas were inspected for signs of bats. Emergence counts at tunnels and bridge culverts were conducted using telemetry equipment as well as night vision goggles, in an attempt to see bats emerging from possible roosts and to detect any swarming behavior near possible roosts.

RESULTS

Mist-net Surveys

Mist-nest surveys were completed on 98 complete net nights at five sites between August 17, 2015 and October 11, 2015 (Tables 1 and 2). Maps and pictures of mist-net sites are included in Appendix A and B, respectively. In total, 76 bats were captured at five sites, including 17 NLEB, 30 big brown bats (*Eptesicus fuscus*), 10 eastern red bats (*Lasiurus borealis*), 3 hoary bats (*L. cinereus*), 11 evening bats (*Nycticeius humeralis)*, 2 silver-haired bats (*Lasionycteris noctivagans*), and 3 little brown bats (*M. lucifugus*; Table 2). No Indiana bats were captured. Of the 76 bats captured, only one big brown bat exhibited any outward signs of damage from WNS (Appendix Table D4). Photos of captured bat species are included in Appendix C and capture details for all bats can be found in Appendix D.

All captured NLEB were marked with wing bands attached to the forearms and were outfitted with radio-transmitters. Of the 17 captured NLEB, 14 were captured within the MWP, and the remaining three were captured within the DWMA. No NLEB were captured within the SCWMA.

Fourteen NLEB were outfitted with Lotek transmitters, and three NLEB were outfitted with Holohil transmitters (Table 3). Ten of the seventeen NLEB captured were female (seven adults and three juveniles), and seven were male (four adults and three juveniles).

Table 1. Location and site description of mist-net sites used for the 2015 northern long-eared fall migration study.

Site ID	Net	Size	UTM Coordinates		Site Description
MB-9	A	2x6	401616	4559072	creek bottom
	B	3x9	401580	4559010	dried creek bottom
	C	3x12	401546	4559031	creek bottom
	D	3x9	401757	4559038	forest edge/corridor
	E	2x6	401760	4559065	forest edge
	F	2x9	401744	4559120	forest opening/corridor
MB-6	A	3x6	403797	4563122	creek bottom/corridor
	B	2x4	403778	4563111	creek bottom/corridor
	C	2x4	403749	4563093	creek bottom/corridor
	D	2x6	403694	4563017	creek bottom/corridor
MB-N1	A	3x9	408115	4563553	creek bottom
	B	2x6	408127	4563609	creek bottom
	C	2x9	408105	4563636	creek bottom
DNR-M1	A	3x6	416476	4523180	forest opening/corridor
	B	2x6	416390	4523136	forest corridor
	C	3x12	416361	4523063	forest corridor
	D	3x9	416425	4523003	creek bottom
	E	3x9	416483	4523126	creek bottom
DNR-M2	A	2x6	429552	4521717	creek bottom
	B	2x4	429526	4521685	creek bottom/forest opening
	C	3x9	429473	4521532	creek bottom

Table 2. Summary of bat captures at mist-net sites during the 2015 northern long-eared bat fall migration study. Species abbreviations: BBBA (big brown bat); ERBA (eastern red bat); EVBA (evening bat); HOBA (hoary bat); SHBA (silver-haired bat); LBBA (little brown bat); NLEB (northern long-eared bat); INBA (Indiana bat).

Site	Date	BBBA	ERBA	EVBA	HOBA	SHBA	LBBA	NLEB	INBA	Total
MB-9	8/17/15	6	-	3	-	-	1	2	-	12
	8/20/15	8	-	1	-	-	-	1	-	10
	8/24/15	1	-	3	-	-	-	1	-	5
	8/27/15	3	-	-	-	-	-	-	-	3
	8/31/15	1	-	3	-	-	-	-	-	4
	Total	19	-	10	-	-	1	4	-	34
MB-6	8/23/15	-	-	-	-	-	-	1	-	1
	8/24/15	-	-	-	-	-	-	2	-	2
	8/27/15	-	-	-	-	-	-	2	-	2
	8/30/15	-	-	-	-	-	-	1	-	1
	9/21/15	-	-	-	-	-	-	-	-	-
	9/24/15	-	-	-	-	-	-	2	-	2
	9/28/15	-	-	-	-	-	-	-	-	-
	9/30/15	-	-	-	-	-	-	-	-	-
	10/7/15	1	-	-	-	-	-	-	-	1
	10/11/15	-	-	-	-	-	-	-	-	-
	Total	1	-	-	-	-	-	8	-	9
MB-M1	8/26/15	2	-	-	-	-	2	2	-	6
	10/6/15	1	-	-	-	-	-	-	-	1
	Total	3	-	-	-	-	2	2	-	7
DNR-M1	8/31/15	1	2	1	3	1	-	-	-	8
	9/1/15	4	3	-	-	1	-	-	-	8
	9/26/15	-	1	-	-	-	-	-	-	1
	10/9/15	-	-	-	-	-	-	-	-	-
	Total	5	6	1	3	2	-	-	-	17
DNR-M2	9/1/15	-	-	-	-	-	-	2	-	2
	9/19/15	1	1	-	-	-	-	-	-	2
	9/20/15	-	-	-	-	-	-	-	-	-
	9/25/15	1	1	-	-	-	-	1	-	3
	9/27/15	-	2	-	-	-	-	-	-	2
	10/10/15	-	-	-	-	-	-	-	-	-
	Total	2	4	-	-	-	-	3	-	9
Totals		30	10	11	3	2	3	17	-	76

Table 1. Location and site description of mist-net sites used for the 2015 northern long-eared fall migration study.

Site ID	Net	Size	UTM Coordinates	Site Description

Table 3. Characteristics of northern long-eared bats captured, banded and tracked during the 2015 fall migration study..

Bat ID	Sex/Age	Date Captured	Capture Site	Band	Frequency
MB9-MYSE-1	MJ	8/17/15	MB-9	WEST B0304	166.380 ID 8
MB9-MYSE-2	FJ	8/17/15	MB-9	WEST B0305	166.380 ID 7
MB9-MYSE-3	FA	8/20/15	MB-9	WEST B0306	166.380 ID 6
MB6-MYSE-1	FA	8/23/15	MB-6	WEST B0307	172.4980
MB6-MYSE-2	MJ	8/24/15	MB-6	WEST B0310	166.380 ID 17
MB6-MYSE-3	MJ	8/24/15	MB-6	WEST B0460	172.3342
MB9-MYSE-4	FA	8/24/15	MB-9	WEST B0481	166.380 ID 15
MBM1-MYSE-1	MA	8/26/15	MB-M1	WEST B0309	172.4844
MBM1-MYSE-2	FA	8/26/15	MB-M1	WEST B0308	166.380 ID 16
MB6-MYSE-4	MA	8/27/15	MB-6	WEST B0482	166.388 ID 14
MB6-MYSE-5	MA	8/27/15	MB-6	WEST B0483	166.388 ID 13
MB6-MYSE-6	FA	8/30/15	MB-6	WEST B0480	166.380 ID 18
DNRM2-MYSE-1	FA	9/1/15	DNR-M2	WEST B0484	166.380 ID 10
DNRM2-MYSE-2	MA	9/1/15	DNR-M2	WEST B0485	166.380 ID 9
MB6-MYSE-7	FA	9/24/15	MB-6	WEST B0461	166.380 ID 12
MB6-MYSE-8	FJ	9/24/15	MB-6	WEST B0462	166.380 ID 11
DNRM2-MYSE-3	FJ	9/25/15	DNR-M2	WEST B0463	166.380 ID 467

Telemetry

Roost telemetry occurred on 28 days for 11 NLEB. During roost telemetry surveys, WEST documented three tagged NLEB using five different roost trees (Appendix A). Four of the five roosts were in oak (*Quercus* spp.*)* trees; two bur oaks (*Q. macrocarpa),* one white oak (*Q. alba*), and one unidentified oak species (*Q.* spp.), all found in the MWP. One roost was found in a basswood (*Tilia Americana*), located at the SCWMA. Three of the five roost trees found were in snags, while the remaining two were in living trees with dead branches and crevices. Average tree height of all identified roosts was 13.0 m (42.7 ft), and the average DBH was 54.8 centimeters (cm; 21.6 in). Emergence counts were conducted when possible at four of the roosts, resulting in a total of seven emergence counts. Emergence counts yielded 0 – 7 bats emerging from a roost tree in a night. Locations, characteristics, and emergence count data for all located roost trees are included in Tables 4 and 5. Photographs of all roost trees are included in Appendix E.

For bats that could be tracked to roosts or for which the roosting area could be identified, we calculated the size of the forest patch that bat(s) used. At site MB-9, the forest patch was 14.2 hectares (35.2 acres). The forest patch at site MB-6 was measured to be 7.1 hectares (17.5 acres). The forest patch at MB-M1 was 39.0 hectares (96.3 acres). In all cases, the forest patches were connected to other patches by wooded riparian corridors.

Table 4. Locations of northern long-eared bat roost trees located during the 2015 northern long-eared bat fall migration study.

Tree ID	Site	Bat ID	Xmitter Frequency	County	Easting†	Northing†
MB9-MYSE-3-R1	MB-9	MB9-MYSE-3	166.380 ID 6	Madison (IA)	401656	4559166
MB9-MYSE-3-R2	MB-9	MB9-MYSE-3	166.380 ID 6	Madison (IA)	401605	4559108
MB9-MYSE-3-R3*	MB-9	MB9-MYSE-3	166.380 ID 6	Madison (IA)	401764	4558926
MB9-MYSE-4-R1	MB-9	MB9-MYSE-4	166.380 ID 15	Madison (IA)	401593	4559084
DNRM2-MYSE-2-R1	DNR-M2	DNRM2-MYSE-2	166.380 ID 9	Decatur (IA)	429567	4521540

† UTM Zone 15, North American Datum 1983.
* Two bats found in same roost tree.

Table 5. Northern long-eared bat roost tree characteristics, 2015 northern long-eared bat fall migration study. Exit Count refers to the number of bats observed leaving the roost at dusk.

Roost ID	Bat Band	Frequency	Tree Species	Height (m)	DBH (cm)	Exit Count 1	Exit Count 2
MB9-MYSE3-R1	WEST B0306	166.380 ID 6	*Quercus alba*	25.0	58.5	1	---*
MB9-MYSE3-R2	WEST B0306	166.380 ID 6	*Quercus* spp.	2.5	45.0	---*	---*
MB9-MYSE3-R3	WEST B0306	166.380 ID 6	*Quercus macrocarpa*	15.4	68.1	3	1
MB9-MYSE4-R1	WEST B0481	166.380 ID 15	*Quercus macrocarpa*	2.0	23.7	7	5
DNRM2-MYSE2-R1	WEST B0485	166.380 ID 9	*Tilia americana*	20.0	78.5	1	0

* Emergence counts not performed due to roost change and weather.

Four of the roost trees were located within 200 m (656 ft) of capture site MB-9, within the MWP. These four roost trees were located in a forest stand along a bottomland creek. Three of the four roost trees were located to the west of the capture site, while the fourth roost tree was located to the south of capture site MB9. The fifth located roost was found approximately 100 m (328 ft) east of capture site DNR-M2, within the SCWMA, located within a forested patch surrounded by agriculture. Roost tree MB9-MYSE3-R3 was used by bat MB9-MYSE-3 and MB9-MYSE-4 for at least one night. MB9-MYSE3-R3 was the second tree that MB9-MYSE-4 was tracked to and joined MB9-MYSE-3 on August 25, 2015. These two bats were also confirmed to be in this same roost on August 27, 29 and 30, 2015.

Fixed telemetry towers were deployed at 13 stations, 10 of which were located within the MWP, two within the DWMA, and 1 within the SCWMA. Towers were active for a total of 635 days from August 18, 2015 to October 25, 2015 (Table 6). During 584 tower-days, 4.4 million (4,421,625) data observations were recorded, 699,845 of which were determined to be detections of active NLEB tags.

Table 6. Locations and site description for fixed telemetry towers, 2015 northern long-eared bat migration study.

Tower	Capture site	Date Placed	Date Removed	UTM		Description
T1	MB-9	8/19/2015	8/31/2015	401803	4558992	Just southeast of MB-9
T1b	MB-9	8/31/2015	10/18/2015	401865	4558876	T1 moved south closer to gate entrance
T2	MB-9	8/21/2015	10/1/2015	402155	4559597	Northeast of MB-9 along property line and Elmwood Ave
T3	MB-9	8/24/2015	10/18/2015	400702	4559401	Northwest of MB-9 along Deer Run Ave
T4	MB-6	8/25/2015	10/18/2015	402512	4563137	West of MB-6 at gravel pit near the intersection of Macksburg Rd and Elmwood Ave
T5	MB-6	8/25/2015	10/18/2015	403742	4563115	At site MB-6 along creek
T6	MB-6	8/29/2015	10/25/2015	404609	4562884	East of MB-6 on hilltop in field west of fieldstone Ave
T7	MB-6	8/29/2015	9/28/2015	403561	4562400	South of MB-6 behind house west off of Fawn Ave
T8	MB-M1	8/29/2015	10/25/2015	408096	4563659	Capture site MB-M1 east of creek north of Homestead Ave
T9	DNR-M1	8/31/2015	10/25/2015	416364	4522835	Hilltop south of net site
T10	MB-M1	9/1/2015	10/25/2015	407326	4564629	1.3 km northwest of capture site on hilltop
T11	DNR-M2	9/1/2015	10/25/2015	429740	4521624	East of capture site on hilltop
T12	DNR-M2	9/3/2015	10/25/2015	427205	4521650	West of capture site along 137th Street in field

Bat Identification 7 and 8: These two bats were the first bats captured within the MWP, prior to any fixed telemetry towers being set. These two juvenile bats were not located on any of the following days after capture, nor detected by any fixed tower.

Bat Identification 6: This bat was detected for a total of 16 nights at six different fixed towers. During the 16 days, Bat identification 6 was most often detected roosting and foraging in the surrounding area around mist-net site MB-9 at towers T1, T1b, T2, and T3. In addition to the habitat around MB9, Bat identification 6 was detected south of capture site MB-6 by tower T4 and on one evening by tower T7 (see Figure 3). This bat was detected by three different fixed towers within the last fifteen minutes of activity. From tower T1b, the bat was detected primarily to the west (44.6% of detections) and north (36.1%) while also being detected south (15.7%) and east (3.6%). From tower T2 the bat was detected mainly to the south (59.3%) and west (37%) but also slightly to the north (3.7%). Tower T3 detected the bat 100% to the east in the last fifteen minutes of detection (Figure 4).

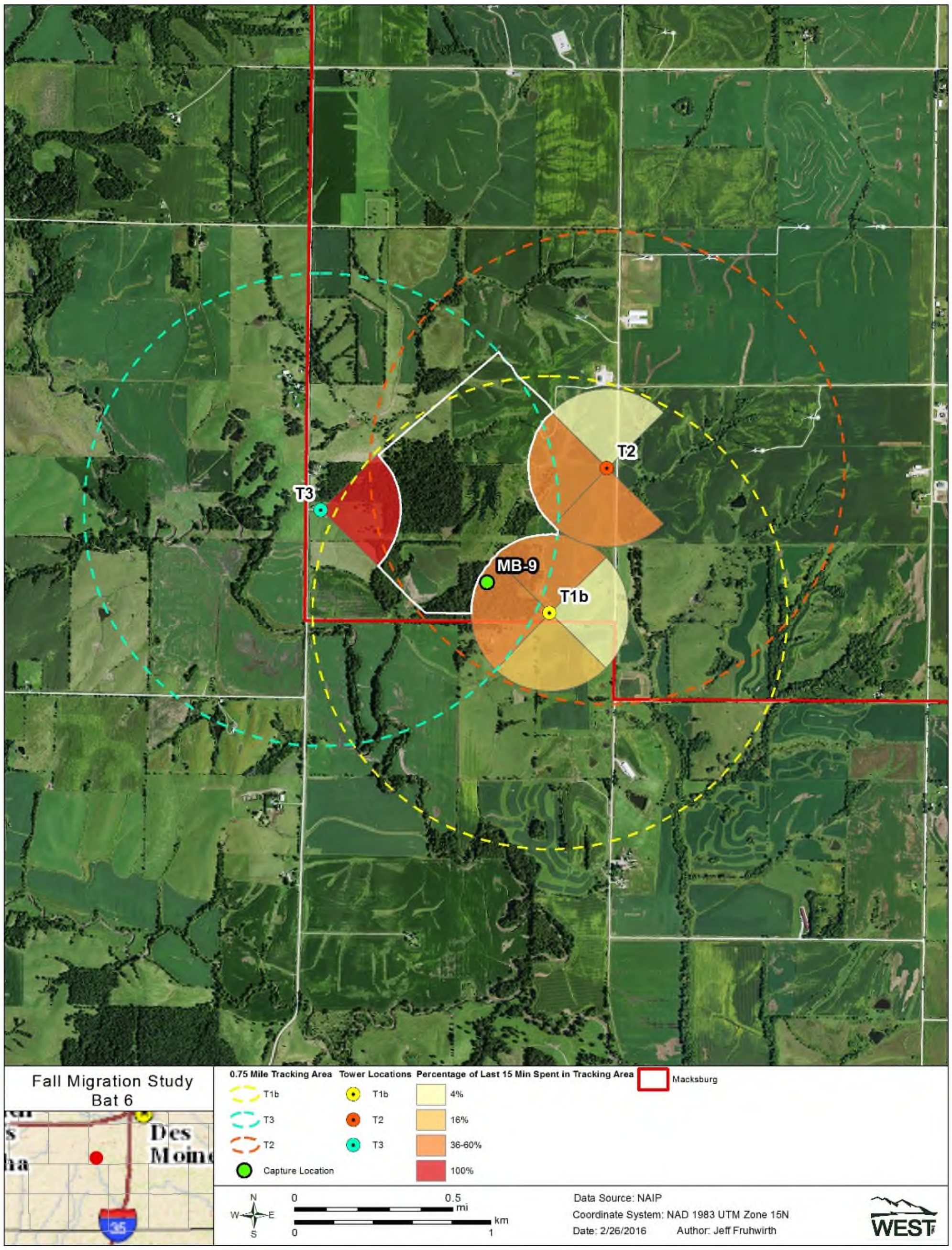

Figure 4. Map of direction of detections for Bat Identification 6 for the last 15 minutes of detection. The white polygon represents the area the bat is thought to have been during those 15 minutes.

Bat Identification 17: Bat identification 17 was detected for four nights at four towers. Throughout that time the bat was recorded by towers T2 and T3 all four nights, northwest of capture site MB-9. During active foraging telemetry the bat was detected southwest of capture site MB-6. Within the last fifteen minutes of detection, 100% of detections were to the north of tower (Figure 5).

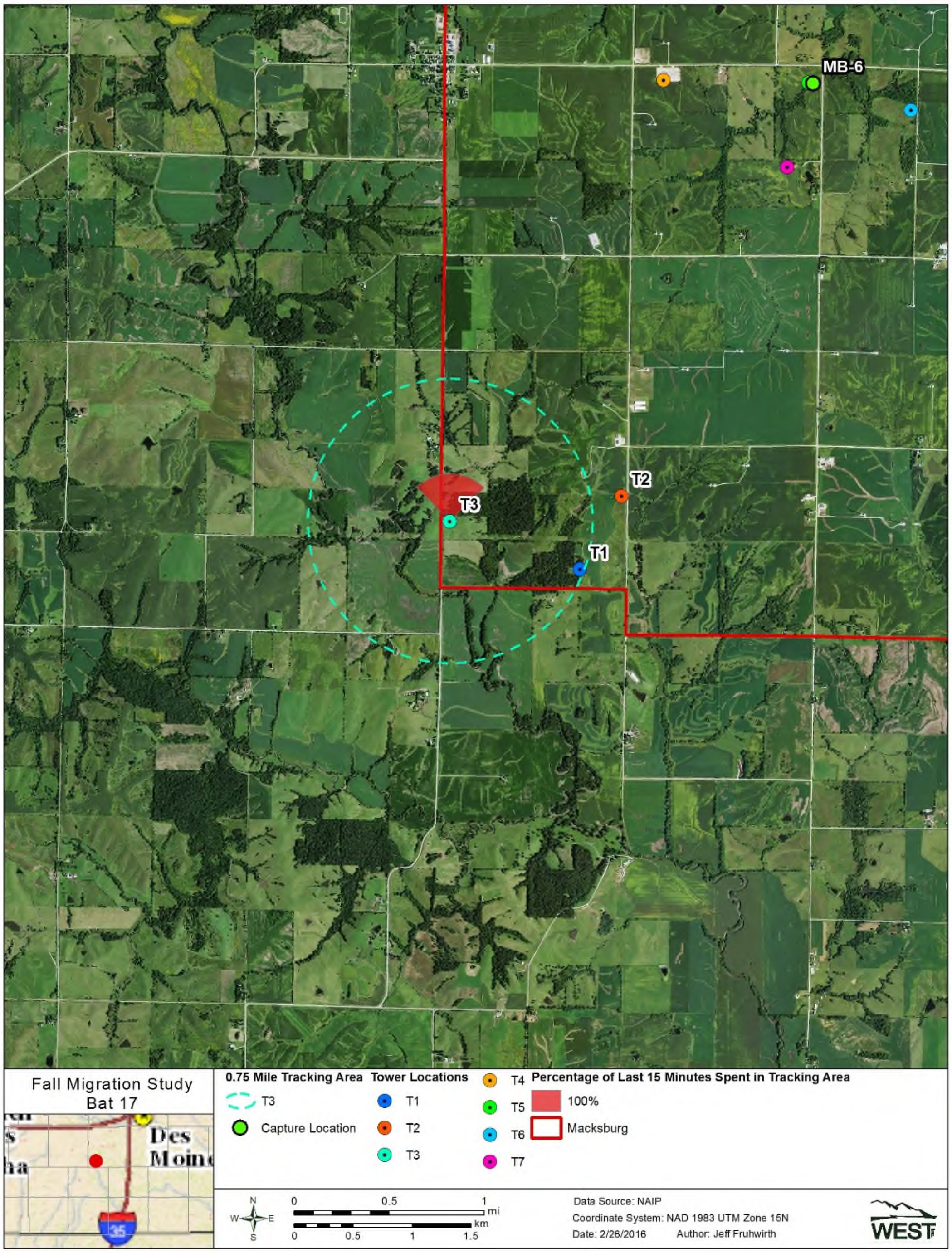

Figure 5. Map of direction of detections for Bat Identification 17 for the last 15 minutes of detection.

Bat Identification 15: Bat identification 15 was detected for 27 nights over the course of 30 nights at 9 different towers. Throughout this time bat identification 15 was tracked manually and detected by fixed towers roosting and foraging primarily in the area surrounding capture site MB-9 primarily. However the bat was also detected at fixed towers to the north of MB-9 (towers T4, T5, T6, T7, and T10; see Figure 3). Within the last fifteen minutes of detection, 100% of detections were to the west of the tower T1b (Figure 6).

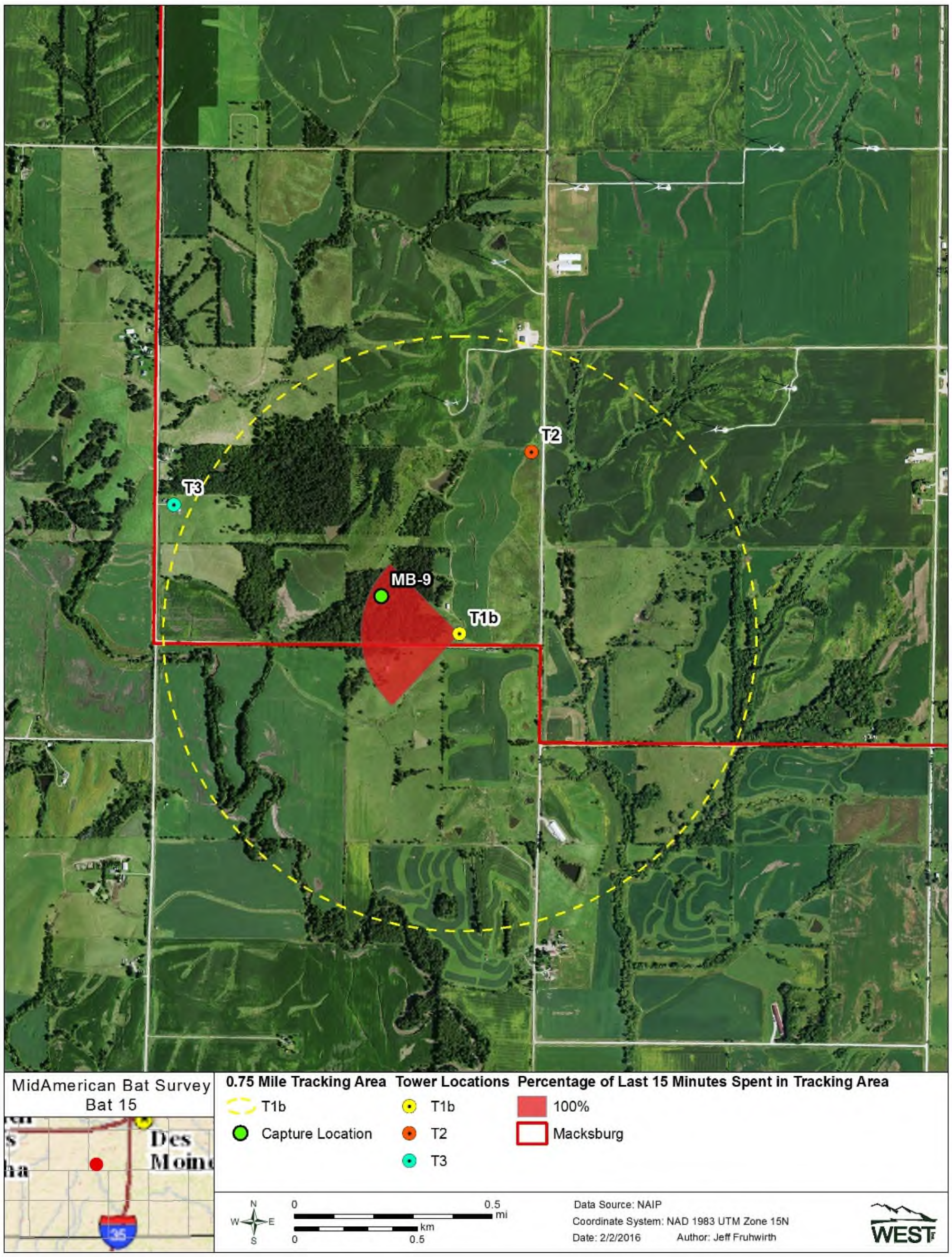

Figure 6. Map of direction of detections for Bat Identification 15 for the last 15 minutes of detection.

Bat Identification 16: Bat identification 16 was detected at fixed towers during 9 nights over a period of 18 days. Active telemetry efforts confirmed bat identification 16 foraging and roosting along the creek bottom and to the east of the capture site MB-M1. Within the last fifteen minutes of detection, 100% of detections were to the east of tower T8 (Figure 7).

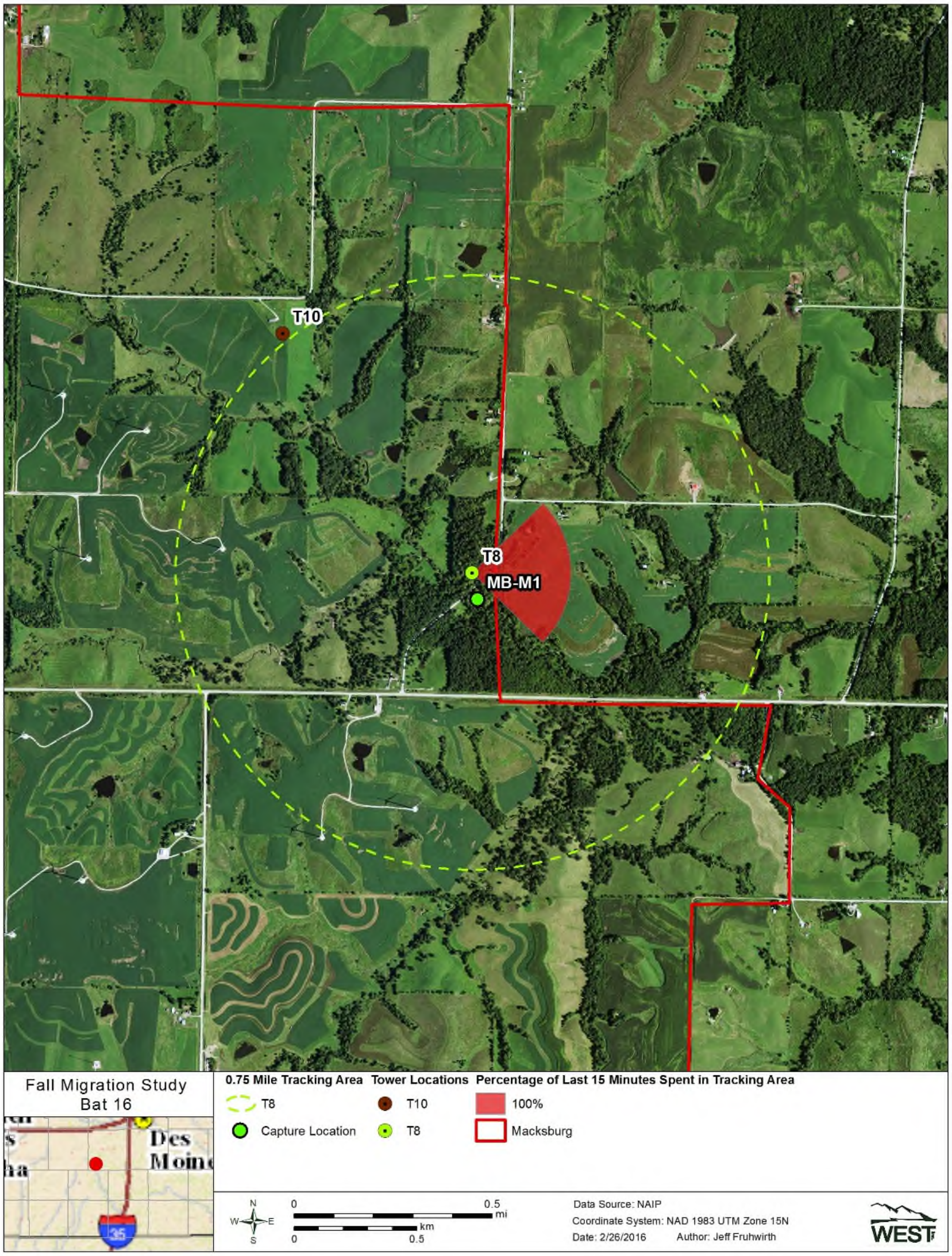

Figure 7 Map of direction of detections for Bat Identification 16 for the last 15 minutes of detection.

<u>Bat Identification 14:</u> Bat identification 14 was primarily detected around its capture site MB-9 at towers T1, T1b, T2, and T3. This bat was detected at fixed towers for 14 nights. On two separate nights it was detected for periods of time at towers T4, T5 and T7 to the north. Within the last fifteen minutes of detection, 100% of detections were to the south of towers T1b and T2 (Figure 8).

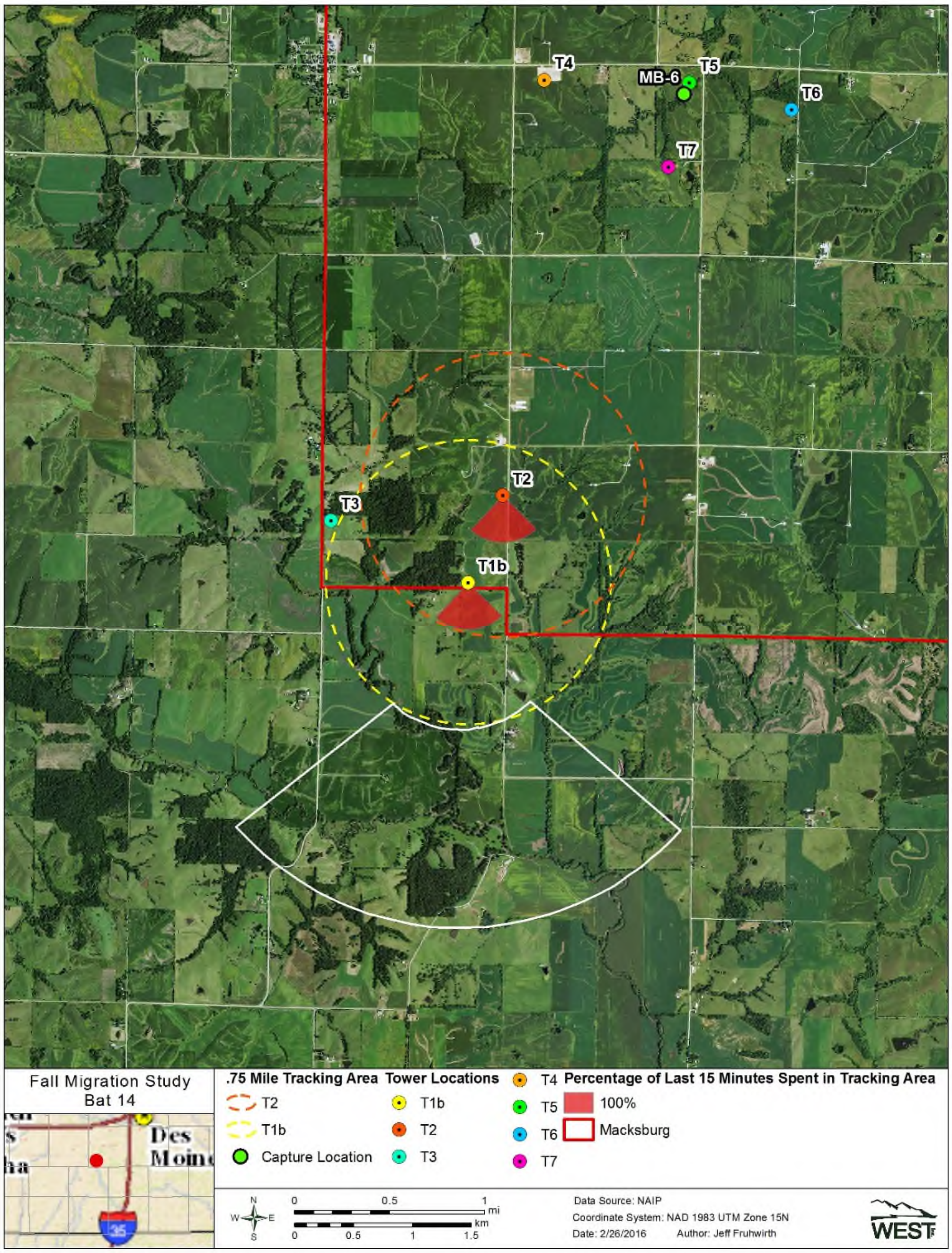

Figure 8. Map of direction of detections for Bat Identification 14 for the last 15 minutes of detection. The white polygon represents the area the bat is thought to have been during those 15 minutes.

Bat Identificaiton 13: Bat Identification 13 was detected at 6 fixed towers for a total of 10 nights. After being captured at mist-net site MB-6, the bat was detected at fixed towers T5 and T4, but the following nights, the bat was detected primarily south of tower T3 near MB-9. Within the last fifteen minutes of detection, 90.9% of detections were to the south of tower T3 and 9.1% were to the west of the tower (Figure 9).

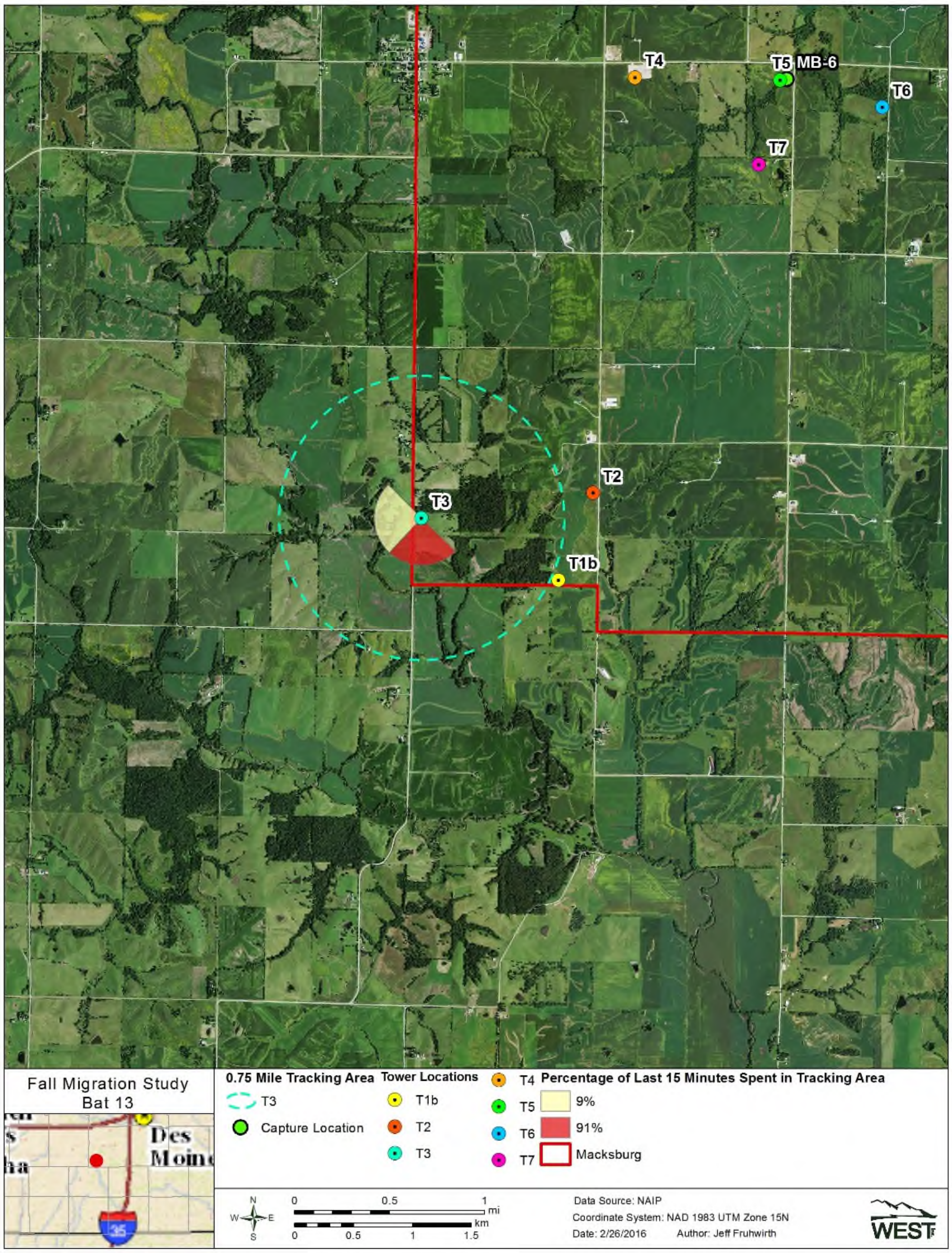

Figure 9. Map of direction of detections for Bat Identification 13 for the last 15 minutes of detection.

Bat Identification 18: Bat Identification 18 was captured at mist-net site MB-6 and was triangulated roosting along a creek bottom southwest site MB-6 in the middle of the square-mi block. This bat was detected at 8 fixed towers on 8 nights over a 9 night period. The bat was detected primarily at towers T4, T5, T6, and T7 near MB-6, and at towers near mist-net site MB-9 (T1, T2, and T3). Within the last fifteen minutes of detection 100% of detections were to the east of tower T3 (Figure 10).

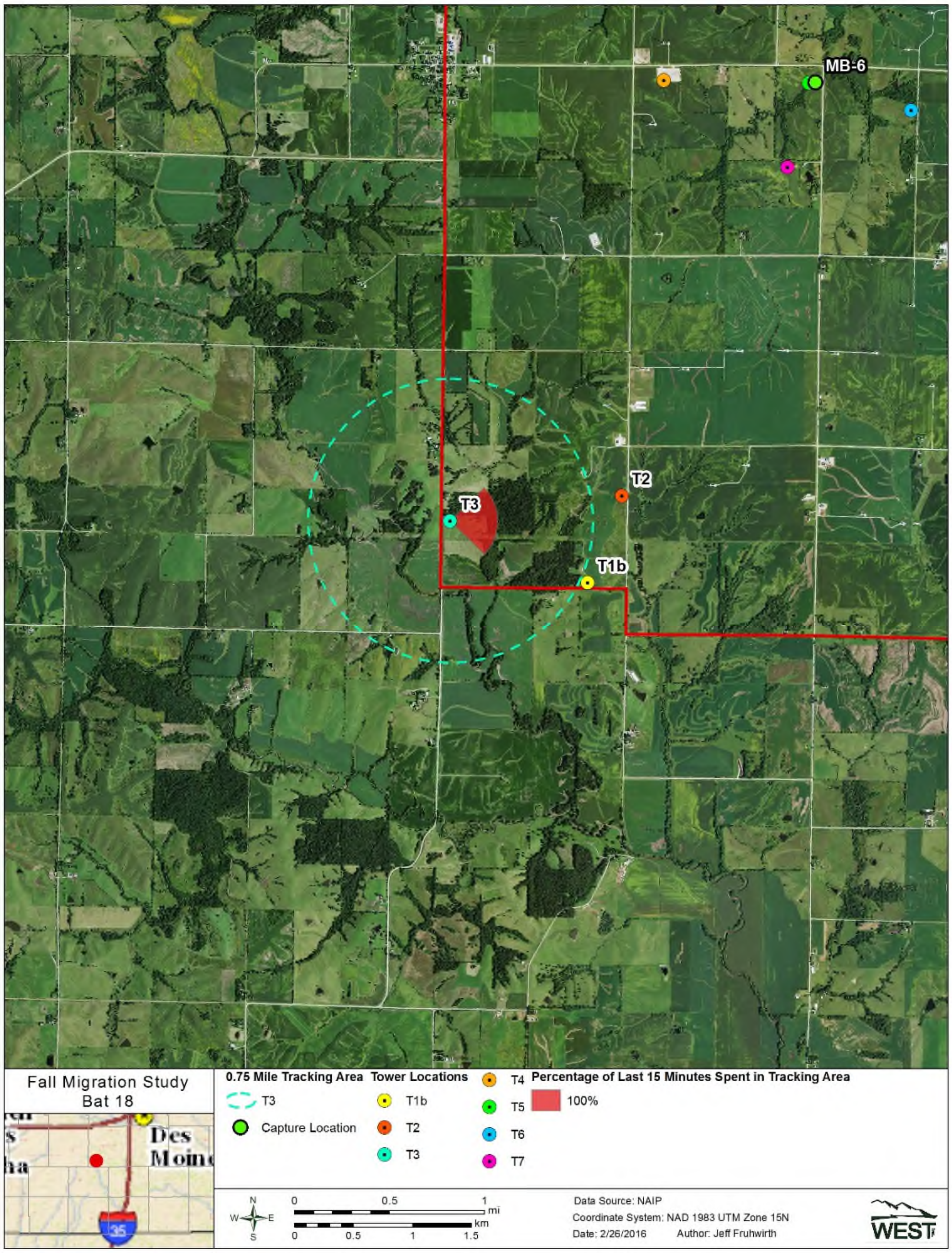

Figure 10. Map of direction of detections for Bat Identification 18 for the last 15 minutes of detection.

Bat Identificaiton 10: Bat Identification 10 was detected for a total of three nights at towers T11 and T12. Within the last fifteen minutes of detection, 100% of detections were to the west of tower T11 (Figure 11).

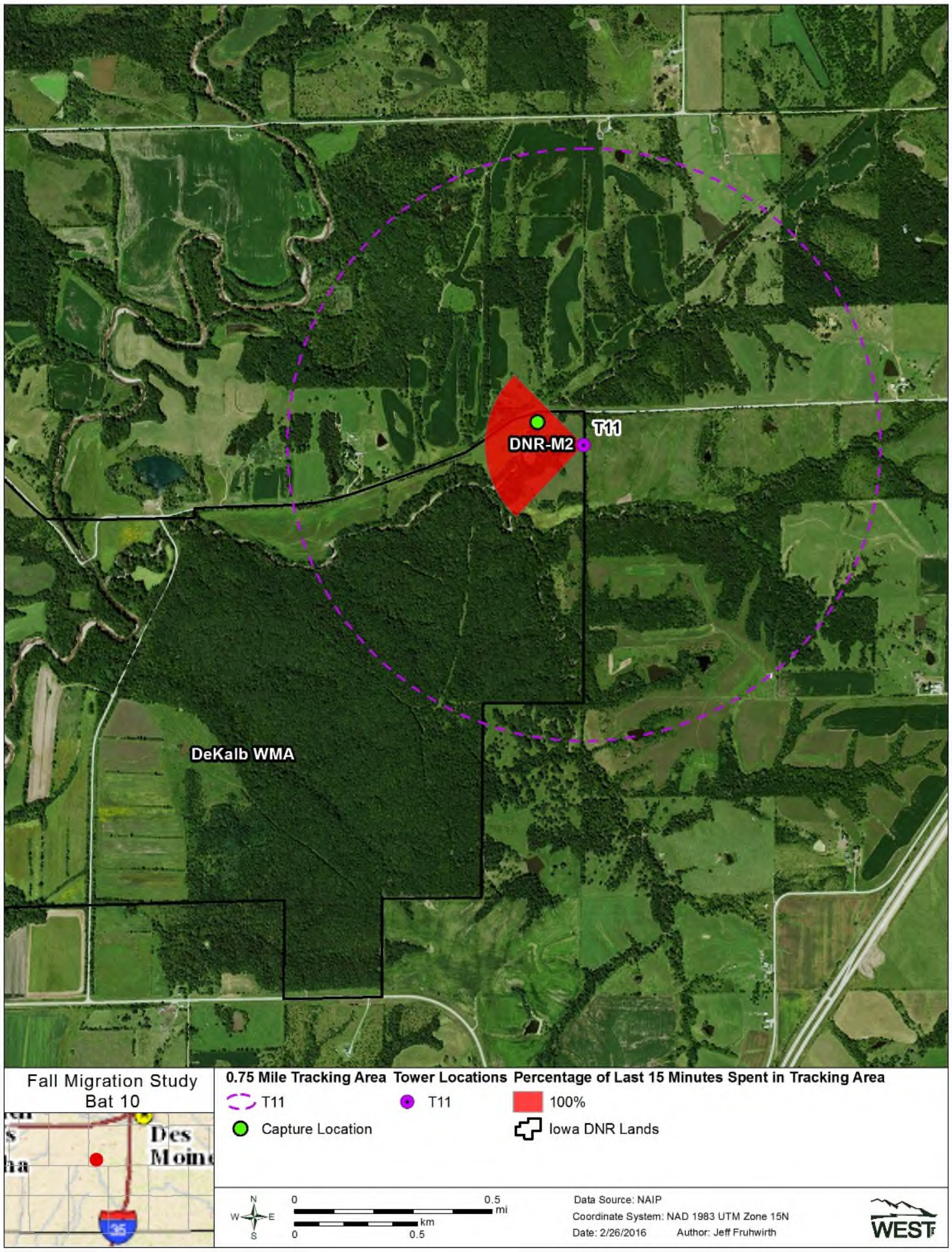

Figure 11. Map of direction of detections for Bat Identification 10 for the last 15 minutes of detection.

Bat Identification 9: This bat was detected for a total of 16 nights over an 18 night period at fixed towers T11 and T12. The bat roosted close to the capture site DNR-M2 and was tracked to a roost tree the first day after capture (Tables 4 and 5). The bat was continually detected by towers west of tower T11 and east of tower T12 and was found roosting close enough to tower T11 to be detected by the tower during the day. Within the last fifteen minutes of detection, 100% of detections were to the west of tower T11 (Figure 12).

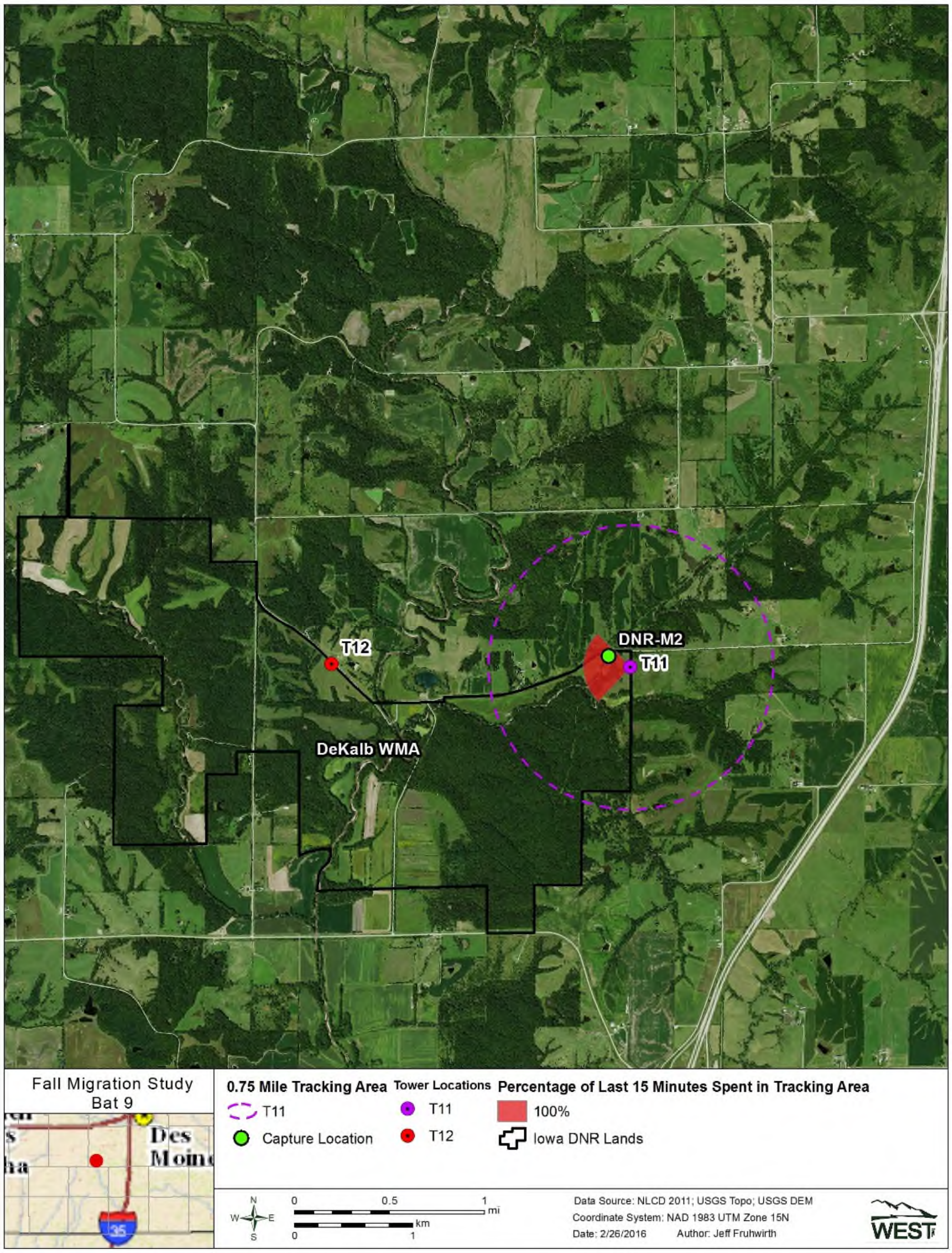

Figure 12. Map of direction of detections for Bat Identification 9 for the last 15 minutes of detection.

Bat Identification 12: Bat Identification 12 was detected at five fixed towers for a total of six nights. The bat was found foraging and roosting near capture site MB-6. The bat was detected during the day light hours as well as during the night by towers T4, T5, T6, and T7. This bat was detected by three different fixed towers within the last fifteen minutes of activity. From tower T4, the bat was detected primarily from the east (92.9% of detections), while also being detected south (3.6%) and west (3.6%). From tower T5 the bat was detected mainly from the east (37.2%) and north (33%), but also from the west (20%) and slightly from the south (9.6%). Tower T6 detected the bat primarily from the north (41.5%), while less from the south (26.2%) and east (23.1%) from the east in the last fifteen minutes of detection (Figure 13).

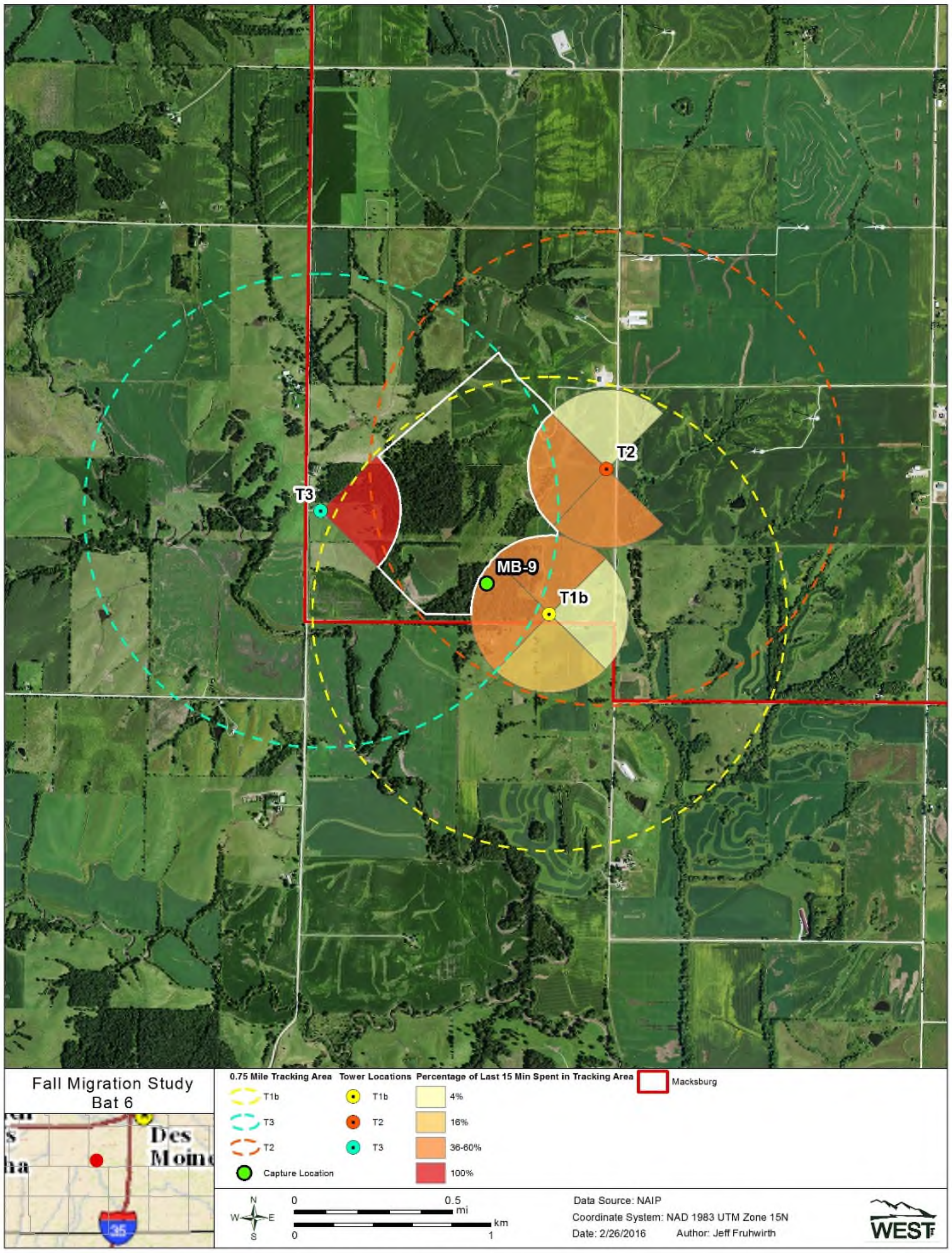

Figure 13. Map of direction of detections for Bat Identification 12 for the last 15 minutes of detection. The white polygon represents the area the bat is thought to have been during those 15 minutes.

Bat Identification 11: This bat was only detected for two hours on the night of capture (September 24, 2015). The bat was detected at towers T4, T5, T6, T7 and T10. However, all towers detected the bat within the last fifteen minutes of detectable activity. Tower T4 detected the bat from the east (60%) and the north (40%). Tower T5 primarily detected the bat from the north (50%), while also detecting the bat from the east (23.5%), the south (14.7%), and the west (11.8%). Tower T6 detected the bat primarily from the north (96%), but also slightly from the west (4%). Tower T7 primarily detected the bat from the north (94%), but also slightly from the west (6%). Tower T10 detected the bat primarily from the west (95%), but also slightly from the north (5%; Figure 14).

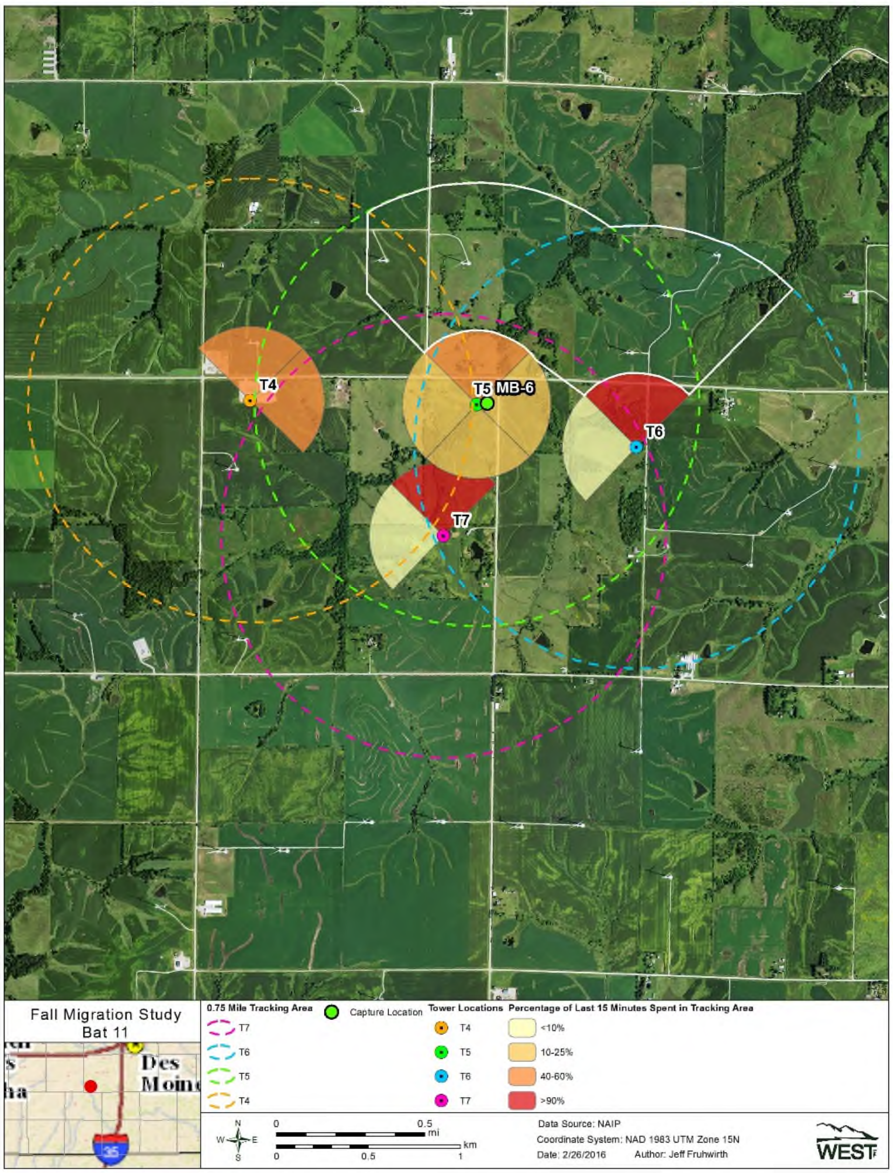

Figure 14. Map of direction of detections for Bat Identification 11 for the last 15 minutes of detection. The white polygon represents the area the bat is thought to have been during those 15 minutes.

Bat Identification 467: Bat Identification 467 was detected for four nights at fixed towers T11 and T12. Within the last fifteen minutes of detection, this bat was detected at towers T11 and T12. During the last fifteen minutes this bat was detected primarily from the west (43.5%) and the north (39.1%) of T11, while also having some detections from the east (13%) and south (4.3%). During the last fifteen minutes this bat primarily detected from the north (37.9%) and the east (34.5%) at T12, while also being detected from the west (19%) and the south of T12 (8.6%; Figure 15).

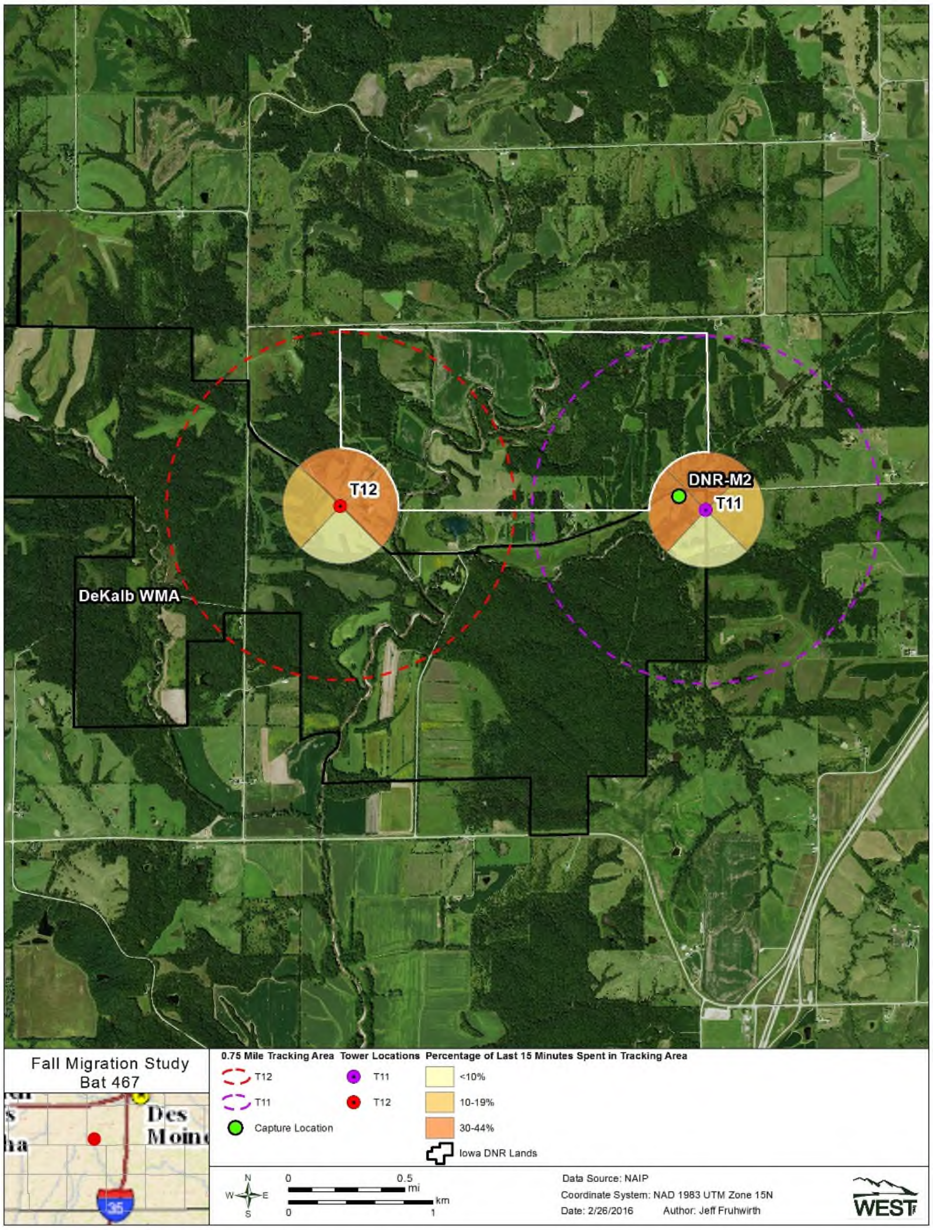

Figure 15. Map of direction of detections for Bat Identification 467 for the last 15 minutes of detection. The white polygon represents the area the bat is thought to have been during those 15 minutes.

Weather and Temporal Correlates of Migratory Movements

Using weather data from local weather stations, we plotted daily temperature and precipitation conditions associated with last detections of bats in the study areas (Figure 16). There appears to be a trend associated with temperature, with 8 of 14 bats being last detected during periods with decreasing temperatures. Decreasing temperature is often associated with precipitation events, and 11 of the 14 bats appear to have left the study area during, or immediately before or after precipitation. Based on these data, NLEB may have timed migratory movements with periods of passing weather fronts. It is also evident from Figure 16 that there was not a single migration event. Instead, bats remained within the study areas, generally foraging each night, until they left the area. It is unclear if we captured resident bats that migrated out of the area at different times, or if we captured bats that were moving into and then out of the area at different times.

There was a trend toward tagged adult bats remaining within the study area for shorter periods as the season progressed (Figure 17). However, due to small sample sizes and variability in the data this is not considered a statistically significant relationship. Transmittered bats remained in the study areas and were detected for an average of 11.1 days (excluding the two bats that were lost on the first night), but ranged from 0-31 days (including the two bats that were lost on the first night). Adults appeared to remain after tagging longer than juveniles. The nine adults were tracked for an average of 14 days (range 2-31; median 14 days), whereas the 5 juveniles were tracked for only 1.4 days (range 0-3; median 1 day). The two juvenile males were captured early in the study; both within the first week. One of the juvenile females was captured in the first week, however, two of the three juvenile females were capture late – in the 6^{th} and 7^{th} weeks. Considering only adults, three males were tracked for an average of 14.3 days (range 11-18; median 14 days) and six females were tracked for an average of 13.8 days (range 2-31; median 13.5 days). Although males were tracked for slightly longer, they were on average the first to leave. Adult males were last detected during the 4^{th} week of the study and the average adult male left the area on September 11 (median September 9). The average adult female also left during the 4^{th} week on September 13 (median September 10).

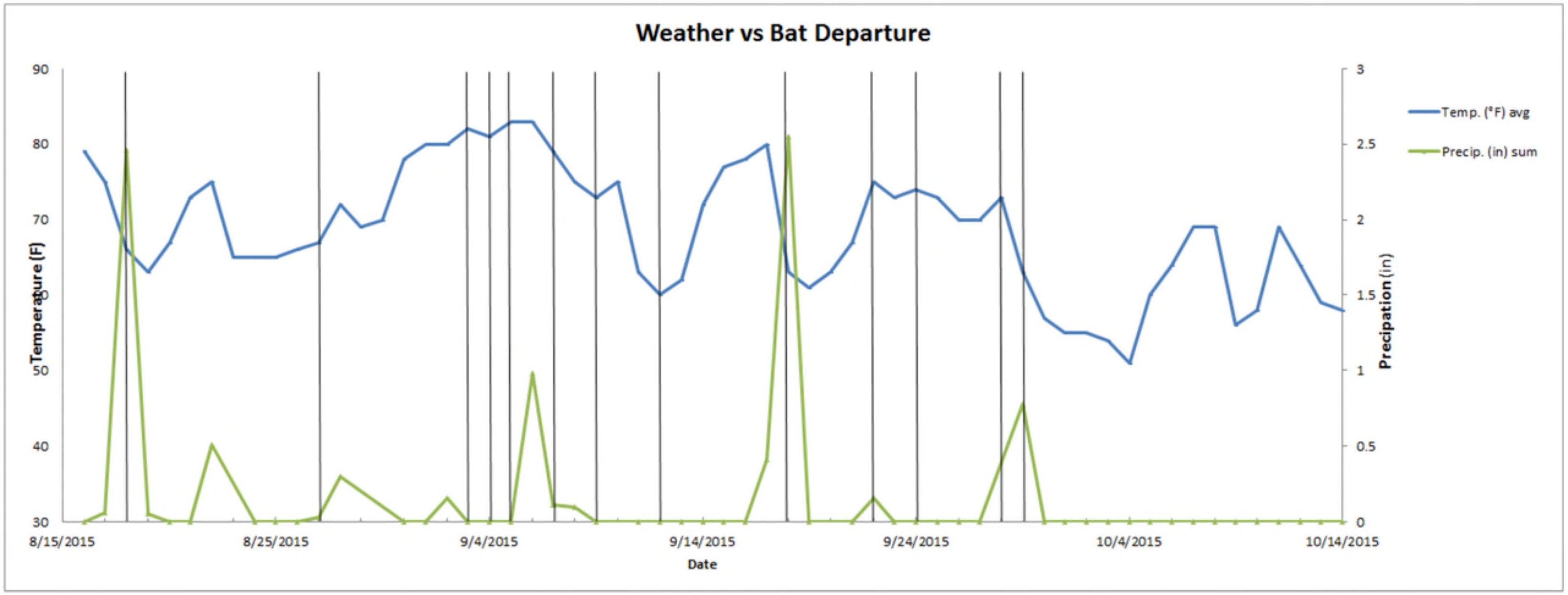

Figure 16. Weather conditions associated with migratory movements of northern long-eared bats, fall 2015. Vertical lines represent dates that bats were last detected in the study areas and are assumed to be the dates that the bats left the areas. The line at 8/17/2015 represents two bats that left the area the same night they were tagged.

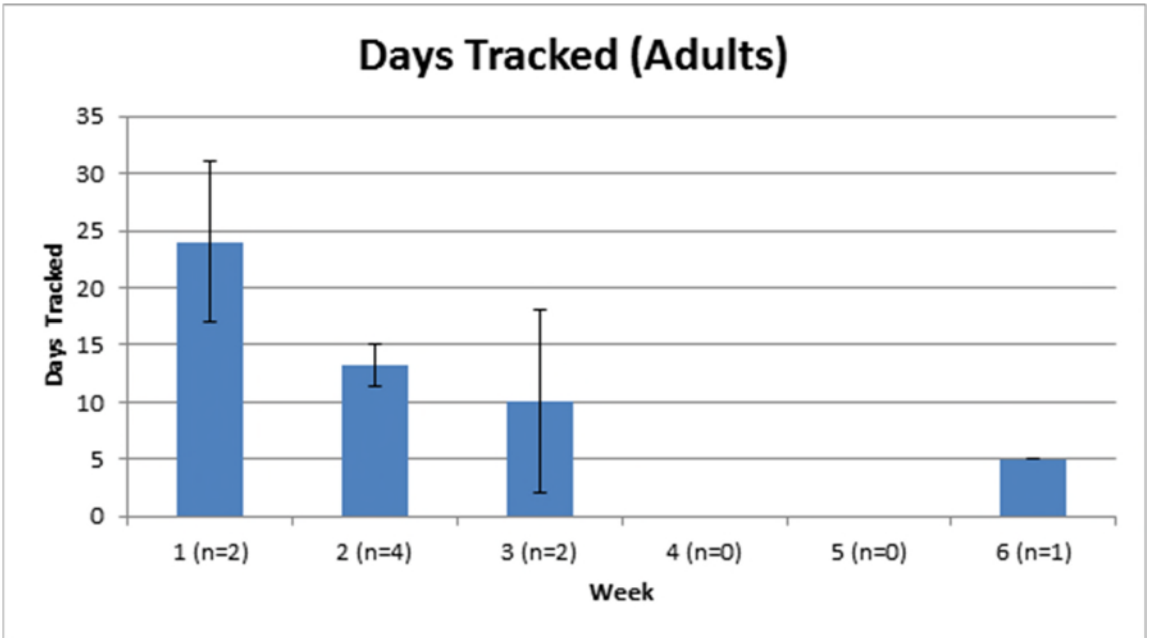

Figure 17. Summary of the duration that tagged bats remained in the study areas before migrating outside of the areas. Week 1 began on August 17, 2015. Vertical bars represent ± one standard error. The data suggest that bats more quickly initiated migratory movements out of the areas as the study progressed, but small sample sizes and high variability within weeks preclude strong statistical conclusions.

DISCUSSION

Northern long-eared bats were captured and tagged between August 17, 2015 and September 25, 2015 and bats migrated out of the study areas between August 27, 2015 and September 29, 2015. Netting continued, when weather conditions were suitable, until October 11, but no additional northern long-eared bats were captured after September 25. During the two months of this study no large exiting event by transmittered bats was observed. Instead, the 17 transmittered bats appeared to gradually move out of the study areas, though adults appeared to remain in the areas much longer than did juveniles. Similar to previous bat migration studies, we found that it is difficult to track bats during migration due to their large movements, short transmitter detection distances and short-lived home ranges (Rommé et al. 2002, Cryan and Diehl 2009). Due to limited land access and the 1.2-km (0.75-mi) reliable detection range, towers were concentrated around mist-net captures sites and high points in and around the study areas. The concentration of towers allowed us to track bats during normal nightly movements, but could not provide detection of migrating bats when they left the area. However, the clustering resulted in five of 12 bats being detected on multiple towers as they left the study area, allowing for some deduction as to direction of travel. In one scenario a bat (bat ID 11) was detected by five towers as it left the area. Two of the towers at which the bat was detected were more than five km (>3 mi) apart, which suggests that the bat was flying relatively high, providing a good line of sight to both towers. Bats are known to fly at higher altitudes when migrating in comparison to foraging flight heights (Cryan and Diehl 2009) and this may allow for easier detection of tagged bats during migration. However, overall we were unable to demonstrate unequivocally if bats were just leaving the area to forage and roost elsewhere or truly migrating when it left the project area. NLEBs during this study period tended to roost around the areas captures for at least a short period, but based on tower detection records, they would forage throughout the area. For example, bats that were captured and roosted at MB-6 were detected during foraging bouts at towers around MB-9 and vice-versa (estimated maximum distance range of 7.5 km detectability between MB-9 and MB-6, 10.9 km for all of MWP and 5 km for Dekalb WMA). However, in terms of attempting to detect transmittered bats during migratory flights, it seems clear that considerable effort must be invested in identifying likely migratory routes from a particular study area, in identifying landowners and gaining access to areas suitable for monitoring those routes and in capturing enough NLEB during fall to increase odds of detecting tagged bats at medium to long distances from capture points. In cases where known or suspected hibernacula are located within the known migration distance of NLEB, then it may be profitable to attempt to set up telemetry stations near these features in hopes of detecting a tagged bat. Currently, the location of overwintering areas for the NLEB that were captured in the MWP and DNR lands south of the MWP remain unknown, and to our knowledge, there are no known hibernacula within the presumed migratory distance (40-50 miles; USFWS 2015) of the study areas. However, because we banded all the NLEB that we captured, there is a chance that one or more of these individuals will be resighted during hibernacula surveys. If the two migratory endpoints for NLEB in the MWP could be established, then identifying potential routes of travel between the two points would likely be made considerably easier.

We observed that drops in temperature, especially when associated with rain storms, seemed to trigger migratory movements. There are likely several reasons why bats may have chosen to initiate movements during periods of cool, wet weather. It is possible, for example, that such weather patterns signal the pending approach of very cold weather that will necessitate hibernation. If so, and if bats are not already in or near hibernacula, then they may continue to move toward those features. There likely has been selection pressure for behaviors that place individuals in a position to avoid being caught far from a hibernaculum during a sudden cold snap. It is also possible that by initiating migratory movements during rainy periods, the potential for predators to detect and attack bats is reduced. Likely predators of migrating bats in Iowa are owls, which may cease to hunt during rainy conditions (e.g., Bunn 1972, Michelat and Giraudoux 2000).

We observed that male and female adults remained in the study areas for about the same lengths of time before leaving, but that juveniles were very short term residents in the area. While our sample size of juveniles is small (n=5), they were captured only at the beginning and end of the study, which suggests that they may have been part of migratory pulses of individuals moving through the area. Contra this pattern, adults of both sexes that were captured during the first 2 weeks of the study remained for not less than 10 days and averaged 16.8 days of residence, with males leaving the area 2 days earlier, on average, than females. Males are often the first to arrive at hibernacula, presumably to increase their chances of mating once females begin to arrive (Thomas et al. 1979).

During this study, we found no clear consensus in direction of migration. Using telemetry towers placed around the MWP and DNR lands to the south, we were able to gather movement information on the bats' use of the area when they were detected by multiple towers. We were also able to glean some information regarding directionality as the bats left the area. However, due to limited detection distances, we were limited in our understanding of movements and habitat usage by bats outside the MWP. Some bats appeared to leave in a northern direction. Assuming that the bats were indeed engaged in migratory movements, northerly flight paths would intersect with several larger drainages, including the Middle River and Clanton Creek, both of which continue in generally northerly directions. However, other bats, particularly those in the southwest corner of the MWP seemed to be heading south or southwesterly when last detected. If they continued that trajectory, they would intercept the Thompson River, and if they use that drainage as a migration corridor, they could travel either upstream or downstream. The Thompson River flows in a southerly direction toward the Sand Creek and Dekalb Wildlife Management Areas. In addition to the MWP, we included two capture sites on the Sand Creek and Dekalb Wildlife Management Areas. We hoped that by including these areas, which have larger riparian drainages with connectivity to the MWP, that we might be able to detect some movements between the two DNR lands or between the DNR lands and the MWP. Unfortunately, no NLEBs were detected at one of the other two study areas once they left their original area of capture. While we did not detect any bats from the MWP at towers at the WMAs to the south, it is possible that tagged bats moved past those areas undetected due to forest cover and topography. However, assuming that bats were following the Thompson, they could also have moved upstream (northwesterly) after leaving the MWP, toward the its headwaters, at which point it is very near the Middle River, from which bats could continue northwest or turn easterly.

Detailed information about the migration ecology of most bat species in North America remains unavailable, and this can hamper attempts to manage or conserve resources used by bats during migration. To date, a handful of studies have tracked Indiana bats during the spring migration (e.g., South Penn Tunnel 2000; Chenger 2003, 2005; NYDEC 2004, 2005, 2006, 2007; Bat Conservation and Management 2006; Bat Conservation and Management and Sanders Environmental 2007; Sanders et al. 2001; Hicks et al. 2012). The picture painted by these and other studies is that exodus from the hibernacula in spring occurs during a relatively short period, and that migration to summer grounds is direct and non-punctuated. In other words, following arousal from hibernation, the bats move as directly and quickly to summer grounds. In more densely forested areas (e.g., Pennsylvania and New York), spring migrating bats appeared to fly in a more or less straight line toward summer areas, perhaps because they could do so without leaving the relative safety of forest cover. In northern Illinois, where the forest cover was largely restricted to river riparian areas, Indiana bats appeared to remain close to the river and its forest cover, and thus followed a more circuitous route to summer areas (Hicks et al. 2012). We suspect that northern long-eared bats are also likely to use forested riparian areas as corridors for migratory movements, and given their apparent affinity for forest cover (e.g., they are considered forest interior species in parts of their range; USFWS 2015), it seems likely that in less densely forested parts of their range (e.g., the Midwest) they may adhere more closely to forested areas than do either little brown or Indiana bats. If so, this could partially explain why relatively few NLEB have been discovered as turbine fatalities at utility scale wind farms. Moreover, if true, then telemetry monitoring stations situated along forested river riparian areas may yield information about the direction of migratory movements. Another useful approach to understanding migratory behaviors of NLEB would be to conduct spring migration telemetry studies, similar to those referenced above, assuming that a suitable concentration of overwintering NLEB could be discovered.

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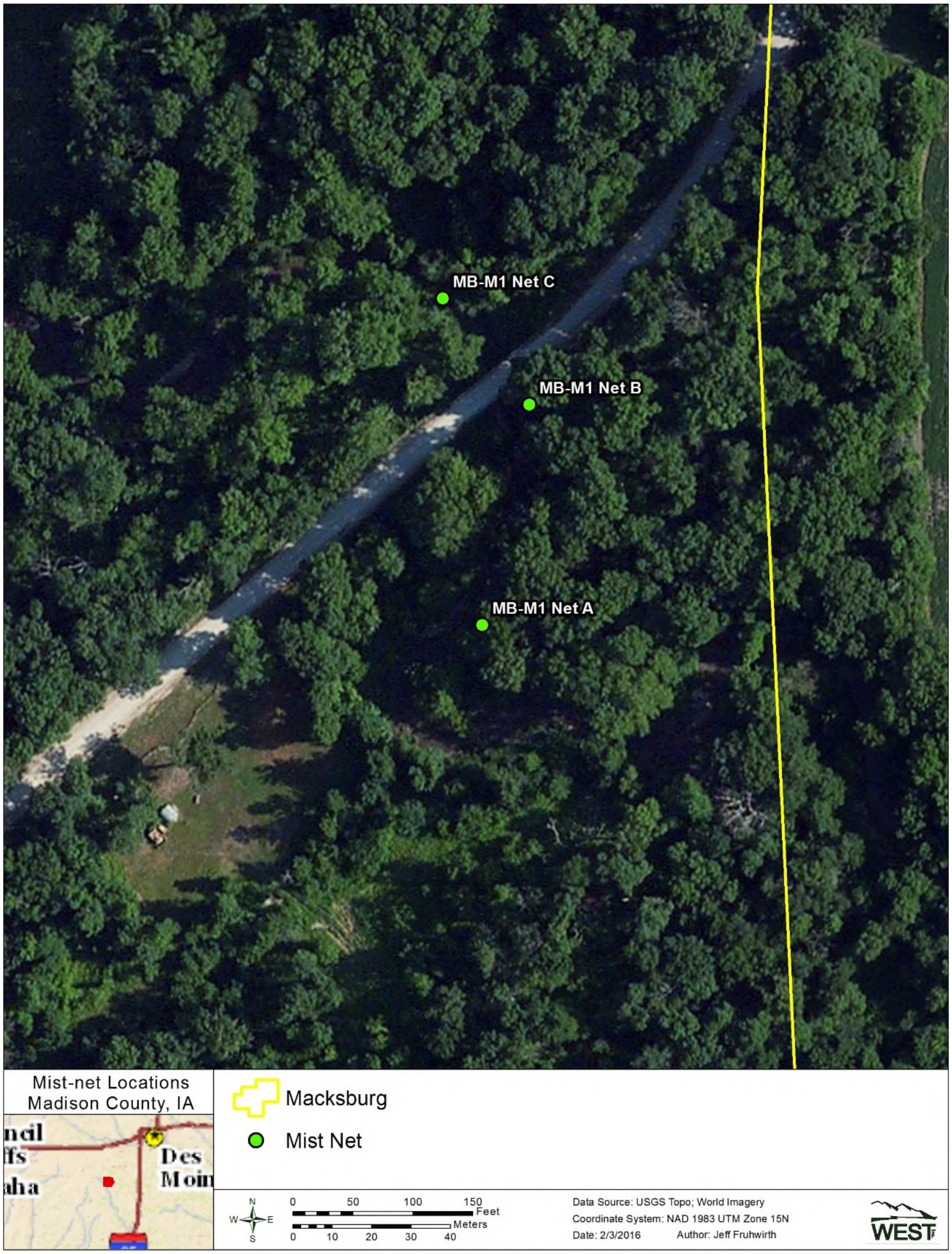
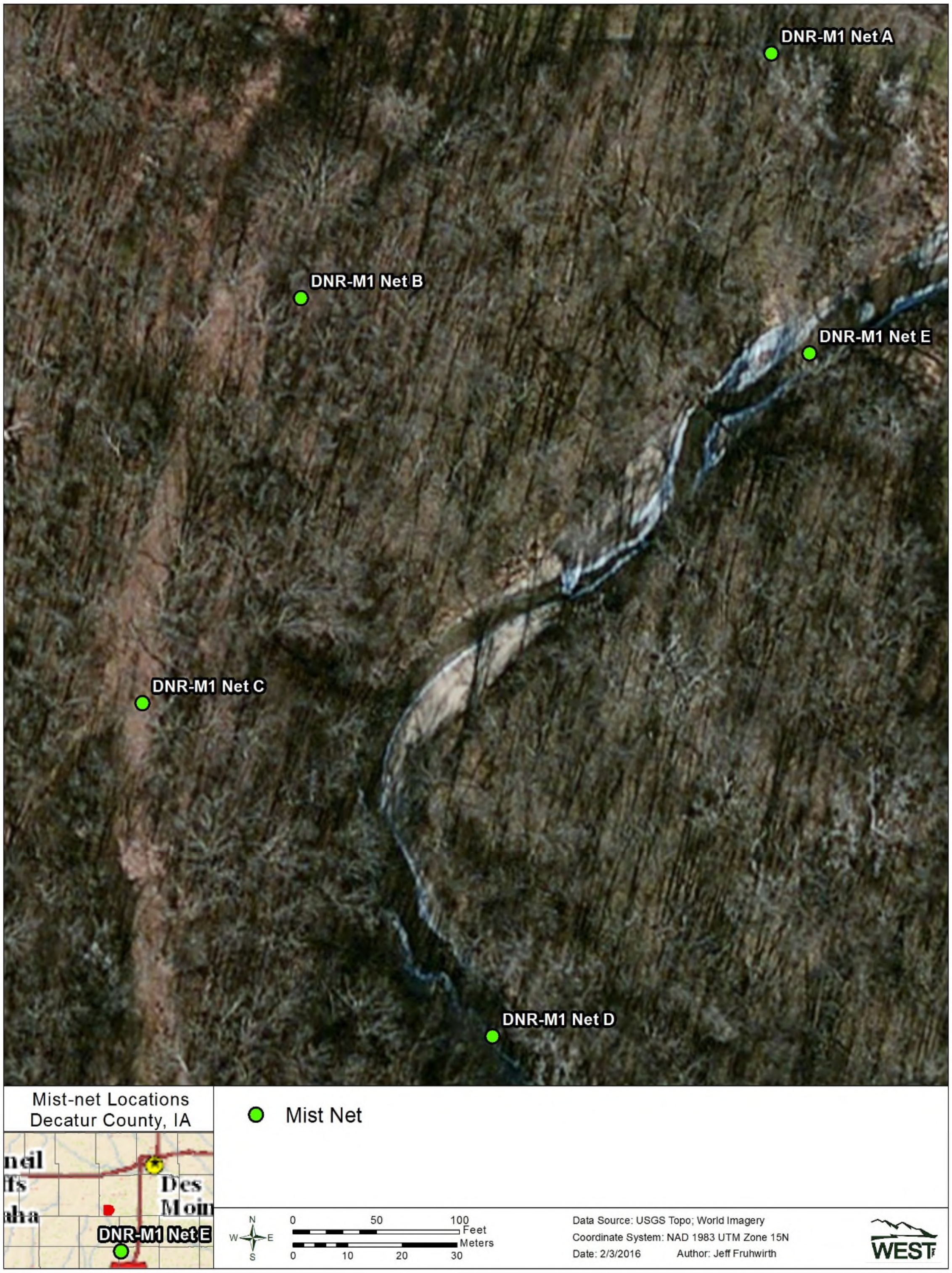
Appendix A. Aerial Imagery of Mist-net Sites

Appendix A 1. Mist-net locations at site MB-9 within the Macksburg Wind Project for the northern long-eared bat fall migration study, 2015.

Appendix A 2. Mist-net locations at site MB-6 within the Macksburg Wind Project for the northern long-eared bat fall migration study, 2015.



Appendix A 2. Mist net locations at site MB-M1 within the Macksburg Wind Project for the northern long-eared bat fall migration study, 2015.



Appendix A 3. Mist-net locations at site DNR-M1 within the Sand Creek Wildlife Management Area for the for the northern long-eared bat fall migration study, 2015.

Appendix A 4. Mist net locations at site DNR-M1 within the Dekalb Wildlife Management Area for the northern long-eared bat fall migration study, 2015.

Appendix B. Photographs of Mist-net Survey Sites

Appendix B 1. Two photographs of bat habitat surveyed by mist nets at MB-9 net A.

Appendix B 2. Two photographs of bat habitat surveyed by mist nets at MB-9 net B.

Appendix B 3. Two photographs of bat habitat surveyed by mist nets at MB-9 net C.

Appendix B 4. Two photographs of bat habitat surveyed by mist nets at MB-9 net D.

Appendix B 5. Two photographs of bat habitat surveyed by mist nets at MB-9 net E.

Appendix B 6. Two photographs of bat habitat surveyed by mist nets at MB-9 net F.

Appendix B 7. Two photographs of bat habitat surveyed by mist nets at MB-6 net A.

Appendix B 8. Two photographs of bat habitat surveyed by mist nets at MB-6 net B.

Appendix B 9. Two photographs of bat habitat surveyed by mist nets at MB-6 net C.

Appendix B 10. Two photographs of bat habitat surveyed by mist nets at MB-6 net D.

Appendix B 11. Two photographs of bat habitat surveyed by mist nets at MB-M1 net A.

Appendix B 12. Two photographs of bat habitat surveyed by mist nets at MB-M1 net B.

Appendix B 13. Two photographs of bat habitat surveyed by mist nets at MB-M1 net C.

Appendix B 14. Bat habitat surveyed by mist nets at DNR-M1 net A.

Appendix B 15. Bat habitat surveyed by mist nets at DNR-M1 net B.

Appendix B 16. Bat habitat surveyed by mist nets at DNR-M1 net C.

Appendix B 17. Bat habitat surveyed by mist nets at DNR-M1 net D.

Appendix B 18. Bat habitat surveyed by mist nets at DNR-M1 net E.

Appendix B 19. Bat habitat surveyed by mist nets at DNR-M2 net A.

Appendix B 20. Bat habitat surveyed by mist nets at DNR-M2 net B.

Appendix B 21. Bat habitat surveyed by mist nets at DNR-M2 net C.

Appendix C. Photographs of Captured Bats

Appendix C 1. Big brown bat captured at MB-9.

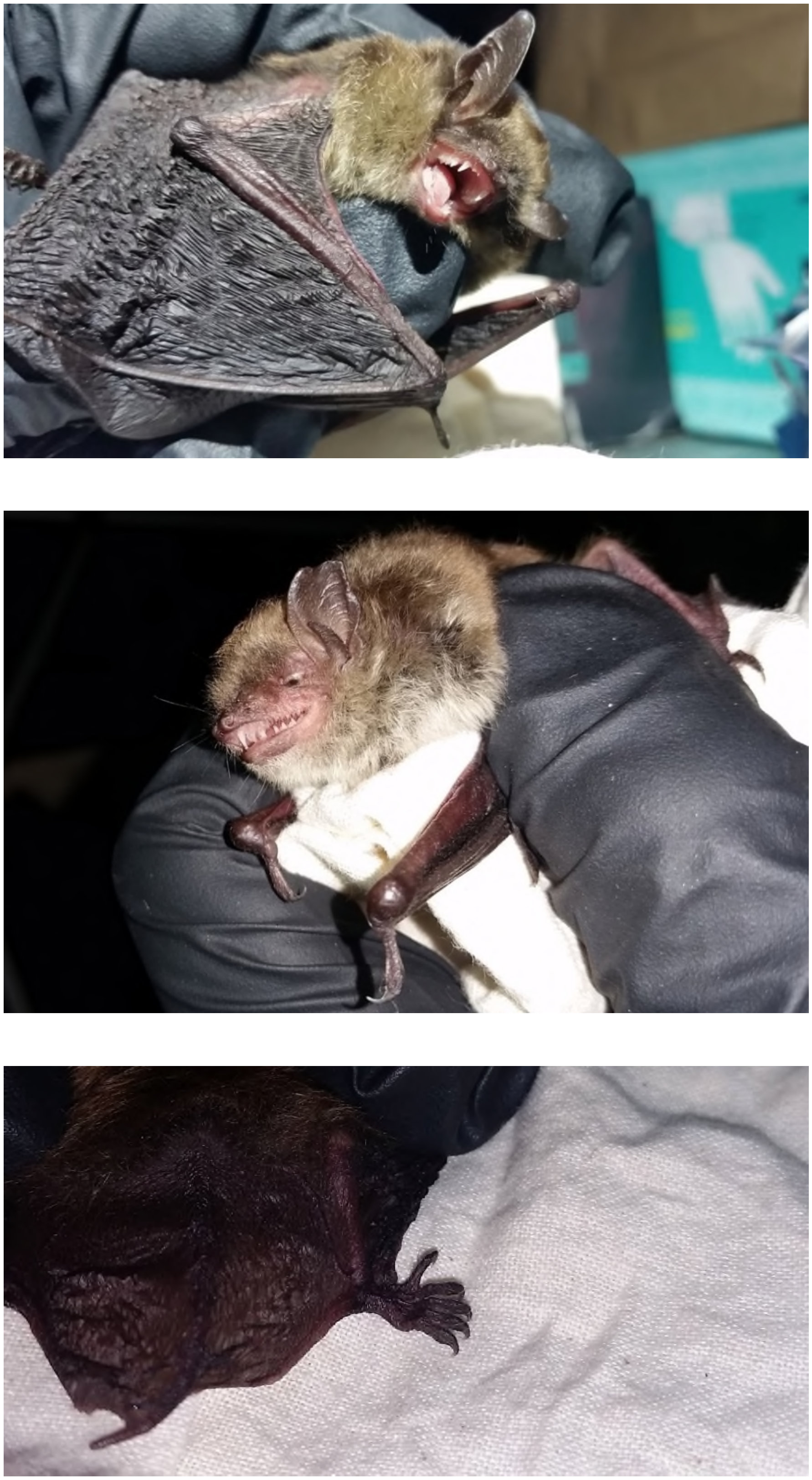
Appendix C 2. Evening bat captured at MB-9.

Appendix C 3. Three photographs of a little brown bat captured at MB-9.

Appendix C 4. Three photographs of a northern long-eared bat captured at MB-9.

Appendix C 5. Two photographs of a northern long-eared bat at MB-6.

Appendix C 6. Big brown bat captured at MB-M1.



Appendix C 7. Three photographs of a little brown bat captured at MB-M1.

Appendix C 8. Three photographs of a northern long-eared bat at MB-M1.

Appendix C 9. Big brown bat captured at DNR-M1.

Appendix C 10. Silver-haired bat captured at DNR-M1.

Appendix C 11. Evening bat captured at DNR-M1.

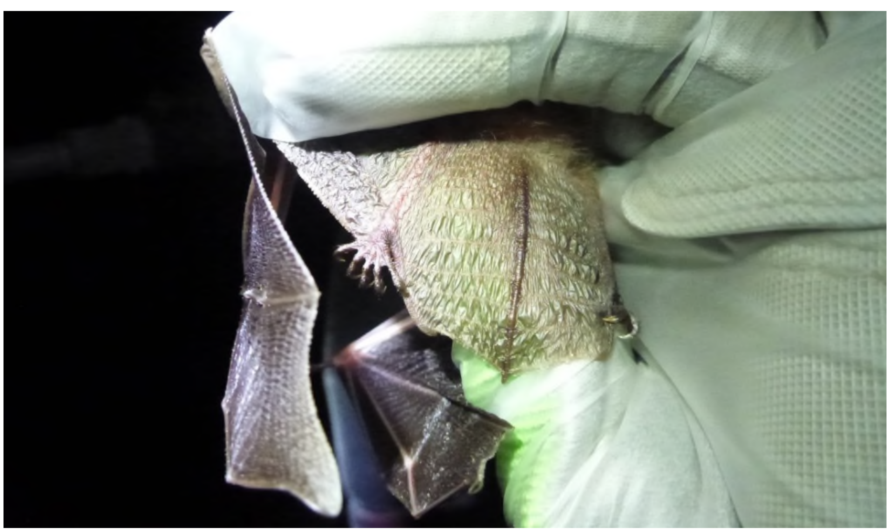
Appendix C 12. Hoary bat captured at DNR-M1.

Appendix C 13. Two photographs of a eastern red bat captured at DNR-M1.

Appendix C 14. Comparison of a hoary bat and eastern red bat captured at DNR-M1.

Appendix C 15. Big brown bat captured at DNR-M2.

Appendix C 16. Eastern red bat at DNR-M2.



Appendix C 17. Three photographs of a northern long-eared bat captured at DNR-M2.

Appendix D. Summary of Mist-net Captures

Appendix Table D1. Details of bats captured at mist-net site MB-9; August 17, 20, 24, 27, and 31, 2015.

Species	Sex	Age	Reproductive Status	Reichard Score	Weight (g)	Forearm Length (mm)
August 17						
Little brown	Male	Juvenile	Non-reproductive	-	7.5	37.8
Big brown bat	Female	Adult	Post-lactating	-	22.0	48.4
Northern long-eared bat	Male	Juvenile	Non-reproductive	-	7.0	35.5
Northern long-eared bat	Female	Juvenile	Non-reproductive	-	5.75	35.7
Big brown bat	Male	Adult	Reproductive	-	18.5	45.9
Evening bat	Female	Juvenile	Non-reproductive	-	13.5	37.7
Evening bat	Female	Juvenile	Non-reproductive	-	13.5	39.9
Big brown bat	Female	Adult	Post-lactating	-	>22	48.4
Big brown bat	Female	Adult	Non-reproductive	-	>22	44.9
Big brown bat	Female	Adult	Post-lactating	-	>22	46.7
Big brown bat	Female	Juvenile	Non-reproductive	-	19.3	47.3
Evening bat	Female	Juvenile	Non-reproductive	-	12.0	37.5
August 20						
Northern long-eared bat	Female	Adult	Post-lactating	-	7.0	35.8
Evening bat	Female	Adult	Post-lactating	-	12.25	36.0
Big brown bat	Female	Adult	Post-lactating	-	21.5	47.9
Big brown bat	Male	Adult	Reproductive	-	16.5	46.4
Big brown bat	Female	Juvenile	Non-reproductive	-	18.5	50.0
Big brown bat	Female	Adult	Post-lactating	-	21.0	45.6
Big brown bat	Male	Adult	Reproductive	-	15.5	46.8
Big brown bat	Female	Juvenile	Non-reproductive	-	16.0	45.3
Big brown bat	Female	Juvenile	Non-reproductive	-	17.5	47.9
Big brown bat	Female	Juvenile	Non-reproductive	-	16.8	48.1
August 24						
Evening bat	Female	Adult	Non-reproductive	-	12.0	35.9
Evening bat	Female	Adult	Post-lactating	-	13.0	36.2
Evening bat	Female	Adult	Post-lactating	-	12.5	37.9
Big brown bat	Female	Adult	Non-reproductive	-	20.5	46.7
Northern long-eared bat	Female	Adult	Post-lactating	-	7.5	37.1
August 27						
Big brown bat	Female	Juvenile	Non-reproductive	-	23.5	48.9
Big brown bat	Female	Adult	Post-lactating	-	24.5	48.1
Big brown bat	Female	Juvenile	Non-reproductive	-	23.5	45.3
August 31						
Evening bat	Female	Adult	Post-lactating	-	15.25	37.0
Evening bat	Female	Adult	Post-lactating	-	15.25	36.8
Evening bat	Female	Juvenile	Non-reproductive	-	13.5	36.2
Big brown bat	Female	Adult	Post-lactating	-	28.5	48.1

Appendix Table D2. Details of bats captured at mist-net site MB-6; August 23, 24, 27, 30, 2015; September 21, 24, 28, 30, 2015; and October 7, 11, 2015.

Species	Sex	Age	Reproductive Status	Reichard Score	Weight (g)	Forearm Length (mm)
August 23						
Northern long-eared bat	Female	Adult	Post-lactating	-	7.0	37.5
August 24						
Northern long-eared bat	Male	Juvenile	Non-reproductive	-	6.0	36.0
Northern long-eared bat	Male	Juvenile	Non-reproductive	-	6.0	33.2
August 27						
Northern long-eared bat	Male	Adult	Reproductive	-	6.25	35.0
Northern long-eared bat	Male	Adult	Non-reproductive	-	6.0	35.7
August 30						
Northern long-eared bat	Female	Adult	Post-lactating	-	7.0	37.7
September 21						
None captured						
September 24						
Northern long-eared bat	Female	Adult	Post-lactating	-	8.5	35.0
Northern long-eared bat	Female	Juvenile	Non-reproductive	-	8.0	36.2
September 28						
None captured	-	-	-	-	-	-
September 30						
None captured	-	-	-	-	-	-
October 7						
Big brown bat	Female	Adult	Post-lactating	-	23.25	45.4
October 11						
None captured	-	-	-	-	-	-

Appendix Table D3. Details of bats captured at mist-net site MB-M1; August 26, 2015and October 6, 2015.

Species	Sex	Age	Reproductive Status	Reichard Score	Weight (g)	Forearm Length (mm)
August 26						
Big brown bat	Male	Adult	Non-reproductive	-	19.0	44.1
Little brown	Male	Adult	Reproductive	-	8.25	37.1
Northern long-eared bat	Male	Adult	Non-reproductive	-	7.0	37.7
Little brown	Male	Adult	Non-reproductive	-	10.5	35.6
Northern long-eared bat	Female	Adult	Post-lactating	-	7.0	35.5
Big brown bat	Male	Juvenile	Non-reproductive	-	17.2 5	46.9
October 6						
Big brown bat	Female	Adult	Post-lactating	-	27.75	50.4

Appendix Table D4. Details of bats captured at mist-net site DNR-M1; August 31, 2015, September 1 and 26, 2015 and October 9, 2015.

Species	Sex	Age	Reproductive Status	Reichard Score	Weight (g)	Forearm Length (mm)
August 31						
Eastern red bat	Female	Juvenile	Non-reproductive	-	16.75	40.6
Hoary bat	Female	Juvenile	Non-reproductive	-	23.1	53.0
Hoary bat	Male	Juvenile	Reproductive	-	21.8	55.3
Evening bat	Female	Juvenile	Non-reproductive	-	12.25	37.1
Big brown bat	Male	Adult	Reproductive	-	17.5	44.9
Hoary bat	Female	Adult	Post-lactating	-	25.5	54.0
Silver-haired bat	Female	Juvenile	Non-reproductive	-	13.0	42.5
Eastern red bat	Male	Adult	Reproductive	-	10.75	38.7
September 1						
Eastern red bat	Male	Adult	Reproductive	-	9.5	41.6
Eastern red bat	Male	Adult	Reproductive	-	10.0	37.5
Silver-haired bat	Male	Adult	Reproductive	-	11.5	41.4
Big brown bat	Male	Adult	Reproductive	-	20.5	47.0
Big brown bat	Female	Adult	Post-lactating	1	20.75	49.0
Big brown bat	Female	Adult	Post-lactating	-	19.75	48.2
Big brown bat	Female	Adult	Post-lactating	-	20.5	46.2
Eastern red bat	Female	Adult	Non-reproductive	-	11.5	41.4
September 26						
Eastern red bat	---	---	---	---	---	---
October 9						
None captured	-	-	-	-	-	-

---- Escaped from net

Appendix Table D5. Details of bats captured at mist-net site DNR-M2; September 1, 19, 20, 25, 27, 2015 and October 10, 2015.

Species	Sex	Age	Reproductive Status	Reichard Score	Weight (g)	Forearm Length (mm)
September 1						
Northern long-eared bat	Female	Adult	Post-lactating	-	8.1	37.7
Northern long-eared bat	Male	Adult	Reproductive	-	8.25	35.5
September 19						
Big brown bat	Female	Juvenile	Non-reproductive	-	22.5	44.7
Eastern red bat	Male	Juvenile	Non-reproductive	-	10.0	37.9
September 20						
None captured	-	-	-	-	-	-
September 25						
Northern long-eared bat	Female	Juvenile	Non-reproductive	-	9.25	37.0
Big brown bat	Male	Adult	Reproductive	-	26.5	44.5
Eastern red bat	Male	Juvenile	Non-reproductive	-	10.5	38.0
Eastern red bat	---	---	---	---	---	---
Eastern red bat	Male	Adult	Reproductive	-	12.0	39.5
October 10						
None captured	-	-	-	-	-	-

---- Escaped from net

Appendix E. Photographs of Roost Trees


Appendix E 1. Two photographs of roost MB9-MYSE3-R1.

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Appendix E 4. Three photographs of roost MB9-MYSE4-R1.

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Appendix F 2. The landscape north of tower 1 near MB-9.

Appendix F 3. Two photographs of the landscape east of tower 1 near MB-9. The first picture is east directly from the tower and the second is the landscape beyond the barn.

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Appendix F 7. The landscape north of tower 1b near MB-9.

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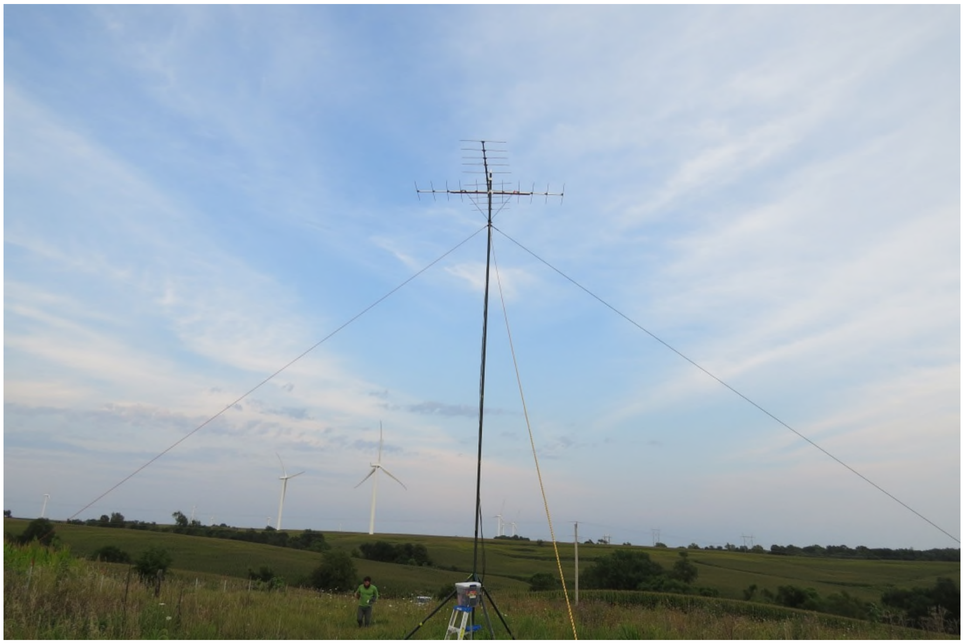
Appendix F 9. The landscape south of tower 1b near MB-9.

Appendix F 10. The landscape west of tower 1b near MB-9.

Appendix F 11. Tower 2 near MB-9.

Appendix F 12. The landscape north of tower 2 near MB-9.



Appendix F 13. The landscape east of tower 2 near MB-9.

Appendix F 14. The landscape south of tower 2 near MB-9.

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Appendix F 65. The landscape west of tower 12 near DNR-M2.

2014-2016 Eagle Use Surveys

MidAmerican Energy Company
Iowa Wind Energy Portfolio
December 2014 – February 2016

Prepared for:

MidAmerican Energy Company

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INTRODUCTION

MidAmerican Energy Company (MidAmerican) requested that Western EcoSystems Technology, Inc. (WEST) conduct an eagle use study at their Iowa wind energy facilities using methodology outlined in the U.S. Fish and Wildlife Service's (USFWS) *Land-Based Wind Energy Guidelines* (USFWS 2012) and *Eagle Conservation Plan Guidance* (USFWS 2013). The eagle use study was designed to address three primary objectives to better understand and interpret eagle use at MidAmerican's wind energy facilities:

- Analyze the level of bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) use within the MidAmerican Project footprints (to provide a measure of eagle activity and the primary input for models estimating fatality rate of eagles associated with wind turbines per the current *Eagle Conservation Plan Guidance* [USFWS 2013]);

- Confirm seasonal use patterns of eagles (to identify higher risk periods for potential eagle take); and

- Concurrently analyze the level of eagle use outside of the Project footprints at reference sites with similar habitats that are within 5 kilometers (km; 3 miles [mi]) of turbine infrastructure (to better understand general eagle use patterns in the vicinity of the Projects and test the hypothesis that eagles will generally avoid clusters of wind turbines).

WEST included 18 operating wind energy projects (Projects) with a combined 3335.08 megawatts of wind generation nameplate capacity in this study (Figure 1, Table 1). These Projects comprised MidAmerican's wind energy portfolio within Iowa at the time this study began in December 2014.

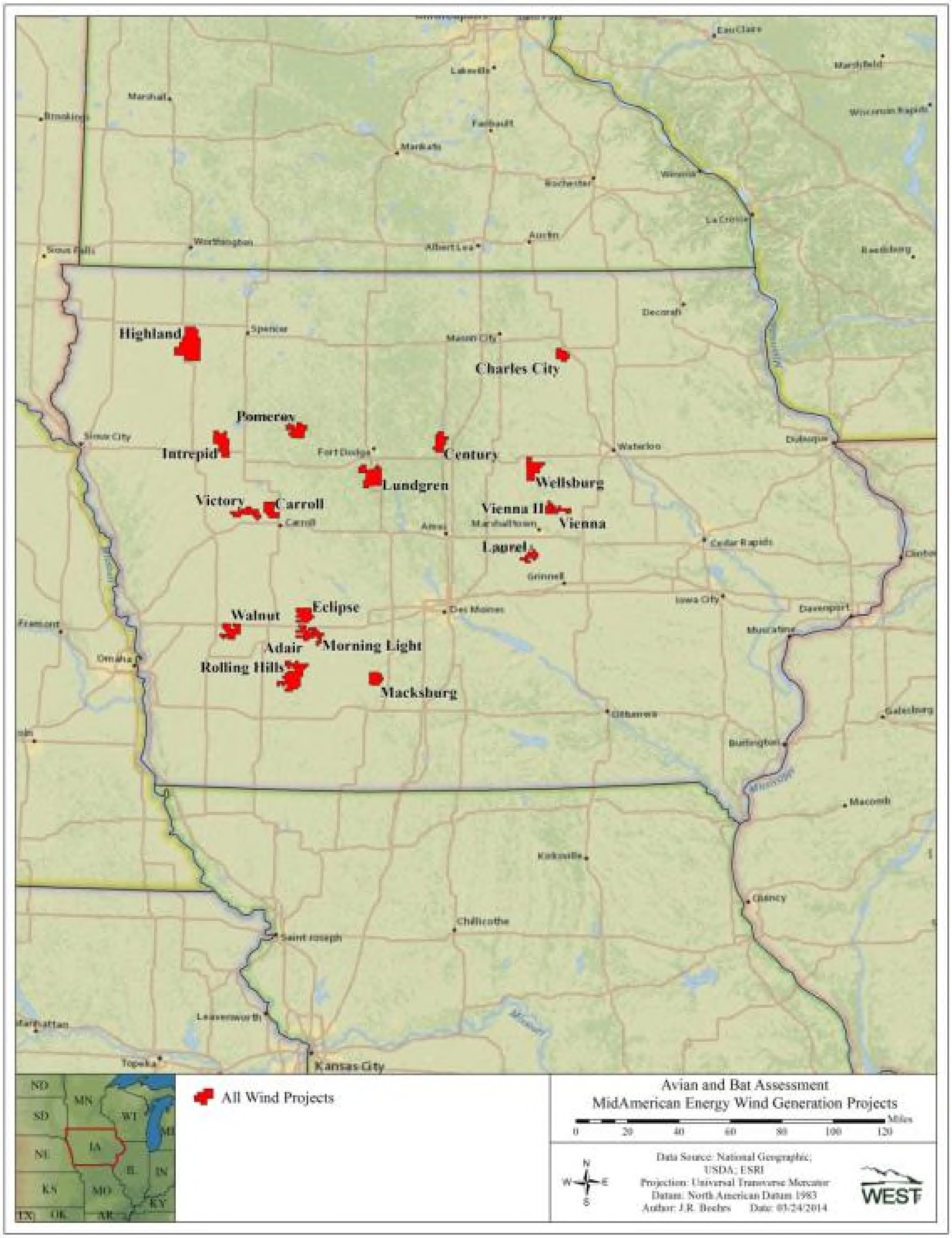

Figure 1. Locations of facilities included in the eagle use study for the MidAmerican's Iowa Wind Energy Portfolio.

Table 1. MidAmerican's Iowa Wind Energy Projects, including facility specifications.

Facility Name	County	Project Area		Number of Turbines	Turbine Size (Megawatt)	Total Project Megawatts
		Square Miles	Acres			
Adair	Adair/Cass	26	16,640	76	2.3	174.8
Carroll	Carroll	25	16,000	100	1.5	150.0
Century	Hamilton/Wright	28	17,920	145	1.5/1.0	200.0
Charles City	Floyd	18	11,520	50	1.5	75.0
Eclipse	Audubon/Guthrie	31	19,840	87	2.3	200.1
Highland	O'Brien	92	58,880	214	2.3	495.0
Intrepid	Sac/Buena Vista	43	27,520	122	1.5/1.0	175.5
Laurel	Marshall	16	10,240	52	2.3	119.6
Lundgren	Webster	52	33,280	107	2.3	251.0
Macksburg	Madison	22	14,080	51	2.3	119.6
Morning Light	Adair	13	8,320	44	2.3	101.2
Pomeroy	Pocahontas	33	21,120	184	1.5/2.3	286.4
Rolling Hills	Adair/Adams/Cass	69	44,160	193	2.3	443.9
Victory	Carroll/Crawford	28	17,920	66	1.5	99.0
Vienna I	Marshall/Tama	15	9,600	45	2.3	105.6
Vienna II	Marshall	11	7,040	19	2.3	44.6
Walnut	Pottawattamie	32	20,480	102	1.5	153.0
Wellsburg	Grundy	36	23,040	60	2.3	140.8

Study Area

The Adair, Laurel, Morning Light, Rolling Hills, and Macksburg facilities are located in the Rolling Loess Prairies Level 4 Ecoregion (Chapman et al. 2001), while the Eclipse facility straddles both the Rolling Loess Prairies and Steeply Rolling Loess Prairies Level 4 Ecoregions (Chapman et al. 2001). The Vienna I, Vienna II, and Wellsburg facilities are located in both the Rolling Loess Prairies and Eastern Iowa and Minnesota Drift Level 4 Ecoregion. The Victory and Walnut facilities are also located in the Steeply Rolling Loess Prairies Level 4 Ecoregion, and the Carroll facility straddles the Des Moines Lobe and Steeply Rolling Loess Prairies Level 4 Ecoregions (Chapman et al. 2001). The Highland and Intrepid facilities are located in the Loess Prairies Level 4 Ecoregion. The Lundgren, Century, and Pomeroy facilities are located in the Des Moines Lobe Level 4 Ecoregion (Chapman et al. 2001).

According to the U.S. Geological Survey National Land Cover Database (2011, Homer et al. 2015), landscapes were predominately cropland (i.e., corn [*Zea mays*] and soybeans [*Glycine max*]) at all sites, except Rolling Hills and Macksburg, which were characterized by a combination of cropland and pasture/hayfields (U.S. Geological Survey National Land Cover Database 2011, Homer et al. 2015).

FIELD METHODS

Eagle Use Surveys

Survey Plots

The eagle use study plan included the use of fixed points to gather information on bird use near and around turbines, with a particular focus on bald eagles and other large bird species. Additionally, this study documented eagle use at reference sites that were located in similar habitats adjacent to but outside the Project boundaries (and away from turbines) to compare the level of eagle use in both settings (see Appendix A for point locations for each Project). The eagle use surveys consisted of counts of eagle use within circular plots around fixed observation points, following methods similar to Reynolds et al. (1980).

To assess eagle use, the USFWS recommends that enough point count locations be placed to cover at least 30% of the project footprint.[1] The area of the Projects' footprints and the number of survey points per site is listed in Tables 1 and 2, respectively. Each point count circle consisted of an 800-meter (m; 2,625-foot [ft]) radius and covered approximately two square kilometers (0.8 square mile) and the total survey coverage of each site was at least 30%, with no fewer than 10 survey points per Project site. This survey approach is consistent with the recommendations included in *Appendix C: Stage 2 – Site-Specific Surveys and Assessments* in the USFWS's *Eagle Conservation Plan Guidance* (USFWS 2013). Due to abutting Project boundaries, the Adair/Morning Light and Vienna I and Vienna II boundary acreages were combined for the purposes of calculating percent coverage and total survey hours.

The same data was collected at "reference" survey points located at each of the Project locations in similar habitats located from 2 to 5 km (1 to 3 mi) from the Project boundary. To the extent practicable, the number of reference survey points equaled the number of survey points within the Project footprint for each Project. In an attempt to control for landscape features and habitats, the reference points were located in similar habitats and distances from major features such as lakes or rivers as those survey points located within the Project footprint.

<u>Survey Schedule</u>

Surveys were conducted in Project areas for 15 months from December 2014 through February 2016. Because the intent of this survey was to assess the potential influence that turbines have on eagle activity, surveys were only completed in the reference areas from December 2014 through March 2015, and from October 2015 through February 2016 (i.e., the periods of the year when eagle activity in Iowa is expected to be the highest). Surveys were conducted once per month during the following seasons: winter 2014-2015 (winter 1; December 1, 2014 – March 31, 2015), spring (April 1 – May 31, 2015), summer (June 1 – August 31, 2015), fall (September 1 – November 14, 2015), and winter 2015-2016 (winter 2; November 15, 2015 – February 29, 2016). The survey duration for all survey points was 60 minutes per point count location per month. All points were typically not visited during the same survey event, but rather staggered over the course of the month. Half of the reference survey points for each Project were surveyed each month during the defined time period (i.e., even numbered reference survey points conducted one month followed by the odd numbered the next).

Plot surveys were conducted throughout daylight hours. During a set of surveys, each plot was visited once. A pre-established schedule was developed prior to the field surveys

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[1] For purposes of this study, the Project "footprint" was defined as the area within 1 km (0.6 mi) of turbine locations.

to ensure that each station was surveyed approximately the same number of times[2], to spread survey times throughout the day, and to minimize travel time between plots.

WEST has completed simulations of the USFWS eagle model's performance under various scenarios. WEST's analysis of the USFWS model has shown that at least 200 hours of survey effort are needed before the USFWS model's fatality predictions are driven by the number of eagle observations from the project versus the "prior" information included in the Bayesian model. There was a large bias in the results when fewer than 200 hours of effort were done with baseline eagle use of 0.01 flight minutes per observation hour or less. While it is counterintuitive to think that low observed use would warrant additional effort, the models in the USFWS eagle guidance documents (USFWS 2012, 2013) resulted in wide variance in the projected take estimate under such scenarios. WEST's survey effort at all the MidAmerican Projects typically exceeded the 200-hour threshold (Table 2). For four of the smallest Project sites (Charles City, Laurel, Macksburg, and Victory), the level of survey effort was somewhat lower at just under 150 hours per site (Table 2), a level of survey that may have resulted in somewhat more conservative fatality predictions than the other Project sites.

[2] Some surveys were missed due to poor visibility as a result of weather conditions or site access issues (e.g., impassable roads).

Table 2. Number of survey points and survey effort (hours) by season and facility for the 2014 – 2016 eagle use surveys at all 18 MidAmerican's Iowa wind energy facilities.

Facility	Study Area	Number of Points	Seasonal Hours of Effort: Winter 1	Spring	Summer	Fall	Winter 2	Total Survey Hours
Adair/Morning Light[2]	Project area	19	76	37.6	56.1	54	57	280.7
	Reference area	13	26	0	0	11	18	55
Carroll	Project area	12	48	24	36	30.6	31.7	170.3
	Reference area	10	20	0	0	10	15	45
Century	Project area	13	52	26	39	36	34	187
	Reference area	13	26	0	0	13	18	57
Charles City	Project area	10	40	20	30	24	23	137
	Reference area	10	20	0	0	10	19	49
Eclipse	Project area	13	50	26	51.6	25	33	185.6
	Reference area	10	20	0	0	9	16	45
Highland[1]	Project area	32	126	64	96	96	95	477
	Reference area	32	63	0	0	32	47	142
Intrepid	Project area	15	60	30	45	45	42	222
	Reference area	15	30	0	0	15	22	67
Laurel	Project area	10	39	20	30	27	30	146
	Reference area	10	20	0	0	10	15	45
Lundgren	Project area	18	72	36	54	54	47	263
	Reference area	18	36	0	0	18	27	81
Macksburg	Project area	10	40	20	40	20	27	147
	Reference area	10	20	0	0	10	15	45
Pomeroy	Project area	16	64	32	48	48	47.2	239.2
	Reference area	16	32	0	0	16	20.6	68.6
Rolling Hills	Project area	28	111.5	55.7	84	82	83	416.2
	Reference area	28	56	0	0	28	42	126
Victory	Project area	10	39	20	30	27.6	29	145.6
	Reference area	8	16	0	0	7	12	35
Vienna I/Vienna II[2]	Project area	12	46	24	35.4	36	36	177.4
	Reference area	12	24	0	0	12	18	54
Walnut	Project area	14	56	28	55.7	28	40	207.7
	Reference area	14	28	0	0	14	16	58
Wellsburg	Project area	14	56	28	42	42	38	206
	Reference area	14	28	0	0	14	21	63
Overall	Project areas	**246**	**975.5**	**491.3**	**772.8**	**675.2**	**692.9**	**3,607.7**
	Reference areas	**233**	**465**	**0**	**0**	**229**	**341.6**	**1,035.6**

[1] Construction at Highlands began in November 2013 and was completed in early December 2015

[2] Abutting Projects with acreage combined for purposes of calculating percent coverage and total survey hours

Survey Methods

Eagles were recorded during each survey over a 60-minute period at each survey point. Estimated distance to each bird observed was recorded to the nearest 5 m (16 ft). Landmarks were located to aid in estimating distances to each bird. The date, start and end time of observation period, plot number, species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed (in meters), closest distance (in meters), height above ground (in meters), activity, and habitat were also recorded.

Flight or movement paths for eagles were mapped and given corresponding unique observation numbers. The map indicates whether the bird was within or outside the survey plot based on reference points at known distances from the plot center. If time allowed and it did not distract from eagle observation work, the flight paths of other large birds were recorded, such as other raptors, cranes, and waterfowl.

Eagle behavior and habitat were recorded during each one-minute interval the bird was within view, per the *Eagle Conservation Plan Guidance* (USFWS 2013). Behavior categories for eagles included soaring flight; flapping-gliding; hunting; kiting-hovering; stooping/diving at prey; stooping or diving in an antagonistic context with other bird species; perched; being mobbed; undulating/territorial flight; auditory; and other, as noted in comments on the data sheet. The initial flight patterns and habitat types (at first observation) were uniquely identified on the data sheet and subsequent patterns and habitats were also recorded. The flight direction of observed birds was also recorded on the data sheet map. Approximate flight height at first observation was recorded to the nearest 5 m (16 ft); the approximate lowest and highest flight heights observed were also recorded. Any comments or unusual observations were noted in the comments section. Weather information recorded for each survey point included temperature, wind speed, wind direction, precipitation, and cloud cover.

Statistical Analysis

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. Potentially erroneous data was identified using a series of database queries. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage

A Microsoft® ACCESS database was developed to store, organize, and retrieve survey data. Data were keyed into the electronic database using a pre-defined protocol to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks (if provided), and electronic data files were retained for reference.

Data were checked thoroughly for data entry errors. Any errors were corrected by referencing the raw data forms and/or consulting with the observers that collected the data. Any irregular codes detected, or any data suspected as questionable, were discussed with the observer and study team leader. Any changes made to the raw data were documented for future reference.

Mean Use and Frequency of Occurrence

Exposure to facility infrastructure is affected by how much a species utilizes an area (mean use), as well as how often use occurs (frequency of occurrence). Frequency of occurrence and mean use provide relative measures of species exposure to the proposed facility. For the standardized fixed-point eagle mean use estimates, eagles detected within the 800-m radius plot at any time were included in the analysis. The metric used to measure mean eagle use was the number of eagles per 800-m plot per 60-minute survey. These standardized estimates of mean bird use were used to compare differences between seasons and survey points by Project. Mean use by season was calculated by first averaging the total number of eagles seen within each plot during a visit, then averaging across plots within each visit, followed by averaging across visits within the season. Overall mean use was calculated as a weighted average of seasonal values by the number of days in each season.

Frequency of occurrence was calculated as the percent of surveys during which eagles were observed. For example, eagles can be observed individually or in groups. If eagles are often observed in groups, the mean use may be relatively high; however, examining mean use alone would not account for the acute exposure to the facility associated with several observations of groups of eagles. A high mean use may indicate a higher exposure, but when the exposure is brief (i.e., low frequency of occurrence), eagles may be less likely to be adversely affected. Conversely, if eagles have a low mean use and high frequency of occurrence, they would have long-term exposure to the facility, increasing the likelihood that eagles may be affected by the facility. Exposure to facility infrastructure is more accurately assessed by evaluating both mean use and frequency of occurrence.

Spatial Use

WEST conducted a qualitative analysis of spatial use through recording flight paths and high use areas, such as near nests or foraging areas frequented by eagles. Flight path data from reference point surveys was compared to flight path from Project points to provide additional documentation of areas consistent flight paths or flight patterns (i.e., north/south, east/west orientation) in the surrounding Project areas.

Mean eagle use data gathered at the reference points was used to quantitatively compare data recorded at the survey points within Projects to assess if eagle use appears higher outside of the Project boundaries.

RESULTS

Bald Eagles

Eagle use surveys began December 2014 at each of the 18 facilities and continued through February 2016. Detailed survey effort (hours) are provided in Table 2. The total number of survey hours at points within each Project ranged from 137 hours at the Charles City Project to 477 hours at the Highland Project, while the number of survey hours at reference points varied from 35 hours at the Victory Project to 142 hours at the Highland Project. Across all Projects, approximately 3,608 survey hours were completed at Project points and 1,036 survey hours at reference points (Table 2).

During all eagle use surveys, a total of 1,049 bald eagle observations were recorded in 1,005 groups at Project points, and 547 bald eagle observations were recorded in 532 groups at reference points (Table 3). Bald eagle observations were recorded as individual birds at most Projects; however, several groups of more than one individual were observed at a few Projects, including the Rolling Hills and Macksburg Projects. A few groups of bald eagles were also observed at the Adair/Morning Light Projects, and one group of two bald eagles was observed at both the Lundgren and Wellsburg Projects. Among the Project points, which were surveyed the entire 15-month study period, approximately 93.1% of all bald eagle observations were seen during the winter months, with 50.9% observed in winter 1 and 42.2% in winter 2 (Table 3); the remaining 6.9% of eagle observations were made in spring (1.1%), summer (1.3%), and fall (4.5%). Of the 1,596 bald eagle observations recorded at Project and reference points combined, more than half (57.1%) were recorded at two facilities, the Macksburg and Rolling Hills Projects (21.9% and 35.2% of the total eagle observations, respectively). By contrast, each remaining facility accounted for less than 8.0% of bald eagle observations at Project and reference points combines (Table 3).

Table 3. Bald eagle observations (Obs) and groups (Grps) observed within the Project Area or Reference Area[1] by season for the 18 MidAmerican's Iowa wind energy facilities studied from December 2014 to February 2016.

Facility	Study Area	Winter 1		Spring		Summer		Fall		Winter 2		Total	
		# Grps	# Obs	# Grps	# Obs	# Grps	# Obs	# Grps	# Obs	# Grps	# Obs	# Grps	# Obs
Adair/Morning Light	Project area	37	42	3	3	0	0	1	1	1	1	42	47
	Reference area	16	17	--	--	--	--	1	1	9	9	26	27
Carroll	Project area	14	14	0	0	0	0	0	0	2	2	16	16
	Reference area	1	1	--	--	--	--	2	2	4	4	7	7
Century	Project area	2	2	1	1	0	0	1	1	3	3	7	7
	Reference area	7	7	--	--	--	--	3	3	0	0	10	10
Charles City	Project area	25	25	2	2	2	2	2	2	28	28	59	59
	Reference area	19	19	--	--	--	--	13	13	1	1	33	33
Eclipse	Project area	3	3	0	0	0	0	0	0	6	6	9	9
	Reference area	5	5	--	--	--	--	0	0	4	4	9	9
Highland	Project area	15	15	0	0	0	0	1	1	2	2	18	18
	Reference area	8	8	--	--	--	--	0	0	3	3	11	11
Intrepid	Project area	10	10	0	0	0	0	0	0	8	8	18	18
	Reference area	8	8	--	--	--	--	0	0	0	0	8	8
Laurel	Project area	29	29	1	1	0	0	1	1	16	16	47	47
	Reference area	9	9	--	--	--	--	1	1	16	16	26	26
Lundgren	Project area	15	15	0	0	0	0	0	0	14	15	29	30
	Reference area	11	11	--	--	--	--	0	0	1	1	12	12
Macksburg	Project area	110	129	0	0	2	2	13	13	90	90	215	234
	Reference area	39	47	--	--	--	--	10	10	59	59	108	116
Pomeroy	Project area	7	7	2	2	1	1	2	2	1	1	13	13
	Reference area	2	2	--	--	--	--	2	2	4	4	8	8
Rolling Hills	Project area	146	164	2	2	1	1	22	22	184	184	355	373
	Reference area	99	104	--	--	--	--	12	12	72	72	183	188
Victory	Project area	2	2	0	0	0	0	0	0	7	7	9	9
	Reference area	2	2	--	--	--	--	0	0	0	0	2	2
Vienna I/Vienna II	Project area	24	24	0	0	5	5	2	2	47	47	78	78
	Reference area	22	23	--	--	--	--	3	3	9	9	34	35
Walnut	Project area	15	15	0	0	0	0	0	0	0	0	15	15
	Reference area	6	6	--	--	--	--	1	1	6	6	13	13
Wellsburg	Project area	37	38	0	0	3	3	2	2	33	33	75	76
	Reference area	14	14	--	--	--	--	4	4	24	24	42	42
All facilities	**Project areas**	**491**	**534**	**11**	**11**	**14**	**14**	**47**	**47**	**442**	**443**	**1,005**	**1,049**
	Reference areas	**268**	**283**	**--**	**--**	**--**	**--**	**52**	**52**	**212**	**212**	**532**	**547**

[1] Reference area points were not surveyed during spring or summer, which is represented by dash lines in the table.

Mean Use and Frequency of Occurrence

Bald eagle mean use and percent frequency were calculated for each of the 18 Project areas (Table 4). Mean use and percent frequency within the 800-m plot were greatest during the two winter seasons, with bald eagle use recorded at all but two of the Project areas (Century and Pomeroy) during winter 1, and all but four of the Project areas (Century, Intrepid, Pomeroy, and Walnut) during winter 2. The highest observed mean use during the study period was at the Macksburg Project area during winter 2 (0.93 bald eagles/800-m plot/60-minute survey) and winter 1 (0.88), with bald eagles observed during 46.2% and 42.5% of surveys, respectively (Table 4). Mean use was lowest in summer and spring seasons, with bald eagle use recorded at only three Project areas during summer (Rolling Hills, Vienna I/Vienna II, and Wellsburg) and four Project areas during spring (Adair/Morning Light, Charles City, Laurel, and Rolling Hills). Mean use during fall was generally low, with the highest bald eagle use observed at the Macksburg Project (0.15 bald eagles/800-m plot/60-minute survey), and bald eagles were observed during about 15.0% of surveys. Rolling Hills was the only Project area with bald eagle mean use recorded during all five surveyed seasons (Table 4).

Temporal Patterns

Mean use data collected during the 2014-2016 study suggest variation in seasonal bald eagles use among Project areas; however, bald eagle mean use was significantly higher in winter across the Project areas (Table 4). When mean bald eagle use for all of Projects' survey points were combined, bald eagle mean use was highest in the winter months: December, January, February, and March (Figure 2).

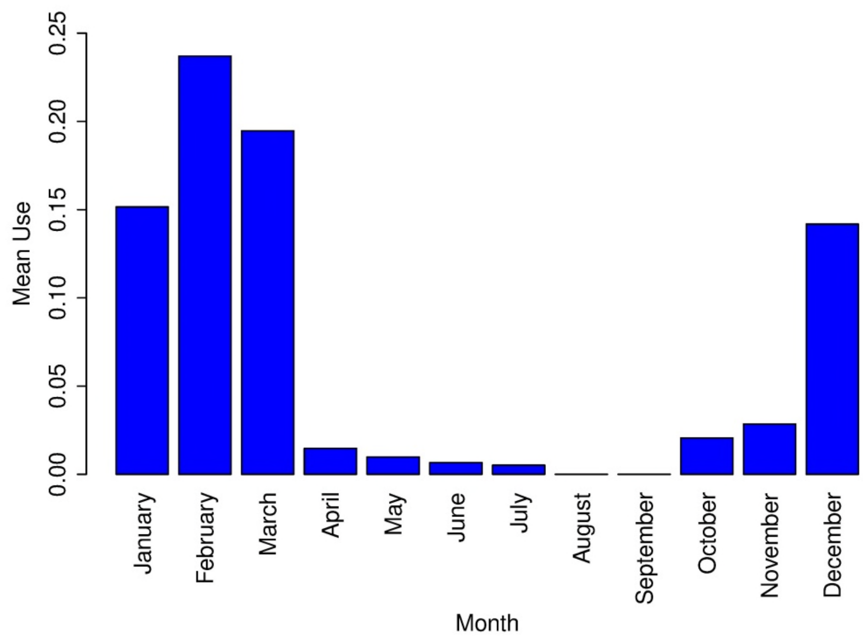


Figure 2. Mean bald eagle use for all survey points combined by month within the Project Area for the 18 MidAmerican Iowa wind energy projects studied from December 2014 to February 2016.

Winter bald eagle use was highest at the Macksburg and Rolling Hills Projects (Table 4). Winter bald eagle use at the Macksburg Project was 0.88 eagles/800-m plot/60-minute survey in the winter 1, and 0.93 in the winter2 (Table 4). At Rolling Hills, mean use suggests this facility is primarily used by wintering bald eagles; however, bald eagle use was recorded in all seasons. Mean bald eagle use at Rolling Hills in winter 1 was 0.32 bald eagles/800-m plot/60-minute survey and was 0.53 in winter 2, with bald eagles observed during 22.3% and 37.6% of surveys, respectively (Table 4). Bald eagle use observed at the Rolling Hills Project was much lower in the other seasons, ranging from 0.01 bald eagles/800-m plot/60-minute survey in summer to 0.07 in fall. Winter 1 bald eagle use was relatively high at the Wellsburg Project as well (0.41 bald eagles/800-m plot/60-minute survey), and lower in winter 2 (0.28), with bald eagles observed during 17.9% and 13.8% of the winter surveys, respectively. Conversely, winter 1 bald eagle use at the Charles City Project was relatively low (0.12 bald eagles/800-m plot/60-minute survey) but higher in winter 2 (0.48), with bald eagle observed during 10.0% and 20.8% of winter surveys, respectively (Table 4). Seasonal use did not exceed 0.25 eagles/800-m plot/60-minute survey at any of the other facilities (Table 4).

Bald eagle use was observed only in fall at the Century Project (0.03 bald eagles/800-m plot/60-minute survey) and the Pomeroy Project (0.02; Table 4).

Table 4. Bald eagle mean use[1] and percent frequency for eagle use surveys conducted at the project areas by season at the 18 MidAmerican's Iowa wind energy facilities from December 2014 to February 2016

Facility	Mean Use					Percent Frequency				
	Winter 1	Spring	Summer	Fall	Winter 2	Winter 1	Spring	Summer	Fall	Winter 2
Adair/Morning Light	0.09	0.08	0	0	0.02	5.3	5.3	0	0	1.8
Carroll	0.21	0	0	0	0.06	14.6	0	0	0	5.6
Century	0	0	0	0.03	0	0	0	0	2.6	0
Charles City	0.12	0.05	0	0	0.48	10.0	5.0	0	0	20.8
Eclipse	0.06	0	0	0	0.11	4.2	0	0	0	8.3
Highland	0.06	0	0	0.01	0.01	5.5	0	0	1.0	1.0
Intrepid	0.02	0	0	0	0	1.7	0	0	0	0
Laurel	0.15	0.05	0	0.03	0.17	12.8	5	0	3.3	6.7
Lundgren	0.10	0	0	0	0.03	8.3	0	0	0	2.8
Macksburg	0.88	0	0	0.15	0.93	42.5	0	0	15.0	46.2
Pomeroy	0	0	0	0.02	0	0	0	0	2.1	0
Rolling Hills	0.32	0.02	0.01	0.07	0.53	22.3	1.8	1.2	6.0	37.6
Victory	0.02	0	0	0	0.17	2.5	0	0	0	3.3
Vienna I/Vienna II	0.13	0	0.03	0	0.31	10.8	0	2.8	0	19.4
Walnut	0.14	0	0	0	0	12.5	0	0	0	0
Wellsburg	0.41	0	0.02	0	0.28	17.9	0	2.4	0	13.8

[1] Number of bald eagle observations/800-m plot/60-minute survey.

Mean Use Where Bald Eagle Nests Present

During aerial raptor nest surveys conducted March 27 – April 10, 2015, two occupied bald eagle nests were found. One nest was within a 3.2-km (2-mi) buffer of the Charles City Project area and the other within a 3.2-km (2-mi) buffer of the Lundgren Project area. There was no apparent relationship between the occupied bald eagle nests within the 3.2-km (2-mi) buffer of the Projects and spring or summer mean use. There was no summer bald eagle mean use documented at either Project, and spring use was documented only at the Charles City Project (0.05 bald eagles/800-m plot/60-minute survey), which was comparable to the other three Projects with spring bald eagle use (Table 4). Bald eagle use was recorded at only three Projects during the summer season: Rolling Hills, Vienna I and II, and Wellsburg. No bald eagle nests were found within 3.2 km (2 mi) of these Projects (Table 4).

Comparison of Bald Eagle Use between Project and Reference Points

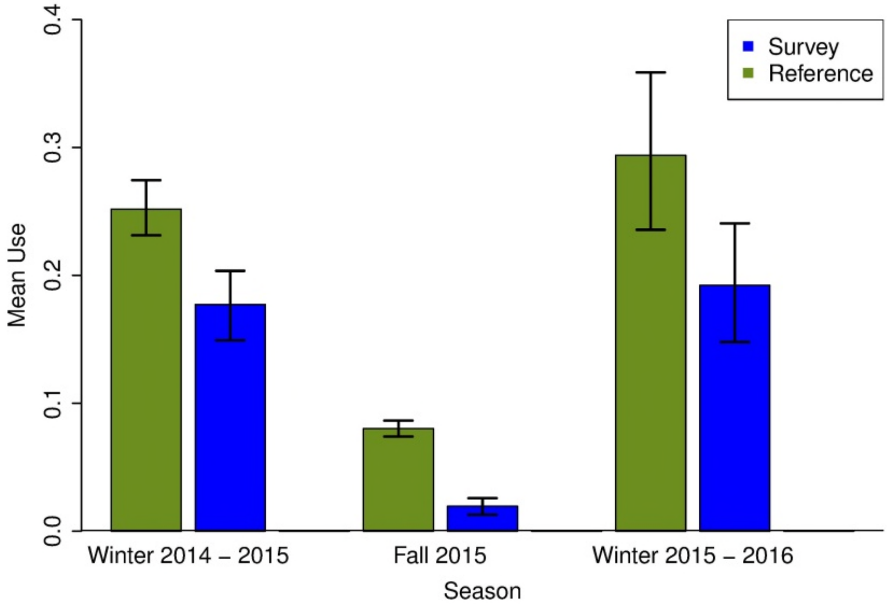
Data from all facilities were combined to compare the difference between mean bald eagle use at reference points and survey points, seasonally and for all data combined (Figure 3). The difference between mean bald eagle use at reference and Project survey points was compared in fall, winter 1, and winter 2[3]. Bald eagle use was significantly higher at reference points during fall and winter 1 and winter 2 (Figure 3). Similarly, when all data were combined, regardless of season, reference points had significantly higher use compared to survey points (Figure 3).

The trend of significantly higher eagle use at the reference sites was not observed at each Project. When comparing eagle use data by point at Project and reference points when both efforts were conducted concurrently, Rolling Hills represents the typical pattern of higher eagle use at reference sites. The majority of Project points at Rolling Hills ranged between 0.01 to 0.4 eagles/800-m plot/60-minute survey compared to reference points, which ranged from 0.41 to 0.8 eagles/800-m plot/60-minute survey (Appendix B). Eagle use as Macksburg was comparable both in the Project and in the reference area, with both ranging from 0.01 to 2.4 eagles/800-m plot/60-minute survey where data were recorded. But eagle use was higher in the Victory Project area with eagle use documented at two points, with the highest ranging from 0.21 to 0.5 eagles/800-m plot/60-minute survey compared to one point in the reference area with eagle use less than 0.2 eagles/800-m plot/60-minute survey (Appendix B).

[3] Data was collected at reference sites to test the hypothesis that the presence of turbines influences eagle use. When looking for differences in eagle use, it strengthens the statistical analysis if data is collected during periods where there is potential for differential use. As such, surveys were only completed in the reference areas during the fall and winter months – the periods of the year where eagle numbers throughout Iowa are highest (i.e., there would unlikely be any difference in use during the late spring or summer months when eagle use is expected to be extremely low both in and outside of the Projects).

Spatial Use

Appendix C presents mapped eagle flight paths recorded at Project and reference points for all Projects. At most of the Projects, no consistent flight patterns were observed based on location of flight paths within Project or reference area or prevailing flight orientation (i.e., north/south, east/west). Overall, eagle flight paths were highest at the Macksburg and Rolling Hills Projects compared to the other facilities, but flight paths at these Projects were more or less evenly distributed throughout the Project and reference areas, with the exception that there were fewer flights at the eastern/southeastern Macksburg Project reference points compared to the remaining reference points (Appendix C). Considering locations of flight paths within the Project and reference areas, there did appear to be some portions or points with minor concentration of flight paths at a few of the Projects, including: the west-central edge of the Charles City Project area; the north-central portion of the Laurel Project area; the Laurel Project reference point R4; the Victory Project point S7 and reference point R3; the Vienna I and Vienna II Projects points S4, S8, and S2; the Walnut Project reference point R3; and the Wellsburg Project points S7 and S1 (Appendix C).



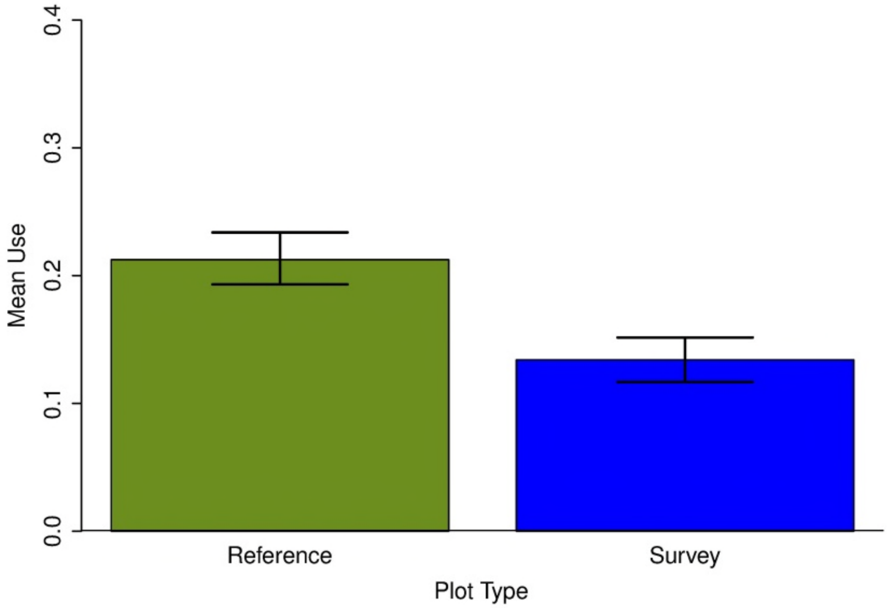


Figure 3. Comparison of mean bald eagle use for reference and survey points during eagle use surveys by season (above), and for all surveys during fall and winter (below) at the 18 Midamerican's Iowa wind energy facilities.

Monthly Mean Eagle Use

The majority of Projects had the highest mean eagle use, on a monthly basis, in December, January, February, and March (Appendix D). Macksburg mean eagle use was highest in March, and highest in February at Rolling Hills. However, several Projects had higher mean eagle use outside of these months (i.e., winter season) including: Adair/Morning Light (highest mean eagle use in May), Pomeroy (mean eagle use only documented in October), and Century (mean eagle use only documented in November; Appendix D).

Golden Eagles

Nine golden eagles were observed during the 2014 – 2016 study period at two of the 18 Projects, Rolling Hills (seven observations) and Macksburg (two observations). At the Macksburg Project, one golden eagle was observed at a Project point and one golden eagle was observed at a reference point during the winter 1 season (Appendix C). At the Rolling Hills Project, one golden eagle was observed at a Project point during fall and four observations were recorded during winter 1. Two golden eagle observations were recorded at reference points during winter 1 at the Rolling Hills Project (Appendix C).

There were no concentrations of golden eagles within either the Macksburg or Rolling Hills Projects, and the greatest number of golden eagle observations recorded at a given survey point at the same time was two observations.

DISCUSSION

Data collected during eagle use surveys at the 18 MidAmerican's wind energy facilities indicate that the level of use varies between Projects. However, the majority of bald eagle use at the Projects occurred in winter, suggesting that bald eagle presence across Iowa is much higher in winter relative to other seasons. Winter habitat suitability for bald eagles is often defined by food availability, presence of roost sites that provide protection from inclement weather, and minimal disturbance from humans (Buehler 2000).

Winter and fall use at the Macksburg and Rolling Hills Projects was consistently higher than at other Projects and likely driven by the availability of suitable winter habitat (e.g., deciduous and coniferous woodlots) scattered throughout both Project areas. While wooded areas are scattered throughout other facilities, they are typically associated with farmsteads where human activity consistently occurs. At the Macksburg and Rolling Hills Projects, there are abundant woodlots to provide cover during winter, many of which are not associated with homesteads. Additionally, food sources at these Projects are plentiful; the abundance of carrion at the sites, often in the form of road-killed deer (*Odocelius virginianus*; see Buehler 2000), provides suitable forage. Waste grain left in fields in and around the Projects provides forage for small mammals, which in turn may also provide food for bald eagles (Buehler 2000). Lastly, the Macksburg Project is also situated between two tributaries to the Des Moines River system, where bald eagles may forage for fish. The combination of lower human disturbance, suitable roosting habitat, and available food sources likely contribute to higher bald eagle use at the Macksburg and Rolling Hills facilities.

Bald Eagle Displacement from Wind Facilities

Another pattern clearly observed in the data is higher use in reference areas relative to within the Projects, which suggest possible avoidance and/or displacement at the Projects. While literature specific to bald eagle avoidance of wind turbines is sparse, some research suggests that avoidance may occur. The few available studies of bald eagle use, flight paths, and nesting before and after construction of wind facilities suggest that bald eagles avoid wind facilities. At the Forward Wind Energy Center, pre-construction bald eagle use observed during point counts was 0.004 bald eagles/800-meter plot/20-minute survey; bald eagle use declined in the first year after construction (0.001 bald eagles/800-meter plot/20-minute survey), and no bald eagles were observed during point counts two years following construction (Garvin and Drake 2011). At Pillar Mountain, Alaska, bald eagle use was statistically similar between pre- and post-construction surveys; however, bald eagles flights did not occur over the ridge where three wind turbines were constructed, despite flights over the ridge being commonly recorded before construction of the turbines (Sharp et al. 2010). At Pillar Mountain, bald eagles crossed the ridge two years following construction, but only flew between turbines when they were off (Sharp et al. 2012).

There is also some evidence at utility scale wind farms in Scotland that there are similar patterns of potential displacement of golden eagles (Fielding & Haworth 2010). For example, based on several years of pre- and post-construction avian monitoring at the Ben Aketil and Edinbane wind farms, a relatively small number of golden eagle foraging flights were observed within the wind farm’s footprints after these facilities went into operation. Similarly, fewer golden eagle flights were reported over or through the Beinn an Tuirc wind farm after it became operational, and no foraging flights were recorded within the wind farm’s footprint. The results of these observations are difficult to interpret and/or directly attribute to displacement given the confounding effects of disturbances associated with simultaneous construction activities and/or on-site habitat management. Nevertheless, this report suggests golden eagle use of wind farms after they begin operations is reduced compared to use prior to wind farm construction.

The studies at the MidAmerican Projects suggest that eagles will not completely avoid wind farms. However, bald eagle use is about 30 to 40% lower within operating wind farms compared to use in reference areas outside of the wind farms. Whether or not bald eagles will acclimate to wind farms over longer periods of operational time and to what degree turbine density might impact eagle use remains unclear.

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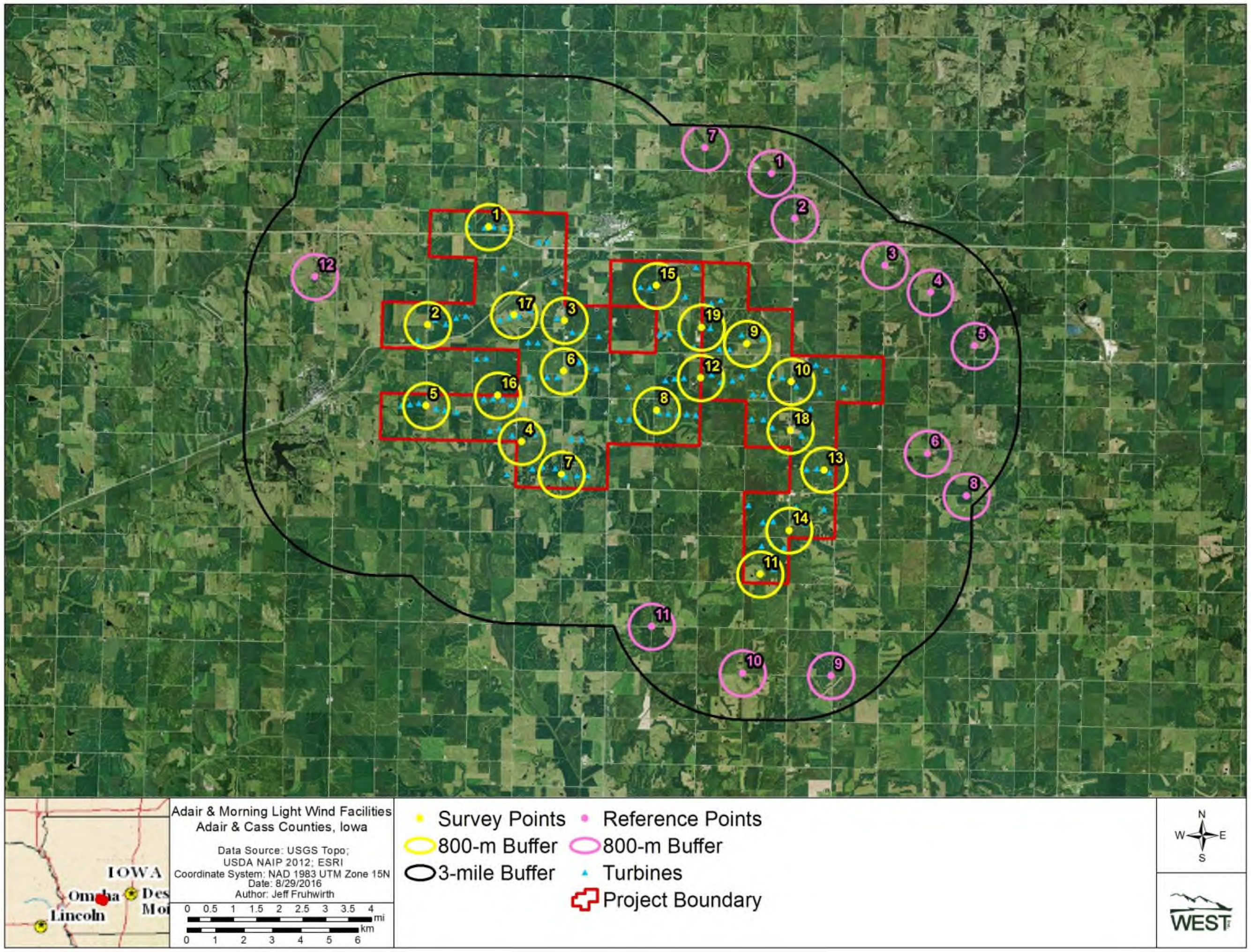
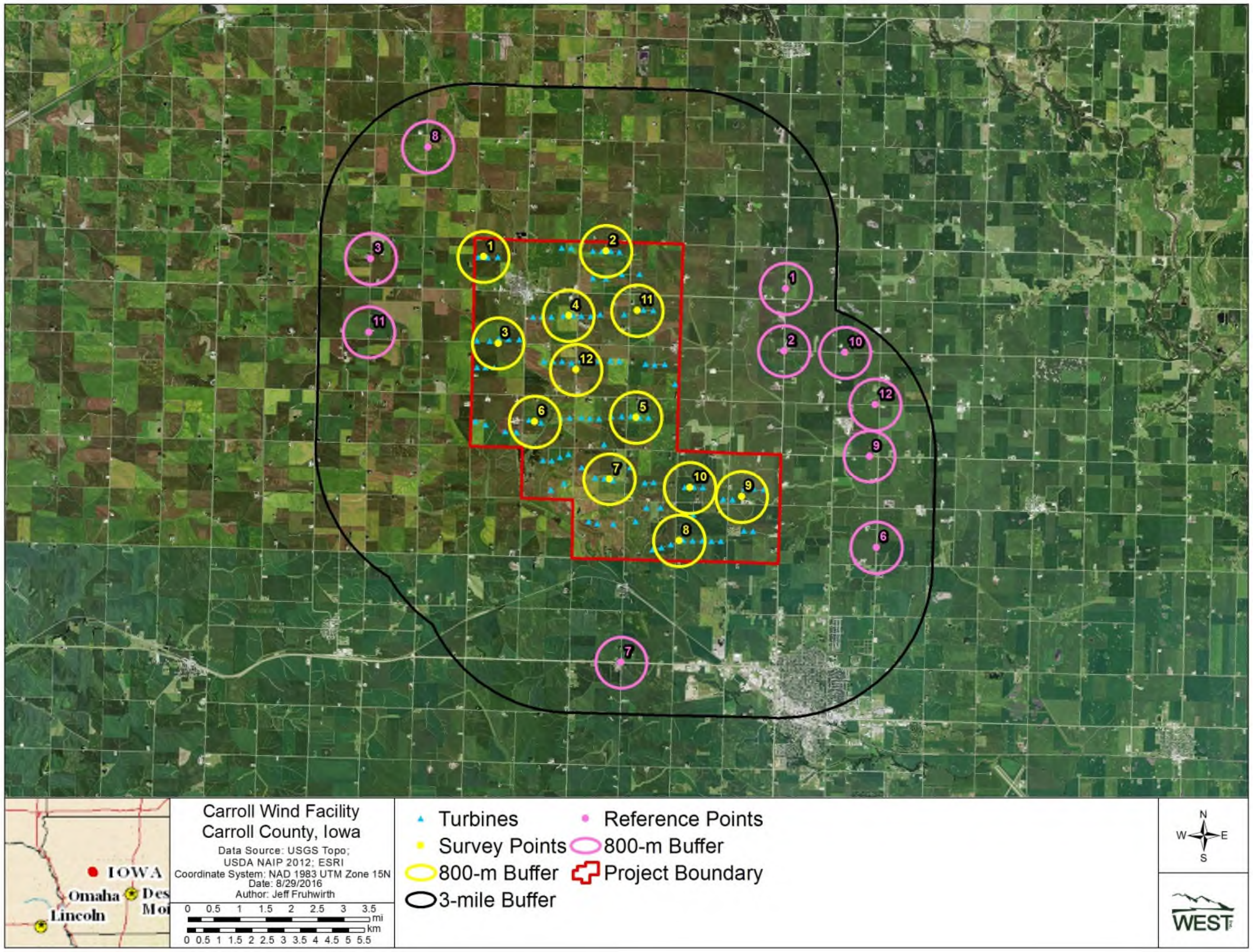
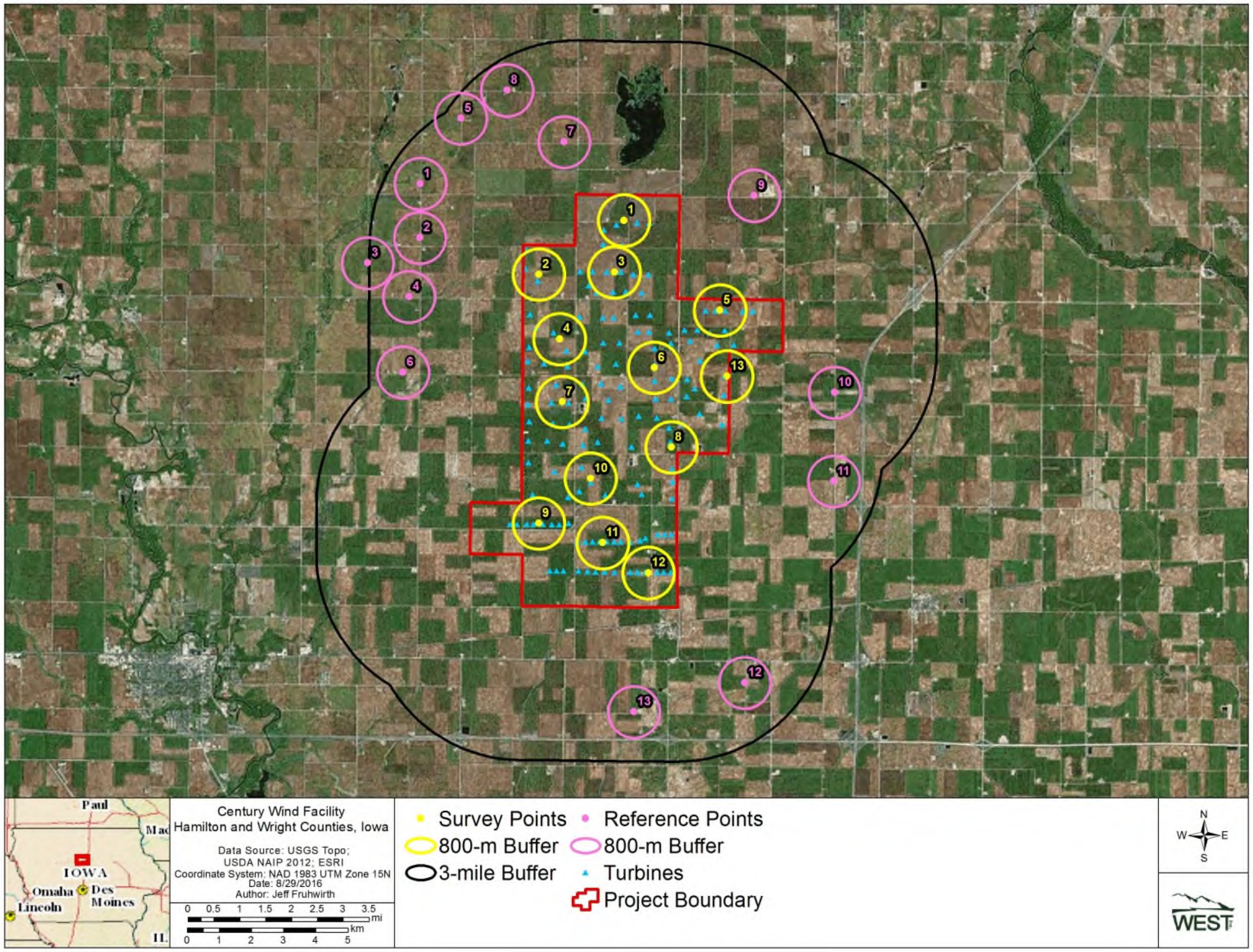
Appendix A: Point Location of Project and Reference Points for Eagle Use Surveys at the 18 MidAmerican Wind Energy Facilities Studied from December 2014 to February 2016.



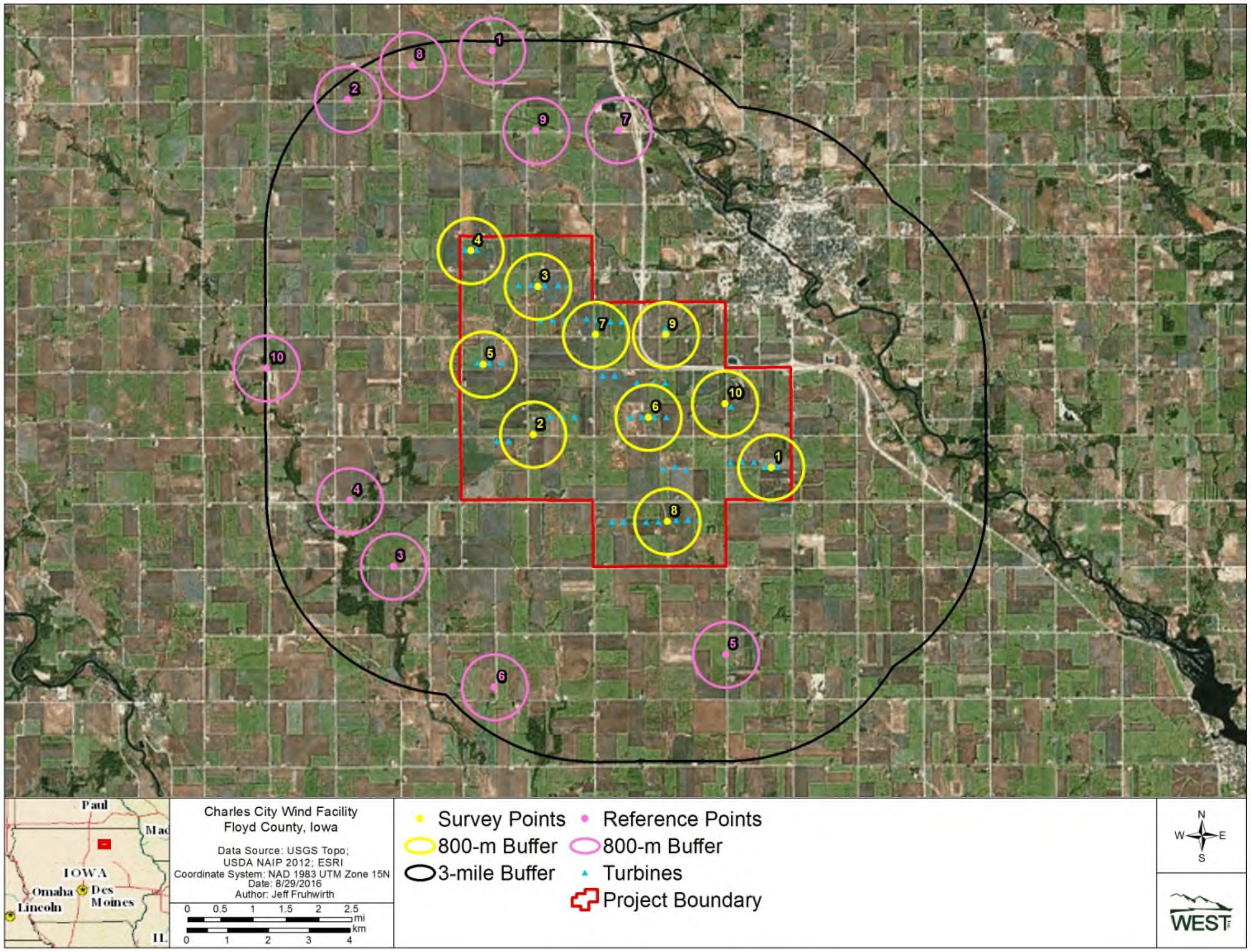
Appendix A1. Project and reference points locations for the eagle use surveys conducted at the Adair and Morning Light wind energy facilities, Adair and Cass counties, Iowa, from December 2014 to February 2016.



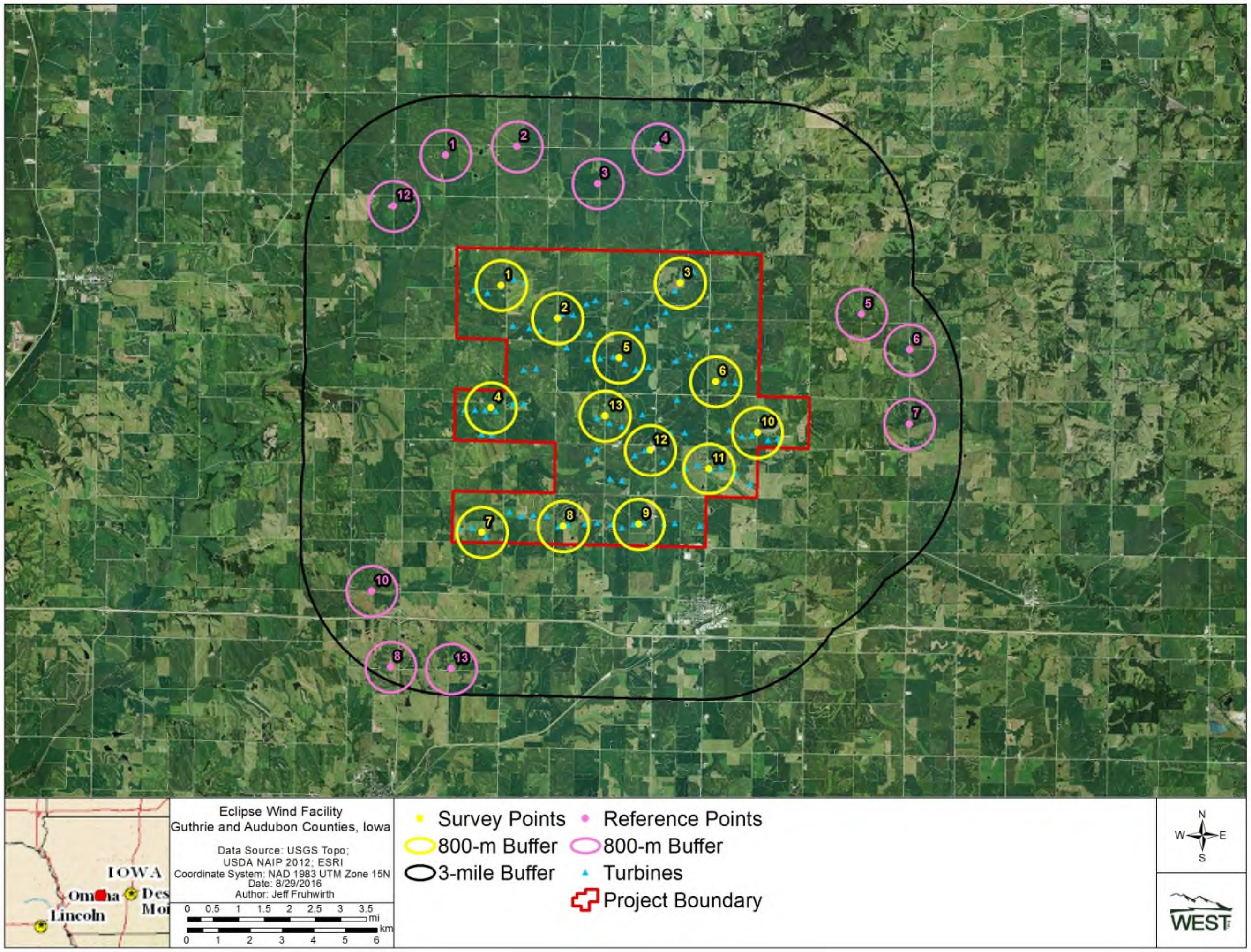
Appendix A2. Project and reference points locations for the eagle use surveys conducted at the Carroll wind energy facility, Carroll county, Iowa, from December 2014 to February 2016.



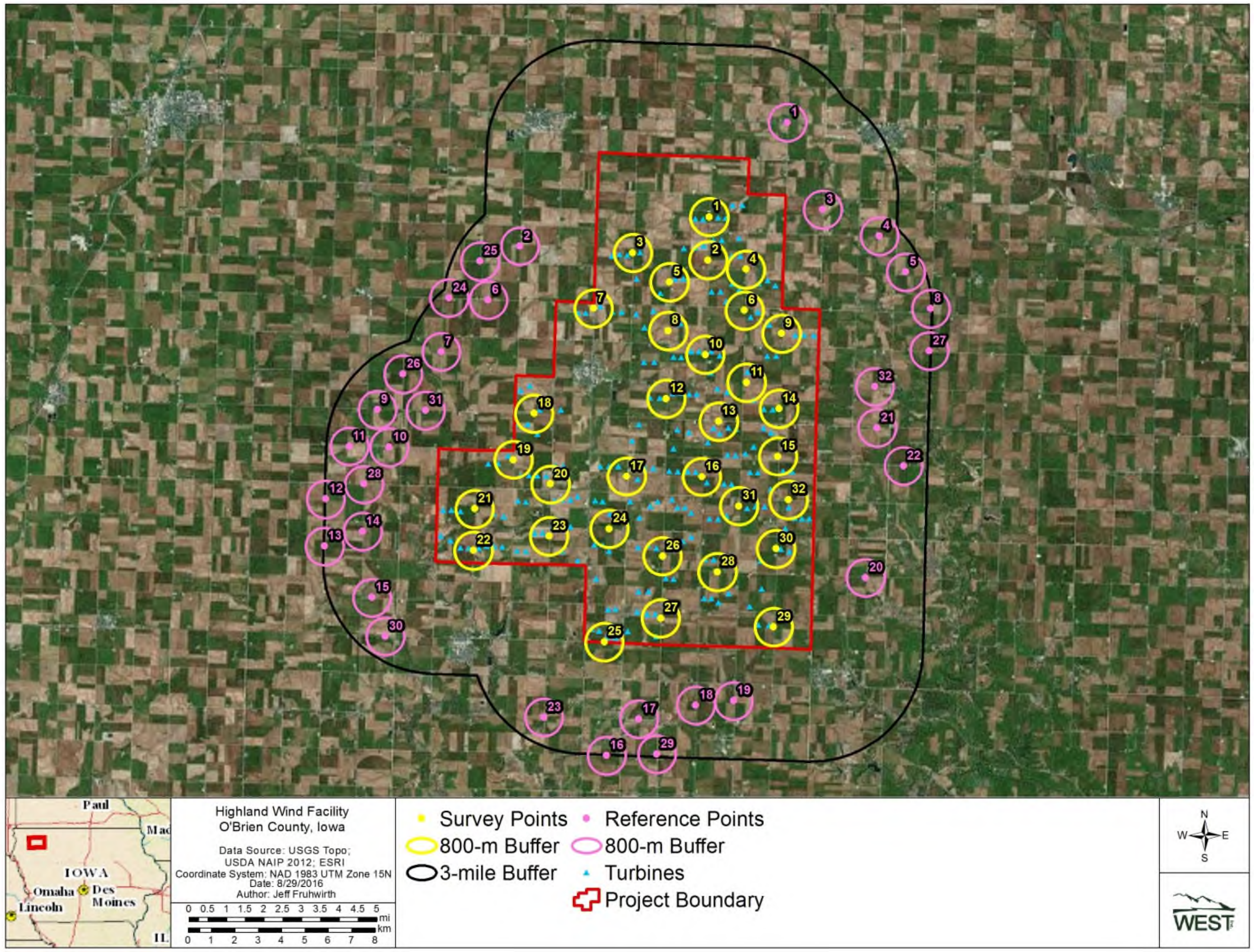
Appendix A3. Project and reference points locations for the eagle use surveys conducted at the Century wind energy facility, Hamilton and Wright counties, Iowa, from December 2014 to February 2016.



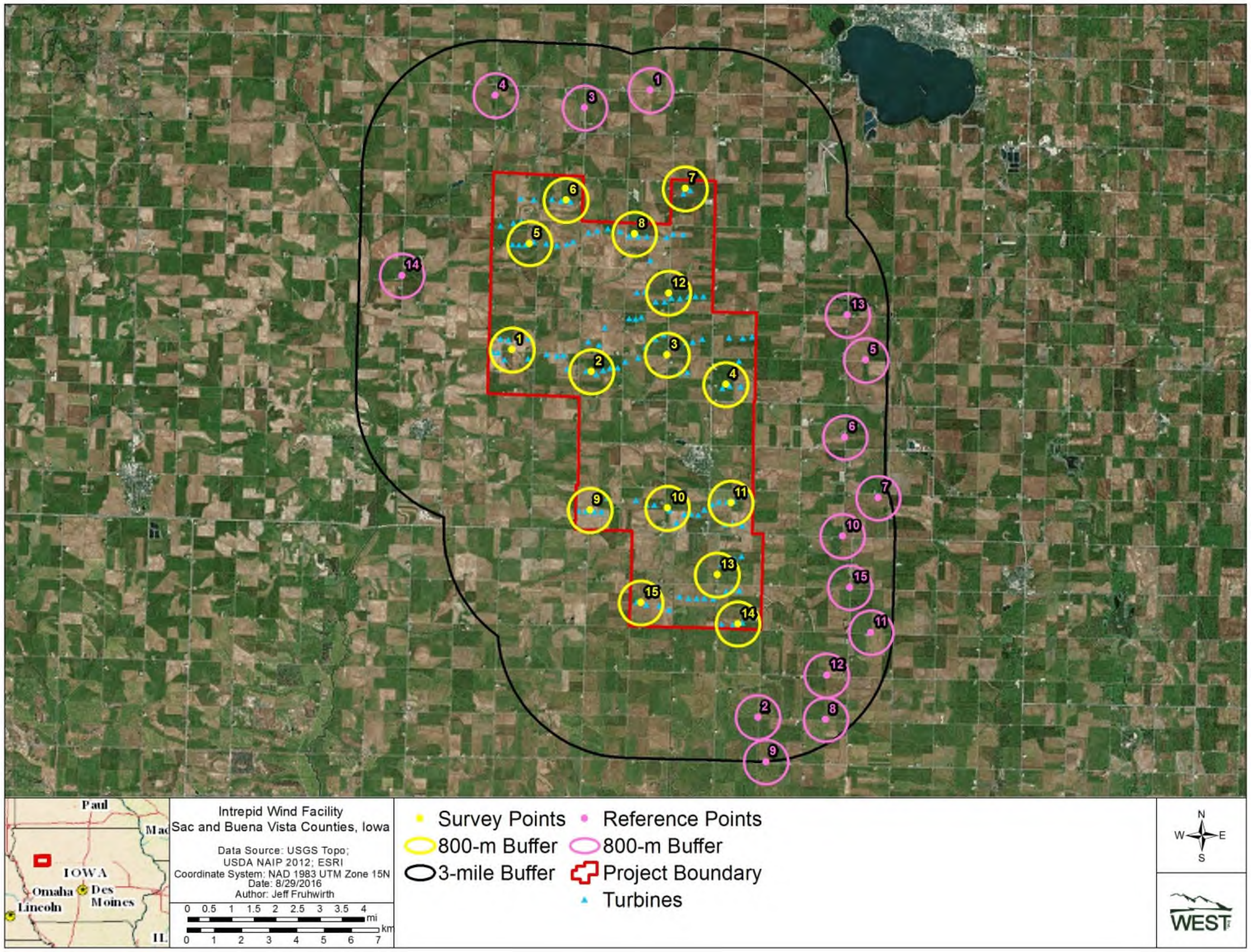
Appendix A4. Project and reference points locations for the eagle use surveys conducted at the Charles City wind energy facility, Floyd County, Iowa, from December 2014 to February 2016.



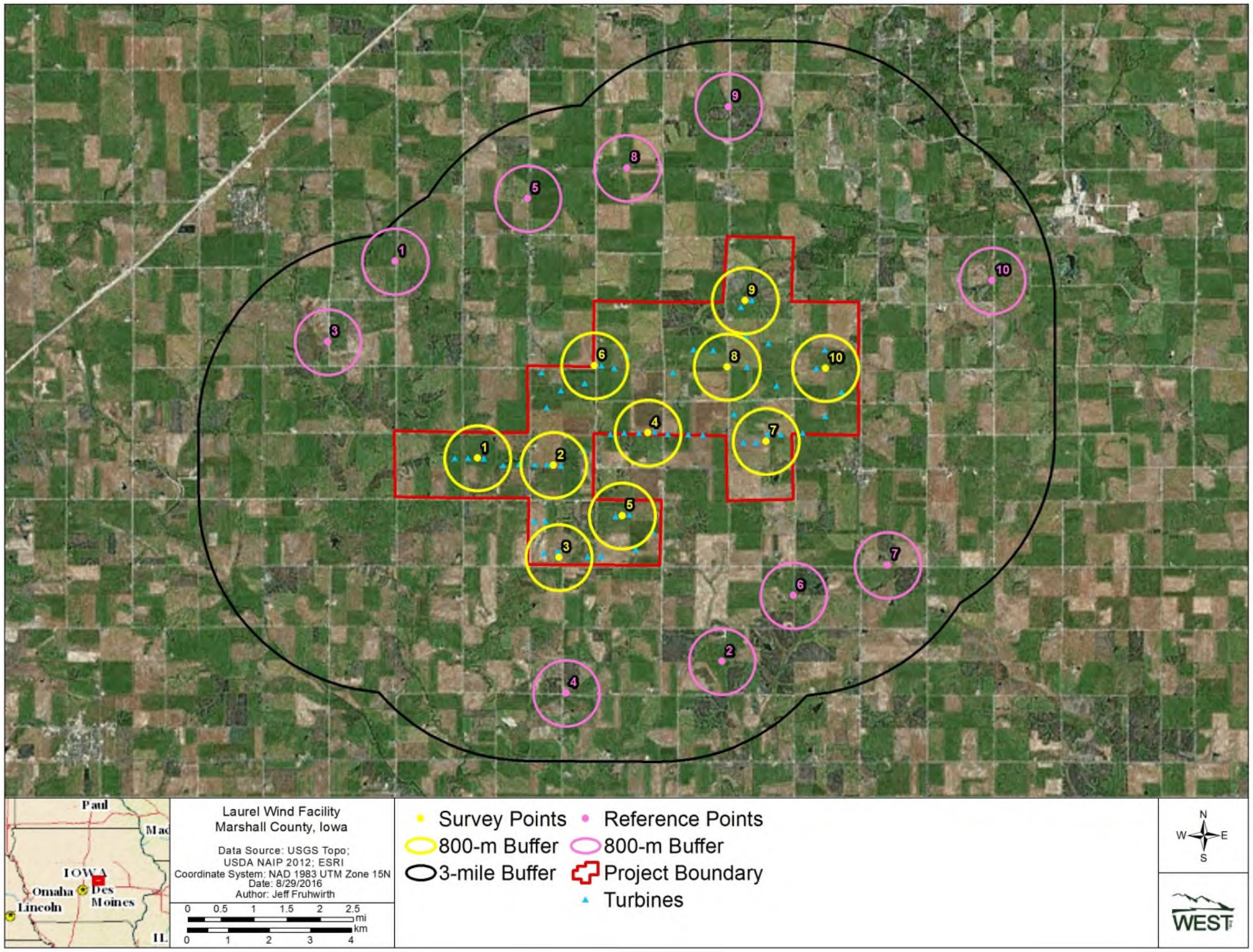
Appendix A5. Project and reference points locations for the eagle use surveys conducted at the Eclipse wind energy facility, Audubon and Guthrie counties, Iowa, from December 2014 to February 2016.



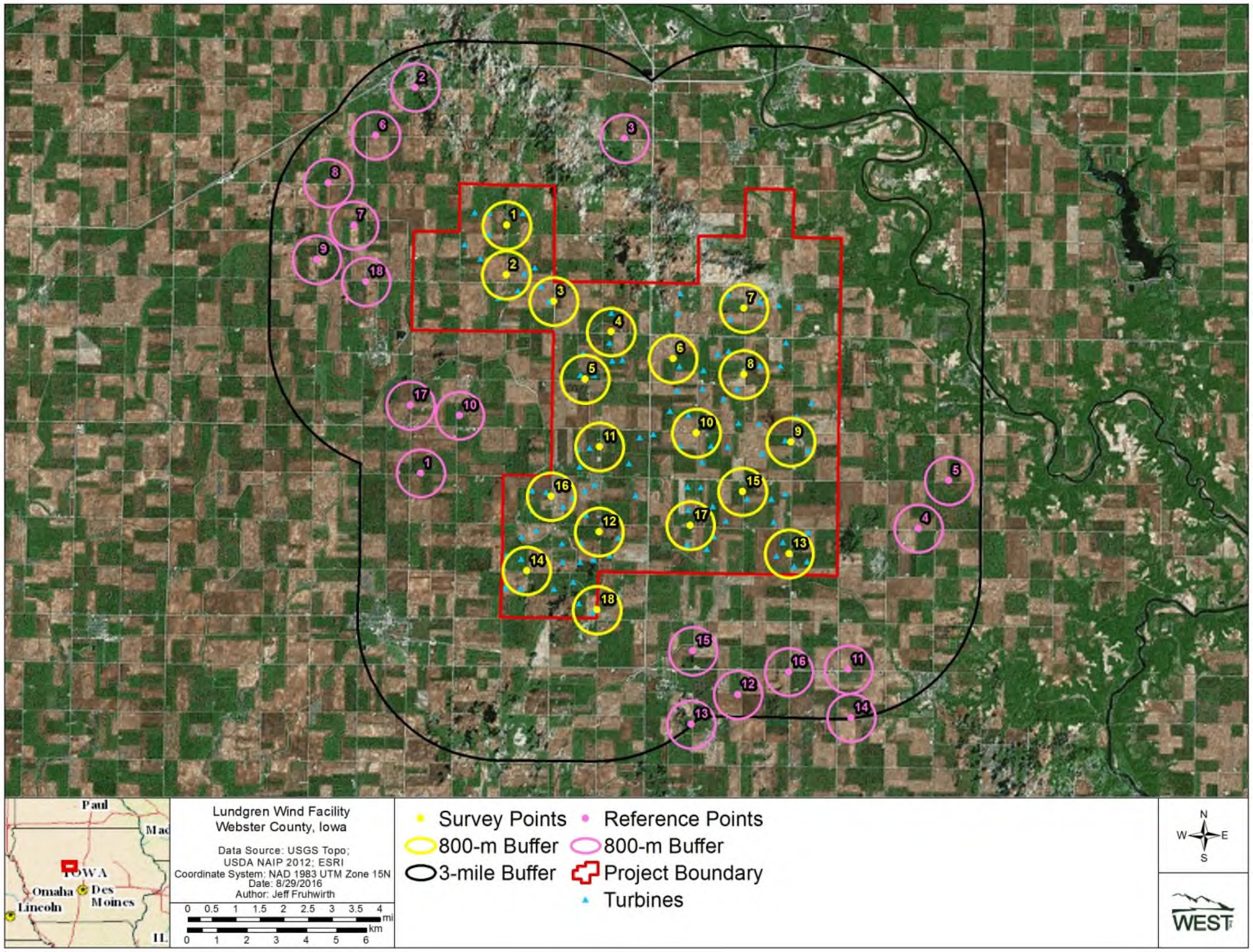
Appendix A6. Project and reference points locations for the eagle use surveys conducted at the Highland wind energy facility, O'Brien County, Iowa, from December 2014 to February 2016.



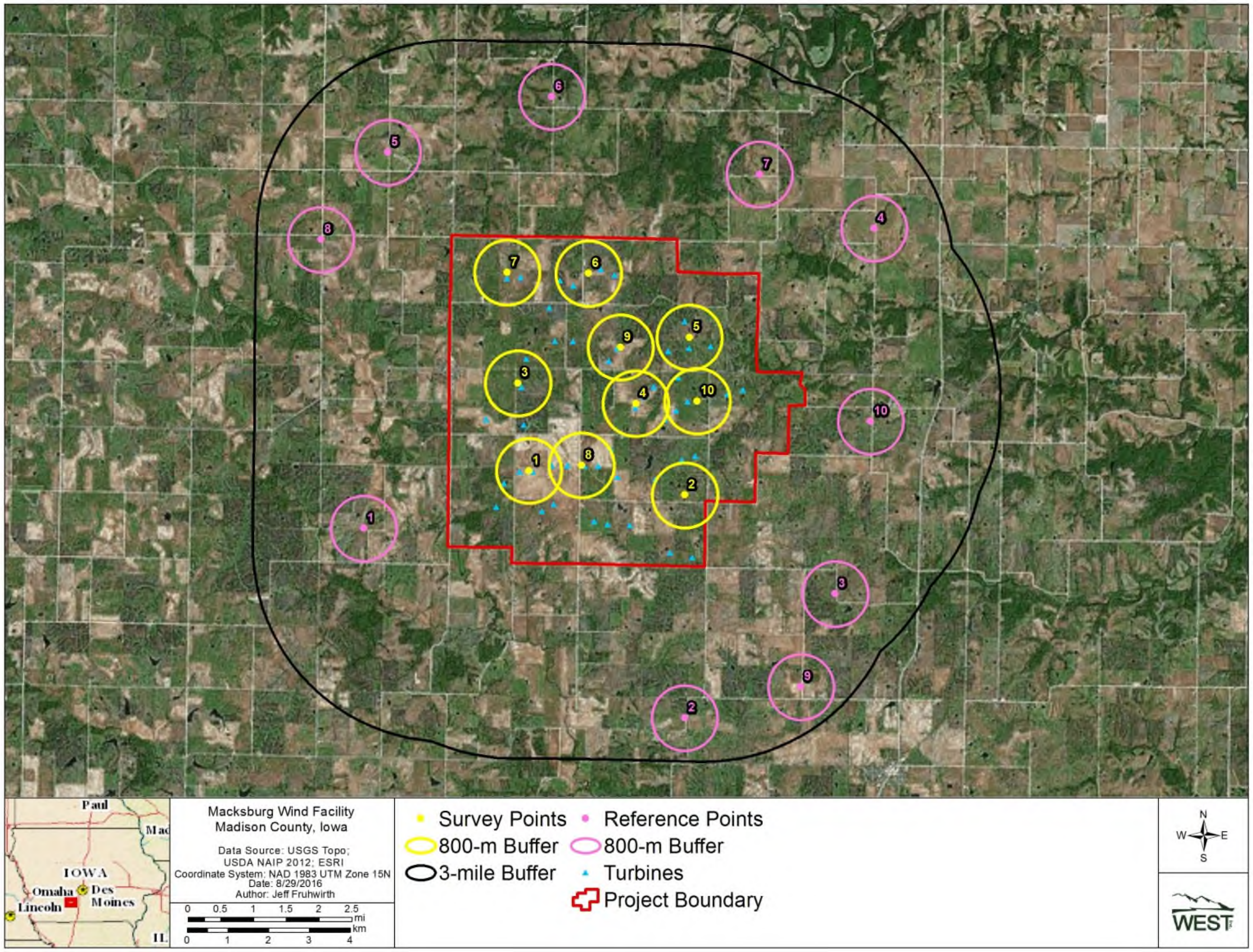
Appendix A7. Project and reference points locations for the eagle use surveys conducted at the Intrepid wind energy facility, Sac and Buena Vista counties, Iowa, from December 2014 to February 2016.



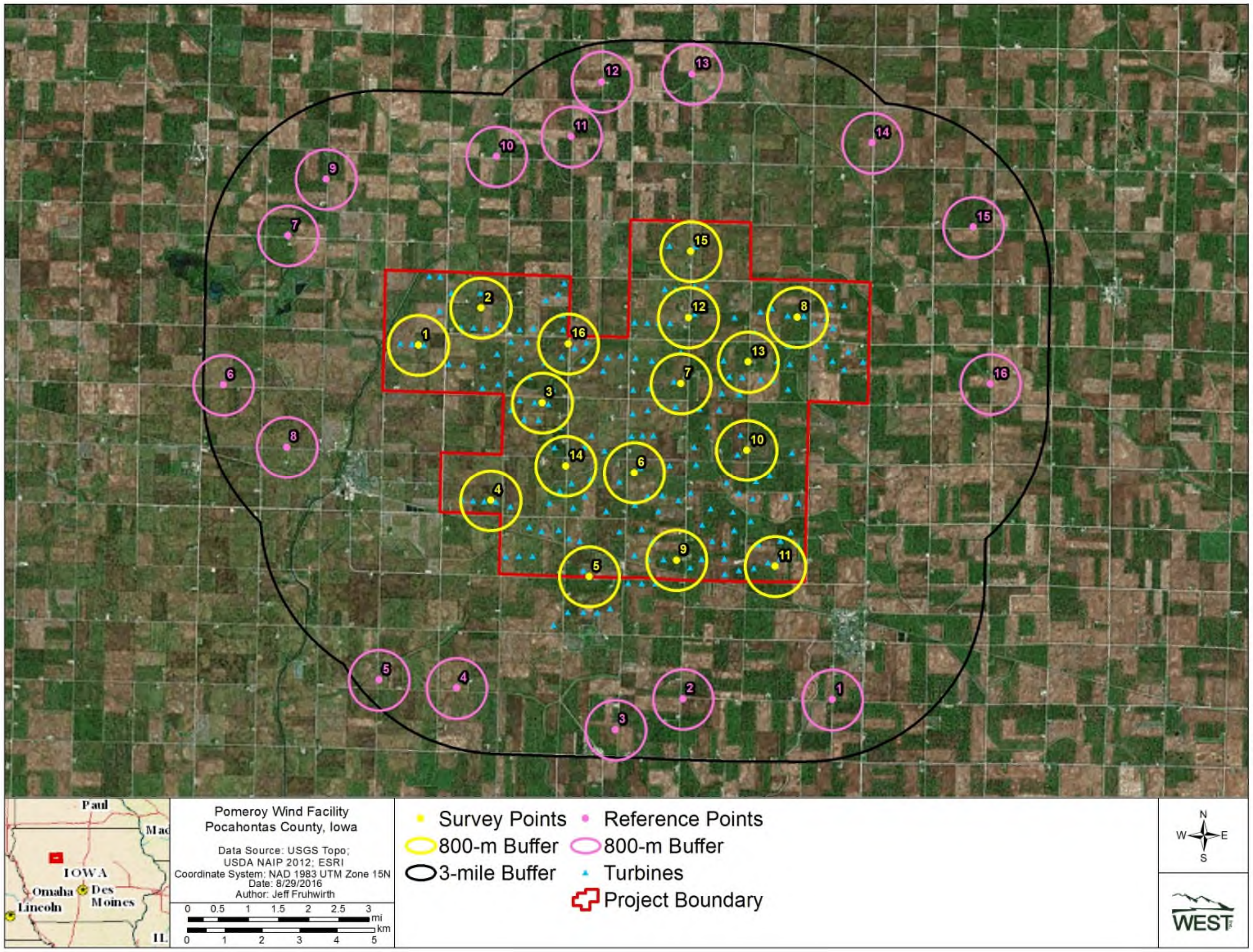
Appendix A8. Project and reference points locations for the eagle use surveys conducted at the Laurel wind energy facility, Marshall County, Iowa, from December 2014 to February 2016.



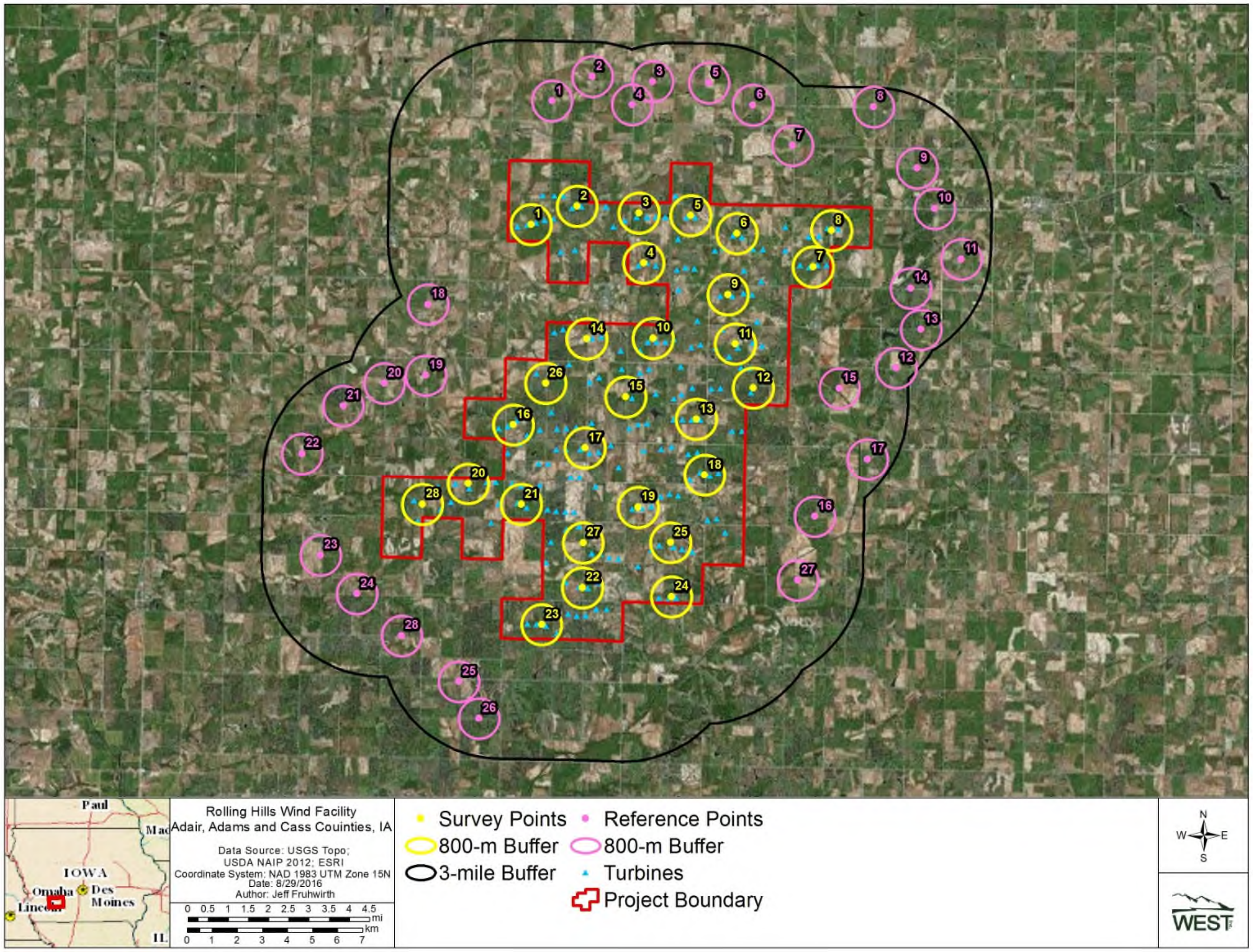
Appendix A9. Project and reference points locations for the eagle use surveys conducted at the Lundgren wind energy facility, Webster County, Iowa, from December 2014 to February 2016.



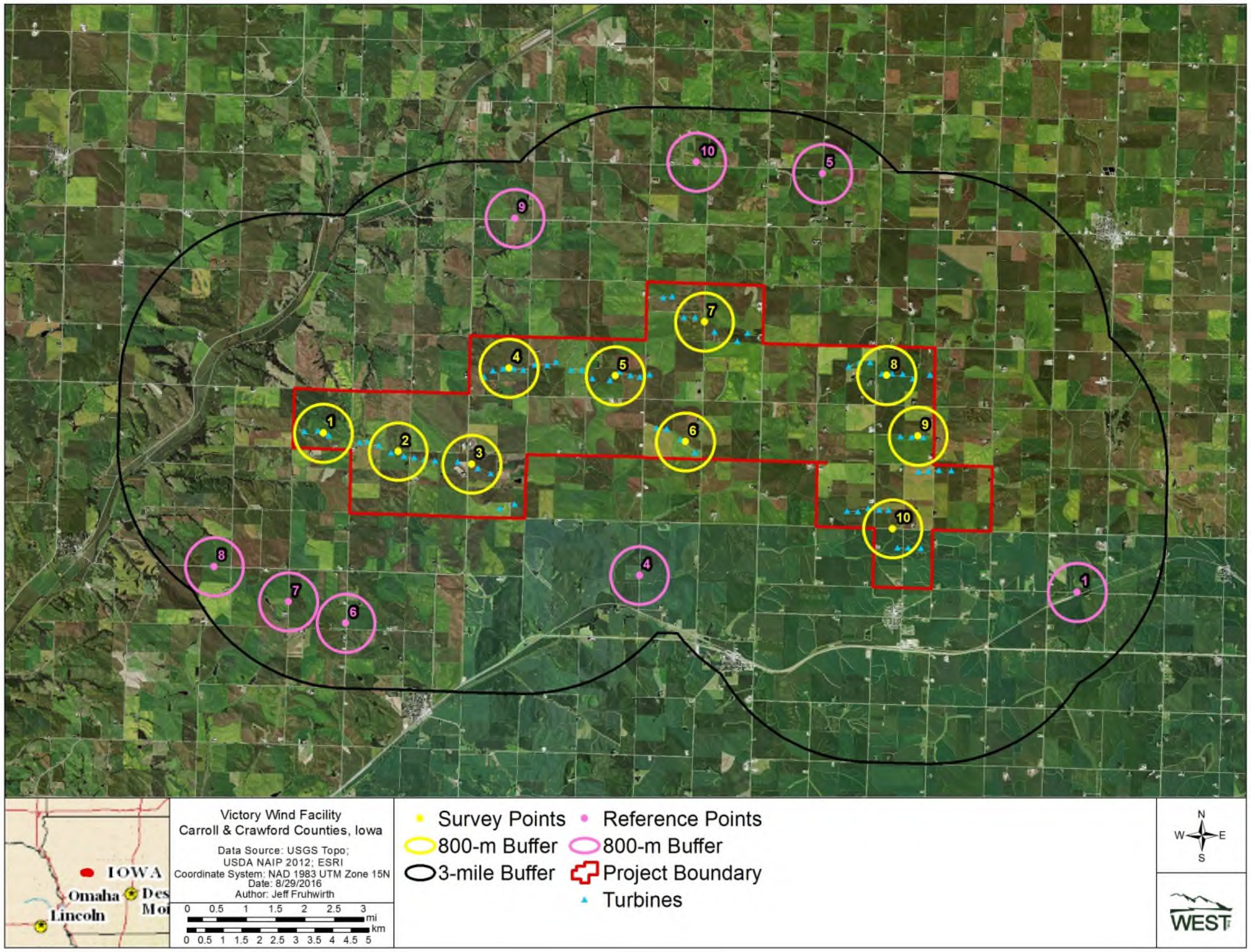
Appendix A10. Project and reference points locations for the eagle use surveys conducted at the Macksburg wind energy facility, Madison County, Iowa, from December 2014 to February 2016.



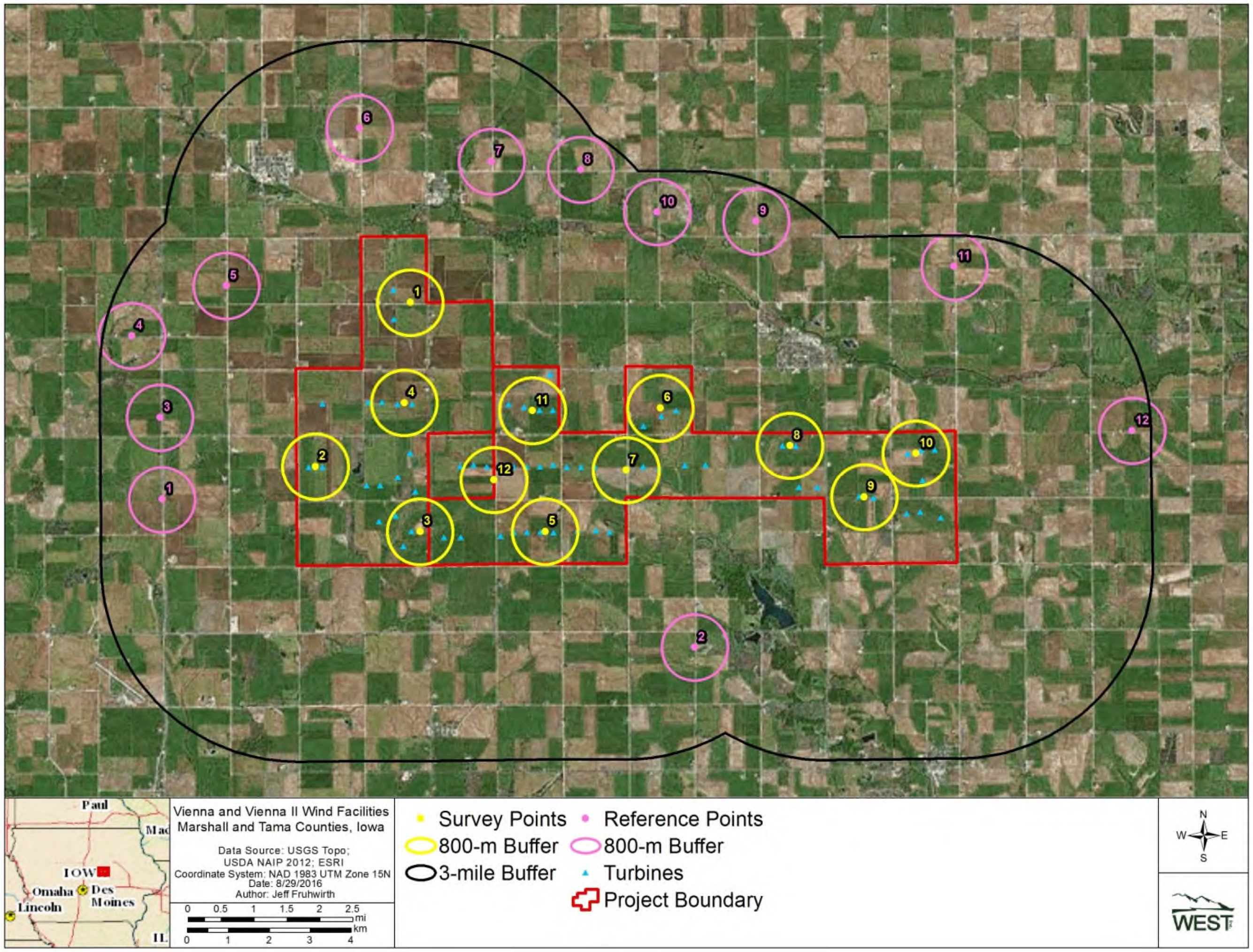
Appendix A11. Project and reference points locations for the eagle use surveys conducted at the Pomeroy wind energy facility, Pocahontas County, Iowa, from December 2014 to February 2016.



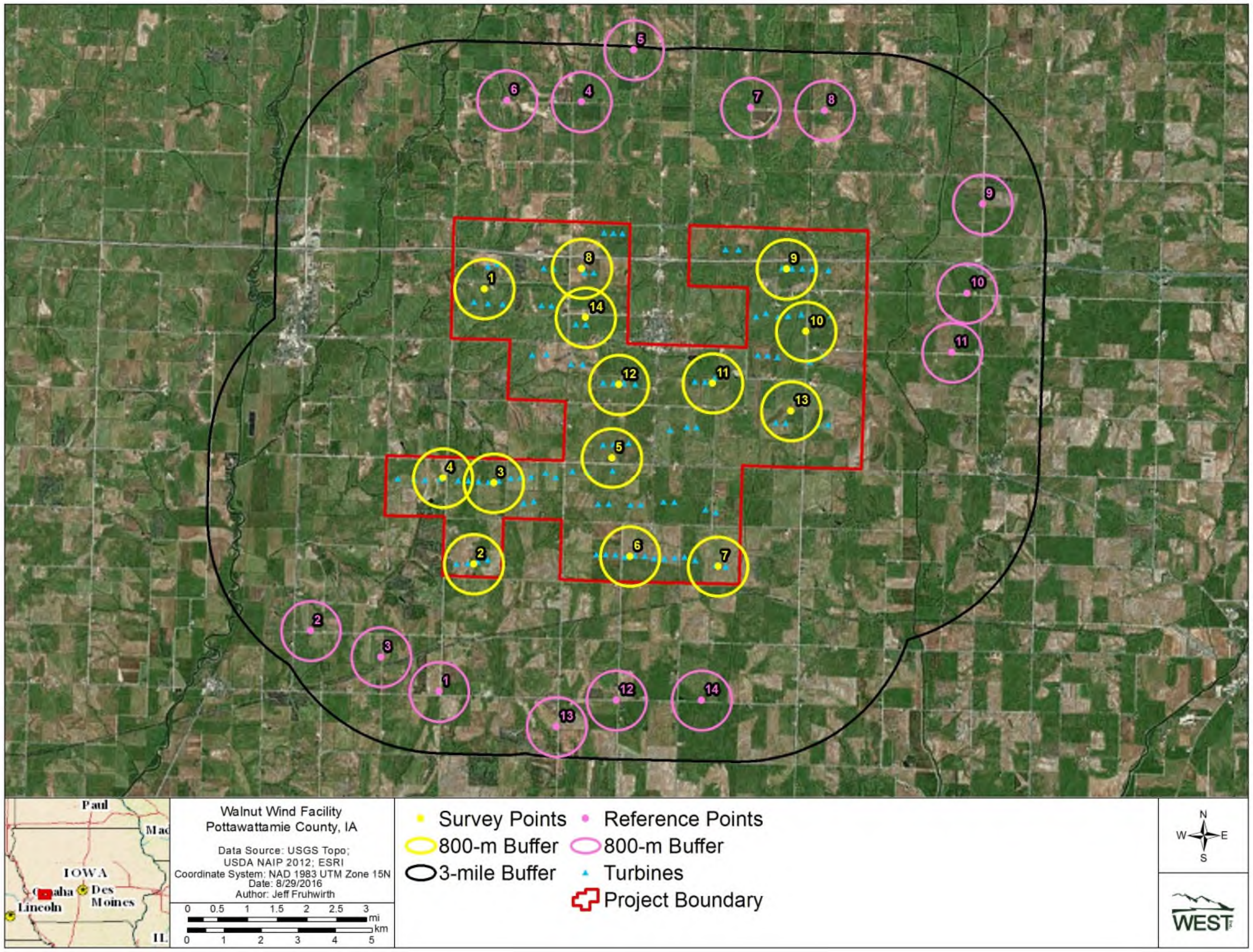
Appendix A12. Project and reference points locations for the eagle use surveys conducted at the Rolling Hills wind energy facility, Adair, Adams, and Cass counties, Iowa, from December 2014 to February 2016.



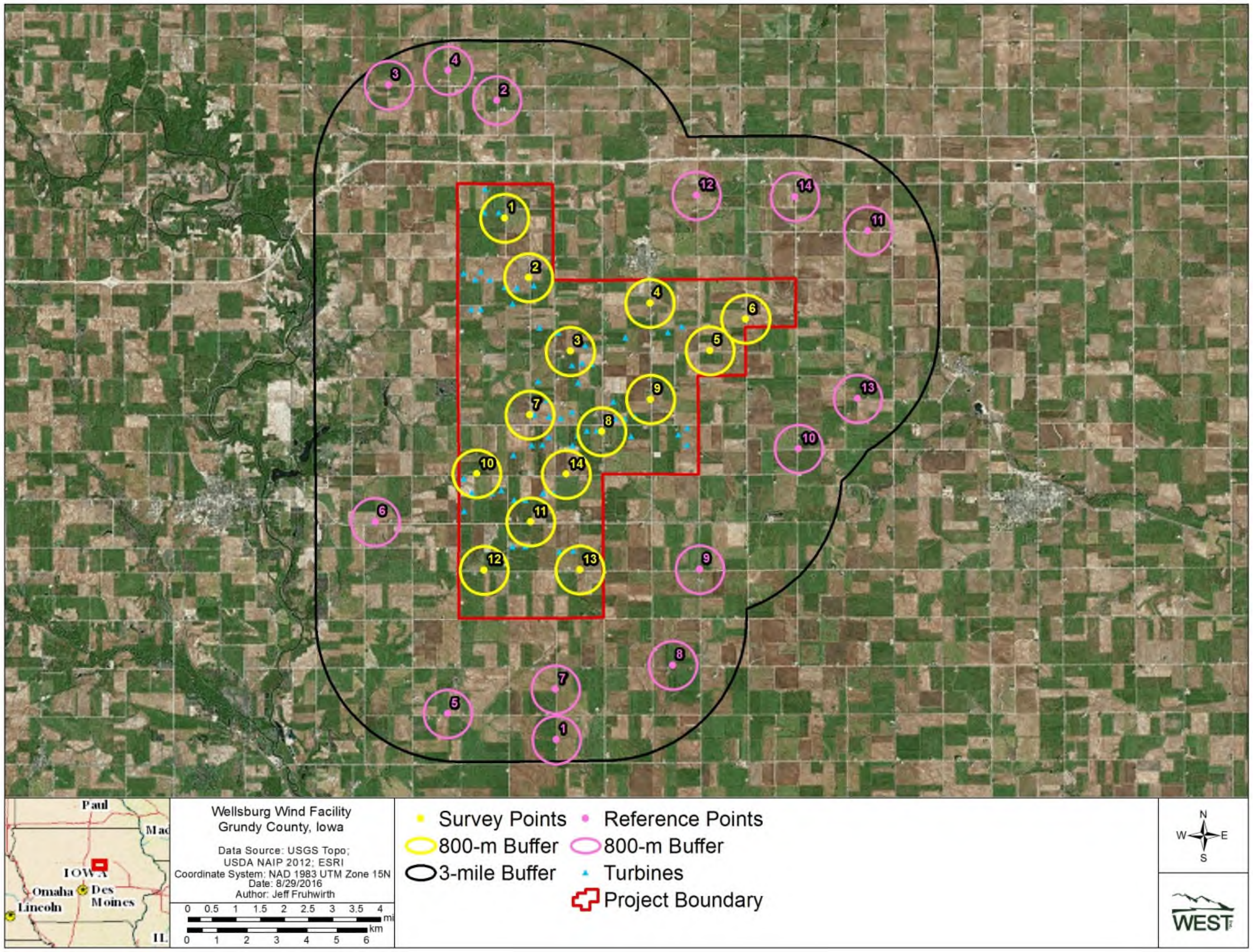
Appendix A13. Project and reference points locations for the eagle use surveys conducted at the Victory wind energy facility, Carroll and Crawford counties, Iowa, from December 2014 to February 2016.



Appendix A14. Project and reference points locations for the eagle use surveys conducted at the Vienna I and Vienna II wind energy facilities, Marshall and Tama counties, Iowa, from December 2014 to February 2016.

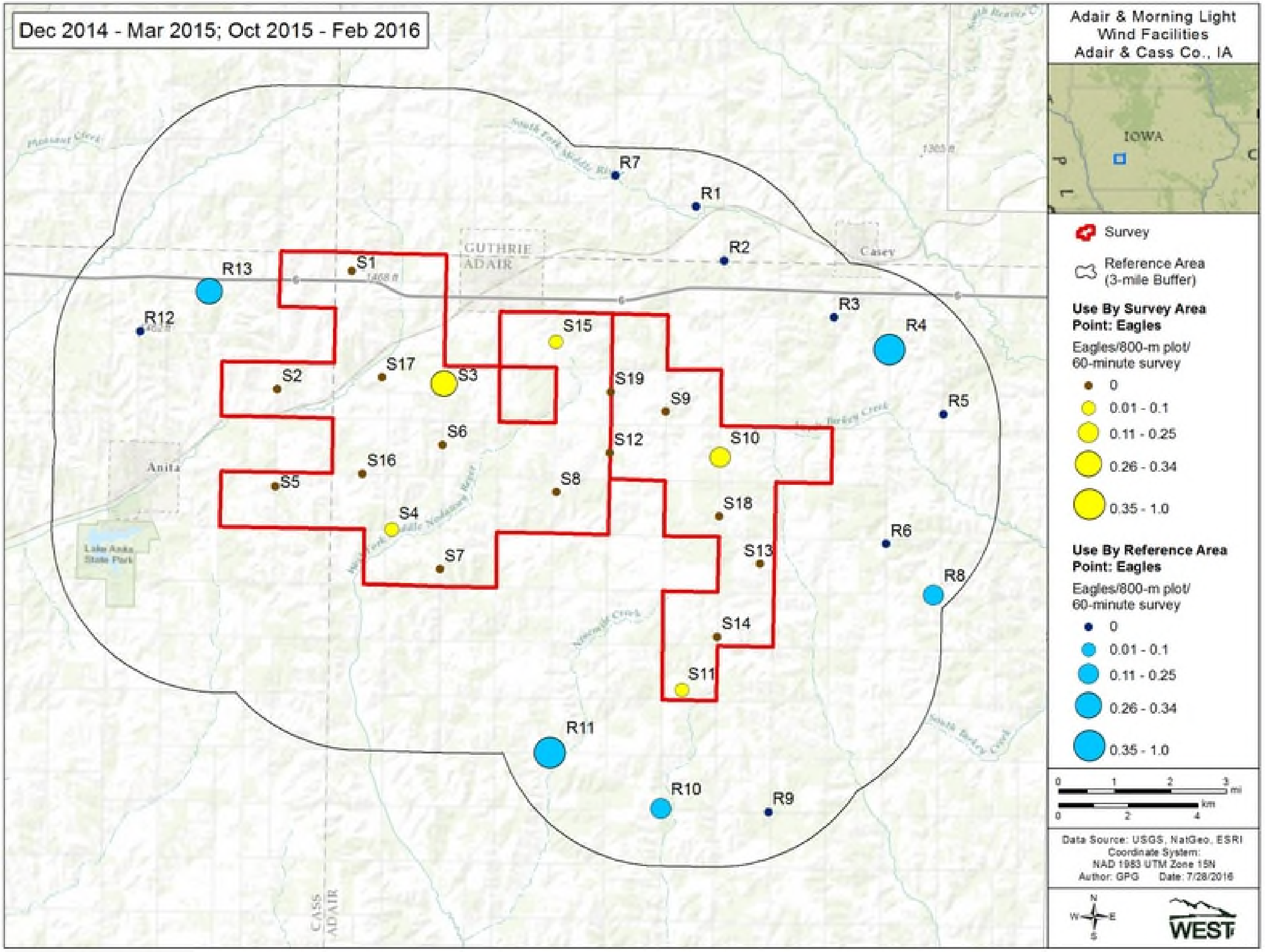


Appendix A15. Project and reference points locations for the eagle use surveys conducted at the Walnut wind energy facility, Pottawattamie County, Iowa, from December 2014 to February 2016.

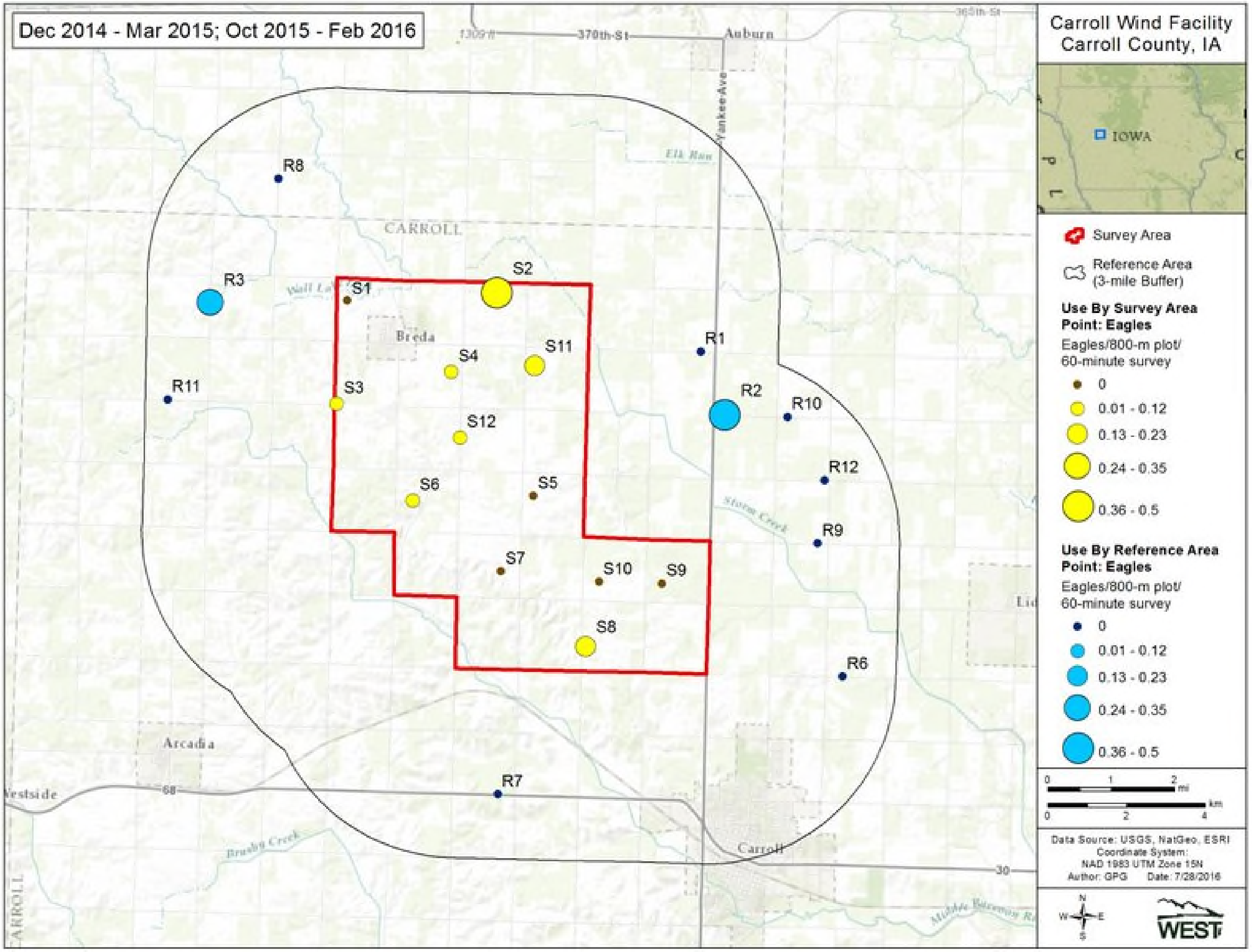


Appendix A16. Project and reference points locations for the eagle use surveys conducted at the Wellsburg wind energy facility, Grundy County, Iowa, from December 2014 to February 2016.

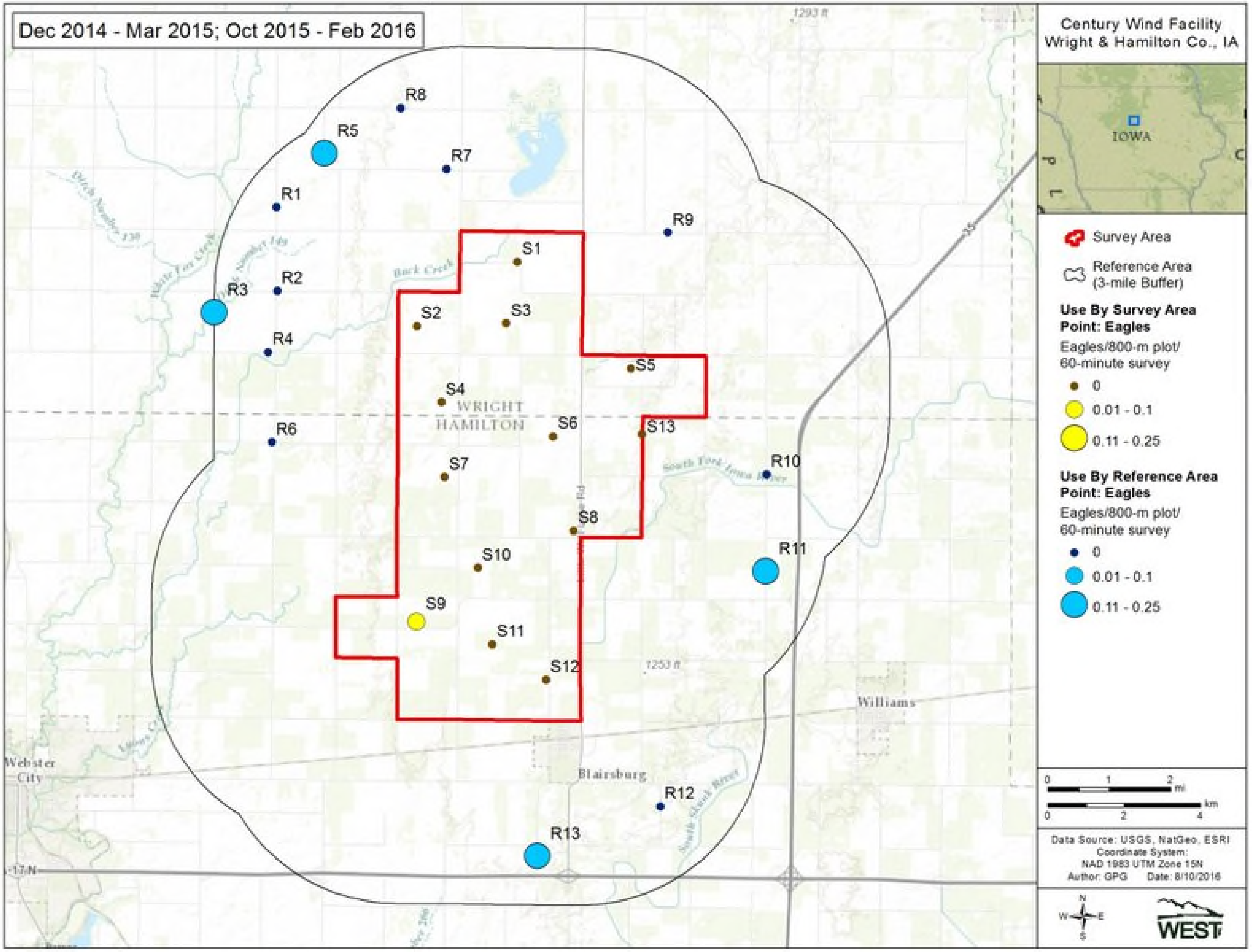
Appendix B: Mean Eagle Use by Point at Project and Reference Points during Eagle Use Surveys Conducted at the 18 MidAmerican Wind Energy Facilities Studied from December 2014 to March 2015 and October 2015 to February 2016.



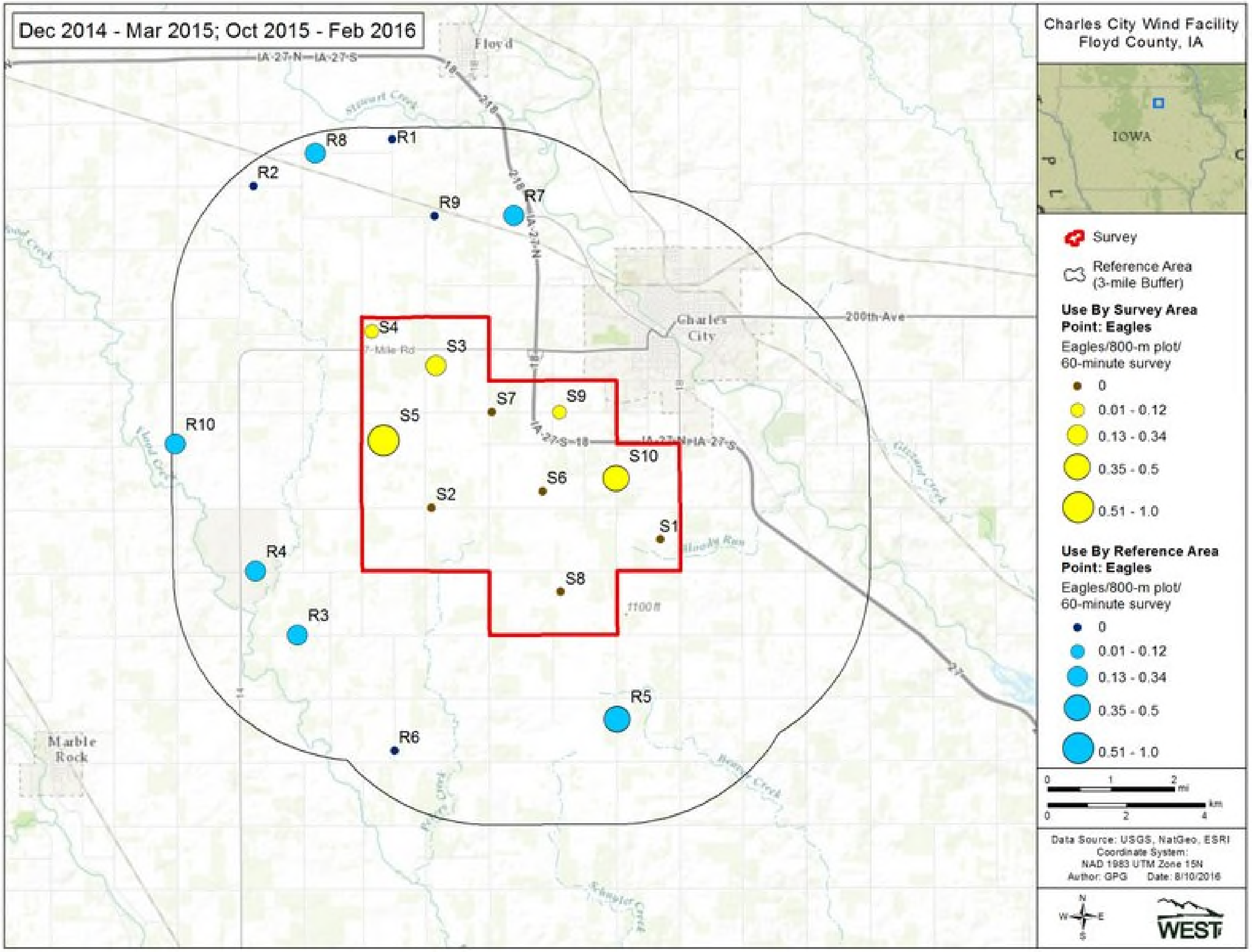
Appendix B-1. Mean eagle use at project and reference points during eagle use surveys at the Adair/Morning Light wind energy facilities, Adair and Cass counties, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



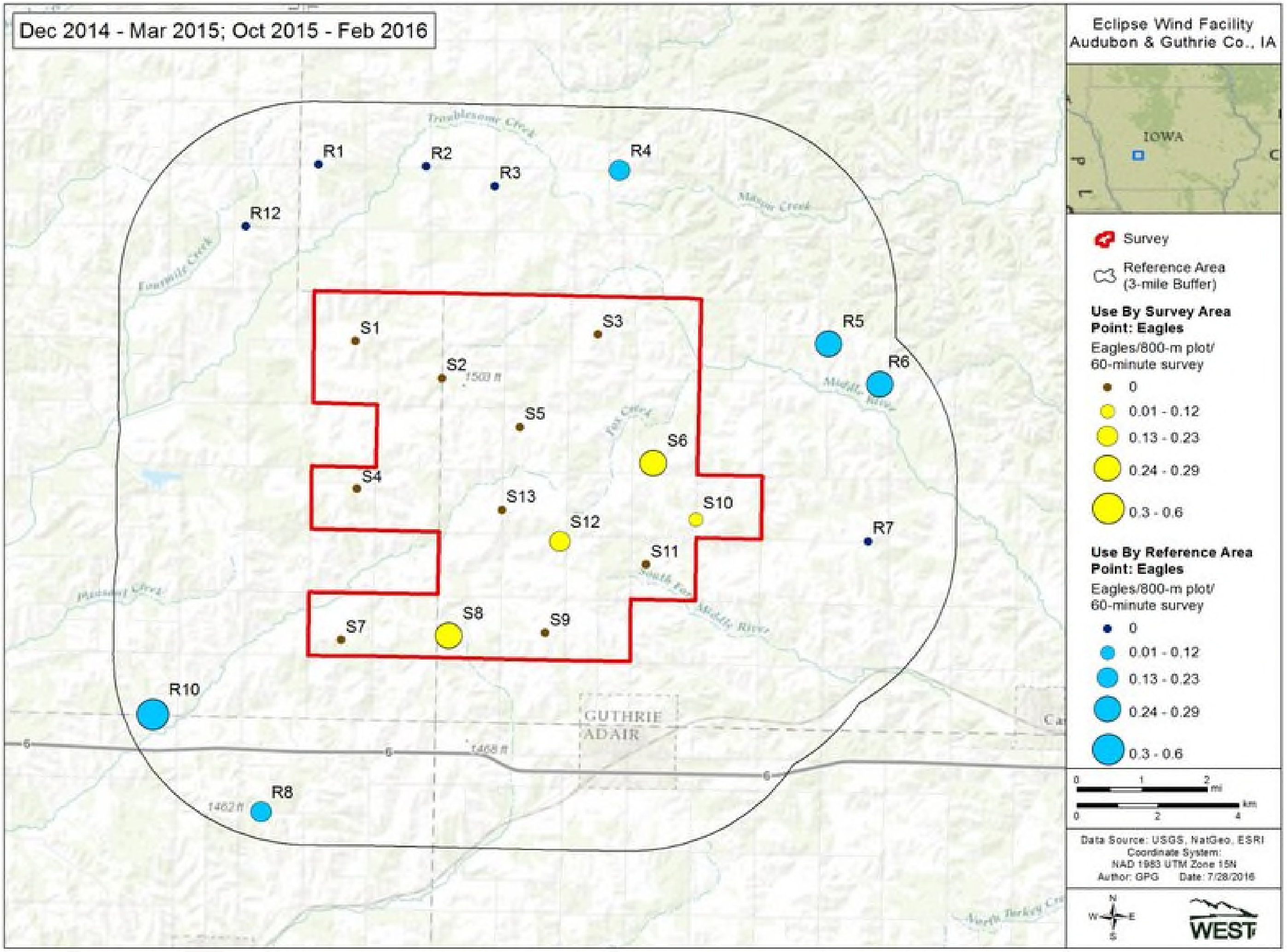
Appendix B-2. Mean eagle use at project and reference points during eagle use surveys at the Carroll wind energy facility, Carroll County, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



Appendix B-3. Mean eagle use at project and reference points during eagle use surveys at the Century wind energy facility, Wright and Hamilton counties, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



Appendix B-4. Mean eagle use at project and reference points during eagle use survey at the Charles City wind energy facility, Floyd County, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



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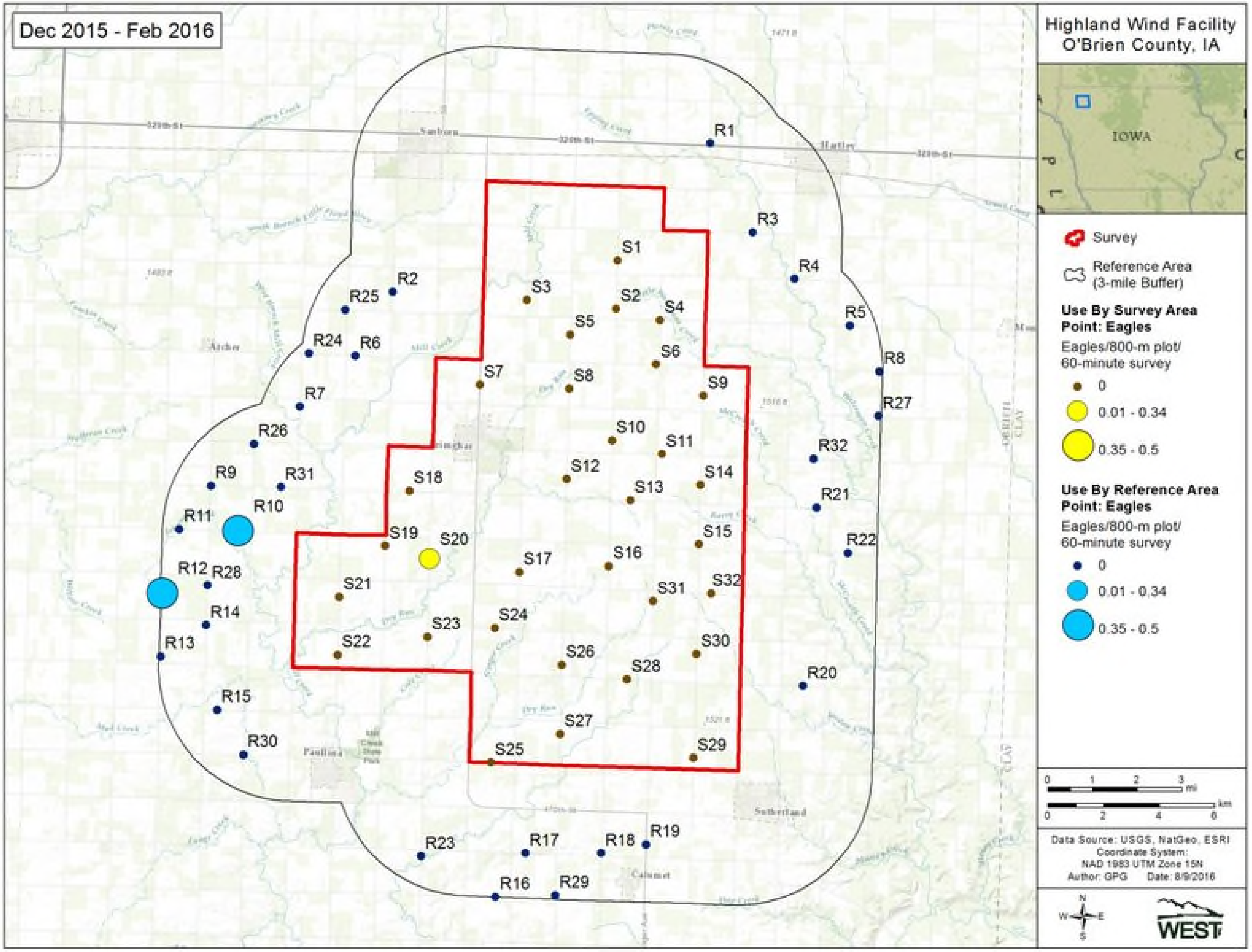
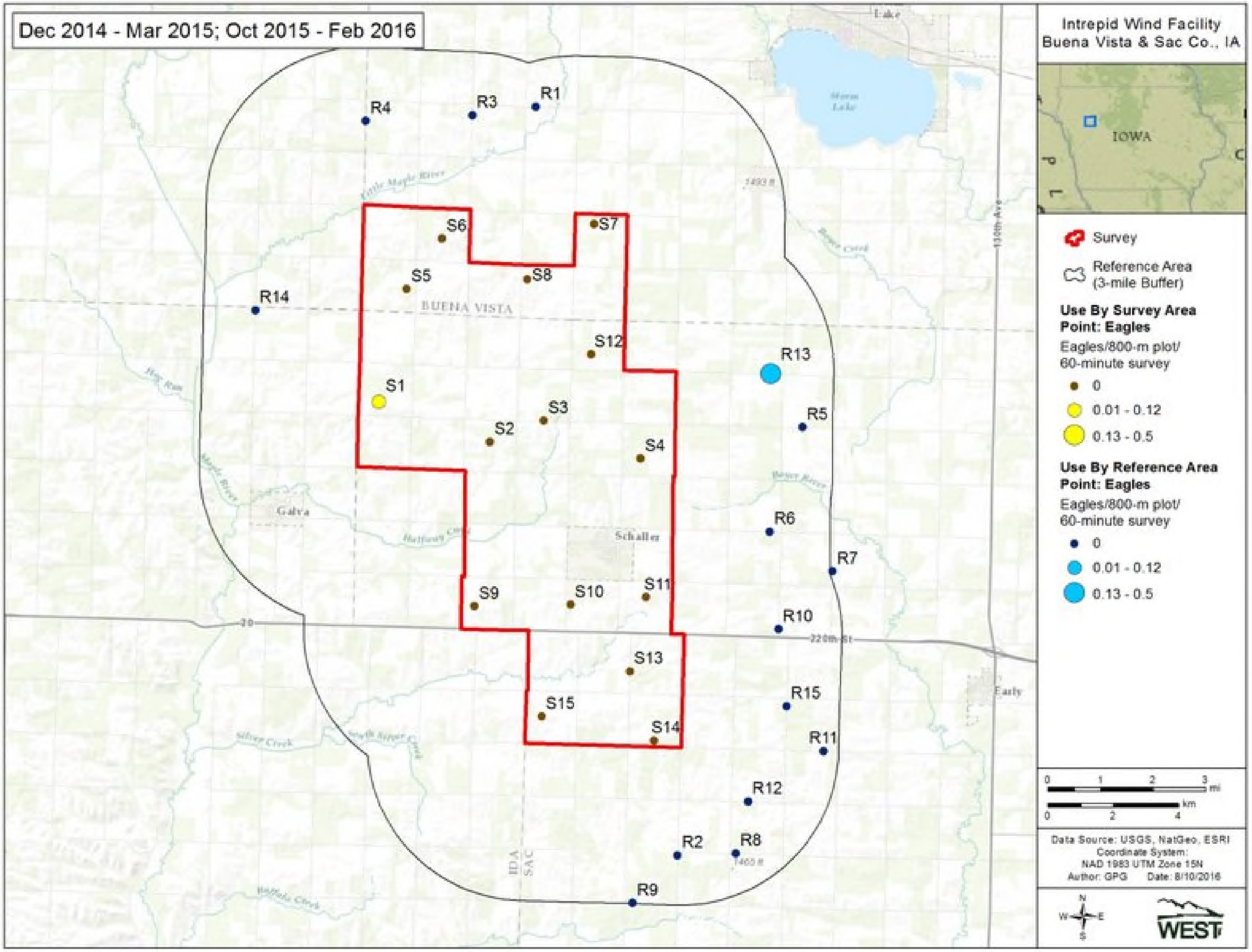
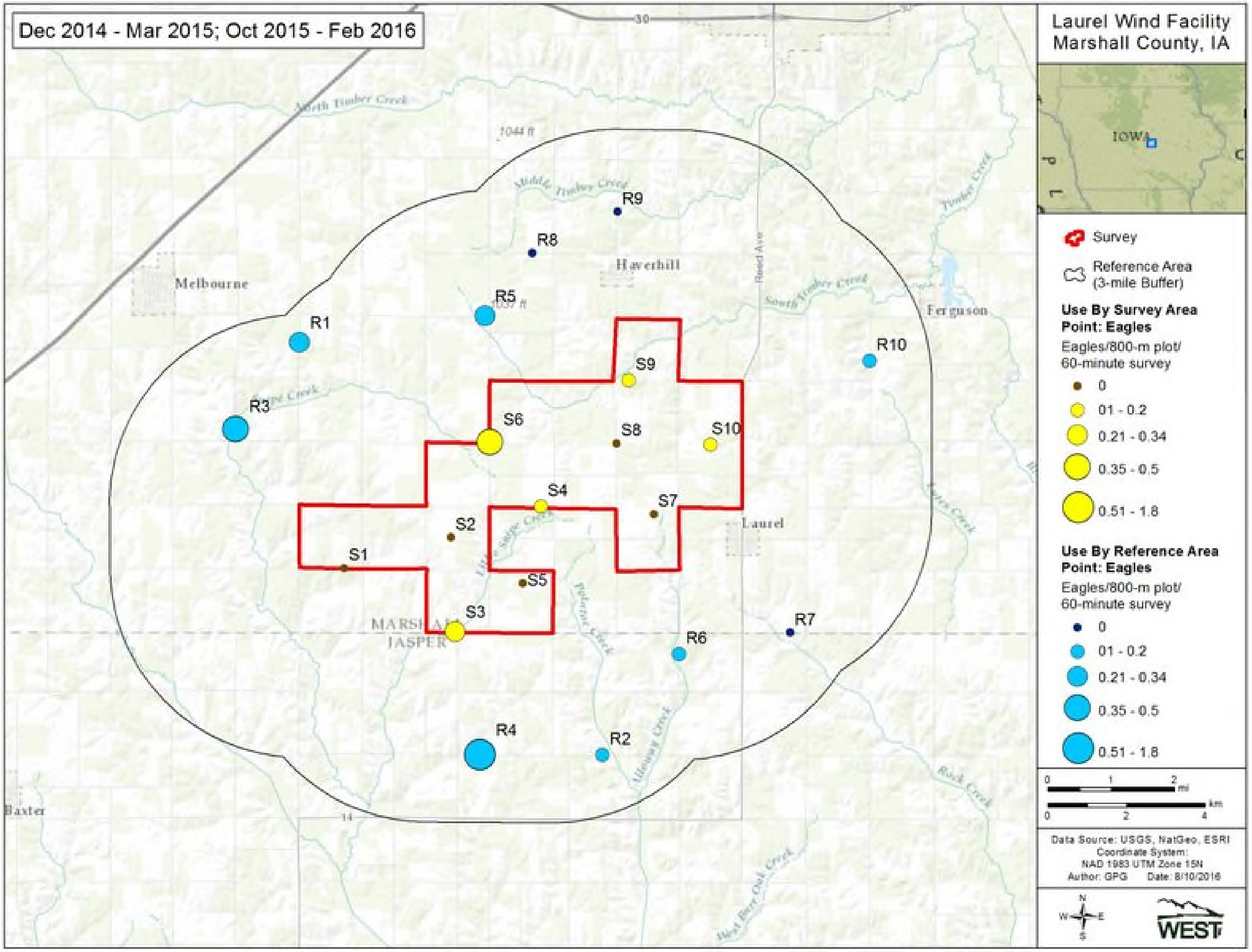


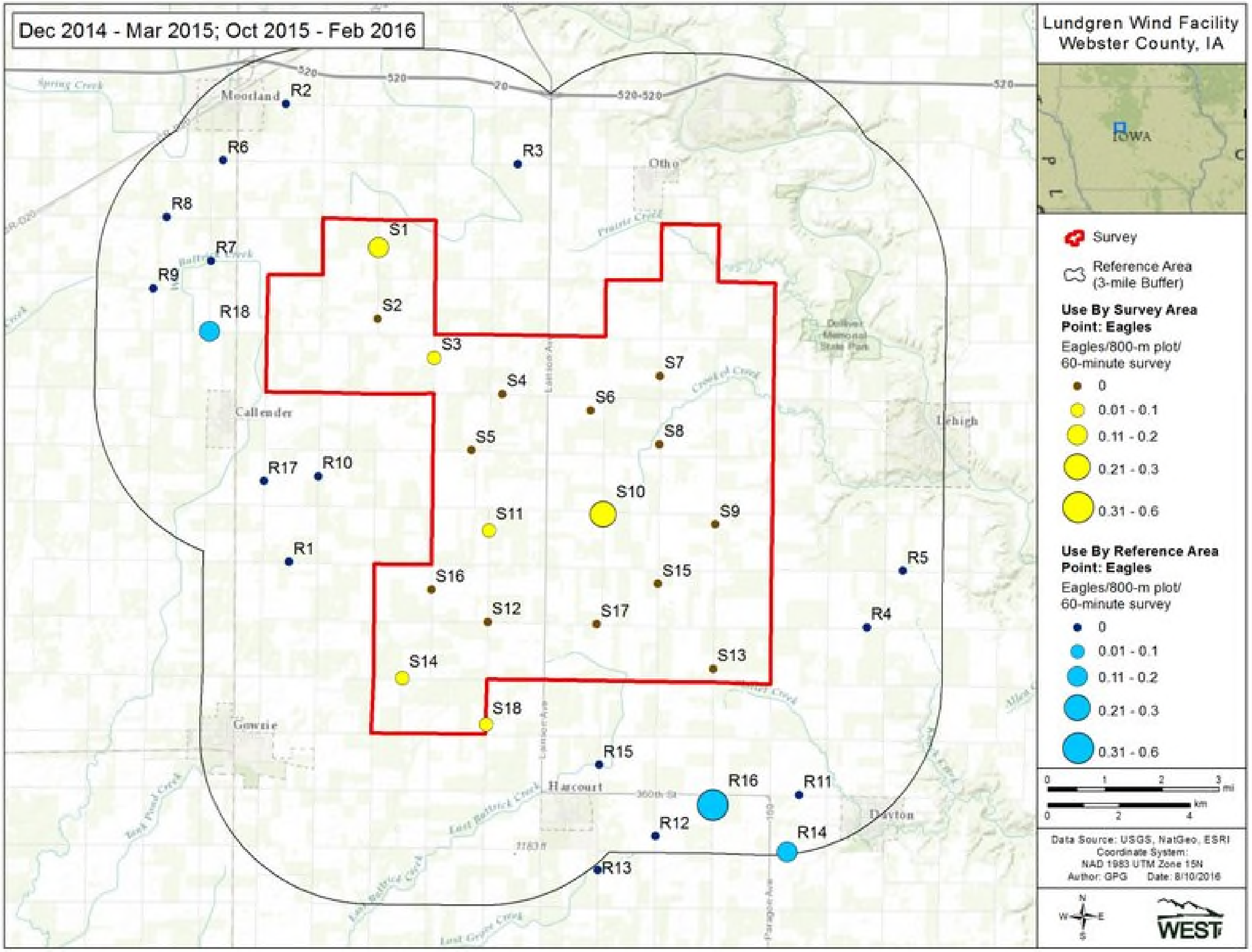
Appendix B-6. mean eagle use at project and reference points during eagle use surveys at the Highland wind energy facility, O'Brien County, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



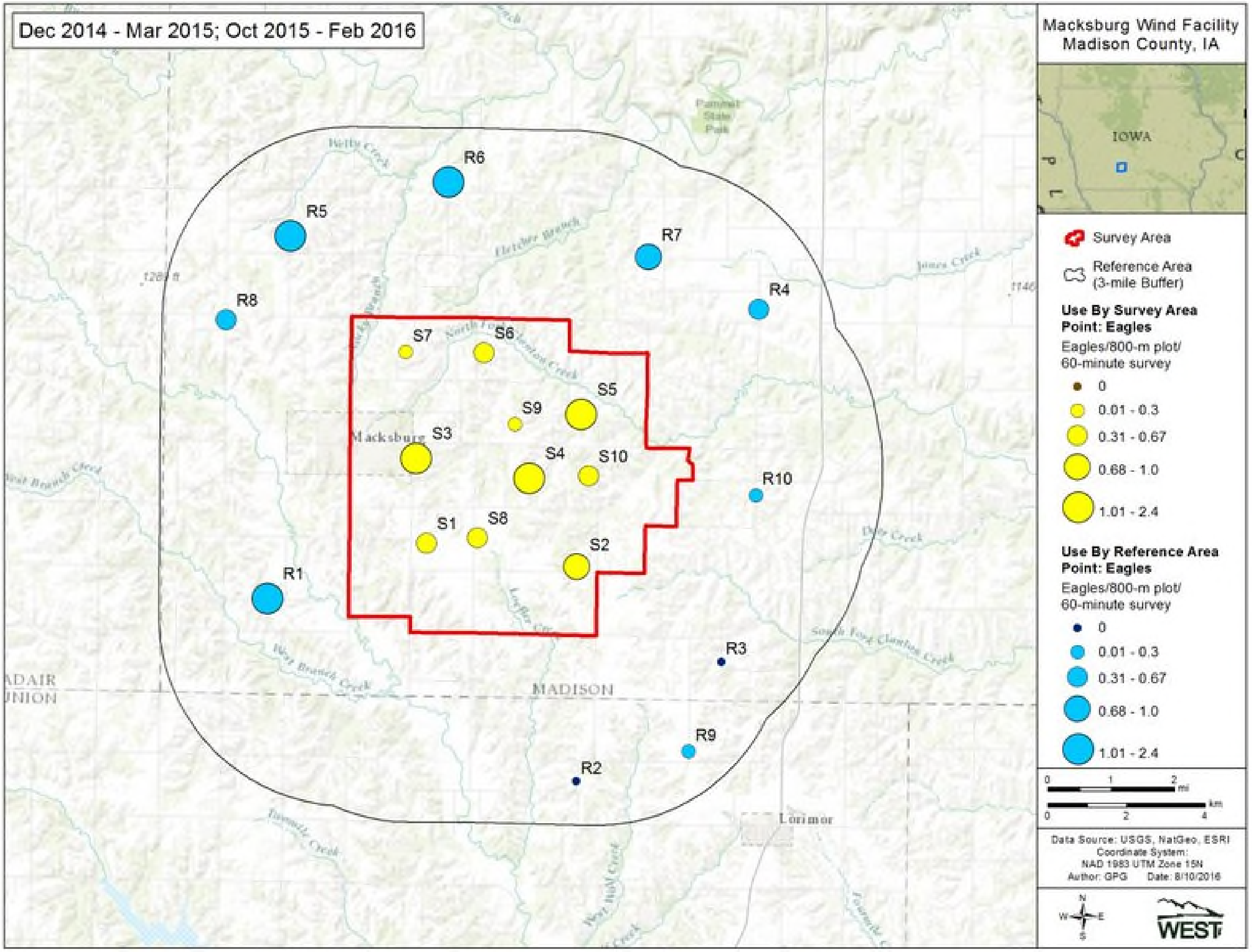
Appendix B-7. Mean eagle use at project and reference points during eagle use surveys at the Intrepid wind energy facility, Buena Vista and Sac counties, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



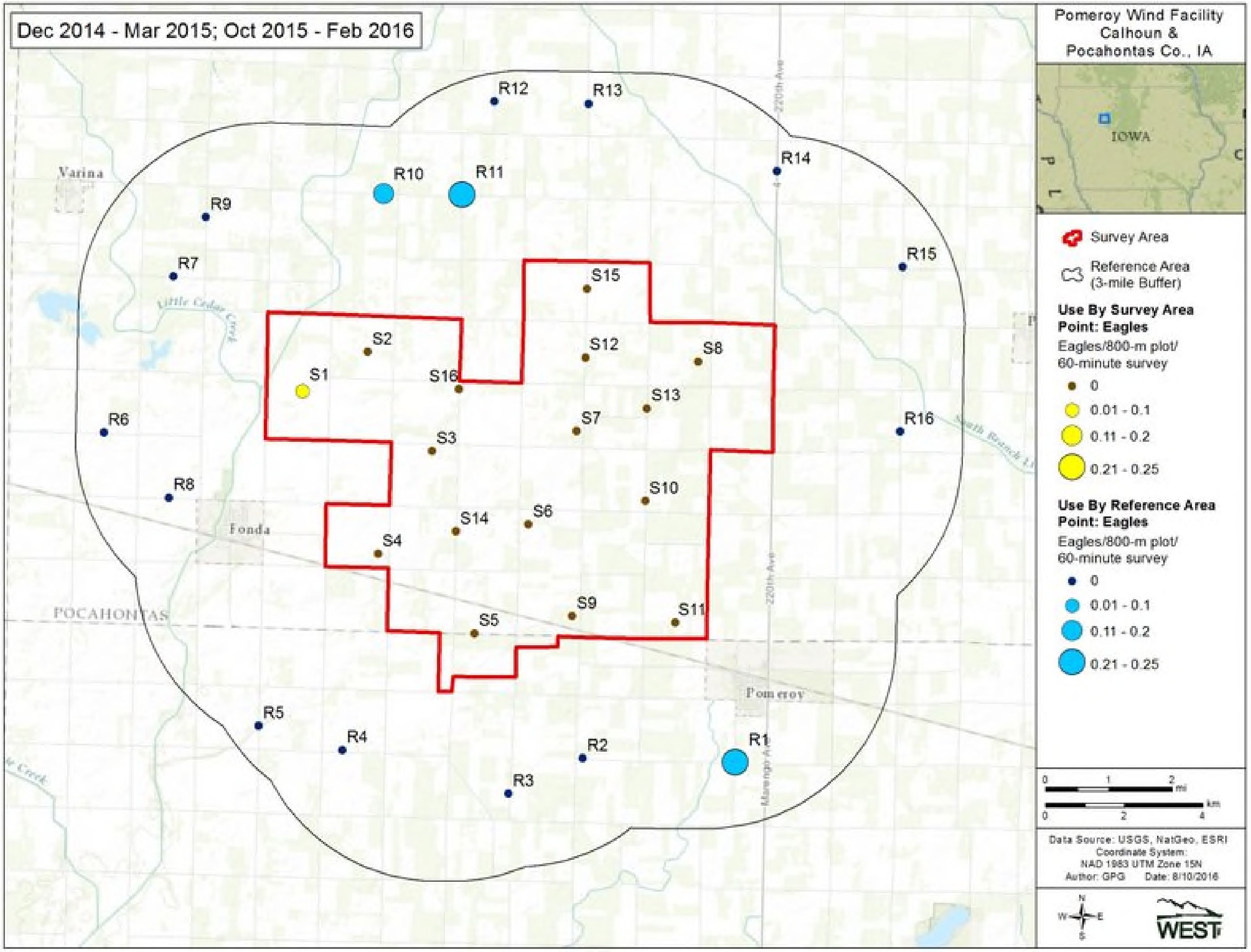
Appendix B-8. Mean eagle use at project and reference points during eagle use surveys at the Laurel wind energy facility, Marshall County, Iowa, from December 2014 to March 2015 and October 2015 and February 2016.



Appendix B-9. Mean eagle use at project and reference points during eagle use surveys at the Lundgren wind energy facility, Webster County, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



Appendix B-10. Mean eagle use at project and reference points during eagle use surveys at the Macksburg wind energy facility, Madison County, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



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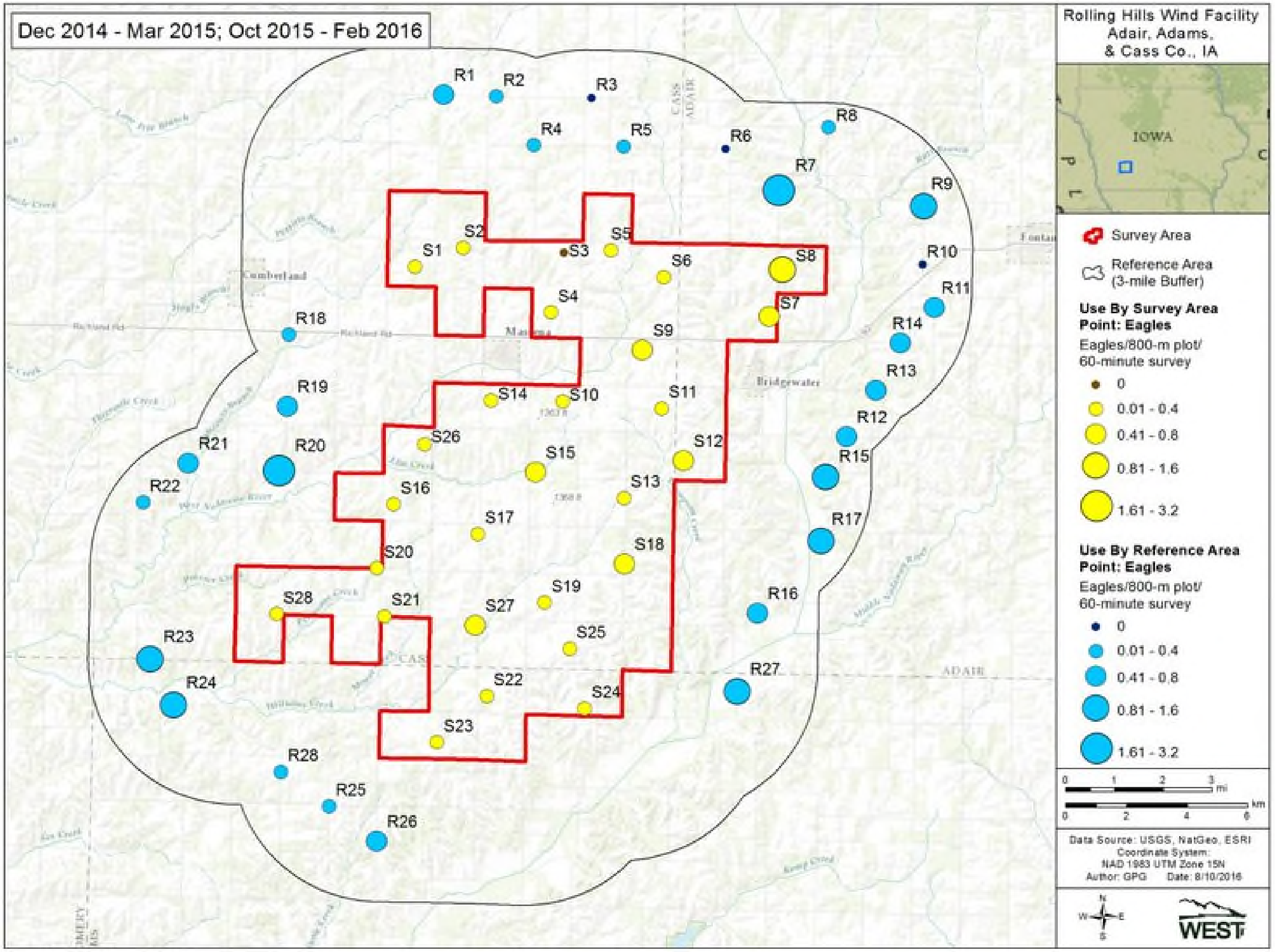
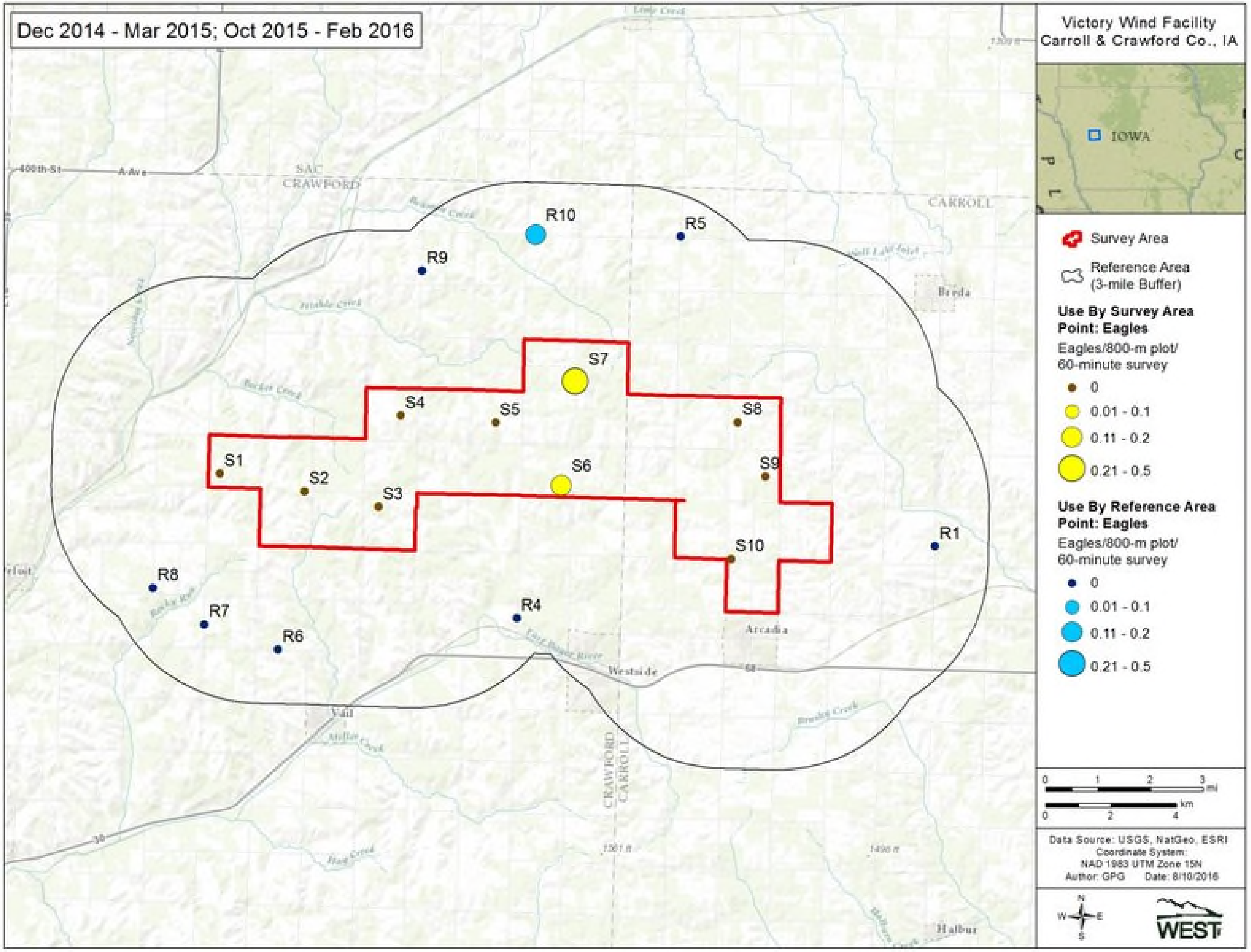
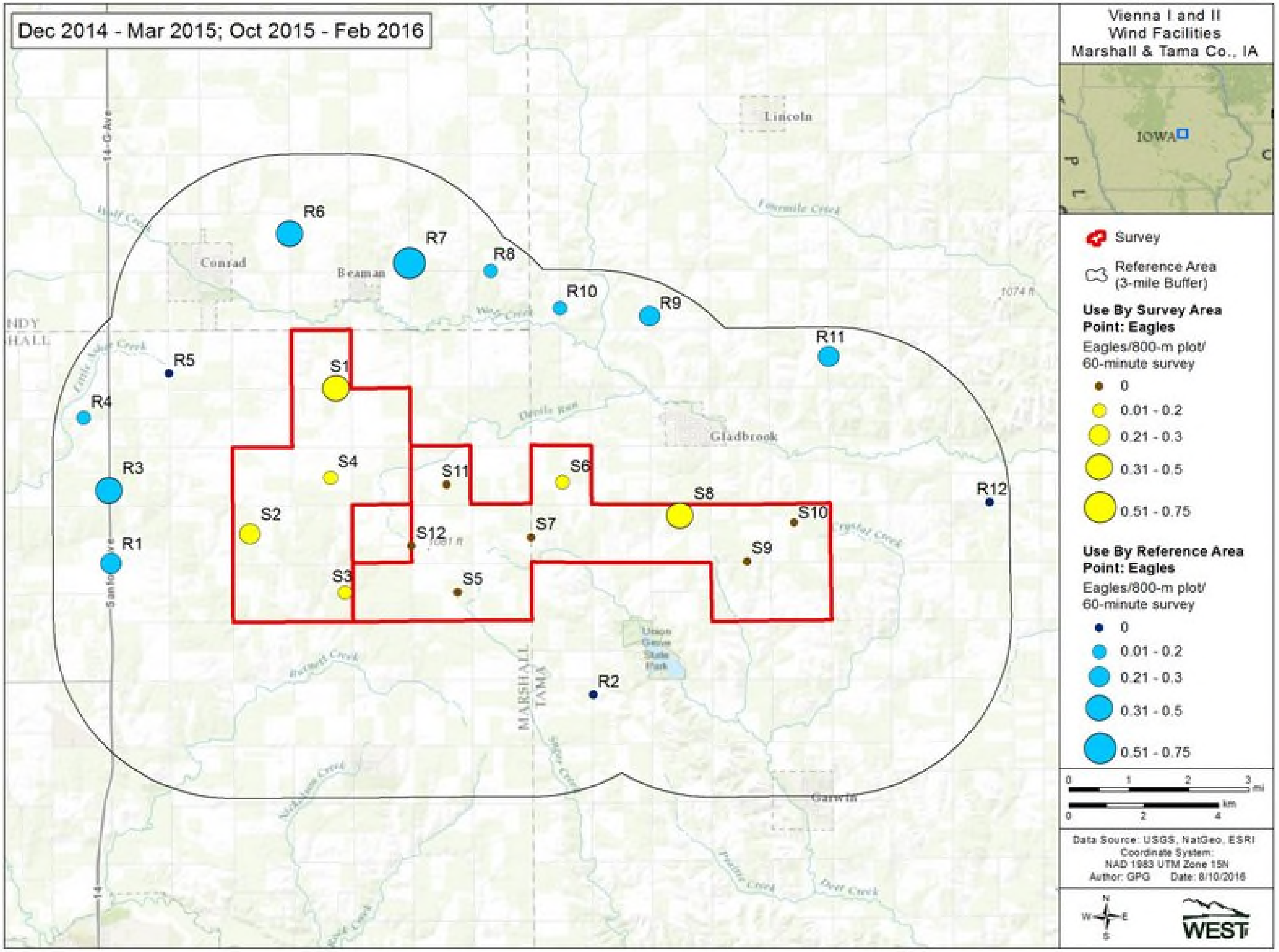


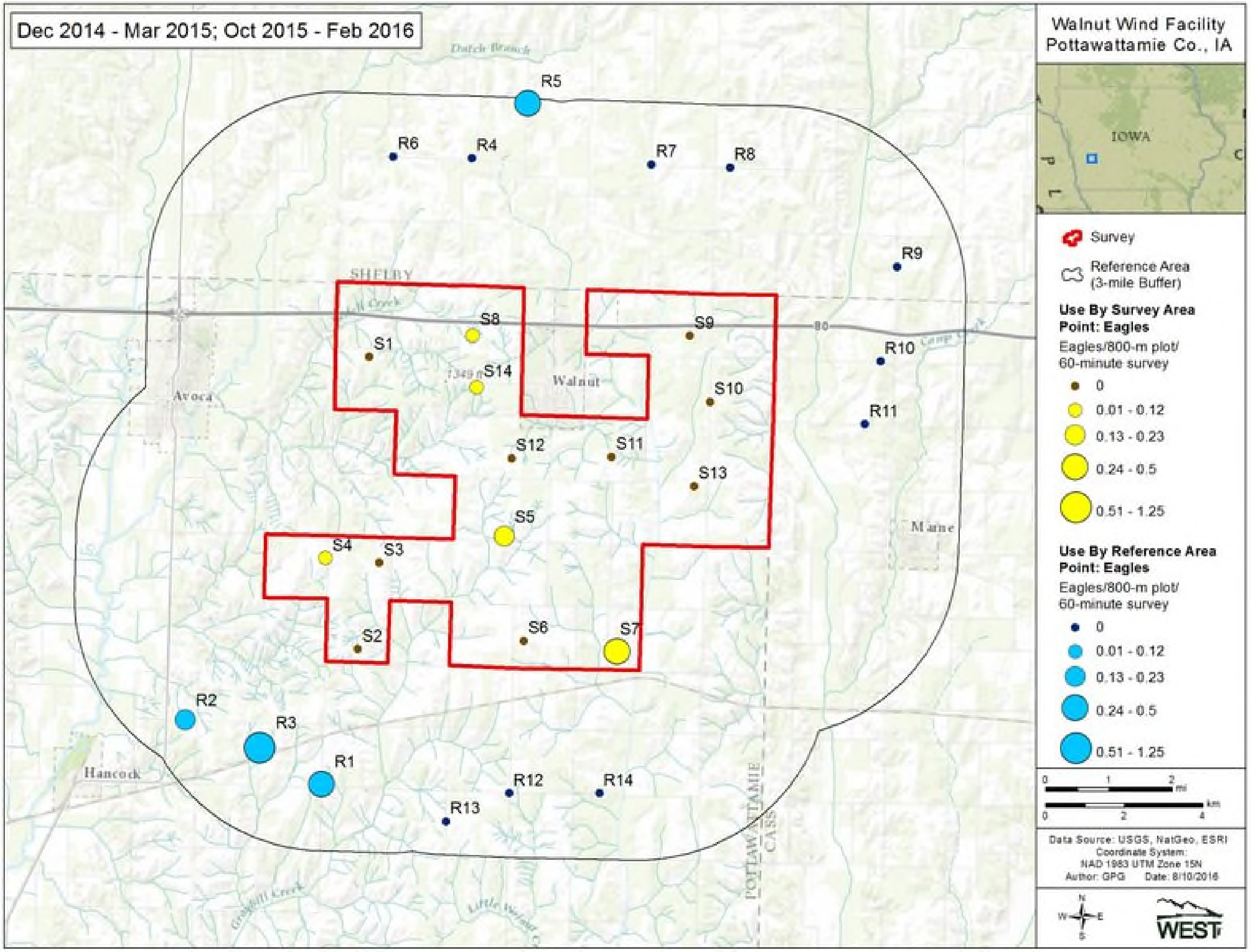
Appendix B-12. mean eagle use at project and reference points during eagle use surveys at the Rolling Hills wind energy facility, Adair, Adams, and Cass counties, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



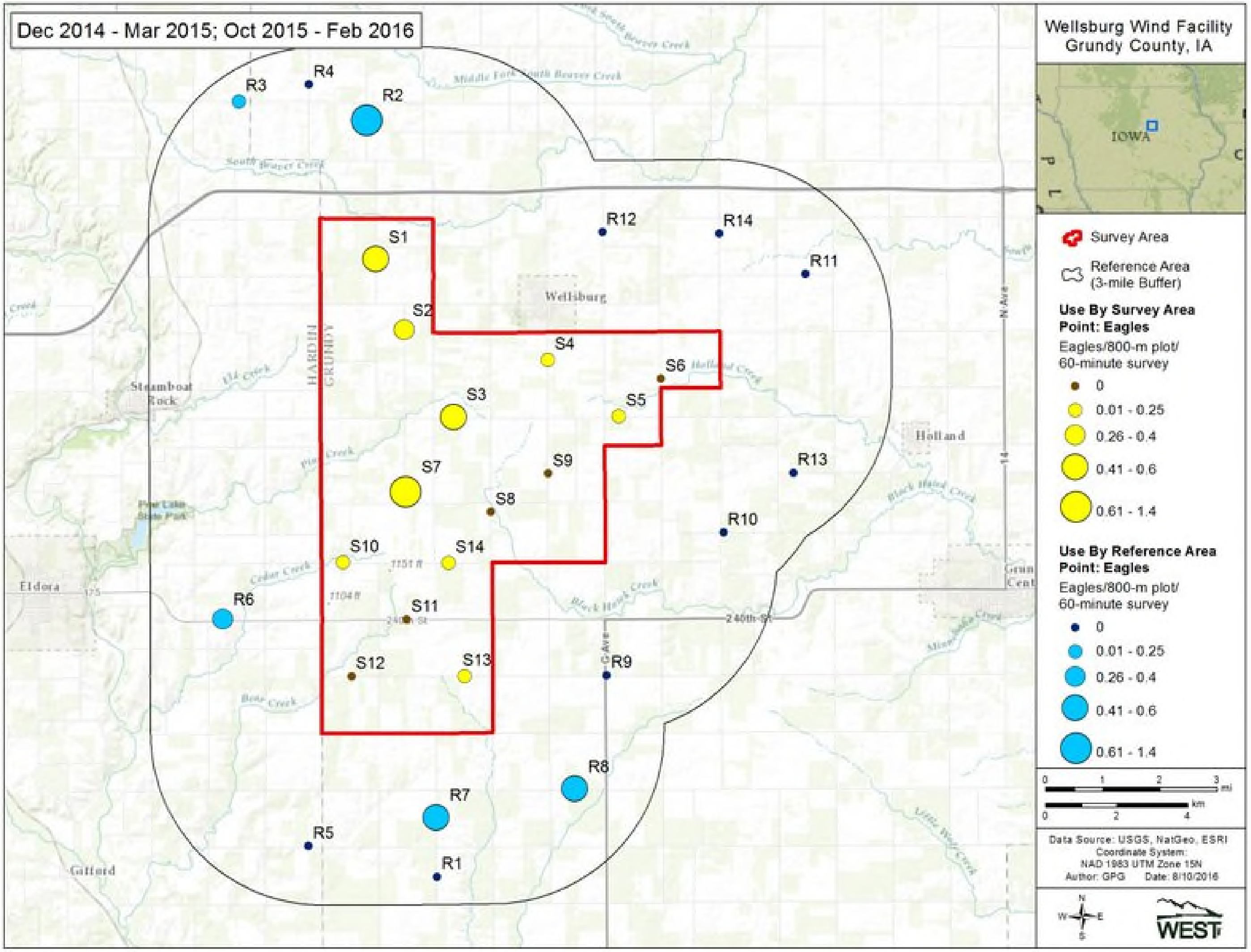
Appendix B-13. mean eagle use at project and reference points during eagle use surveys at the Victory wind energy facility, Carroll and Crawford counties, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



Appendix B-14. Mean eagle use at project and reference points during eagle use surveys at the Vienna I and Vienna II wind energy facilities, Marshall and Tama counties, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



Appendix B-15. Mean eagle use at project and reference points during eagle use surveys at the Walnut wind energy facility, Pottawattamie County, Iowa, from December 2014 to March 2015 and October 2015 to February 2016.



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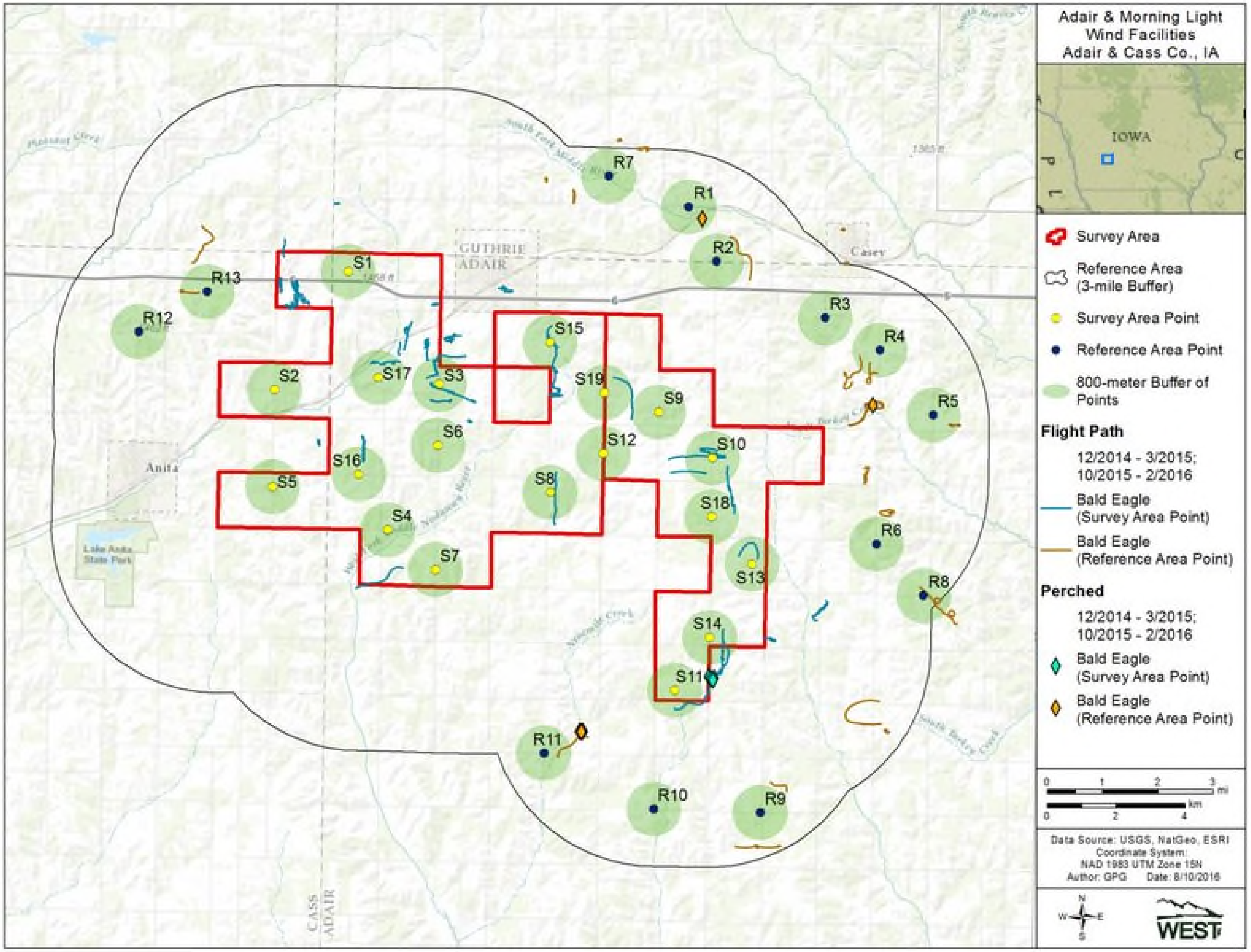

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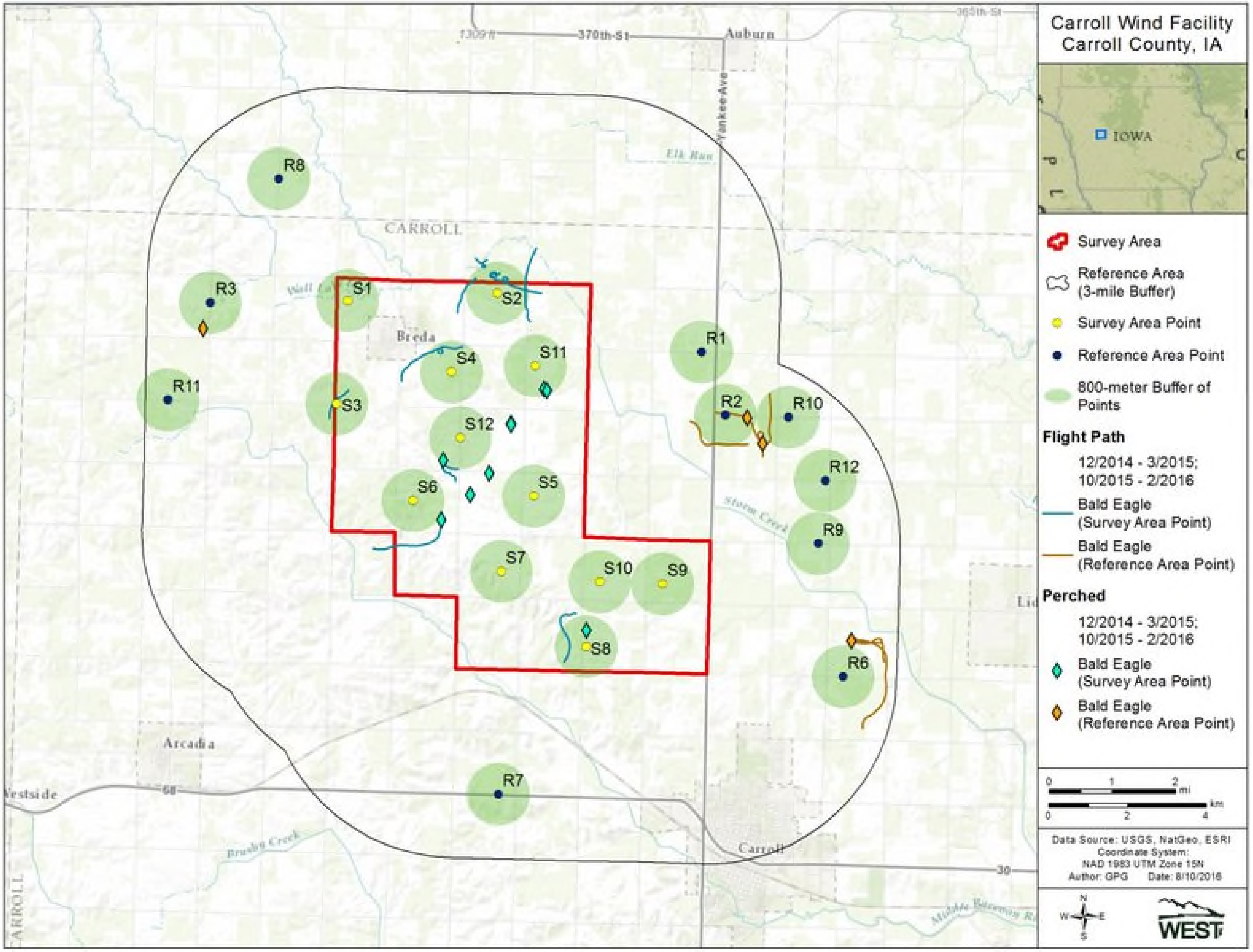

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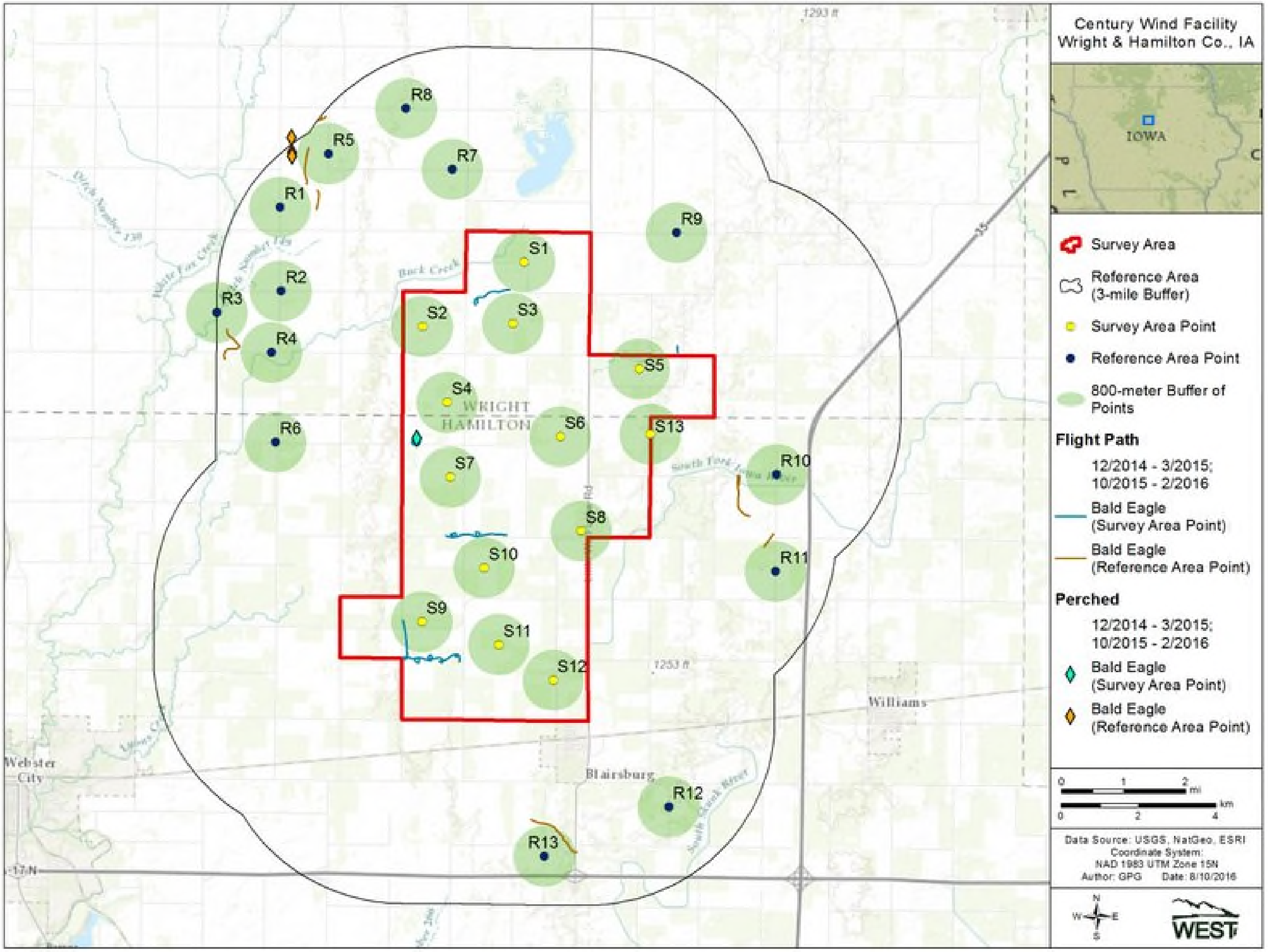

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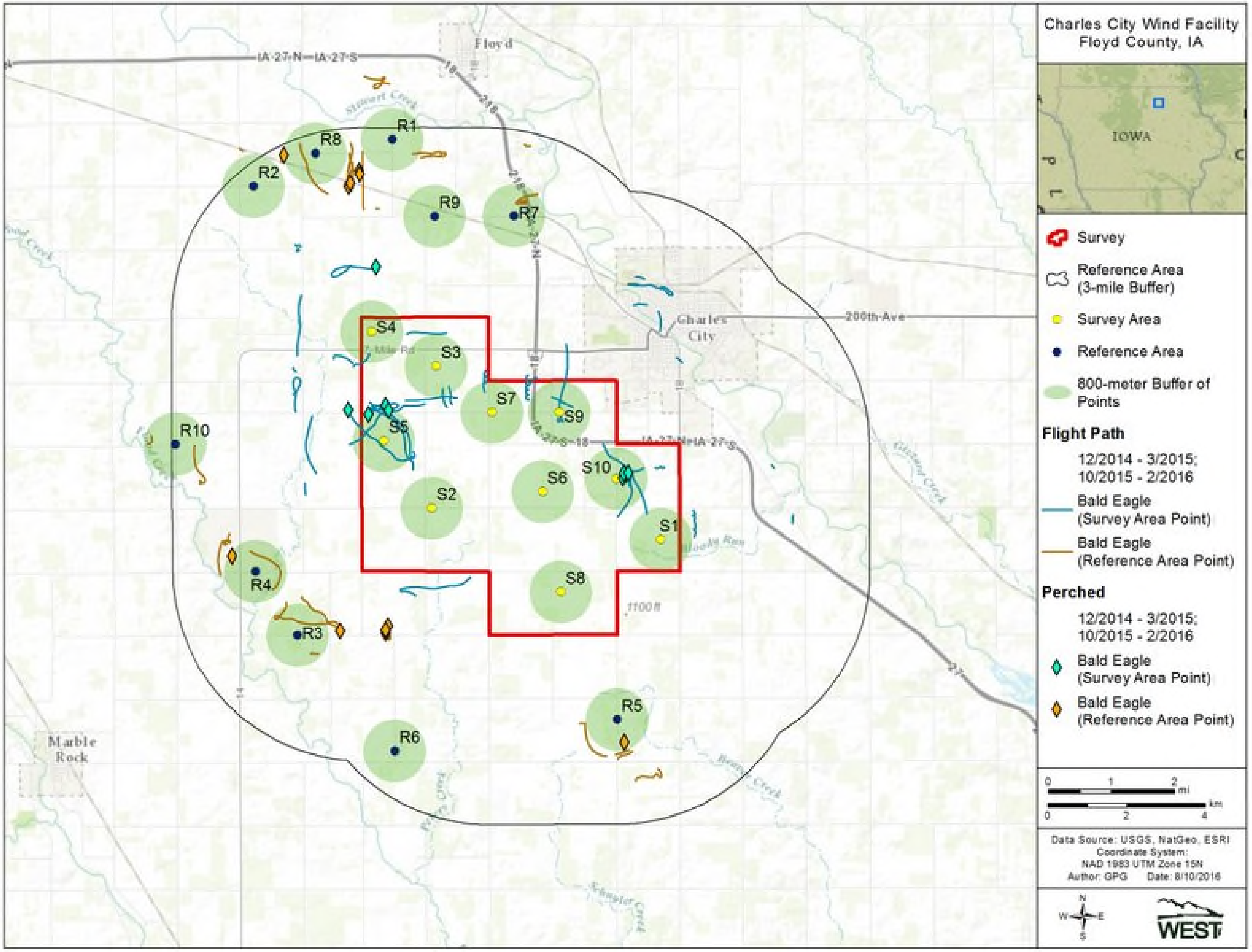

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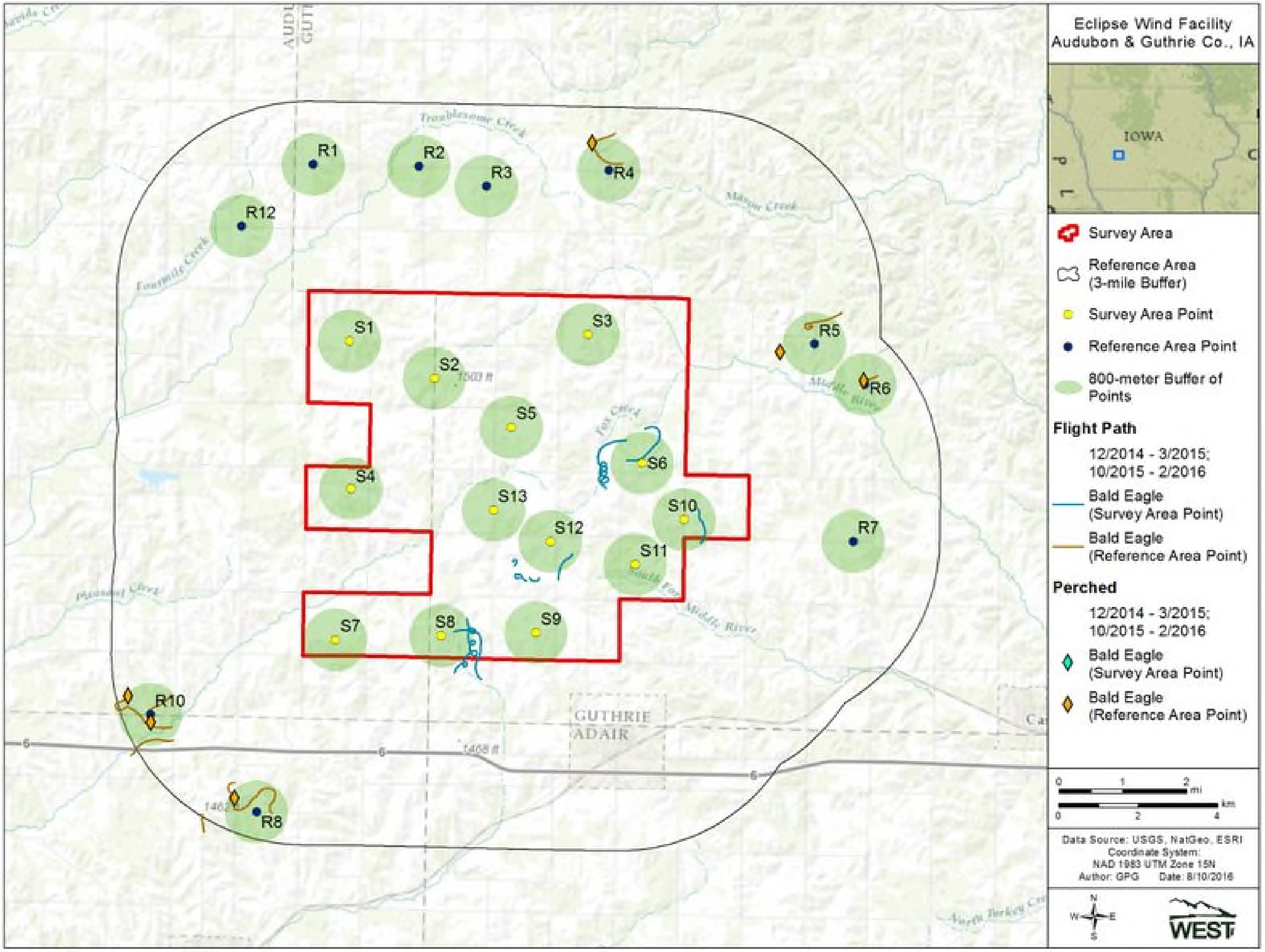

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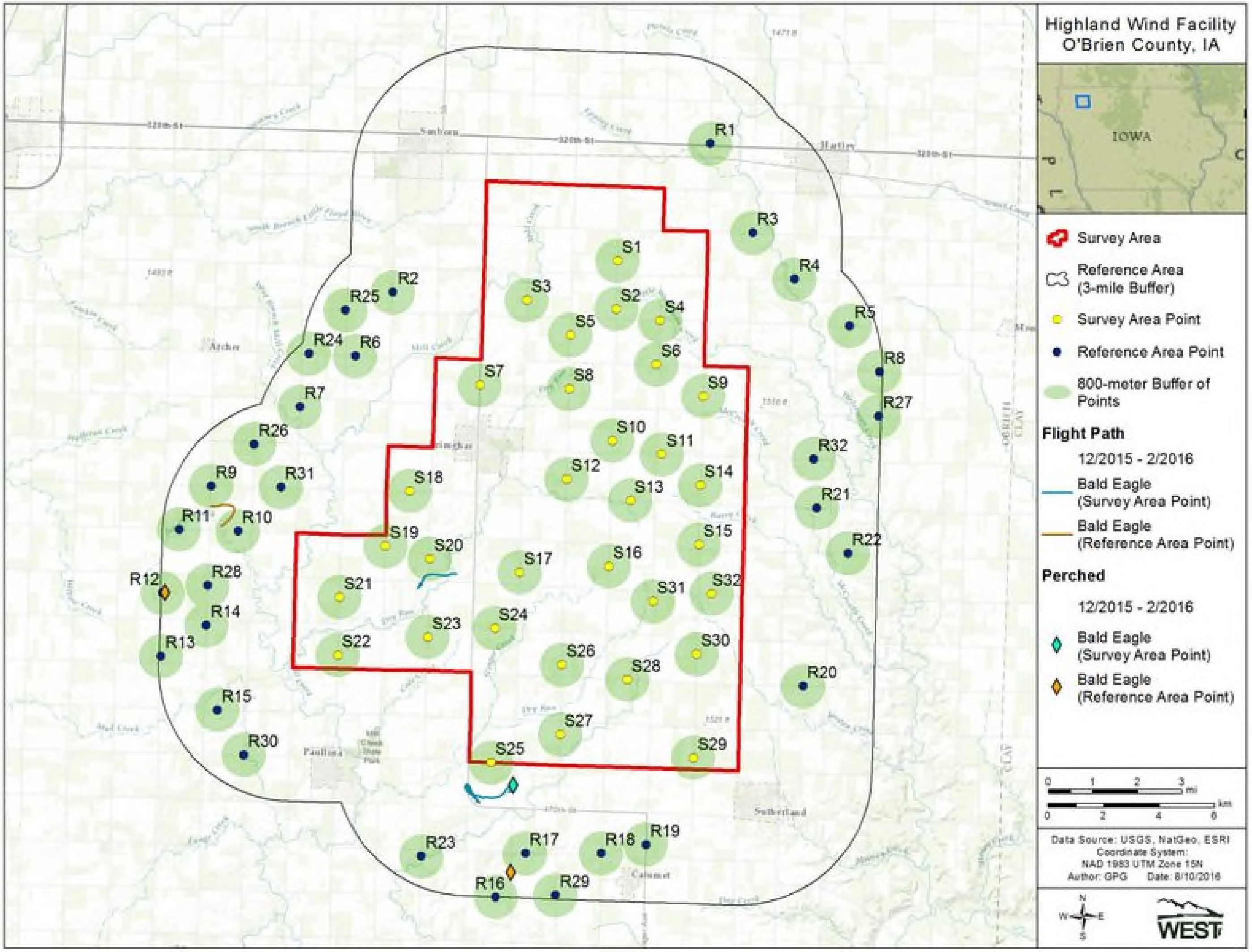

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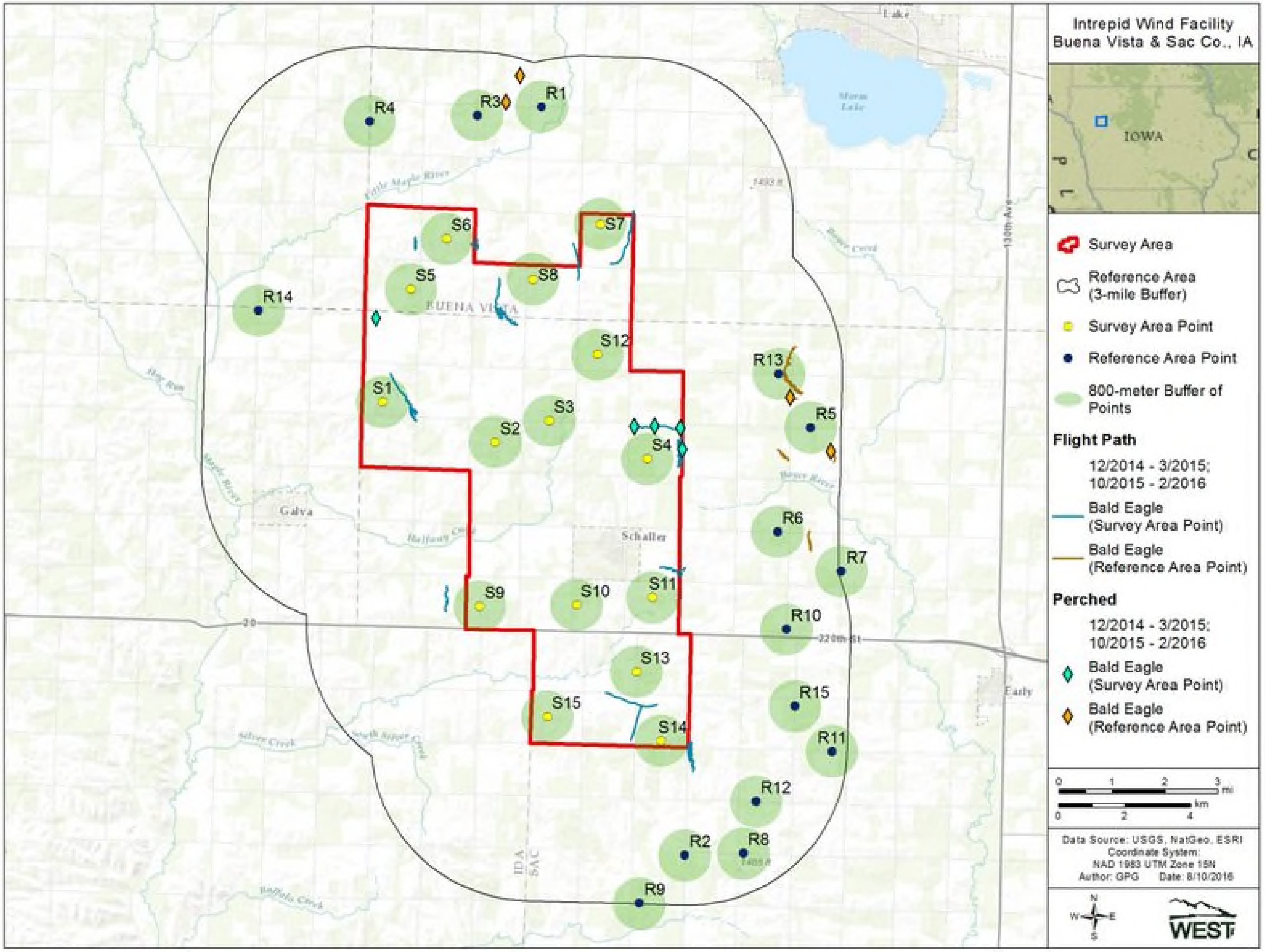

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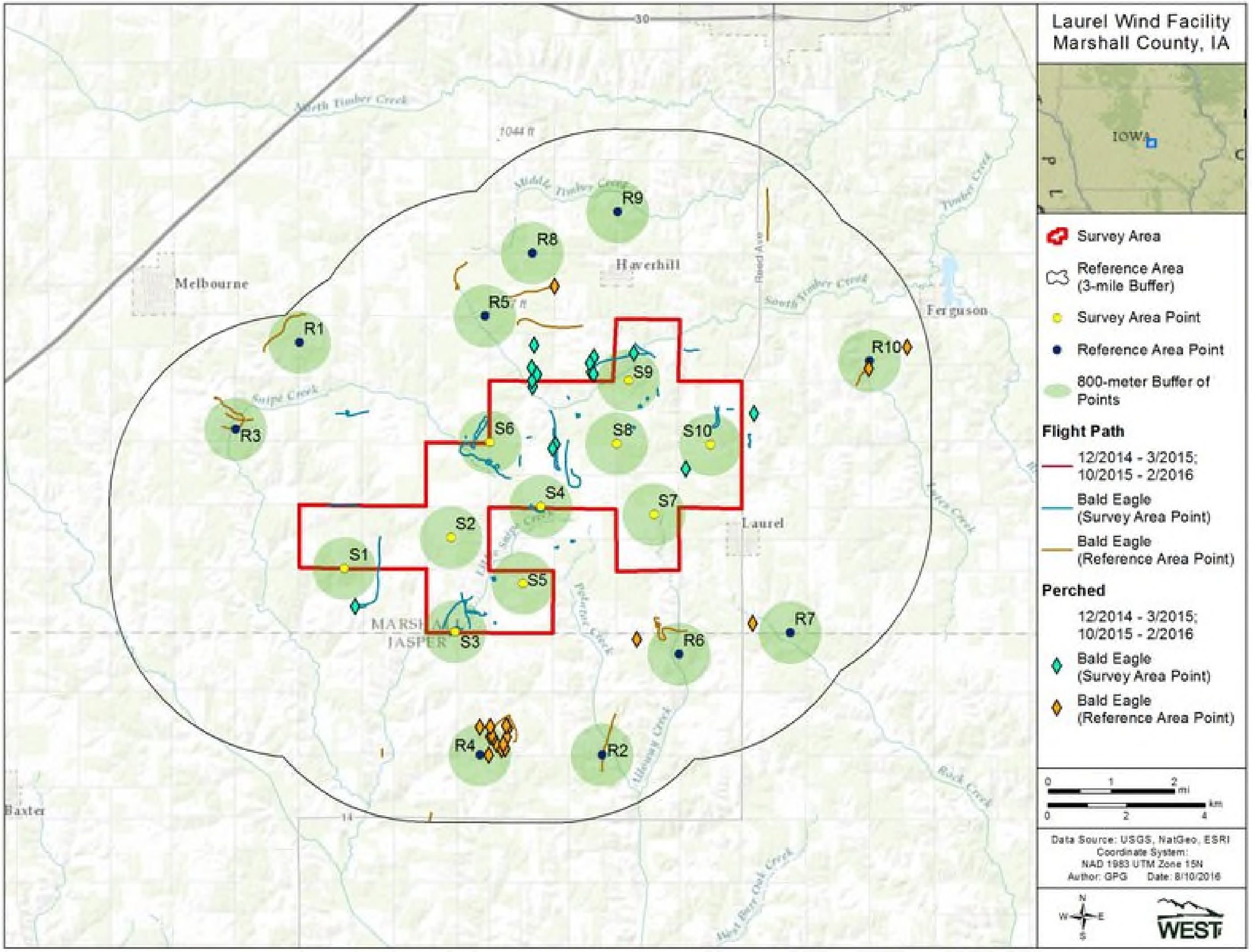

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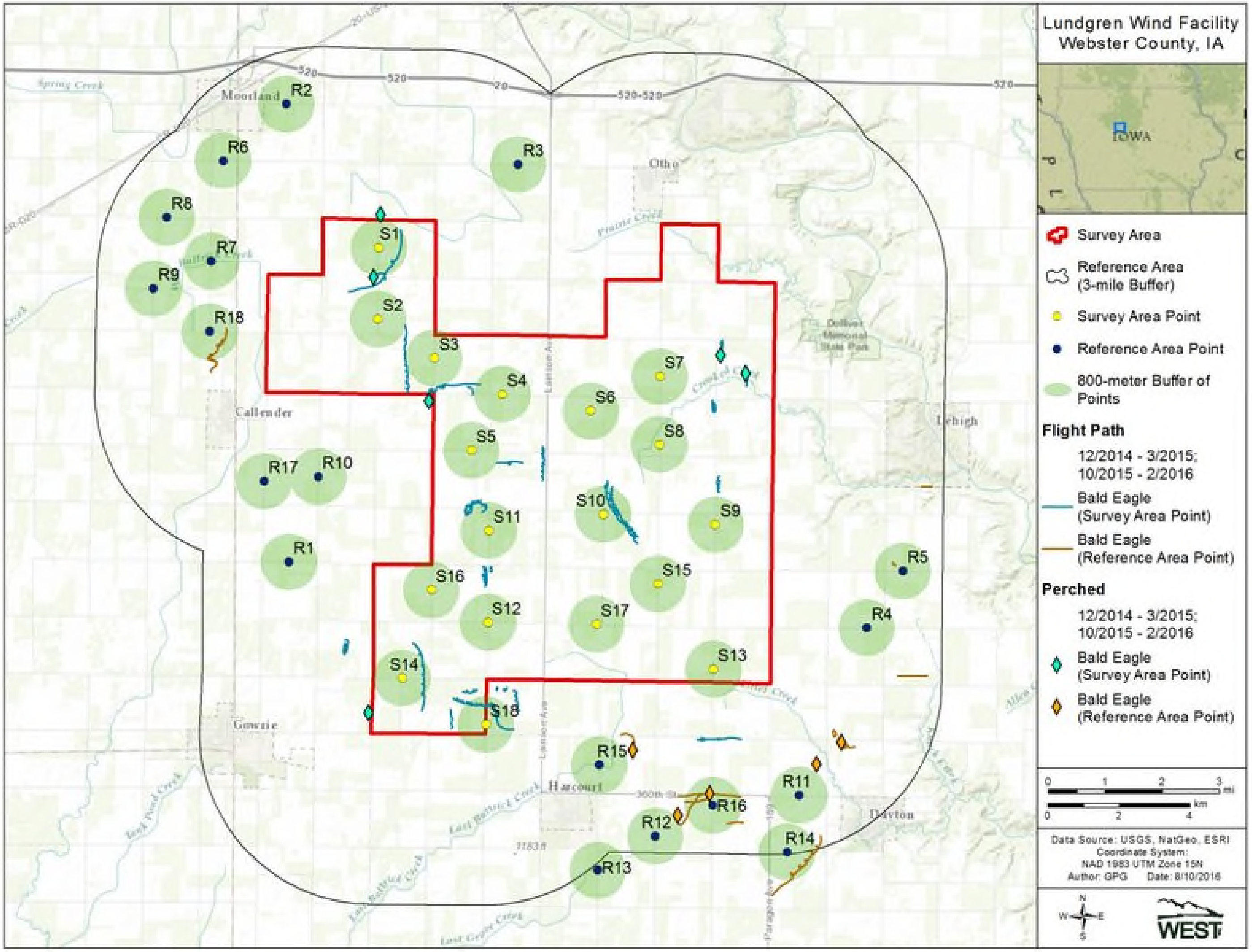

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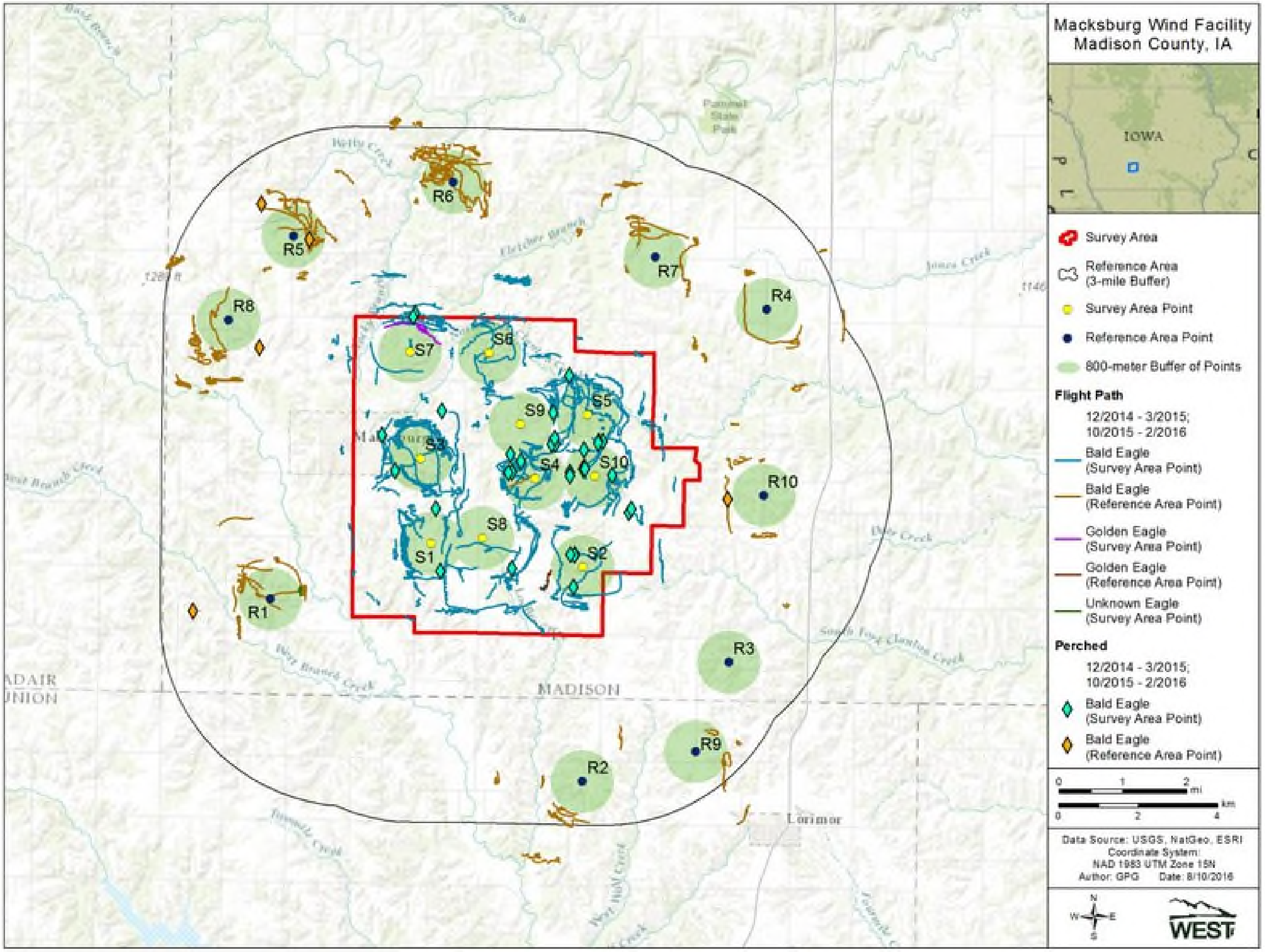

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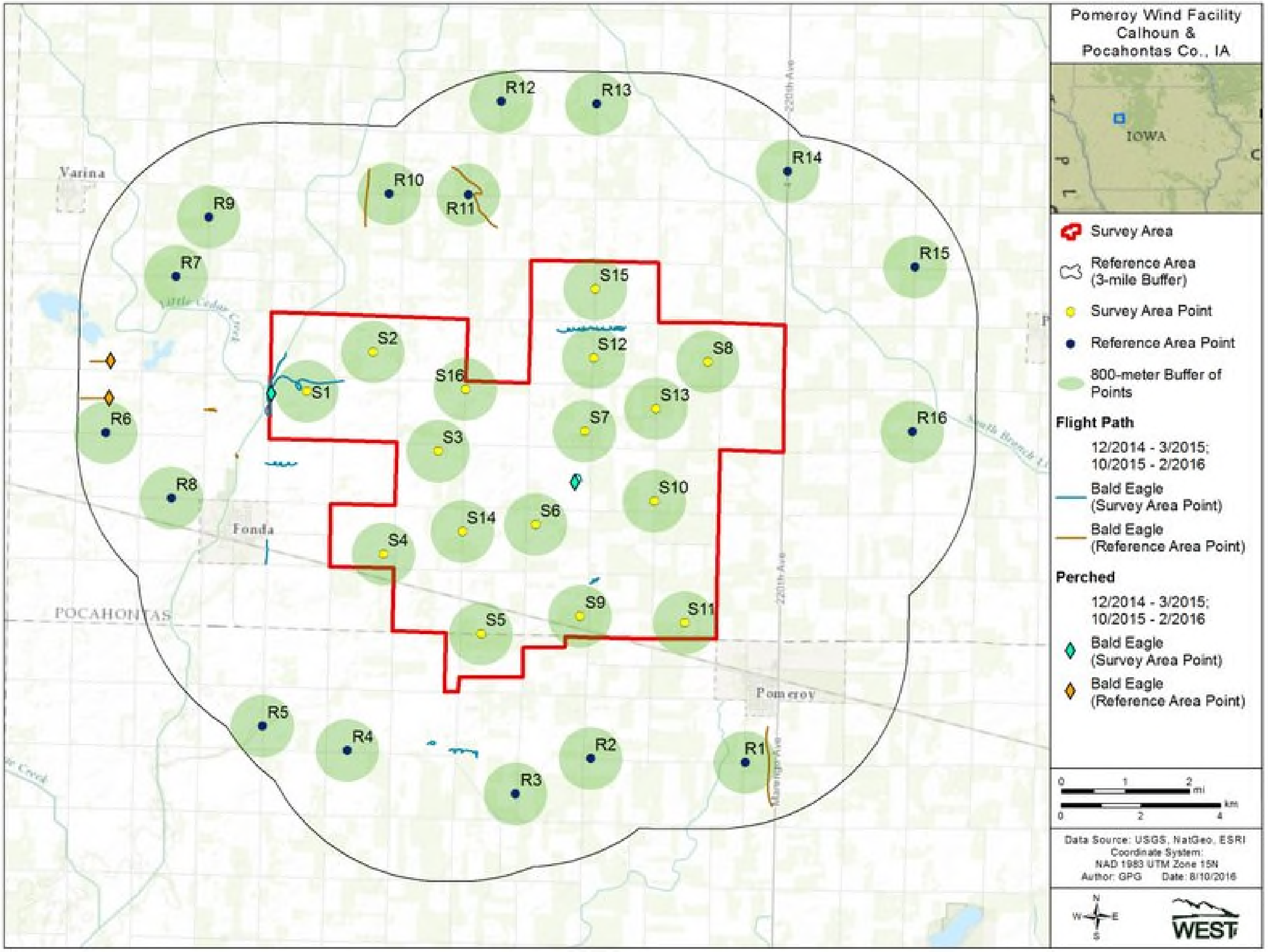

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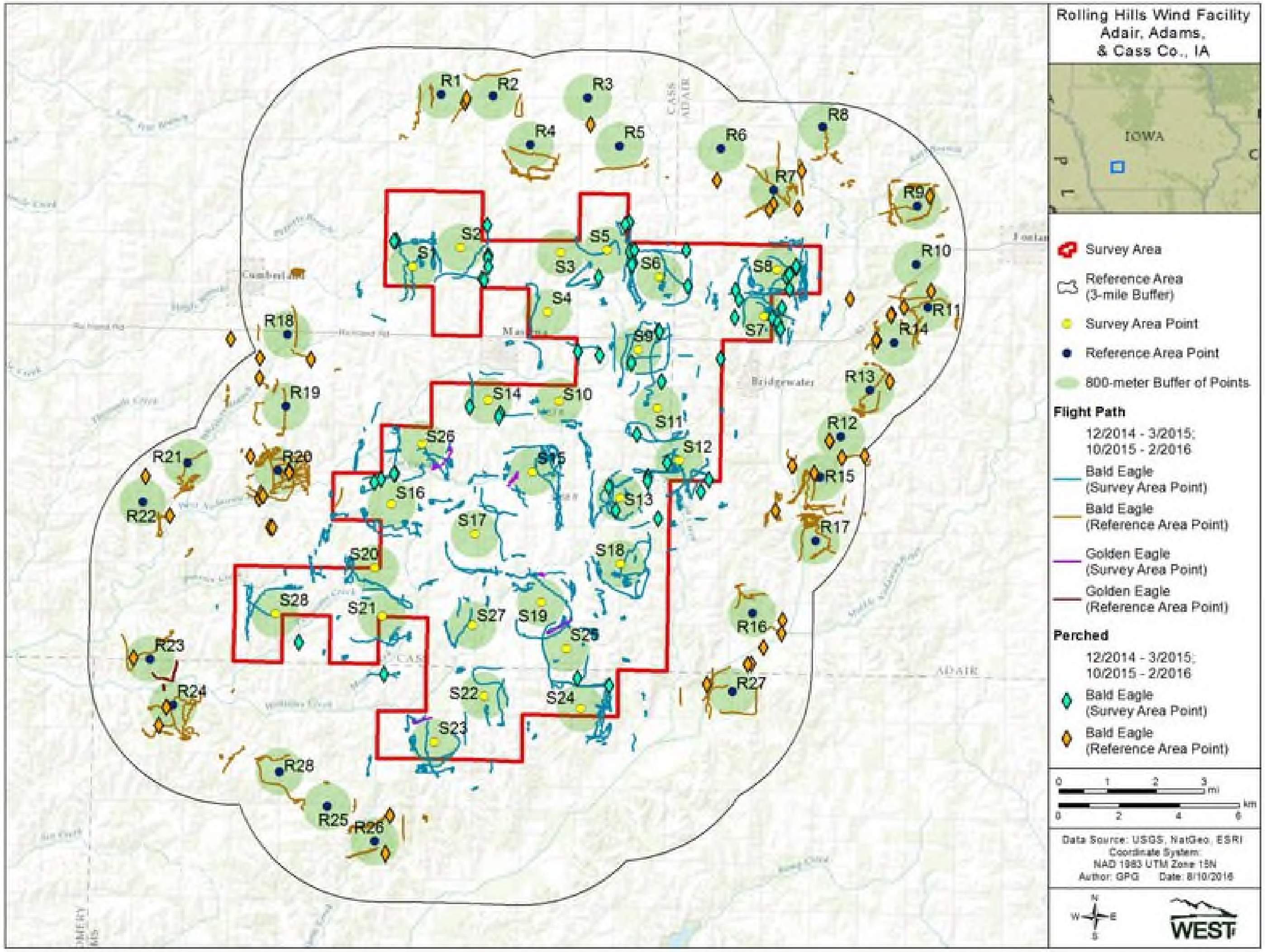

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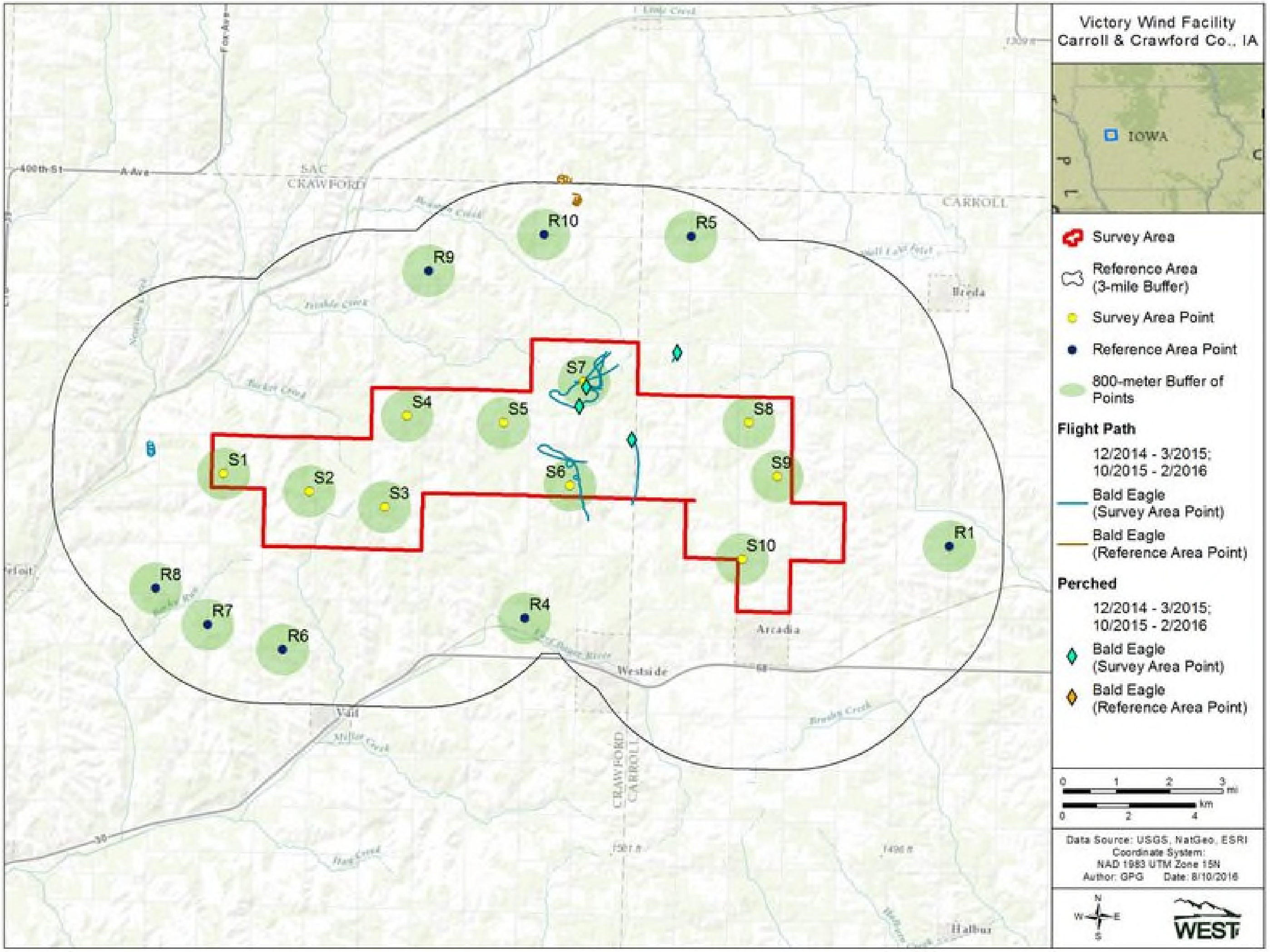

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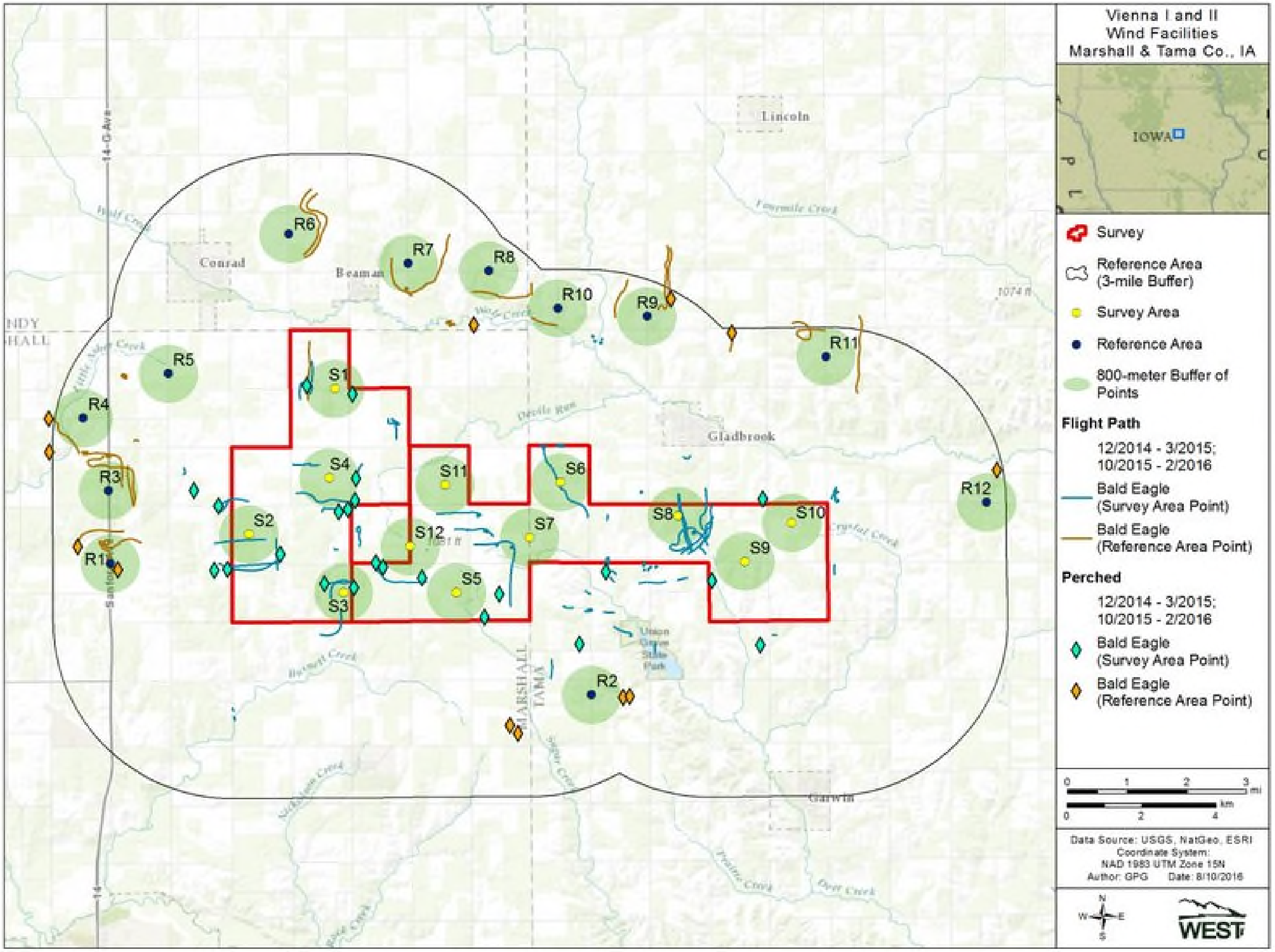

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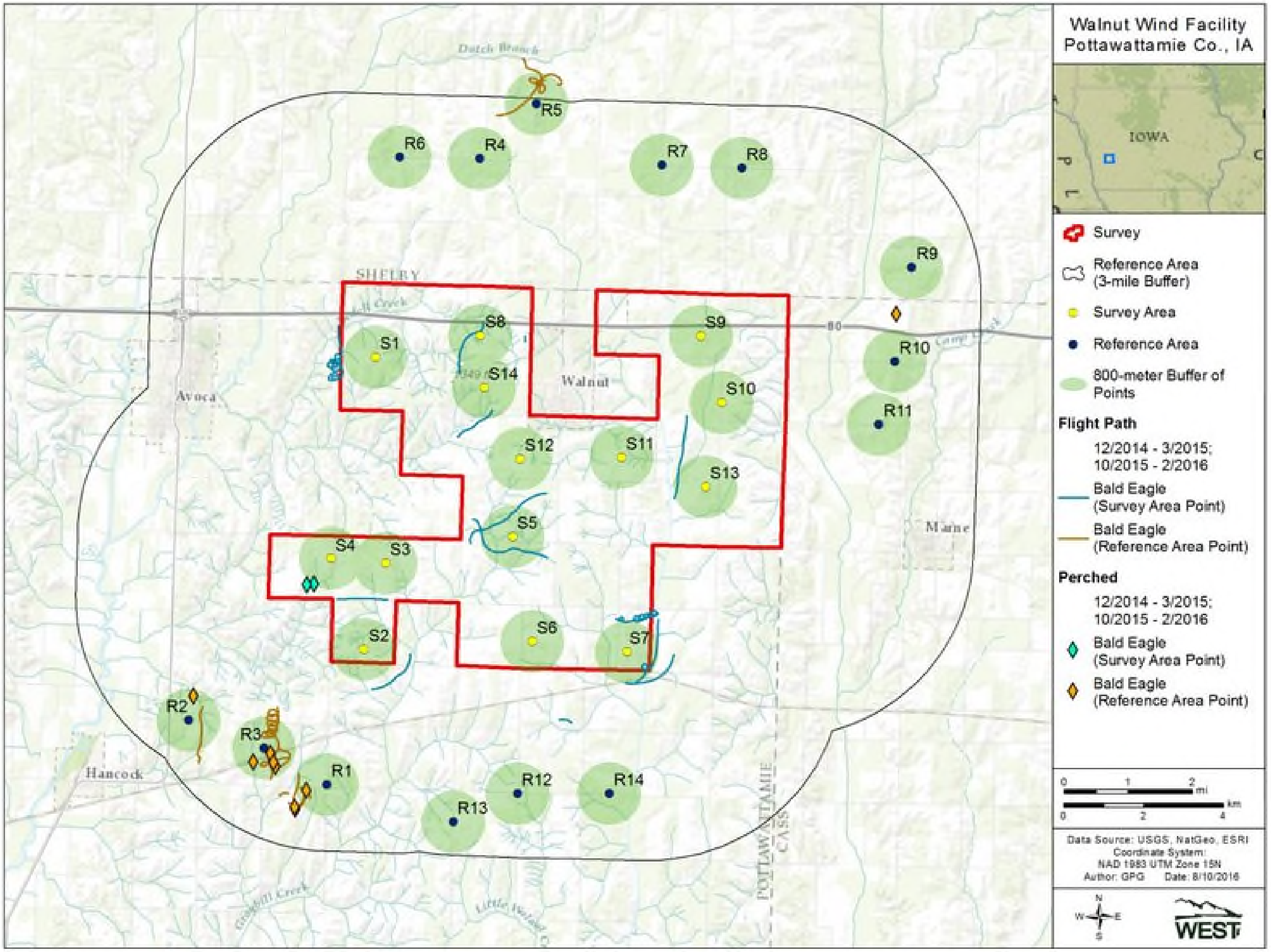

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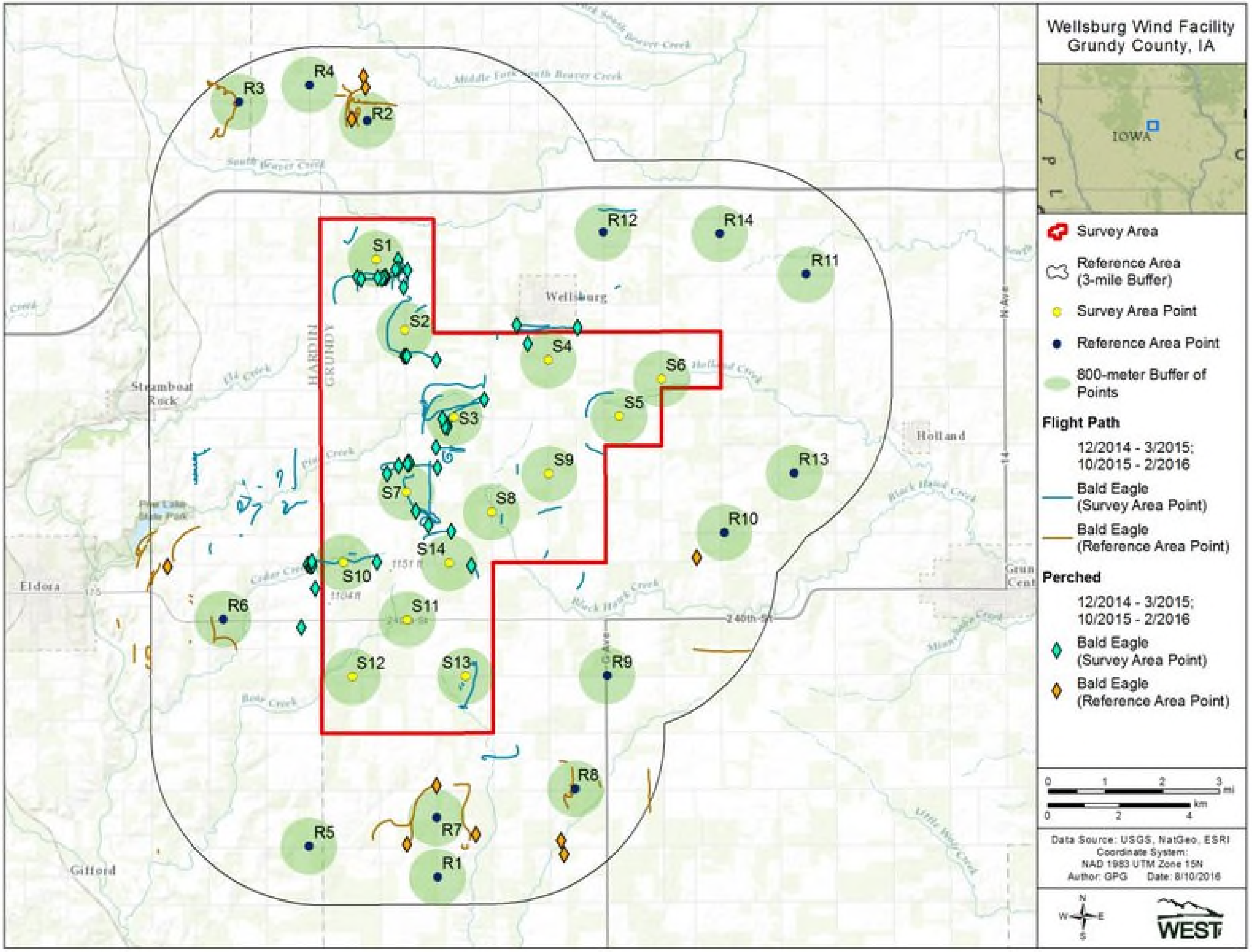

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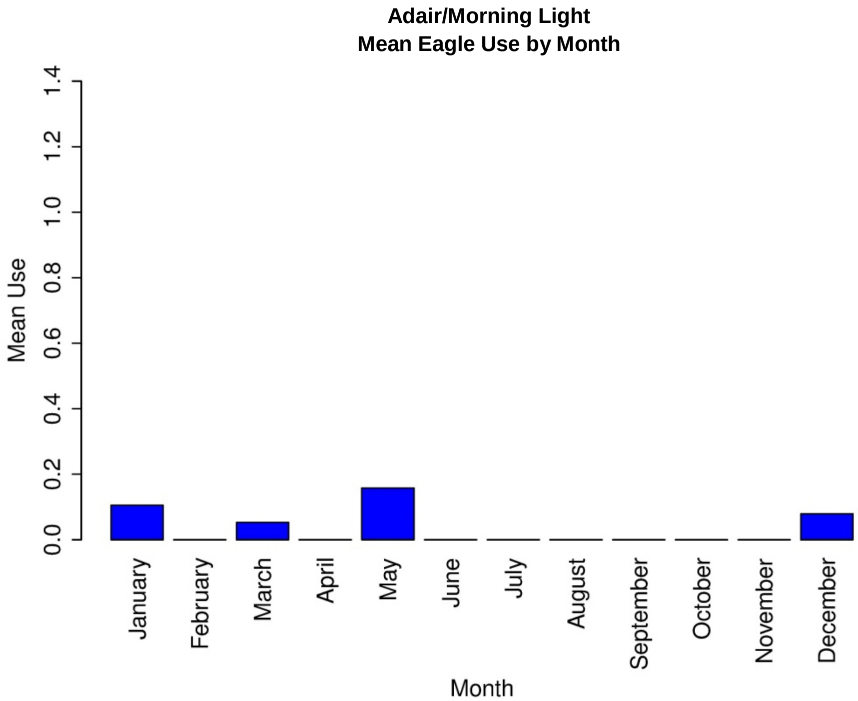
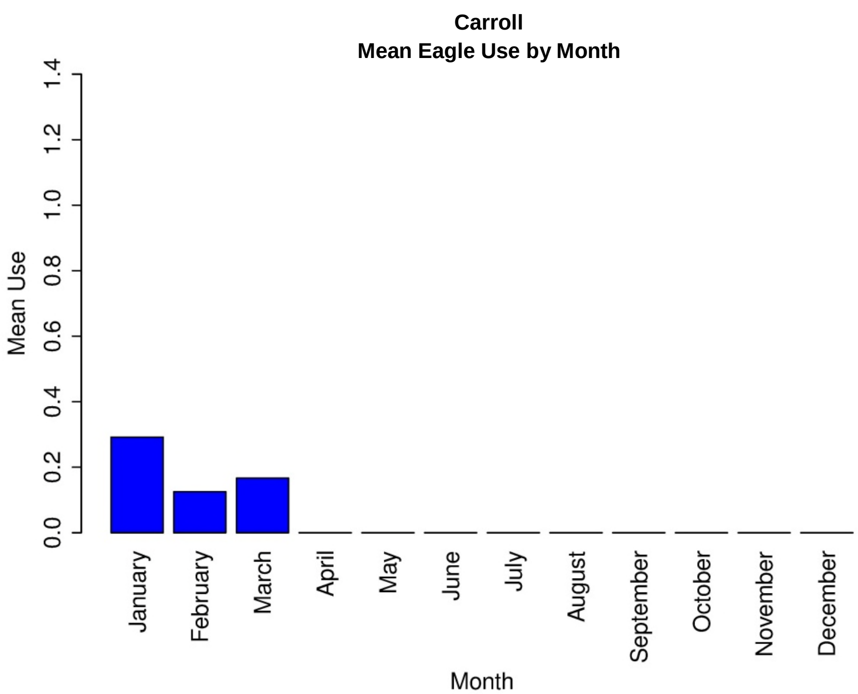
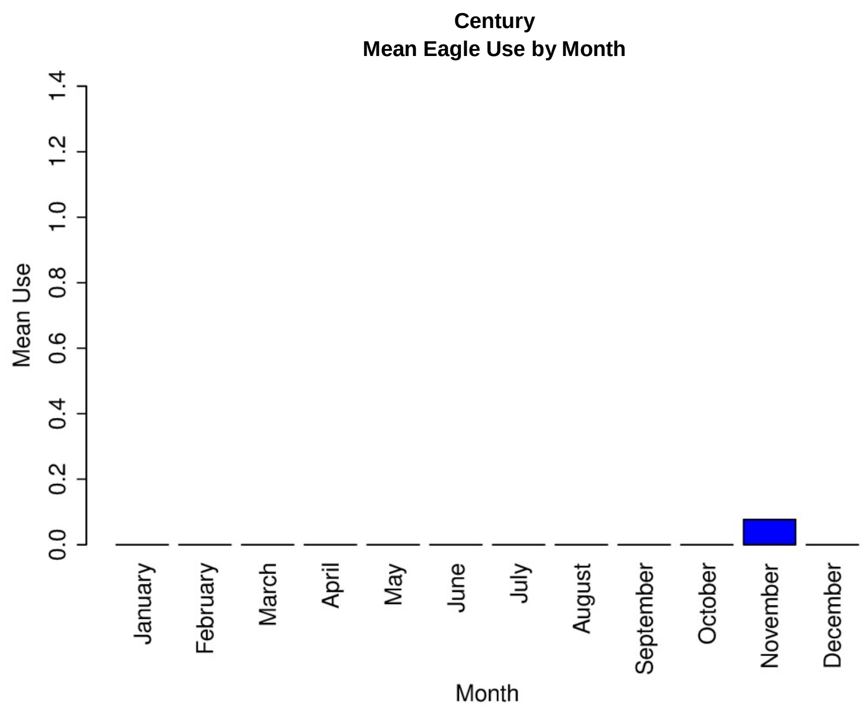
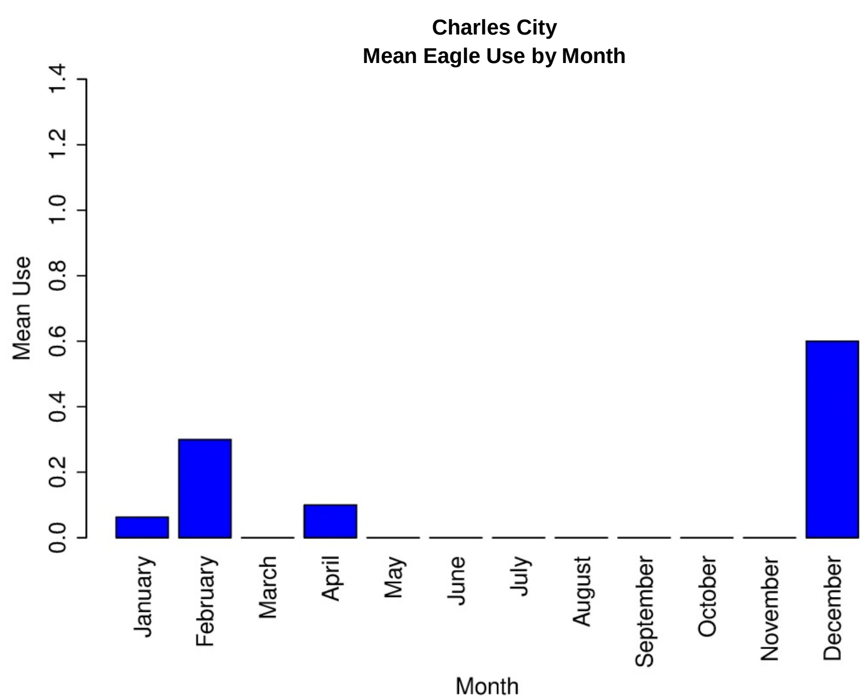
Appendix D: Monthly Mean Eagle Use at Project Points during Eagle Use Surveys Conducted at the 18 MidAmerican Wind Energy Facilities Studied from December 2014 to February 2016.



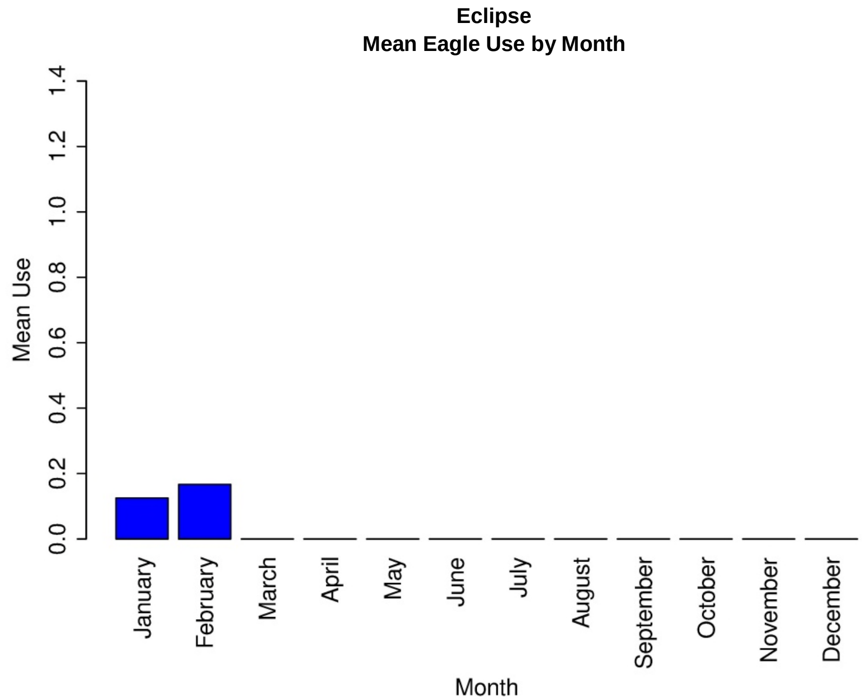


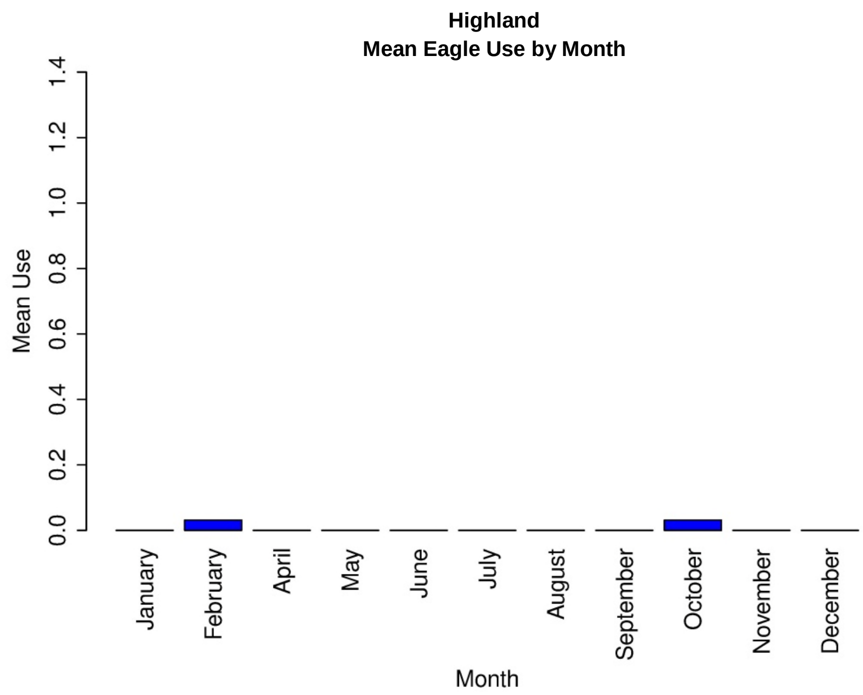
Appendix D1. Mean eagle use by month at the project points during eagle use surveys for the Adair/Morning Light (above) and Carroll (below) wind energy facilities from December 2014 to February 2016.



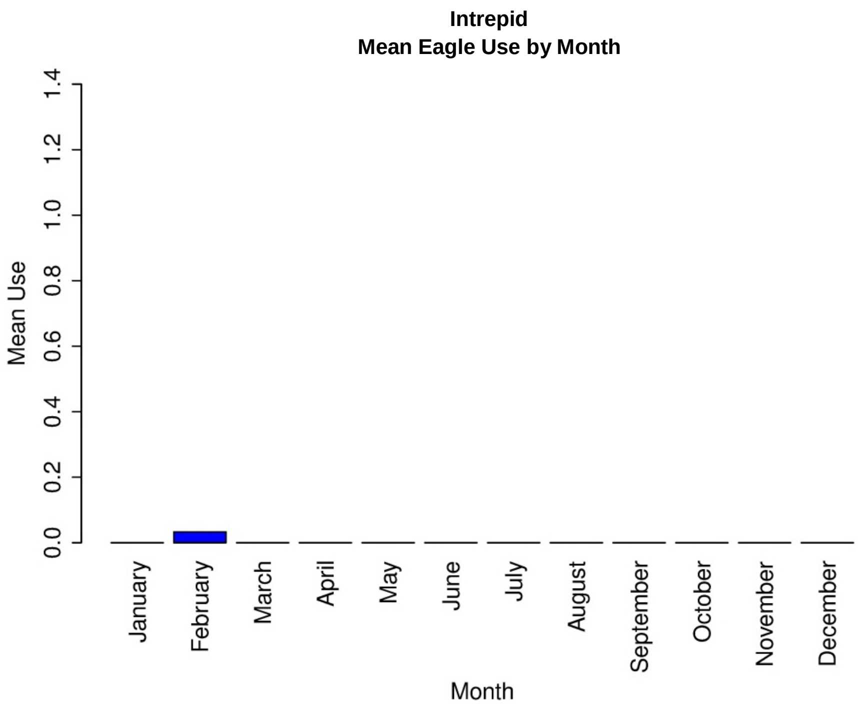


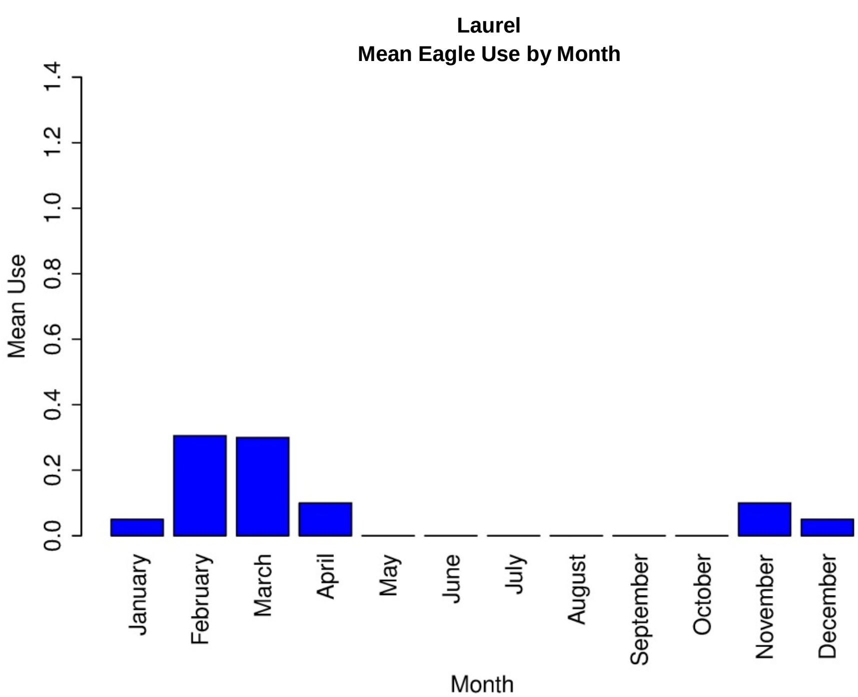
Appendix D2. Mean eagle use by month at the project points during eagle use surveys for the Century (above) and Charles City (below) wind energy facilities from December 2014 to February 2016.



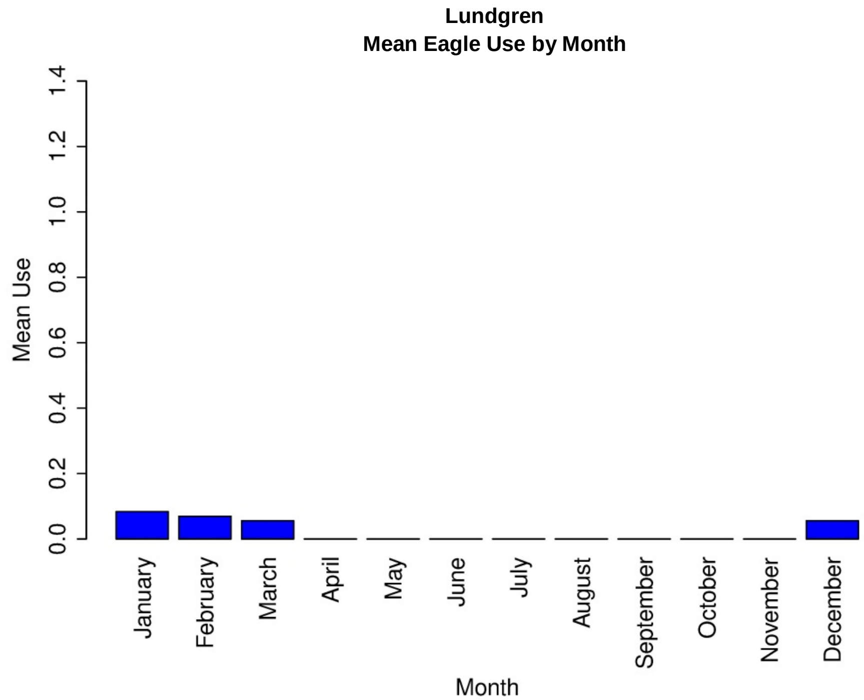


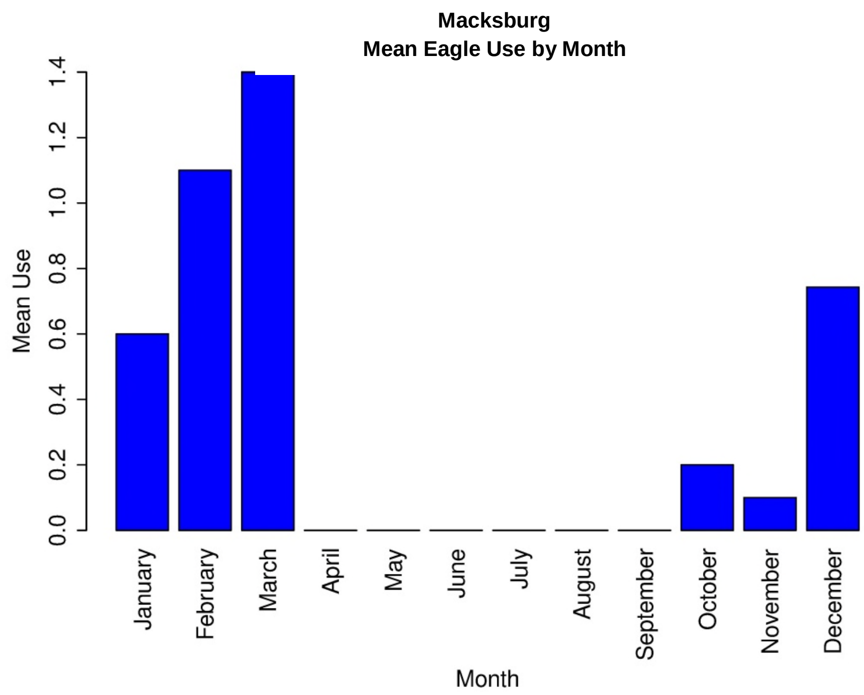
Appendix D3. Mean eagle use by month at the project points during eagle use surveys for the Eclipse (above) and Highland (below) wind energy facilities from December 2014 to February 2016.



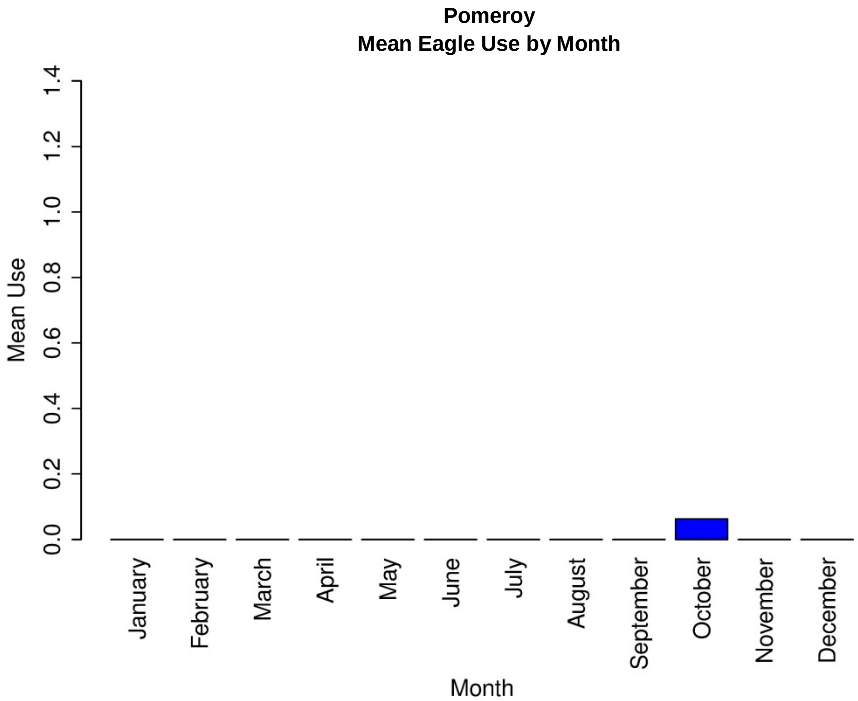


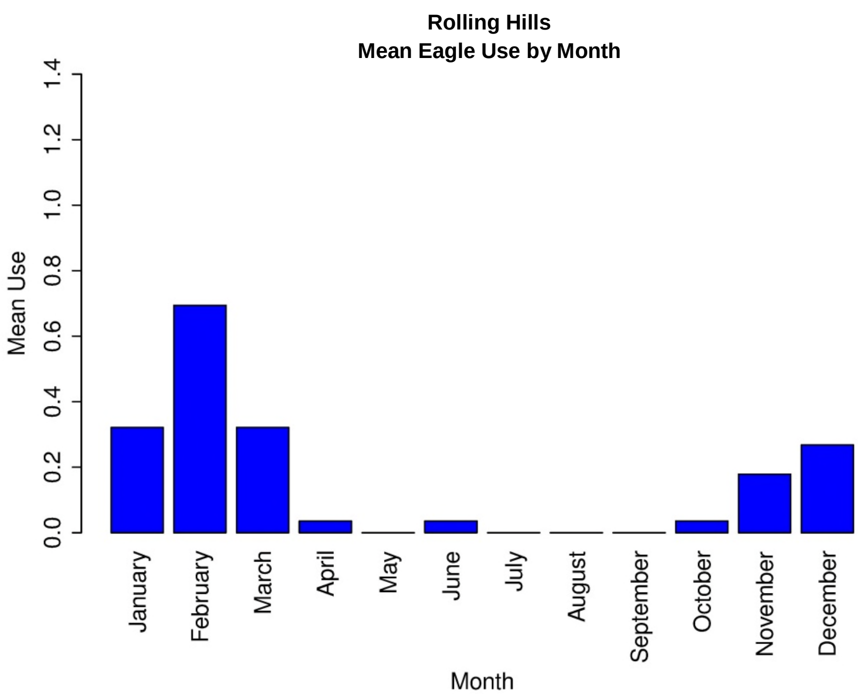
Appendix D4. Mean eagle use by month at the project points during eagle use surveys for the Intrepid (above) and Laurel (below) wind energy facilities from December 2014 to February 2016.



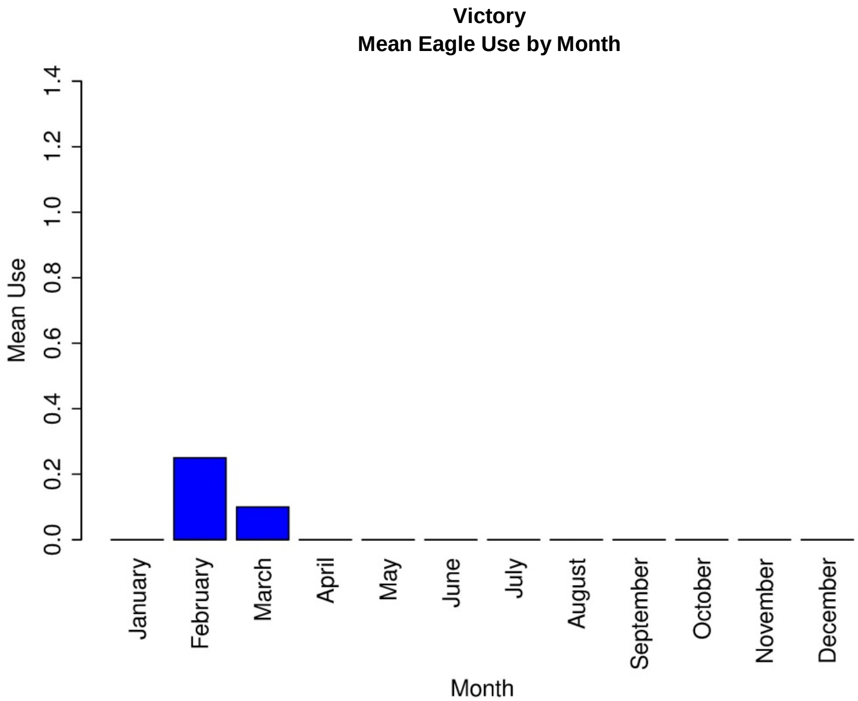


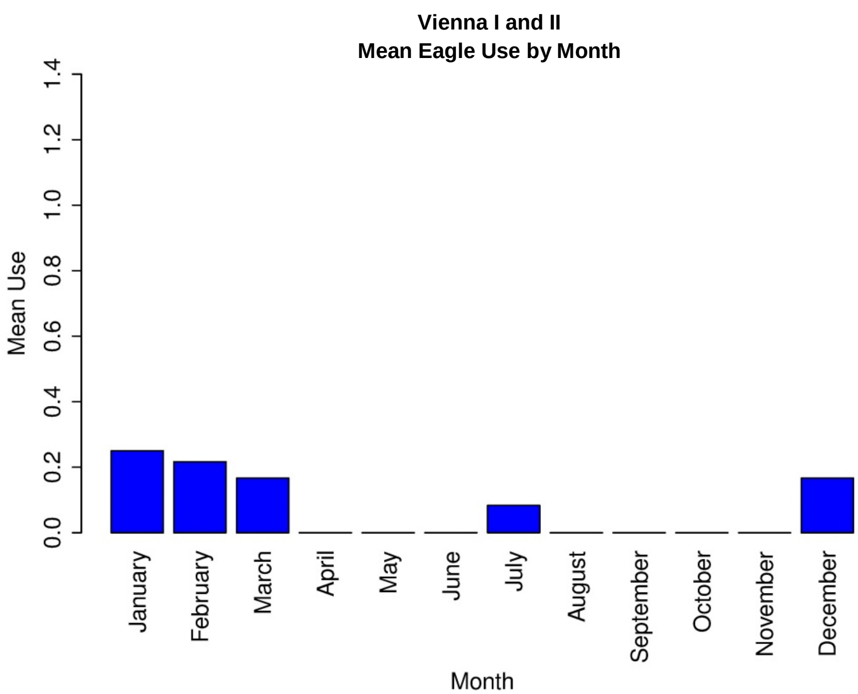
Appendix D5. Mean eagle use by month at the project points during eagle use surveys for the Lundgren (above) and Macksburg (below) wind energy facilities from December 2014 to February 2016.



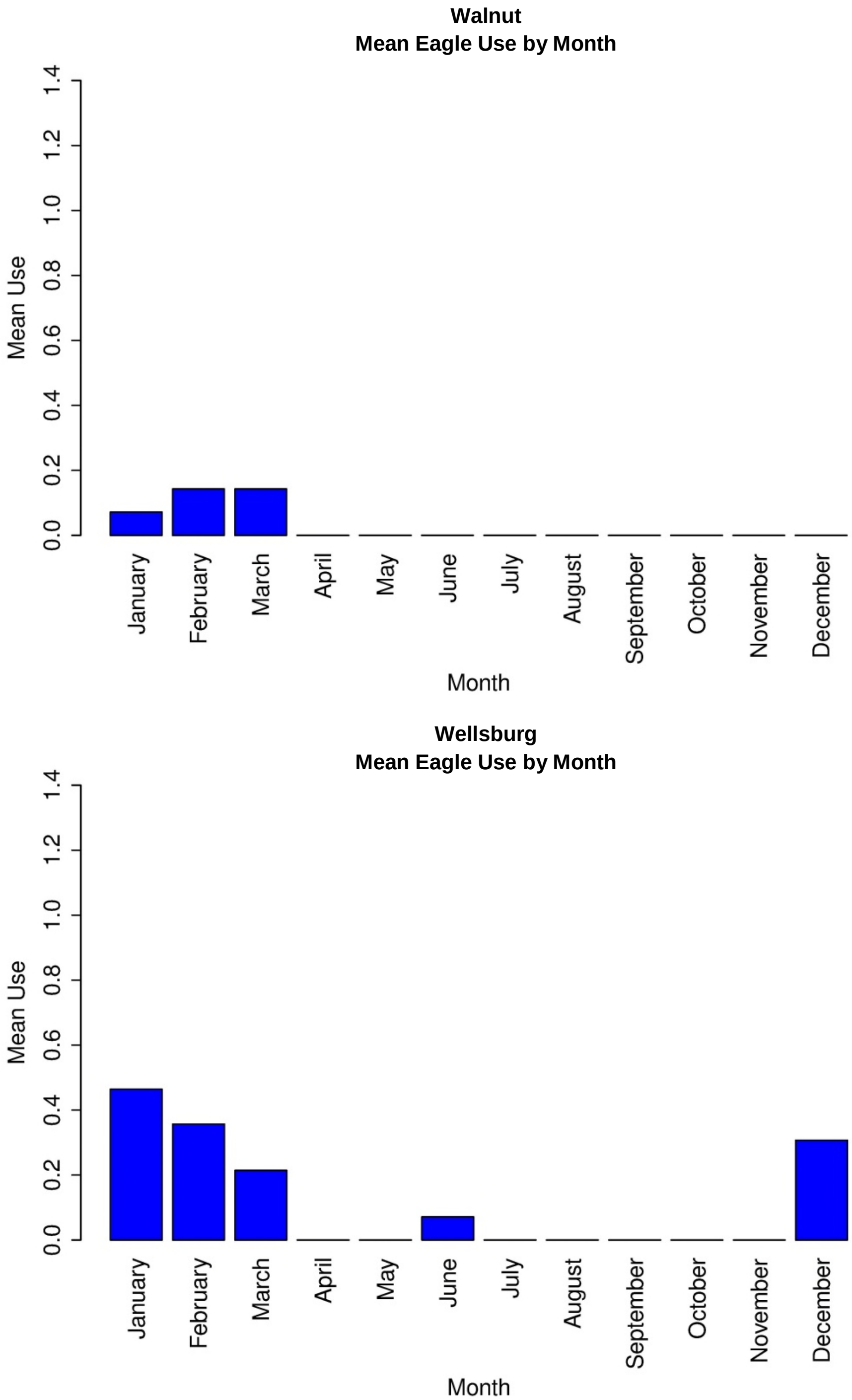


Appendix D6. Mean eagle use by month at the project points during eagle use surveys for the Pomeroy (above) and Rolling Hills (below) wind energy facilities from December 2014 to February 2016.





Appendix D7. Mean eagle use by month at the project points during eagle use surveys for the Victory (above), Vienna I, and Vienna II (below) wind energy facilities from December 2014 to February 2016.



Appendix D8. Mean eagle use by month at the project points during eagle use surveys for the Walnut (above) and Wellsburg (below) wind energy facilities from December 2014 to February 2016.

2015 Aerial Bald Eagle and Raptor Nest Survey

MidAmerican Energy Company

Iowa Wind Energy Portfolio

Prepared for:

MidAmerican Energy Company

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Prepared by:

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October 20, 2015

Revised January 25, 2017

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INTRODUCTION

MidAmerican Energy Company (MidAmerican) requested that Western EcoSystems Technology, Inc. (WEST) conduct aerial raptor nest surveys, including bald eagle (*Haliaeetus leucocephalus*) and other non-eagle raptors, at its 18 existing wind energy facilities in Iowa. This report describes the methodologies and results of these surveys. In conducting these nest surveys, WEST followed protocols based upon the most recent methods and recommendations provided in the U.S. Fish and Wildlife Service (USFWS) in the *Eagle Conservation Plan Guidance* (ECPG; USFWS 2013) and *Interim Golden Eagle Inventory and Monitoring Protocols; and Other Recommendations* (Pagel et al. 2010). Similar protocols have been implemented by WEST on numerous other wind energy projects in the agricultural regions of Iowa and the Midwestern U.S.

The principal objectives of the raptor nest surveys were to: (1) identify the species and estimate the density of nesting raptors, including eagles, at MidAmerican's 18 existing Iowa wind energy facilities and within the associated buffers; and (2) provide background information that could be used to assess risk to eagles and raptors from operation of the 18 Iowa wind energy facilities. Additional follow-up monitoring of eagle activity around those nests closest to the project facilities is also discussed in this report.

METHODS

Aerial Bald Eagle and Raptor Nest Surveys

WEST surveyed all potential bald eagle and raptor nest habitat at MidAmerican's Iowa wind energy facilities from March 27 to April 10, 2015 (Figure 1). All areas within the project footprints and two-mile buffers were surveyed for bald eagle nests. Additionally, WEST's bald eagle nest survey extended beyond the two-mile buffers in likely suitable habitat areas within five miles of the project boundaries (e.g., historically known nest sites, wooded riparian corridors, wildlife management areas). All other raptor stick nests were also documented within the project footprints and half-mile buffers.

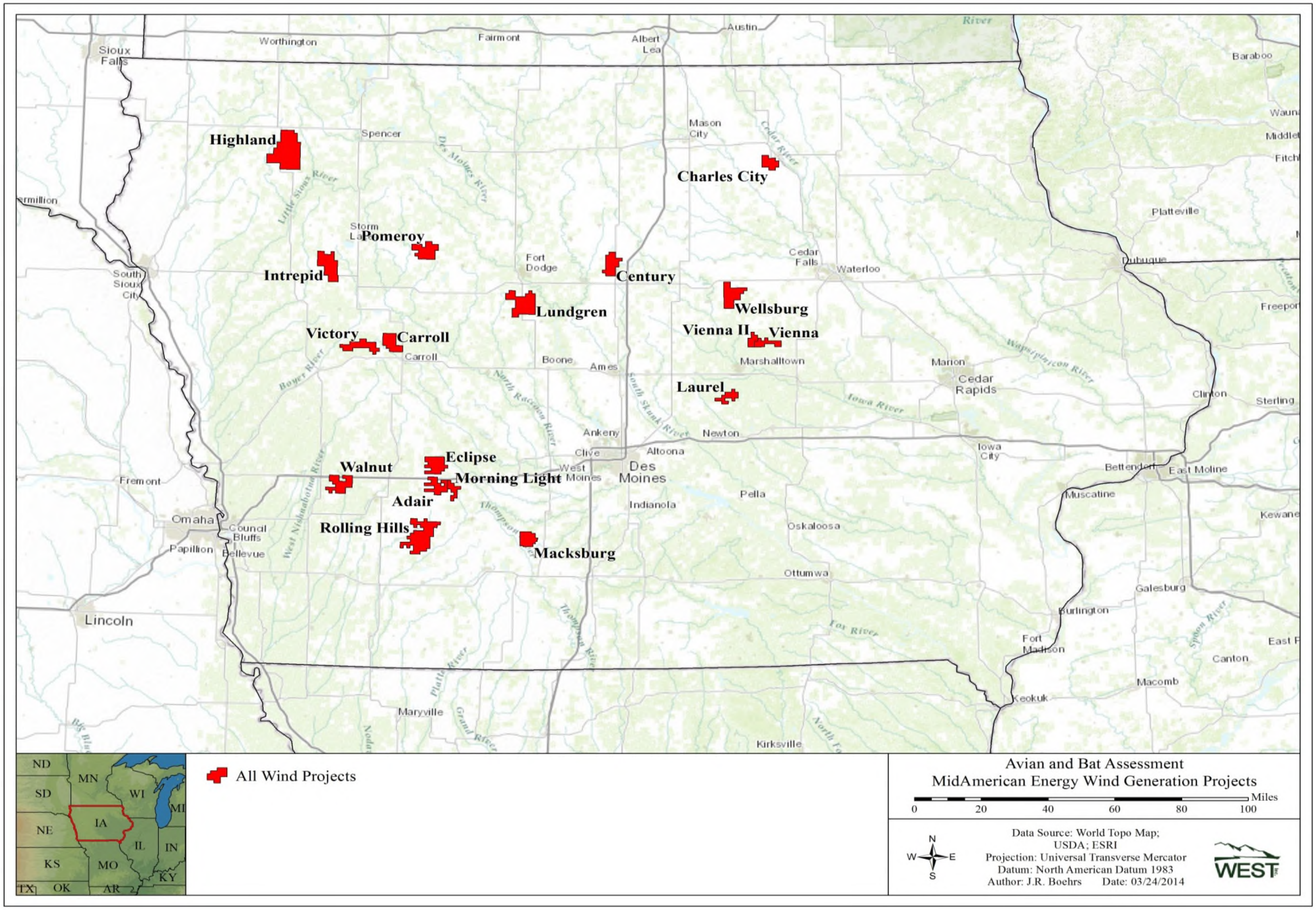

Figure 1. Location of the Iowa Wind Energy Facilities included in aerial raptor nest surveys conducted March 27 to April 10, 2015.

Aerial surveys were conducted from a helicopter by flying meandering transects between 0.25 and 0.5 mile ([mi]; 0.4 and 0.8 kilometers [km]) apart, flying at speeds of 60 to 75 miles per hour (mph) within MidAmerican's wind energy facility project footprints and associated buffers. The Iowa Department of Natural Resources (IDNR) provided historical bald eagle nest locations (IDNR 2013). WEST assessed the nest status and condition for all historical bald eagle nest locations that fell within the survey area.

Surveys were typically conducted between 08:00 hours and 17:00 hours. The locations of all potential raptor nests were recorded using a hand-held Global Positioning System (GPS); coordinates were set at Universal Transverse Mercator (UTMs) North American Datum (NAD) 83 unit. This included all confirmed and potential nests regardless of their activity status. To determine the status of a nest, the biologist relied on clues that included behavior of adults and presence of eggs, young, or whitewash. WEST attempted to identify the species of raptor associated with each occupied/active nest. Raptor species, nest type, nest status, nest condition, and substrate, were recorded at each nest location to the extent possible. The field biologists took photographs of potential and historical bald eagle nests whenever possible (Appendix A).

Terminology

Included below are descriptions of terms used during the documentation of nests (see Results section).

Nest Identification (ID) - WEST assigned a unique nest identification number for each nest documented.

Species - A species was assigned to each nest when possible; otherwise, it was classified as an unknown raptor nest. Nests documented as unknown raptor species are defined as any stick nest that did not have an occupant associated with it at the time of the survey. Many times, nests will become abandoned or no longer used and, over time, may become a historic nest site. Unknown raptor nests, including old nests or nests that could become suitable for raptors, are documented in order to populate a nest database to ensure that future surveys include all potentially suitable nest sites.

Nest Condition - Nest condition was categorized using descriptions ranging from poor to excellent. Although the determination of nest condition can be subjective and may vary between observers, it gives a general sense of when a nest or nest site may have last been used. Nests in poor to fair condition are typically in disrepair, sloughing, or sagging heavily, and would require some level of effort to rebuild in order to be suitable for successful nesting. Nests in good to excellent condition are those that appear to have been well maintained, have a well-defined bowl shape, are not sagging or sloughing, and appear to be suitable for nesting.

Substrate - The substrate in which a nest was observed was recorded to provide observers a visual reference. Substrates range from manmade structures (such as power lines, nest platforms, and dock hoists) to biological and physical structures (conifer and deciduous tree species).

Nest Status - WEST categorizes basic nest use consistent with definitions from the USFWS ECPG (April 2013). Nests were classified as occupied if any of the following were observed at the nest structure: (1) an adult in an incubating position, (2) eggs, (3) nestlings or fledglings, (4) occurrence of a pair of adults (sometimes sub-adults), (5) a newly constructed or refurbished stick nest in the area where territorial behavior of a raptor had been observed early in the breeding season, or (6) a recently repaired nest with fresh sticks (clean breaks) or fresh boughs on top, and/or droppings and/or molted feathers on its rim or underneath. Occupied nests were further classified as active if an egg or eggs had been laid or nestlings were observed, or inactive if no eggs or chicks were present. A nest that did not meet the above criteria for "occupied" was classified as "unoccupied".

Follow-up Ground Nest Monitoring Surveys

During May and June 2015, WEST biologists conducted follow-up ground surveys to monitor eagle activity at two occupied/active eagle nests that were found within two miles of the MidAmerican wind energy facilities. WEST biologists conducted follow-up ground nest monitoring surveys at one occupied bald eagle nest (nest ID 0) that was located in the northeast two-mile buffer at the Charles City Wind Energy Facility. Three bald eagle nest-monitoring surveys were conducted at the Charles City Wind Energy Facility on May 19 and 29 and June 30, 2015. An attempt was made to monitor the occupied bald eagle nest (nest ID 0) located in the northeast two-mile buffer at the Lundgren Wind Energy Facility; however, the nest could not be located due to full leaf out conditions and limited public road access to this nest site.

The bald eagle nest monitoring surveys consisted of one 800-meter (m) radius fixed point established on public roads near the occupied bald eagle nest, following methods similar to Reynolds et al. (1980) and consistent with recommendations outlined in the ECPG. The monitoring plot was located approximately 150 m from the bald eagle nest (Figure 2). The nest monitoring plot was established to attempt to document flight paths of the bald eagles in an effort to determine the nesting territory and surrounding use area in relation to the Charles City Wind Energy Facility.

Biologists recorded all eagles seen during each survey, regardless of distance to the observer. Estimated distance to each bird observed was recorded to the nearest five meters. Landmarks were located to aid in estimating distances to each bird. Point count duration was four hours during each monitoring event, except for the initial event which was conducted for 15 minutes to locate nest from public road access and confirm nest occupancy. The date, start, and end time of observation period, plot number, number of individuals, sex and age class (if possible), distance from plot center when first observed (in m), closest distance (m), height above ground (m), activity, and habitat were recorded.

Biologists recorded eagle behavior and habitat for each eagle observation during each one-minute interval the bird was within view, per the USFWS ECPG. Behavior categories included soaring flight, flapping-gliding, hunting, kiting-hovering, stooping/diving at prey, stooping or diving in an antagonistic context with other bird species perched, being mobbed, undulating/territorial flight, auditory, and other (noted in comments). The initial flight patterns and habitat types (at first observation) were uniquely identified on the data sheet and subsequent patterns and habitats were also recorded. The flight directions of observed bald eagles were recorded on the data sheet map. Approximate flight height at first observation was recorded to the nearest five meters; the approximate lowest and highest flight heights observed were also recorded. The WEST biologist also noted any unusual observations in the comments section of the data forms. Weather information recorded for each survey point included temperature, wind speed, wind direction, precipitation, and cloud cover.

RESULTS

Aerial Bald Eagle and Raptor Nest Surveys

WEST biologists conducted aerial surveys for eagle and raptor nests at MidAmerican's wind energy facilities from March 27 – April 10, 2015. Detailed summaries of the aerial raptor nest surveys conducted at each of MidAmerican's facilities is included in Appendices B through Q. Summaries include wind energy facility description, survey dates, nesting species, total nests, nest densities, nest location, nest status, and condition of nest.

Overall, a total of 25 bald eagle nests were documented at 11 of MidAmerican's wind energy facilities (Table 1). An additional eight historical bald eagle nests were not located during surveys. Of the bald eagle nests located, 18 were occupied and active with one adult sitting on the nest in an incubating position, and the remaining seven considered potential bald eagle nests (Table 1). Total number of bald eagle nests documented at each facility ranged from one bald eagle nest at the Vienna I&II Wind Energy Facility to nine bald eagle nests at the Lundgren Wind Energy Facility (Table 1; Appendices B through

Q; includes occupied, unoccupied, and did not locate nests). Of these sites, Lundgren, Charles City, Rolling Hills, and Wellsburg wind energy facilities had more than one occupied active bald eagle nest within the surveyed areas (four, two, two, and two, respectively; Table 1). The majority (21 of the 25) bald eagle nests (includes occupied and unoccupied only), were located greater than 2 miles from MidAmerican's wind energy facilities (Table 1) and were typically located along a large river or other large body of water (Appendices E, J, M, and Q). No bald eagle nests were documented within any of MidAmerican's wind energy facility boundaries (Table 1; Appendices B through Q).

Only two bald eagle nests were located within two miles of MidAmerican's wind energy facilities. This included one occupied, active bald eagle nest at the Charles City Wind Energy Facility and a second occupied, active bald eagle nest at the Lundgren Wind Energy Facility (Table 1; Appendices E and J).

Excluding eagles, a total of 267 other raptor nests were documented at all of MidAmerican's wind energy facilities and associated buffers during aerial nest surveys (Table 1; Appendices B through Q). Typical non-eagle raptor nests that WEST documented included red-tailed hawk (*Buteo jamaicensis*; 103 nests) and unknown raptor (153 nests; Appendix B). Adair and Morning Light (42 nests), Laurel (27 nests), Macksburg (30 nests), Rolling Hills (58 nests), and Walnut (28 nests) facilities had the largest number of non-eagle raptor nests out of all of the facilities (Table 1; Appendices B, I, K, M, and P). At each of the Carroll, Highland, and Pomeroy facilities, one great blue heron (*Ardea herodias*) rookery was documented (Appendices C, G, and L). For all of MidAmerican's wind energy facilities, non-eagle raptor nests appear to be most prevalent near the outer edge of the wind energy facilities (Appendices B through Q).

Based on the results of this survey, overall eagle nest density was typically between 0.01 and 0.02 eagle nests per square mile (Table 2). Highest eagle nest density was within the 0.5-mi buffer for the Rolling Hills Wind Energy Facility (Table 2). No Federal- or State-threatened or endangered species were documented during raptor nest surveys at MidAmerican's wind energy facilities.

Table 1. Bald eagle and non-eagle raptor nests documented during raptor nest surveys conducted March 27 – April 10, 2015, within the Iowa Wind Energy Facilities and the associated buffers.

Project	Area of Interest	Bald Eagle			Non-Eagle Raptors†		Total
		Occupied	Unoccupied*	Did Not Locate**	Occupied	Unoccupied	
Adair/Morning Light	Project area	0	0	0	6	16	**22**
	0.5-mi buffer	0	0	0	5	6	**11**
	2-mi buffer	0	0	0	6	0	**6**
	informed 5-mi buffer	0	0	0	3	0	**3**
Carroll	Project area	0	0	0	1	2	**3**
	0.5-mi buffer	0	0	0	1	0	**1**
	2-mi buffer	0	0	0	0	0	**0**
	informed 5-mi buffer	1	1	2	0	0	**4**
Century	Project area	0	0	0	0	2	**2**
	0.5-mi buffer	0	0	0	0	1	**1**
	2-mi buffer	0	0	0	0	0	**0**
	informed 5-mi buffer	1	1	0	0	0	**2**
Charles City	Project area	0	0	0	0	2	**2**
	0.5-mi buffer	0	0	0	0	2	**2**
	2-mi buffer	1	0	0	0	1	**2**
	informed 5-mi buffer	1	0	0	1	0	**2**
Eclipse	Project area	0	0	0	1	6	**7**
	0.5-mi buffer	0	0	0	1	2	**3**
	2-mi buffer	0	0	0	0	0	**0**
	informed 5-mi buffer	0	0	0	0	0	**0**
Highland	Project area	0	0	0	4	7	**11**
	0.5-mi buffer	0	0	0	0	2	**2**
	2-mi buffer	0	0	0	0	0	**0**
	informed 5-mi buffer	1	0	2	0	0	**3**
Intrepid	Project area	0	0	0	1	3	**4**
	0.5-mi buffer	0	0	0	0	0	**0**
	2-mi buffer	0	0	0	0	0	**0**
	informed 5-mi buffer	0	0	0	0	0	**0**

Table 1 Continued. Bald eagle and non-eagle raptor nests documented during raptor nest surveys conducted March 27 – April 10, 2015, within the Iowa Wind Energy Facilities and the associated buffers.

Project	Area of Interest	Bald Eagle			Non-Eagle Raptors†		Total
		Occupied	Unoccupied*	Did Not Locate**	Occupied	Unoccupied	
Laurel	Project area	0	0	0	3	3	**6**
	0.5-mi buffer	0	0	0	5	12	**17**
	2-mi buffer	0	0	0	4	0	**4**
	informed 5-mi buffer	0	0	0	0	0	**0**
Lundgren	Project area	0	0	0	0	0	**0**
	0.5-mi buffer	0	0	0	1	3	**4**
	2-mi buffer	1	1	2	1	0	**5**
	informed 5-mi buffer	3	1	1	1	0	**6**
Macksburg	Project area	0	0	0	5	6	**11**
	0.5-mi buffer	0	0	0	6	6	**12**
	2-mi buffer	0	0	0	2	1	**3**
	informed 5-mi buffer	2	0	0	2	2	**6**
Pomeroy	Project area	0	0	0	0	1	**1**
	0.5-mi buffer	0	0	0	0	2	**2**
	2-mi buffer	0	0	0	1	0	**1**
	informed 5-mi buffer	1	0	1	0	0	**2**
Rolling Hills	Project area	0	0	0	12	11	**23**
	0.5-mi buffer	0	1	0	8	11	**20**
	2-mi buffer	0	0	0	6	3	**9**
	informed 5-mi buffer	2	0	0	6	1	**9**
Victory	Project area	0	0	0	0	3	**3**
	0.5-mi buffer	0	0	0	2	0	**2**
	2-mi buffer	0	0	0	1	0	**1**
	informed 5-mi buffer	0	0	0	1	1	**2**
Vienna I&II	Project area	0	0	0	2	0	**2**
	0.5-mi buffer	0	0	0	0	2	**2**
	2-mi buffer	0	0	0	4	0	**4**
	informed 5-mi buffer	1	0	0	3	1	**5**

Table 1 Continued. Bald eagle and non-eagle raptor nests documented during raptor nest surveys conducted March 27 – April 10, 2015, within the Iowa Wind Energy Facilities and the associated buffers.

Project	Area of Interest	Bald Eagle			Non-Eagle Raptors†		Total
		Occupied	Unoccupied*	Did Not Locate**	Occupied	Unoccupied	
Walnut	Project area	0	0	0	2	5	**7**
	0.5-mi buffer	0	0	0	5	7	**12**
	2-mi buffer	0	0	0	2	5	**7**
	informed 5-mi buffer	1	1	0	2	0	**4**
Wellsburg	Project area	0	0	0	1	2	**3**
	0.5-mi buffer	0	0	0	2	1	**3**
	2-mi buffer	0	0	0	0	0	**0**
	informed 5-mi buffer	2	1	0	5	1	**9**
Total		**18**	**7**	**8**	**125**	**142**	**300**

† - Non-eagle raptors includes red-tailed hawk, barred owl, unknown owl, unknown accipiter; and unknown raptor
* - Unoccupied nests were considered potential bald eagle nests
** - Did not locate status pertains to historical nests only

Table 2. Bald eagle nest density documented during raptor nest surveys conducted March 27 – April 10, 2015, within the within the Iowa Wind Energy Facilities and the associated buffers where bald eagles were documented.

Project	Density of Bald Eagle Nests*			
	Within Project Area	Within 0.5-mi Buffer of Project Area	Within 2-mi Buffer of Project Area	Within Informed 5-mi Buffer of Project Area
Carroll	0	0	0	0.02
Century	0	0	0	0.02
Charles City	0	0	0.02	0.01
Highland	0	0	0	<0.01
Lundgren	0	0	0.02	0.02
Macksburg	0	0	0	0.01
Pomeroy	0	0	0	0.01
Rolling Hills	0	0.03	0	0.01
Vienna I&II	0	0	0	0.01
Walnut	0	0	0	0.02
Wellsburg	0	0	0	0.02

* - includes occupied and unoccupied nests

Follow-up Ground Nest Monitoring Surveys

From May 19 to June 30, 2015, WEST biologists completed 8.25 hours of surveys at the bald eagle nest at the Charles City Wind Energy Facility. Two bald eagle chicks and two adult bald eagles were documented at the nest during the initial 15-minute observation; no flight paths were observed at this time. Figure 2 shows perch locations and flight paths documented for bald eagles. During the second monitoring event (four-hour duration) on May 29, 2015, both juveniles and adults were observed at the nest, with juveniles remaining in the nest; no flights were observed. Adult bald eagles perched near the nest or took short flights within 200 m of the nest, generally flying north of the nest, with one adult documented staying near the nest while the other would forage (Figure 2). Biologists documented one fledgling during the third monitoring event (four-hour duration) on June 30, 2015. The fledgling was perched next to the nest the majority of the monitoring duration, with one single flight (approximately 200 m) to the east over the Cedar River. Adult and fledgling movement patterns involved perching near the nest tree or conducting short flights between trees near the nest, with movement patterns generally observed along the Cedar River riparian corridor.

Though biologists could not locate the occupied bald eagle nest at the Lundgren Wind Energy Facility, biologists observed the general nest location on May 19, 2015, for 20 minutes with no bald eagle activity documented.

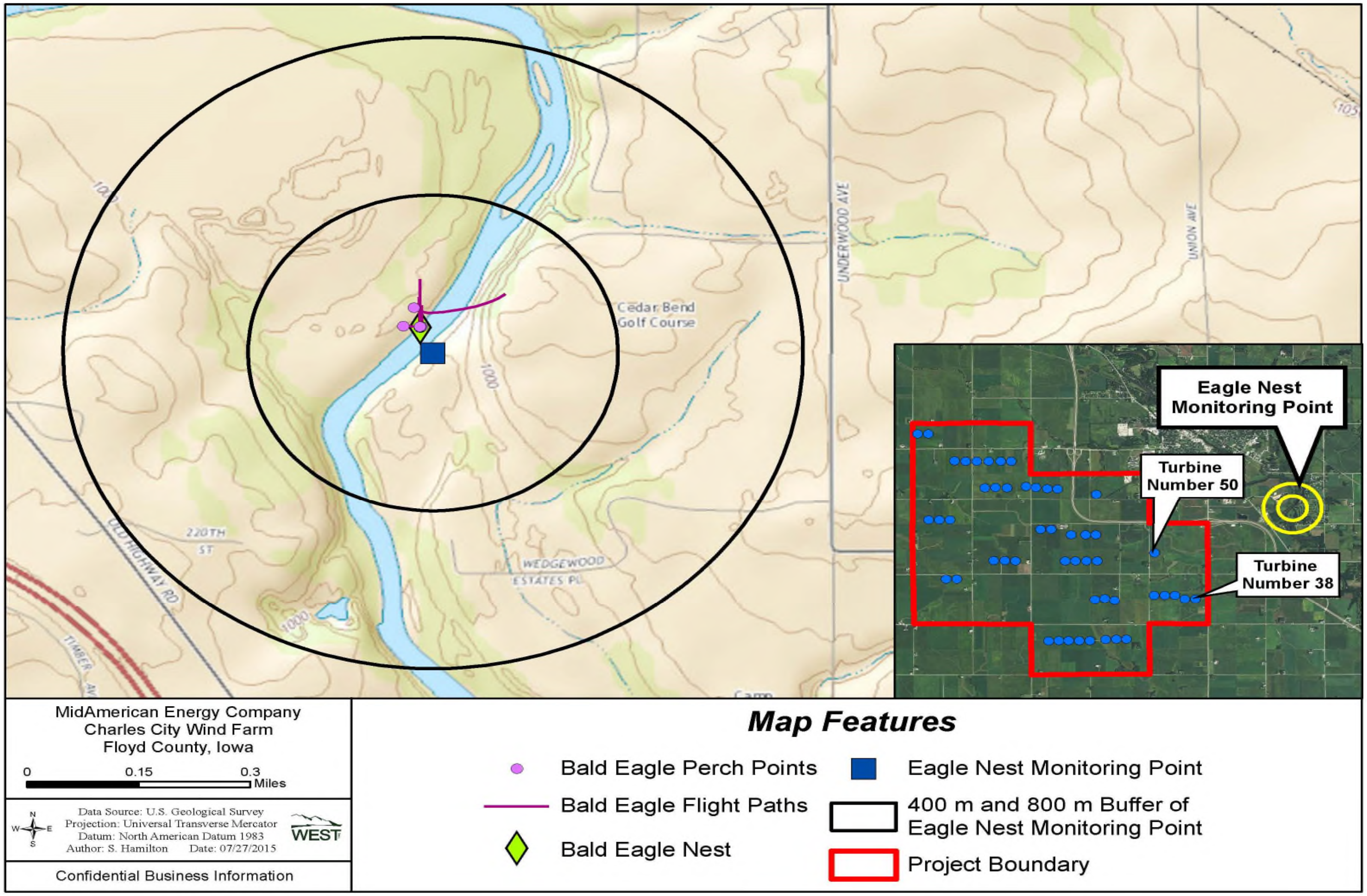

Figure 2. Bald eagle nest survey point location and flight paths at the Charles City Wind Energy Facility, Floyd County, Iowa from May 19 – June 30, 2015.

DISCUSSION/SUMMARY

WEST completed aerial raptor nest surveys from March 27 – April 10, 2015, at MidAmerican's 18 existing wind energy facilities in Iowa. Overall, a total of 33 bald eagle nests were documented at 11 of these facilities. The majority of the documented bald eagle nests (includes occupied, unoccupied, or not located) were located greater than two miles from the wind energy facilities. This is likely attributed to the lack of quality nesting habitat and the limited prey resources within each of MidAmerican's wind energy facilities. Bald eagles prefer to nest, roost, and forage from large, mature trees, near permanent bodies of water (e.g., rivers or lakes) with an abundant prey source (Swenson et al. 1986, Mojica et al. 2008). More suitable bald eagle nesting habitat exists along forested riparian corridors more than two miles from the Iowa wind energy facilities. Bald eagle nests were primarily located along the larger rivers (North Raccoon River – Carroll Wind Energy Facility; Little Sioux River – Highland Wind Energy Facility; Des Moines River – Lundgren Wind Energy Facility) or larger bodies of water, which were typically greater than two miles from the wind energy facilities.

Overall, 267 non-eagle raptor nests were documented during aerial nest surveys, with 69.5% of these nests documented at the Adair and Morning Light, Laurel, Macksburg, Rolling Hills, and Walnut wind energy facilities. Comparatively, these six facilities provide more suitable nesting habitat along small streams and tributaries of larger rivers traversing throughout the project areas. The majority of non-eagle raptor nests were located closer to the outer edge of the project areas, likely indicative of where suitable nesting habitat is located.

At this time, there is limited data available showing correlations between the number of collision fatalities and raptor nest density within one mile of project facilities. It is likely that raptors nesting near turbines have a higher probability of collision with turbines but data on nests within a half-mile of turbines are currently inadequate to determine potential impact. For example, the existing wind-energy facility with one of the highest reported nest densities is the Foote Creek Rim project in Wyoming. Most of the nests within two miles of Foote Creek Rim are red-tailed hawks (Johnson et al. 2000b); however, no red-tailed hawk fatalities have been documented at this facility (Young et al. 2003c). Although publicly available data is limited, the majority of available information suggests that raptor, including bald eagle, fatalities at new wind generation facilities is more likely related to use rates and not nest density.

Due to the lack of quality nesting habitat within MidAmerican's wind energy facilities, general lack of prey, no bald eagle nests located within any of the project footprints, and nesting raptor species composition, risk to nesting bald eagles and non-eagle raptors at MidAmerican's facilities is low.

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Appendix A. Photos of Select Bald Eagle Nests Documented During Aerial Nest Surveys at the Iowa Wind Energy Facilities From March 27 to April 10, 2015

Photo A: Bald eagle nest ID 0 at the Carroll wind energy facility, Carroll County, Iowa, and associated buffers.

Photo B: Bald eagle nest ID 0 at the Carroll wind energy facility, Carroll County, Iowa.

Photo C: Bald eagle nest ID 0 at the Lundgren Wind Energy facility, Webster County, Iowa.

Photo D: Bald eagle nest ID 0 at the Lundgren Wind Energy facility, Webster County, Iowa.

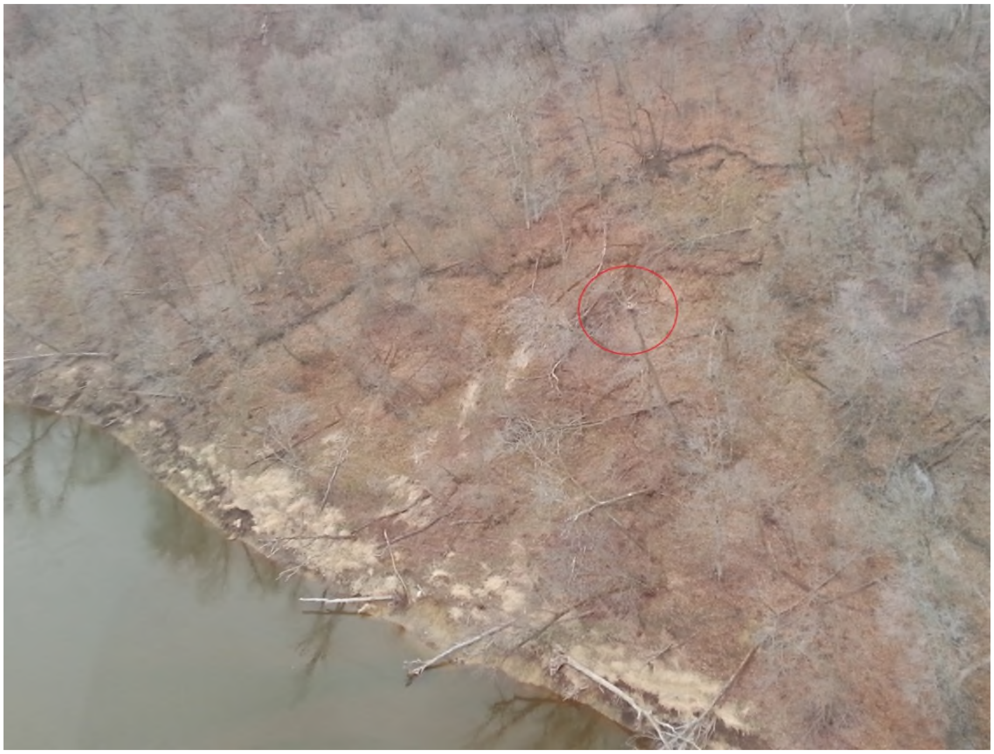


Photo E: Bald eagle nest ID 1 at the Lundgren Wind Energy facility, Webster County, Iowa.

Photo F: Bald eagle nest ID 1 at the Lundgren Wind Energy facility, Webster County, Iowa.

Photo G: Bald eagle nest ID 3 at the Lundgren Wind Energy facility, Webster County, Iowa.

Photo H: Bald eagle nest ID 3 at the Lundgren Wind Energy facility, Webster County, Iowa.

Photo I: Bald eagle nest ID 4 at the Lundgren Wind Energy facility, Webster County, Iowa.

Photo J: Bald eagle nest ID 4 at the Lundgren Wind Energy facility, Webster County, Iowa.

Photo K: Bald eagle nest ID 0 at the Pomeroy Wind Energy facility, Pocahontas County, Iowa.

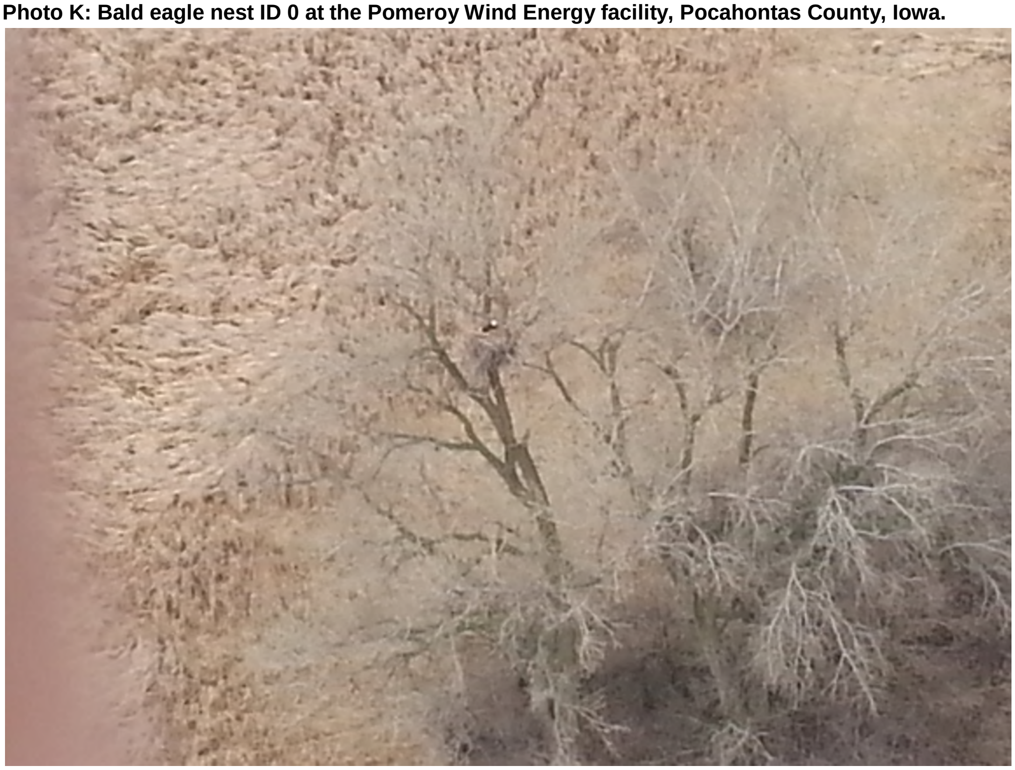


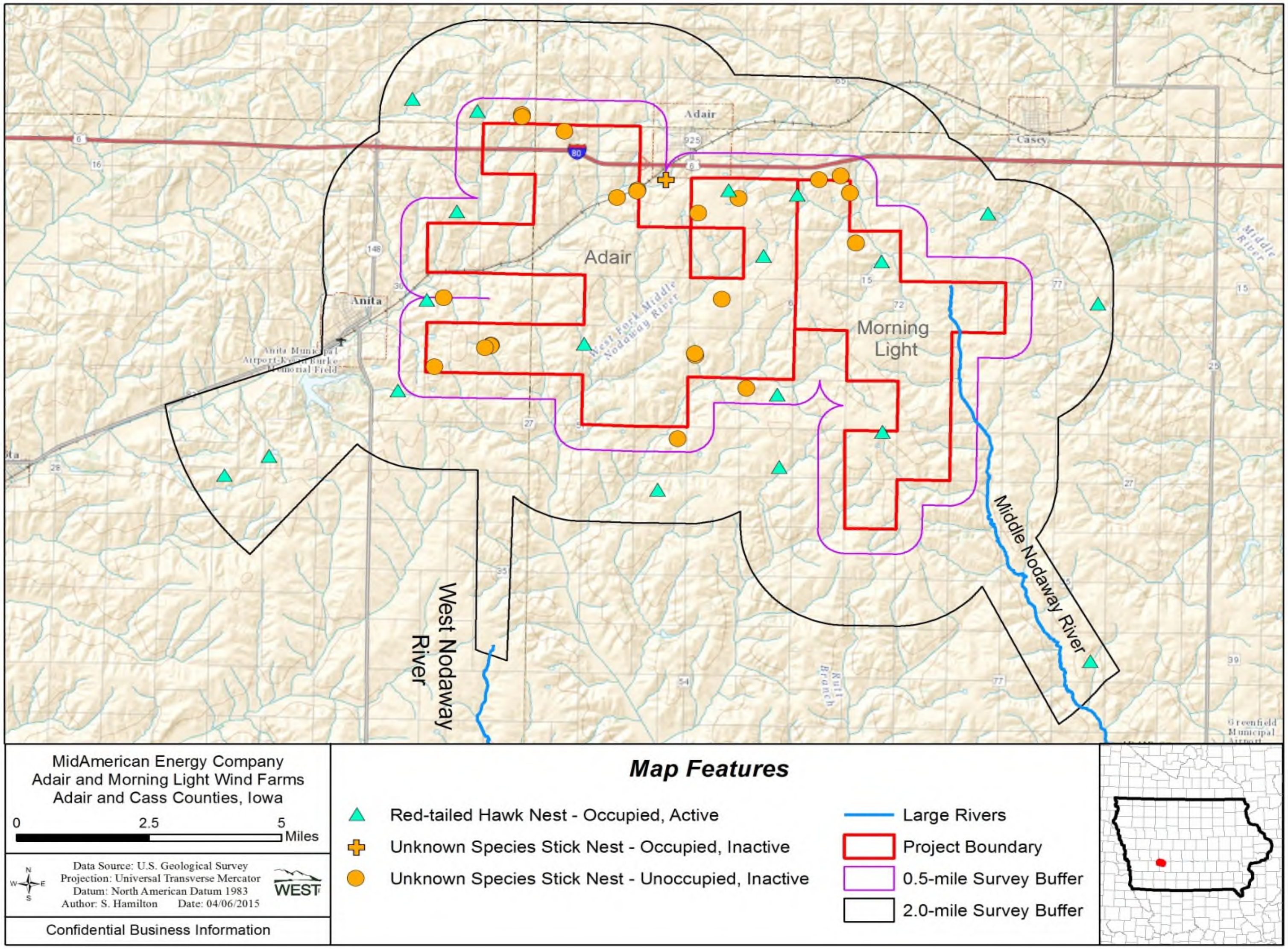
Photo L: Bald eagle nest ID 0 at the Pomeroy Wind Energy facility, Pocahontas County, Iowa.

Appendix B. Summary of Raptor Nest Surveys Conducted at the Adair/Morning Light Wind Energy Facilities From March 27 to April 10, 2015

Appendix B1. Summary of raptor nest surveys for the Adair/Morning Light wind energy facility

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in SW Iowa, Cass and Adair counties, approx. 0.5 miles (mi) S of the town of Adair
	Facility Size	• 25,530.57 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Rolling Loess Prairies L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 17,743.76 ac • 2-mi buffer: 51,100.61 ac • Total area surveyed (facility plus buffers [includes informed 5-mi buffer]): 93,501.01 ac
	Survey Dates	• March 27 - 28, 2015
Nest Survey Results	Nesting Species	• red-tailed hawk (RTHA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 42 nests o RTHA: 19 nests o UNKN: 23 nests • By area and status o Facility ▪ 6 RTHA occupied – active nests ▪ 16 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 4 RTHA occupied – active nest ▪ 6 UNKN unoccupied – inactive nests ▪ 1 UNKN occupied – inactive o 2-mi buffer ▪ 6 RTHA occupied – active nest o Informed 5-mi buffer ▪ 3 RTHA occupied – active nest
	Bald Eagle Nests	• Active: none • Historical: none • Potential: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0009 nests/ac o Total area surveyed: 0.0004 nests/ac • By species (number of nests/ac) o RTHA: 0.0002 nests/ac o UNKN: 0.0002 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix B2. Overview of the Adair/Morning Light wind energy facility, Cass and Adair counties, Iowa, and associated buffers. Location of observations and/or nests during aerial raptor nest surveys conducted March 27-28, 2015 within and around the project area is shown.

Appendix B3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys conducted March 27 - 28, 2015, within the Adair/Morning Light Wind Energy Facilities, Cass and Adair counties, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (Number/Ac) of Nests				
	Within Adair/Morning Light	Within 0.5-mi Buffer of Adair/Morning Light	Within 2-mi Buffer of Adair/Morning Light	Within Informed 5-mi Buffer of Adair/Morning Light	Overall Within Adair/Morning Light Plus Buffers
red-tailed hawk	6 (<0.001)	4 (<0.001)	6 (<0.001)	3 (<0.001)	19 (<0.001)
unknown raptor	16 (<0.001)	7 (<0.001)	0	0	23 (<0.001)
Total by Area	**22 (<0.001)**	**11 (<0.001)**	**9 (<0.001)**	**9 (<0.001)**	**42 (<0.001)**

Appendix B4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Adair/Morning Light wind energy facility, Cass and Adair counties, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	RTHA	4596952.508	354325.956	occupied - active	excellent
1	RTHA	4584852.751	348613.246	occupied - active	excellent
2	RTHA	4585470.434	349971.333	occupied - active	excellent
3	RTHA	4585124.462	365461.442	occupied - active	excellent
4	RTHA	4584376.070	361775.688	occupied - active	excellent
5	RTHA	4578852.947	374907.393	occupied - active	excellent
6	RTHA	4590372.092	375149.469	occupied - active	excellent
7	RTHA	4593281.991	371798.686	occupied - active	excellent
8	RTHA	4596565.863	356303.154	occupied - active	excellent
9	UNKN	4596451.790	357647.495	unoccupied - inactive	good
10	UNKN	4596368.624	357653.529	unoccupied - inactive	fair
11	UNKN	4595905.637	358941.971	unoccupied - inactive	fair
12	UNKN	4594475.601	367331.585	unoccupied - inactive	fair
13	UNKN	4594353.812	366671.683	unoccupied - inactive	fair
14	RTHA	4594020.499	363934.290	occupied - active	excellent
15	UNKN	4594341.833	362022.471	occupied - inactive	excellent
16	UNKN	4593779.375	360537.342	unoccupied - inactive	excellent
17	UNKN	4594022.561	361159.128	unoccupied - inactive	fair
18	UNKN	4593983.524	361147.652	unoccupied - inactive	fair
19	UNKN	4593751.218	364234.520	unoccupied - inactive	good
20	RTHA	4593874.124	366009.919	occupied - active	excellent
21	UNKN	4593919.570	367616.120	unoccupied - inactive	excellent
22	UNKN	4593274.524	363005.322	unoccupied - inactive	fair
23	RTHA	4593335.325	355679.778	occupied - active	excellent
24	RTHA	4591726.300	368568.825	occupied - active	excellent
25	UNKN	4592308.566	367789.162	unoccupied - inactive	fair
26	RTHA	4591914.626	364992.779	occupied - active	excellent
27	UNKN	4590505.268	363716.471	unoccupied - inactive	poor
28	UNKN	4590560.334	355276.361	unoccupied - inactive	poor
29	RTHA	4590498.691	354757.947	occupied - active	good
30	UNKN	4588709.479	362912.180	unoccupied - inactive	poor
31	UNKN	4588763.194	362902.700	unoccupied - inactive	poor
32	RTHA	4589085.637	359544.475	occupied - active	good
33	UNKN	4589033.187	356714.043	unoccupied - inactive	poor
34	UNKN	4589015.367	356704.959	unoccupied - inactive	poor
35	UNKN	4588945.560	356531.685	unoccupied - inactive	poor
36	UNKN	4588336.435	354994.044	unoccupied - inactive	poor
37	RTHA	4586249.000	368598.236	occupied - active	excellent
38	RTHA	4587454.387	365409.548	occupied - active	excellent
39	UNKN	4587645.608	364466.735	unoccupied - inactive	good
40	UNKN	4586027.765	362376.343	unoccupied - inactive	good
41	RTHA	4587586.978	353882.526	occupied - active	excellent

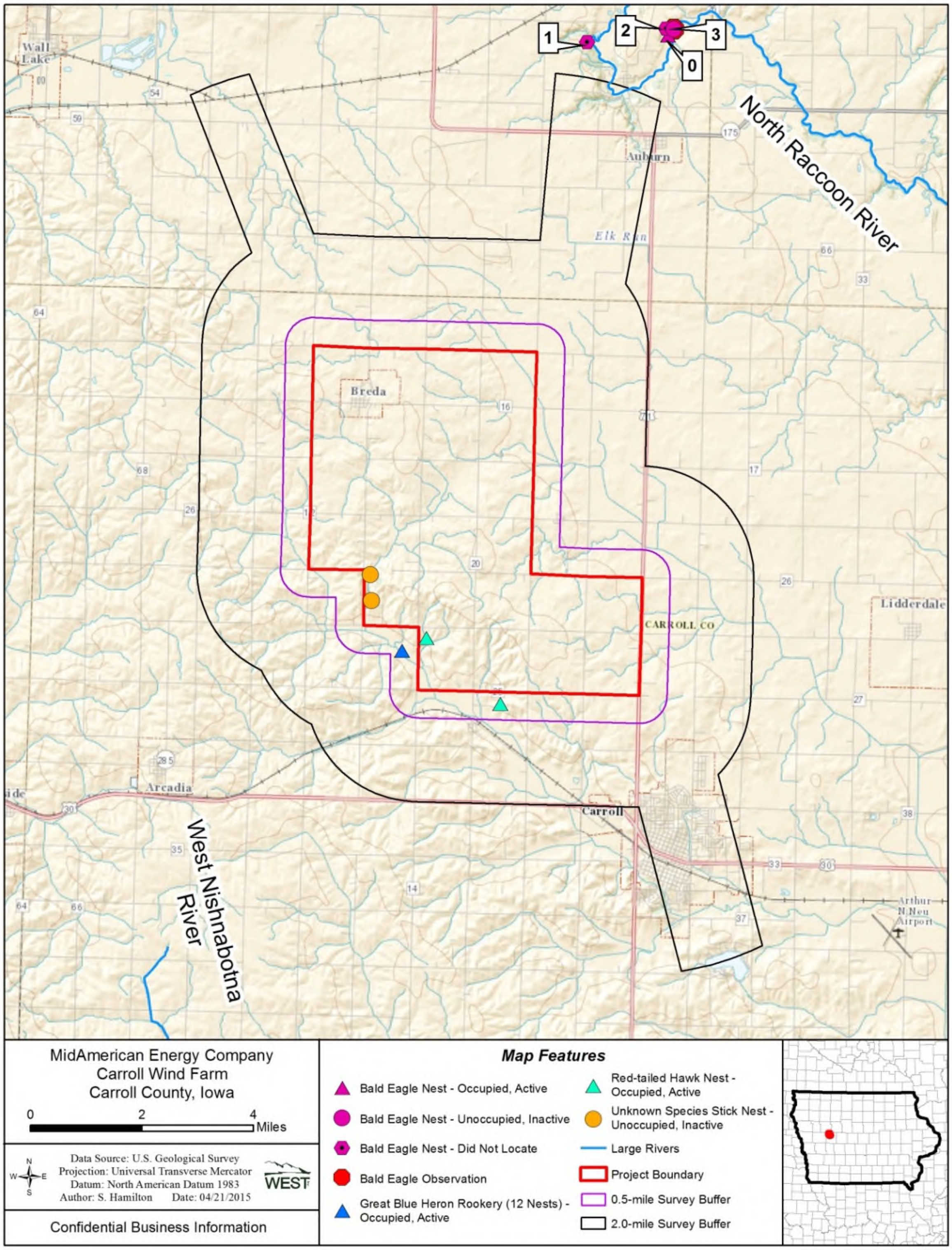
[1] RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species

Appendix C. Summary of Raptor Nest Surveys Conducted at the Carroll Wind Energy Facility From March 27 to April 10, 2015

Appendix C1. Summary of raptor nest surveys for the Carroll wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in central Iowa, Wright and Hamilton counties, 1 mile (mi) NW of Carroll
	Facility Size	• 16,240.79 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Des Moines Lobe and Steeply Rolling Loess Prairies L4 Ecoregion [2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 8,149.62 ac • 2-mi buffer: 38,117.34 ac • Total area surveyed (facility plus buffers[includes informed 5-mi buffer]): 62,507.75 ac
	Survey Dates	• April 8 - 10, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • red-tailed hawk (RTHA) • great blue heron (GBHE) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 9 nests o BAEA: 4 nests o GBHE: 1 rookery o RTHA: 2 nests o UNKN: 2 nests • By area and status o Facility: ▪ 1 RTHA occupied – active nest ▪ 2 UNKN unoccupied – inactive nests o 0.5-mi buffer: ▪ 1 GBHE rookery ▪ 1 RTHA occupied – active nest o 2-mi buffer: ▪ No observations o Informed 5-mi buffer: ▪ 1 BAEA unoccupied – inactive nest (historical) ▪ 1 BAEA occupied – active nest ▪ 2 BAEA did not locate - historical nests
	Bald Eagle Nests	• Active: 1 nest • Historical: 3 nests • Potential: none
	Sensitive/Listed Species Observations	• BAEA: 1 observation > 5-mi from Project boundary • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0002 nests/ac o Total area surveyed: 0.0001 nests/ac • By species (number of nests/ac): o BAEA: 0.00006 nests/ac o GBHE: 0.00002 nests/ac o RTHA: 0.00003 nests/ac o UNKN: 0.00003 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix C2. Overview of the Carroll wind energy facility, Carroll County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix C3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Carroll wind energy facility, Carroll County, Iowa, and the associated buffers. Nest densities are shown in parentheses (includes historical bald eagle nests that were not located).

Species	Number and Density (number/ac) of Nests				
	Within Carroll	Within 0.5-mi Buffer of Carroll	Within 2-mi Buffer of Carroll	Within Informed 5-mi Buffer of Carroll	Within Carroll Plus Buffers
bald eagle	0	0	0	4 (<0.001)	4 (<0.001)
great blue heron	0	1 (<0.001)	0	0	1 (<0.001)
red-tailed hawk	1 (<0.001)	1 (<0.001)	0	0	2 (<0.001)
unknown raptor	2 (<0.001)	0	0	0	2 (<0.001)
Total by Area	**3 (<0.001)**	**2 (<0.001)**	**0**	**4 (<0.001)**	**9 (<0.001)**

Appendix C4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Carroll wind energy facility, Carroll County, Iowa and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	BAEA	4682444.371	345502.167	occupied - active	good
1	BAEA**	4682247.995	343168.006	did not locate	not available
2	BAEA**	4682640.997	345454.004	did not locate	not available
3	BAEA**	4682625.991	345676.006	unoccupied - inactive	good
4	RTHA	4663166.760	340664.335	occupied - active	good
5	RTHA	4665065.701	338530.929	occupied - active	good
6	GBHE^	4664689.687	337828.647	occupied - active	good
7	UNKN	4666133.660	336941.694	unoccupied - inactive	fair
8	UNKN	4666883.711	336912.199	unoccupied - inactive	good

[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); GBHE: great blue heron (*Ardea herodias*); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species; ** denotes historical BAEA nest; ^ denotes GBHE rookery

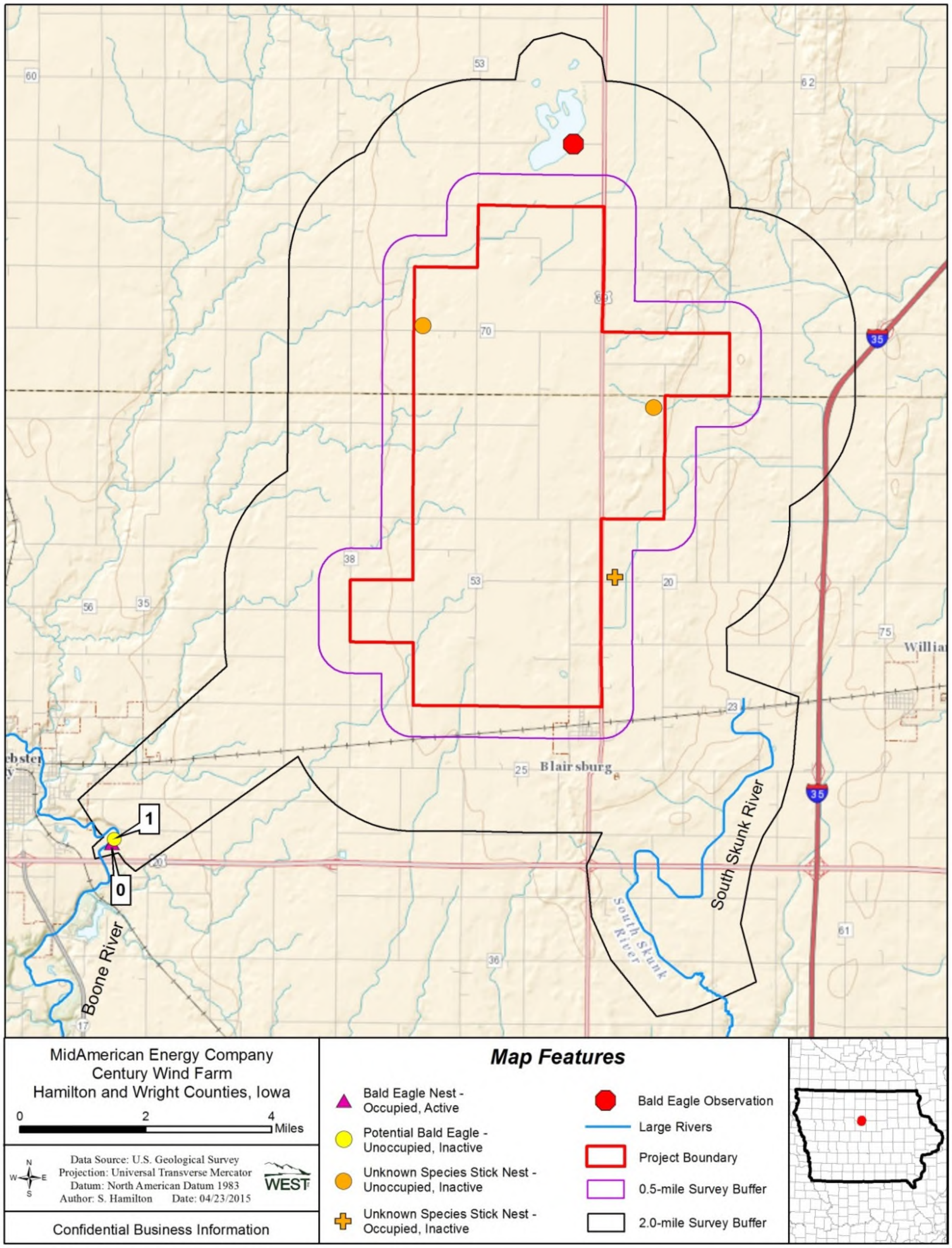
Note: BAEA nest FID 0 is potentially historic nest FID 2 (based on proximity)

Appendix D. Summary of Raptor Nest Surveys Conducted at the Century Wind Energy Facility From March 27 to April 10, 2015

Appendix D1. Summary of raptor nest surveys for the Century wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in central Iowa, Wright and Hamilton counties, 0.5 miles (mi) N of the town of Blairsburg
	Facility Size	• 17,831.01 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion Des Moines Lobe L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 9,245.31 ac • 2-mi buffer: 41,495.55 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 68,571.87 ac
	Survey Dates	• April 4, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 5 nests o BAEA: 2 nest o UNKN: 3 nests • By area and status o Facility ▪ 2 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 1 UNKN occupied – inactive nest o 2-mi buffer ▪ No observations o Informed 5-mi buffer: ▪ 1 BAEA unoccupied - inactive nest (potential) ▪ 1 BAEA occupied – active nest
	Bald Eagle Nests	• Active: 1 nest • Historical: none • Potential: 1 nest
	Sensitive/Listed Species Observations	• BAEA: 1 observation • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0001 nests/ac o Total area surveyed: 0.00007 nests/ac • By species (number of nests/ac) o BAEA: 0.00003 nests/ac o UNKN: 0.00004 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix D2. Overview of the Century wind energy facility, Hamilton and Wright counties, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix D3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Century wind energy facility, Hamilton and Wright counties, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (Number/Ac) of Nests				
	Within Century	Within 0.5-mi Buffer of Century	Within 2-mi Buffer of Century	Within Informed 5-mi Buffer of Century	Within Century Plus Buffers
bald eagle	0	0	0	2 (<0.001)	2 (<0.001)
unknown raptor	2 (<0.001)	1 (<0.001)	0	0	3 (<0.001)
Total By Area	**2 (<0.001)**	**1 (<0.001)**	**0**	**2 (<0.001)**	**5 (<0.001)**

Appendix D4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Century wind energy facility, Hamilton and Wright counties, Iowa and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	BAEA	4700404.632	435165.634	occupied - active	excellent
1	BAEA*	4700499.955	435219.373	unoccupied - inactive	excellent
2	UNKN	4713660.422	443117.495	unoccupied - inactive	good
3	UNKN	4707212.528	448029.142	occupied - inactive	good
4	UNKN	4711555.992	449023.219	unoccupied - inactive	fair

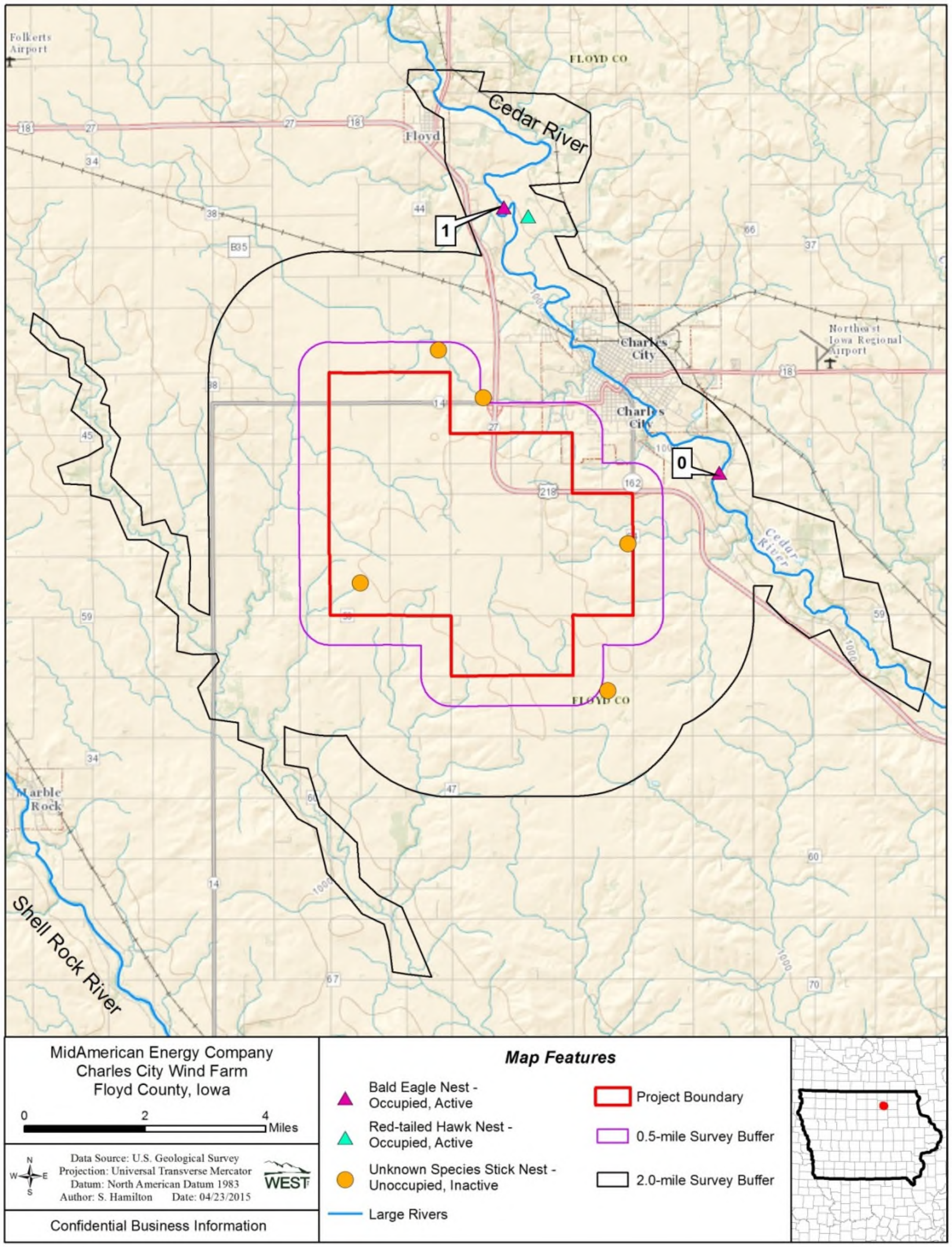
[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); UNKN: unknown raptor species; * denotes historical BAEA nest

Appendix E. Summary of Raptor Nest Surveys Conducted at the Charles City Wind Energy Facility From March 27 to April 10, 2015

Appendix E1. Summary of raptor nest surveys for the Charles City wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in NE Iowa, Floyd County, 1 mile (mi) SW of Charles City
	Facility Size	• 11,665.68 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion Eastern Iowa and Minnesota Drift Plains L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 6,802.73 ac • 2-mi buffer: 35,935.97 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 54,404.37 ac
	Survey Dates	• April 3 - 4, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • red-tailed hawk (RTHA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 8 nests o BAEA: 2 nest o RTHA: 1 nests o UNKN: 5 nests • By area and status o Facility ▪ 2 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 2 UNKN unoccupied – inactive nests o 2-mi buffer ▪ 1 BAEA occupied – active nest ▪ 1 UNKN unoccupied – inactive nest o Informed 5-mi buffer: ▪ 1 BAEA occupied – active nest ▪ 1 RTHA occupied – active nest
	Bald Eagle Nests	• Active: 2 nests • Historical: none • Potential: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0002 nests/ac o Total area surveyed: 0.0001 nests/ac • By species (number of nests/ac) o BAEA: 0.00004 nests/ac o RTHA: 0.00002 nests/ac o UNKN: 0.00009 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix E2. Overview of the Charles City wind energy facility, Floyd County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix E3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Charles City wind energy facility, Floyd County, Iowa and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (Number/Ac) of Nests				
	Within Charles City	Within 0.5-mi Buffer of Charles City	Within 2-mi Buffer of Charles City	Within Informed 5-mi Buffer of Charles City	Within Charles City Plus Buffers
bald eagle	0	0	1 (<0.001)	1 (<0.001)	2 (<0.001)
red-tailed hawk	0	0	0	1 (<0.001)	1 (<0.001)
unknown raptor	2 (<0.001)	2 (<0.001)	1 (<0.001)	0	5 (<0.001)
Total By Area	**2 (<0.001)**	**2 (<0.001)**	**2 (<0.001)**	**2 (<0.001)**	**8 (<0.001)**

Appendix E4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Charles City wind energy facility, Floyd County, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	BAEA	4765665.182	528969.822	occupied - active	excellent
1	BAEA	4772730.141	523227.312	occupied - active	excellent
2	RTHA	4772497.626	523874.074	occupied - active	excellent
3	UNKN	4763760.942	526539.338	unoccupied - inactive	good
4	UNKN	4759843.255	525998.195	unoccupied - inactive	poor
5	UNKN	4767649.968	522675.958	unoccupied - inactive	poor
6	UNKN	4768924.134	521480.108	unoccupied - inactive	fair
7	UNKN	4762719.024	519392.291	unoccupied - inactive	good

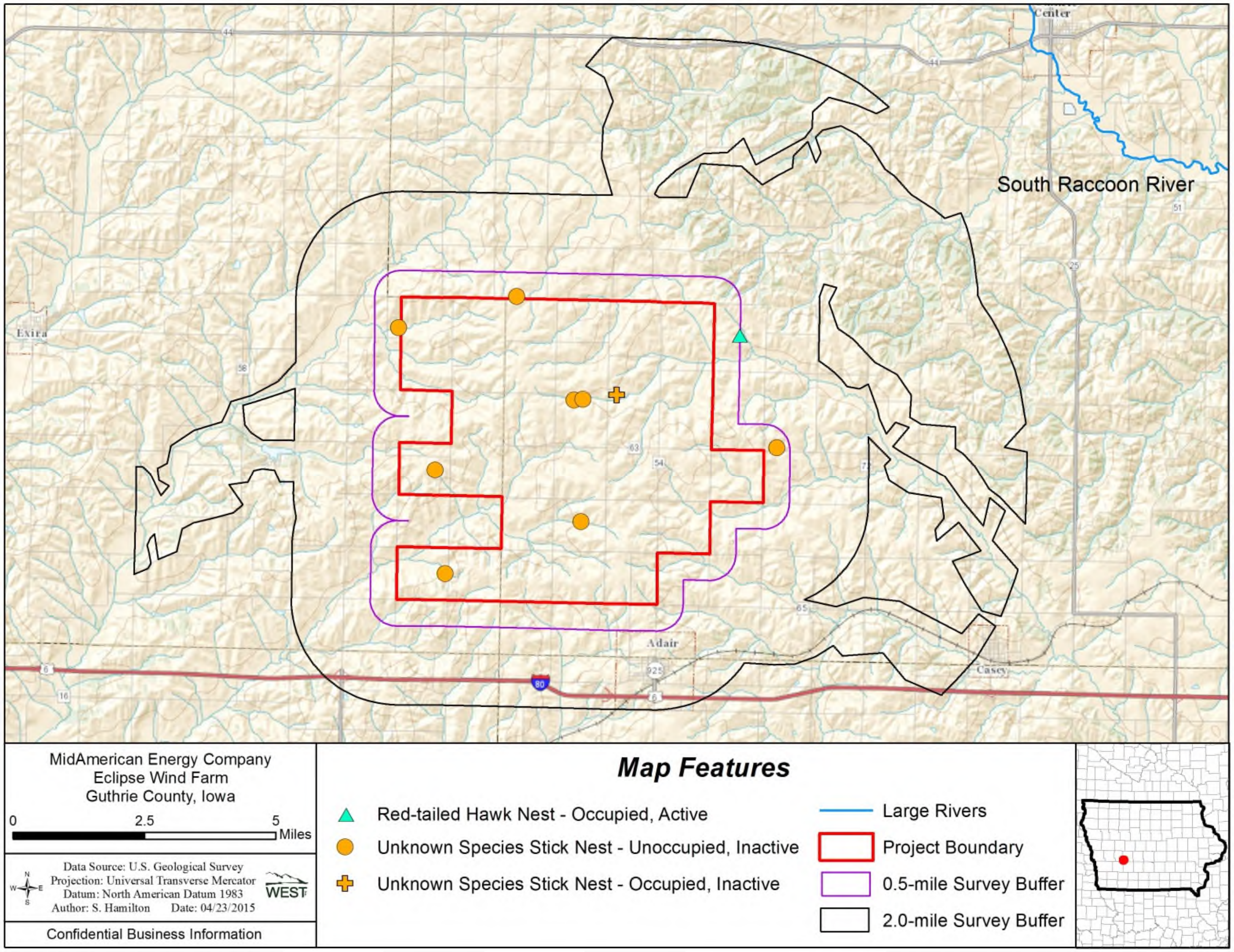
[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species.

Appendix F. Summary of Raptor Nest Surveys Conducted at the Eclipse Wind Energy Facility From March 27 to April 10, 2015

Appendix F1. Summary of raptor nest surveys for the Eclipse wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in SW Iowa, Guthrie and Audubon counties, 0.6 miles (mi) NW of Adair, IA.
	Facility Size	• 20,046.12 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Rolling Loess Prairies and Steeply Rolling Loess Prairies L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 10,283.95 ac • 2-mi buffer: 55,392.86 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 85,722.93 ac
	Survey Dates	• March 30, 2015
Nest Survey Results	Nesting Species	• red-tailed hawk (RTHA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 10 nests o RTHA: 1 nest o UNKN: 9 nests • By area and status o Facility ▪ 6 UNKN unoccupied – inactive nests ▪ 1 UNKN occupied – inactive o 0.5-mi buffer ▪ 1 RTHA occupied – active nest ▪ 2 UNKN unoccupied – inactive nests o 2-mi buffer ▪ No nests o Informed 5-mi buffer: ▪ No nests
	Bald Eagle Nests	• Active: none • Historical: none • Potential: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0003 nests/ac o Total area surveyed: 0.0001 nests/ac • By species (number of nests/ac) o RTHA: 0.00001 nests/ac o UNKN: 0.0001 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix F2. Overview of the Eclipse wind energy facility, Guthrie and Audubon counties, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix F3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Eclipse wind energy facility, Guthrie and Audubon counties, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (Number/Ac) of Nests				
	Within Eclipse	Within 0.5-mi Buffer of Eclipse	Within 2-mi Buffer of Eclipse	Within Informed 5-mi Buffer of Eclipse	Within Eclipse Plus Buffers
red-tailed hawk	0	1 (<0.001)	0	0	1 (<0.001)
unknown raptor	7 (<0.001)	2 (<0.001)	0	0	9 (<0.001)
Total By Area	**7 (<0.001)**	**3 (<0.001)**	**0**	**0**	**10 (<0.001)**

Appendix F4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Eclipse wind energy facility, Guthrie and Audubon counties, Iowa, and associated buffers.

Fid	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	UNKN	4606124.353	354986.230	unoccupied - inactive	fair
1	UNKN	4601766.869	356098.495	unoccupied - inactive	poor
2	UNKN	4598587.976	356413.567	unoccupied - inactive	fair
3	UNKN	4607083.429	358596.036	unoccupied - inactive	fair
4	UNKN	4603910.486	360350.096	unoccupied - inactive	fair
5	UNKN	4603934.788	360625.176	unoccupied - inactive	fair
6	UNKN	4600176.626	360566.246	unoccupied - inactive	fair
7	UNKN	4602448.184	366559.854	unoccupied - inactive	fair
8	RTHA	4605888.812	365426.466	occupied - active	good
9	UNKN	4604063.590	361663.612	occupied - inactive	excellent

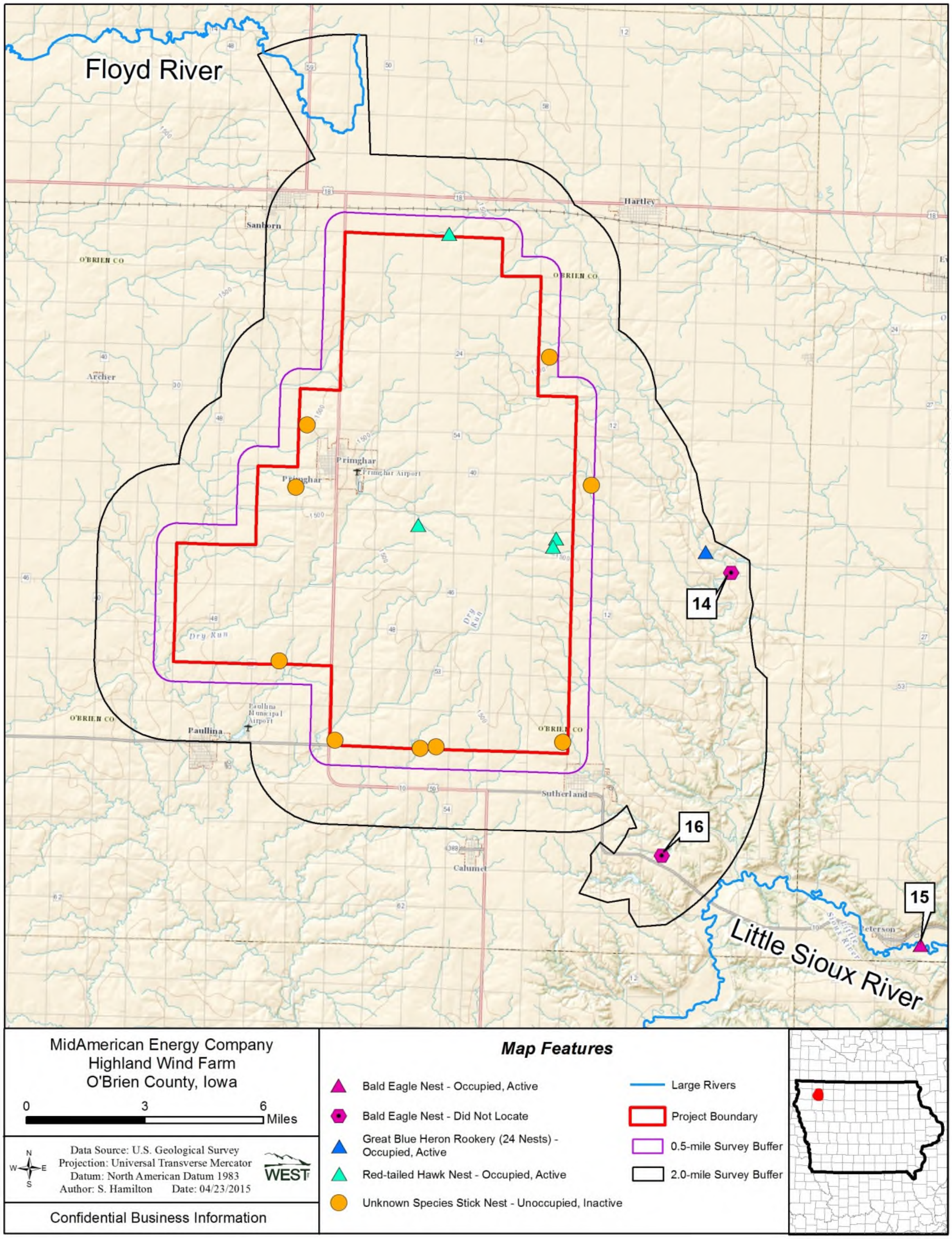
[1] RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species

Appendix G. Summary of Raptor Nest Surveys Conducted at the Highland Wind Energy Facility From March 27 to April 10, 2015

Appendix G1. Summary of raptor nest surveys for the Highland wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in NW Iowa, O'Brien County, 1 mile (mi) N of Sutherland
	Facility Size	• 54,660.18 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Loess Prairies L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 15,037.97 ac • 2-mi buffer: 72,594.79 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 146, 015.69 ac
	Survey Dates	• April 4, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • great blue heron (GBHE) • red-tailed hawk (RTHA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 17 nests o BAEA: 3 nest o GBHE: 1 rookery o RTHA: 4 nests o UNKN: 9 nests • By area and status o Facility ▪ 4 RTHA occupied – active nest ▪ 7 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 2 UNKN unoccupied – inactive nests o 2-mi buffer ▪ no nests o Informed 5-mi buffer: ▪ 1 BAEA occupied – active nest ▪ 2 BAEA did not locate – historical nest ▪ 1 GBHE rookery
	Bald Eagle Nests	• Active: 1 nest • Historical: 2 nests • Potential: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0002 nests/ac o Total area surveyed: 0.0001 nests/ac • By species (number of nests/ac) o BAEA: 0.00002 nests/ac o GBHE: 0.000007 nests/ac o RTHA: 0.00003 nests/ac o UNKN: 0.00006 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix G2. Overview of the Highland wind energy facility, O'Brien County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix G3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Highland wind energy facility, O'Brien County, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (Number/Ac) of Nests				
	Within Highland	Within 0.5-mi Buffer of Highland	Within 2-mi Buffer of Highland	Within Informed 5-mi Buffer of Highland	Within Highland Plus Buffers
bald eagle	0	0	0	3 (<0.001)	3 (<0.001)
great blue heron	0	0	0	1 (<0.001)	1 (<0.001)
red-tailed hawk	4 (<0.001)	0	0	0	4 (<0.001)
unknown raptor	7 (<0.001)	2 (<0.001)	0	0	9 (<0.001)
Total By Area	**11 (<0.001)**	**2 (<0.001)**	**0**	**4 (<0.001)**	**17 (<0.001)**

Appendix G4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Highland wind energy facility, O'Brien County, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	GBHE^	4770158.169	301390.613	occupied - active	good
1	UNKN	4772861.761	296742.687	unoccupied - inactive	good
2	UNKN	4765696.273	284036.090	unoccupied - inactive	good
3	UNKN	4772788.173	284715.738	unoccupied - inactive	good
4	UNKN	4775324.555	285159.757	unoccupied - inactive	good
5	UNKN	4762466.836	286298.028	unoccupied - inactive	good
6	RTHA	4771258.044	289687.063	occupied - active	good
7	UNKN	4762133.810	289776.457	unoccupied - inactive	good
8	UNKN	4762206.821	290412.610	unoccupied - inactive	good
9	RTHA	4783127.791	290962.013	occupied - active	good
10	UNKN	4778098.153	295038.806	unoccupied - inactive	good
11	RTHA	4770700.435	295307.185	occupied - active	good
12	RTHA	4770377.946	295176.108	occupied - active	good
13	UNKN	4762390.427	295570.137	unoccupied - inactive	good
14	BAEA**	4769304.997	302434.006	did not locate	not available
15	BAEA	4754125.998	310152.000	occupied - active	good
16	BAEA**	4757757.991	299610.003	did not locate	not available

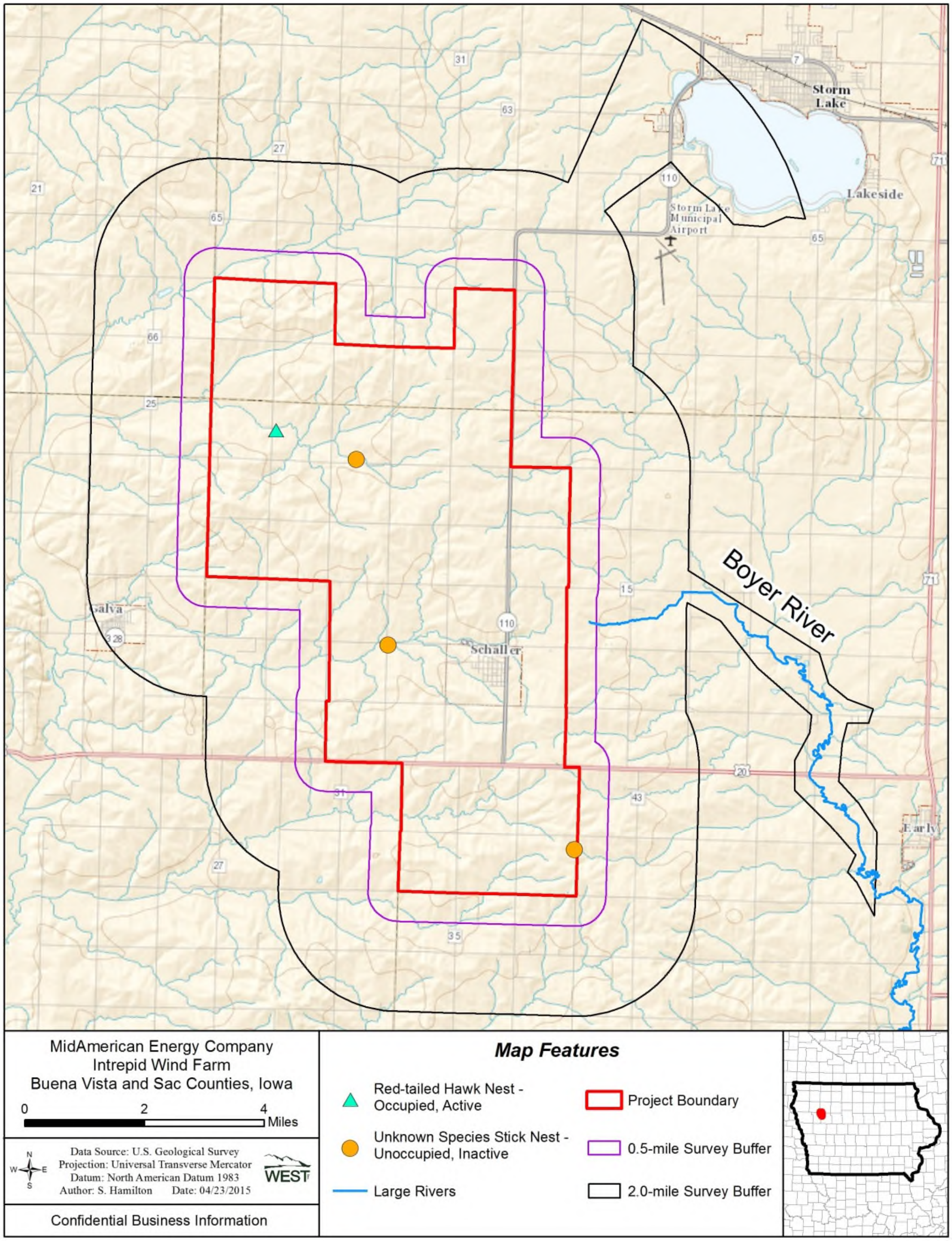
[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); GBHE: great blue heron (*Ardea herodias*); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species; ** denotes historical BAEA nest; ^ denotes GBHE rookery

Appendix H. Summary of Raptor Nest Surveys Conducted at the Intrepid Wind Energy Facility From March 27 to April 10, 2015

Appendix H1. Summary of raptor nest surveys for the Intrepid wind energy facility.

<table>
<tr><th>Topic</th><th>Sub-Topic</th><th>Summary</th></tr>
<tr><td rowspan="3">Project Description</td><td>Facility Location</td><td>• Located in NW Iowa, Sac and Buena Vista counties, 7 miles (mi) SW of the town of Storm Lake</td></tr>
<tr><td>Facility Size</td><td>• 27,734.91 acres (ac)[1]</td></tr>
<tr><td>Ecoregions</td><td>• Western Corn Belt Plains L3 Ecoregion Loess Prairies L4 Ecoregion[2]</td></tr>
<tr><td rowspan="2">Nest Survey Description</td><td>Survey Areas</td><td>• 0.5-mi buffer: 11,477.49 ac
• 2-mi buffer: 45,238.22 ac
• Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 84,450.62 ac</td></tr>
<tr><td>Survey Dates</td><td>• April 10, 2015</td></tr>
<tr><td rowspan="5">Nest Survey Results</td><td>Nesting Species</td><td>• red-tailed hawk (RTHA)
• unknown raptor (UNKN)</td></tr>
<tr><td>Numbers and Types of Nests Recorded</td><td>• Total: 4 nests
o RTHA: 1 nest
o UNKN: 3 nests
• By area and status
o Facility
▪ 1 RTHA occupied – active nest
▪ 3 UNKN unoccupied – inactive nests
o 0.5-mi buffer
▪ none
o 2-mi buffer
▪ None
o Informed 5-mi buffer:
▪ None</td></tr>
<tr><td>Bald Eagle Nests</td><td>• Active: none
• Historical: none
• Potential: none</td></tr>
<tr><td>Sensitive/Listed Species Observations</td><td>• BAEA: no observations
• Federally/State-listed species: no observations</td></tr>
<tr><td>Nest Densities</td><td>• By area (number of nests/ac)
o Facility: 0.0001 nests/ac
o Total area surveyed: 0.00005 nests/ac
• By species (number of nests/ac)
o RTHA: 0.00001 nests/ac
o UNKN: 0.00004 nests/ac</td></tr>
</table>

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix H2. Overview of the Intrepid wind energy facility, Sac and Buena Vista counties, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix H3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Intrepid wind energy facility, Sac and Buena Vista counties, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (Number/Ac) of Nests				
	Within Intrepid	Within 0.5-mi Buffer of Intrepid	Within 2-mi Buffer of Intrepid	Within Informed 5-mi Buffer of Intrepid	Within Intrepid Plus Buffers
red-tailed hawk	1 (<0.001)	0	0	0	1 (<0.001)
unknown raptor	3 (<0.001)	0	0	0	3 (<0.001)
Total by Area	**4 (<0.001)**	**0**	**0**	**0**	**4 (<0.001)**

Appendix H4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Intrepid wind energy facility, Sac and Buena Vista counties, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	RTHA	4714046.109	305717.673	occupied - active	0
1	UNKN	4702760.830	313741.549	unoccupied - inactive	1
2	UNKN	4708268.088	308730.027	unoccupied - inactive	2
3	UNKN	4713259.766	307873.703	unoccupied - inactive	3

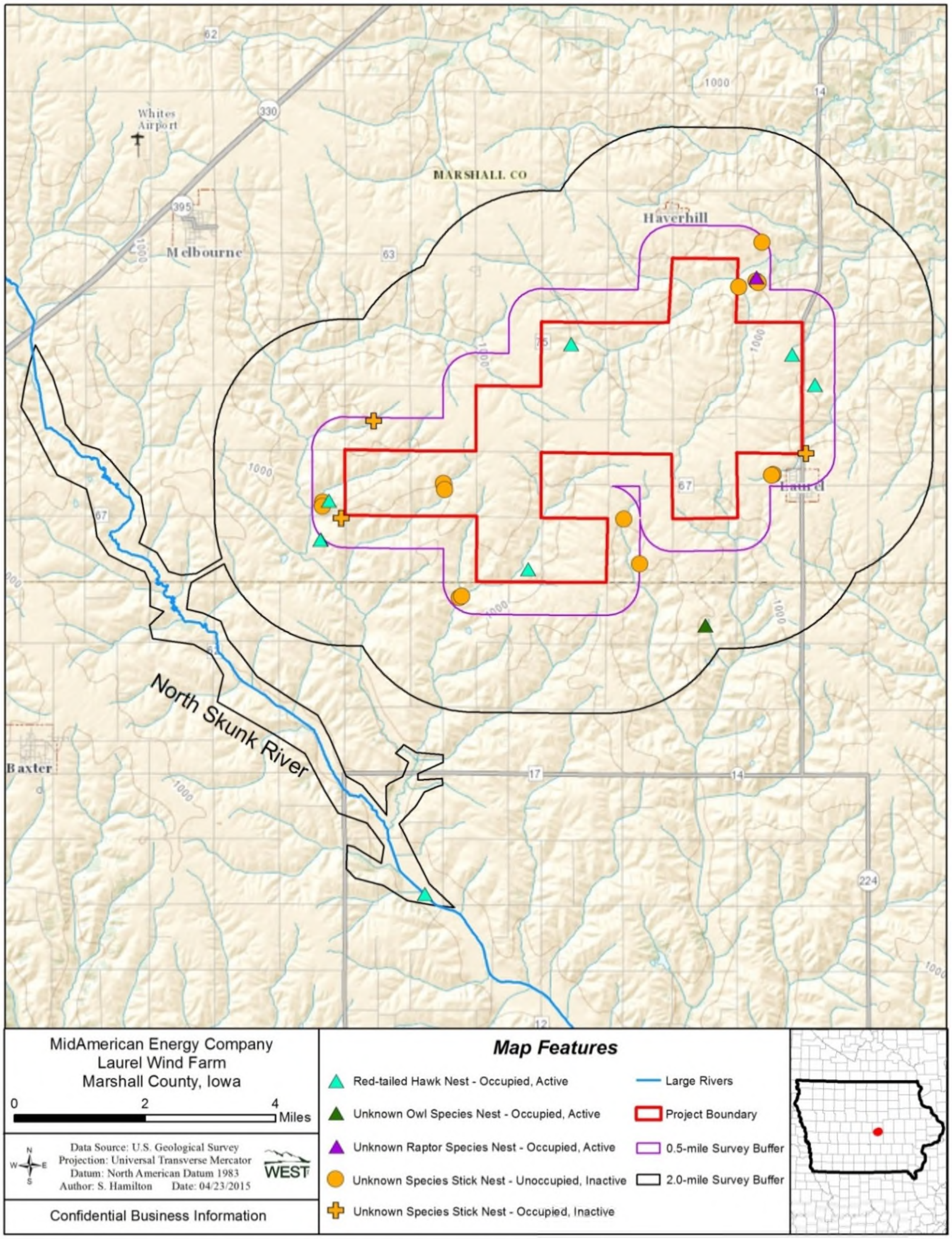
[1] RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species

Appendix I. Summary of Raptor Nest Surveys Conducted at the Laurel Wind Energy Facility From March 27 to April 10, 2015

Appendix I1. Summary of raptor nest surveys for the Laurel wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in SW Iowa, Marshall County, 1 mile (mi) NW of the town of Laure
	Facility Size	• 10,240.88 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Rolling Loess Prairies L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 9,142.74 ac • 2-mi buffer: 31,568.53 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 50,952.15 ac
	Survey Dates	• April 1, 2015
Nest Survey Results	Nesting Species	• red-tailed hawk (RTHA) • unknown owl (UNOW) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 27 nests o RTHA: 8 nests o UNOW: 1 nest o UNKN: 18 nests • By area and status o Facility ▪ 3 RTHA occupied – active nest ▪ 3 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 2 RTHA occupied – active nest ▪ 12 UNKN unoccupied – inactive nests ▪ 3 UNKN occupied – inactive nests o 2-mi buffer ▪ 3 RTHA occupied – active nest ▪ 1 UNOW occupied – active nest o Informed 5-mi buffer: ▪ None
	Bald Eagle Nests	• Active: none • Historical: none • Potential: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0006 nests/ac o Total area surveyed: 0.0005 nests/ac • By species (number of nests/ac) o RTHA: 0.0002 nests/ac o UNOW: 0.00002 nests/ac o UNKN: 0.0004 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix I2. Overview of the Laurel wind energy facility, Marshall County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix I3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Laurel wind energy facility, Marshall County, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (Number/Ac) of Nests				
	Within Laurel	Within 0.5-mi Buffer of Laurel	Within 2-mi Buffer of Laurel	Within Informed 5-mi Buffer of Laurel	Within Laurel Plus Buffers
red-tailed hawk	3 (<0.001)	2 (<0.001)	3 (<0.001)	0	8 (<0.001)
unknown owl	0	0	1 (<0.001)	0	1 (<0.001)
unknown raptor	3 (<0.001)	15 (0.002)	0	0	18 (<0.001)
Total by Area	**6 (<0.001)**	**17 (0.002)**	**4 (<0.001)**	**0**	**27 (<0.001)**

Appendix I4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Laurel wind energy facility, Marshall County, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	RTHA	4626833.849	497139.956	occupied - active	excellent
1	UNOW	4633458.305	504057.987	occupied - active	excellent
2	RTHA	4635575.560	494578.084	occupied - active	excellent
3	UNKN	4638484.104	495886.614	occupied - inactive	excellent
4	UNKN	4642895.229	505449.258	unoccupied - inactive	poor
5	UNKN	4642033.889	505323.171	occupied - active	excellent
6	UNKN	4641939.437	505307.189	unoccupied - inactive	poor
7	UNKN	4641902.499	505354.333	unoccupied - inactive	good
8	UNKN	4641799.754	504881.510	unoccupied - inactive	fair
9	RTHA	4640394.156	500746.924	occupied - active	excellent
10	RTHA	4640139.195	506201.272	occupied - active	excellent
11	RTHA	4639391.158	506763.050	occupied - active	excellent
12	UNKN	4637690.023	506536.213	occupied - inactive	excellent
13	UNKN	4637170.148	505725.117	unoccupied - inactive	fair
14	UNKN	4637155.551	505694.008	unoccupied - inactive	poor
15	UNKN	4636954.274	497598.784	unoccupied - inactive	poor
16	UNKN	4636800.834	497625.759	unoccupied - inactive	good
17	UNKN	4636498.224	494620.555	unoccupied - inactive	fair
18	UNKN	4636390.225	494609.729	unoccupied - inactive	good
19	RTHA	4636530.397	494772.192	occupied - active	excellent
20	UNKN	4636076.679	502042.492	unoccupied - inactive	poor
21	UNKN	4636090.654	495077.634	occupied - inactive	excellent
22	RTHA	4635568.571	494566.539	occupied - active	excellent
23	UNKN	4634970.693	502438.338	unoccupied - inactive	fair
24	RTHA	4634846.484	499684.780	occupied - active	excellent
25	UNKN	4634137.238	497987.527	unoccupied - inactive	poor
26	UNKN	4634172.746	498044.274	unoccupied - inactive	poor

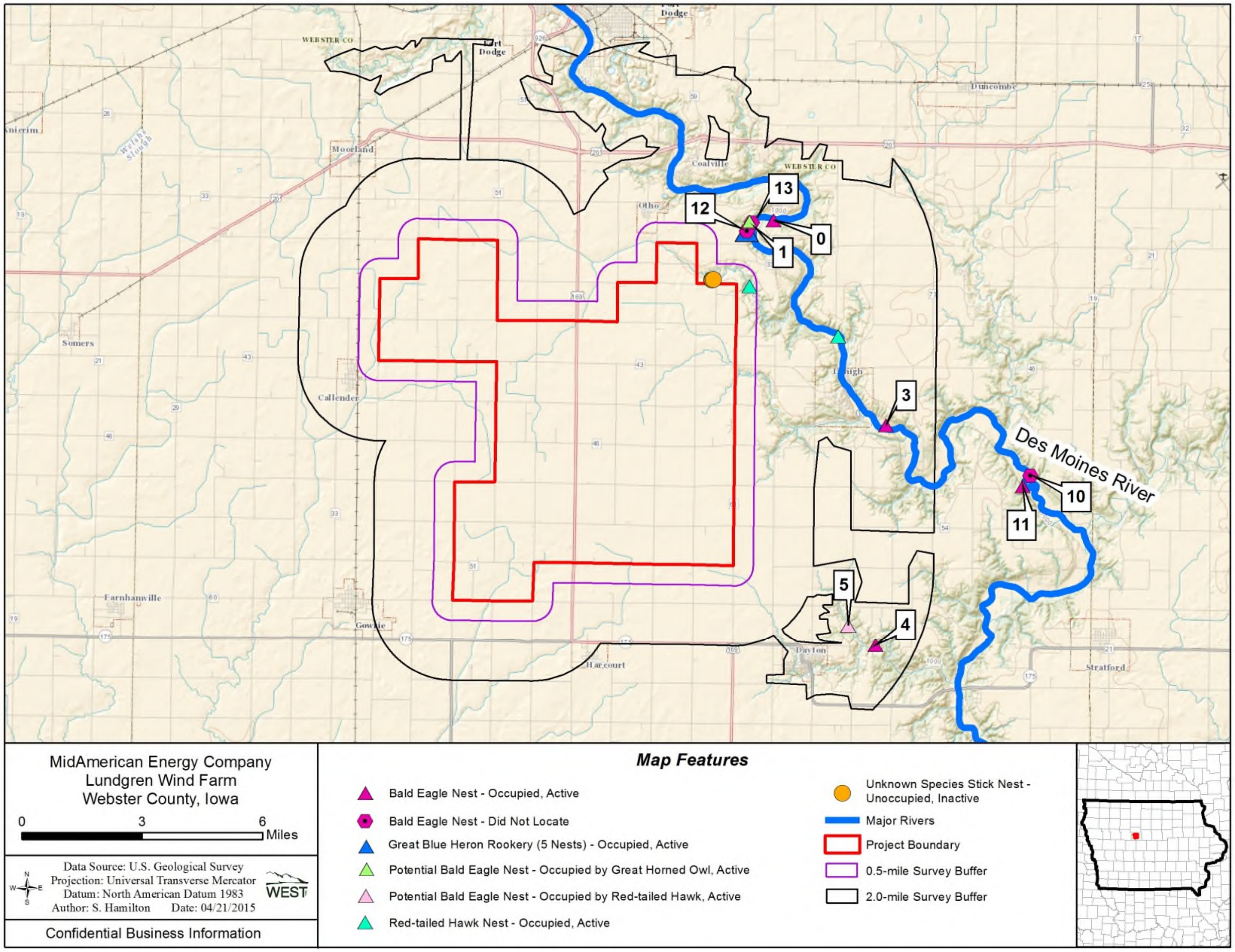
[1] RTHA: red tailed hawk (*Buteo jamaicensis*); UNOW: unknown owl species; UNKN: unknown raptor species

Appendix J. Summary of Raptor Nest Surveys Conducted at the Lundgren Wind Energy Facility From March 27 to April 10, 2015

Appendix J1. Summary of raptor nest surveys for the Lundgren wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in west-central Iowa, Webster County, 4 miles (mi) S of the town of Fort Dodge
	Facility Size	• 33,188.72 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Des Moines Lobe L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 13,603.14 ac • 2-mi buffer: 76,027.19 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 122,819.05 ac
	Survey Dates	• April 6, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • great blue heron (GBHE) • great horned owl (GHOW) • red-tailed hawk (RTHA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 14 nests o BAEA: 9 nests (3 of them occupied by GBH, GHOW and RTHA) o RTHA: 2 nests o UNKN: 3 nests • By area and status o Facility ▪ No nests o 0.5-mi buffer ▪ 1 RTHA occupied – active nest ▪ 3 UNKN unoccupied – inactive nests o 2-mi buffer ▪ 1 BAEA occupied – active nest ▪ 2 BAEA did not locate – historical nest ▪ 1 BAEA potential nest ▪ 1 RTHA occupied – active nest o Informed 5-mi buffer: ▪ 3 BAEA occupied – active nest ▪ 1 BAEA did not locate – historical nest ▪ 1 BAEA potential nest ▪ 1 RTHA occupied – active nest
	Bald Eagle Nests	• Active: 4 nests • Historical: 3 nests (one of which is a occupied – active GBHE rookery) • Potential: 2 nests (occupied – active GHOW and RTHA nests)
	Sensitive/Listed Species Observations	• BAEA: no observation • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0 nests/ac o Total area surveyed: 0.0001 nests/ac • By species (number of nests/ac) o BAEA: 0.00007 nests/ac o RTHA: 0.00002 nests/ac o UNKN: 0.00002 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix J2. Overview of the Lundgren wind energy facility, Webster County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix J3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Lundgren wind energy facility, Webster County, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (number/ac) of Nests				
	Within Lundgren	Within 0.5-mi Buffer of Lundgren	Within 2-mi Buffer of Lundgren	Within Informed 5-mi Buffer of Lundgren	Within Lundgren Plus Buffers
bald eagle	0	0	4(<0.001)	5 (<0.001)	9 (<0.001)
red-tailed hawk	0	1 (<0.001)	0	1 (<0.001)	2 (<0.001)
unknown raptor	0	3 (<0.001)	0	0	3 (<0.001)
Total by Area	**0**	**4 (<0.001)**	**4 (<0.001)**	**6 (<0.001)**	**14 (<0.001)**

Appendix J4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Lundgren wind energy facility, Webster County, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	BAEA	4697130.239	410409.210	occupied - active	good
1	BAEA*,°	4697088.418	409457.920	occupied - active GHOW nest	good
2	RTHA	4692466.279	413014.294	occupied - active	good
3	BAEA	4688895.967	414926.552	occupied - active	good
4	BAEA	4680067.447	414505.598	occupied - active	good
5	BAEA*,°°	4680854.094	413409.034	occupied - active RTHA nest	good
6	RTHA	4694487.031	409458.052	occupied - active	good
7	UNKN	4694729.807	407944.887	unoccupied - inactive	good
8	UNKN	4694733.755	407962.491	unoccupied - inactive	good
9	UNKN	4694752.559	407997.070	unoccupied - inactive	good
10	BAEA**	4686870.000	420730.003	did not locate	not available
11	BAEA	4686452.000	420420.000	occupied - active	good
12	BAEA**,^	4696695.991	409353.001	did not locate, occupied - active GBHE	not available
13	BAEA**	4697031.999	409543.402	did not locate	not available

[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); GBHE: great blue heron (*Ardea herodias*); RTHA: red-tailed hawk (*Buteo jamaicensis*); GHOW: great horned owl (*Bubo virginianus*); UNKN: unknown raptor species; * denotes potential BAEA nest; ** denotes historical BAEA nest; ^ denotes GBHE rookery; ° denotes occupied/active GHOW nest; °° denotes occupied/active RTHA nest

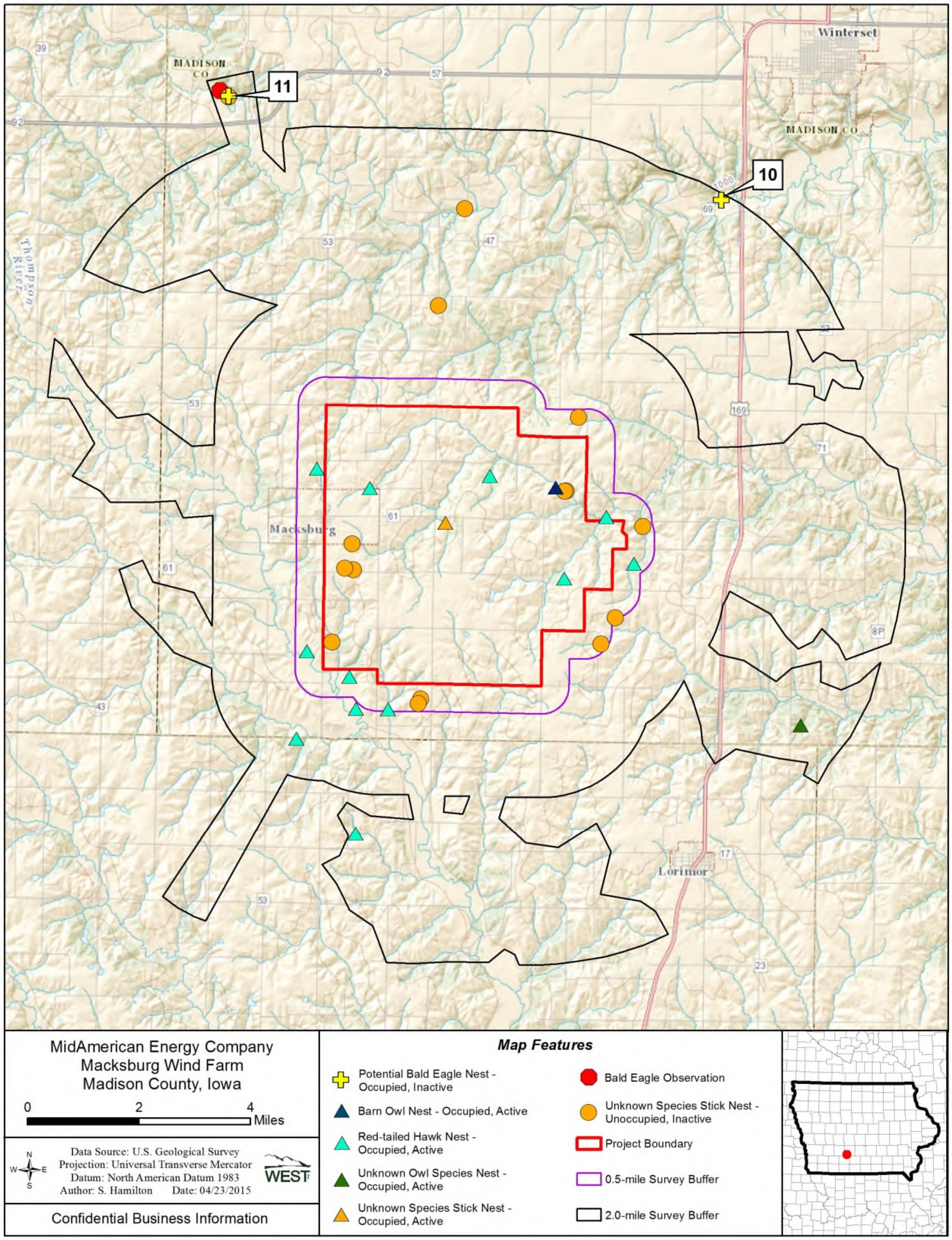
Note: 2 potential BAEA nests and 1 historical BAEA nest are currently occupied by other species (GBHE, GHOW, and RTHA)

Appendix K. Summary of Raptor Nest Surveys Conducted at the Macksburg Wind Energy Facility From March 27 to April 10, 2015

Appendix K1. Summary of raptor nest surveys for the Macksburg wind energy facility.

<table>
<tr><th>Topic</th><th>Sub-Topic</th><th>Summary</th></tr>
<tr><td rowspan="3">Project Description</td><td>Facility Location</td><td>• Located in west-central Iowa, Madison County, 2 miles (mi) SW of the town of Winterset. Includes a portion of the town of Macksburg.</td></tr>
<tr><td>Facility Size</td><td>• 14,366.93 acres (ac)[1]</td></tr>
<tr><td>Ecoregions</td><td>• Western Corn Belt Plains L3 Ecoregion, Rolling Loess Prairies L4 Ecoregion[2]</td></tr>
<tr><td rowspan="2">Nest Survey Description</td><td>Survey Areas</td><td>• 0.5-mi buffer: 6,962.48 ac
• 2-mi buffer: 71,411.31 ac
• Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 92,740.73 ac</td></tr>
<tr><td>Survey Dates</td><td>• March 31, 2015</td></tr>
<tr><td rowspan="5">Nest Survey Results</td><td>Nesting Species</td><td>• bald eagle (BAEA)
• barn owl (BAOW)
• red-tailed hawk (RTHA)
• unknown owl (UNOW)
• unknown raptor (UNKN)</td></tr>
<tr><td>Numbers and Types of Nests Recorded</td><td>• Total: 32 nests
o BAEA: 2 nests
o BAOW: 1 nest
o RTHA: 12 nests
o UNOW: 1 nest
o UNKN: 16 nests
• By area and status
o Facility
▪ 1 BAOW occupied – active nest
▪ 3 RTHA occupied – active nest
▪ 6 UNKN unoccupied – inactive nests
▪ 1 UNKN occupied – active
o 0.5-mi buffer
▪ 6 RTHA occupied – active nest
▪ 6 UNKN unoccupied – inactive nests
o 2-mi buffer
▪ 2 RTHA occupied – active nest
▪ 1 UNKN unoccupied – inactive nests
o Informed 5-mi buffer:
▪ 2 BAEA occupied – inactive nests (potential)
▪ 1 RTHA occupied – active nest
▪ 1 UNOW occupied – active nest
▪ 2 UNKN unoccupied – inactive nests</td></tr>
<tr><td>Bald Eagle Nests</td><td>• Active: none
• Historical: none
• Potential: 2 nests</td></tr>
<tr><td>Sensitive/Listed Species Observations</td><td>• BAEA: 1 observation
• Federally/State-listed species: no observations</td></tr>
<tr><td>Nest Densities</td><td>• By area (number of nests/ac)
o Facility: 0.0008 nests/ac
o Total area surveyed: 0.0003 nests/ac
• By species (number of nests/ac)
o BAEA: 0.00002 nests/ac
o BAOW: 0.00001
o RTHA: 0.0001 nests/ac
o UNOW: 0.00001 nests/ac
o UNKN: 0.0001 nests/ac</td></tr>
</table>

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix K2. Overview of the Macksburg wind energy facility, Madison County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix K3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Macksburg wind energy facility, Madison County, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located)

Species	Number and Density (number/ac) of Nests				
	Within Macksburg	Within 0.5-mi Buffer of Macksburg	Within 2-mi Buffer of Macksburg	Within Informed 5-mi Buffer of Macksburg	Within Macksburg Plus Buffers
bald eagle	0	0	0	2 (<0.001)	2 (<0.001)
barn owl	1 (<0.001)	0	0	0	1 (<0.001)
red-tailed hawk	3 (<0.001)	6 (<0.001)	2 (<0.001)	1 (<0.001)	12 (<0.001)
unknown owl	0	0	0	1 (<0.001)	1 (<0.001)
unknown raptor	7 (<0.001)	6 (<0.001)	1 (<0.001)	2 (<0.001)	16 (<0.001)
Total by Area	**11 (<0.001)**	**12 (0.002)**	**3 (<0.001)**	**6 (<0.001)**	**32 (<0.001)**

Appendix K4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Macksburg wind energy facility, Madison County, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	UNKN	4575387.000	397902.600	unoccupied - inactive	good
1	RTHA	4557704.000	401571.700	occupied - active	good
2	RTHA	4554094.000	401559.000	occupied - active	good
3	RTHA	4556838.000	399850.100	occupied - active	good
4	RTHA	4557691.000	402506.900	occupied - inactive	excellent
5	UNKN	4557987.000	403441.900	unoccupied - inactive	fair
6	UNKN	4557851.000	403368.800	unoccupied - inactive	fair
7	UNOW	4557228.000	414419.700	occupied - active	excellent
8	UNKN	4572159.000	404719.400	unoccupied - inactive	poor
9	UNKN	4569361.000	403956.700	unoccupied - inactive	excellent
10	BAEA*	4572406.000	412123.400	occupied - inactive	excellent
11	BAEA*	4575407.000	397892.300	occupied - inactive	excellent
12	RTHA	4564644.000	400443.100	occupied - active	excellent
13	RTHA	4559367.000	400151.600	occupied - active	excellent
14	UNKN	4559626.000	400877.700	unoccupied - inactive	fair
15	RTHA	4564088.000	401977.300	occupied - active	excellent
16	UNKN	4561716.000	401497.500	unoccupied - inactive	fair
17	UNKN	4561756.000	401249.700	unoccupied - inactive	good
18	RTHA	4558632.000	401387.600	occupied - active	excellent
19	UNKN	4562461.000	401463.800	unoccupied - inactive	poor
20	UNKN	4563082.000	404158.000	occupied - active	excellent
21	RTHA	4564431.000	405436.700	occupied - active	excellent
22	BAOW	4564100.000	407342.500	occupied - active	excellent
23	UNKN	4566117.000	408004.700	unoccupied - inactive	fair
24	UNKN	4563996.000	407648.600	unoccupied - inactive	fair
25	UNKN	4563990.000	407595.600	unoccupied - inactive	poor
26	RTHA	4561469.000	407589.300	occupied - active	excellent
27	RTHA	4563244.000	408807.200	occupied - active	good
28	UNKN	4559566.000	408652.100	unoccupied - inactive	excellent
29	UNKN	4560333.000	409060.300	unoccupied - inactive	fair
30	RTHA	4561899.000	409595.400	occupied - active	excellent
31	UNKN	4562972.000	409856.400	unoccupied - inactive	fair

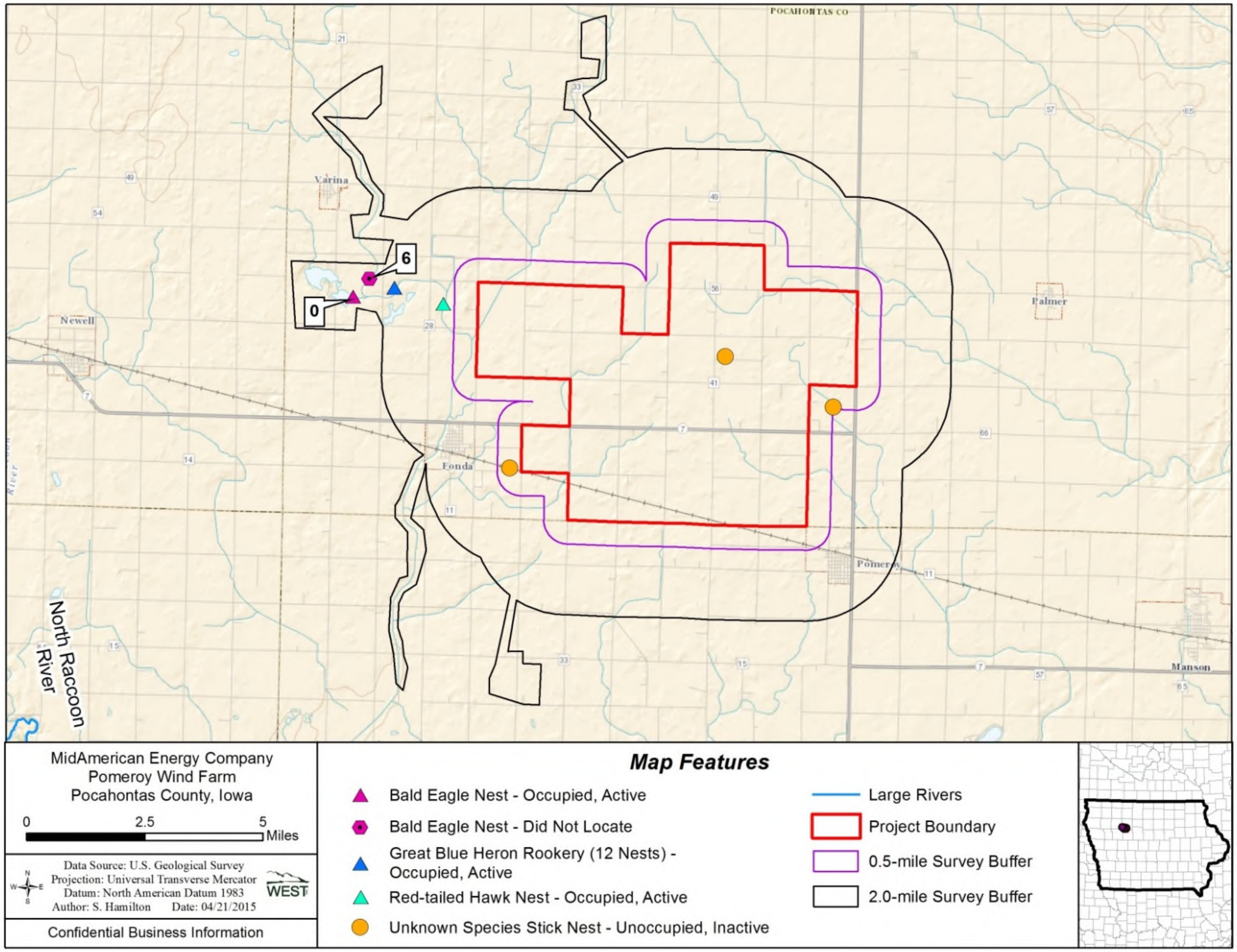
[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); BAOW: barn owl (Bubo virginianus); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNOW: unknown owl species; UNKN: unknown raptor species; * denotes potential BAEA nest

Appendix L. Summary of Raptor Nest Surveys Conducted at the Pomeroy Wind Energy Facility From March 27 to April 10, 2015

Appendix L1. Summary of raptor nest surveys for the Pomeroy wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in central-west Iowa, Pocahontas County, 1 mile (mi) W of the town of Pomeroy
	Facility Size	• 21,798.22 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Des Moines Lobe L4 Ecoregion [2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 10,468.70ac • 2-mi buffer: 37,341.77ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 68,985.45ac
	Survey Dates	• April 8, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • great blue heron (GBHE) • red-tailed hawk (RTHA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 7 nests o BAEA: 2 nest o GBHE: 1 rookery o RTHA: 1 nests o UNKN: 3 nests • By area and status o Facility ▪ 1 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 2 UNKN unoccupied – inactive nests o 2-mi buffer ▪ 1 RTHA occupied – active nest o Informed 5-mi buffer: ▪ 1 BAEA occupied – active nest ▪ 1 BAEA did not locate – historical nest ▪ 1 GBHE rookery with approximately 12 nests
	Bald Eagle Nests	• Active: 1 nest • Historical: 3 nests • Potential: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.00005 nests/ac o Total area surveyed: 0.0001 nests/ac • By species (number of nests/ac) o BAEA: 0.00003 nests/ac o GBHE: 0.00001 nests/ac o RTHA: 0.00001 nests/ac o UNKN: 0.00004 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix L2. Overview of the Pomeroy wind energy facility, Pocahontas County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown (Includes historical bald eagle nests that were not located)

Appendix L3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Pomeroy wind energy facility, Pocahontas County, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (Number/Ac) of Nests				
	Within Pomeroy	Within 0.5-mi Buffer of Pomeroy	Within 2-mi Buffer of Pomeroy	Within Informed 5-mi Buffer of Pomeroy	Within Pomeroy Plus Buffers
bald eagle	0	0	0	2 (<0.001)	2 (<0.001)
great blue heron	0	0	0	1 (<0.001)	1 (<0.001)
red-tailed hawk	0	0	1 (<0.001)	0	1 (<0.001)
unknown raptor	1 (<0.001)	2 (<0.001)	0	0	3 (<0.001)
Total by Area	**1 (<0.001)**	**2 (<0.001)**	**1 (<0.001)**	**3 (<0.001)**	**7 (<0.001)**

Appendix L4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Pomeroy wind energy facility, Pocahontas County, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	BAEA*	4721123.361	345229.034	occupied - active	good
1	GBHE^	4721427.185	346637.783	occupied - active	good
2	RTHA	4720873.801	348298.448	occupied - active	good
3	UNKN	4719064.335	357893.981	unoccupied - inactive	good
4	UNKN	4717342.949	361576.793	unoccupied - inactive	good
5	UNKN	4715270.771	350555.179	unoccupied - inactive	fair
6	BAEA**	4721725.994	345779.002	did not locate	not applicable

[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); GBHE: great blue heron (*Ardea herodias*); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species; * denotes potential BAEA nest; ** denotes historical BAEA nest; ^ denotes GBHE rookery

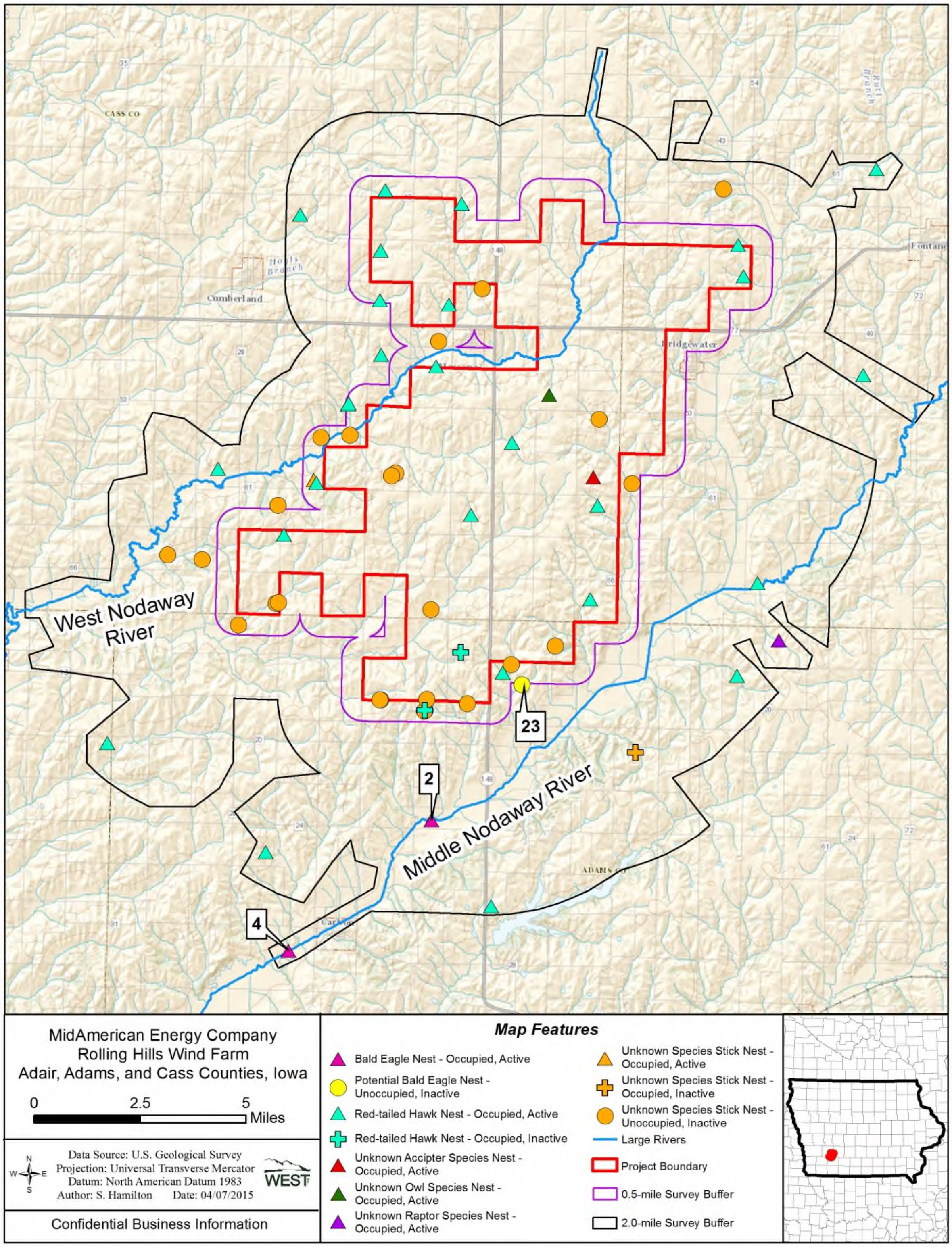
Note: potential BAEA nest FID 0 is potentially historic nest FID 6 (based on proximity)

Appendix M. Summary of Raptor Nest Surveys Conducted at the Rolling Hills Wind Energy Facility From March 27 to April 10, 2015

Appendix M1. Summary of raptor nest surveys for the Rolling Hills wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in SW Iowa, Cass, Adair, and Adams counties, < 0.5 miles (mi) W of the town of Bridgewater
	Facility Size	• 44,293.74 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Rolling Loess Prairies L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 21,382.75 ac • 2-mi buffer: 100,453.87 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 166,130.36 ac
	Survey Dates	• March 27 - 28, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • red-tailed hawk (RTHA) • unknown accipiter (UNAC) • unknown owl (UNOW) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 61 nests o BAEA: 3 nest o RTHA: 29 nests o UNAC: 1 nest o UNOW: 1 nest o UNKN: 27 nests • By area and status o Facility ▪ 1 RTHA occupied – inactive nest ▪ 10 RTHA occupied – active nest ▪ 1 UNAC occupied – active nest ▪ 1 UNOW occupied – active nest ▪ 10 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 1 BAEA unoccupied - inactive nest (potential) ▪ 1 RTHA occupied – inactive nest ▪ 7 RTHA occupied – active nest ▪ 10 UNKN unoccupied – inactive nests ▪ 1 UNKN occupied – active nest o 2-mi buffer ▪ 5 RTHA occupied – active nest ▪ 3 UNKN unoccupied – inactive nests ▪ 1 UNKN occupied – inactive nest o Informed 5-mi buffer: ▪ 2 BAEA occupied – active nest ▪ 5 RTHA occupied – active nest ▪ 1 UNKN unoccupied – inactive nests ▪ 1 UNKN occupied – active nest
	Bald Eagle Nests	• Active: 2 nests • Potential: 1 nest • Historical: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0005 nests/ac o Total area surveyed: 0.0004 nests/ac • By species (number of nests/ac) o BAEA: 0.00002 nests/ac o RTHA: 0.0002 nests/ac o UNAC: 0.000006 nests/ac o UNOW: 0.000006 nests/ac o UNKN: 0.0002 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix M2. Overview of the Rolling Hills wind energy facility, Adair, Adams, and Cass counties, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix M3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Rolling Hills wind energy facility, Adair, Adams, and Cass counties, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (number/ac) of Nests				
	Within Rolling Hills	Within 0.5-mi Buffer of Rolling Hills	Within 2-mi Buffer of Rolling Hills	Within Informed 5-mi Buffer of Rolling Hills	Within Rolling Hills Plus Buffers
bald eagle	0	1 (<0.001)	0	2 (<0.001)	3 (<0.001)
red-tailed hawk	11 (<0.001)	8 (<0.001)	5 (<0.001)	5 (<0.001)	29 (<0.001)
unknown accipiter	1 (<0.001)	0	0	-	1 (<0.001)
unknown owl	1 (<0.001)	0	0	-	1 (<0.001)
unknown raptor	10 (<0.001)	11 (<0.001)	4 (<0.001)	2 (<0.001)	27 (<0.001)
Total by Area	**23 (<0.001)**	**20 (<0.001)**	**9 (<0.001)**	**9 (<0.001)**	**61 (<0.001)**

Appendix M4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Rolling Hills wind energy facility, Adair, Adams, and Cass counties, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	RTHA	4553138.093	338006.762	occupied - active	good
1	UNKN	4552774.567	358051.484	occupied - inactive	good
2	BAEA	4550214.534	350304.270	occupied - active	good
3	RTHA	4548993.541	344005.304	occupied - active	good
4	BAEA	4545245.249	344876.725	occupied - active	good
5	RTHA	4546943.781	352569.815	occupied - active	good
6	RTHA	4555695.859	361897.358	occupied - active	good
7	RTHA	4559203.355	362671.780	occupied - active	good
8	UNKN	4557041.296	363481.585	occupied - active	good
9	RTHA	4567123.695	366686.671	occupied - active	good
10	RTHA	4574927.306	367187.936	occupied - active	good
11	UNKN	4574165.842	361382.578	unoccupied - inactive	good
12	RTHA	4565992.738	347137.303	occupied - active	good
13	RTHA	4573207.461	345320.162	occupied - active	good
14	RTHA	4563547.283	342199.551	occupied - active	good
15	UNKN	4560268.317	340285.676	unoccupied - inactive	good
16	RTHA	4554378.610	350046.524	occupied - inactive	good
17	UNKN	4554369.517	350059.843	unoccupied - inactive	fair
18	UNKN	4554346.944	350041.713	unoccupied - inactive	fair
19	UNKN	4554621.653	351669.307	unoccupied - inactive	poor
20	UNKN	4554782.038	350128.439	unoccupied - inactive	good
21	UNKN	4554770.829	348378.737	unoccupied - inactive	fair
22	UNKN	4554770.917	348343.093	unoccupied - inactive	fair
23	BAEA*	4555337.715	353748.601	unoccupied - inactive	good
24	UNKN	4556114.226	353335.835	unoccupied - inactive	fair
25	RTHA	4555809.350	352999.359	occupied - active	good
26	RTHA	4556568.048	351417.735	occupied - inactive	excellent
27	UNKN	4556807.998	355009.422	unoccupied - inactive	fair
28	UNKN	4557611.365	342983.263	unoccupied - inactive	poor
29	UNKN	4558437.191	344410.348	unoccupied - inactive	good
30	UNKN	4558466.802	344499.635	unoccupied - inactive	good
31	UNKN	4558191.235	350280.125	unoccupied - inactive	good
32	RTHA	4558586.270	356328.253	occupied - active	excellent
33	UNKN	4560087.384	341594.750	unoccupied - inactive	fair
34	RTHA	4561044.737	344703.125	occupied - active	excellent
35	RTHA	4561791.657	351794.613	occupied - active	excellent
36	RTHA	4562154.302	356605.815	occupied - active	excellent
37	UNKN	4562149.145	344488.788	unoccupied - inactive	good
38	UNKN	4563115.333	345836.918	occupied - active	good
39	RTHA	4563022.044	345935.779	occupied - active	good
40	UNKN	4563372.392	348953.886	unoccupied - inactive	good
41	UNKN	4563274.354	348783.174	unoccupied - inactive	good
42	UNAC	4563221.430	356447.879	occupied - active	good

Appendix M4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Rolling Hills wind energy facility, Adair, Adams, and Cass counties, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
43	UNKN	4562966.838	357917.332	unoccupied - inactive	fair
44	RTHA	4564536.427	353358.215	occupied - active	good
45	UNKN	4564727.511	346117.875	unoccupied - inactive	poor
46	UNKN	4564808.488	347221.630	unoccupied - inactive	good
47	UNKN	4565412.337	356659.182	unoccupied - inactive	good
48	RTHA	4566049.629	347157.480	occupied - active	good
49	UNOW	4566359.922	354773.909	occupied - active	good
50	RTHA	4567444.408	350483.120	occupied - active	good
51	RTHA	4567883.864	348393.053	occupied - active	good
52	UNKN	4568382.236	350588.276	unoccupied - inactive	poor
53	RTHA	4569953.347	348340.672	occupied - active	good
54	RTHA	4569793.154	350959.331	occupied - active	good
55	UNKN	4570374.664	352229.408	unoccupied - inactive	poor
56	RTHA	4570868.091	362155.716	occupied - active	good
57	RTHA	4571840.990	348374.648	occupied - active	good
58	RTHA	4572044.331	361940.140	occupied - active	good
59	RTHA	4573612.182	351442.818	occupied - active	good
60	RTHA	4574124.763	348545.782	occupied - active	good

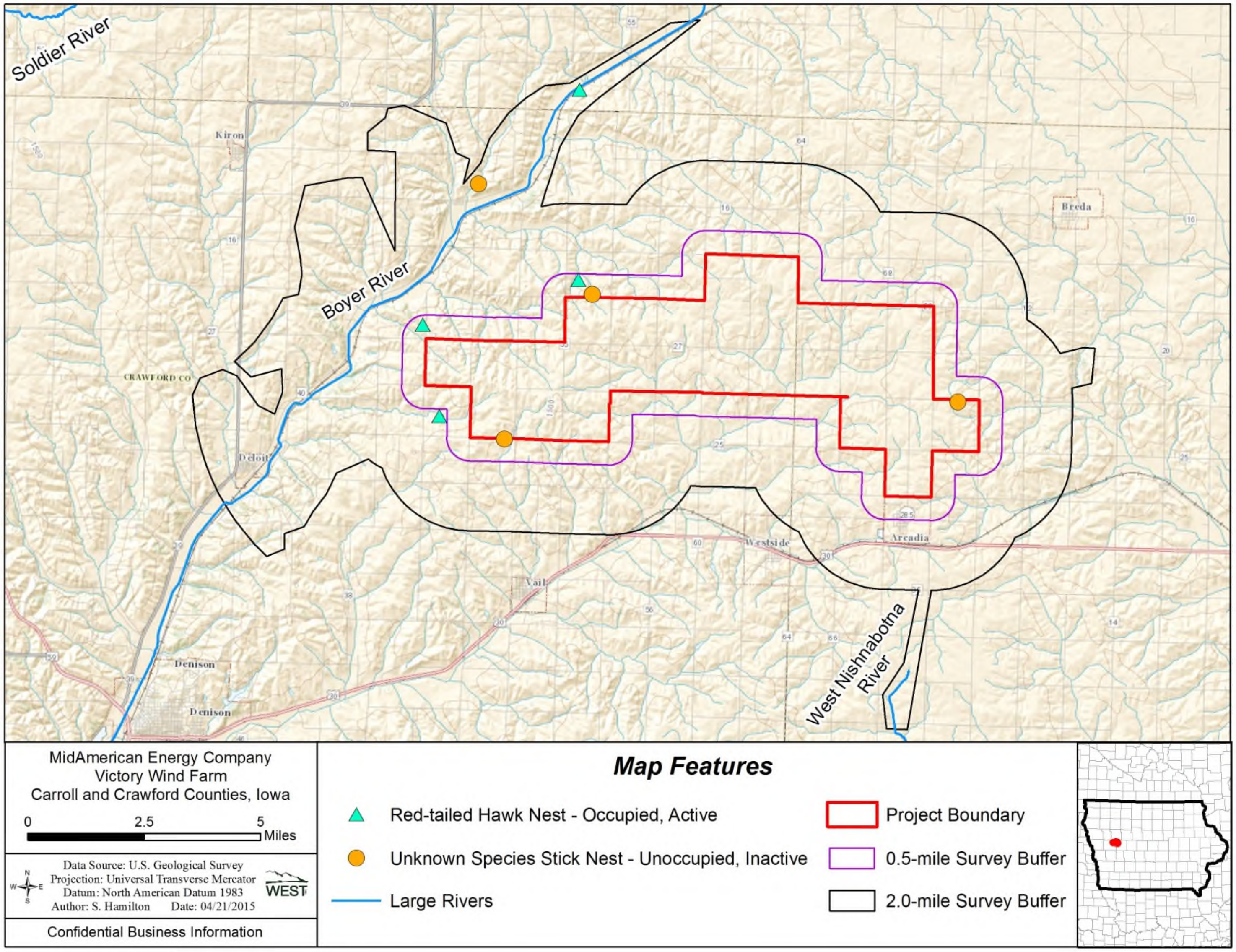
[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNOW: unknown owl species; UNAC: unknown accipiter; UNKN: unknown raptor species; * denotes potential BAEA nest

Appendix N. Summary of Raptor Nest Surveys Conducted at the Victory Wind Energy Facility From March 27 to April 10, 2015

Appendix N1. Summary of raptor nest surveys for the Victory wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in SW Iowa, Crawford and Carroll counties, 2.5 miles (mi) N of the town of Westside.
	Facility Size	• 18,129.07 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Eastern Iowa and Minnesota Drift Plains L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 11,760.65 ac • 2-mi buffer: 55,864.08 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 85,753.80 ac
	Survey Dates	• April 10, 2015
Nest Survey Results	Nesting Species	• red-tailed hawk (RTHA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 8 nests o RTHA: 4 nests o UNKN: 4 nests • By area and status o Facility ▪ 3 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 2 RTHA occupied – active nest o 2-mi buffer ▪ 1 RTHA occupied – active nest o Informed 5-mi buffer: ▪ 1 RTHA occupied – active nest ▪ 1 UNKN unoccupied – inactive nest
	Bald Eagle Nests	• Active: none • Historical: none • Potential: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0002 nests/ac o Total area surveyed: 0.00009 nests/ac • By species (number of nests/ac) o RTHA: 0.00005 nests/ac o UNKN: 0.00005 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix N2. Overview of the Victory wind energy facility, Carroll and Crawford counties, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix N3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Victory wind energy facility, Carroll and Crawford counties, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (number/ac) of Nests				
	Within Victory	Within 0.5-mi Buffer of Victory	Within 2-mi Buffer of Victory	Within Informed 5-mi Buffer of Victory	Within Victory Plus Buffers
red-tailed hawk	0	2 (<0.001)	1 (<0.001)	1 (<0.001)	4(<0.001)
unknown raptor	3 (<0.001)	0	0	1 (<0.001)	4 (<0.001)
Total by Area	**3 (<0.001)**	**2 (<0.001)**	**1 (<0.001)**	**2 (<0.001)**	**8 (<0.001)**

Appendix N4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Victory wind energy facility, Carroll and Crawford counties, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	UNKN	4672966.141	316200.284	unoccupied - inactive	excellent
1	RTHA	4676212.116	319683.600	occupied - active	good
2	UNKN	4664146.135	317094.940	unoccupied - inactive	good
3	RTHA	4664949.089	314843.127	occupied - active	good
4	UNKN	4665428.195	332762.627	unoccupied - inactive	good
5	RTHA	4668113.201	314264.106	occupied - active	good
6	RTHA	4669660.525	319652.912	occupied - active	good
7	UNKN	4669163.552	320129.625	unoccupied - inactive	good

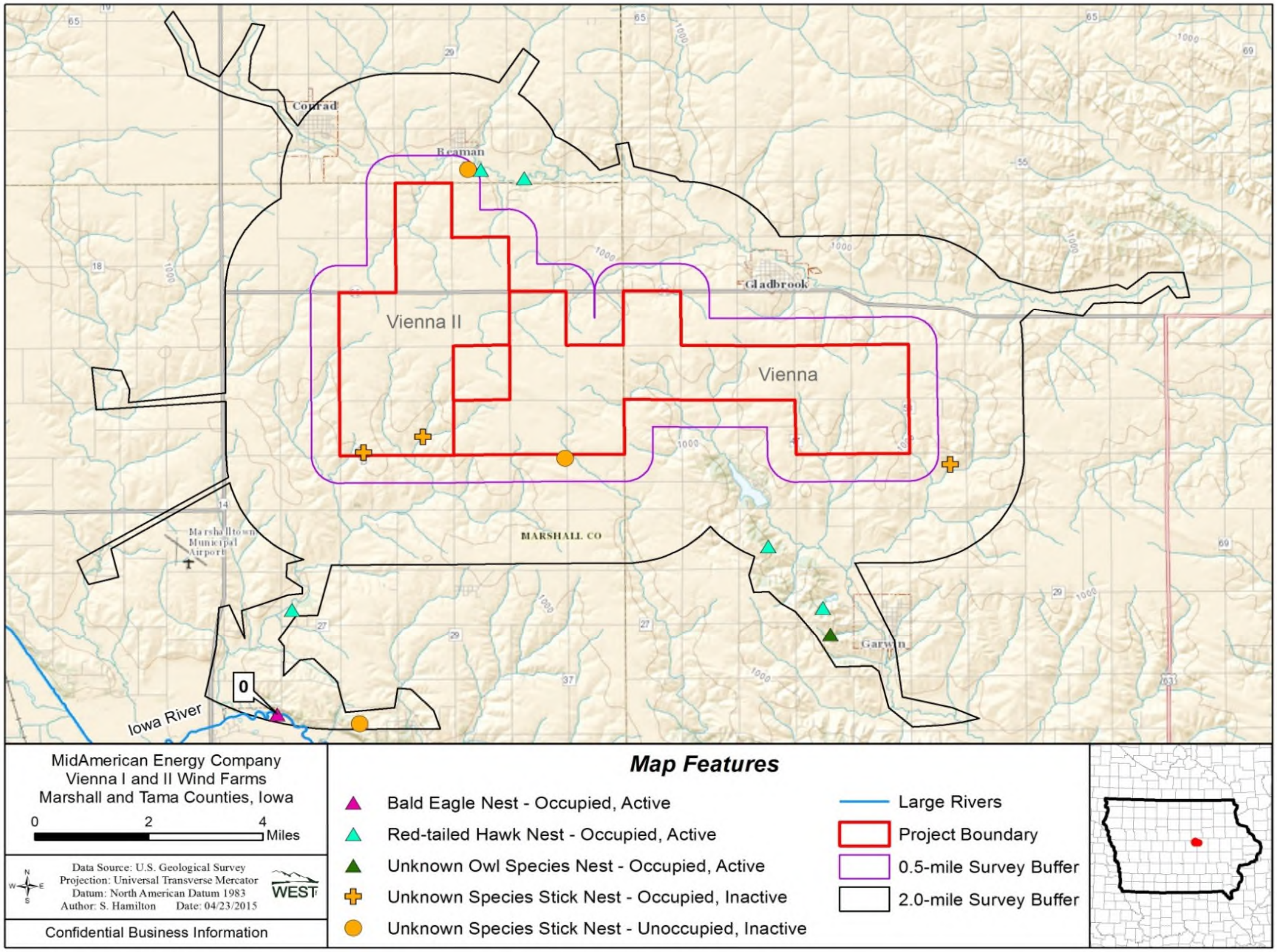
[1] RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species

Appendix O. Summary of Raptor Nest Surveys Conducted at the Vienna I & II Wind Energy Facility From March 27 to April 10, 2015

Appendix O1. Summary of raptor nest surveys for the Vienna I&II wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in central Iowa, Marshall and Tama counties, 0.5 miles (mi) S of the town of Beaman
	Facility Size	• 16,506.16 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Eastern Iowa and Minnesota Drift Plains and Rolling Loess Prairies L4 Ecoregion [2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 10,454.78 ac • 2-mi buffer: 43,658.70 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 70,619.63 ac
	Survey Dates	• April 2, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • red-tailed hawk (RTHA) • unknown owl (UNOW) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 13 nests o BAEA: 1 nest o RTHA: 5 nests o UNOW: 1 nest o UNKN: 6 nests • By area and status o Facility: ▪ 2 UNKN occupied – inactive nest o 0.5-mi buffer: ▪ 2 UNKN unoccupied – inactive nests o 2-mi buffer: ▪ 3 RTHA occupied – active nests ▪ 1 UNKN occupied – inactive o Informed 5-mi buffer: ▪ 1 BAEA occupied – active nest ▪ 2 RTHA occupied – active nests ▪ 1 UNOW occupied – active nest ▪ 1 UNKN unoccupied – inactive nest
	Bald Eagle Nests	• Active: 1 nest • Historical: none • Potential: none
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0001 nests/ac o Total area surveyed: 0.0002 nests/ac • By species (number of nests/ac): o BAEA: 0.00001 nests/ac o RTHA: 0.00007 nests/ac o UNOW: 0.00001 nests/ac o UNKN: 0.00008 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix O2. Overview of the Vienna I-II Wind Energy Facility, Marshall and Tama counties, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix O3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Vienna I/II Wind Energy Facility, Marshall and Tama counties, Iowa, and the associated buffers. Nest densities are shown in parentheses. (Includes historical bald eagle nests that were not located).

Species	Number and Density (number/ac) of Nests				
	Within Vienna I/II	Within 0.5-mi Buffer of Vienna I/II	Within 2-mi Buffer of Vienna I/II	Within Informed 5-mi Buffer of Vienna I/II	Within Vienna I/II Plus Buffers
bald eagle	0	0	0	1 (<0.001)	1 (<0.001)
red-tailed hawk	0	0	3 (<0.001)	2 (<0.001)	5 (<0.001)
unknown owl	0	0	0	1 (<0.001)	1 (<0.001)
unknown raptor	2 (<0.001)	2(<0.001)	1 (<0.001)	1 (<0.001)	6 (<0.001)
Total by Area	**2 (<0.001)**	**2 (<0.001)**	**4 (<0.001)**	**5 (<0.001)**	**13 (<0.001)**

Appendix O4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Vienna I-II Wind Energy Facility, Marshall and Tama counties, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	BAEA	4657483.527	509464.718	occupied - active	excellent
1	UNKN	4657202.991	511795.008	occupied - inactive	excellent
2	RTHA	4660558.161	509879.284	occupied - active	excellent
3	RTHA	4662422.149	523323.843	occupied - active	excellent
4	UNOW	4659821.720	525073.041	occupied - active	excellent
5	RTHA	4660614.664	524857.925	occupied - active	excellent
6	RTHA	4673266.758	516430.761	occupied - active	excellent
7	RTHA	4673515.033	515213.349	occupied - active	excellent
8	UNKN	4673504.678	514848.900	occupied - inactive	good
9	UNKN	4664829.742	528450.079	occupied - inactive	excellent
10	UNKN	4665631.446	513579.324	occupied - inactive	excellent
11	UNKN	4665169.435	511909.366	occupied - inactive	excellent
12	UNKN	4665010.506	517588.706	occupied - inactive	good

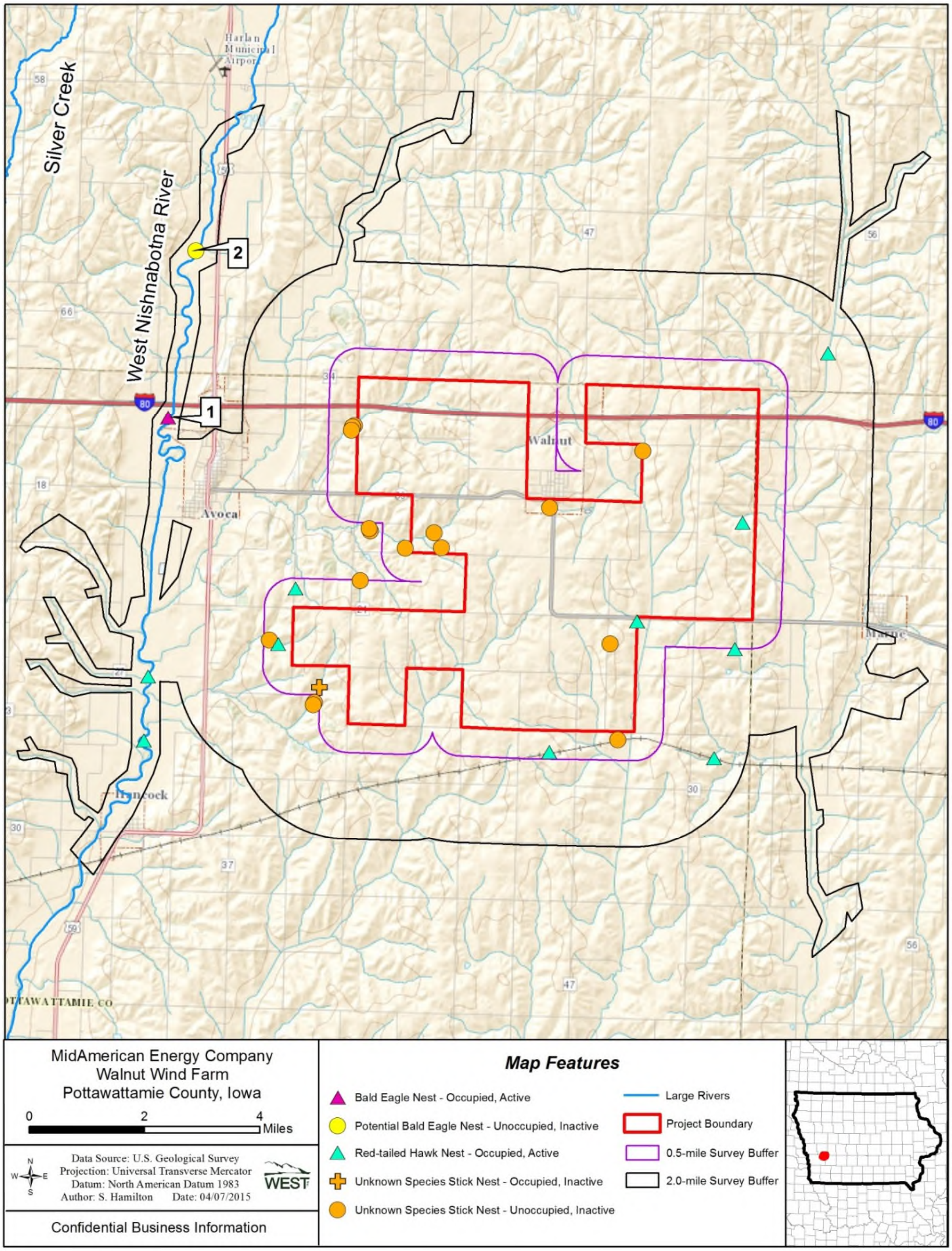
[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNOW: unknown owl species; UNKN: unknown raptor species

Appendix P. Summary of Raptor Nest Surveys Conducted at the Walnut Wind Energy Facility From March 27 to April 10, 2015

Appendix P1. Summary of raptor nest surveys for the Walnut wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in SW Iowa, Pottawattamie County, 1 mile (mi) E of the town of Avoca
	Facility Size	• 20,409.22 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Steeply Rolling Loess Prairies L4 Ecoregion [2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 12,905.58 ac • 2-mi buffer: 43,864.77 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 77,179.57 ac
	Survey Dates	• March 30, 2015
Nest Survey Results	Nesting Species	• red-tailed hawk (RTHA) • bald eagle (BAEA) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 25 nests o BAEA: 2 nests o RTHA: 10 nests o UNKN: 13 nests • By area and status o Facility: ▪ 2 RTHA occupied – active nests ▪ 5 UNKN unoccupied – inactive nests o 0.5-mi buffer: ▪ 4 RTHA occupied – active nest ▪ 7 UNKN unoccupied – inactive nests ▪ 1 UNKN occupied – inactive nests o 2-mi buffer: ▪ 2 RTHA occupied – active nests o 4 UNKN unoccupied – inactive nest Informed 5-mi buffer: ▪ 1 BAEA occupied – active nest ▪ 1 BAEA unoccupied – inactive (potential) ▪ 2 RTHA occupied – active nests
	Bald Eagle Nests	• Active: 1 nest • Historical: none • Potential: 1 nest
	Sensitive/Listed Species Observations	• BAEA: no observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0003 nests/ac o Total area surveyed: 0.0004 nests/ac • By species (number of nests/ac): o BAEA: 0.00002 nests/ac o RTHA: 0.0001 nests/ac o UNKN: 0.0002 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix P2. Overview of the Walnut wind energy facility, Pottawattamie County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix P3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Walnut wind energy facility, Pottawattamie County, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (number/ac) of Nests				
	Within Walnut	Within 0.5-mi Buffer of Walnut	Within 2-mi Buffer of Walnut	Within Informed 5-mi Buffer of Walnut	Within Walnut Plus Buffers
bald eagle	0	0	0	2 (<0.001)	2 (<0.001)
red-tailed hawk	2 (<0.001)	4 (<0.001)	2 (<0.001)	2 (<0.001)	10 (<0.001)
unknown raptor	5 (<0.001)	8 (<0.001)	5 (<0.001)	0	13 (<0.001)
Total by Area	**7 (<0.001)**	**12 (<0.001)**	**7 (<0.001)**	**4 (<0.001)**	**30 (<0.001)**

Appendix P4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Walnut wind energy facility, Pottawattamie County, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	RTHA	4598111.862	322107.596	occupied -active	good
1	BAEA	4596318.566	303669.327	occupied -active	excellent
2	BAEA*	4600958.343	304442.514	unoccupied - inactive	excellent
3	RTHA	4589085.433	303109.315	occupied -active	excellent
4	RTHA	4587301.532	302991.123	occupied -active	excellent
5	RTHA	4586983.852	314322.954	occupied -active	excellent
6	RTHA	4586808.701	318920.957	occupied -active	excellent
7	UNKN	4596048.730	308848.136	unoccupied - inactive	good
8	UNKN	4596078.357	308877.924	unoccupied - inactive	good
9	UNKN	4596046.577	308823.804	unoccupied - inactive	good
10	UNKN	4595950.200	308787.289	unoccupied - inactive	good
11	UNKN	4595368.960	316932.209	unoccupied - inactive	good
12	RTHA	4593379.449	319713.115	occupied -active	excellent
13	UNKN	4593782.924	314326.200	unoccupied - inactive	good
14	UNKN	4593090.907	311106.111	unoccupied - inactive	excellent
15	UNKN	4593143.799	309315.973	unoccupied - inactive	good
16	UNKN	4593202.648	309283.586	unoccupied - inactive	good
17	UNKN	4592655.916	310298.219	unoccupied - inactive	fair
18	UNKN	4592671.415	311310.820	unoccupied - inactive	fair
19	UNKN	4591759.176	309033.763	unoccupied - inactive	fair
20	RTHA	4591543.163	307231.758	occupied -active	good
21	RTHA	4590627.885	316772.386	occupied -active	excellent
22	RTHA	4589852.743	319504.456	occupied -active	excellent
23	UNKN	4589986.276	316016.538	unoccupied - inactive	fair
24	RTHA	4589993.597	306751.812	occupied -active	excellent
25	UNKN	4590094.681	306506.023	unoccupied - inactive	good
26	UNKN	4588776.179	307899.482	occupied - inactive	good
27	UNKN	4588352.217	307755.444	unoccupied - inactive	good
28	UNKN	4588293.603	307721.761	unoccupied - inactive	good
29	UNKN	4587308.981	316227.653	unoccupied - inactive	good

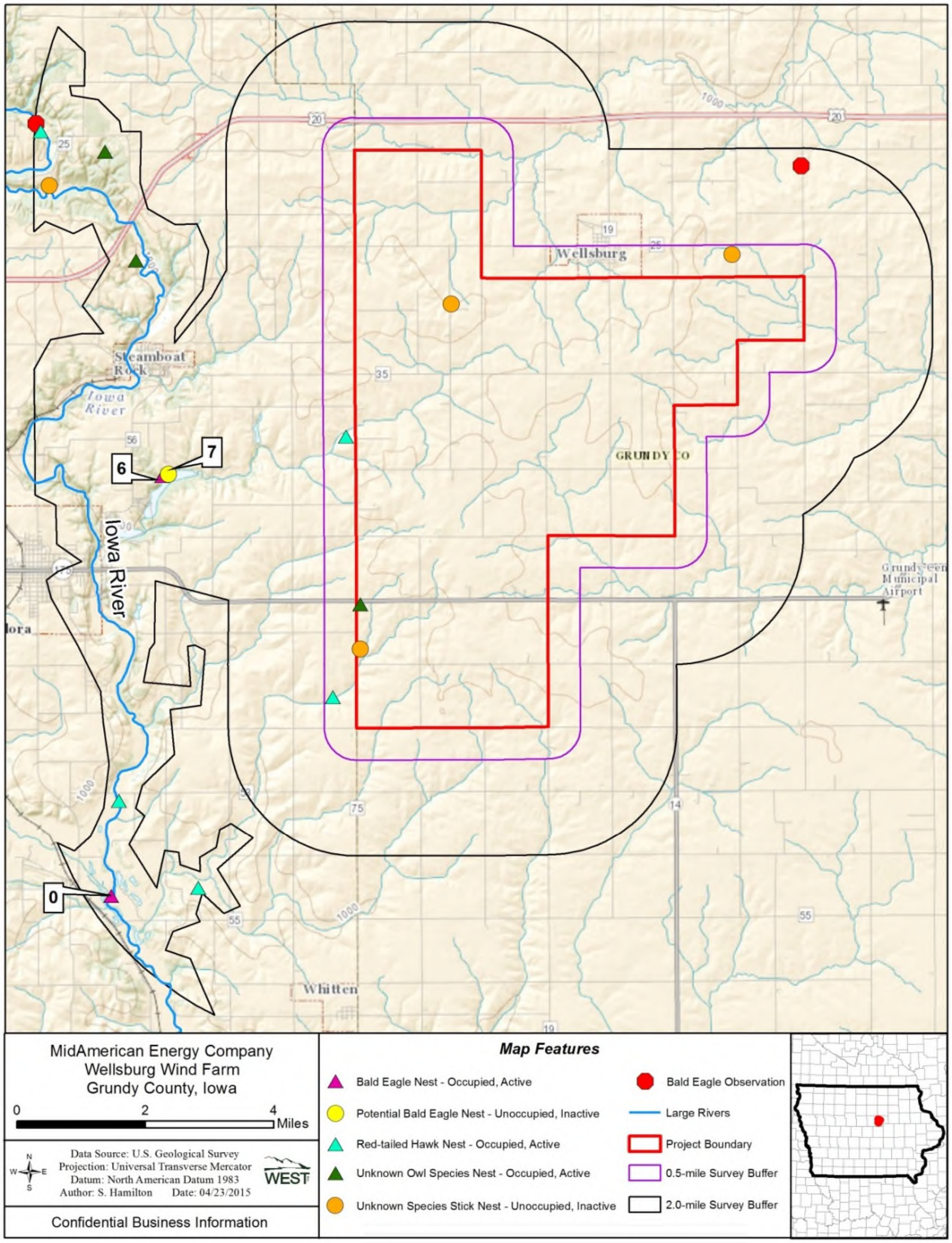
[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNKN: unknown raptor species; * potential BAEA nest

Appendix Q. Summary of Raptor Nest Surveys Conducted at the Wellsburg Wind Energy Facility From March 27 to April 10, 2015

Appendix Q1. Summary of raptor nest surveys for the Wellsburg wind energy facility.

Topic	Sub-Topic	Summary
Project Description	Facility Location	• Located in central-east Iowa, Grundy County, 0.5 miles (mi) S of the town of Wellsburg
	Facility size	• 22,979.01 acres (ac)[1]
	Ecoregions	• Western Corn Belt Plains L3 Ecoregion, Rolling Loess Prairies and Eastern Iowa and Minnesota Drift Plains L4 Ecoregion[2]
Nest Survey Description	Survey Areas	• 0.5-mi buffer: 10,622 ac • 2-mi buffer: 52,852.13 ac • Total area surveyed (facility plus buffers [includes informed 2-mi buffer]): 86,453.14 ac
	Survey Dates	• April 2 - 3, 2015
Nest Survey Results	Nesting Species	• bald eagle (BAEA) • red-tailed hawk (RTHA) • unknown owl (UNOW) • unknown raptor (UNKN)
	Numbers and Types of Nests Recorded	• Total: 15 nests o BAEA: 3 nest o RTHA: 5 nests o UNOW: 3 nests o UNKN: 4 nests • By area and status o Facility ▪ 1 UNOW occupied – active nest ▪ 2 UNKN unoccupied – inactive nests o 0.5-mi buffer ▪ 2 RTHA occupied – active nest ▪ 1 UNKN unoccupied – inactive nests o 2-mi buffer ▪ No nests o Informed 5-mi buffer: ▪ 2 BAEA occupied – active nest ▪ 1 BAEA unoccupied – inactive nest (potential) ▪ 3 RTHA occupied – active nest ▪ 2 UNOW occupied – active nests ▪ 1 UNKN unoccupied – inactive nest
	Bald Eagle Nests	• Active: 2 nest • Historical: none • Potential: 1 nest
	Sensitive/Listed Species Observations	• BAEA: 2 observations • Federally/State-listed species: no observations
	Nest Densities	• By area (number of nests/ac) o Facility: 0.0001 nests/ac o Total area surveyed: 0.0002 nests/ac • By species (number of nests/ac) o BAEA: 0.00004 nests/ac o RTHA: 0.00006 nests/ac o UNOW: 0.00004 nests/ac o UNKN: 0.00005 nests/ac

[1] US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. Land Use/Land Cover, USGS NLCD 2011 Data.
[2] US Environmental Protection Agency (USEPA). 2004. Level III and IV Ecoregions. USEPA, Corvallis, Oregon.



Appendix Q2. Overview of the Wellsburg wind energy facility, Grundy County, Iowa, and associated buffers. Location of observations and/or nests during raptor nest surveys within and around the project area are shown.

Appendix Q3. Nesting species, number of nests, and nest density (number of nests/acre) by area and by species, based on raptor nest surveys within the Wellsburg wind energy facility, Grundy County, Iowa, and the associated buffers. Nest densities are shown in parentheses (Includes historical bald eagle nests that were not located).

Species	Number and Density (number/ac) of Nests				
	Within Wellsburg	Within 0.5-mi Buffer of Wellsburg	Within 2-mi Buffer of Wellsburg	Within Informed 5-mi Buffer of Wellsburg	Within Wellsburg Plus Buffers
bald eagle	0	0	0	3 (<0.001)	3 (<0.001)
red-tailed hawk	0	2 (<0.001)	0	3 (<0.001)	5 (<0.001)
unknown owl	1 (<0.001)	0	0	2 (<0.001)	3 (<0.001)
unknown raptor	2 (<0.001)	1 (<0.001)	0	1 (<0.001)	4 (<0.001)
Total by Area	**3 (<0.001)**	**3 (<0.001)**	**0**	**9 (<0.001)**	**15 (<0.001)**

Appendix Q4. Raptor nest Unique ID (FID), locations (NAD83, Zone 15), and features for identified nests during the spring 2015, survey for the Wellsburg wind energy facility, Grundy County, Iowa, and associated buffers.

FID	Species[1]	Northing	Easting	Status at Time of Survey	Condition
0	BAEA	4681646.007	493648.737	occupied - active	excellent
1	RTHA	4684038.568	493848.043	occupied - active	excellent
2	RTHA	4681843.477	495837.599	occupied - active	excellent
3	RTHA	4700848.027	491885.717	occupied - active	excellent
4	UNKN	4699481.678	492099.607	unoccupied - inactive	excellent
5	UNOW	4700332.675	493493.250	occupied - active	excellent
6	BAEA	4692196.004	494932.431	occupied - active	excellent
7	BAEA*	4692231.909	495090.121	unoccupied - inactive	excellent
8	UNOW	4697608.168	494273.746	occupied - active	excellent
9	RTHA	4686637.819	499213.245	occupied - active	excellent
10	UNKN	4687845.669	499903.666	unoccupied - inactive	good
11	UNOW	4688973.618	499907.492	occupied - active	excellent
12	RTHA	4693180.958	499542.881	occupied - active	excellent
13	UNKN	4696512.706	502182.934	unoccupied - inactive	good
14	UNKN	4697750.635	509228.6534	unoccupied - inactive	good

[1] BAEA: bald eagle (*Haliaeetus leucocephalus*); RTHA: red-tailed hawk (*Buteo jamaicensis*); UNOW: unknown owl species; UNKN: unknown raptor species; * potential BAEA nest

2014-2017 Post-Construction Fatality Monitoring

MidAmerican Energy Company Iowa Wind Energy Portfolio: 2-Year Summary

December 2014 – March 2017

DRAFT REPORT

Confidential Commercial Information – Protected from disclosure under the Freedom of Information Act, Including exemptions (b)(4) and (b)(7)

Prepared for:

MidAmerican Energy Company

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May 23, 2017

WEST Inc.

INTRODUCTION

MidAmerican Energy Company (MidAmerican Energy or MidAmerican) retained Western EcoSystems Technology, Inc. (WEST) 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). WEST has conducted 28 months of post-construction monitoring as its operating wind energy facilities in Iowa to evaluate impacts to bats and birds. This document provides a summary of post-construction monitoring conducted from December 4, 2014, to March 15, 2017.

Post-construction monitoring consisted of two study designs: one focused on detection of bat carcasses and one focused on detection of eagle carcasses. Detailed study methods for each design are presented in the annual technical reports (Attachments A-D; Bay et al. 2016a, b; Bay et al. 2017a, b). MidAmerican divided the post-construction monitoring into various study periods. Throughout the entire study, MidAmerican operated all turbines without any operational constraints or curtailments in order to evaluate baseline fatality estimates and to inform development of a habitat conservation plan.

SUMMARY OF BAT DATA

Post-construction monitoring for bats was conducted at nine facilities in the 2015 study period: Adair, Carroll, Eclipse, Lundgren, Macksburg, Morning Light, Rolling Hills, Victory, and Walnut. All-bat fatality rates among these nine facilities varied widely, with more than an approximately 10-fold difference between the site with the lowest estimate (Rolling Hills) and the site with the highest estimate (Macksburg). Species composition of fatalities at the nine Projects monitored in the first study period was similar to that at most other wind energy facilities, in that most bat fatalities were comprised of three migratory tree bat species: hoary bat, eastern red bat and silver-haired bat. No Indiana bat or northern long-eared bats were found. Thirty four little brown bats and 18 tri-colored bats were found.

Post-construction monitoring for bats was conducted in 2016 at the nine projects not studied in 2015; in addition, MidAmerican repeated and expanded monitoring efforts at three projects studied in 2015. The 2016 study covered the Adams, Century, Charles City, Highland, Intrepid, Laurel, Pomeroy, Vienna I, Vienna II and Wellsburg projects. The three projects studied in both 2015 and 2016 were Lundgren, Macksburg and Rolling Hills. As in 2015, all-bat fatality rates among the 13 facilities varied considerably, with nearly a three-fold difference between the site with the lowest estimate (Pomeroy) and the site with the highest estimate (Intrepid) (Table 9). Species composition of fatalities at these 13 projects remained similar to that at most other wind energy facilities. One Indiana bat was found at the Macksburg project; no northern long-eared bats were found. Thirty-nine little brown bats and 27 tricolored bats were found at the projects monitored.

Based upon two years of intensive study, data indicate there are few fatalities of Indiana bat and northern long-eared bat and such fatalities are rare events at MidAmerican's Iowa wind energy facilities, event at baseline operational levels. Two projects in particular – Lundgren and Macksburg – exhibited relatively higher mortality levels for the bat species of interest (Myotis and Perimyotis) based on the observed number of carcasses found (Table 1).

Table 1. Facility specific all bat fatality estimates by year and observed number of carcass from the monitoring studies of the MidAmerican 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	pending	104		-	-	-	-	-
Ida Grove	pending	134		-	-	-	-	-
State Fair	pending	1		-	-	-	-	-

Overall species composition of fatalities was similar to that at most other wind energy facilities, in that most bat fatalities were comprised of three migratory tree bat species: hoary bat, eastern red bat, and silver-haired bat. In several cases, hoary bat composed over 35 percent of the total species composition at individual projects under normal turbine operations.

Monitoring data also indicate that the period of highest risk for the species of interest ranged from about mid-June to about mid-September at MidAmerican's Iowa wind energy facilities, with the majority of species of interest discovered between July 1 and September 15 (Table 2).

Table 2. Timing of Covered Bat Species Discoveries at All Facilities

Species	85% Start and End Dates		75% Start and End Dates	
	2015			
All bats	6/16/2015	9/15/2015	7/13/2015	9/9/2015
Myotis and Perimyotis	6/16/2015	9/9/2015	6/26/2015	9/1/2015
	2016			
All bats	6/15/2016	9/22/2016	7/13/2016	9/12/2016
Myotis and Perimyotis	7/13/2016	9/18/2016	7/27/2016	9/7/2016

SUMMARY OF EAGLE DATA

MidAmerican Energy has conducted 28 months (December 2014 through March 2017) of post-construction monitoring as its operating wind energy facilities in Iowa, of which 18 months were designed to evaluate impacts to eagles. The post-construction monitoring protocols are consistent with and meant to implement 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). MidAmerican divided the post-construction monitoring into various study periods. Throughout the entire study, MidAmerican operated all turbines without any operational constraints or curtailments in order to evaluate baseline fatality estimates and to inform development of a habitat conservation plan.

Post-construction monitoring for eagles was conducted at nine facilities in the 2014-2016 study period: Adair, Carroll, Eclipse, Lundgren, Macksburg, Morning Light, Rolling Hills, Victory, and Walnut. A single eagle carcass was found at both Macksburg and Carroll. Both carcasses were found within the search plot and were included in take estimation process discussed in the HCP.

Post-construction monitoring for eagles was conducted in 2015-2017 at the ten projects not studied previously; surveys overlapped between the two sets of facilities between November 16, 2015 and March 15, 2016. The 2015-2017 study covered the Adams, Century, Charles City, Highland, Intrepid, Laurel, Pomeroy, Vienna I, Vienna II and Wellsburg projects. A single eagle carcass was discovered at Charles City whereas two eagle carcasses were discovered at Highland. An additional juvenile bald eagle carcass was found at Rolling Hills in March 2017; however, this carcass was not included in the technical report (Attachment D), as it was not found at a facility surveyed during the 2015-2017 study period. Among these carcasses, one was found within the search plot and within the monitoring study period and was retained for the take estimate in the HCP.

Based upon two years of intensive study, data indicate there are few eagle fatalities and such fatalities are rare events at MidAmerican’s Iowa wind energy facilities, even at baseline operational levels.

2014-2015 Post-Construction Fatality Monitoring: Bat-focused Surveys

MidAmerican Energy Company Iowa Wind Energy Portfolio: Carroll, Victory, Lundgren, Walnut, Rolling Hills, Adair, Eclipse, Morning Light, and Macksburg December 2014 – November 2015

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INTRODUCTION

MidAmerican Energy Company (MidAmerican) has developed and is operating 18 wind projects in Iowa, for a combined 3,335.08 megawatts of wind generation nameplate capacity in MidAmerican's current Iowa wind energy portfolio (Table 1, Figure 1).

MidAmerican requested that Western EcoSystems Technology, Inc. (WEST) conduct standardized post-construction fatality monitoring at their Iowa wind energy facilities to be 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 Iowa wind energy portfolio (WEST 2015). Similar protocols have been implemented by WEST on numerous wind energy projects in Midwestern agricultural regions.

The primary objective of the post-construction monitoring was to quantify fatality estimates for bats and eagles. A secondary objective was to quantify fatality estimates for other birds in general. The monitoring protocol, which includes separate eagle-focused and bat-focused study designs, was approved by the USFWS Rock Island Field Office.

During the 2014-2015 study year, post-construction fatality monitoring was conducted at nine MidAmerican facilities: Adair, Carroll, Eclipse, Lundgren, Macksburg, Morning Light, Rolling Hills, Victory, and Walnut (Figure 1). This report provides site-specific data that were collected using the bat-focused study design, which includes the all bird estimates, at these nine facilities between December 1, 2014, and November 15, 2015. Eagle-focused data will be presented in a separate report. In addition to site-specific data, this report provides a comparison of fatality rates estimated for each MidAmerican facility with the rates estimated for other Midwestern wind energy facilities.

Table 1. MidAmerican's Iowa wind energy portfolio, including facility specifications.

Facility Name	County	Project Area (Square Miles)	Project Area (Acres)	Number of Turbines	Turbine Size (MW)	Total Project (MW)
Facilities included in the 2014-2015 Fatality Monitoring Study (This report)						
Adair	Adair/Cass	27	17,355	76	2.3	174.8
Carroll	Carroll	25	16,241	100	1.5	150.0
Eclipse	Audubon/Guthrie	31	20,046	87	2.3	200.1
Lundgren	Webster	52	33,189	107	2.3	251.0
Macksburg	Madison	22	14,367	51	2.3	119.6
Morning Light	Adair	13	8,176	44	2.3	101.2
Rolling Hills	Adair/Adams/Cass	69	44,294	193	2.3	443.9
Victory	Carroll/Crawford	28	18,129	66	1.5	99.0
Walnut	Pottawattamie	32	20,409	102	1.5	153.0
Operational Facilities to be Studied in 2015-2016						
Century	Hamilton/Wright	28	17,831	145	1.5/1.0	200.0
Charles City	Floyd	18	11,666	50	1.5	75.0
Highland	O'Brien	85	54,660	214	2.3	495.0
Intrepid	Sac/Buena Vista	43	27,735	122	1.5/1.0	175.5
Laurel	Marshall	16	10,241	52	2.3	119.6
Pomeroy	Pocahontas	34	21,798	184	1.5/2.3	286.4
Vienna	Marshall/Tama	15	9,536	45	2.3	105.6
Vienna II	Marshall	11	6,970	19	2.3	44.6
Wellsburg	Grundy	36	22,979	60	2.3	140.8
Planned Facilities						
Adams	Adams	21	13,199	64	2.4	154.3
Ida Grove	Ida	103	65,963	134	1.8/2.3	301.1
O'Brien	O'Brien	92	58,992	104	2.3/2.4	250.3

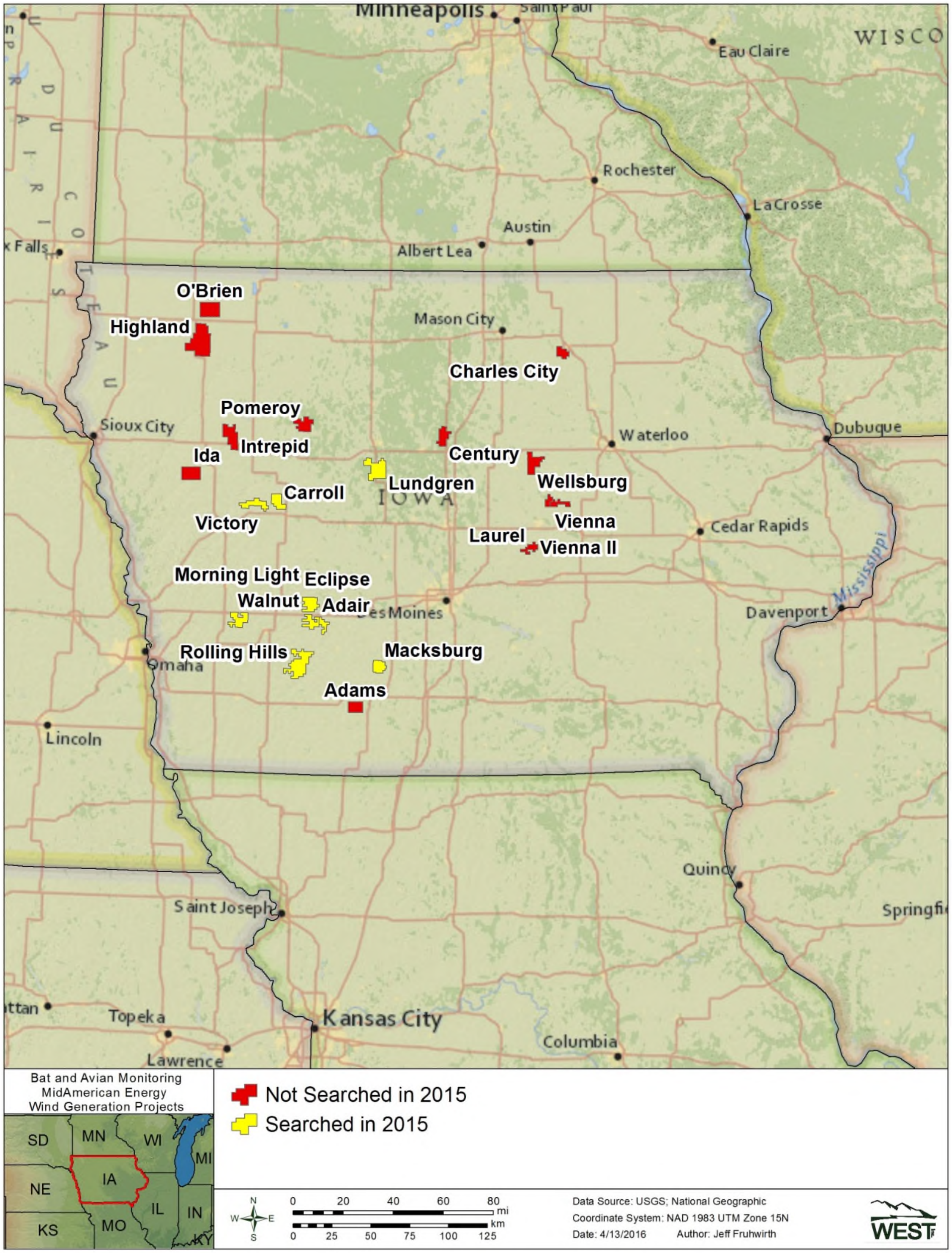

Figure 1. Locations of the existing and planned facilities in the Iowa MidAmerican wind energy portfolio

Study Area

The Adair, Morning Light, Rolling Hills, and Macksburg facilities are located in the Rolling Loess Prairies Level 4 Ecoregion, while Eclipse facility straddles both the Rolling Loess Prairies and Steeply Rolling Loess Prairies Level 4 Ecoregions. The Victory and Walnut facilities are also located in the Steeply Rolling Loess Prairies Level 4 Ecoregion, and the Carroll facility straddles the Des Moines Lobe and Steeply Rolling Loess Prairies Level 4 Ecoregions. The Lundgren Facility is located in the Des Moines Lobe Level 4 Ecoregion.

According to the U.S. Geological Survey National Land Cover Database, the Adair, Morning Light, Eclipse, Carroll, Victory, Walnut, and Lundgren landscapes are predominately cropland (i.e., corn and soybeans). The land cover at Rolling Hills and Macksburg is a combination of cropland and pasture/hay.

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 non-eagle 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 removal trials, and (4) statistical analysis.

Standardized Carcass Searches

To determine the observed number of bat and non-eagle bird fatalities, the roads and pads of all turbines at each of the nine facilities were searched from December 1, 2014, through November 15, 2015. Searches were conducted on road and pads as adjacent agricultural activities reduce ground visibility outside the graveled areas for much of the year. Biologists trained in proper search techniques conducted all carcass searches. Searchers walked at a rate of approximately 45 to 60 meters per minute. Road and pad searches were conducted approximately every other week during winter (November 16 to March 15) and were conducted weekly in the spring (March 16 to May 15), summer (May 16 to July 15), and fall (July 16 to November 15).

The road and pad search area included the entire gravel turbine pad and all gravel access roads within a 100-meter radius of the turbine (Figure 2). It has been demonstrated that greater than 80% of bat fatalities fall within half the maximum distance of turbine height to ground (Erickson et al. 2003a, 2003b), thus a 100-meter radius for the turbines was determined to be adequate for bats. This search area is often used for birds as well and has been found to be sufficient for estimating bird fatality rates.

Figure 2. Example of a road and pad search plot used for bat-focused surveys at the Iowa MidAmerican Wind Energy Portfolio.

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), and if any fatalities 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 road and pad. 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, 2-3 days). For carcasses where the cause of death was not apparent, we 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.

Bird carcasses were not collected but were marked with spray paint to avoid duplicate counting. Intact diurnal raptors, owls, and vultures were not marked with spray paint, and instead left in place for carcass removal trials. The state-listed owl species found were also used in the bias trials. Bat carcasses were collected, placed in a freezer bag, labeled with a freezer tag, and placed in a freezer on-site. Any injured bats or birds were recorded and treated as fatalities in the final analysis. WEST staff biologists confirmed all bird and bat identifications. Potential *Myotis* bat species were verified in-hand by a staff bat biologist. Bat carcasses that were not identifiable based on photographs or in-hand examinations were identified using DNA analysis.

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.

Wildlife salvage/collection permits held by WEST for the collection of bats, issued by the Iowa Department of Natural Resources, were amended to include the counties in which surveys were conducted. 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 (eagle, large bird, small bird, and bat), and, when appropriate, by season (spring, summer, fall, and winter). 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 efficiency trials for bats were conducted in spring, summer, and fall. The person placing the carcasses did not inform the personnel conducting the searches when the trial was being conducted or where trial carcasses were placed. At each facility, approximately 10 bat carcasses or surrogate mice were placed for searcher efficiency trials in spring, and up to 20 bat or surrogate mice were used for summer and fall search periods. 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. Approximately 10 small bird carcasses and 10 large bird carcasses were placed at each facility during each season, for a total of 80 bird carcasses per facility. Bird carcasses consisted of non-native/non-protected or commercially available species, with house sparrows (*Passer domesticus*) and juvenile coturnix quail (*Coturnix coturnix* L.) representing likely small birds, and rock pigeons (*Columba livia*), chukar (*Alectoris chukar*), and juvenile ring-necked pheasants (*Phasianus colchicus*) representing likely large birds.

All searcher efficiency trial carcasses were placed at random locations within the search area prior to scheduled carcass searches for that day. 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 Removal Trials

The objective of carcass removal 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 removal studies were conducted approximately monthly to cover all seasons. Estimates of carcass removal 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 removal rates at each facility, approximately 10 bat carcasses or surrogates were used during the spring season and up to 20 bat carcasses or surrogates were used during summer and fall, for up to 50 total bat or surrogate carcasses at each facility. If bat carcasses were not available in sufficient numbers, brown or black mice were used as surrogates for bats in carcass removal trials. Only non-*Myotis* bat species were used for carcass removal trials. Approximately 10 small bird carcasses and 10 large bird carcasses were placed along access roads and outside of the search area, during each search season, for a total of 80 bird carcasses per facility. Bird carcasses consisted of species similar to those used in the searcher efficiency 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 study carcass.

Personnel conducting carcass searches monitored the trial birds over a 30-day period according to the following schedule as closely as possible. Carcasses were checked every day for the first four days, then on day seven, day 10, day 14, day 20, and day 30. This schedule varied depending on weather and coordination with other survey work. At the end of the 30-day period, any evidence of the carcasses that remained was removed. Remains of intact diurnal raptors, owls, or vultures found during scheduled searches and used for carcass removal trials were marked and left in the field at the end of the 30-day 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 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® ACCESS 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 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 road and pad within 100 meters of the 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 fatalities are based on:

- 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;

- Removal 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 removal trials;
- Searcher efficiency, expressed as the proportion of planted carcasses found by searchers during searcher efficiency trials; and
- Search area adjustment based on the road and pad search area and carcass density.

Annual and, if necessary based on bias trial results, seasonal fatality estimates are provided for the following groups: 1) all birds, 2) small birds, 3) large birds, 4) diurnal raptors[1], and 5) bats. The total number of fatalities in each group listed above was estimated by adjusting for carcass removal and searcher efficiency bias via a fatality estimator model. The Huso (Huso 2011, Huso et al. 2012) estimator 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 Project
- n number of turbines sampled at the Project
- k number of carcass categories (e.g., combinations of size, season, search interval, etc.)
- $\hat{a}_i$ density weighted area correction for category *i*
- I_i time interval between the previous search and discovery for category *i*
- $\hat{\hat{I}}_i$ 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*

Estimation of Searcher Efficiency Rates

Searcher efficiency rates were estimated using a logistic regression. Potential covariates for this logistic model included season, size, and interactions between these variables. The logistic model 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 Akaike information criterion with a correction for finite sample sizes, hereafter referred to as AICc.

[1] Diurnal raptors include kites, accipiters, buteos, eagles, falcons, northern harriers, and osprey. Eagles would be included in the diurnal raptor estimate if they were found on the road and pad search areas. Eagle-specific fatality estimates for the eagle-focused study design will be presented in a separate report after the second winter surveys.

Estimation of Carcass Removal Rates

Estimates of carcass removal rates were used to adjust carcass counts for removal bias. Carcass removal can be modeled as a function of a variety of variables including size, season, and the interactions between these variables. The average probability of persistence of a carcass ($\hat{r}$) was estimated from an interval censored carcass persistence model. Exponential, log-logistic, lognormal, and Weibull distributions were fit and the best model was selected using AICc (Burnham and Anderson 2002).

Area Correction Calculation

To account for unsearched area within 100 meters of the turbine, an area correction was used to adjust fatality estimates found in the searched area; separate estimates were calculated for small birds, large birds, and bats. When a sufficient number of carcasses were available (i.e., 50 carcasses), a weighted maximum likelihood method was used. If carcass counts were low (i.e., less than 50 carcasses), the carcass density distribution was estimated using a triangular distribution approached based on Hull and Muir (2010). In both cases, the result is an estimate of the proportion of fatalities expected to land within searched and unsearched areas around a turbine.

Adjusted Facility-Related Fatality Rates

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

$$\widehat{\pi_\iota} = \widehat{a_\iota} \cdot \widehat{p_\iota} \cdot \widehat{r_\iota} \cdot \hat{v}_i$$

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

$$\widehat{m_\iota} = \frac{c_i}{\widehat{\pi_\iota}}.$$

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

RESULTS

All 826 turbines within the nine facilities were searched, for a total of 32,956 road and pad searches during 368 visits. A total of 907 bats and 265 birds were found during standardized carcass surveys or incidentally (Table 2, Table 3). Detailed summaries of the post-construction monitoring surveys conducted at each of the facilities are included in Appendices A through I.

Bat Carcasses

Six hundred sixty-one bat fatalities representing seven species were found during scheduled turbine searches or incidentally in the search area and were included in the analysis. An additional 124 bats were found during scheduled searches; however, the estimated times since death were identified as longer than the search interval so they were excluded from the analysis based on the Huso estimator (Huso 2011, Huso et al. 2012) statistical methods. Additionally, 122 bats were found outside of the search area (i.e., road and pad) and were not included in the analysis. Considering all bats found, the most commonly found bat species were eastern red bat (*Lasiurus borealis*; 340 carcasses) and hoary bat (*Lasiurus cinereus*; 294), which combined accounted for nearly 70% of all bats found (Table 2). Thirty-four little brown bats (*Myotis lucifugus*) were found and 26 of these were included in the analysis (Table 2). No other *Myotis* carcasses were found. Likewise, no bat species listed under the Endangered Species Act or listed in the state of Iowa were found.

The majority of bats included in the analysis were found relatively close to the turbine, with 61.5% of bats found within 10 meters (33 feet). Nearly all bats (97.1%) were found within 60 meters (197 feet) of turbines (Figure 3). The majority of fatalities was found during the late summer and early fall (Figure 4).

Table 2. Total number of bat carcasses and the composition of carcasses discovered at the MidAmerican facilities studied from December 1, 2014, to November 15, 2015.

Species	Included in Analysis		Out of Search Interval		Out of Search Area		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%).	Total	Percent Composition (%)
eastern red bat	234	35.4	51	41.1	55	45.1	340	37.5
hoary bat	219	33.1	44	35.5	31	25.4	294	32.4
big brown bat	95	14.4	14	11.3	14	11.5	123	13.6
silver-haired bat	44	6.7	9	7.3	12	9.8	65	7.2
little brown bat	26	3.9	4	3.2	4	3.3	34	3.7
evening bat	28	4.2	2	1.6	3	2.5	33	3.6
tricolored bat	15	2.3	0	0.0	3	2.5	18	2.0
Overall bats	**661**	**100**	**124**	**100**	**122**	**100**	**907**	**100**

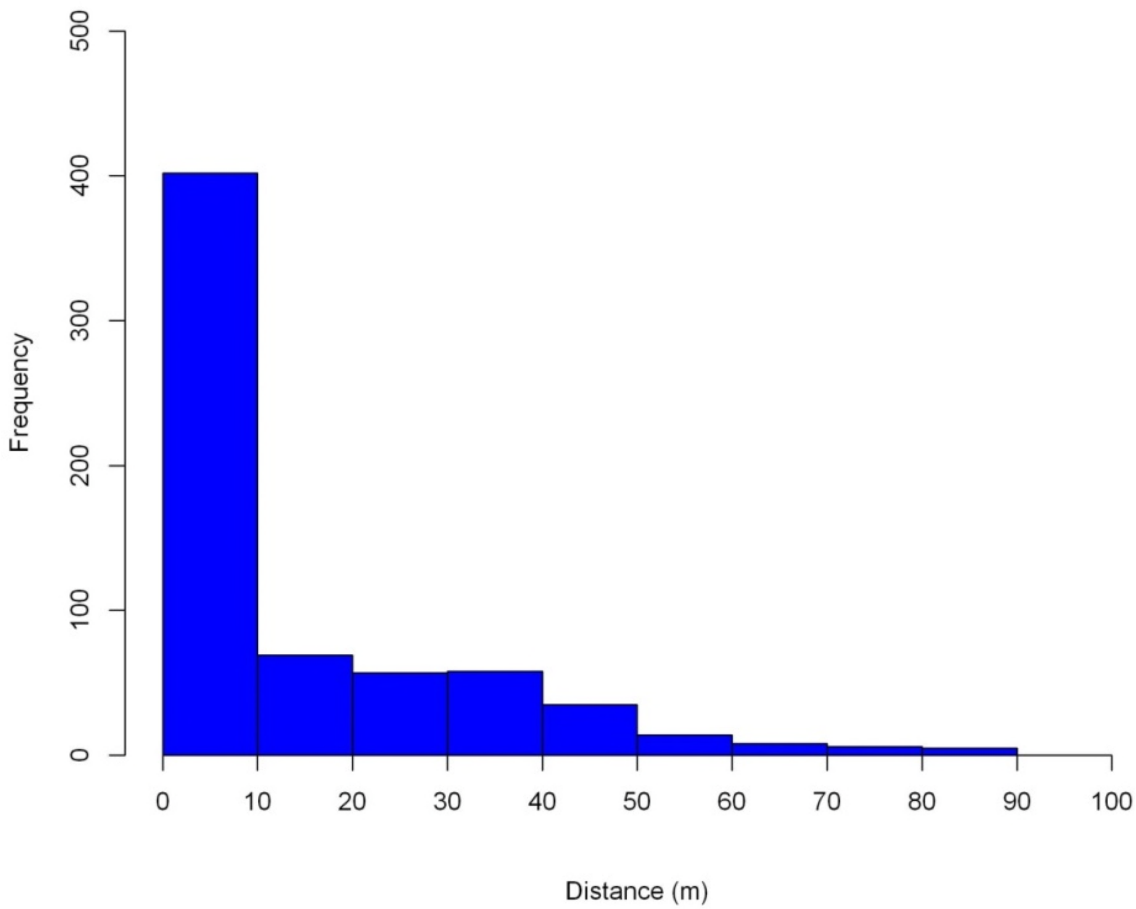

Figure 3. Distance from the turbine of bat carcasses included in the analysis for the nine MidAmerican facilities studied from December 1, 2014, to November 15, 2015.

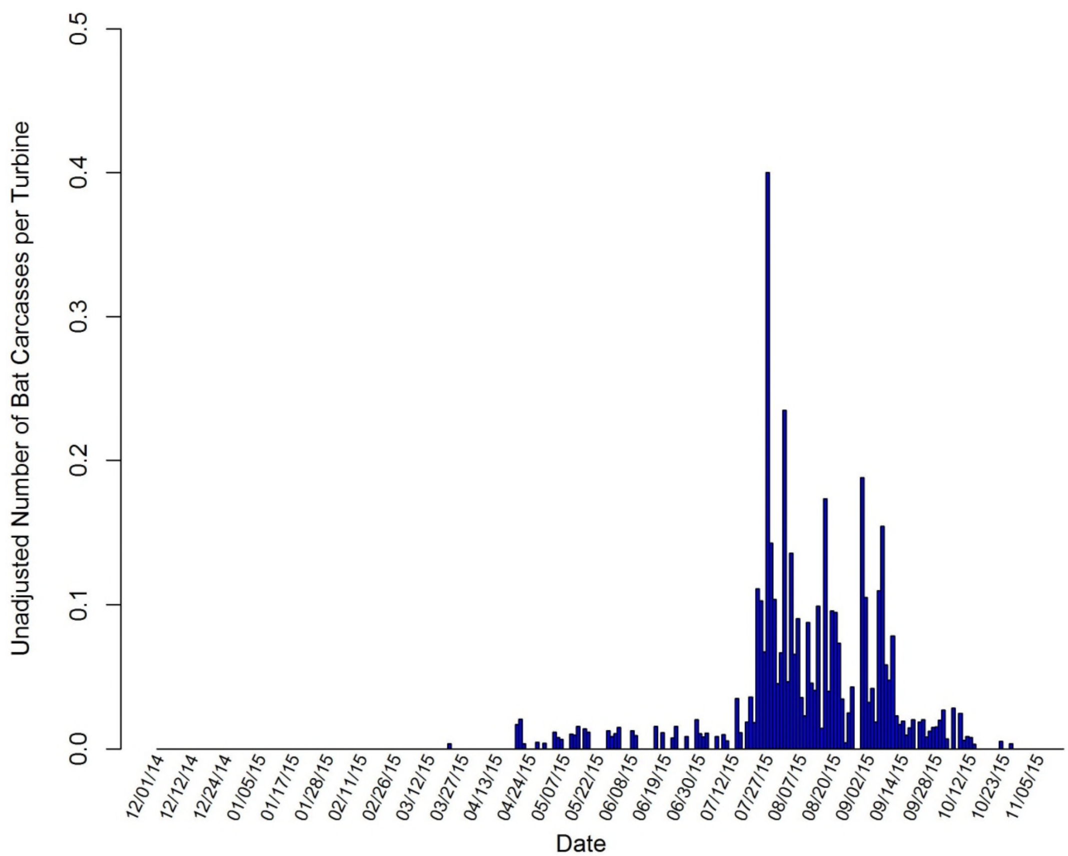

Figure 4. Timing of bat carcasses found in search areas at the nine MidAmerican facilities studied from December 1, 2014, to November 15, 2015.

Bird Carcasses

In total, 265 birds representing 81 identifiable species were found during the first year of fatality monitoring. One hundred thirty-five birds representing 59 identifiable species were found during scheduled searches or incidentally in the search area and were included in the analysis. American coot (*Fulica americana*; 23 carcasses), turkey vulture (*Cathartes aura*; 15) and European starling (*Sturnus vulgaris*; 15) were the most commonly found bird species; each remaining species accounted for fewer than 5% of all birds found (Table 3). No bird species listed under the Endangered Species Act were found; however, two state-listed species were found: one short-eared owl (*Asio flammeus*; state endangered) and one long-eared owl (*Asio otus*; state threatened; Iowa Department of Natural Resources 2016).

Of the16 diurnal raptors found, four (two red-tailed hawk [*Buteo jamaicensis*], two sharp-shinned hawk [*Accipiter striatus*]) were included in the analysis. Two raptors (a red-tailed hawk and an unidentified raptor) were found out of search interval. Ten additional raptors were found off the road and pad search area: red-tailed hawk (six carcasses), bald eagle[2] (*Haliaeetus leucocephalus*; two), and two unidentified falcons (Table 3). Bald eagles are federally protected under the Bald and Golden Eagle Protection Act (1940), and are a special concern species in Iowa (Iowa Department of Natural Resources 2016).

Of the bird fatalities, most were found within 10 meters of turbines, and 85.2% were within 60 meters (164 feet; Figure 5). The bird fatalities were distributed throughout the spring, summer, and fall seasons, with fewer bird carcasses found during the winter (Figure 6).

[2] Plots differed for eagle-focused surveys. These bald eagle finds will be discussed in the context of the eagle-focused surveys in a separate report.

Table 3. Total number of bird carcasses and the composition of carcasses discovered at the MidAmerican Facilities studied from December 1, 2014, to November 15, 2015.

Species	Included in Analysis		Out of Search Interval		Out of Search Area		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
American coot	10	7.4	1	2.9	12	12.5	23	8.7
European starling	11	8.1	1	2.9	3	3.1	15	5.7
turkey vulture	4	3.0	1	2.9	10	10.4	15	5.7
cliff swallow	8	5.9	2	5.9	3	3.1	13	4.9
mourning dove	9	6.7	1	2.9	1	1.0	11	4.2
red-tailed hawk	2	1.5	1	2.9	6	6.3	9	3.4
ring-necked pheasant	2	1.5	3	8.8	4	4.2	9	3.4
killdeer	3	2.2	2	5.9	1	1.0	6	2.3
ruby-crowned kinglet	5	3.7	0	0.0	0	0.0	5	1.9
dickcissel	4	3.0	1	2.9	0	0.0	5	1.9
golden-crowned kinglet	3	2.2	1	2.9	1	1.0	5	1.9
horned lark	2	1.5	0	0.0	3	3.1	5	1.9
unidentified flycatcher	2	1.5	1	2.9	2	2.1	5	1.9
dark-eyed junco	1	0.7	1	2.9	3	3.1	5	1.9
house sparrow	0	0.0	1	2.9	4	4.2	5	1.9
chipping sparrow	3	2.2	0	0.0	1	1.0	4	1.5
American robin	2	1.5	2	5.9	0	0.0	4	1.5
lesser scaup	2	1.5	1	2.9	1	1.0	4	1.5
unidentified passerine	2	1.5	1	2.9	1	1.0	4	1.5
red-eyed vireo	1	0.7	0	0.0	3	3.1	4	1.5
American redstart	3	2.2	0	0.0	0	0.0	3	1.1
sedge wren	3	2.2	0	0.0	0	0.0	3	1.1
marsh wren	2	1.5	0	0.0	1	1.0	3	1.1
unidentified empidonax	2	1.5	0	0.0	1	1.0	3	1.1
brown-headed cowbird	1	0.7	1	2.9	1	1.0	3	1.1
northern bobwhite	1	0.7	0	0.0	2	2.1	3	1.1
northern flicker	1	0.7	1	2.9	1	1.0	3	1.1
unidentified small bird	1	0.7	1	2.9	1	1.0	3	1.1
blue-winged teal	0	0.0	0	0.0	3	3.1	3	1.1
American tree sparrow	2	1.5	0	0.0	0	0.0	2	0.8
sharp-shinned hawk	2	1.5	0	0.0	0	0.0	2	0.8
unidentified kinglet	2	1.5	0	0.0	0	0.0	2	0.8
western meadowlark	2	1.5	0	0.0	0	0.0	2	0.8
yellow warbler	2	1.5	0	0.0	0	0.0	2	0.8
brown creeper	1	0.7	0	0.0	1	1.0	2	0.8
eastern kingbird	1	0.7	1	2.9	0	0.0	2	0.8
pied-billed grebe	1	0.7	1	2.9	0	0.0	2	0.8
red-winged blackbird	1	0.7	0	0.0	1	1.0	2	0.8
rock pigeon	1	0.7	0	0.0	1	1.0	2	0.8
swamp sparrow	1	0.7	0	0.0	1	1.0	2	0.8
unidentified warbler	1	0.7	1	2.9	0	0.0	2	0.8

Table 3. Total number of bird carcasses and the composition of carcasses discovered at the MidAmerican Facilities studied from December 1, 2014, to November 15, 2015.

Species	Included in Analysis		Out of Search Interval		Out of Search Area		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
vesper sparrow	1	0.7	1	2.9	0	0.0	2	0.8
bald eagle	0	0.0	0	0.0	2	2.1	2	0.8
domestic chicken	0	0.0	0	0.0	2	2.1	2	0.8
gadwall	0	0.0	0	0.0	2	2.1	2	0.8
mallard	0	0.0	1	2.9	1	1.0	2	0.8
unidentified falcon	0	0.0	0	0.0	2	2.1	2	0.8
unidentified large bird	0	0.0	1	2.9	1	1.0	2	0.8
yellow-billed cuckoo	0	0.0	0	0.0	2	2.1	2	0.8
Acadian flycatcher	1	0.7	0	0.0	0	0.0	1	0.4
American goldfinch	1	0.7	0	0.0	0	0.0	1	0.4
barn swallow	1	0.7	0	0.0	0	0.0	1	0.4
belted kingfisher	1	0.7	0	0.0	0	0.0	1	0.4
cedar waxwing	1	0.7	0	0.0	0	0.0	1	0.4
common yellowthroat	1	0.7	0	0.0	0	0.0	1	0.4
eastern meadowlark	1	0.7	0	0.0	0	0.0	1	0.4
eastern phoebe	1	0.7	0	0.0	0	0.0	1	0.4
Franklin's gull	1	0.7	0	0.0	0	0.0	1	0.4
hermit thrush	1	0.7	0	0.0	0	0.0	1	0.4
house wren	1	0.7	0	0.0	0	0.0	1	0.4
Lapland longspur	1	0.7	0	0.0	0	0.0	1	0.4
lark sparrow	1	0.7	0	0.0	0	0.0	1	0.4
Lincoln's sparrow	1	0.7	0	0.0	0	0.0	1	0.4
northern parula	1	0.7	0	0.0	0	0.0	1	0.4
northern rough-winged swallow	1	0.7	0	0.0	0	0.0	1	0.4
northern waterthrush	1	0.7	0	0.0	0	0.0	1	0.4
pine warbler	1	0.7	0	0.0	0	0.0	1	0.4
savannah sparrow	1	0.7	0	0.0	0	0.0	1	0.4
song sparrow	1	0.7	0	0.0	0	0.0	1	0.4
sora	1	0.7	0	0.0	0	0.0	1	0.4
unidentified egret	1	0.7	0	0.0	0	0.0	1	0.4
unidentified shorebird	1	0.7	0	0.0	0	0.0	1	0.4
upland sandpiper	1	0.7	0	0.0	0	0.0	1	0.4
warbling vireo	1	0.7	0	0.0	0	0.0	1	0.4
yellow-bellied flycatcher	1	0.7	0	0.0	0	0.0	1	0.4
yellow-throated vireo	1	0.7	0	0.0	0	0.0	1	0.4
American white pelican	0	0.0	0	0.0	1	1.0	1	0.4
blue jay	0	0.0	0	0.0	1	1.0	1	0.4
downy woodpecker	0	0.0	0	0.0	1	1.0	1	0.4
grasshopper sparrow	0	0.0	1	2.9	0	0.0	1	0.4
gray catbird	0	0.0	0	0.0	1	1.0	1	0.4
hairy woodpecker	0	0.0	1	2.9	0	0.0	1	0.4

Table 3. Total number of bird carcasses and the composition of carcasses discovered at the MidAmerican Facilities studied from December 1, 2014, to November 15, 2015.

Species	Included in Analysis		Out of Search Interval		Out of Search Area		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
long-eared owl	0	0.0	0	0.0	1	1.0	1	0.4
orchard oriole	0	0.0	1	2.9	0	0.0	1	0.4
ruby-throated hummingbird	0	0.0	0	0.0	1	1.0	1	0.4
ruddy duck	0	0.0	0	0.0	1	1.0	1	0.4
short-eared owl	0	0.0	0	0.0	1	1.0	1	0.4
snow goose	0	0.0	0	0.0	1	1.0	1	0.4
unidentified raptor	0	0.0	1	2.9	0	0.0	1	0.4
Virginia rail	0	0.0	0	0.0	1	1.0	1	0.4
wood duck	0	0.0	0	0.0	1	1.0	1	0.4
Overall Birds	**135**	**100**	**34**	**100**	**96**	**100**	**265**	**100**

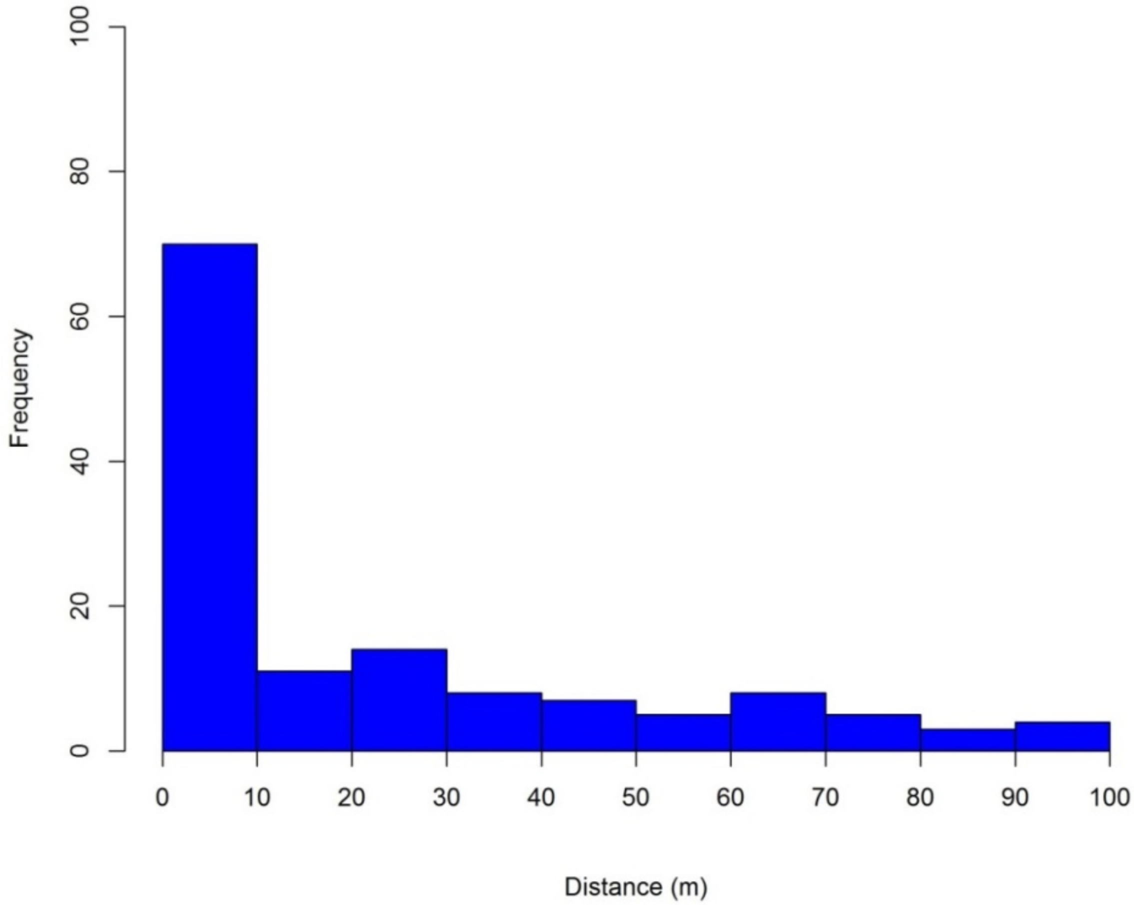

Figure 5. Distance from the turbine of bird carcasses included in the analysis for the nine MidAmerican facilities studied from December 1, 2014, to November 15, 2015.

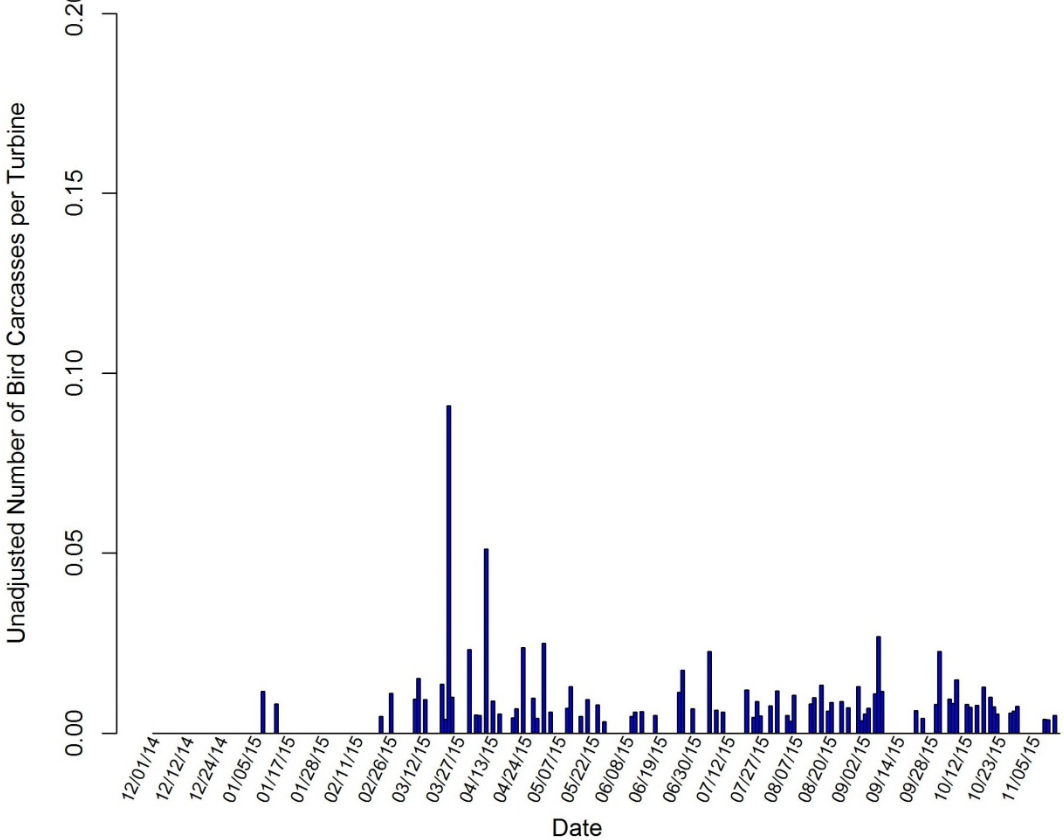

Figure 6. Timing of bird carcasses included in the analysis for the nine MidAmerican facilities studied from December 1, 2014, to November 15, 2015.

Searcher Efficiency

Searcher efficiency was modeled using the Huso method (Huso 2011, Huso et al. 2012). Logistic regression was used to model searcher efficiency and model selection was based on AICc. Seasonal estimates were calculated when season was included in the best model, based on the lowest AICc. Searcher efficiency for each facility is presented in Table 4 and described in detail in Appendices A through I. Seasonal estimates are only provided if season was included in the top model selected.

Table 4. Searcher efficiency for each of the nine MidAmerican facilities studied from December 1, 2014, to November 15, 2015.

	Fall	Spring	Summer	Winter	Overall
Adair					
Bat	-	-	-	-	0.86
Large bird	-	-	-	-	1.00
Small bird	-	-	-	-	0.77
Carroll					
Bat	0.94	0.72	0.90	-	-
Large bird	1.00	0.99	1.00	0.92	-
Small bird	0.95	0.79	0.93	0.38	-
Eclipse					
Bat	-	-	-	-	0.98
Large bird	-	-	-	-	0.95
Small bird	-	-	-	-	0.83
Lundgren					
Bat	-	-	-	-	0.93
Large bird	-	-	-	-	1.00
Small bird	-	-	-	-	0.89
Macksburg					
Bat	0.96	0.61	0.89	-	-
Large bird	1.00	0.93	0.98	0.49	-
Small bird	0.98	0.77	0.94	0.21	-
Morning light					
Bat	-	-	-	-	0.84
Large bird	-	-	-	-	0.92
Small bird	-	-	-	-	0.85
Rolling hills					
Bat	-	-	-	-	0.90
Large bird	-	-	-	-	0.97
Small bird	-	-	-	-	0.77
Victory					
Bat	-	-	-	-	0.77
Large bird	-	-	-	-	0.92
Small bird	-	-	-	-	0.78
Walnut					
Bat	0.87	1.00	0.78	-	-
Large bird	0.99	1.00	0.99	0.82	-
Small bird	0.97	1.00	0.95	0.58	-

Carcass Removal Time

The Huso method 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 various variables. Seasonal estimates were calculated when the model with the lowest AICc included season. The average carcass removal time for each facility is presented in Table 5 and described in detail in Appendices A through I. Seasonal estimates are only provided if season was included in the top model selected.

Table 5. Average carcass removal time, in days, for each of the nine MidAmerican facilities studied between December 1, 2014, and November 15, 2015. The distribution used in the calculation of carcass removal time varied by facility.

	Fall	Spring	Summer	Winter	Overall
Adair					
Bat	1.11	4.91	2.80	-	-
Large bird	3.07	13.59	7.75	33.65	-
Small bird	1.96	8.65	4.93	21.42	-
Carroll					
Bat	2.33	3.56	1.66	-	-
Large bird	8.07	12.35	5.74	29.25	-
Small bird	3.04	4.65	2.16	11.03	-
Eclipse					
Bat	1.42	4.55	1.79	-	-
Large bird	3.97	12.72	5.02	9.64	-
Small bird	1.85	5.91	2.33	4.48	-
Lundgren					
Bat	-	-	-	-	2.50
Large bird	-	-	-	-	7.29
Small bird	-	-	-	-	3.16
Macksburg					
Bat	0.68	3.44	1.65	-	-
Large bird	1.91	9.66	4.64	17.35	-
Small bird	0.97	4.93	2.37	8.86	-
Morning light					
Bat	1.45	3.21	2.29	-	-
Large bird	7.20	15.93	11.39	29.28	-
Small bird	2.17	4.80	3.43	8.82	-
Rolling hills					
Bat	-	-	-	-	5.26
Large bird	-	-	-	-	18.76
Small bird	-	-	-	-	6.86
Victory					
Bat	-	-	-	-	2.53
Large bird	-	-	-	-	14.56
Small bird	-	-	-	-	8.11
Walnut					
Bat	1.20	2.10	2.62	-	-
Large bird	2.49	4.34	5.43	7.45	-
Small bird	2.14	3.72	4.65	6.39	-

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, and all birds for all nine facilities in the study (Table 6; Appendices A through I). Diurnal raptor fatality estimates were calculated for Adair, Eclipse, and Rolling Hills, which were the only facilities where raptor fatalities were found on search areas and within the search interval (Table 6). When at least five casualties were included in the analysis, 90% confidence intervals were calculated. The fatality estimate calculations for each facility are presented in Appendices A through I.

Bats

Bat fatality estimates at the nine facilities ranged from 6.13 bats/MW/year at the Rolling Hills facility to 73.08 at the Macksburg facility (Table 6). The second highest fatality estimate for bats was at Lundgren (28.74 bats/MW/year). Facilities with relatively moderate rates included Walnut (21.69 bats/MW/year), Morning Light (20.19), and Adair (14.05). Estimates for Victory (6.48 bats/MW/year) and Rolling Hills were the lowest among the nine facilities.

All Birds

The estimated fatality rates for all birds were similar among all nine facilities. All-bird fatality estimates ranged from 1.52 birds/MW/year at Victory to 4.64 at Adair (Table 6).

Large Birds

The estimated fatality rates for large birds were relatively low across all sites. Macksburg had the highest large bird fatality rate (1.77 large birds/MW/year); the eight remaining facilities had large bird fatality estimates of 0.6 or lower (Table 6).

Raptors

Estimated fatality rates for raptors were calculated for three sites where raptor fatalities were found on area and within the search interval: Adair, Eclipse and Rolling Hills. Confidence intervals were not calculated given the low number of casualties found at each facility. The raptor fatality estimate was highest at Eclipse (0.12 raptors/MW/year), followed by Adair (0.07) and Rolling Hills (0.04; Table 6).

Small Birds

The estimated fatality rates for small birds generally followed the overall bird fatality estimates. The highest small bird estimate was at Adair (4.03 birds/MW/year) and lowest at Victory (1.27; Table 6).

Table 6. Adjusted fatality rate estimate (fatalities/mw/year) and 90% Confidence Intervals[1] at the MidAmerican facilities studied from December 1, 2014, to November 15, 2015

Facility	Bats		Large Birds		Raptors	Small Birds		All Birds	
	Estimate	90% CI	Estimate	90% CI	Estimate	Estimate	90% CI	Estimate	90% CI
Adair	14.05	9.57-22.09	0.60	0.24-1.06	0.07	4.03	2.00-7.54	4.64	2.62-8.19
Carroll	11.71	8.05-17.02	0.53	0.20-0.96	-	3.02	1.51-6.21	3.55	1.97-6.87
Eclipse	10.01	7.28-13.72	0.47	0.19-0.77	0.12	3.15	1.84-4.94	3.62	2.30-5.47
Lundgren	28.74	23.45-36.89	0.13	-	-	2.79	1.72-4.16	2.91	1.85-4.31
Macksburg	73.08	51.77-113.55	1.77	0.88-2.92	-	1.61	-	3.38	1.52-5.73
Morning Light	20.19	12.61-32.87	0.14	-	-	2.22	0.81-4.46	2.36	0.92-4.56
Rolling Hills	6.13	4.78-7.86	0.25	0.10-0.44	0.04	1.54	0.94-2.33	1.79	1.15-2.63
Victory	6.48	3.03-10.99	0.26	-	-	1.27	-	1.52	0.57-2.99
Walnut	21.69	15.09-31.67	0.15	-	-	2.73	1.50-4.33	2.88	1.59-4.51

[1.] 90% confidence intervals were not calculated when fewer than five casualties were included in the analysis.

DISCUSSION AND IMPACT ASSESSMENT

The approach outlined by Huso (2011, Huso et al. 2012) was used for calculating adjusted fatality estimates; however, bat fatality estimates calculated using the Shoenfeld estimator are presented in Appendix J to allow for a more direct comparison to historic data collected in the region as that was the estimator generally used. The Huso approach 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 removal rates, and search area. It is hypothesized that scavenging could change through time at a given site and must be accounted for when attempting to estimate fatality rates. We accounted for this by conducting scavenging trials throughout the year and, when appropriate, calculating estimates of carcass removal by season. We also estimated searcher efficiency rates throughout the study period to account for any biases associated with changes in conditions; similarly, seasonal searcher efficiency was used to calculate fatality estimates, when appropriate.

Given the primary objective of this survey effort, and the generally low bird mortality across all nine facilities, discussion of bird mortality will focus only on bird species listed under the Endangered Species Act or by the Iowa Department of Natural Resources.

Bat Carcasses

Bat fatality rates among the nine facilities varied widely, with more than a 10-fold difference between the site with the lowest estimate (Rolling Hills) and the site with the highest estimate (Macksburg). Species composition of fatalities at the Iowa wind energy facilities was similar to that at most other wind energy facilities, in that most bat fatalities (77.1%) comprised of three migratory tree bat species: the hoary, eastern red, and silver-haired bat. The timing of bat fatalities occurred during the likely period when pups are dispersing and bats are migrating through the study area.

Species of Interest

No species listed under the Endangered Species Act were found. No state-listed bat species were found; however, two bald eagles (state special concern species), one short-eared owl (state endangered), and one long-eared owl (state threatened) were found.

REFERENCES

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Appendix A: Summary of Fatality Monitoring Surveys Conducted at the Adair Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Adair Wind Energy Facility (Adair) consists of 76 SWT-2.3-93 2.3-megawatt turbines for a nameplate capacity of 174.8 MW. The facility is located across approximately 17,355 acres (27 mi^2) in northern Adair and Cass counties in southwest Iowa. The facility is located in the Rolling Loess Prairies Level 4 Ecoregion. According to the National Land Cover Database, the landscape predominantly consists of cropland (71.4%), followed by pasture/hay (22.3%). Approximately 4% of the Adair project area is developed, and deciduous forest, open water, herbaceous, shrub/scrub, and woody or emergent herbaceous wetlands each accounted for than1% of land cover.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 3,042 road and pad searches were conducted at Adair during 41 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

Fifty-four bats and thirty-six birds were found on standardized road and pad search areas or incidentally at Adair (Table A1). Of the five bat species found, the most frequently found bat species were eastern red bat and hoary bat (19 carcasses each). Of the 25 unique bird species found on standardized road and pad searches or incidentally, red-tailed hawk was the most commonly found species (four carcasses). No federal or state listed species were found, and there were no *Myotis* bats found (Table A1).

Most bat carcasses included in the analysis were found within 50 meters of turbines, and birds were found throughout the 100 meter search area (Figures A1 and A2). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at Adair (Figures A3 and A4). Most bat fatalities were found from mid-July to early October, while birds were found throughout the study period (Figures A5 and A6).

Table A1. Total number and species composition of bat and bird carcasses discovered during road and pad searched and incidentally at the Adair Wind Energy Facility, Adair and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
hoary bat	16	39.0	0	0	3	42.9	19	35.2
eastern red bat	12	29.3	3	50.0	4	57.1	19	35.2
big brown bat	7	17.1	3	50.0	0	0	10	18.5
evening bat	3	7.3	0	0	0	0	3	5.6
silver-haired bat	3	7.3	0	0	0	0	3	5.6
Overall Bats	**41**	**100**	**6**	**100**	**7**	**100**	**54**	**100**
Birds								
red-tailed hawk	0	0	1	14.3	3	30.0	4	11.1
American coot	2	10.5	0	0	0	0	2	5.6
cliff swallow	2	10.5	0	0	0	0	2	5.6
brown-headed cowbird	1	5.3	1	14.3	0	0	2	5.6
eastern kingbird	1	5.3	1	14.3	0	0	2	5.6
mourning dove	1	5.3	1	14.3	0	0	2	5.6
unidentified passerine	1	5.3	0	0	1	10.0	2	5.6
brown creeper	1	5.3	0	0	0	0	1	2.8
dickcissel	1	5.3	0	0	0	0	1	2.8
lesser scaup	1	5.3	0	0	0	0	1	2.8
marsh wren	1	5.3	0	0	0	0	1	2.8
northern bobwhite	1	5.3	0	0	0	0	1	2.8
ruby-crowned kinglet	1	5.3	0	0	0	0	1	2.8
ring-necked pheasant	1	5.3	0	0	0	0	1	2.8
song sparrow	1	5.3	0	0	0	0	1	2.8
sharp-shinned hawk	1	5.3	0	0	0	0	1	2.8
unidentified flycatcher	1	5.3	0	0	0	0	1	2.8
vesper sparrow	1	5.3	0	0	0	0	1	2.8
dark-eyed junco	0	0	1	14.3	0	0	1	2.8
orchard oriole	0	0	1	14.3	0	0	1	2.8
unidentified raptor	0	0	1	14.3	0	0	1	2.8
blue-winged teal	0	0	0	0	1	10.0	1	2.8
chipping sparrow	0	0	0	0	1	10.0	1	2.8
European starling	0	0	0	0	1	10.0	1	2.8
horned lark	0	0	0	0	1	10.0	1	2.8
turkey vulture	0	0	0	0	1	10.0	1	2.8
Virginia rail	0	0	0	0	1	10.0	1	2.8
Overall Birds	**19**	**100**	**7**	**100**	**10**	**100**	**36**	**100**

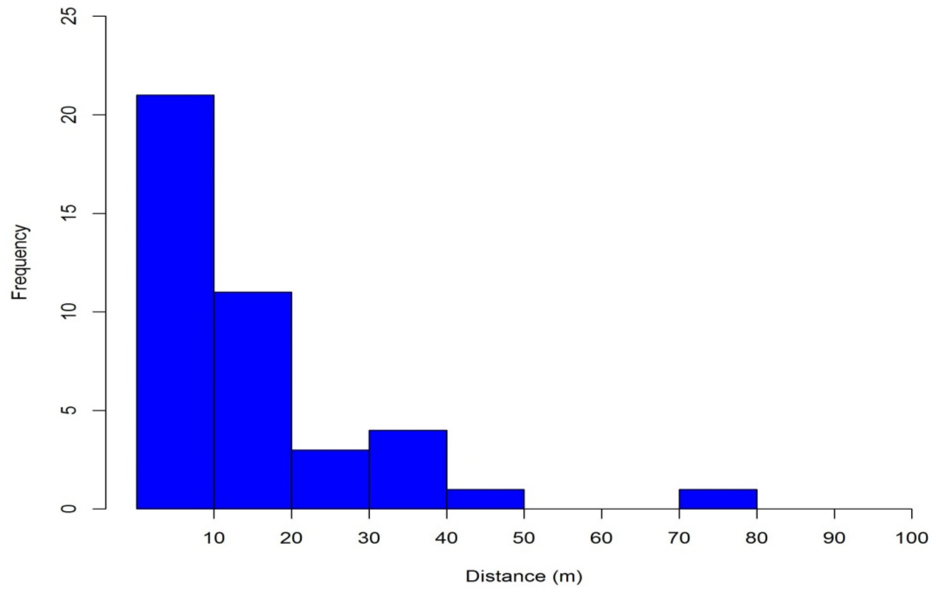

Figure A1. Distance from the turbine for bat carcasses included in the analysis for the Adair Wind Energy Facility, Adair and Cass counties, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

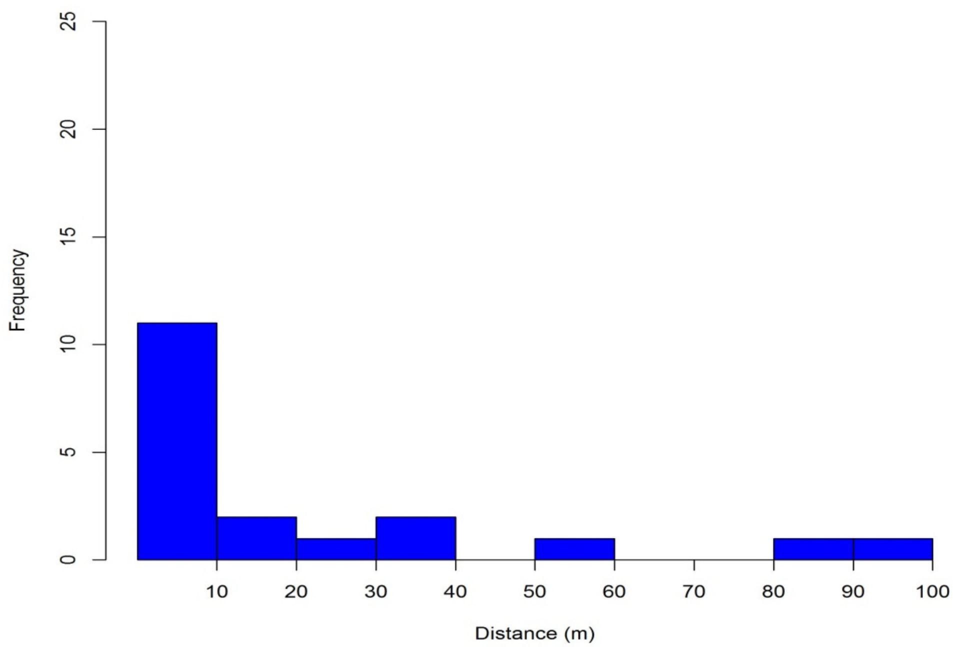

Figure A2. Distance from the turbine for bird carcasses included in the analysis for the Adair Wind Energy Facility, Adair and Cass counties, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

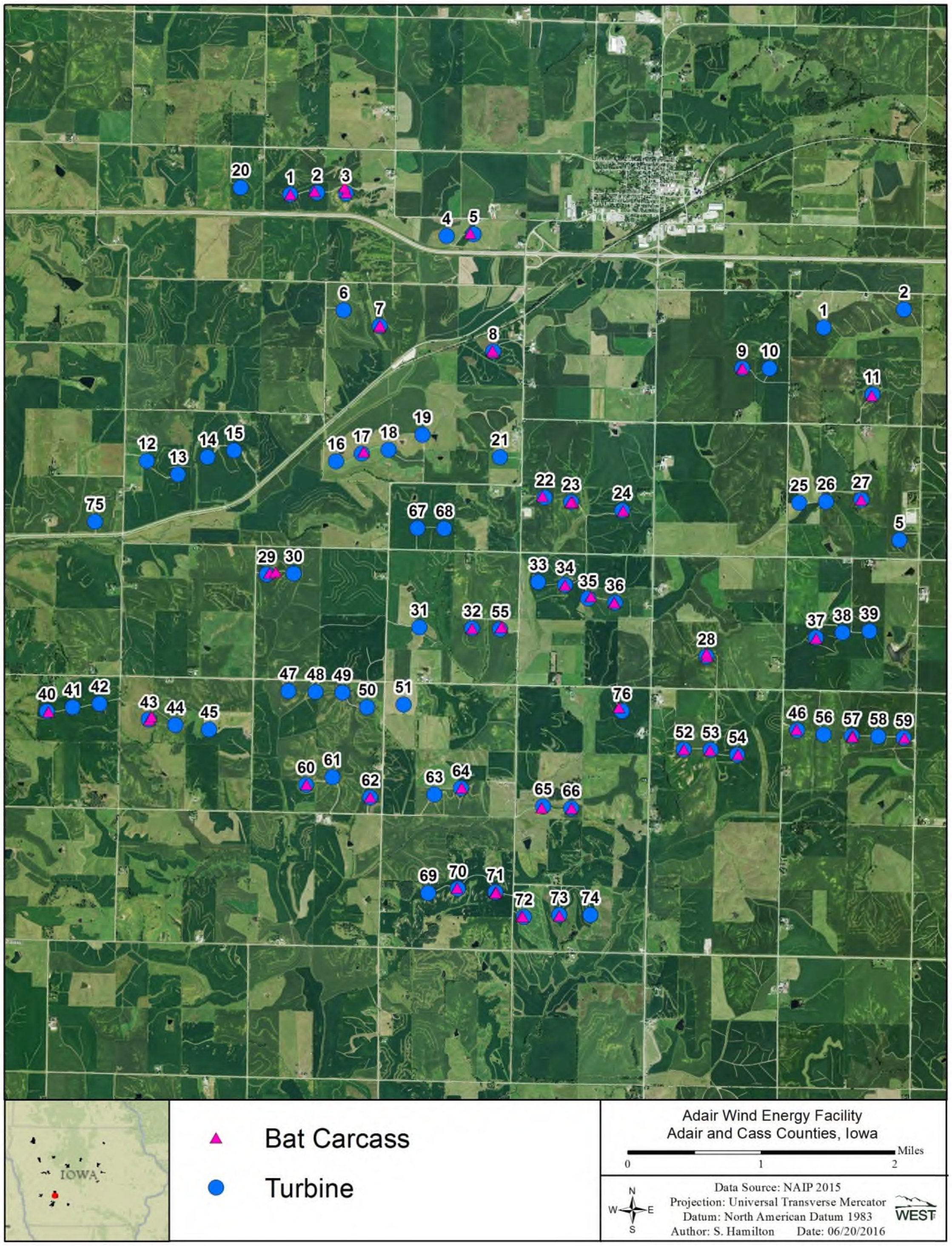

Figure A3. Location of all bat carcasses found during scheduled searches or incidentally at the Adair Wind Energy Facility, Adair and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

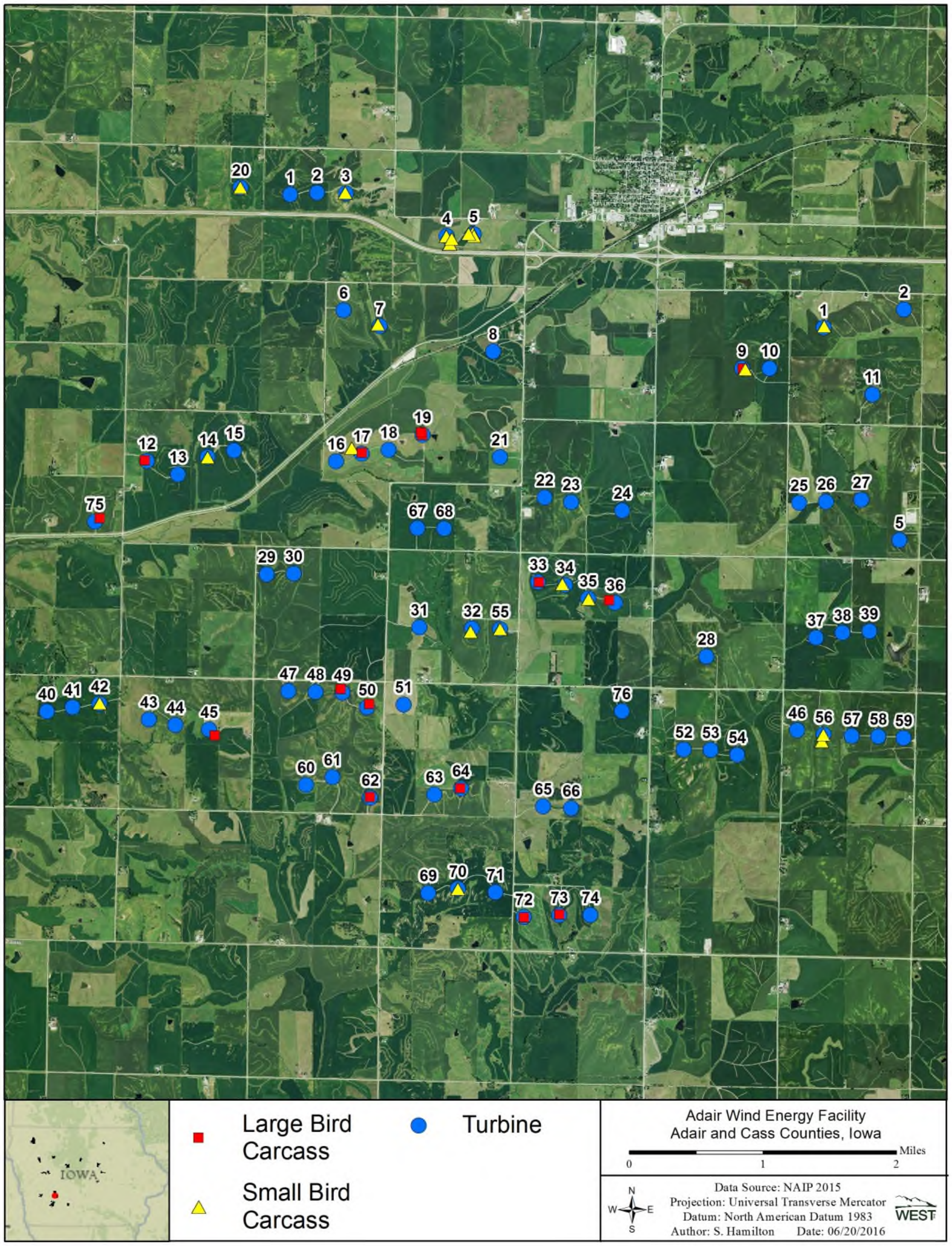

Figure A4. Location of all bird carcasses found at the Adair Wind Energy Facility, Adair and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

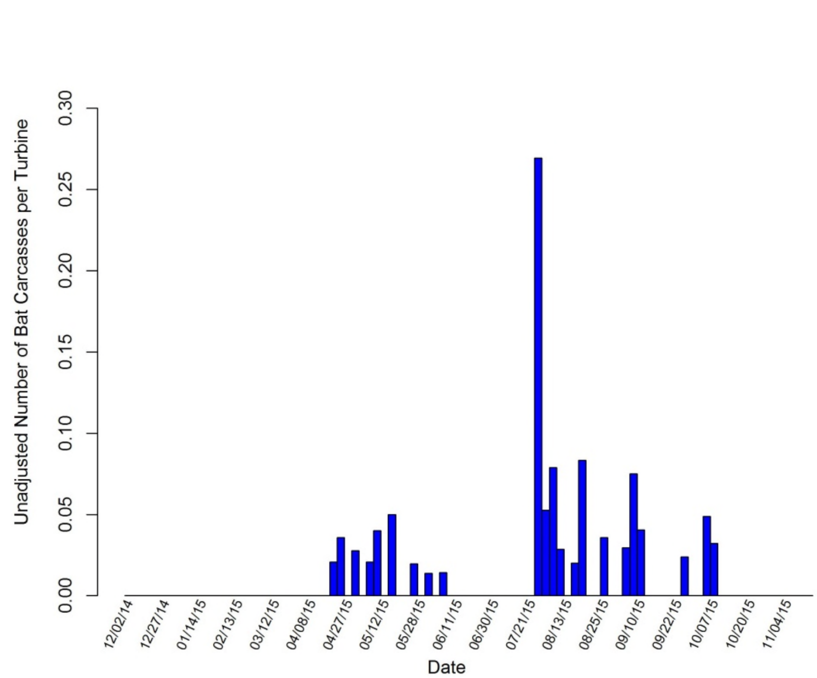

Figure A5. Timing of bat carcasses included in the analysis for the Adair Wind Energy Facility, Adair and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

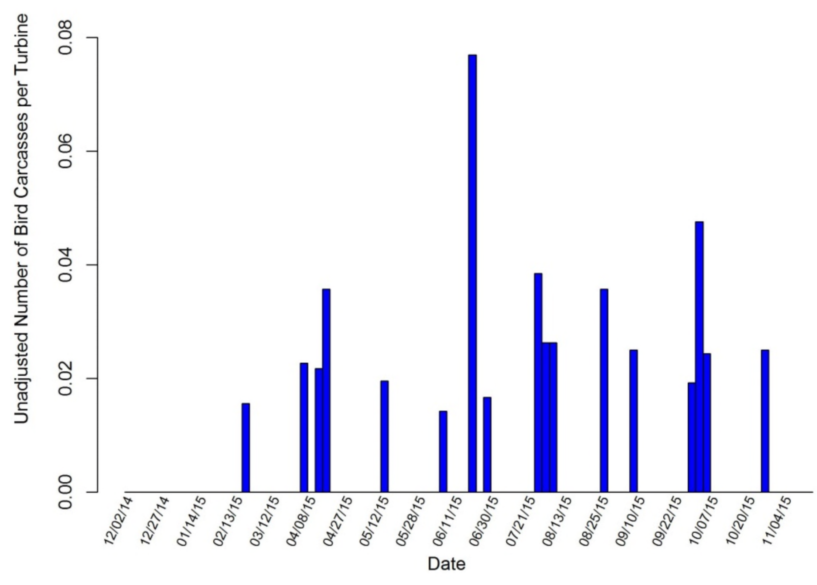

Figure A6. Timing of bird carcasses included in the analysis for the Adair Wind Energy Facility, Adair and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Adair, the majority of bat carcasses (89.3%) were found within seven days of the estimated time of death (Table A2). Most large bird carcasses (70.0%) were estimated to have been found within one week of death, and 75.0% of small birds were estimated to have been found within one week of death (Table A2). Whether carcasses were included in analysis was based on the specific search interval for the turbine where the carcass was found. If the estimated time since death of the carcass was more recent than the previous search of the turbine the carcass was found, the carcass was included in the fatality estimate. If the estimated time since death was greater than the most recent search of the turbine the carcass was found, 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). Six bat carcasses and seven bird carcasses were excluded from the analysis for having been found outside of the search interval. All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table A2. Estimated Time of Death for Carcasses Found at the Adair Wind Energy Facility from December 1, 2014, to November 15, 2015.

Type	Estimated Time of Death	Number of Carcasses	Percent Composition (%)
Bats	Last night	16	34.0
	2-3 days	17	36.2
	4-7 days	9	19.1
	7-14 days	4	8.5
	>2 week	1	2.1
	> Month	0	0
	Unknown	0	0
Large birds	Last night	2	20.0
	2-3 days	3	30.0
	4-7 days	2	20.0
	7-14 days	2	20.0
	>2 week	0	0
	> Month	0	0
	Unknown	1	10.0
Small birds	Last night	0	0
	2-3 days	10	62.5
	4-7 days	2	12.5
	7-14 days	2	12.5
	>2 week	0	0
	> Month	0	0
	Unknown	2	12.5

Searcher Efficiency

A total of 136 carcasses (50 bats, 43 large birds, and 43 small birds) were placed in the search area for searcher efficiency trials during the first year of monitoring. Logistic regression was used to model searcher efficiency, and model selection was based on corrected Akaike's Information Criterion, hereafter referred to as AICc. Seasonal estimates are only provided if season was included in the top model selected. The overall searcher efficiency rate for bats was 86.0%. The searcher efficiency rate was 77% for small birds and 100% for large birds (Table A3).

Carcass Removal

A total of 136 carcasses (50 bats, 51 large birds, and 35 small birds) were placed in the project area for carcass removal trials during the one-year monitoring period. The Huso method 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 various variables. The spring carcass removal time for bats was 4.91 days, the summer carcass removal time was 2.80 days, and fall carcass removal time was 1.11 days. For large birds, the winter carcass removal time was much longer (33.65 days) than in other seasons (3.07 to 13.59 days). Small bird carcass removal times were 21.42 days in winter, 8.65 days in spring, 4.93 days in summer, and 1.96 days in fall (Table A3).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, diurnal raptors, small birds, and all birds, and 90% confidence intervals were calculated when at least five casualties were found (Table A3). The overall adjusted bat fatality rate was 14.05 bats/MW/year. For all birds combined, the adjusted fatality rate was 4.64 birds/MW/year, which consisted of 4.03 small birds/MW/year and 0.60 large birds/MW/year. The diurnal raptor fatality rate was 0.07 raptors/MW/year (Table A3). A complete list of casualties discovered at the Adair Wind Energy Facility is found in Table A4.

Table A3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Adair Wind Energy Facility, Adair and Cass counties, Iowa, December 1, 2014, to November 15, 2015.

	Winter			Spring			Summer			Fall		
	Mean	90 % Confidence Interval		Mean	90 % Confidence Interval		Mean	90% Confidence Interval		Mean	90% Confidence Interval	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
Search Area Adjustment												
Bats	10.52	-	-	10.52	-	-	10.52	-	-	10.52	-	-
Large birds	9.46	-	-	9.46	-	-	9.46	-	-	9.46	-	-
Small birds	14.39	-	-	14.39	-	-	14.39	-	-	14.39	-	-
Observer Detection Rate												
Bats	0.86	0.78	0.94	0.86	0.78	0.94	0.86	0.78	0.94	0.86	0.78	0.94
Large birds	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Small birds	0.77	0.65	0.88	0.77	0.65	0.88	0.77	0.65	0.88	0.77	0.65	0.88
Mean Carcass Removal Time (days)												
Bats	-	-	-	4.91	3.16	7.40	2.80	1.88	4.02	1.11	0.74	1.55
Large birds	33.65	16.70	75.96	13.59	8.45	21.57	7.75	5.03	11.52	3.07	1.96	4.82
Small birds	21.42	8.95	49.32	8.65	4.99	14.13	4.93	3.04	7.55	1.96	1.24	2.89
Average Probability of Carcass Persistence Through Search Interval With Effective Interval Adjustment												
Bats	-	-	-	0.52	0.41	0.63	0.38	-	-	0.19	0.13	0.25
Large birds	0.80	-	-	0.73	-	-	0.61	-	-	0.39	-	-
Raptors	0.80	-	-	-	-	-	-	-	-	-	-	-
Small birds	-	-	-	0.53	-	-	0.45	-	-	0.29	-	0.20-0.39
Observed Carcass Counts Per Turbine												
Bats	-	-	-	0.08	0.03	0.13	0.04	-	-	0.42	0.32	0.55
Large birds	0.01	-	-	0.04	-	-	0.03	-	-	0.01	-	-
Raptors	0.01	-	-	-	-	-	-	-	-	-	-	-
Small birds	-	-	-	0.03	-	-	0.01	-	-	0.12	0.05	0.20
Average Probability that Carcass Available and Detected												
Bats	-	-	-	0.44	0.35	0.55	0.33	-	-	0.16	0.11	0.21
Large birds	0.80	-	-	0.73	-	-	0.61	-	-	0.39	-	-
Raptors	0.80	-	-	-	-	-	-	-	-	-	-	-
Small birds	-	-	-	0.41	-	-	0.34	-	-	0.23	0.15	0.30
Adjusted Fatality Rates (fatalities/turbine/season)												
Bats	-	-	-	1.88	0.75	3.31	1.26	-	-	29.18	18.97	46.70
Large birds	0.15	-	-	0.51	-	-	0.41	-	-	0.32	-	-
Raptors	0.15	-	-	-	-	-	-	-	-	-	-	-
Small birds	-	-	-	0.94	-	-	0.55	-	-	7.79	3.59	15.21

Table A3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Adair Wind Energy Facility, Adair and Cass counties, Iowa, December 1, 2014, to November 15, 2015.

Overall Adjusted Fatality Rates (Fatalities/Turbine/Year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	32.32	22.01	50.80
Large birds	1.39	0.56	2.43
Diurnal raptors	0.15	-	-
Small birds	9.28	4.60	17.34
All birds	10.67	6.03	18.84
Overall Adjusted Fatality Rates (fatalities/mw/year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	14.05	9.57	22.09
Large birds	0.60	0.24	1.06
Diurnal raptors	0.07	-	-
Small birds	4.03	2.00	7.54
All birds	4.64	2.62	8.19

Table A4. Complete carcass listing for the Adair Wind Energy Facility, Adair and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
			Bats			
4/20/2015	silver-haired bat	2	34	carcass search	RandP	intact
4/21/2015	silver-haired bat	71	0	carcass search	RandP	intact
4/29/2015	big brown bat	52	1	carcass search	RandP	intact
5/4/2015	evening bat	72	19	carcass search	RandP	scavenged
5/5/2015	hoary bat	23	2	carcass search	RandP	intact
5/13/2015	evening bat	34	2	carcass search	RandP	intact
5/27/2015	hoary bat	24	9	carcass search	RandP	NA
6/2/2015	evening bat	9	1	carcass search	RandP	scavenged
6/9/2015	hoary bat	59	7	carcass search	RandP	intact
6/30/2015	eastern red bat	35	48	carcass search	RandP	scavenged
7/14/2015	eastern red bat	57	8	carcass search	RandP	intact
7/22/2015	eastern red bat	3	69	carcass search	RandP	scavenged
7/22/2015	eastern red bat	5	32	carcass search	RandP	intact
7/22/2015	hoary bat	7	6	carcass search	RandP	intact
7/22/2015	hoary bat	7	3	carcass search	RandP	intact
7/22/2015	big brown bat	11	16	carcass search	RandP	intact
7/22/2015	hoary bat	17	33	carcass search	RandP	intact
7/22/2015	big brown bat	23	9	carcass search	RandP	intact
7/22/2015	hoary bat	23	20	carcass search	RandP	intact
7/31/2015	big brown bat	36	9	carcass search	RandP	intact
7/31/2015	eastern red bat	46	13	carcass search	RandP	scavenged
7/31/2015	big brown bat	62	8	carcass search	RandP	scavenged
7/31/2015	big brown bat	66	5	carcass search	RandP	intact
7/31/2015	hoary bat	70	10	carcass search	RandP	NA
7/31/2015	eastern red bat	71	17	carcass search	RandP	dismembered
8/4/2015	eastern red bat	65	26	carcass search	RandP	injured
8/4/2015	hoary bat	72	29	carcass search	RandP	NA
8/4/2015	eastern red bat	73	5	carcass search	RandP	intact
8/5/2015	big brown bat	8	7	carcass search	RandP	intact
8/5/2015	big brown bat	43	10	carcass search	RandP	intact
8/5/2015	eastern red bat	60	4	carcass search	RandP	intact
8/13/2015	big brown bat	64	6	carcass search	RandP	scavenged
8/14/2015	silver-haired bat	40	25	carcass search	RandP	scavenged
8/17/2015	hoary bat	1	8	incidental find	RandP	scavenged
8/19/2015	hoary bat	8	9	carcass search	RandP	scavenged
8/19/2015	big brown bat	9	8	carcass search	RandP	intact
8/19/2015	hoary bat	22	30	carcass search	RandP	scavenged
8/25/2015	eastern red bat	36	13	carcass search	RandP	scavenged
8/26/2015	hoary bat	28	1	carcass search	RandP	intact
8/26/2015	hoary bat	29	105	carcass search	RandP	scavenged
9/1/2015	eastern red bat	3	4	carcass search	RandP	scavenged
9/3/2015	eastern red bat	28	6	carcass search	RandP	scavenged
9/3/2015	hoary bat	53	10	carcass search	RandP	scavenged
9/3/2015	hoary bat	76	43	carcass search	RandP	intact
9/10/2015	hoary bat	32	6	carcass search	RandP	intact
9/10/2015	eastern red bat	43	53	carcass search	RandP	scavenged
9/10/2015	eastern red bat	54	8	carcass search	RandP	intact
9/10/2015	eastern red bat	55	19	carcass search	RandP	scavenged
9/10/2015	hoary bat	55	34	carcass search	RandP	scavenged
9/10/2015	hoary bat	71	7	carcass search	RandP	intact
9/24/2015	eastern red bat	27	5	carcass search	RandP	scavenged
10/6/2015	eastern red bat	37	5	carcass search	RandP	intact
10/6/2015	eastern red bat	57	8	carcass search	RandP	intact
10/7/2015	eastern red bat	29	30	carcass search	RandP	intact
			Birds			
12/9/2014	dark-eyed junco	4	100	carcass search	20m Trans	scavenged
12/9/2014	Virginia rail	4	64	carcass search	20m Trans	scavenged
2/23/2015	sharp-shinned hawk	64	8	carcass search	RandP	intact
3/23/2015	turkey vulture	75	67	carcass search	100m Scan	scavenged

Table A4. Complete carcass listing for the Adair Wind Energy Facility, Adair and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
4/1/2015	red-tailed hawk	49	42	carcass search	40m Trans	scavenged
4/1/2015	unidentified passerine	32	45	carcass search	20m Trans	scavenged
4/1/2015	European starling	56	79	carcass search	20m Trans	scavenged
4/7/2015	brown creeper	34	34	carcass search	RandP	intact
4/10/2015	American coot	12	25	incidental find	NA	intact
4/13/2015	American coot	36	25	carcass search	RandP	intact
4/13/2015	chipping sparrow	5	20	carcass search	RandP	intact
4/15/2015	lesser scaup	9	1	carcass search	RandP	NA
4/21/2015	red-tailed hawk	50	44	carcass search	100m Scan	scavenged
4/27/2015	blue-winged teal	19	30	carcass search	RandP	dismembered
5/12/2015	eastern kingbird	55	5	carcass search	RandP	intact
5/20/2015	orchard oriole	9	41	carcass search	RandP	scavenged
5/21/2015	unidentified raptor	17	10	carcass search	RandP	dismembered
6/9/2015	northern bobwhite	62	1	carcass search	RandP	intact
6/17/2015	mourning dove	73	1	carcass search	RandP	intact
6/25/2015	brown-headed cowbird	4	7	carcass search	RandP	intact
6/25/2015	brown-headed cowbird	56	2	carcass search	RandP	intact
7/22/2015	song sparrow	20	1	carcass search	RandP	intact
7/31/2015	dickcissel	3	1	carcass search	RandP	intact
7/31/2015	cliff swallow	7	30	carcass search	RandP	dismembered
7/31/2015	eastern kingbird	14	1	carcass search	RandP	feather spot
8/4/2015	red-tailed hawk	33	10	carcass search	RandP	dismembered
8/4/2015	cliff swallow	35	8	carcass search	RandP	intact
8/21/2015	mourning dove	19	1	carcass search	RandP	scavenged
8/25/2015	unidentified flycatcher	4	106	carcass search	RandP	scavenged
9/3/2015	vesper sparrow	70	1	carcass search	RandP	intact
9/16/2015	horned lark	17	141	incidental find	NA	intact
9/29/2015	ring-necked pheasant	72	4	carcass search	RandP	intact
9/30/2015	marsh wren	5	56	carcass search	RandP	intact
10/6/2015	ruby-crowned kinglet	42	7	carcass search	RandP	intact
10/28/2015	red-tailed hawk	45	100	carcass search	RandP	scavenged
10/28/2015	unidentified passerine	5	17	carcass search	RandP	dismembered

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix B: Summary of Fatality Monitoring Surveys Conducted at the Carroll Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Wind Energy Facility (Carroll) consists of 100 GE 1.5 SLE Salem pitch 1.5-megawatt turbines for a nameplate capacity of 150 MW. The facility is located across approximately 16,241 acres (25 mi^2) in Carroll County in west-central Iowa. The facility is located approximately one mile northwest of Carroll, Iowa. The facility is located in the Des Moines Lobe and Steeply Rolling Loess Prairies Level 4 Ecoregions. According to the National Land Cover Database, the landscape predominantly consists of cropland (87.7%). Approximately 7% of the project area is developed, and about 4.5% is pasture/hay. Grassland, deciduous forest, evergreen forests, open water, emergent wetlands and barren areas each account for less than 1% of the land cover.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 4,090 road and pad searches were conducted at Carroll during 41 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

Fifty-six bat carcasses and 29 bird carcasses were found on standardized road and pad search areas or incidentally at Carroll (Table B1). Of the five bat species found, eastern red (26 carcasses, total) and hoary bats (17) were found most commonly; fewer than 10 carcasses of each of the remaining three species (big brown, silver-haired, and evening bat) were found. No federal or state listed bat species were found and no *Myotis* bats were found. Of the 20 unique bird species found on standardized road and pad searches or incidentally, mourning dove (five carcasses), American coot (three), golden-crowned kinglet (three), and turkey vulture (two) were the only species of which more than a single carcass were found. One bald eagle was found incidentally off plot (Table B1). Bald eagles are protected under the federal Bald and Golden Eagle Protection Act (1940) and are a special concern species in Iowa (Iowa Department of Natural Resources 2016).

Most bat and bird carcasses included in the analysis were found within 10 meters of turbines (Figures B1 and B2). All bat carcasses were found within 60 meters of turbines, and all bird carcasses were found within 80 meters. There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at the Carroll facility (Figures B3 and B4). Most bat fatalities were found from mid-July to late September, while birds were found throughout the study period, with slight increases in the spring and fall (Figures B5 and B6).

Table B1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Carroll Wind Energy Facility, Carroll County, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside Search Interval		Incidentals Found off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
eastern red bat	16	45.7	7	63.6	3	30.0	26	46.4
hoary bat	11	31.4	2	18.2	4	40.0	17	30.4
big brown bat	7	20.0	0	0	1	10.0	8	14.3
silver-haired bat	0	0	2	18.2	2	20.0	4	7.1
evening bat	1	2.9	0	0	0	0	1	1.8
Overall Bats	**35**	**100**	**11**	**100**	**10**	**100**	**56**	**100**
Birds								
mourning dove	4	28.6	0	0	1	8.3	5	17.2
golden-crowned kinglet	1	7.1	1	33.3	1	8.3	3	10.3
American coot	0	0	0	0	3	25.0	3	10.3
turkey vulture	1	7.1	0	0	1	8.3	2	6.9
American redstart	1	7.1	0	0	0	0	1	3.4
cliff swallow	1	7.1	0	0	0	0	1	3.4
eastern phoebe	1	7.1	0	0	0	0	1	3.4
European starling	1	7.1	0	0	0	0	1	3.4
Lapland longspur	1	7.1	0	0	0	0	1	3.4
swamp sparrow	1	7.1	0	0	0	0	1	3.4
unidentified flycatcher	1	7.1	0	0	0	0	1	3.4
unidentified kinglet	1	7.1	0	0	0	0	1	3.4
bald eagle	0	0	0	0	1	8.3	1	3.4
house sparrow	0	0	0	0	1	8.3	1	3.4
killdeer	0	0	0	0	1	8.3	1	3.4
lesser scaup	0	0	1	33.3	0	0	1	3.4
mallard	0	0	0	0	1	8.3	1	3.4
pied-billed grebe	0	0	1	33.3	0	0	1	3.4
ring-necked pheasant	0	0	0	0	1	8.3	1	3.4
rock pigeon	0	0	0	0	1	8.3	1	3.4
Overall Birds	**14**	**100**	**3**	**100**	**12**	**100**	**29**	**100**

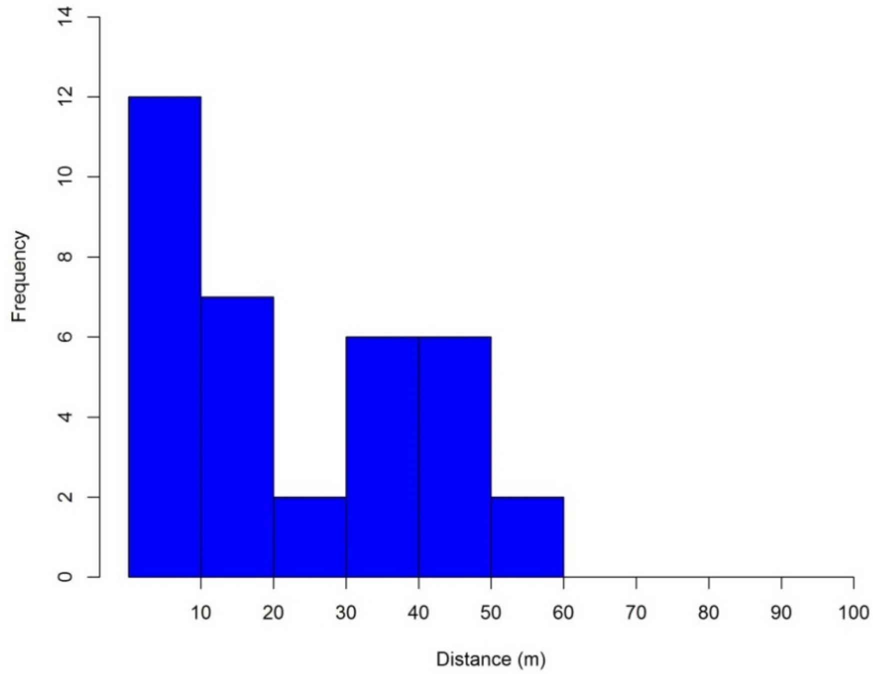

Figure B1. Distance from turbine for bat carcasses included in the analysis for the Carroll Wind Energy Facility, Carroll County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

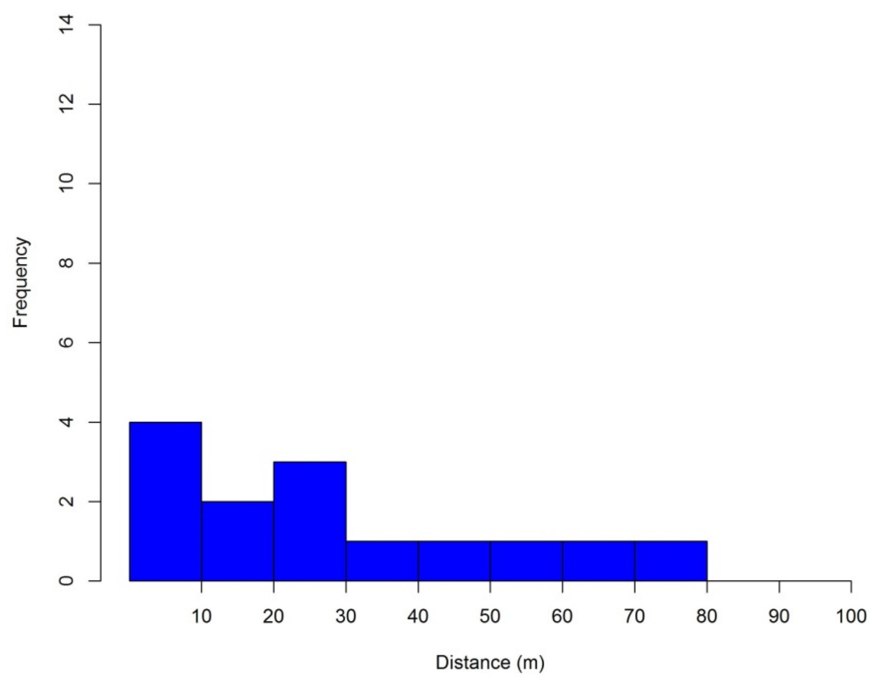

Figure B2. Distance from the turbine for bird carcasses included in the analysis for the Carroll Wind Energy Facility, Carroll County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

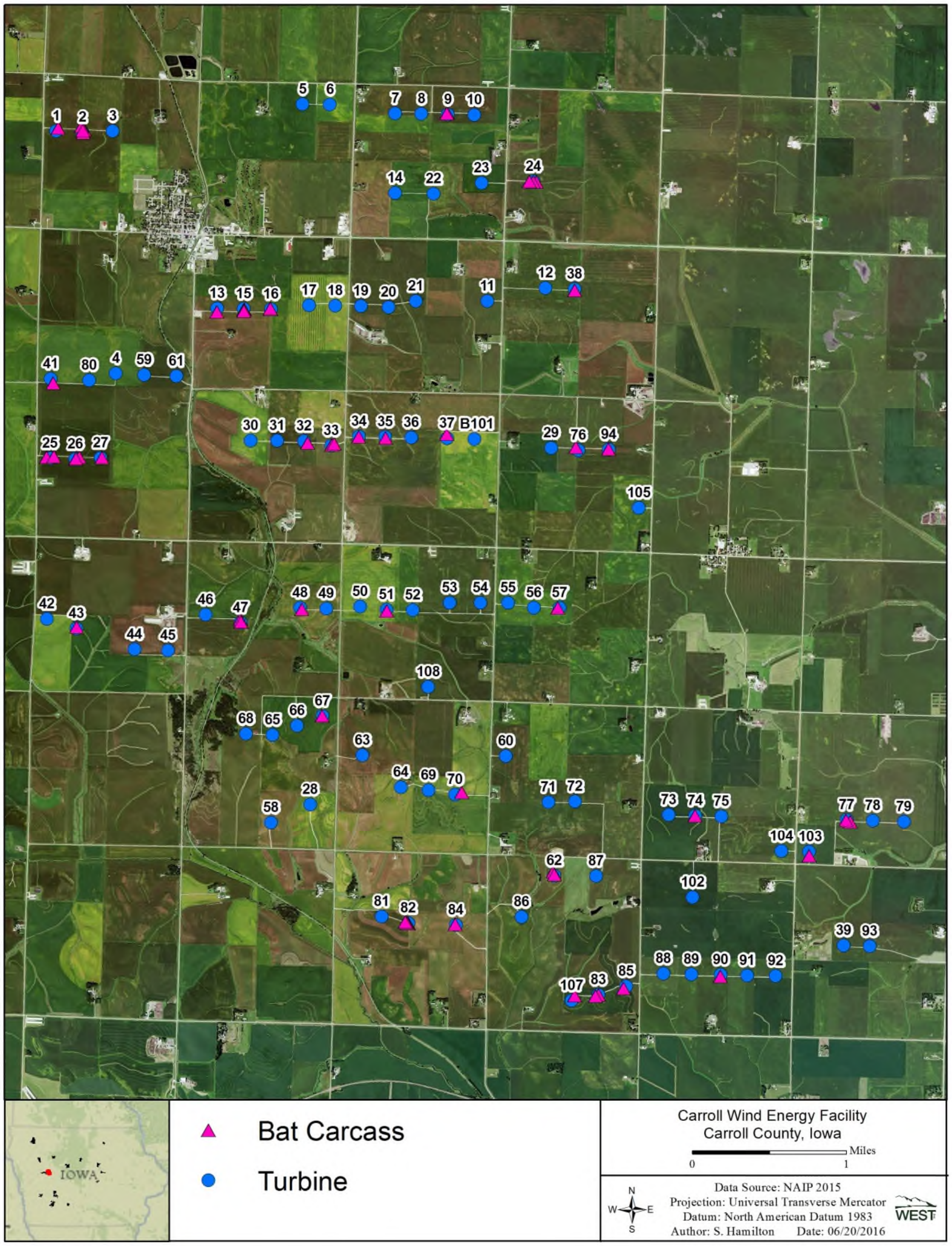

Figure B3. Location of all bat carcasses found during scheduled searches or incidentally at the Carroll Wind Energy Facility, Carroll County, Iowa from December 1, 2014, to November 15, 2015.

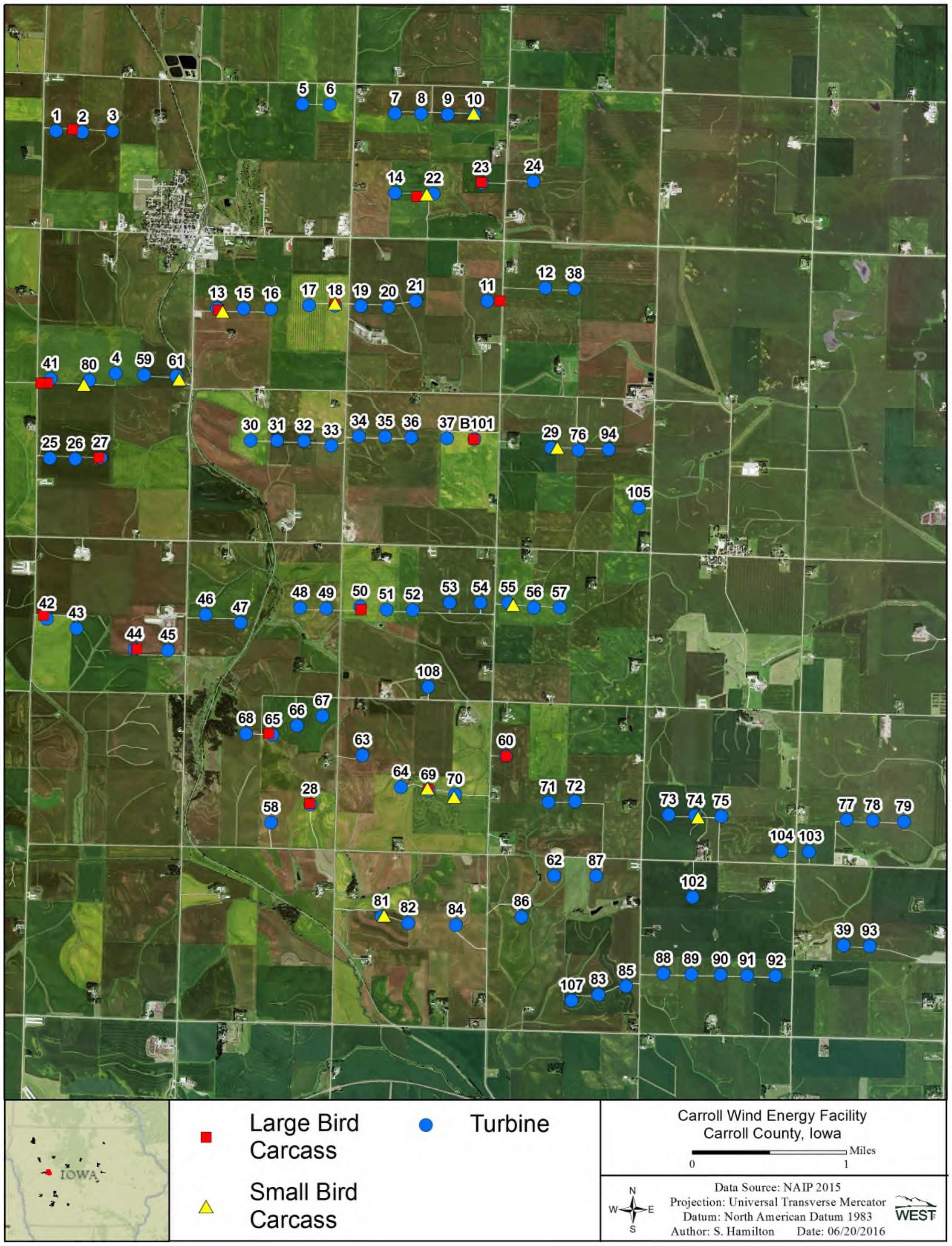

Figure B4. Location of all bird carcasses found during scheduled searches or incidentally at the Carroll Wind Energy Facility, Carroll County, Iowa, from December 1, 2014, to November 15, 2015.

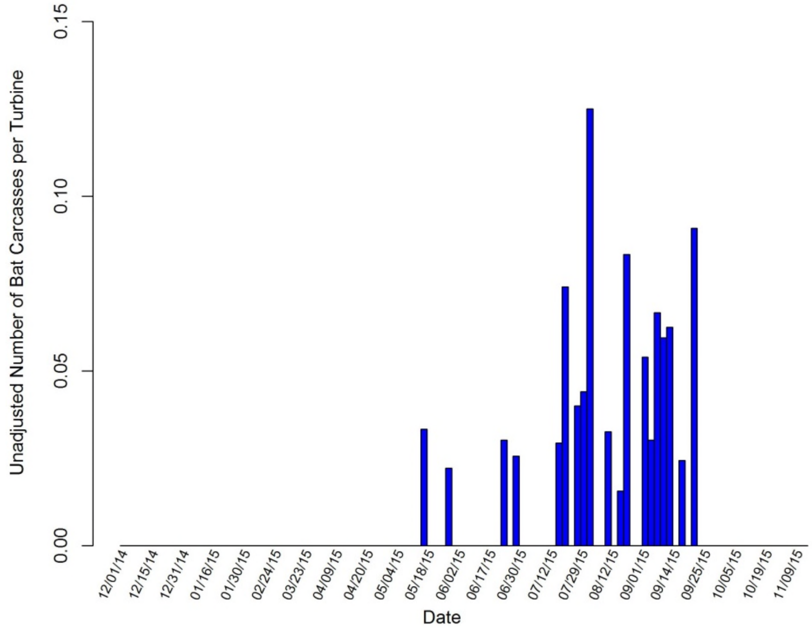

Figure B5. Timing of bat carcasses included in the analysis for the Carroll Wind Energy Facility, Carroll County, Iowa, from December 1, 2014, to November 15, 2015.

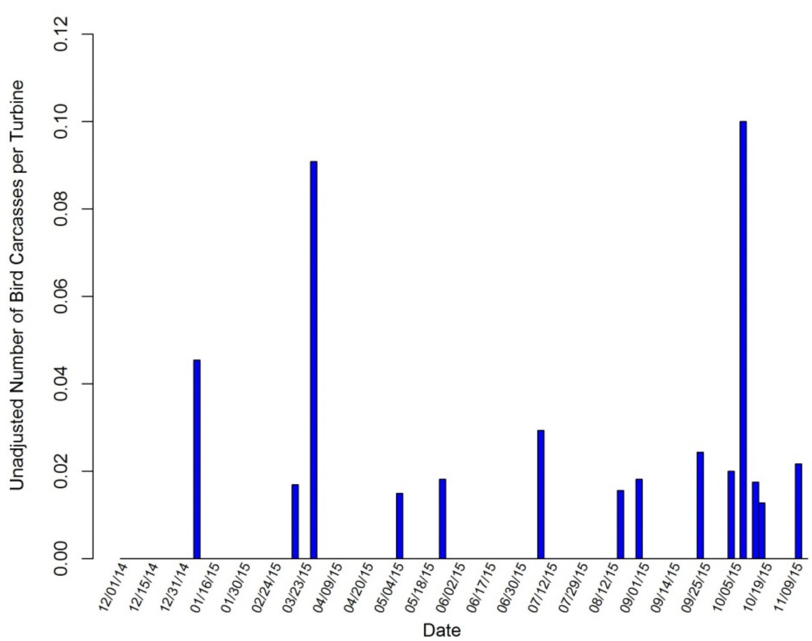

Figure B6. Timing of bird carcasses included in the analysis the Carroll Wind Energy Facility, Carroll County, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Carroll, the majority of bat carcasses (76.1%) were found within one week of the estimated time of death (Table B2). All large bird carcasses were estimated to have been found within one week of death, and 90% of small birds were estimated to have been found within one week of death (Table B2). Whether carcasses were included in analysis was based on the specific search interval for the turbine where the carcass was found. If the estimated time since death of the carcass was more recent than the previous search of the turbine the carcass was found, the carcass was included in the fatality estimate. If the estimated time since death was greater than the most recent search of the turbine the carcass was found, 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). Eleven bat carcasses and three bird carcasses were excluded from the analysis for having been found outside of the search interval. All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table B2. Estimated time of death for carcasses found at the Carroll Wind Energy Facility from December 1, 2014, to November 15, 2015.

Type	Estimated Time of Death	Number of Carcasses	Percent Composition (%)
Bats	Last night	11	23.9
	2-3 days	12	26.1
	4-7 days	12	26.1
	7-14 days	9	19.6
	>2 week	1	2.2
	> Month	0	0
	Unknown	1	2.2
Large birds	Last night	2	28.6
	2-3 days	1	14.3
	4-7 days	4	57.1
	7-14 days	0	0
	>2 week	0	0
	> Month	0	0
	Unknown	0	0
Small birds	Last night	3	30.0
	2-3 days	3	30.0
	4-7 days	3	30.0
	7-14 days	0	0
	>2 week	1	10.0
	> Month	0	0
	Unknown	0	0

Searcher Efficiency

A total of 135 carcasses (50 bats, 35 large birds, and 50 small birds) were placed on search area for searcher efficiency trials during the first year of monitoring. Logistic regression was used to model searcher efficiency, and model selection was based on corrected Akaike's Information Criterion, hereafter referred to as AICc. Seasonal estimates are only provided is season was included in the top model selected. The searcher efficiency rate for bats was 0.72 in spring, 0.90 in summer, and 0.94 in fall. The searcher efficiency rate for large birds was 0.92 in winter, 0.99 in spring, 1.00 in summer, and 1.00 in fall. The small bird searcher efficiency rate was 0.38 in winter, 0.79 in spring, 0.93 in summer, and 0.95 in fall (Table B3).

Carcass Removal

A total of 135 carcasses (50 bats, 50 large birds, and 35 small birds) were placed in the project area throughout the duration of the one-year monitoring period for carcass removal trials. The Huso method 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 various variables. The average carcass removal time for bats was 3.56 days for spring, 1.66 days for summer, and 2.33 days for fall (Table B3). Large bird carcass removal rate during winter was 29.25 days, spring was 12.35 days, summer was 5.74, and fall was 8.07 days. The winter carcass removal time for small birds was 11.03 days, spring was 4.65 days, summer 2.16 days, and fall was 3.04 days (Table B3).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, and all birds, and 90% confidence intervals were calculated when at least five casualties were found (Table B3). Fatality estimates were not calculated for raptors because no raptors were found on search plots during the study period. The overall adjusted bat fatality rate was 11.71 bat fatalities/MW/year. The overall adjusted fatality rate for all birds combined was 3.55 bird fatalities/MW/year, which consisted of 0.53 large bird fatalities/MW/year and 3.02 small bird fatalities/MW/year (Table B3). A complete list of casualties discovered at the Carroll Wind Energy Facility is found in Table B4.

Table B3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Carroll Wind Energy Facility, Carroll County, Iowa, from December 1, 2014, to November 15, 2015.

	Winter			Spring			Summer			Fall		
	Mean	90 % Confidence Interval		Mean	90 % Confidence Interval		Mean	90% Confidence Interval		Mean	90% Confidence Interval	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
Search Area Adjustment												
Bats	12.61	-	-	12.61	-	-	12.61	-	-	12.61	-	-
Large birds	10.76	-	-	10.76	-	-	10.76	-	-	10.76	-	-
Small birds	15.96	-	-	15.96	-	-	15.96	-	-	15.96	-	-
Observer Detection Rate												
Bats	-	-	-	0.72	0.51	0.91	0.90	0.81	0.98	0.94	0.84	1.00
Large birds	0.92	0.75	1.00	0.99	0.95	1.00	1.00	0.98	1.00	1.00	0.99	1.00
Small birds	0.38	0.17	0.60	0.79	0.60	0.95	0.93	0.80	1.00	0.95	0.91	1.00
Mean Carcass Removal Time (days)												
Bats	-	-	-	3.56	2.33	5.09	1.66	1.19	2.25	2.33	1.71	3.02
Large birds	29.25	18.51	48.74	12.35	7.90	17.66	5.74	3.87	8.01	8.07	5.33	11.06
Small birds	11.03	7.05	17.34	4.65	2.32	7.72	2.16	1.34	3.08	3.04	1.61	4.76
Average Probability of Carcass Persistence Through Search Interval With Effective Interval Adjustment												
Bats	-	-	-	0.44	-	-	0.24	0.17	0.31	0.29	0.21	0.36
Large birds	0.81	-	-	-	-	-	0.58	-	-	0.71	-	-
Small birds	0.61	-	-	0.43	-	-	0.30	-	-	0.38	0.22	0.51
Observed Carcass Counts Per Turbine												
Bats	-	-	-	0.01	-	-	0.06	0.03	0.10	0.28	0.20	0.38
Large birds	0.01	-	-	-	-	-	0.0.1	-	-	0.03	-	-
Small birds	0.01	-	-	0.02	-	-	0.01	-	-	0.05	0.02	0.09
Average Probability that Carcass Available and Detected												
Bats	-	-	-	0.32	-	-	0.21	0.15	0.29	0.27	0.19	0.34
Large birds	0.74	-	-	-	-	-	0.58	-	-	0.70	-	-
Small birds	0.23	-	-	0.34	-	-	0.28	-	-	0.36	0.21	0.49
Adjusted Fatality Rates (Fatalities/Turbine/Season)												
Bats	-	-	-	0.40	-	-	3.62	1.40	6.90	13.55	8.93	20.46
Large birds	0.15	-	-	-	-	-	0.19	-	-	0.46	-	-
Small birds	0.69	-	-	1.03	-	-	0.58	-	-	2.24	0.77	4.88

Table B3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Carroll Wind Energy Facility, Carroll County, Iowa, from December 1, 2014, to November 15, 2015.

Overall Adjusted Fatality Rates (Fatalities/Turbine/Year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	17.56	12.08	25.53
Large birds	0.79	0.30	1.44
Small birds	4.54	2.27	9.32
All birds	5.33	2.96	10.31
Overall Adjusted Fatality Rates (Fatalities/MW/Year)			
	Mean	**90% Confidence Interval**	
		Lower Limit	**Upper Limit**
Bats	11.71	8.05	17.02
Large birds	0.53	0.20	0.96
Small birds	3.02	1.51	6.21
All birds	3.55	1.97	6.87

Table B4. Complete carcass listing for the Carroll Wind Energy Facility, Carroll County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search[1] Type	Condition
Bats						
4/22/2015	silver-haired bat	16	39	carcass search	RandP	intact
5/12/2015	evening bat	34	2	carcass search	RandP	intact
5/27/2015	hoary bat	41	50	carcass search	RandP	intact
6/22/2015	hoary bat	83	0	incidental find	NA	intact
6/29/2015	hoary bat	85	32	carcass search	RandP	scavenged
7/13/2015	hoary bat	24	45	carcass search	RandP	intact
7/14/2015	hoary bat	2	15	carcass search	RandP	scavenged
7/14/2015	eastern red bat	25	43	carcass search	RandP	intact
7/21/2015	eastern red bat	15	6	carcass search	RandP	intact
7/21/2015	eastern red bat	82	17	carcass search	RandP	intact
7/21/2015	eastern red bat	82	3	carcass search	RandP	intact
7/29/2015	eastern red bat	70	74	carcass search	RandP	dismembered
7/29/2015	eastern red bat	74	0	carcass search	RandP	intact
7/29/2015	big brown bat	77	38	carcass search	RandP	intact
7/29/2015	eastern red bat	82	34	carcass search	RandP	intact
7/29/2015	big brown bat	90	19	carcass search	RandP	intact
7/30/2015	eastern red bat	2	31	carcass search	RandP	intact
7/30/2015	eastern red bat	2	4	carcass search	RandP	intact
7/30/2015	eastern red bat	15	23	carcass search	RandP	scavenged
7/30/2015	eastern red bat	32	42	carcass search	RandP	intact
7/30/2015	hoary bat	47	9	carcass search	RandP	scavenged
8/6/2015	hoary bat	2	3	carcass search	RandP	scavenged
8/11/2015	big brown bat	35	23	carcass search	RandP	scavenged
8/11/2015	hoary bat	62	9	carcass search	RandP	scavenged
8/11/2015	eastern red bat	76	40	carcass search	RandP	scavenged
8/11/2015	big brown bat	94	4	carcass search	RandP	scavenged
8/11/2015	eastern red bat	103	1	carcass search	RandP	intact
8/19/2015	eastern red bat	57	21	carcass search	RandP	intact
8/19/2015	eastern red bat	77	2	carcass search	RandP	intact
8/20/2015	hoary bat	24	8	incidental find	NA	intact
8/20/2015	hoary bat	26	1	carcass search	RandP	intact
8/20/2015	eastern red bat	33	2	carcass search	RandP	scavenged
8/20/2015	hoary bat	33	32	carcass search	RandP	intact
8/25/2015	hoary bat	27	5	carcass search	RandP	dismembered
9/1/2015	hoary bat	84	5	carcass search	RandP	intact
9/1/2015	big brown bat	107	55	carcass search	RandP	intact
9/2/2015	eastern red bat	9	22	carcass search	RandP	intact
9/2/2015	silver-haired bat	24	7	carcass search	RandP	intact
9/3/2015	eastern red bat	26	43	carcass search	RandP	intact
9/3/2015	eastern red bat	47	30	carcass search	RandP	intact
9/3/2015	eastern red bat	82	1	carcass search	RandP	intact
9/9/2015	hoary bat	38	17	carcass search	RandP	dismembered
9/9/2015	eastern red bat	48	23	carcass search	RandP	intact
9/9/2015	eastern red bat	51	12	carcass search	RandP	intact
9/9/2015	hoary bat	67	3	carcass search	RandP	intact
9/9/2015	big brown bat	83	28	carcass search	RandP	intact
9/10/2015	big brown bat	43	16	carcass search	RandP	intact
9/15/2015	hoary bat	1	40	carcass search	RandP	scavenged
9/15/2015	big brown bat	13	31	carcass search	RandP	scavenged
9/15/2015	eastern red bat	26	5	carcass search	RandP	scavenged
9/16/2015	eastern red bat	37	42	carcass search	RandP	intact
9/22/2015	eastern red bat	16	1	incidental find	RandP	scavenged
9/24/2015	silver-haired bat	15	0	incidental find	NA	scavenged
9/25/2015	hoary bat	25	1	carcass search	RandP	intact
10/4/2015	silver-haired bat	9	13	carcass search	RandP	dismembered
10/12/2015	eastern red bat	62	32	carcass search	RandP	intact
Birds						
12/4/2014	golden-crowned kinglet	13	62	carcass search	RandP	intact
12/15/2014	turkey vulture	65	32	incidental find	RandP	intact

Table B4. Complete carcass listing for the Carroll Wind Energy Facility, Carroll County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search[1] Type	Condition
1/13/2015	mourning dove	101	6	incidental find	NA	intact
1/30/2015	ring-necked pheasant	2	101	incidental find	100m Scan	feather spot
1/30/2015	rock pigeon	42	54	carcass search	RandP	feather spot
3/9/2015	Lapland longspur	18	13	carcass search	RandP	injured
3/10/2015	bald eagle	44	22	incidental find	NA	dismembered
3/24/2015	European starling	69	24	carcass search	RandP	intact
4/10/2015	American coot	11	129	carcass search	RandP	scavenged
4/14/2015	pied-billed grebe	27	21	carcass search	RandP	dismembered
4/14/2015	lesser scaup	41	57	carcass search	RandP	dismembered
4/15/2015	American coot	50	32	carcass search	RandP	intact
4/28/2015	mallard	13	22	carcass search	RandP	intact
5/4/2015	cliff swallow	81	27	carcass search	RandP	intact
5/12/2015	mourning dove	18	5	carcass search	RandP	intact
5/19/2015	American coot	41	113	incidental find	NA	dismembered
5/25/2015	American redstart	74	35	carcass search	RandP	intact
6/2/2015	house sparrow	22	69	carcass search	RandP	dismembered
7/7/2015	mourning dove	23	0	carcass search	RandP	intact
8/6/2015	killdeer	22	180	incidental find	NA	intact
8/19/2015	unidentified kinglet	55	50	carcass search	RandP	dismembered
8/25/2015	unidentified flycatcher	29	30	carcass search	RandP	scavenged
9/24/2015	eastern phoebe	10	11	carcass search	RandP	scavenged
10/4/2015	mourning dove	60	0	carcass search	RandP	intact
10/4/2015	golden-crowned kinglet	70	32	carcass search	RandP	intact
10/6/2015	swamp sparrow	80	67	carcass search	RandP	scavenged
10/13/2015	golden-crowned kinglet	61	36	carcass search	RandP	intact
10/18/2015	mourning dove	69	2	carcass search	RandP	scavenged
11/9/2015	turkey vulture	28	8	carcass search	RandP	dismembered

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix C: Summary of Fatality Monitoring Surveys Conducted at the Eclipse Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Eclipse Wind Energy Facility consists of 87 SWT- 2.3-108 2.3-megawatt turbines for a nameplate capacity of 200.1 MW. The facility is located across approximately 20,046 acres (31 square miles) in Audubon and Guthrie counties in southwest Iowa. The facility is located one-half mile north of the town of Adair, Iowa. The facility is located in the Rolling Loess Prairies and Steeply Rolling Loess Level 4 Ecoregions. According to the National Land Cover Database, the landscape predominantly consists of cropland (81.4%). Approximately 4% of the project area is developed, and about 14.2% is pasture/hay. Grassland, deciduous forest, woody wetlands, shrub/scrub, and open water each account for less than 1% of the land cover.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 3,422 road and pad searches were conducted at Eclipse during 41 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

Seventy-two bats and 38 birds were found on standardized road and pad search areas or incidentally at Eclipse (Table C1). Of the six bat species found, hoary, eastern red, and big brown bats (24, 21, and 19 carcasses, respectively) were the bat species most commonly found. No federal or state listed bat species were found, and no *Myotis* bats were found. Of the 26 unique bird species found on standardized road and pad searches or incidentally, American coot and cliff swallow (four carcasses, each) were the most commonly found bird species. No federal or state listed bird species were found. One short-eared owl, listed as threatened in Iowa, was found incidentally off search plot (Table C1; Iowa Department of Natural Resources 2016).

All bat carcasses included in the analysis were found within 70 meters of turbines, and all birds were found within 80 meters of turbines (Figures C1 and C2). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at Eclipse (Figures C3 and C4). Most bat fatalities were found from mid-July to mid-September (Figure C5), while most birds were found in either the spring or fall (Figure A6).

Table C1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
hoary bat	19	36.5	2	15.4	3	42.9	24	33.3
eastern red bat	17	32.7	3	23.1	1	14.3	21	29.2
big brown bat	13	25.0	5	38.5	1	14.3	19	26.4
silver-haired bat	3	5.8	1	7.7	1	14.3	5	6.9
evening bat	0	0	2	15.4	0	0	2	2.8
tricolored bat	0	0	0	0	1	14.3	1	1.4
Overall Bats	**52**	**100**	**13**	**100**	**7**	**100**	**72**	**100**
Birds								
American coot	2	8.7	0	0	2	18.2	4	10.5
cliff swallow	2	8.7	1	25.0	1	9.1	4	10.5
European starling	3	13.0	0	0	0	0.0	3	7.9
American tree sparrow	2	8.7	0	0	0	0.0	2	5.3
unidentified empidonax	1	4.3	0	0	1	9.1	2	5.3
Acadian flycatcher	1	4.3	0	0	0	0	1	2.6
American redstart	1	4.3	0	0	0	0	1	2.6
belted kingfisher	1	4.3	0	0	0	0	1	2.6
chipping sparrow	1	4.3	0	0	0	0	1	2.6
golden-crowned kinglet	1	4.3	0	0	0	0	1	2.6
mourning dove	1	4.3	0	0	0	0	1	2.6
red-eyed vireo	1	4.3	0	0	0	0	1	2.6
red-tailed hawk	1	4.3	0	0	0	0	1	2.6
ring-necked pheasant	1	4.3	0	0	0	0	1	2.6
sedge wren	1	4.3	0	0	0	0	1	2.6
sharp-shinned hawk	1	4.3	0	0	0	0	1	2.6
sora	1	4.3	0	0	0	0	1	2.6
yellow warbler	1	4.3	0	0	0	0	1	2.6
brown creeper	0	0	0	0	1	9.1	1	2.6
dickcissel	0	0	1	25.0	0	0	1	2.6
gadwall	0	0	0	0	1	9.1	1	2.6
grasshopper sparrow	0	0	1	25.0	0	0	1	2.6
marsh wren	0	0	0	0	1	9.1	1	2.6
short-eared owl	0	0	0	0	1	9.1	1	2.6
snow goose	0	0	0	0	1	9.1	1	2.6
turkey vulture	0	0	0	0	1	9.1	1	2.6
unidentified warbler	0	0	1	25.0	0	0	1	2.6
wood duck	0	0	0	0	1	9.1	1	2.6
Overall Birds	**23**	**100**	**4**	**100**	**11**	**100**	**38**	**100**

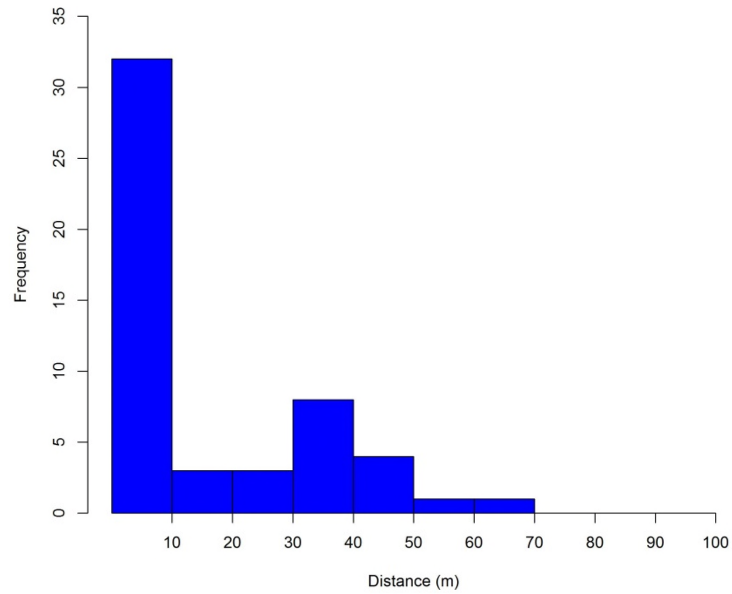

Figure C1. Distance from the turbine for bat carcasses included in the analysis for the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

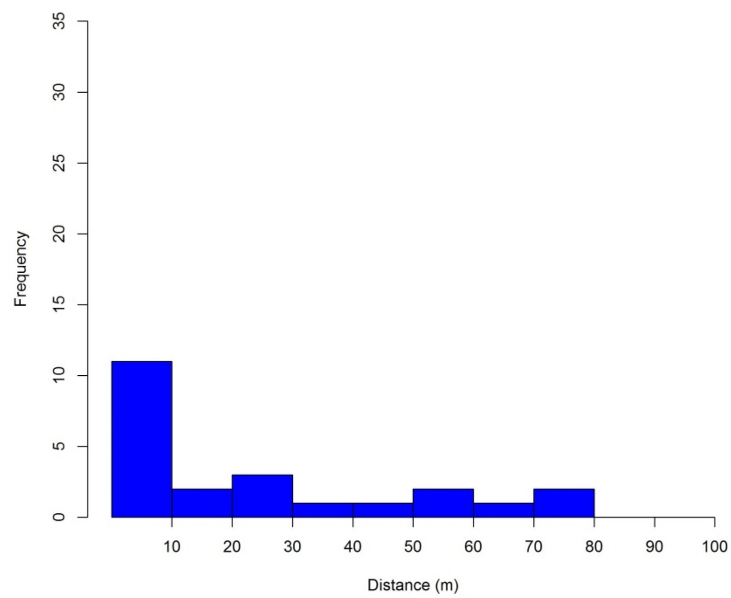

Figure C2. Distance from the turbine for bird carcasses included in the analysis for the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

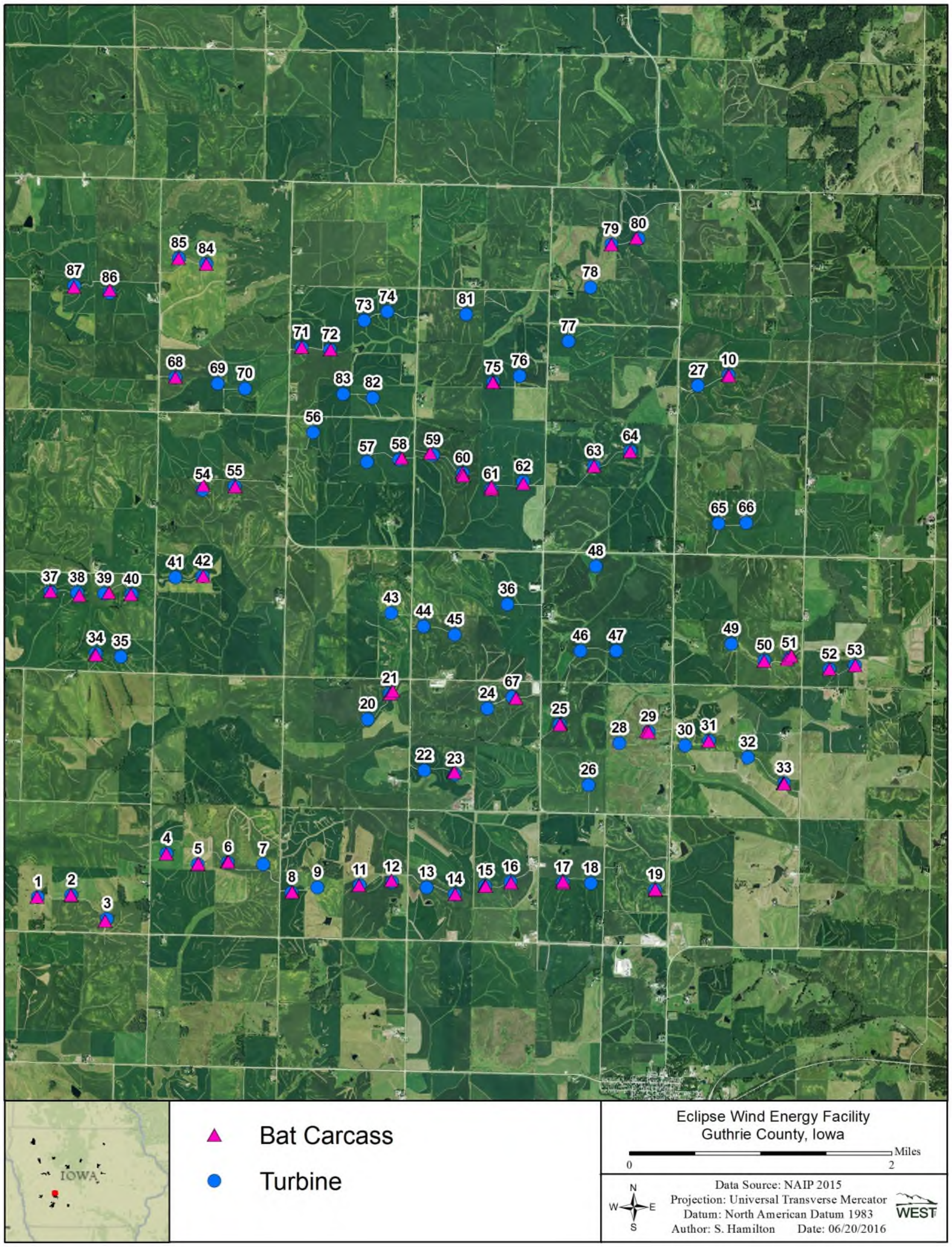

Figure C3. Location of all bat carcasses found during scheduled searches or incidentally at the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 1, 2014, to November 15, 2015.

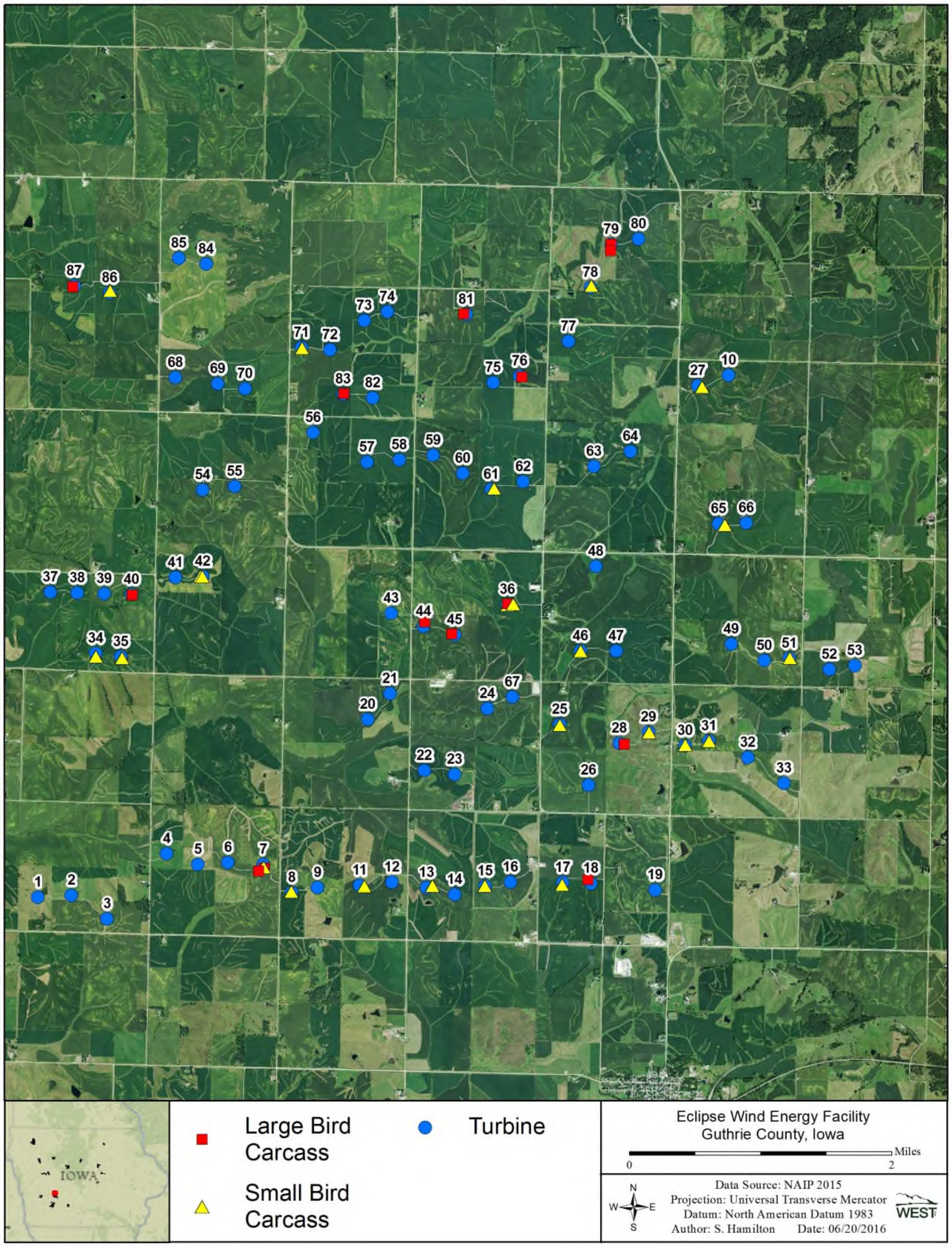

Figure C4. Location of all bird carcasses found during scheduled searches or incidentally at the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 3, 2014, to November 13, 2015.

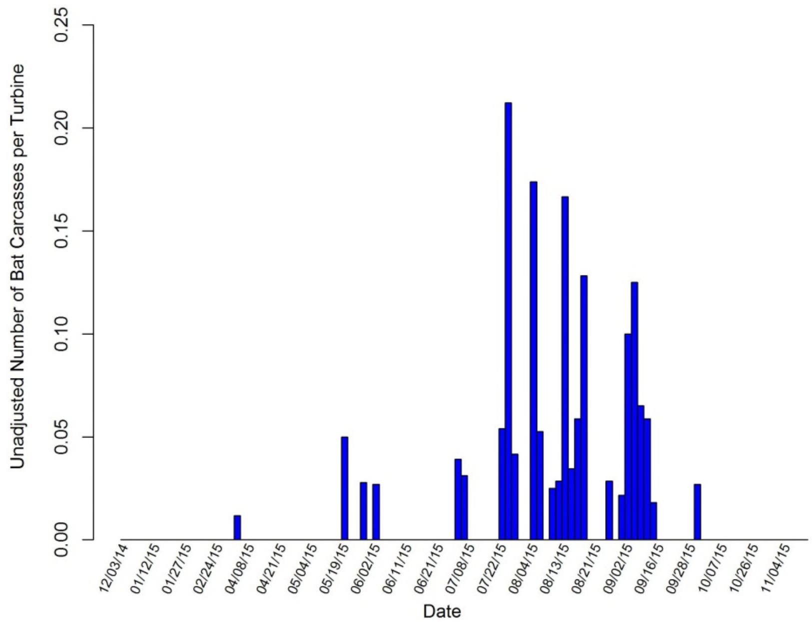

Figure C5. Timing of bat carcasses included in the analysis for the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 1, 2014, to November 15, 2015.

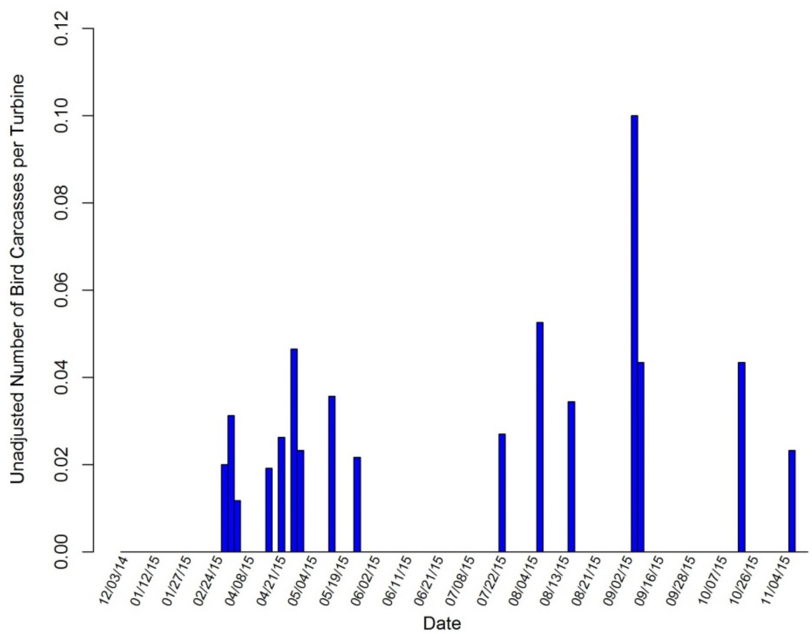

Figure C6. Timing of bird carcasses included in the analysis for the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Eclipse, 80% of bat carcasses were found within seven days of the estimated time of death (Table C2). Most large bird carcasses (75%) were estimated to have been found within one week of death, and 85% of small birds were estimated to have been found within one week of death (Table C2). Whether carcasses were included in analysis was based on the specific search interval for the turbine where the carcass was found. If the estimated time since death of the carcass was more recent than the previous search of the turbine the carcass was found, the carcass was included in the fatality estimate. If the estimated time since death was greater than the most recent search of the turbine the carcass was found, 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). Thirteen bat carcasses and four bird carcasses were excluded from the analysis for having been found outside of the search interval (Table C1). All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table C2. Estimated time of death for carcasses found at the Eclipse Wind Energy Facility from December 1, 2014, to November 15, 2015.

Type	Estimated Time of Death	Number of Carcasses	Percent Composition (%)
Bats	Last night	17	26.2
	2-3 days	21	32.3
	4-7 days	14	21.5
	7-14 days	8	12.3
	>2 week	1	1.5
	> Month	1	1.5
	Unknown	3	4.6
Large birds	Last night	0	0
	2-3 days	5	62.5
	4-7 days	1	12.5
	7-14 days	1	12.5
	>2 week	0	0
	> Month	0	0
	Unknown	1	12.5
Small birds	Last night	1	5.0
	2-3 days	8	40.0
	4-7 days	8	40.0
	7-14 days	0	0
	>2 week	2	10.0
	> Month	0	0
	Unknown	1	5.0

Searcher Efficiency

A total of 130 carcasses (50 bats, 39 large birds, and 41 small birds) were placed in the search area for searcher efficiency trials during the first year of monitoring. Logistic regression was used to model searcher efficiency. Model selection was based on corrected Akaike's Information Criterion, hereafter referred to as AICc. Seasonal estimates are only provided if season was included in the top model selected. The overall searcher efficiency rate for bats was 98.0%. The searcher efficiency rate for large birds was 94.9% and for small birds was 82.9% (Table C3).

Carcass Removal

A total of 136 carcasses (50 bats, 51 large birds, and 35 small birds) were placed in the project area for carcass removal trials during the first year of monitoring. The Huso method 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 various variables. The bat carcass removal rate in spring was higher (4.55 days) compared to summer and fall (1.79 days and 1.42 days, respectively; Table C3). Carcass removal rates for large birds varied throughout seasons, being highest in spring (12.72 days) and ranging from 9.64 days in winter to 3.97 in fall (Table C2). Small bird carcass removal rate was highest in spring (5.91 days) and varied from 4.48 days in winter to 1.85 days in fall (Table C3).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, raptors, small birds, and all birds, and 90% confidence intervals were calculated when at least five casualties were found (Table C3). The overall adjusted bat fatality rate was 10.01 bats/MW/year. For all birds combined, the adjusted fatality rate was 3.62 birds/MW/year, which consisted of 0.47 large birds/MW/year and 3.15 small birds/MW/year. The adjusted raptor fatality rate was 0.12 raptor/MW/year (Table C3). A complete list of casualties discovered at the Eclipse Wind Energy Facility is found in Table C4.

Table C3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 1, 2014, to November 15, 2015.

	Winter			Spring			Summer			Fall		
	Mean	90% Confidence Interval		Mean	90 % Confidence Interval		Mean	90% Confidence Interval		Mean	90% Confidence Interval	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
Search Area Adjustment												
Bats	10.64	-	-	10.64	-	-	10.64	-	-	10.64	-	-
Large birds	9.44	-	-	9.44	-	-	9.44	-	-	9.44	-	-
Small birds	14.19	-	-	14.19	-	-	14.19	-	-	14.19	-	-
Observer Detection Rate												
Bats	0.98	0.94	1.00	0.98	0.94	1.00	0.98	0.94	1.00	0.98	0.94	1.00
Large birds	0.95	0.90	1.00	0.95	0.90	1.00	0.95	0.90	1.00	0.95	0.90	1.00
Small birds	0.83	0.73	0.93	0.83	0.73	0.93	0.83	0.73	0.93	0.83	0.73	0.93
Mean Carcass Removal Time (days)												
Bats	-	-	-	4.55	3.27	6.34	1.79	1.41	2.31	1.42	1.08	1.92
Large birds	9.64	6.75	14.65	12.72	9.33	17.77	5.02	3.47	7.60	3.97	2.81	6.04
Small birds	4.48	3.17	6.28	5.91	4.23	7.96	2.33	1.76	3.14	1.85	1.39	2.46
Average Probability of Carcass Persistence Through Search Interval With Effective Interval Adjustment												
Bats	-	-	-	0.42	-	-	0.30	0.24	0.37	0.28	0.22	0.36
Large birds	-	-	-	0.89	-	-	-	-	-	0.61	-	-
Raptors	-	-	-	0.83	-	-	-	-	-	-	-	-
Small birds	0.41	-	-	0.72	-	-	0.42	-	-	0.38	0.30	0.46
Observed Carcass Counts Per Turbine												
Bats	-	-	-	0.01	-	-	0.08	0.03	0.014	0.51	0.40	0.62
Large birds	-	-	-	0.05	-	-	-	-	-	0.03	-	-
Raptors	-	-	-	0.02	-	-	-	-	-	-	-	-
Small birds	0.02	-	-	0.05	-	-	0.01	-	-	0.10	0.06	0.16
Average Probability that Carcass Available and Detected												
Bats	-	-	-	0.41	-	-	0.30	0.23	0.37	0.28	0.22	0.35
Large birds	-	-	-	0.84	-	-	-	-	-	0.58	-	-
Raptor	-	-	-	0.79	-	-	-	-	-	-	-	-
Small birds	0.34	-	-	0.59	-	-	0.35	-	-	0.31	0.24	0.40
Adjusted Fatality Rates (Fatalities/Turbine/Season)												
Bats	-	-	-	0.30	-	-	2.94	1.04	5.40	19.79	14.19	27.61
Large birds	-	-	-	0.52	-	-	-	-	-	0.56	-	-
Raptors	-	-	-	0.28	-	-	-	-	-	-	-	-
Small birds	0.95	-	-	1.11	-	-	0.46	-	-	4.72	2.43	8.03

Table C3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 1, 2014, to November 15, 2015.

Overall Adjusted Fatality Estimates (Fatalities/Turbine/Year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	23.03	16.75	31.54
Large birds	1.08	0.44	1.78
Diurnal raptors	0.28	-	-
Small birds	7.24	4.24	11.36
All birds	8.32	5.29	12.59
Overall Adjusted Fatality Estimates (Fatalities/MW/Year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	10.01	7.28	13.72
Large birds	0.47	0.19	0.77
Diurnal raptors	0.12	-	-
Small birds	3.15	1.84	4.94
All birds	3.62	2.30	5.47

Table C4. Complete carcass listing for the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
			Bats			
3/23/2015	big brown bat	51	36	carcass search	RandP	intact
5/5/2015	silver-haired bat	19	7	carcass search	RandP	dismembered
5/19/2015	silver-haired bat	61	31	carcass search	RandP	intact
5/19/2015	eastern red bat	67	42	carcass search	RandP	intact
5/28/2015	eastern red bat	25	2	carcass search	RandP	intact
6/2/2015	eastern red bat	85	3	carcass search	RandP	intact
6/30/2015	big brown bat	33	4	carcass search	RandP	scavenged
6/30/2015	eastern red bat	33	3	carcass search	RandP	intact
7/2/2015	big brown bat	21	43	carcass search	RandP	intact
7/22/2015	eastern red bat	10	9	carcass search	RandP	dismembered
7/22/2015	big brown bat	54	51	carcass search	RandP	scavenged
7/22/2015	hoary bat	71	2	carcass search	RandP	injured
7/29/2015	big brown bat	14	3	carcass search	RandP	scavenged
7/29/2015	big brown bat	17	5	carcass search	RandP	scavenged
7/29/2015	big brown bat	19	6	carcass search	RandP	intact
7/29/2015	hoary bat	23	36	carcass search	RandP	scavenged
7/29/2015	big brown bat	33	10	carcass search	RandP	scavenged
7/29/2015	eastern red bat	34	5	carcass search	RandP	intact
7/29/2015	big brown bat	51	30	carcass search	RandP	scavenged
7/30/2015	big brown bat	2	0	carcass search	RandP	scavenged
7/30/2015	big brown bat	10	7	carcass search	RandP	scavenged
7/30/2015	eastern red bat	61	6	carcass search	RandP	intact
7/30/2015	eastern red bat	84	2	carcass search	RandP	intact
8/3/2015	silver-haired bat	29	9	carcass search	RandP	dismembered
8/4/2015	eastern red bat	1	4	carcass search	RandP	intact
8/4/2015	eastern red bat	3	34	carcass search	RandP	intact
8/4/2015	big brown bat	5	2	carcass search	RandP	intact
8/4/2015	eastern red bat	6	6	carcass search	RandP	intact
8/4/2015	big brown bat	11	4	carcass search	RandP	scavenged
8/4/2015	hoary bat	15	4	carcass search	RandP	scavenged
8/4/2015	eastern red bat	16	2	carcass search	RandP	intact
8/4/2015	big brown bat	40	1	carcass search	RandP	intact
8/4/2015	big brown bat	42	7	carcass search	RandP	intact
8/5/2015	eastern red bat	60	6	carcass search	RandP	intact
8/5/2015	evening bat	79	5	carcass search	RandP	dismembered
8/11/2015	eastern red bat	23	38	carcass search	RandP	scavenged
8/11/2015	evening bat	29	5	carcass search	RandP	intact
8/11/2015	silver-haired bat	31	7	carcass search	RandP	intact
8/12/2015	big brown bat	53	4	carcass search	RandP	scavenged
8/13/2015	eastern red bat	58	37	carcass search	RandP	intact
8/13/2015	hoary bat	86	36	carcass search	RandP	scavenged
8/17/2015	hoary bat	12	28	carcass search	RandP	scavenged
8/18/2015	hoary bat	21	1	incidental find	NA	intact
8/19/2015	hoary bat	38	38	carcass search	RandP	intact
8/19/2015	eastern red bat	39	55	carcass search	RandP	intact
8/19/2015	hoary bat	62	15	carcass search	RandP	intact
8/19/2015	big brown bat	75	3	carcass search	RandP	scavenged
8/19/2015	eastern red bat	75	4	carcass search	RandP	intact
8/25/2015	eastern red bat	37	7	carcass search	RandP	scavenged
8/25/2015	hoary bat	64	13	carcass search	RandP	scavenged
8/26/2015	big brown bat	6	8	carcass search	RandP	intact
8/26/2015	eastern red bat	59	48	carcass search	RandP	intact
9/1/2015	hoary bat	34	16	carcass search	RandP	scavenged
9/2/2015	hoary bat	15	8	carcass search	RandP	scavenged
9/2/2015	hoary bat	68	1	carcass search	RandP	scavenged
9/2/2015	big brown bat	72	0	carcass search	RandP	scavenged
9/2/2015	hoary bat	80	31	carcass search	RandP	scavenged
9/2/2015	hoary bat	87	7	carcass search	RandP	scavenged
9/8/2015	hoary bat	2	6	carcass search	RandP	scavenged

Table C4. Complete carcass listing for the Eclipse Wind Energy Facility, Audubon and Guthrie counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
9/8/2015	hoary bat	8	22	carcass search	RandP	intact
9/8/2015	hoary bat	8	11	carcass search	RandP	intact
9/8/2015	hoary bat	17	25	carcass search	RandP	intact
9/8/2015	hoary bat	33	4	carcass search	RandP	scavenged
9/8/2015	hoary bat	52	6	carcass search	RandP	scavenged
9/9/2015	eastern red bat	5	19	carcass search	RandP	intact
9/9/2015	hoary bat	25	7	carcass search	RandP	scavenged
9/9/2015	hoary bat	55	2	carcass search	RandP	scavenged
9/9/2015	tricolored bat	60	1	carcass search	RandP	scavenged
9/9/2015	hoary bat	63	4	carcass search	RandP	scavenged
9/14/2015	hoary bat	19	1	carcass search	RandP	injured
9/15/2015	silver-haired bat	4	0	carcass search	RandP	dismembered
9/29/2015	eastern red bat	50	3	carcass search	RandP	intact
Birds						
12/3/2014	short-eared owl	7	102	incidental find	RandP	intact
3/4/2015	turkey vulture	44	55	carcass search	20m Trans	scavenged
3/9/2015	European starling	51	1	carcass search	RandP	dismembered
3/10/2015	European starling	42	28	carcass search	RandP	intact
3/23/2015	red-tailed hawk	18	55	carcass search	100m Scan	dismembered
4/8/2015	snow goose	45	30	carcass search	RandP	scavenged
4/8/2015	wood duck	76	15	carcass search	RandP	intact
4/10/2015	gadwall	79	82	carcass search	RandP	scavenged
4/13/2015	American tree sparrow	30	10	carcass search	RandP	dismembered
4/21/2015	American coot	28	60	carcass search	RandP	injured
4/21/2015	American coot	87	24	carcass search	100m Scan	scavenged
4/21/2015	American tree sparrow	13	69	carcass search	RandP	intact
4/27/2015	American coot	7	48	carcass search	RandP	dismembered
4/27/2015	American coot	36	0	carcass search	RandP	dismembered
4/28/2015	sharp-shinned hawk	81	33	carcass search	RandP	intact
5/12/2015	American redstart	36	69	carcass search	RandP	intact
5/12/2015	chipping sparrow	65	80	carcass search	RandP	intact
5/25/2015	yellow warbler	35	20	carcass search	RandP	scavenged
5/28/2015	unidentified warbler	46	2	carcass search	RandP	dismembered
7/8/2015	grasshopper sparrow	11	54	carcass search	RandP	intact
7/22/2015	mourning dove	83	2	carcass search	RandP	intact
7/29/2015	cliff swallow	34	34	carcass search	RandP	dismembered
8/3/2015	dickcissel	29	4	carcass search	RandP	injured
8/5/2015	cliff swallow	71	9	carcass search	RandP	intact
8/11/2015	cliff swallow	7	28	carcass search	RandP	intact
8/17/2015	cliff swallow	31	3	carcass search	RandP	intact
9/8/2015	belted kingfisher	40	6	carcass search	RandP	intact
9/8/2015	sora	15	5	carcass search	RandP	intact
9/8/2015	Acadian flycatcher	42	3	carcass search	RandP	intact
9/8/2015	unidentified empidonax	86	20	carcass search	RandP	dismembered
9/9/2015	ring-necked pheasant	79	1	carcass search	RandP	feather spot
9/9/2015	unidentified empidonax	61	41	carcass search	RandP	scavenged
9/9/2015	red-eyed vireo	78	26	carcass search	RandP	scavenged
10/6/2015	brown creeper	8	22	carcass search	RandP	scavenged
10/13/2015	marsh wren	17	1	carcass search	RandP	dismembered
10/20/2015	sedge wren	25	6	carcass search	RandP	intact
10/20/2015	European starling	36	1	carcass search	RandP	scavenged
11/10/2015	golden-crowned kinglet	27	47	carcass search	RandP	intact

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix D: Summary of Fatality Monitoring Surveys Conducted at the Lundgren Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Lundgren Wind Energy Facility consists of 107 SWT-2.3-108 2.346-megawatt turbines for a nameplate capacity of 251.0 MW. The facility is located across approximately 33,189 acres (52 square miles) in Webster County in north-central Iowa. The facility is located approximately four miles south of Fort Dodge, Iowa. The facility is located in the Des Moines Lobe Level 4 Ecoregion. According to the National Land Cover Database, the landscape predominantly consists of cropland (92.2%). Approximately 6.3% of the project area is developed. Grassland, pasture/hay, deciduous forest, emergent wetlands, woody wetlands, and barren land each account for less than 1% of land cover of the Lundgren project area.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 4,982 road and pad searches were conducted at Lundgren during 41 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

Two hundred and ninety-seven bat carcasses and 32 bird carcasses were found on standardized road and pad search areas or incidentally at Lundgren (Table D1). Of the seven bat species found, eastern red (122 carcasses) and hoary bats (95 carcasses) were most commonly found. Twenty-six little brown bats were the only *Myotis* bats found. No federal or state listed bat species were found. Of the 23 unique bird species found on standardized road and pad searches or incidentally, ruby-crowned kinglet (four carcasses) and red-eyed vireo (three) were the species of bird most commonly found. Two carcasses each of killdeer, unidentified flycatcher, house sparrow, and American robin were found, and single carcasses were found for each of the remaining 17 species. No federal listed species were found; however, long-eared owl is listed as a threatened species in Iowa (Iowa Department of Natural Resources; Table D1). Given the study design, most bat and bird carcasses included in the analysis were found within 10 meters of the turbines (Figures D1 and D2). Beyond 10 m from the turbine, the number of bat carcasses decreased, and no bat carcasses were found beyond 90 meters from the turbine (Figure D1). Bird carcasses were found out to 100 meters; however, there was no consistent pattern in distance from turbine (Figure D2). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at the Lundgren facility (Figures D3 and D4). Most bat fatalities were found from mid-July to mid-September; the relatively high number of bats/turbine occurring in mid-June was the result of one bat found during a single search on that day, rather than an increase in mortality (Figure D5). Bird mortality occurred sporadically throughout the study period (Figure D6).

Table D1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

Species	carcasses Included in Analysis		Carcasses Found Outside of Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
Eastern red bat	73	36.9	19	51.4	30	48.4	122	41.1
Hoary bat	68	34.3	13	35.1	14	22.6	95	32.0
Little brown bat	19	9.6	3	8.1	4	6.5	26	8.8
Silver-haired bat	17	8.6	1	2.7	7	11.3	25	8.4
Big brown bat	11	5.6	1	2.7	7	11.3	19	6.4
Tricolored bat	7	3.5	0	0	0	0	7	2.4
Evening bat	3	1.5	0	0	0	0	3	1.0
Overall Bats	**198**	**100**	**37**	**100**	**62**	**100**	**297**	**100**
Birds								
Ruby-crowned kinglet	4	22.2	0	0	0	0	4	12.5
Red-eyed vireo	0	0	0	0	3	25.0	3	9.4
Cliff swallow	2	11.1	0	0	0	0	2	6.3
Killdeer	1	5.6	1	50.0	0	0	2	6.3
Unidentified flycatcher	0	0	1	50.0	1	8.3	2	6.3
House sparrow	0	0	0	0	2	16.7	2	6.3
American robin	1	5.6	0	0	0	0	1	3.1
Barn swallow	1	5.6	0	0	0	0	1	3.1
Chipping sparrow	1	5.6	0	0	0	0	1	3.1
Common yellowthroat	1	5.6	0	0	0	0	1	3.1
Dark-eyed junco	1	5.6	0	0	0	0	1	3.1
Lincoln's sparrow	1	5.6	0	0	0	0	1	3.1
Northern rough-winged swallow	1	5.6	0	0	0	0	1	3.1
Savannah sparrow	1	5.6	0	0	0	0	1	3.1
Sedge wren	1	5.6	0	0	0	0	1	3.1
Turkey vulture	1	5.6	0	0	0	0	1	3.1
Yellow warbler	1	5.6	0	0	0	0	1	3.1
Domestic chicken	0	0	0	0	1	8.3	1	3.1
European starling	0	0	0	0	1	8.3	1	3.1
Long-eared owl	0	0	0	0	1	8.3	1	3.1
Northern flicker	0	0	0	0	1	8.3	1	3.1
Ruby-throated hummingbird	0	0	0	0	1	8.3	1	3.1
Swamp sparrow	0	0	0	0	1	8.3	1	3.1
Overall Birds	**18**	**100**	**2**	**100**	**12**	**100**	**32**	**100**

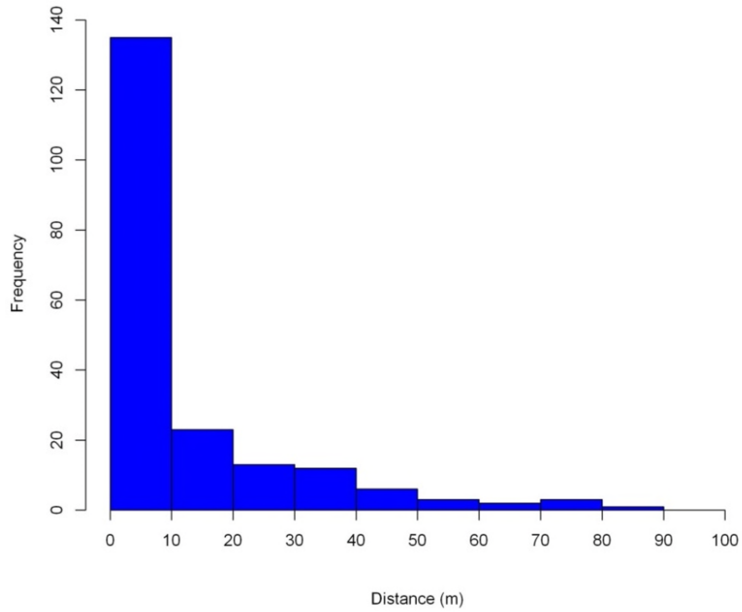

Figure D1. Distance from the turbine for bat carcasses included in the analysis for the Lundgren Wind Energy Facility, Webster County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

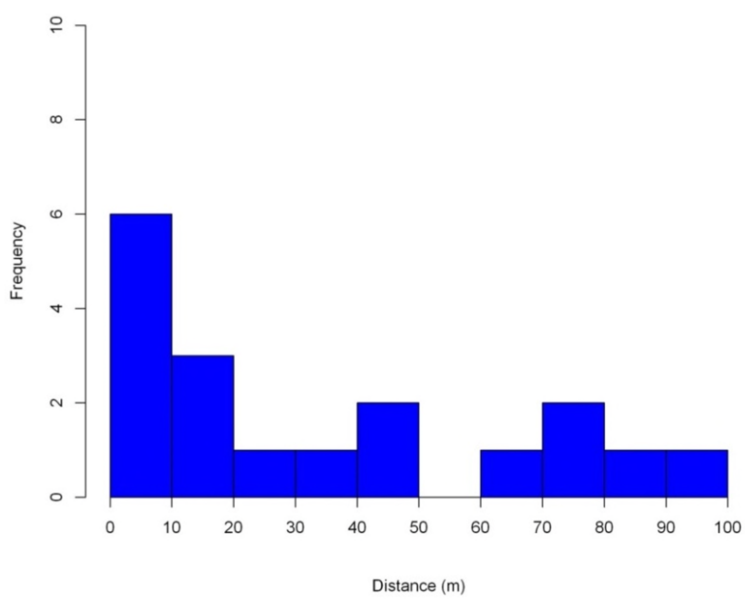

Figure D2. Distance from the turbine for bird carcasses included in the analysis for the Lundgren Wind Energy Facility, Webster County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

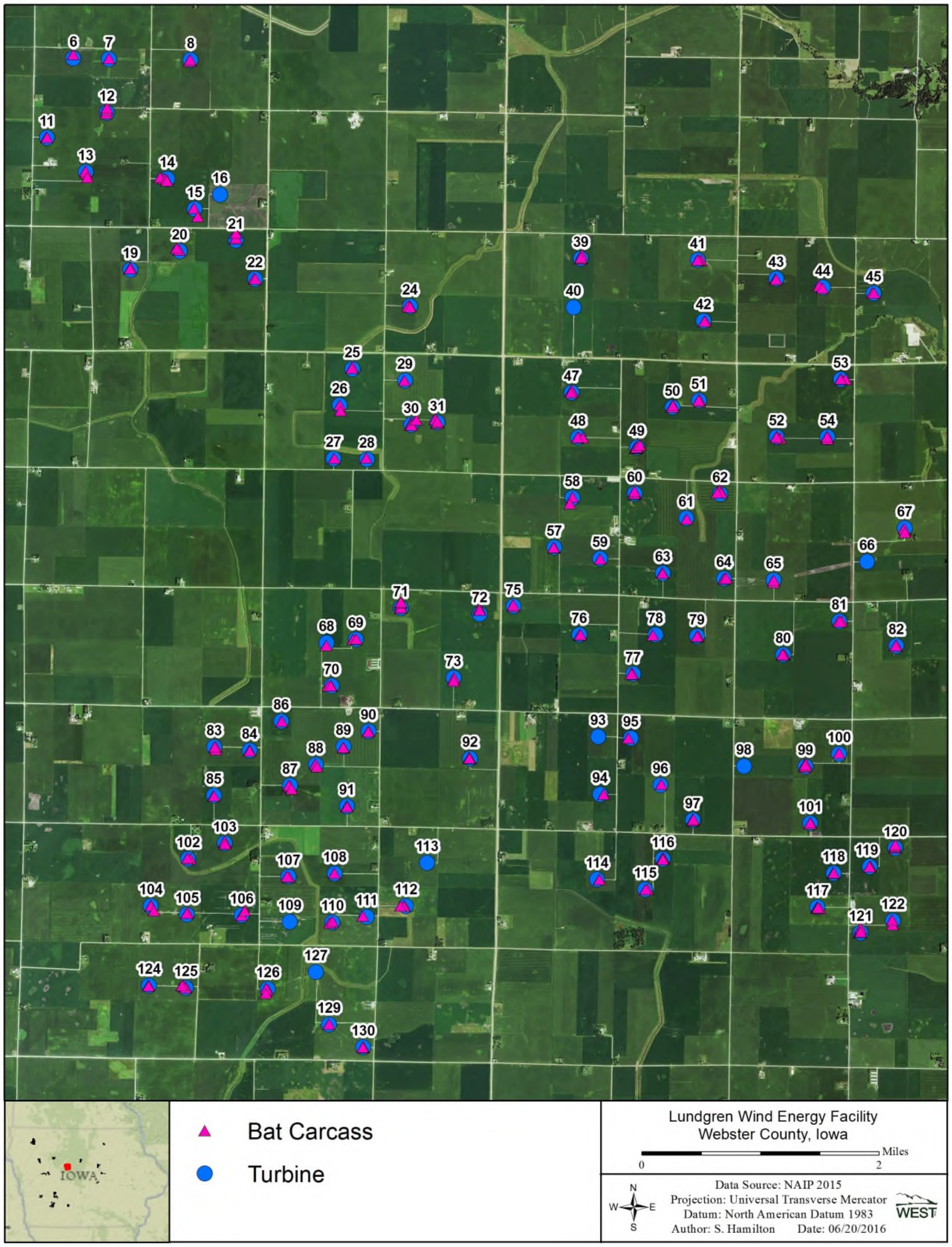

Figure D3. Location of all bat carcasses found during scheduled searches or incidentally at the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

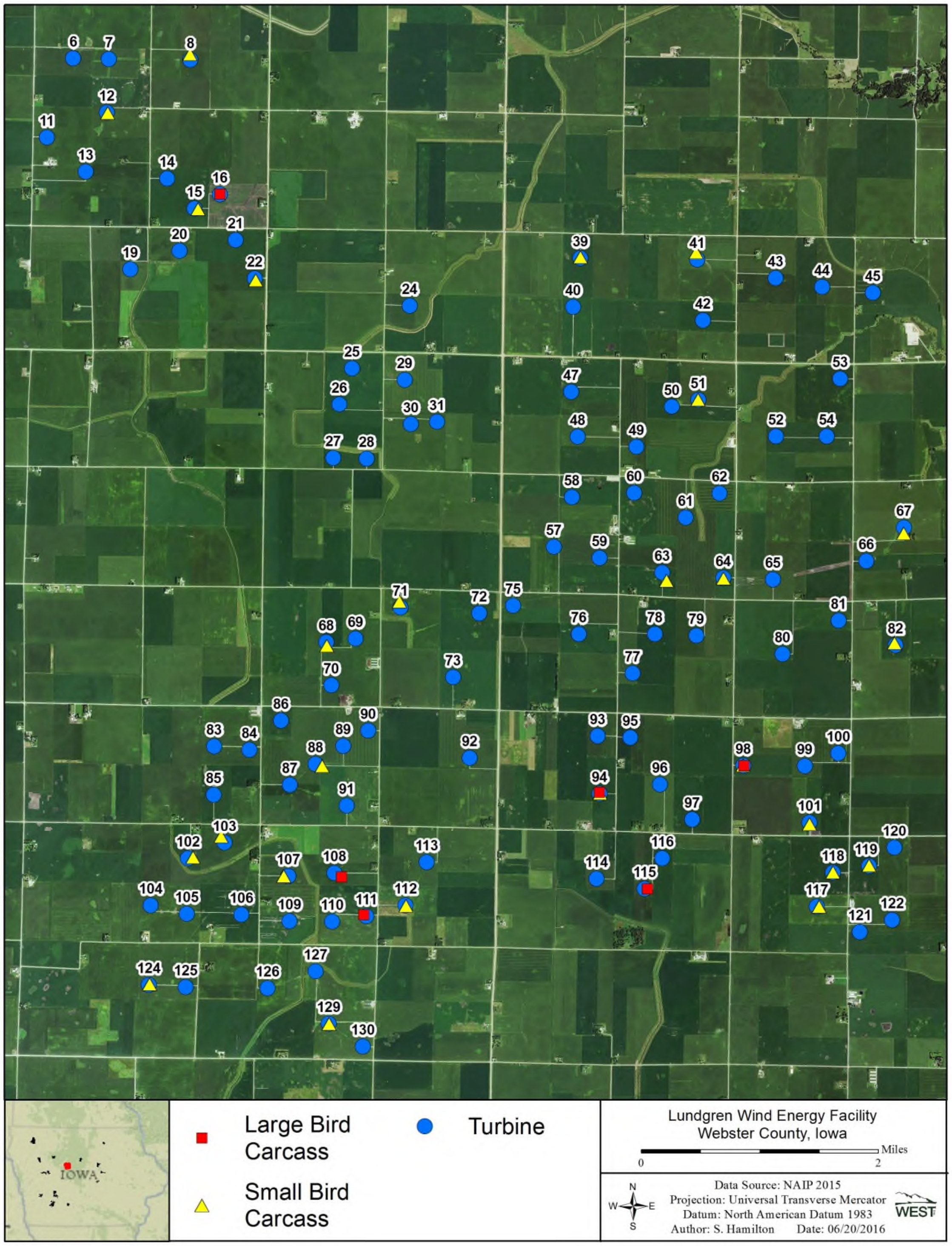

Figure D4. Location of all bird carcasses found during scheduled searches or incidentally at the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

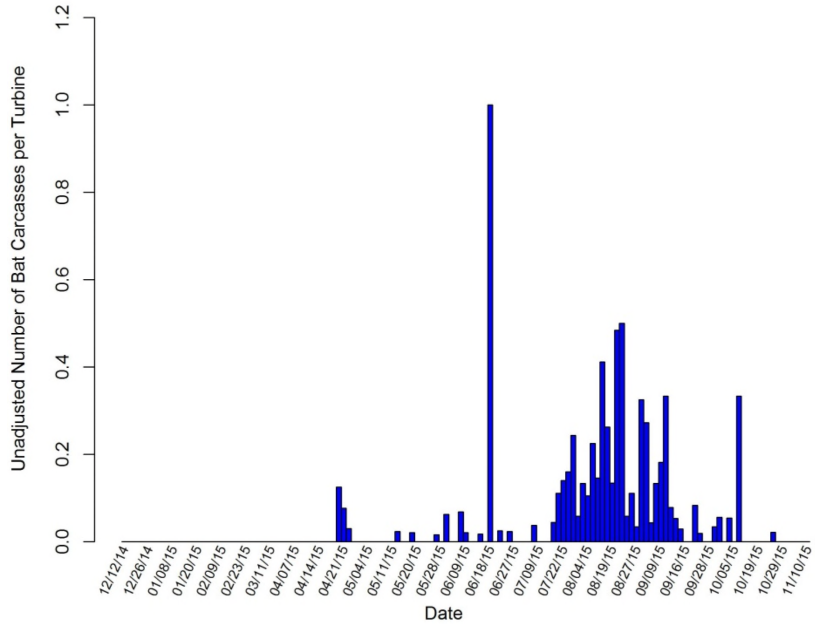

Figure D5. Timing of bat carcasses included in the analysis for the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

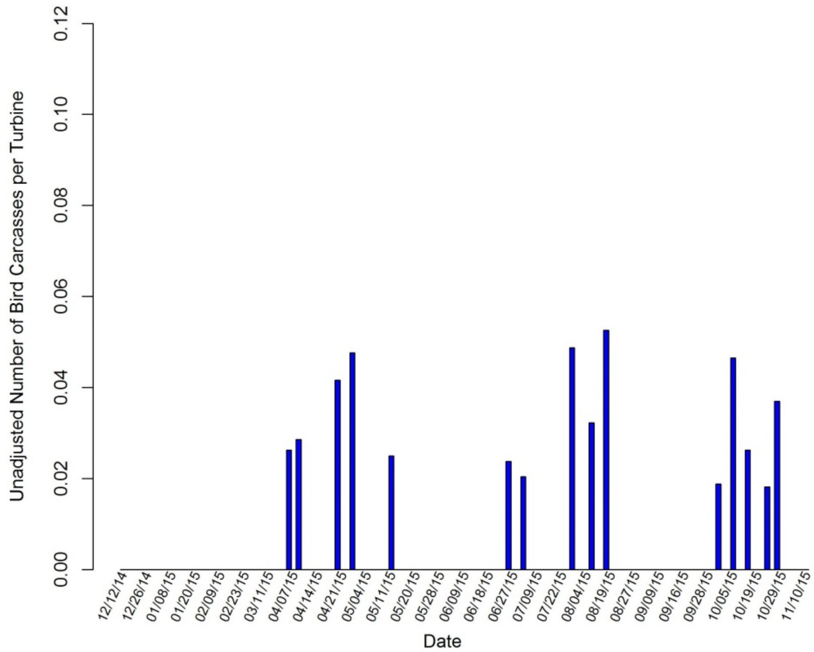

Figure D6. Timing of bird carcasses included in the analysis for the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Lundgren, the majority of bat carcasses (83.5%) were found within seven days of the estimated time of death (Table D2). Most large bird carcasses (80%) were estimated to have been found within two weeks of death, and approximate 94% of small birds were estimated to have been found within one week of death (Table D2). Whether carcasses were included in analysis was based on the specific search interval for the turbine where the carcass was found. If there were no searches occurring since the estimated time of death, the carcass was included in the fatality estimate. If a search occurred since the estimated time of death, it was assumed that the carcass was missed on the first opportunity to have been found, and was therefore excluded from the fatality estimate. Thirty-seven bat carcasses and two bird carcasses were excluded from the analysis for having been found outside of the search interval. All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table D2. Estimated time of death for carcasses found at the Lundgren Wind Energy Facility from December 1, 2014, to November 15, 2015.

Type	Estimated Time of Death	Number of fatalities	Percent composition (%)
Bats	Last night	51	21.1
	2-3 days	83	34.3
	4-7 days	68	28.1
	7-14 days	37	15.3
	>2 week	2	0.8
	> Month	0	0
	Unknown	1	0.4
Large birds	Last night	0	0
	2-3 days	1	20.0
	4-7 days	1	20.0
	7-14 days	2	40.0
	>2 week	0	0
	> Month	1	20.0
	Unknown	0	0
Small birds	Last night	2	11.1
	2-3 days	6	33.3
	4-7 days	9	50.0
	7-14 days	1	5.5
	>2 week	0	0
	> Month	0	0
	Unknown	0	0

Searcher Efficiency

A total of 140 carcasses (55 bats, 40 large birds, and 45 small birds) were placed in the search area for searcher efficiency trials throughout the first year of monitoring. Logistic regression was used to model searcher efficiency. Model selection was based on corrected Akaike's Information Criterion, hereafter referred to as AICc. Seasonal estimates are only provided if season was included in the top model selected. The overall searcher efficiency rate for bats was 92.7%. The searcher efficiency rate for large birds was 100%, and 88.9% for small birds (D2).

Carcass Removal

A total of 135 carcasses (50 bats, 50 large birds, and 35 small birds) were placed in the project area throughout the duration of the first year of monitoring. The Huso method 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 various variables. The model chosen, which did not include season, was within two AIC units of the best model and most parsimonious. The overall mean carcass removal time for bats was 2.50 days. For large and small, birds the overall mean carcass removal time was 7.20 days and 3.16 days respectively (Table D2).

Adjusted Fatality Estimates

Fatality estimates and were calculated for bats, large birds, small birds, raptors, and all birds, and 90% confidence intervals were calculated when at least 5 casualties were found (Table D3). The overall adjusted bat fatality rate was 28.74 bats/MW/year (Table D2). For all birds combined, the adjusted fatality rate was 2.91 birds/MW/year. The adjusted small bird fatality rate was 2.79 birds/MW/year and the adjusted large bird fatality rate was 0.13 birds/MW/year (Table D3). A complete list of casualties discovered at the Lundgren Wind Energy Facility is found in Table D4.

Table D3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

	Overall		
	Mean	90% Confidence Interval	
		Lower	Upper
Search Area Adjustment			
Bats	15.09	-	-
Large birds	12.28	-	-
Small birds	19.09	-	-
Observer Detection Rate			
Bats	0.93	0.87	0.98
Large birds	1.00	1.00	1.00
Small birds	0.89	0.80	0.96
Mean Carcass Removal Time (days)			
Bats	2.50	1.85	3.32
Large birds	7.29	5.55	9.57
Small birds	3.16	2.16	4.52
Average Probability of Carcass persistence Through Search Interval With Effective Interval Adjustments			
Bats	0.46	0.38	0.53
Large birds	0.78	-	-
Small birds	0.51	0.41	0.61
Observed Carcass Counts Per Turbine			
Bats	1.85	1.64	2.08
Large birds	0.02	-	-
Small birds	0.15	0.09	0.21
Average Probability that Carcass Available and Detected			
Bats	0.42	0.35	0.50
Large birds	0.78	-	-
Small birds	0.45	0.35	0.55
Adjusted Fatality Estimates (Fatalities/Turbine/Year)			
Bats	67.42	55.02	86.55
Large birds	0.29	-	-
Small birds	6.54	4.03	9.76
Overall Adjusted Fatality Estimates (Fatalities/Turbine/Year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	67.42	55.02	86.55
Large birds	0.29	-	-
Small birds	6.54	4.03	9.76
All birds	6.84	4.35	10.10
Overall Adjusted Fatality Estimates (Fatalities/MW/Year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	28.74	23.45	36.89
Large birds	0.13	-	-
Small birds	2.79	1.72	4.16
All birds	2.91	1.85	4.31

Appendix D4. Complete carcass listing for the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
			Bats			
4/14/2015	silver-haired bat	21	23	carcass search	RandP	intact
4/14/2015	big brown bat	83	37	carcass search	20m Trans	dismembered
4/20/2015	silver-haired bat	90	7	carcass search	RandP	intact
4/20/2015	silver-haired bat	103	16	carcass search	RandP	intact
4/20/2015	silver-haired bat	111	58	carcass search	RandP	scavenged
4/21/2015	silver-haired bat	28	9	carcass search	RandP	scavenged
4/21/2015	silver-haired bat	31	7	carcass search	RandP	intact
4/21/2015	silver-haired bat	39	2	carcass search	RandP	injured
4/21/2015	silver-haired bat	86	6	carcass search	RandP	intact
4/22/2015	silver-haired bat	82	13	carcass search	RandP	intact
5/11/2015	silver-haired bat	103	23	carcass search	RandP	intact
5/13/2015	little brown bat	63	6	carcass search	RandP	intact
5/19/2015	evening bat	120	6	carcass search	RandP	NA
5/19/2015	silver-haired bat	120	24	carcass search	RandP	dismembered
5/27/2015	little brown bat	49	12	carcass search	RandP	intact
5/27/2015	silver-haired bat	82	8	carcass search	RandP	intact
6/2/2015	eastern red bat	84	7	carcass search	RandP	NA
6/2/2015	evening bat	104	7	carcass search	RandP	intact
6/8/2015	little brown bat	83	4	incidental find	RandP	intact
6/8/2015	hoary bat	104	8	carcass search	RandP	intact
6/9/2015	hoary bat	54	5	carcass search	RandP	intact
6/16/2015	little brown bat	48	4	carcass search	RandP	intact
6/18/2015	little brown bat	8	7	incidental find	NA	intact
6/23/2015	big brown bat	124	6	carcass search	RandP	scavenged
6/26/2015	little brown bat	81	6	carcass search	RandP	intact
6/30/2015	eastern red bat	80	9	carcass search	RandP	intact
7/8/2015	eastern red bat	58	10	carcass search	RandP	intact
7/8/2015	hoary bat	88	10	carcass search	RandP	intact
7/8/2015	eastern red bat	130	3	carcass search	RandP	intact
7/9/2015	silver-haired bat	44	0	carcass search	RandP	intact
7/9/2015	eastern red bat	97	9	carcass search	RandP	intact
7/16/2015	little brown bat	65	30	carcass search	RandP	intact
7/16/2015	eastern red bat	80	6	carcass search	RandP	intact
7/17/2015	hoary bat	115	33	carcass search	RandP	intact
7/22/2015	eastern red bat	27	8	carcass search	RandP	intact
7/22/2015	eastern red bat	75	0	carcass search	RandP	intact
7/22/2015	hoary bat	80	21	carcass search	RandP	intact
7/22/2015	eastern red bat	92	6	carcass search	RandP	intact
7/22/2015	eastern red bat	97	10	incidental find	NA	intact
7/22/2015	hoary bat	97	0	carcass search	RandP	injured
7/22/2015	eastern red bat	99	12	carcass search	RandP	NA
7/22/2015	big brown bat	103	10	incidental find	NA	intact
7/22/2015	eastern red bat	104	3	incidental find	NA	NA
7/22/2015	hoary bat	107	7	carcass search	RandP	intact
7/22/2015	big brown bat	116	12	carcass search	RandP	intact
7/22/2015	eastern red bat	116	12	carcass search	RandP	intact
7/22/2015	eastern red bat	116	11	carcass search	RandP	intact
7/22/2015	hoary bat	117	0	carcass search	RandP	intact
7/22/2015	eastern red bat	121	60	carcass search	RandP	intact
7/22/2015	hoary bat	121	45	carcass search	RandP	intact
7/22/2015	little brown bat	122	51	carcass search	RandP	intact
7/22/2015	eastern red bat	130	10	carcass search	RandP	intact
7/23/2015	eastern red bat	11	5	carcass search	RandP	intact
7/23/2015	hoary bat	12	11	carcass search	RandP	intact
7/23/2015	eastern red bat	15	6	carcass search	RandP	intact
7/23/2015	eastern red bat	20	18	carcass search	RandP	intact
7/23/2015	eastern red bat	24	7	carcass search	RandP	intact
7/23/2015	eastern red bat	24	4	carcass search	RandP	intact

Appendix D4. Complete carcass listing for the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
7/23/2015	hoary bat	24	0	carcass search	RandP	intact
7/23/2015	hoary bat	48	60	carcass search	RandP	intact
7/23/2015	eastern red bat	49	8	carcass search	RandP	intact
7/23/2015	eastern red bat	60	6	carcass search	RandP	intact
7/23/2015	eastern red bat	62	30	carcass search	RandP	intact
7/23/2015	hoary bat	76	25	carcass search	RandP	intact
7/29/2015	hoary bat	13	19	incidental find	NA	intact
7/29/2015	hoary bat	13	8	carcass search	RandP	intact
7/29/2015	hoary bat	70	47	carcass search	RandP	intact
7/29/2015	eastern red bat	71	69	carcass search	RandP	dismembered
7/29/2015	eastern red bat	73	5	carcass search	RandP	intact
7/29/2015	eastern red bat	83	19	carcass search	RandP	intact
7/29/2015	hoary bat	90	6	carcass search	RandP	intact
7/29/2015	eastern red bat	102	8	carcass search	RandP	intact
7/29/2015	eastern red bat	102	31	carcass search	RandP	intact
7/29/2015	eastern red bat	104	76	carcass search	RandP	intact
7/29/2015	hoary bat	105	29	carcass search	RandP	intact
7/29/2015	hoary bat	112	17	carcass search	RandP	intact
7/29/2015	hoary bat	129	1	carcass search	RandP	intact
7/29/2015	eastern red bat	130	6	carcass search	RandP	intact
7/30/2015	eastern red bat	14	44	carcass search	RandP	intact
7/30/2015	little brown bat	43	1	carcass search	RandP	intact
7/30/2015	eastern red bat	50	8	carcass search	RandP	intact
7/30/2015	hoary bat	50	27	carcass search	RandP	intact
7/30/2015	hoary bat	52	51	carcass search	RandP	intact
7/30/2015	hoary bat	52	3	carcass search	RandP	intact
7/31/2015	eastern red bat	48	5	carcass search	RandP	intact
7/31/2015	eastern red bat	49	7	carcass search	RandP	intact
7/31/2015	hoary bat	49	8	carcass search	RandP	intact
7/31/2015	eastern red bat	62	61	carcass search	RandP	intact
7/31/2015	eastern red bat	62	35	carcass search	RandP	intact
7/31/2015	hoary bat	80	3	carcass search	RandP	intact
8/4/2015	little brown bat	12	56	carcass search	RandP	intact
8/4/2015	eastern red bat	22	8	carcass search	RandP	intact
8/4/2015	hoary bat	31	1	carcass search	RandP	injured
8/4/2015	big brown bat	43	8	carcass search	RandP	intact
8/4/2015	eastern red bat	48	12	carcass search	RandP	intact
8/4/2015	hoary bat	50	5	carcass search	RandP	intact
8/4/2015	hoary bat	53	3	carcass search	RandP	scavenged
8/4/2015	hoary bat	60	6	carcass search	RandP	intact
8/4/2015	hoary bat	69	34	carcass search	RandP	intact
8/4/2015	eastern red bat	72	75	carcass search	RandP	intact
8/4/2015	little brown bat	80	6	carcass search	RandP	scavenged
8/4/2015	big brown bat	85	1	carcass search	RandP	intact
8/4/2015	eastern red bat	106	44	carcass search	RandP	intact
8/4/2015	little brown bat	125	7	carcass search	RandP	intact
8/6/2015	little brown bat	91	5	carcass search	RandP	intact
8/6/2015	eastern red bat	92	7	carcass search	RandP	scavenged
8/6/2015	big brown bat	96	12	carcass search	RandP	scavenged
8/6/2015	eastern red bat	97	1	carcass search	RandP	scavenged
8/6/2015	eastern red bat	99	8	carcass search	RandP	scavenged
8/6/2015	hoary bat	101	7	incidental find	NA	scavenged
8/6/2015	eastern red bat	116	6	carcass search	RandP	scavenged
8/6/2015	hoary bat	117	11	carcass search	RandP	intact
8/6/2015	eastern red bat	118	5	carcass search	RandP	scavenged
8/6/2015	little brown bat	118	7	incidental find	NA	scavenged
8/10/2015	hoary bat	24	3	carcass search	RandP	scavenged
8/10/2015	hoary bat	30	24	carcass search	RandP	scavenged
8/10/2015	hoary bat	43	7	incidental find	NA	intact
8/10/2015	hoary bat	70	1	carcass search	RandP	injured

Appendix D4. Complete carcass listing for the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
8/10/2015	hoary bat	87	16	carcass search	RandP	dismembered
8/10/2015	hoary bat	92	7	carcass search	RandP	intact
8/10/2015	hoary bat	106	1	carcass search	RandP	scavenged
8/10/2015	eastern red bat	124	2	carcass search	RandP	scavenged
8/12/2015	eastern red bat	19	32	carcass search	RandP	intact
8/12/2015	eastern red bat	21	34	carcass search	RandP	scavenged
8/12/2015	hoary bat	22	8	carcass search	RandP	scavenged
8/12/2015	big brown bat	25	5	carcass search	RandP	scavenged
8/12/2015	silver-haired bat	47	7	carcass search	RandP	NA
8/12/2015	big brown bat	60	4	incidental find	NA	intact
8/12/2015	little brown bat	60	1	incidental find	NA	scavenged
8/12/2015	little brown bat	64	1	incidental find	NA	intact
8/12/2015	big brown bat	78	38	carcass search	RandP	intact
8/13/2015	big brown bat	8	0	carcass search	RandP	dismembered
8/13/2015	hoary bat	8	8	carcass search	RandP	scavenged
8/13/2015	hoary bat	14	40	carcass search	RandP	scavenged
8/13/2015	hoary bat	14	14	carcass search	RandP	scavenged
8/13/2015	hoary bat	54	20	carcass search	RandP	intact
8/13/2015	little brown bat	65	6	incidental find	NA	intact
8/13/2015	eastern red bat	67	8	carcass search	RandP	intact
8/13/2015	hoary bat	80	10	carcass search	RandP	scavenged
8/13/2015	little brown bat	97	6	carcass search	RandP	dismembered
8/13/2015	eastern red bat	99	45	carcass search	RandP	scavenged
8/13/2015	hoary bat	117	35	carcass search	RandP	intact
8/13/2015	hoary bat	117	5	carcass search	RandP	intact
8/13/2015	hoary bat	119	11	carcass search	RandP	scavenged
8/13/2015	eastern red bat	120	28	carcass search	RandP	scavenged
8/13/2015	hoary bat	121	7	carcass search	RandP	intact
8/13/2015	hoary bat	122	11	carcass search	RandP	intact
8/17/2015	eastern red bat	39	10	incidental find	NA	intact
8/17/2015	hoary bat	39	6	incidental find	NA	intact
8/17/2015	eastern red bat	105	17	incidental find	NA	intact
8/19/2015	hoary bat	8	6	carcass search	RandP	intact
8/19/2015	hoary bat	24	30	carcass search	RandP	scavenged
8/19/2015	hoary bat	30	8	carcass search	RandP	intact
8/19/2015	hoary bat	49	3	carcass search	RandP	intact
8/19/2015	hoary bat	71	8	carcass search	RandP	dismembered
8/19/2015	eastern red bat	75	13	carcass search	RandP	scavenged
8/19/2015	eastern red bat	87	6	carcass search	RandP	intact
8/19/2015	silver-haired bat	89	16	carcass search	RandP	intact
8/19/2015	eastern red bat	125	36	carcass search	RandP	intact
8/19/2015	eastern red bat	130	7	carcass search	RandP	intact
8/20/2015	eastern red bat	41	45	carcass search	RandP	intact
8/20/2015	eastern red bat	41	17	carcass search	RandP	intact
8/20/2015	hoary bat	41	5	carcass search	RandP	scavenged
8/20/2015	little brown bat	41	6	carcass search	RandP	scavenged
8/20/2015	eastern red bat	42	26	carcass search	RandP	intact
8/20/2015	hoary bat	42	10	carcass search	RandP	scavenged
8/20/2015	eastern red bat	44	7	carcass search	RandP	intact
8/20/2015	hoary bat	45	1	carcass search	RandP	scavenged
8/20/2015	eastern red bat	47	29	carcass search	RandP	scavenged
8/20/2015	eastern red bat	50	26	carcass search	RandP	intact
8/20/2015	eastern red bat	51	7	carcass search	RandP	scavenged
8/20/2015	tricolored bat	52	7	carcass search	RandP	intact
8/20/2015	hoary bat	53	61	carcass search	RandP	intact
8/20/2015	tricolored bat	53	6	carcass search	RandP	intact
8/20/2015	tricolored bat	60	25	carcass search	RandP	scavenged
8/20/2015	hoary bat	61	9	carcass search	RandP	intact
8/20/2015	hoary bat	64	12	carcass search	RandP	intact
8/20/2015	hoary bat	64	6	carcass search	RandP	intact

Appendix D4. Complete carcass listing for the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
8/20/2015	hoary bat	81	35	carcass search	RandP	scavenged
8/21/2015	hoary bat	77	19	carcass search	RandP	dismembered
8/21/2015	tricolored bat	77	7	carcass search	RandP	scavenged
8/21/2015	hoary bat	94	46	carcass search	RandP	scavenged
8/21/2015	hoary bat	95	35	carcass search	RandP	intact
8/21/2015	hoary bat	99	23	carcass search	RandP	scavenged
8/21/2015	big brown bat	100	3	carcass search	RandP	intact
8/21/2015	hoary bat	101	7	carcass search	RandP	scavenged
8/21/2015	little brown bat	101	4	carcass search	RandP	intact
8/21/2015	eastern red bat	114	33	incidental find	NA	intact
8/21/2015	eastern red bat	118	3	carcass search	RandP	intact
8/21/2015	big brown bat	119	1	carcass search	RandP	scavenged
8/21/2015	tricolored bat	120	47	carcass search	RandP	dismembered
8/21/2015	hoary bat	121	2	carcass search	RandP	intact
8/24/2015	eastern red bat	6	52	carcass search	RandP	scavenged
8/24/2015	hoary bat	19	12	carcass search	RandP	scavenged
8/24/2015	eastern red bat	21	102	carcass search	RandP	scavenged
8/24/2015	little brown bat	31	8	carcass search	RandP	scavenged
8/24/2015	eastern red bat	71	45	carcass search	RandP	intact
8/24/2015	hoary bat	84	7	carcass search	RandP	intact
8/24/2015	eastern red bat	88	29	carcass search	RandP	scavenged
8/24/2015	hoary bat	92	1	carcass search	RandP	intact
8/26/2015	eastern red bat	12	29	carcass search	RandP	intact
8/26/2015	eastern red bat	39	3	incidental find	NA	injured
8/26/2015	little brown bat	51	10	carcass search	RandP	intact
8/26/2015	hoary bat	54	6	carcass search	RandP	scavenged
8/26/2015	hoary bat	116	1	incidental find	NA	scavenged
8/27/2015	hoary bat	57	8	carcass search	RandP	scavenged
8/31/2015	big brown bat	30	6	carcass search	RandP	intact
8/31/2015	eastern red bat	30	110	incidental find	NA	intact
8/31/2015	hoary bat	31	1	carcass search	RandP	intact
8/31/2015	little brown bat	31	11	carcass search	RandP	intact
8/31/2015	big brown bat	57	7	carcass search	RandP	intact
8/31/2015	eastern red bat	69	6	carcass search	RandP	intact
8/31/2015	eastern red bat	71	3	carcass search	RandP	injured
8/31/2015	hoary bat	83	1	carcass search	RandP	intact
8/31/2015	hoary bat	85	8	carcass search	RandP	scavenged
8/31/2015	eastern red bat	89	6	carcass search	RandP	intact
8/31/2015	eastern red bat	89	13	carcass search	RandP	intact
8/31/2015	tricolored bat	91	1	carcass search	RandP	intact
8/31/2015	eastern red bat	108	1	carcass search	RandP	intact
8/31/2015	eastern red bat	110	7	carcass search	RandP	intact
8/31/2015	eastern red bat	125	1	carcass search	RandP	intact
8/31/2015	eastern red bat	125	60	carcass search	RandP	scavenged
9/1/2015	eastern red bat	7	7	carcass search	RandP	scavenged
9/1/2015	eastern red bat	12	64	carcass search	RandP	intact
9/1/2015	hoary bat	24	7	carcass search	RandP	intact
9/1/2015	eastern red bat	26	1	carcass search	RandP	intact
9/1/2015	hoary bat	29	14	carcass search	RandP	intact
9/1/2015	eastern red bat	39	12	carcass search	RandP	intact
9/1/2015	little brown bat	45	11	carcass search	RandP	scavenged
9/1/2015	eastern red bat	51	3	carcass search	RandP	injured
9/1/2015	big brown bat	64	33	carcass search	RandP	intact
9/1/2015	eastern red bat	77	28	carcass search	RandP	scavenged
9/1/2015	little brown bat	77	4	carcass search	RandP	intact
9/1/2015	eastern red bat	81	7	carcass search	RandP	intact
9/2/2015	eastern red bat	54	11	carcass search	RandP	scavenged
9/2/2015	eastern red bat	116	3	carcass search	RandP	scavenged
9/8/2015	hoary bat	15	2	incidental find	NA	intact
9/8/2015	hoary bat	20	10	incidental find	RandP	intact

Appendix D4. Complete carcass listing for the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
9/8/2015	hoary bat	70	7	incidental find	RandP	injured
9/8/2015	hoary bat	107	20	carcass search	RandP	scavenged
9/9/2015	eastern red bat	21	5	carcass search	RandP	intact
9/9/2015	little brown bat	21	29	carcass search	RandP	dismembered
9/9/2015	eastern red bat	25	30	carcass search	RandP	scavenged
9/9/2015	eastern red bat	29	4	carcass search	RandP	scavenged
9/9/2015	eastern red bat	31	6	carcass search	RandP	intact
9/9/2015	eastern red bat	62	0	incidental find	NA	scavenged
9/9/2015	eastern red bat	62	2	incidental find	NA	intact
9/9/2015	hoary bat	71	8	carcass search	RandP	intact
9/9/2015	hoary bat	72	46	carcass search	RandP	scavenged
9/9/2015	eastern red bat	87	6	carcass search	RandP	scavenged
9/9/2015	silver-haired bat	112	24	carcass search	RandP	intact
9/10/2015	eastern red bat	13	13	carcass search	RandP	intact
9/10/2015	silver-haired bat	45	8	carcass search	RandP	intact
9/10/2015	eastern red bat	53	2	incidental find	NA	intact
9/10/2015	eastern red bat	53	2	incidental find	NA	injured
9/10/2015	hoary bat	53	8	incidental find	NA	intact
9/10/2015	eastern red bat	79	14	incidental find	NA	intact
9/10/2015	hoary bat	79	4	incidental find	NA	scavenged
9/10/2015	hoary bat	79	2	incidental find	NA	scavenged
9/11/2015	eastern red bat	49	24	carcass search	RandP	dismembered
9/11/2015	eastern red bat	52	1	carcass search	RandP	intact
9/11/2015	tricolored bat	52	7	carcass search	RandP	intact
9/11/2015	hoary bat	58	1	carcass search	RandP	intact
9/11/2015	eastern red bat	76	2	carcass search	RandP	scavenged
9/11/2015	silver-haired bat	77	34	carcass search	RandP	intact
9/11/2015	hoary bat	119	3	carcass search	RandP	intact
9/14/2015	big brown bat	30	43	carcass search	RandP	dismembered
9/14/2015	eastern red bat	30	72	carcass search	RandP	dismembered
9/14/2015	eastern red bat	31	3	carcass search	RandP	scavenged
9/14/2015	hoary bat	72	6	carcass search	RandP	dismembered
9/14/2015	big brown bat	126	6	carcass search	RandP	intact
9/15/2015	silver-haired bat	14	5	carcass search	RandP	dismembered
9/15/2015	big brown bat	39	66	carcass search	RandP	intact
9/15/2015	eastern red bat	47	35	carcass search	RandP	dismembered
9/15/2015	eastern red bat	52	1	carcass search	RandP	intact
9/22/2015	eastern red bat	71	75	carcass search	RandP	scavenged
9/22/2015	eastern red bat	71	82	carcass search	RandP	scavenged
9/22/2015	hoary bat	72	36	carcass search	RandP	scavenged
9/22/2015	eastern red bat	110	11	carcass search	RandP	scavenged
9/24/2015	eastern red bat	63	3	carcass search	RandP	intact
9/24/2015	eastern red bat	67	60	carcass search	RandP	scavenged
9/28/2015	eastern red bat	126	17	carcass search	RandP	scavenged
9/29/2015	silver-haired bat	73	44	carcass search	RandP	intact
9/30/2015	hoary bat	11	4	carcass search	RandP	scavenged
9/30/2015	eastern red bat	47	1	carcass search	RandP	intact
9/30/2015	eastern red bat	54	2	carcass search	RandP	scavenged
9/30/2015	silver-haired bat	59	5	carcass search	RandP	dismembered
9/30/2015	eastern red bat	116	8	carcass search	RandP	scavenged
10/4/2015	evening bat	26	78	carcass search	RandP	scavenged
10/4/2015	eastern red bat	68	36	carcass search	RandP	intact
10/4/2015	silver-haired bat	112	72	carcass search	RandP	scavenged
10/6/2015	eastern red bat	114	3	carcass search	RandP	intact
10/6/2015	silver-haired bat	115	4	carcass search	RandP	intact
10/6/2015	eastern red bat	116	2	carcass search	RandP	intact
10/14/2015	silver-haired bat	126	4	incidental find	RandP	intact
10/15/2015	eastern red bat	21	79	carcass search	RandP	scavenged
10/26/2015	silver-haired bat	72	39	carcass search	RandP	scavenged

Appendix D4. Complete carcass listing for the Lundgren Wind Energy Facility, Webster County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
Birds						
1/15/2015	domestic chicken	115	35	carcass search	RandP	NA
2/9/2015	house sparrow	103	18	carcass search	RandP	intact
3/10/2015	European starling	71	51	carcass search	RandP	dismembered
3/25/2015	dark-eyed junco	107	66	carcass search	RandP	intact
4/8/2015	ruby-crowned kinglet	102	71	carcass search	RandP	intact
4/13/2015	long-eared owl	108	87	incidental find	20m Trans	dismembered
4/15/2015	northern flicker	94	11	carcass search	RandP	scavenged
4/20/2015	Savannah sparrow	112	5	carcass search	RandP	scavenged
4/23/2015	ruby-crowned kinglet	94	6	carcass search	RandP	intact
5/11/2015	Lincoln's sparrow	88	92	carcass search	RandP	scavenged
5/18/2015	unidentified flycatcher	12	10	carcass search	RandP	intact
5/19/2015	unidentified flycatcher	98	10	carcass search	RandP	scavenged
6/26/2015	American robin	82	35	carcass search	RandP	intact
6/29/2015	killdeer	16	1	carcass search	RandP	intact
7/29/2015	turkey vulture	111	45	carcass search	RandP	intact
7/29/2015	northern rough-winged swallow	129	7	carcass search	RandP	intact
7/31/2015	house sparrow	124	8	incidental find	NA	intact
8/6/2015	cliff swallow	101	21	incidental find	RandP	intact
8/13/2015	cliff swallow	117	11	carcass search	RandP	scavenged
8/13/2015	barn swallow	119	6	carcass search	RandP	scavenged
9/10/2015	red-eyed vireo	8	35	carcass search	RandP	scavenged
9/11/2015	killdeer	98	7	carcass search	RandP	intact
9/11/2015	red-eyed vireo	63	42	carcass search	RandP	scavenged
9/14/2015	red-eyed vireo	68	41	carcass search	RandP	scavenged
9/15/2015	ruby-throated hummingbird	22	15	carcass search	RandP	dismembered
9/30/2015	common yellowthroat	67	75	carcass search	RandP	scavenged
10/5/2015	chipping sparrow	51	83	carcass search	RandP	scavenged
10/5/2015	yellow warbler	64	5	carcass search	RandP	intact
10/15/2015	sedge wren	15	49	carcass search	RandP	intact
10/15/2015	swamp sparrow	41	32	carcass search	RandP	intact
10/22/2015	ruby-crowned kinglet	118	13	carcass search	RandP	dismembered
10/27/2015	ruby-crowned kinglet	39	17	carcass search	RandP	intact

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix E: Summary of Fatality Monitoring Surveys Conducted at the Macksburg Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Macksburg Wind Energy Facility consists of 51 SWT-2.3-108 2.3-megawatt turbines for a nameplate capacity of 119.6 MW. The facility is located across approximately 14,367 acres (22 mi^2) in Madison County in south-central Iowa. The facility is located one-half mile east of the town Macksburg, Iowa. The facility is located in the Rolling Loess Prairies Level 4 Ecoregion. According to the National Land Cover Database, the landscape predominantly consists of pasture/hay (40.4%) and cropland (49.0%). Approximately 5.6% of the Macksburg project area is deciduous forest and about 4% is developed. Grassland, shrub/sage steppe, open water, woody wetlands and emergent wetlands each account for less than 1% of the land cover in the project area.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 2,059 road and pad searches were conducted at Macksburg during 41 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

A total of 151 bats and 32 birds were found on standardized road and pad search areas and incidentally at Macksburg (Table E1). Of the seven bat species found, eastern red bat (48 carcasses) and hoary bat (38) were the most frequently found bat species. Eight little brown bats were found. No federal or state listed bat species were found. Of the 19 unique bird species found on standardized road and pad searches or incidentally, American coot (10 carcasses) was the most commonly found bird species. One bald eagle was found incidentally (Table E1). Bald eagles are protected under the federal Bald and Golden Eagle Protection Act (1940) and are a special concern species in Iowa (Iowa Department of Natural Resources 2016).

Most bat and bird carcasses included in the analysis were found within 10 meters of turbines (Figures E1 and E2). All bats were found within 70 meters of turbines, and all birds were within 40 meters (Figures E1 and E2). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at the Macksburg facility (Figures E3 and E4). Most bat fatalities were found from mid-July to late August, while most birds were found during the spring season (Figure E5 and E6).

Table E1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside of Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
eastern red bat	38	31.7	7	31.8	3	33.3	48	31.8
hoary bat	27	22.5	10	45.5	1	11.1	38	25.2
big brown bat	20	16.7	1	4.5	1	11.1	22	14.6
evening bat	12	10	0	0	2	22.2	14	9.3
silver-haired bat	10	8.3	3	13.6	1	11.1	14	9.3
little brown bat	7	5.8	1	4.5	0	0	8	5.3
tricolored bat	6	5	0	0	1	11.1	7	4.6
Overall Bats	**120**	**100**	**22**	**100**	**9**	**100**	**151**	**100**
Birds								
American coot	6	46.2	0	0	4	25.0	10	31.3
killdeer	1	7.7	1	33.3	0	0	2	6.3
lesser scaup	1	7.7	0	0	1	6.3	2	6.3
ring-necked pheasant	0	0	0	0	2	12.5	2	6.3
turkey vulture	0	0	0	0	2	12.5	2	6.3
northern parula	1	7.7	0	0	0	0	1	3.1
pied-billed grebe	1	7.7	0	0	0	0	1	3.1
unidentified egret	1	7.7	0	0	0	0	1	3.1
warbling vireo	1	7.7	0	0	0	0	1	3.1
yellow-bellied flycatcher	1	7.7	0	0	0	0	1	3.1
bald eagle	0	0	0	0	1	6.3	1	3.1
blue jay	0	0	0	0	1	6.3	1	3.1
cliff swallow	0	0	1	33.3	0	0	1	3.1
downy woodpecker	0	0	0	0	1	6.3	1	3.1
European starling	0	0	1	33.3	0	0	1	3.1
gadwall	0	0	0	0	1	6.3	1	3.1
horned lark	0	0	0	0	1	6.3	1	3.1
unidentified large bird	0	0	0	0	1	6.3	1	3.1
yellow-billed cuckoo	0	0	0	0	1	6.3	1	3.1
Overall Birds	**13**	**100**	**3**	**100**	**16**	**100**	**32**	**100**

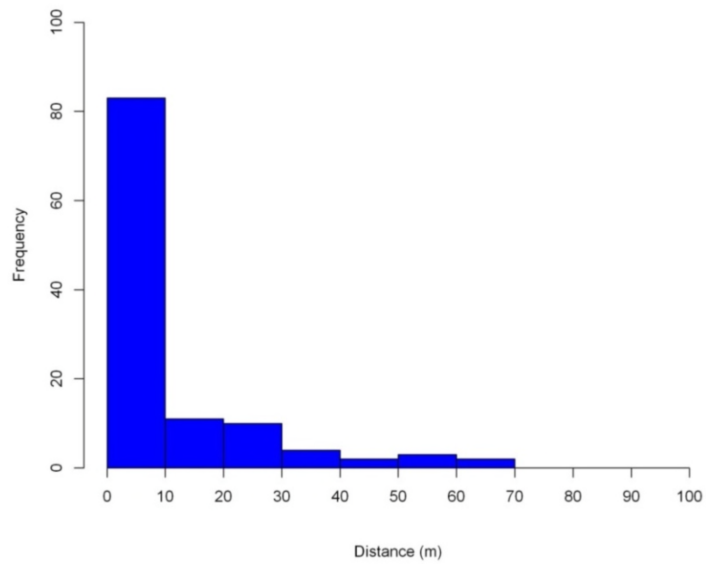

Figure E1. Distance from the turbine for bat carcasses included in the analysis for the Macksburg Wind Energy Facility, Madison County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

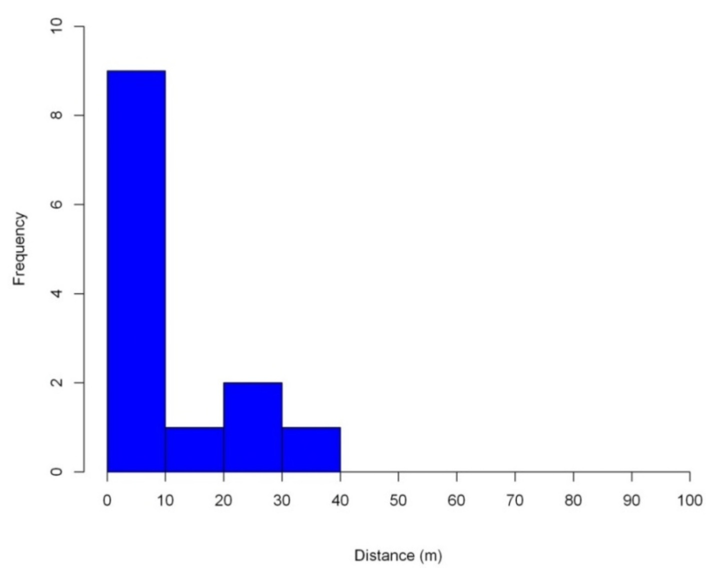

Figure E2. Distance from the turbine for bird carcasses included in the analysis for the Macksburg Wind Energy Facility, Madison County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

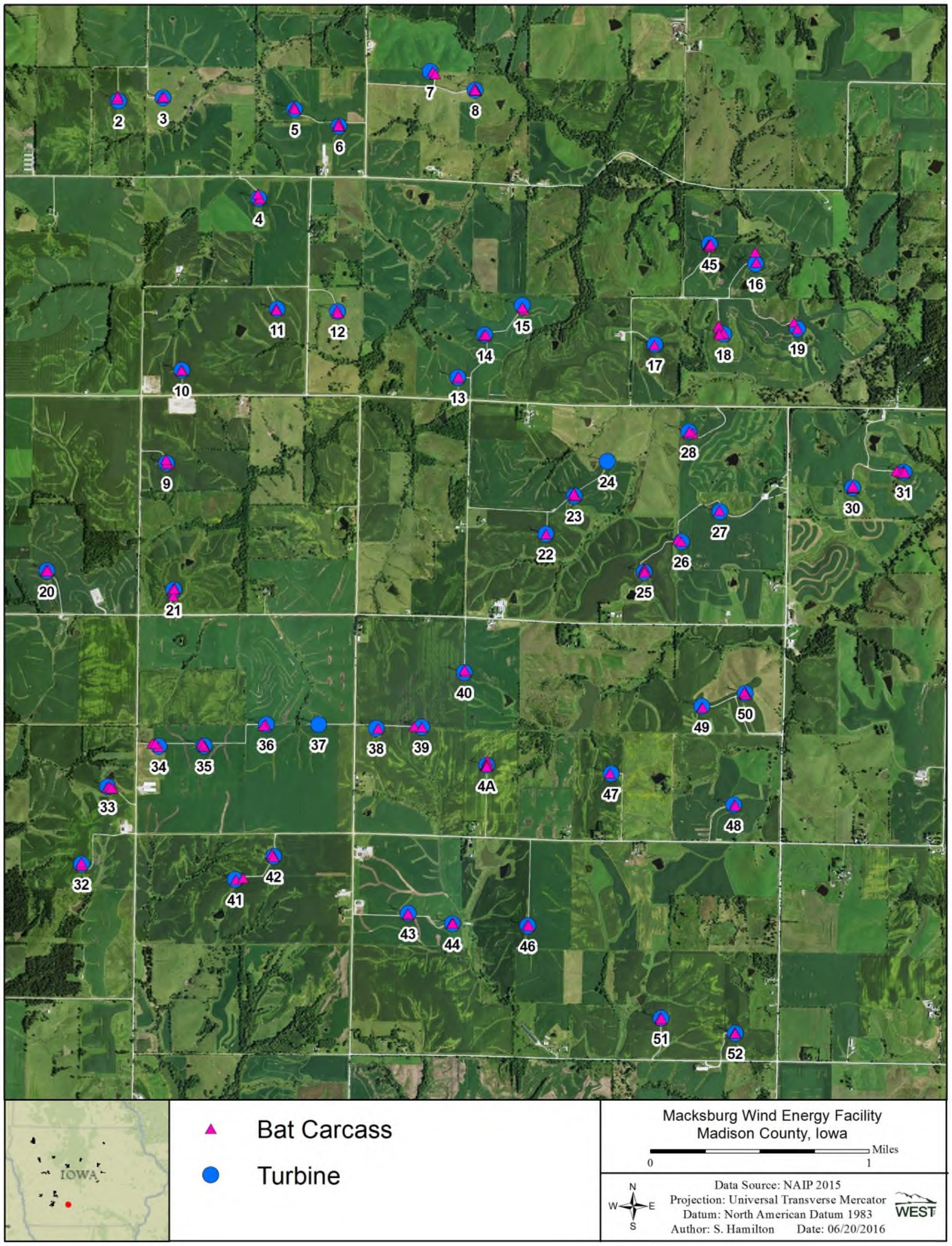

Figure E3. Location of all bat carcasses found during scheduled searches or incidentally at the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

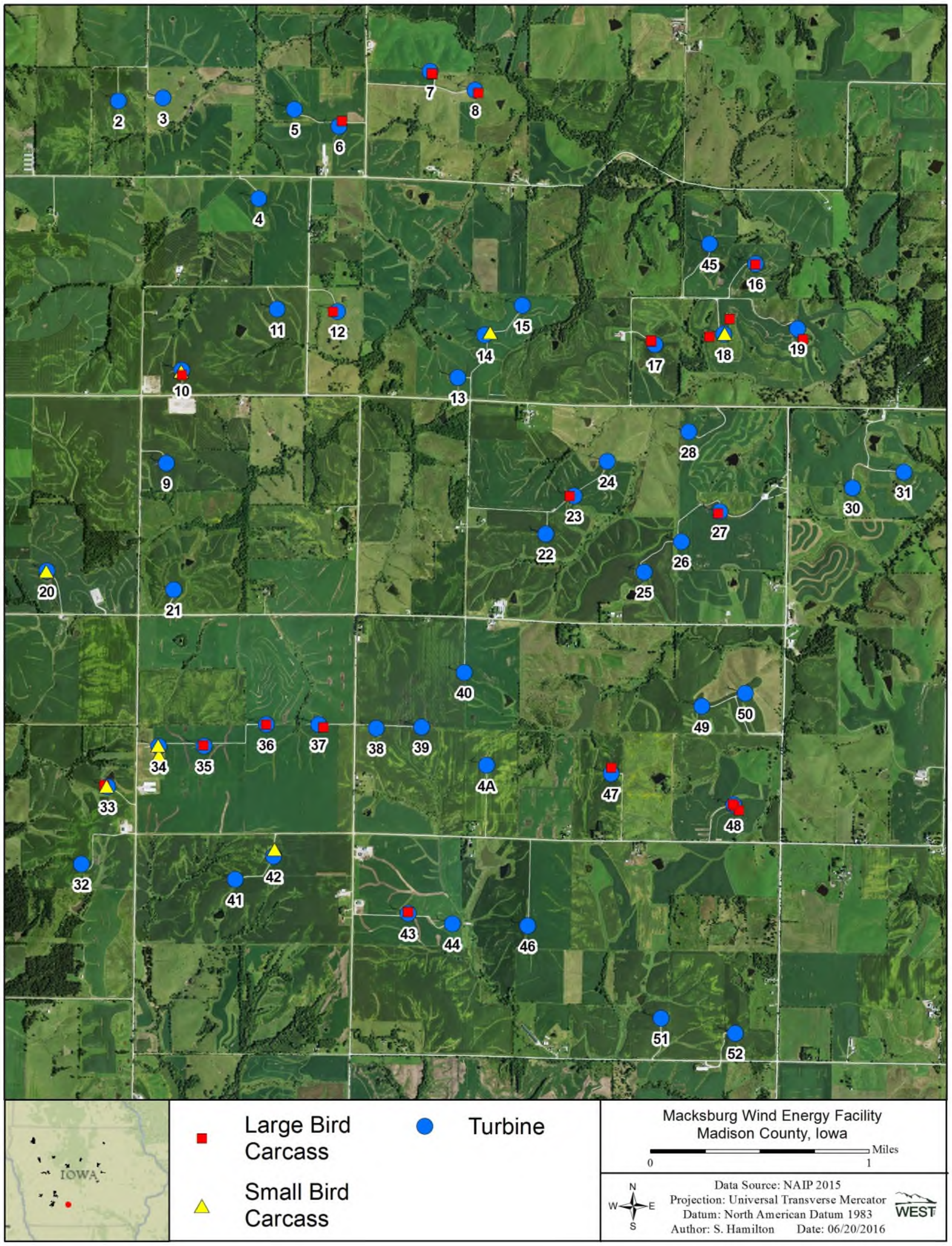

Figure E4. Location of all bird carcasses found at the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

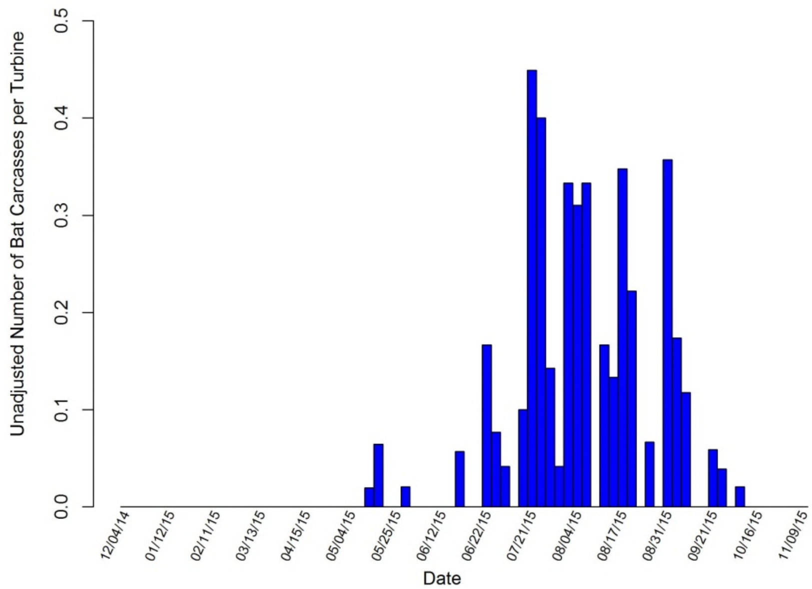

Figure E5. Timing of bat carcasses included in the analysis for the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

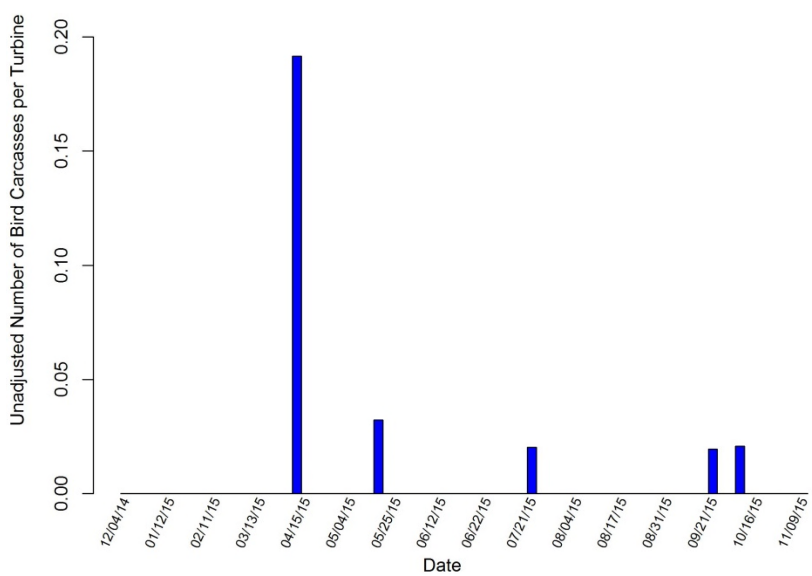

Figure E6. Timing of bat carcasses included in the analysis for the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Macksburg, 80.3% of bats were found within seven days of the estimated time of death (Table E2). Most large bird carcasses (90.9%) and all small birds were estimated to have been found within one week of death (Table E2). Whether carcasses were included in analysis was based on the specific interval for the turbine where the carcass was found. If there were no searches occurring since the estimated time of death, the carcass was included in the fatality estimate. If a search occurred since the estimated time of death, it was assumed that the carcass was missed on the first opportunity to have been found, and was therefore excluded from the fatality estimate. Twenty-two bat carcasses and three bird carcasses were excluded from the analysis for having been found outside of the search interval. All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table E2. Estimated time of death for carcasses found at the Macksburg Wind Energy Facility from December 1, 2014, to November 15, 2015.

Type	Estimated Time of Death	Number of Carcasses	Percent Composition (%)
Bats	Last night	32	22.5
	2-3 days	49	34.5
	4-7 days	33	23.2
	7-14 days	15	10.9
	>2 week	3	2.1
	> Month	3	2.1
	Unknown	7	4.9
Large birds	Last night	2	18.2
	2-3 days	7	63.6
	4-7 days	1	9.1
	7-14 days	0	0
	>2 week	0	0
	> Month	1	9.1
	Unknown	0	0
Small birds	Last night	0	0
	2-3 days	4	80.0
	4-7 days	1	20.0
	7-14 days	0	0
	>2 week	0	0
	> Month	0	0
	Unknown	0	0

Searcher Efficiency

A total of 134 carcasses (52 bats, 42 large birds, and 40 small birds) were placed in the search area for searcher efficiency trials during the first year of monitoring. Logistic regression was used to model searcher efficiency. Model selection was based on corrected Akaike's Information Criterion, hereafter referred to as AICc. Seasonal estimates are only provided if season was included in the top model selected. The searcher efficiency rate for bats was 0.61 in spring, 0.89 in summer, and 0.96 in fall. The overall searcher efficiency rate for large birds was 0.93 in spring, 0.98 in summer, and 1.00 in fall. For small birds, searcher efficiency rate was 0.77 in spring, 0.94 in summer, and 0.98 in fall (Table E3).

Carcass Removal

A total of 134 carcasses (50 bats, 48 large birds, and 36 small birds) were placed for carcass removal trials throughout the project area during first year of monitoring. The Huso method 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 various variables. The mean carcass removal time for bats was 3.44 days for spring, 1.65 days for summer, and 0.68 days for fall (Table E3). Large bird carcass removal rate for winter was 17.35, 9.66 for spring, 4.64 for summer, and 1.91 for fall. The winter carcass removal time for small birds was 8.86, 4.93 for spring, 2.37 for summer, and 0.97 for fall (Table E3).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, and all birds, and 90% confidence intervals were calculated when at least five casualties were found (Table E3). Fatality estimates were not calculated for raptors because no raptors were found on search plots during the study period. The estimated bat fatality rate was 73.08 bats/MW/year. The estimated total bird fatality rate was 3.38 birds/MW/year, which was comprised of 1.77 large birds/MW/year and 1.61 small birds/MW/year (Table E3). A complete list of casualties discovered at the Macksburg Wind Energy Facility is found in Table E4.

Table E3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

	Winter			Spring			Summer			Fall		
	Mean	90% Confidence Interval		Mean	90 % Confidence Interval		Mean	90% Confidence Interval		Mean	90% Confidence Interval	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
Search Area Adjustment												
Bats	-	-	-	13.67	-	-	13.67	-	-	13.67	-	-
Large birds	-	-	-	11.42	-	-	11.42	-	-	11.42	-	-
Small birds	-	-	-	17.60	-	-	17.60	-	-	17.69	-	-
Observer Detection Rate												
Bats	-	-	-	0.61	0.35	0.83	0.89	0.78	0.98	0.96	0.88	1.00
Large birds	-	-	-	0.93	0.80	0.99	0.98	0.95	1.00	1.00	0.98	1.00
Small birds	-	-	-	0.77	0.59	0.94	0.94	0.85	1.00	0.98	0.94	1.00
Mean Carcass Removal Time (days)												
Bats	-	-	-	3.44	2.25	5.26	1.65	1.14	2.38	0.68	0.42	1.04
Large birds	-	-	-	9.66	6.38	14.88	4.64	2.97	7.31	1.91	1.07	3.39
Small birds	-	-	-	4.93	3.33	7.06	2.37	1.58	3.47	0.97	0.61	1.57
Average Probability of Carcass Persistence Through Search Interval With Effective Interval Adjustment												
Bats	-	-	-	0.55	-	-	0.38	0.29	0.47	0.18	0.12	0.25
Large birds	-	-	-	0.62	0.51	0.72	-	-	-	0.37	-	-
Small birds	-	-	-	-	-	-	0.45	-	-	0.24	-	-
Observed Carcass Counts Per Turbine												
Bats	-	-	-	0.02	-	-	0.37	0.25	0.49	1.96	1.63	2.29
Large birds	-	-	-	0.18	0.08	0.27	-	-	-	0.02	-	-
Small birds	-	-	-	-	-	-	0.02	-	-	0.04	-	-
Average Probability that Carcass Available and Detected												
Bats	-	-	-	0.33	-	-	0.33	0.25	0.43	0.18	0.11	0.25
Large birds	-	-	-	0.57	0.45	0.68	-	-	-	0.36	-	-
Small birds	-	-	-	-	-	-	0.43	-	-	0.23	-	-
Adjusted Fatality Rates (Fatalities/Turbine/Season)												
Bats	-	-	-	0.80	-	-	15.27	9.53	22.64	155.36	104.95	246.63
Large birds	-	-	-	3.53	1.59	5.99	-	-		0.61	-	-
Small birds	-	-	-	-	-	-	0.81	-	-	2.97	-	-

Overall Adjusted Fatality Estimates (Fatalities/Turbine/Year)

	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	171.44	121.46	266.38
Large birds	4.15	2.07	6.85
Small birds	3.77	-	-
All birds	7.92	3.57	13.45

Overall Adjusted Fatality Estimates (Fatalities/MW/Year)

	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	73.08	51.77	113.55
Large birds	1.77	0.88	2.92
Small birds	1.61	-	-

Table E3. The point estimates and the bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

All Birds	3.38	1.52	5.73

Table E4. Complete carcass listing for the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
			Bats			
5/11/2015	big brown bat	25	27	carcass search	RandP	intact
5/18/2015	eastern red bat	35	1	carcass search	RandP	intact
5/18/2015	eastern red bat	40	15	carcass search	RandP	intact
5/18/2015	evening bat	4A	34	carcass search	RandP	scavenged
6/1/2015	evening bat	30	10	carcass search	RandP	scavenged
6/8/2015	evening bat	5	24	carcass search	RandP	scavenged
6/16/2015	little brown bat	23	6	carcass search	RandP	intact
6/16/2015	big brown bat	44	1	carcass search	RandP	scavenged
6/22/2015	hoary bat	10	3	carcass search	RandP	intact
6/22/2015	evening bat	8	NA	incidental find	RandP	intact
6/23/2015	eastern red bat	11	6	carcass search	RandP	intact
6/23/2015	big brown bat	19	6	carcass search	RandP	scavenged
6/23/2015	eastern red bat	23	18	carcass search	RandP	intact
6/29/2015	silver-haired bat	20	8	carcass search	RandP	dismembered
6/29/2015	evening bat	33	30	carcass search	RandP	NA
6/29/2015	silver-haired bat	50	12	carcass search	RandP	scavenged
7/10/2015	hoary bat	18	1	incidental find	NA	intact
7/10/2015	silver-haired bat	18	28	incidental find	NA	intact
7/10/2015	little brown bat	6	6	incidental find	NA	NA
7/13/2015	eastern red bat	14	8	carcass search	RandP	intact
7/13/2015	eastern red bat	2	29	carcass search	RandP	NA
7/13/2015	eastern red bat	27	6	carcass search	RandP	intact
7/13/2015	hoary bat	31	5	carcass search	RandP	intact
7/13/2015	big brown bat	35	6	carcass search	RandP	dismembered
7/13/2015	eastern red bat	36	20	carcass search	RandP	intact
7/21/2015	hoary bat	11	7	carcass search	RandP	scavenged
7/21/2015	hoary bat	12	9	carcass search	RandP	scavenged
7/21/2015	big brown bat	14	7	carcass search	RandP	scavenged
7/21/2015	eastern red bat	15	14	carcass search	RandP	scavenged
7/21/2015	hoary bat	16	16	carcass search	RandP	scavenged
7/21/2015	eastern red bat	18	61	carcass search	RandP	scavenged
7/21/2015	hoary bat	18	70	carcass search	RandP	scavenged
7/21/2015	eastern red bat	2	38	carcass search	RandP	scavenged
7/21/2015	silver-haired bat	21	2	carcass search	RandP	intact
7/21/2015	big brown bat	30	2	carcass search	RandP	scavenged
7/21/2015	big brown bat	31	6	carcass search	RandP	scavenged
7/21/2015	silver-haired bat	31	32	carcass search	RandP	dismembered
7/21/2015	hoary bat	35	26	carcass search	RandP	scavenged
7/21/2015	hoary bat	39	52	carcass search	RandP	intact
7/21/2015	hoary bat	43	9	carcass search	RandP	intact
7/21/2015	evening bat	44	8	carcass search	RandP	scavenged
7/21/2015	hoary bat	45	7	carcass search	RandP	scavenged
7/21/2015	evening bat	48	5	carcass search	RandP	NA
7/21/2015	eastern red bat	4A	34	carcass search	RandP	scavenged
7/21/2015	evening bat	4A	5	carcass search	RandP	scavenged
7/21/2015	hoary bat	4A	8	carcass search	RandP	scavenged
7/21/2015	hoary bat	4A	8	carcass search	RandP	intact
7/21/2015	silver-haired bat	4A	9	carcass search	RandP	intact
7/21/2015	hoary bat	5	6	carcass search	RandP	intact
7/21/2015	hoary bat	52	9	carcass search	RandP	scavenged
7/21/2015	hoary bat	52	1	carcass search	RandP	intact
7/21/2015	hoary bat	8	8	carcass search	RandP	scavenged
7/21/2015	big brown bat	9	0	carcass search	RandP	injured
7/25/2015	big brown bat	22	NA	incidental find	RandP	intact
7/27/2015	big brown bat	12	6	carcass search	RandP	intact
7/27/2015	big brown bat	3	8	carcass search	RandP	intact
7/27/2015	silver-haired bat	3	7	carcass search	RandP	scavenged
7/27/2015	hoary bat	6	1	carcass search	RandP	intact
7/28/2015	big brown bat	23	5	carcass search	RandP	scavenged

Table E4. Complete carcass listing for the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
7/28/2015	silver-haired bat	49	5	carcass search	RandP	scavenged
7/29/2015	big brown bat	9	1	carcass search	RandP	scavenged
7/31/2015	eastern red bat	25	4	carcass search	RandP	intact
8/4/2015	evening bat	13	1	carcass search	RandP	scavenged
8/4/2015	hoary bat	13	7	carcass search	RandP	intact
8/4/2015	eastern red bat	18	35	carcass search	RandP	intact
8/4/2015	little brown bat	21	7	carcass search	RandP	scavenged
8/4/2015	evening bat	28	6	carcass search	RandP	scavenged
8/4/2015	big brown bat	31	7	carcass search	RandP	intact
8/4/2015	eastern red bat	32	7	carcass search	RandP	intact
8/4/2015	eastern red bat	33	8	carcass search	RandP	intact
8/4/2015	eastern red bat	6	8	carcass search	RandP	scavenged
8/4/2015	hoary bat	6	14	carcass search	RandP	scavenged
8/4/2015	hoary bat	6	23	carcass search	RandP	intact
8/4/2015	hoary bat	8	8	carcass search	RandP	intact
8/5/2015	eastern red bat	23	21	carcass search	RandP	scavenged
8/5/2015	eastern red bat	26	5	carcass search	RandP	intact
8/5/2015	eastern red bat	41	4	carcass search	RandP	intact
8/5/2015	eastern red bat	44	5	carcass search	RandP	intact
8/5/2015	eastern red bat	4A	3	carcass search	RandP	intact
8/5/2015	eastern red bat	4A	10	carcass search	RandP	intact
8/5/2015	silver-haired bat	51	12	carcass search	RandP	scavenged
8/6/2015	eastern red bat	25	NA	incidental find	NA	intact
8/10/2015	silver-haired bat	10	10	carcass search	RandP	scavenged
8/10/2015	eastern red bat	18	10	carcass search	RandP	scavenged
8/10/2015	little brown bat	18	0	carcass search	RandP	NA
8/10/2015	eastern red bat	21	46	carcass search	RandP	intact
8/10/2015	hoary bat	21	10	carcass search	RandP	intact
8/10/2015	hoary bat	33	12	carcass search	RandP	intact
8/10/2015	eastern red bat	35	3	carcass search	RandP	intact
8/10/2015	eastern red bat	36	8	carcass search	RandP	intact
8/10/2015	big brown bat	47	4	carcass search	RandP	scavenged
8/10/2015	eastern red bat	48	6	carcass search	RandP	intact
8/10/2015	hoary bat	50	2	carcass search	RandP	intact
8/10/2015	hoary bat	50	1	carcass search	RandP	intact
8/11/2015	eastern red bat	4A	7	carcass search	RandP	intact
8/11/2015	eastern red bat	5	10	carcass search	RandP	intact
8/11/2015	hoary bat	5	8	carcass search	RandP	scavenged
8/17/2015	eastern red bat	20	4	carcass search	RandP	intact
8/17/2015	silver-haired bat	20	9	carcass search	RandP	scavenged
8/17/2015	hoary bat	32	0	carcass search	RandP	scavenged
8/17/2015	big brown bat	33	8	carcass search	RandP	intact
8/17/2015	tricolored bat	38	6	carcass search	RandP	intact
8/17/2015	eastern red bat	42	18	carcass search	RandP	intact
8/17/2015	little brown bat	49	6	carcass search	RandP	intact
8/17/2015	hoary bat	50	8	carcass search	RandP	intact
8/17/2015	little brown bat	51	7	carcass search	RandP	intact
8/19/2015	eastern red bat	16	4	carcass search	RandP	intact
8/19/2015	eastern red bat	17	5	carcass search	RandP	intact
8/19/2015	silver-haired bat	30	5	carcass search	RandP	intact
8/19/2015	tricolored bat	30	6	carcass search	RandP	intact
8/19/2015	big brown bat	31	0	incidental find	RandP	dismembered
8/19/2015	eastern red bat	33	25	incidental find	RandP	intact
8/19/2015	eastern red bat	45	6	carcass search	RandP	scavenged
8/19/2015	evening bat	45	20	carcass search	RandP	scavenged
8/19/2015	hoary bat	45	3	carcass search	RandP	scavenged
8/19/2015	evening bat	8	7	carcass search	RandP	intact
8/24/2015	tricolored bat	20	10	carcass search	RandP	intact
8/24/2015	eastern red bat	28	30	carcass search	RandP	intact
8/24/2015	hoary bat	31	30	carcass search	RandP	dismembered

Table E4. Complete carcass listing for the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
8/24/2015	hoary bat	34	6	carcass search	RandP	scavenged
8/27/2015	hoary bat	39	NA	incidental find	NA	intact
8/31/2015	hoary bat	15	32	carcass search	RandP	intact
8/31/2015	silver-haired bat	19	52	carcass search	RandP	intact
8/31/2015	hoary bat	21	5	carcass search	RandP	scavenged
8/31/2015	hoary bat	25	13	carcass search	RandP	scavenged
8/31/2015	tricolored bat	26	28	carcass search	RandP	intact
8/31/2015	tricolored bat	30	4	carcass search	RandP	intact
8/31/2015	eastern red bat	34	47	carcass search	RandP	intact
8/31/2015	eastern red bat	41	54	carcass search	RandP	scavenged
8/31/2015	eastern red bat	42	7	carcass search	RandP	scavenged
8/31/2015	hoary bat	45	7	carcass search	RandP	intact
9/1/2015	tricolored bat	2	16	carcass search	RandP	scavenged
9/1/2015	tricolored bat	43	2	carcass search	RandP	scavenged
9/1/2015	eastern red bat	46	6	carcass search	RandP	scavenged
9/1/2015	big brown bat	7	4	carcass search	RandP	scavenged
9/1/2015	eastern red bat	7	40	carcass search	RandP	scavenged
9/8/2015	evening bat	25	8	carcass search	RandP	scavenged
9/8/2015	big brown bat	28	4	carcass search	RandP	scavenged
9/8/2015	hoary bat	36	6	carcass search	RandP	na
9/8/2015	big brown bat	40	7	carcass search	RandP	intact
9/8/2015	big brown bat	40	8	carcass search	RandP	scavenged
9/8/2015	eastern red bat	9	25	carcass search	RandP	intact
9/21/2015	big brown bat	12	8	carcass search	RandP	intact
9/21/2015	little brown bat	30	5	carcass search	RandP	intact
9/21/2015	eastern red bat	34	36	carcass search	RandP	intact
9/21/2015	eastern red bat	42	5	incidental find	RandP	intact
9/24/2015	eastern red bat	51	NA	incidental find	RandP	intact
9/28/2015	silver-haired bat	14	7	carcass search	RandP	scavenged
9/28/2015	little brown bat	31	6	carcass search	RandP	scavenged
10/5/2015	eastern red bat	46	7	carcass search	RandP	scavenged
10/13/2015	evening bat	3	4	carcass search	RandP	intact
Birds						
12/4/2014	bald eagle	19	86	carcass search	100m Scan	dismembered
12/4/2014	American coot	6	35	incidental find	RandP	scavenged
12/4/2014	European starling	20	0	carcass search	RandP	intact
1/19/2015	ring-necked pheasant	18	110	carcass search	20m Trans	feather spot
1/19/2015	ring-necked pheasant	18	112	carcass search	20m Trans	feather spot
4/10/2015	unidentified egret	10	32	carcass search	RandP	dismembered
4/10/2015	lesser scaup	12	34	carcass search	100m Scan	dismembered
4/10/2015	American coot	16	9	carcass search	RandP	intact
4/10/2015	pied-billed grebe	17	28	carcass search	RandP	intact
4/10/2015	American coot	27	17	carcass search	100m Scan	intact
4/10/2015	American coot	33	26	carcass search	100m Scan	intact
4/10/2015	American coot	36	5	carcass search	RandP	intact
4/10/2015	American coot	43	5	carcass search	RandP	intact
4/10/2015	American coot	43	7	carcass search	RandP	intact
4/10/2015	American coot	47	35	carcass search	RandP	intact
4/10/2015	American coot	48	52	carcass search	100m Scan	dismembered
4/10/2015	lesser scaup	48	6	carcass search	RandP	intact
4/10/2015	American coot	7	28	carcass search	100m Scan	intact
4/10/2015	unidentified large bird	7	20	carcass search	100m Scan	dismembered
4/10/2015	gadwall	8	31	carcass search	100m Scan	intact
4/10/2015	downy woodpecker	14	40	carcass search	RandP	intact
4/28/2015	turkey vulture	37	44	carcass search	RandP	intact
5/4/2015	blue jay	34	66	carcass search	100m Scan	intact
5/18/2015	warbling vireo	33	4	carcass search	RandP	intact
6/8/2015	yellow-billed cuckoo	17	39	carcass search	RandP	scavenged
6/8/2015	horned lark	42	45	carcass search	RandP	scavenged
7/10/2015	cliff swallow	18	6	incidental find	NA	intact

Table E4. Complete carcass listing for the Macksburg Wind Energy Facility, Madison County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
7/21/2015	killdeer	23	31	carcass search	RandP	scavenged
7/21/2015	killdeer	35	1	carcass search	RandP	scavenged
9/21/2015	northern parula	10	2	carcass search	RandP	intact
10/13/2015	yellow-bellied flycatcher	34	7	carcass search	RandP	intact
11/9/2015	turkey vulture	48	11	carcass search	RandP	scavenged

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix F: Summary of Fatality Monitoring Surveys Conducted at the Morning Light Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Morning Light Wind Energy Facility consists of 44 SWT-2.3-108 2.3-megawatt turbines for a nameplate capacity of 101.2 MW. The facility is located across approximately 8,176 acres (13 mi^2) in Adair County in southwestern Iowa. The facility is located south of the Interstate 80 and the city of Adair, Iowa. The facility is located in the Rolling Loess Prairies Level 4 Ecoregion. According to the National Land Cover Database, the landscape predominantly consists of cropland (79.9%), followed by pasture/hay (15.7%) and developed area (4.1%). Open water, deciduous forest, shrub/sage-steppe and barren land each account for less than 1% of the land cover in the project area.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 1,767 road and pad searches were conducted at Morning Light during 41 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

Forty-nine bat carcasses and 13 bird carcasses were found at on standardized road and pad search areas or incidentally at Morning Light (Table F1). Of the six bat species found, eastern red bat and hoary bat were the species most commonly found (19 carcasses per species). No federal or state listed bat species were found, and *Myotis* no bats were found. Of the eight unique identifiable bird species found on standardized road and pad searches or incidentally, dickcissel and European starling (two carcasses, each) were the bird species found most commonly. Single carcasses of the remaining six identifiable species were found. No federal or state listed bird species were found (Table F1).

As expected based on the study design, most bat and bird carcasses included in the analysis were found within 10 meters of turbines (Figures F1 and F2). All bat carcasses were found within 90 meters and all bird carcasses were found within 50 meters of turbines. There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at Morning Light (Figures F3 and F4). Most bat fatalities were found from mid-July to the beginning of September, and there was no discernable temporal pattern of bird fatalities (Figures F5 and F6).

Table F1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
eastern red bat	15	41.7	2	22.2	2	50.0	19	38.8
hoary bat	12	33.3	5	55.6	2	50.0	19	38.8
silver-haired bat	5	13.9	1	11.1	0	0	6	12.2
big brown bat	2	5.6	1	11.1	0	0	3	6.1
evening bat	1	2.8	0	0	0	0	1	2.0
tricolored bat	1	2.8	0	0	0	0	1	2.0
Overall Bats	**36**	**100**	**9**	**100**	**4**	**100**	**49**	**100**
Birds								
dickcissel	2	33.3	0	0	0	0	2	15.4
European starling	2	33.3	0	0	0	0	2	15.4
unidentified small bird	0	0	1	25.0	1	33.3	2	15.4
marsh wren	1	16.7	0	0	0	0	1	7.7
rock pigeon	1	16.7	0	0	0	0	1	7.7
mallard	0	0	1	25.0	0	0	1	7.7
northern flicker	0	0	1	25.0	0	0	1	7.7
unidentified large bird	0	0	1	25.0	0	0	1	7.7
domestic chicken	0	0	0	0	1	33.3	1	7.7
gray catbird	0	0	0	0	1	33.3	1	7.7
Overall Birds	**6**	**100**	**4**	**100**	**3**	**100**	**13**	**100**

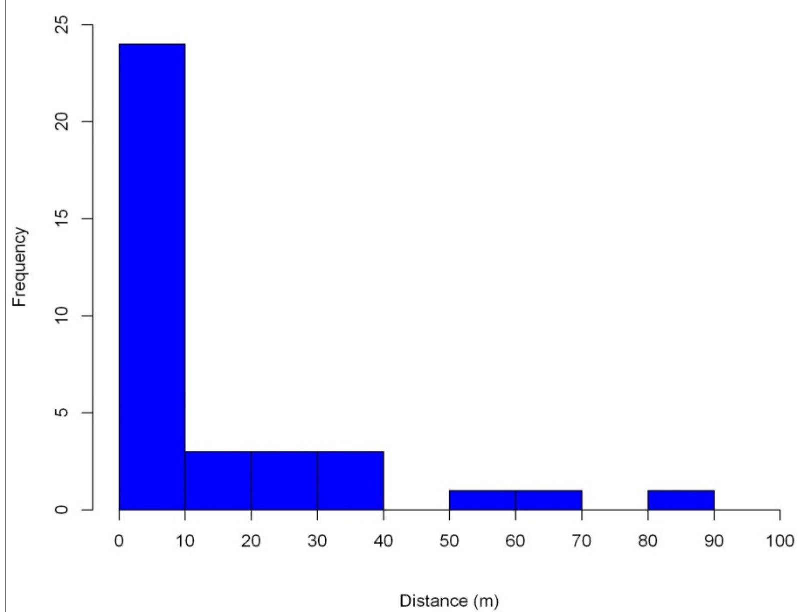

Figure F1. Distance from the turbine for bat carcasses included in the analysis for the Morning Light Wind Energy Facility, Adair County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

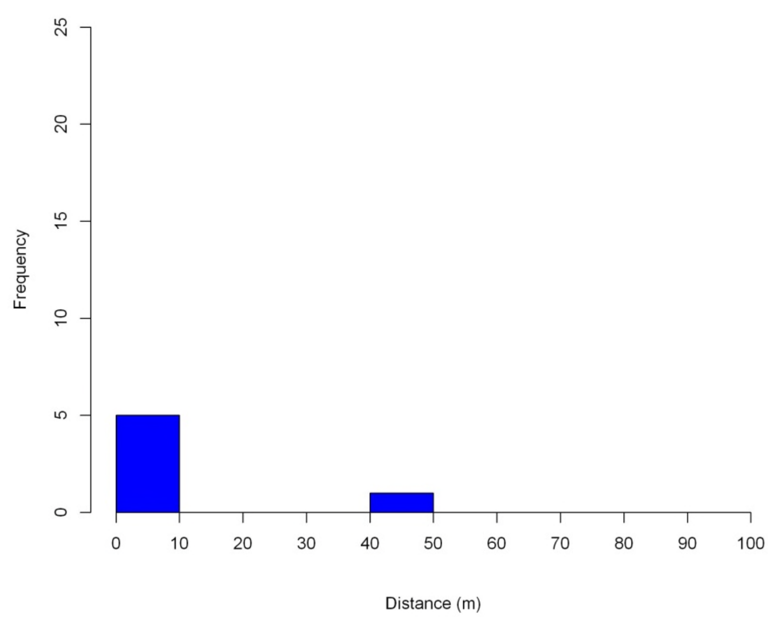

Figure F2. Distance the turbine for bird carcasses included in the analysis for the Morning Light Wind Energy Facility, Adair County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

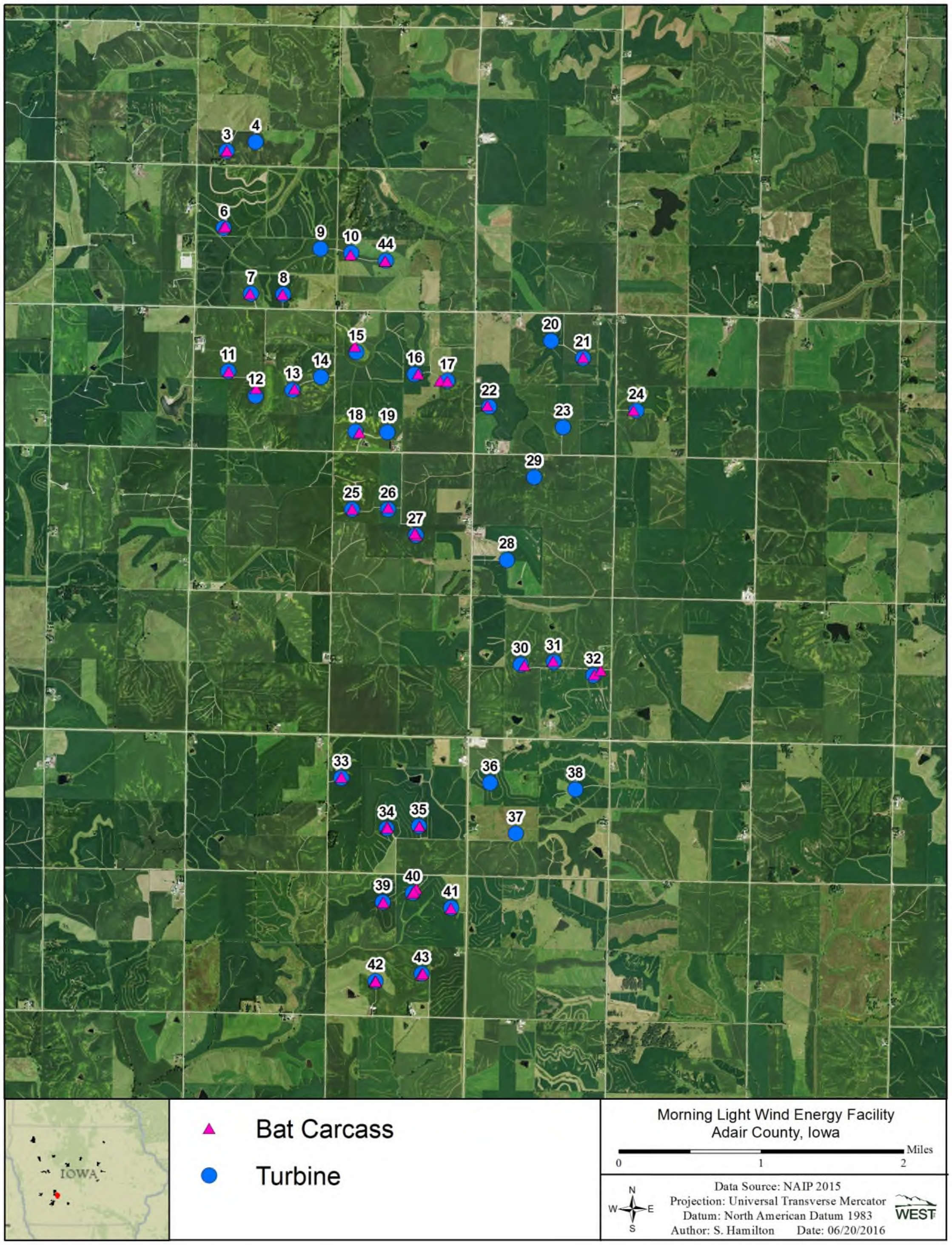

Figure F3. Location of all bat carcasses found during scheduled searches or incidentally at the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

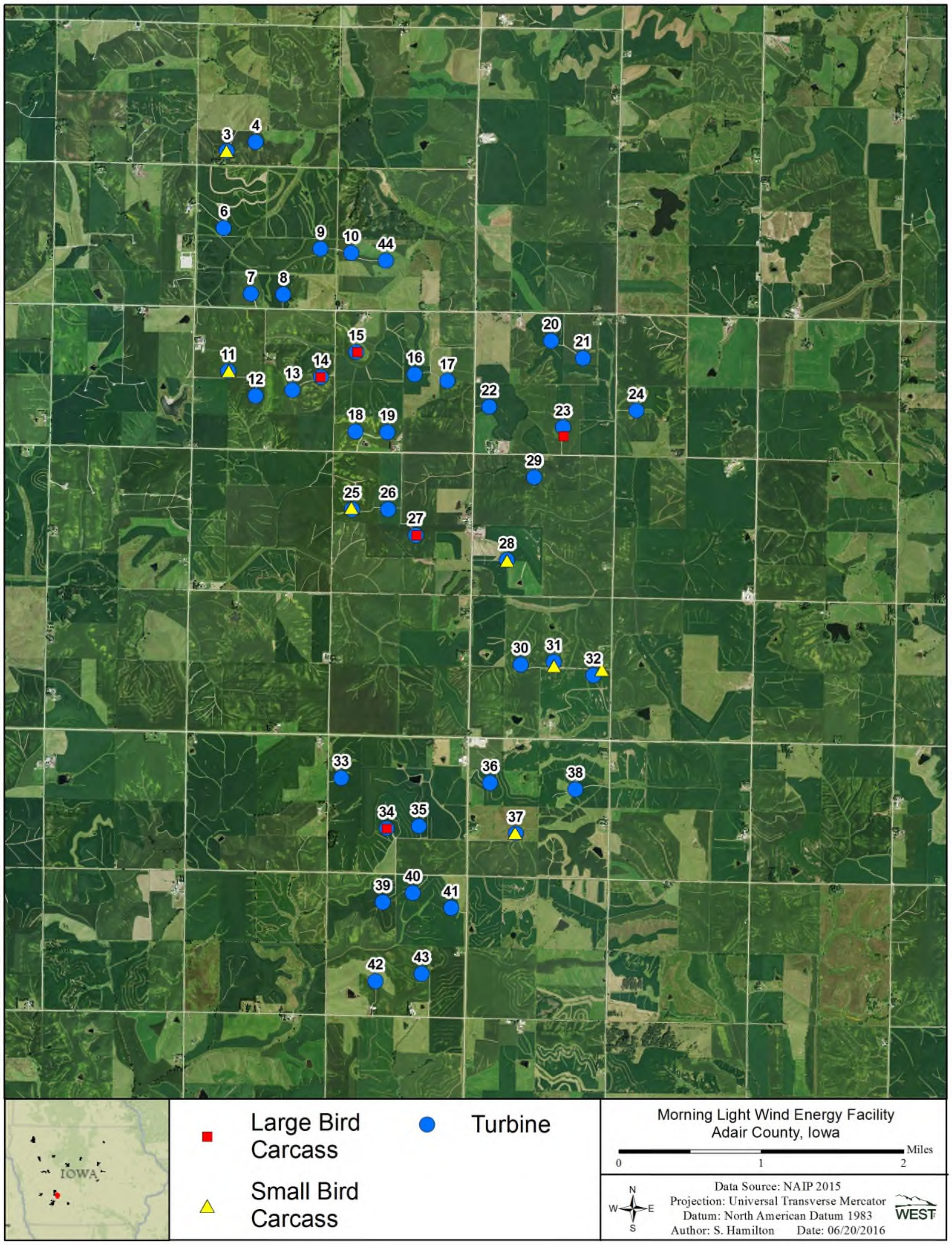

Figure F4. Location of all bird carcasses found during scheduled searches or incidentally at the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

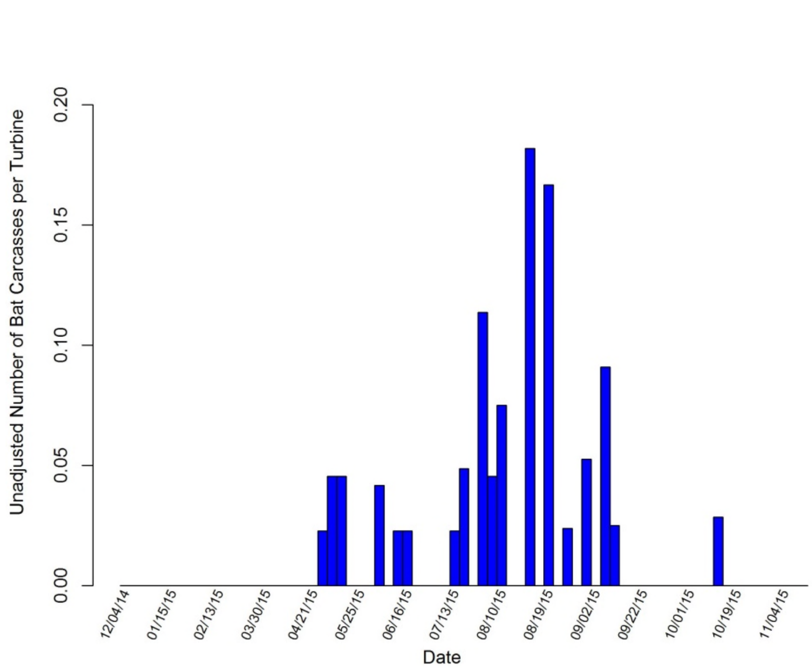

Figure F5. Timing of bat carcasses included in the analysis for the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

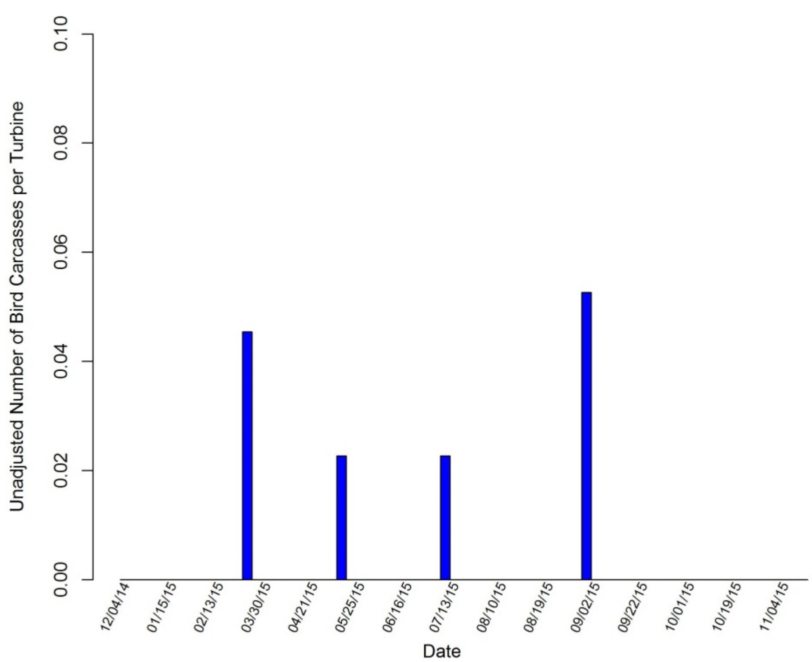

Figure F6. Timing of bird carcasses included in the analysis for the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Morning Light, the majority of bat carcasses (78.7%) were found within seven days of the estimated time of death (Table F2). Half of the large bird carcasses were estimated to have been found within two weeks of death, and approximate 83.3% of small birds were estimated to have been found within one week of death (Table F2). Whether carcasses were included in analysis was based on the specific search interval for the turbine where the carcass was found. If the estimated time since death of the carcass was more recent than the previous search of the turbine the carcass was found, the carcass was included in the fatality estimate. If the estimated time since death was greater than the most recent search of the turbine the carcass was found, 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). Nine bat carcasses and four bird carcasses were excluded from the analysis for having been found outside of the search interval. All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table F2. Estimated time of death for carcasses found at the Morning Light Wind Energy Facility from December 1, 2014, to November 15, 2015.

Type	Estimated Time of Death	Number of Carcasses	Percent Composition (%)
Bats	Last night	10	21.3
	2-3 days	12	25.5
	4-7 days	15	31.9
	7-14 days	8	17.0
	>2 week	1	2.1
	> Month	1	2.1
	Unknown	0	0
Large Birds	Last night	1	25.0
	2-3 days	0	0
	4-7 days	0	0
	7-14 days	1	25.0
	>2 week	0	0
	> Month	1	25.0
	Unknown	1	25.0
Small Birds	Last night	0	0
	2-3 days	4	66.7
	4-7 days	1	16.7
	7-14 days	0	0
	>2 week	0	0
	> Month	0	0
	Unknown	1	16.7

Searcher Efficiency

A total of 130 carcasses (50 bats, 40 large birds, and 40 small birds) were placed in the search area for searcher efficiency trials during the first year of monitoring. Logistic regression was used to model searcher efficiency. Model selection was based on corrected Akaike's Information Criterion, hereafter referred to as AICc. Seasonal estimates are only provided if season was included in the top model selected. The overall searcher efficiency rate for bats was 0.84 or 84.0%. The searcher efficiency rate for large birds was 0.92 or 91.9% and for small birds, it was 0.85 or 85.0% (Table F2).

Carcass Removal

A total of 135 carcasses (50 bats, 47 large birds, and 38 small birds) were placed in the project area for carcass removal trials during the first year of monitoring. The Huso method 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 various variables. The bat carcass removal rate was highest in spring at 3.21 days. In summer, the bat carcass removal rate was 2.29 days and 1.45 days in fall. Large bird carcass removal rates ranged from 29.28 in winter to 7.20 in fall. Carcass removal rate for small birds was highest during winter at 8.82 days and lowest in fall at 2.17 days (Table F2).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, and all birds, and 90% confidence intervals were calculated when at least five casualties were found (Table F3). Fatality estimates were not calculated for raptors because no raptors were found on search plots during the study period. The overall adjusted fatality rate was 20.19 bats/MW/year. For all birds combined, the adjusted fatality rate was 2.36 birds/MW/year, which consisted of 0.14 large birds/MW/year and 2.22 small birds/MW/year (Table F3). A complete list of casualties discovered at the Morning Light Wind Energy Facility is found in Table F4.

Table F3. The point estimates and bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

	Winter			Spring			Summer			Fall		
	Mean	90 % Confidence Interval		Mean	90 % Confidence Interval		Mean	90% Confidence Interval		Mean	90% Confidence Interval	
		Lower	Upper		Lower	Upper		Lower	Upper		Lower	Upper
Search Area Adjustment												
Bats	11.58	-	-	11.58	-	-	11.58	-	-	11.58	-	-
Large birds	10.12	-	-	10.12	-	-	10.12	-	-	10.12	-	-
Small birds	15.20	-	-	15.20	-	-	15.20	-	-	15.20	-	-
Observer Detection Rate												
Bats	0.84	0.76	0.92	0.84	0.76	0.92	0.84	0.76	0.92	0.84	0.76	0.92
Large birds	0.92	0.84	0.97	0.92	0.84	0.97	0.92	0.84	0.97	0.92	0.84	0.97
Small birds	0.85	0.75	0.92	0.85	0.75	0.92	0.85	0.75	0.92	0.85	0.75	0.92
Mean Carcass Removal Time (days)												
Bats	-	-	-	3.21	1.98	5.02	2.29	1.63	3.12	1.45	0.90	2.18
Large Birds	29.28	16.27	57.79	15.93	10.07	24.95	11.39	7.12	18.00	7.20	4.21	11.91
Small Birds	8.82	4.93	14.85	4.80	2.78	7.37	3.43	2.17	5.09	2.17	1.21	3.48
Average Probability of Carcass Persistence Through Search Interval With Effective Interval Adjustment												
Bats	-	-	-	0.40	0.29	0.52	0.32	-	-	0.22	0.15	0.31
Large Birds	-	-	-	-	-	-	0.75	-	-	-	-	-
Small Birds	0.48	-	-	0.50	-	-	-	-	-	0.31	-	-
Observed Carcass Counts Per Turbine												
Bats	-	-	-	0.11	0.05	0.18	0.09	-	-	0.61	0.41	0.84
Large birds	-	-	-	-	-	-	0.02	-	-	-	-	-
Small birds	0.05	-	-	0.02	-	-	-	-	-	0.05	-	-
Average Probability that Carcass Available and Detected												
Bats	-	-	-	0.34	0.24	0.44	0.27	-	-	0.19	0.12	0.27
Large birds	-	-	-	-	-	-	0.69	-	-	-	-	-
Small birds	0.41	-	-	0.43	-	-	-	-	-	0.26	-	-
Adjusted Fatality Rates (Fatalities/Turbine/Season)												
Bats	-	-	-	3.87	1.29	7.23	3.97	-	-	38.60	22.33	66.38
Large birds	-	-	-	-	-	-	0.33	-	-	-	-	-
Small birds	1.68	-	-	0.81	-	-	-	-	-	2.61	-	-

Overall Adjusted Fatality Rates (Fatalities/Turbine/Year)

	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	46.45	28.99	75.59
Large birds	0.33	-	-
Small birds	5.10	1.86	10.25
All birds	5.44	2.11	10.48

Overall Adjusted Fatality Rates (Fatalities/MW/Year)

	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	20.19	12.61	32.87
Large birds	0.14	-	-
Small birds	2.22	0.81	4.46

Table F3. The point estimates and bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

All birds	2.36	0.92	4.56

Table F4. Complete carcass listing for the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
Bats						
4/27/2015	silver-haired bat	17	83	carcass search	RandP	NA
4/27/2015	silver-haired bat	34	5	carcass search	RandP	scavenged
5/4/2015	silver-haired bat	3	8	carcass search	RandP	scavenged
5/4/2015	big brown bat	27	23	carcass search	RandP	intact
5/11/2015	evening bat	35	6	carcass search	RandP	intact
5/11/2015	silver-haired bat	42	1	carcass search	RandP	scavenged
5/19/2015	eastern red bat	34	9	carcass search	RandP	intact
6/1/2015	hoary bat	16	40	carcass search	RandP	NA
6/1/2015	hoary bat	22	35	carcass search	RandP	NA
6/8/2015	hoary bat	25	6	carcass search	RandP	intact
6/8/2015	hoary bat	43	12	carcass search	RandP	scavenged
6/16/2015	silver-haired bat	18	36	carcass search	RandP	scavenged
7/13/2015	eastern red bat	8	5	carcass search	RandP	NA
7/20/2015	hoary bat	3	1	carcass search	RandP	injured
7/20/2015	eastern red bat	30	33	carcass search	RandP	scavenged
7/29/2015	eastern red bat	6	5	carcass search	RandP	intact
7/29/2015	eastern red bat	7	6	carcass search	RandP	scavenged
7/29/2015	eastern red bat	10	24	carcass search	RandP	intact
7/29/2015	hoary bat	12	83	carcass search	RandP	intact
7/29/2015	hoary bat	17	4	carcass search	RandP	scavenged
7/29/2015	big brown bat	24	34	carcass search	RandP	scavenged
7/29/2015	eastern red bat	34	28	carcass search	RandP	scavenged
7/29/2015	eastern red bat	40	8	carcass search	RandP	scavenged
7/29/2015	eastern red bat	43	7	carcass search	RandP	scavenged
8/3/2015	big brown bat	6	6	carcass search	RandP	scavenged
8/3/2015	hoary bat	33	2	carcass search	RandP	NA
8/3/2015	eastern red bat	44	6	carcass search	RandP	NA
8/10/2015	hoary bat	11	6	carcass search	RandP	scavenged
8/10/2015	hoary bat	32	9	carcass search	RandP	scavenged
8/10/2015	hoary bat	39	8	carcass search	RandP	intact
8/10/2015	eastern red bat	44	7	carcass search	RandP	scavenged
8/17/2015	eastern red bat	3	10	carcass search	RandP	intact
8/17/2015	tricolored bat	13	24	carcass search	RandP	intact
8/17/2015	hoary bat	21	9	carcass search	RandP	intact
8/17/2015	eastern red bat	44	8	carcass search	RandP	intact
8/18/2015	hoary bat	31	5	carcass search	RandP	scavenged
8/19/2015	hoary bat	39	7	carcass search	RandP	scavenged
8/19/2015	eastern red bat	41	1	carcass search	RandP	intact
8/19/2015	eastern red bat	42	9	carcass search	RandP	intact
8/24/2015	eastern red bat	42	5	carcass search	RandP	scavenged
8/31/2015	hoary bat	32	68	carcass search	RandP	scavenged
8/31/2015	eastern red bat	35	3	carcass search	RandP	scavenged
8/31/2015	hoary bat	40	58	carcass search	RandP	scavenged
9/7/2015	hoary bat	27	1	carcass search	RandP	intact
9/7/2015	hoary bat	40	12	carcass search	RandP	scavenged
9/7/2015	hoary bat	42	9	carcass search	RandP	scavenged
9/7/2015	eastern red bat	44	7	carcass search	RandP	intact
9/14/2015	silver-haired bat	26	18	carcass search	RandP	scavenged
10/12/2015	eastern red bat	15	65	carcass search	RandP	scavenged
Birds						
12/6/2014	domestic chicken	23	108	incidental find	NA	scavenged
2/24/2015	unidentified large bird	15	9	incidental find	RandP	scavenged
3/5/2015	unidentified small bird	25	22	carcass search	40m Trans	dismembered
3/10/2015	European starling	3	1	carcass search	RandP	dismembered
3/10/2015	European starling	31	46	carcass search	RandP	intact
4/15/2015	mallard	34	10	carcass search	RandP	dismembered
5/11/2015	marsh wren	28	1	carcass search	RandP	intact
5/11/2015	gray catbird	32	110	incidental find	RandP	scavenged

Table F4. Complete carcass listing for the Morning Light Wind Energy Facility, Adair County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
7/5/2015	rock pigeon	27	7	carcass search	RandP	dismembered
7/13/2015	northern flicker	14	1	carcass search	RandP	scavenged
8/31/2015	dickcissel	11	1	carcass search	RandP	dismembered
8/31/2015	dickcissel	37	3	carcass search	RandP	scavenged
9/15/2015	unidentified small bird	1	10	carcass search	RandP	feather spot

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix G: Summary of Fatality Monitoring Surveys Conducted at the Rolling Hills Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Rolling Hills Wind Energy consists of 193 SWT- 2.3-101 2.3-megawatt turbines for a nameplate capacity of 443.9 MW. The facility is located across approximately 44,294 acres (69 mi^2) spanning Adair, Adams, and Cass counties in southwestern Iowa. Rolling Hills is located just west of Bridgewater, Iowa. The facility is located in the Rolling Loess Prairies Level 4 Ecoregion. According to the National Land Cover Database, the landscape predominantly consists of cropland (53.9%) and pasture/hay (37.8%). Approximately 4.0% of the Rolling Hills project area is developed, and deciduous forest, shrub/sage-steppe, open water, grassland, evergreen forest, woody wetlands, barren land or emergent wetlands each represent less than 2% of land cover.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 7,567 road and pad searches were conducted at Rolling Hills during 41 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

A total of 128 bats and 59 birds were found on standardized road and pad search areas of incidentally at Rolling Hills (Table G1). Of the six bat species found, eastern red, hoary, and big brown bats were the bat species most commonly found (47, 43, and 24 carcasses, respectively). No federal or state listed bat species were found, and no *Myotis* bats were found. Of the 29 unique bird species found on standardized road and pad searches and incidentally, turkey vulture (eight carcasses) was the bird species most commonly found. No federal or state listed bird species were found (Table G1).

As expected based on the study design, the majority of bat and bird carcasses included in the analysis were found within 10 meters of the turbine; all bird and bat carcasses included in the analysis were found within 90 meters of the turbine (Figures G1 and G2). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at Rolling Hills (Figures G3-G6). Most bat fatalities were found from mid-July to late September (Figure G7). Birds were found throughout the study period, although slightly more frequently in July and August (Figure G8).

Table G1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
eastern red bat	35	36.8	4	26.7	8	44.4	47	36.7
hoary bat	31	32.6	9	60.0	3	16.7	43	33.6
big brown bat	19	20.0	1	6.7	4	22.2	24	18.8
evening bat	6	6.3	0	0	1	5.6	7	5.5
silver-haired bat	3	3.2	1	6.7	1	5.6	5	3.9
tricolored bat	1	1.1	0	0	1	5.6	2	1.6
Overall Bats	**95**	**100**	**15**	**100**	**18**	**100**	**128**	**100**
Birds								
turkey vulture	2	8.3	1	12.5	5	18.5	8	13.6
red-tailed hawk	1	4.2	0	0	3	11.1	4	6.8
cliff swallow	1	4.2	0	0	2	7.4	3	5.1
American coot	0	0	1	12.5	2	7.4	3	5.1
dark-eyed junco	0	0	0	0	3	11.1	3	5.1
ring-necked pheasant	0	0	3	37.5	0	0	3	5.1
European starling	2	8.3	0	0	0	0	2	3.4
mourning dove	2	8.3	0	0	0	0	2	3.4
American robin	1	4.2	1	12.5	0	0	2	3.4
horned lark	1	4.2	0	0	1	3.7	2	3.4
red-winged blackbird	1	4.2	0	0	1	3.7	2	3.4
blue-winged teal	0	0	0	0	2	7.4	2	3.4
northern bobwhite	0	0	0	0	2	7.4	2	3.4
unidentified falcon	0	0	0	0	2	7.4	2	3.4
American goldfinch	1	4.2	0	0	0	0	1	1.7
American redstart	1	4.2	0	0	0	0	1	1.7
cedar waxwing	1	4.2	0	0	0	0	1	1.7
dickcissel	1	4.2	0	0	0	0	1	1.7
eastern meadowlark	1	4.2	0	0	0	0	1	1.7
killdeer	1	4.2	0	0	0	0	1	1.7
northern waterthrush	1	4.2	0	0	0	0	1	1.7
pine warbler	1	4.2	0	0	0	0	1	1.7
unidentified empidonax	1	4.2	0	0	0	0	1	1.7
unidentified shorebird	1	4.2	0	0	0	0	1	1.7
upland sandpiper	1	4.2	0	0	0	0	1	1.7
western meadowlark	1	4.2	0	0	0	0	1	1.7
yellow-throated vireo	1	4.2	0	0	0	0	1	1.7
hairy woodpecker	0	0	1	12.5	0	0	1	1.7
house sparrow	0	0	1	12.5	0	0	1	1.7
American white pelican	0	0	0	0	1	3.7	1	1.7
brown-headed cowbird	0	0	0	0	1	3.7	1	1.7
unidentified flycatcher	0	0	0	0	1	3.7	1	1.7

Table G1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
yellow-billed cuckoo	0	0	0	0	1	3.7	1	1.7
Overall Birds	**24**	**100**	**8**	**100**	**27**	**100**	**59**	**100**

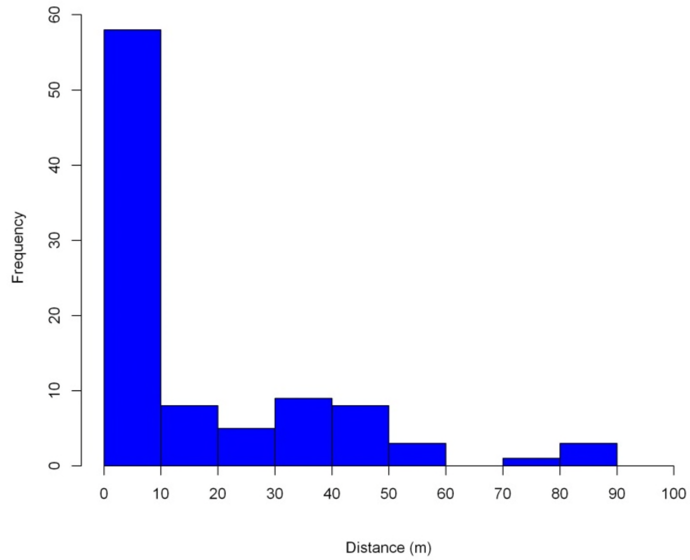

Figure G1. Distance from the turbine for bat carcasses included in the analysis for Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

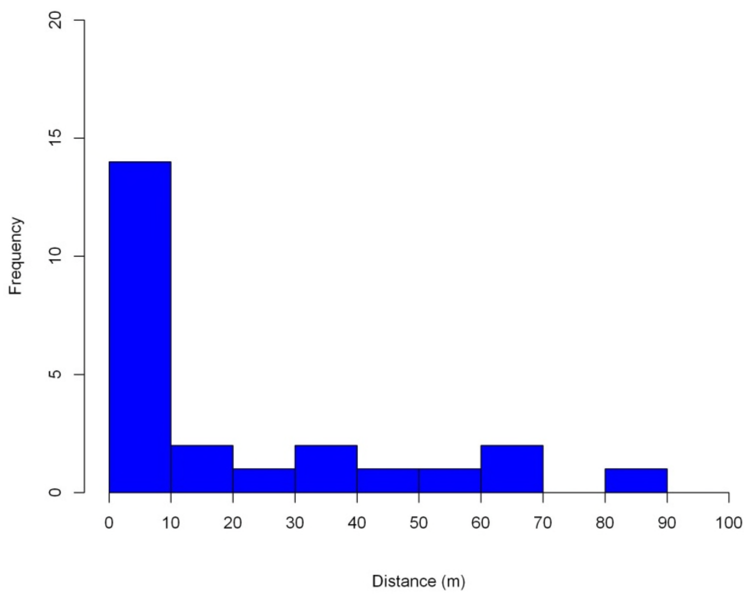

Figure G2. Distance from the turbine for bird carcasses included in the analysis for the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

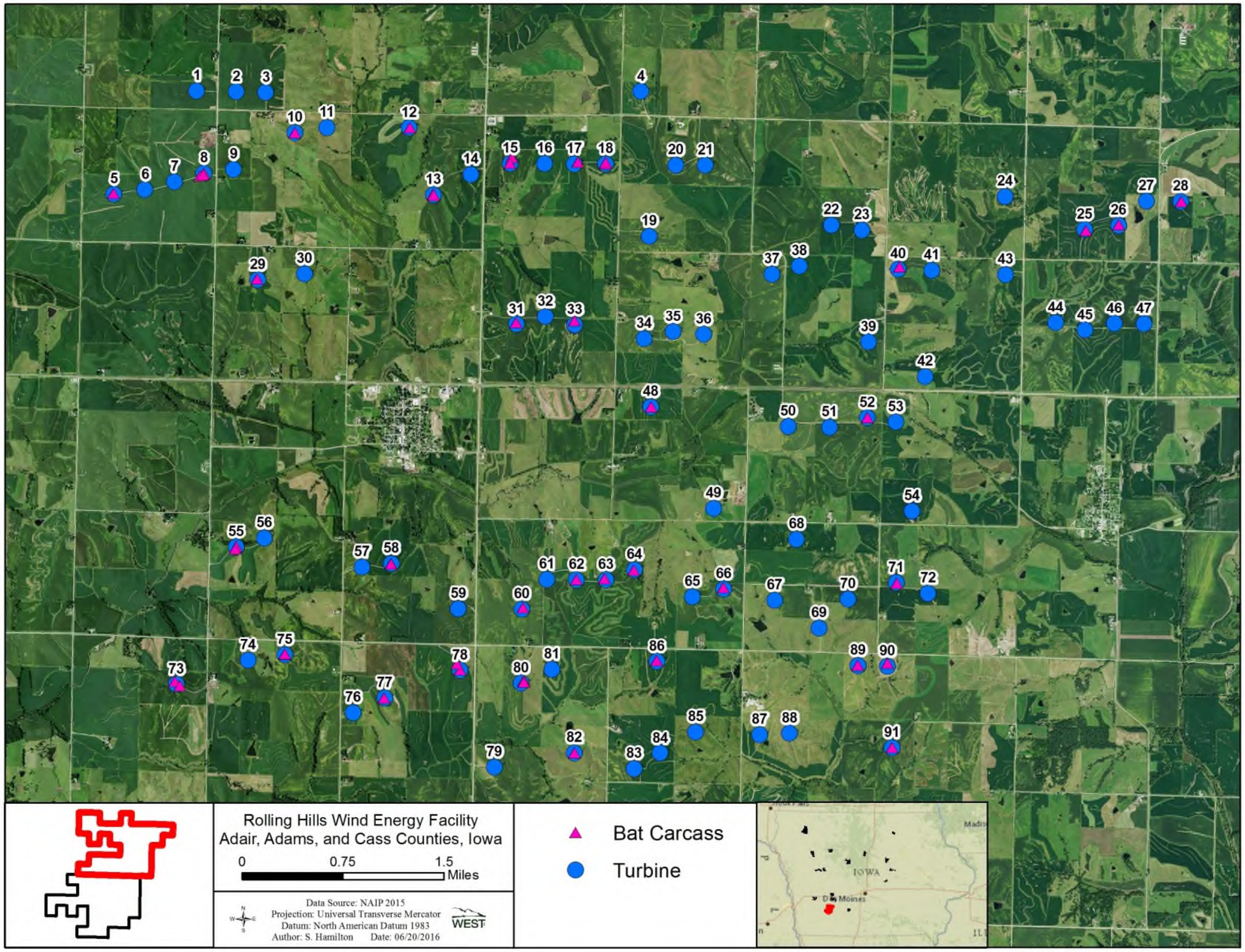

Figure G3. Location of all bat carcasses found during scheduled searches or incidentally in the northern portion of the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

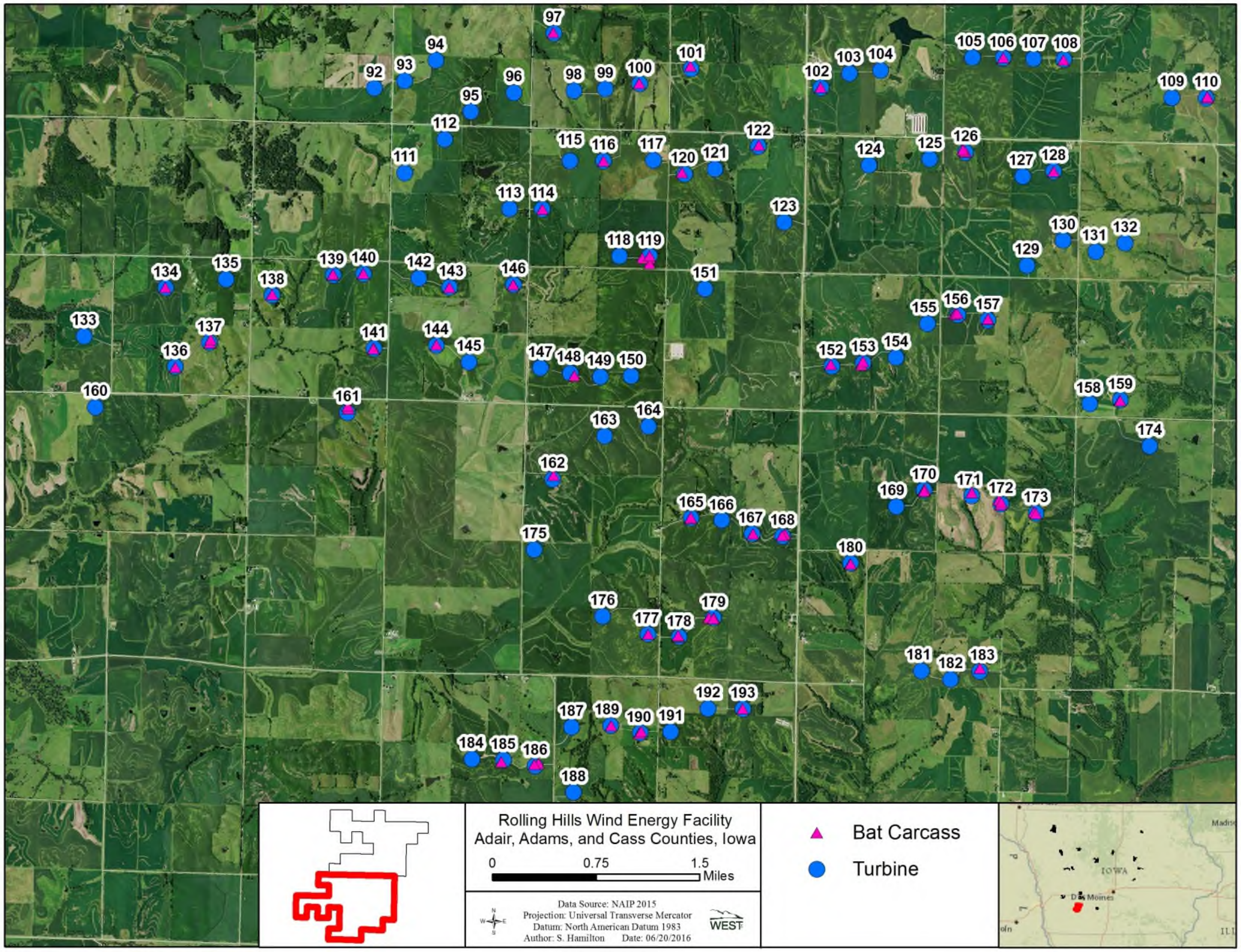

Figure G4. Location of all bat carcasses found during scheduled searches or incidentally in the southern portion of the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

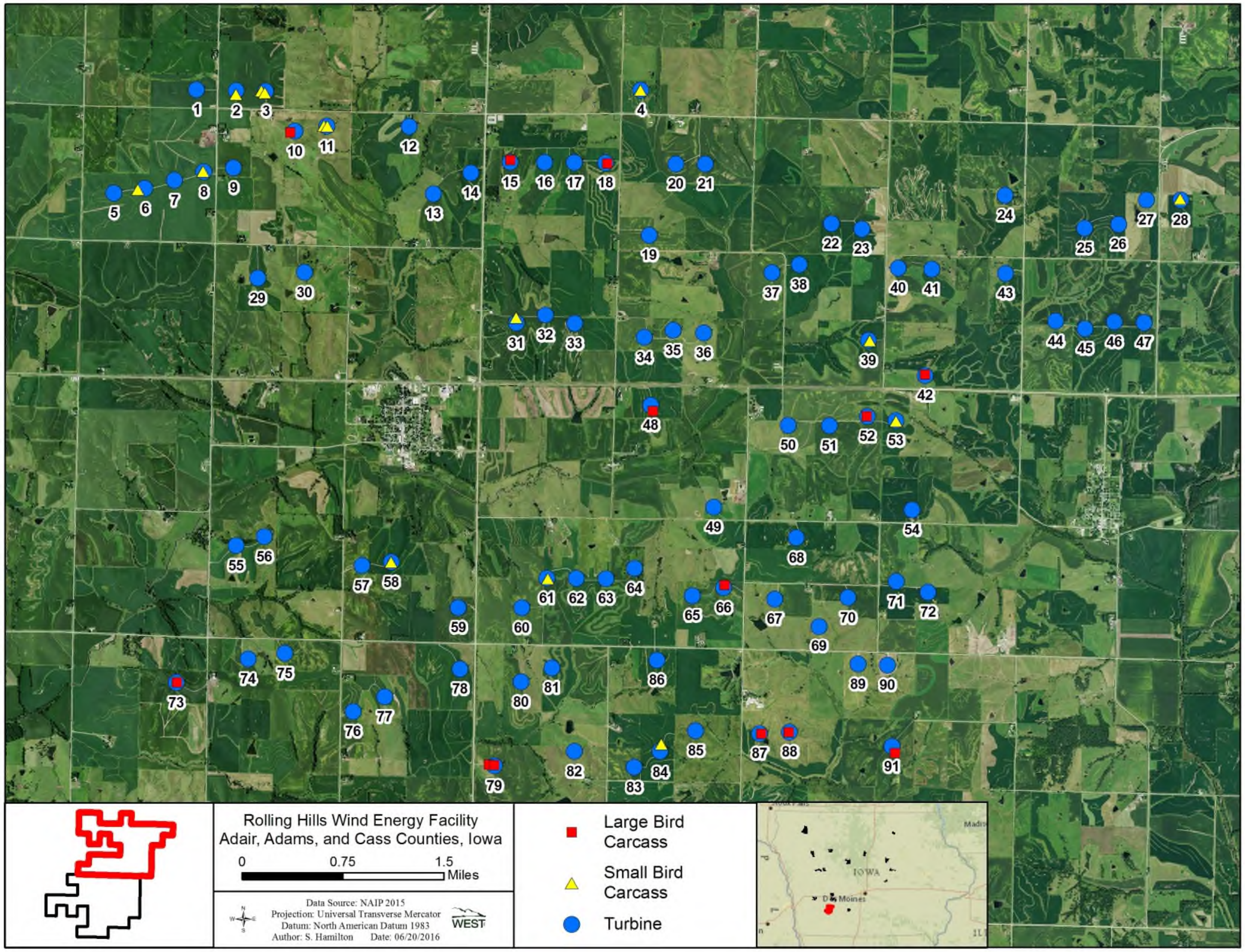

Figure G4. Location of all bird carcasses found during scheduled searches or incidentally in the northern portion of the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

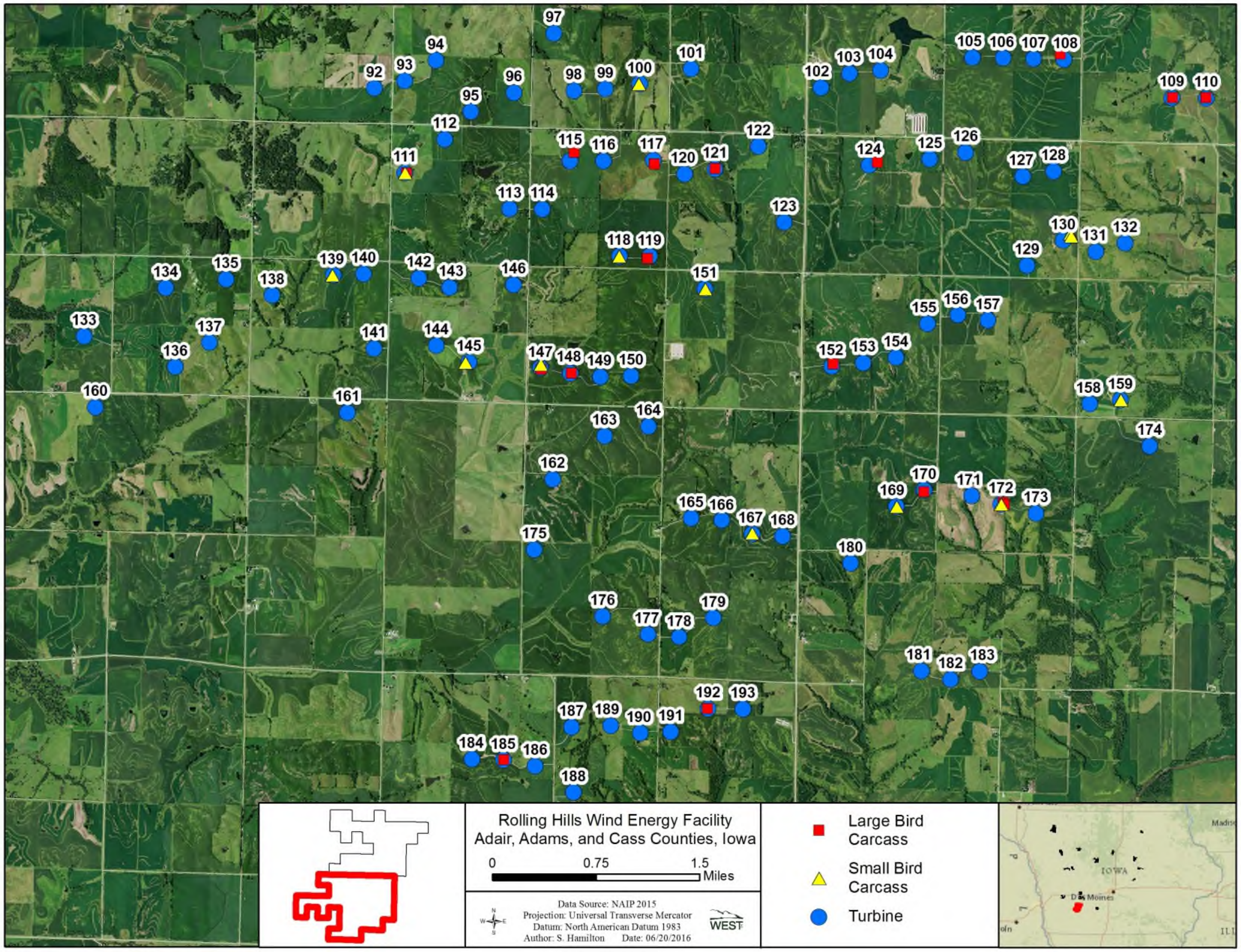

Figure G6. Location of all bird carcasses found during scheduled searches or incidentally in the southern portion of the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

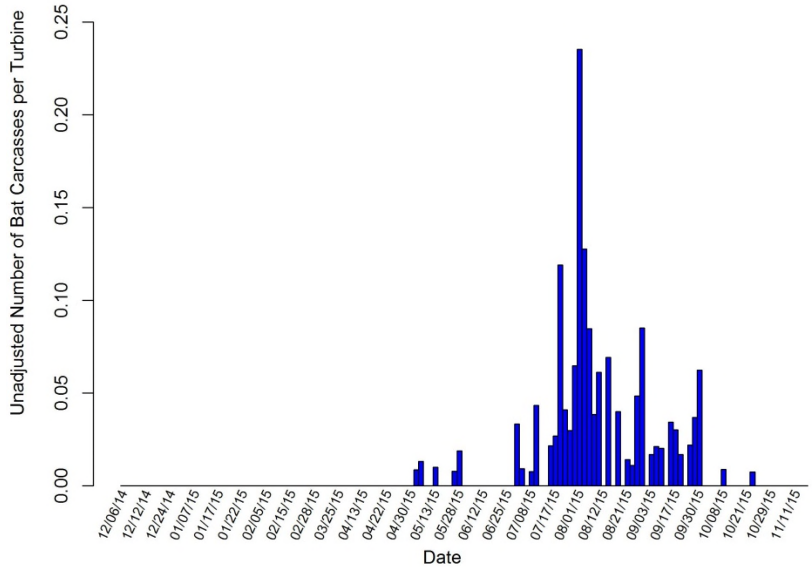

Figure G7. Timing of bat carcasses included in the analysis for the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

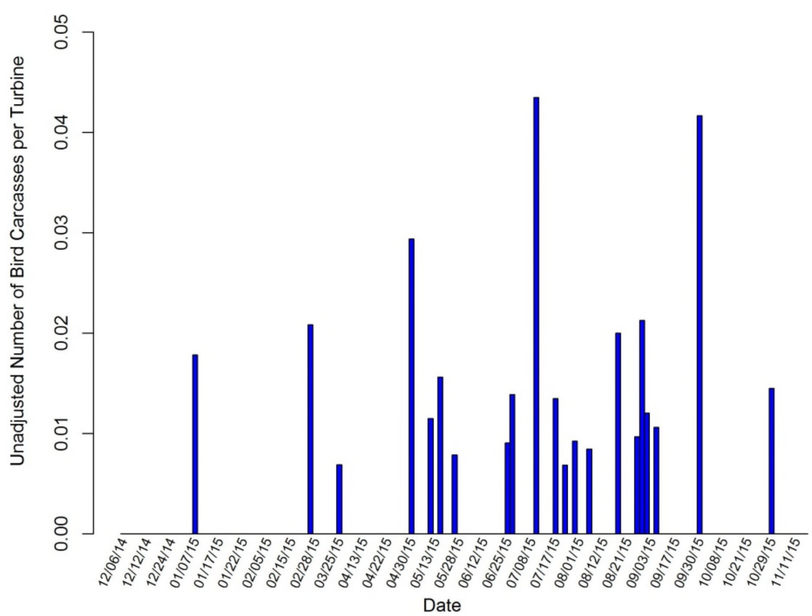

Figure G8. Timing of bird carcasses included in the analysis for the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Rolling Hills, the majority of bat carcasses (84.5%) were found within seven days of the estimated time of death (Table G2). Most large bird carcasses (80.0%) were estimated to have been found within two weeks of death, and 77.3% of small birds were estimated to have been found within one week of death (G2). Whether carcasses were included in analysis was based on the specific search interval for the turbine where the carcass was found. If the estimated time since death of the carcass was more recent than the previous search of the turbine the carcass was found, the carcass was included in the fatality estimate. If the estimated time since death was greater than the most recent search of the turbine the carcass was found, 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). Fifteen bat carcasses and eight bird carcasses were excluded from the analysis for having been found outside of the search interval. All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table G2. Estimated time of death for carcasses found at the Rolling Hills Wind Energy Facility from December 1, 2014, to November 15, 2015.

Type	Estimated Time of Death	Number of Carcasses	Percent Composition (%)
Bats	Last night	35	31.8
	2-3 days	32	29.1
	4-7 days	26	23.6
	7-14 days	9	8.2
	>2 week	4	3.6
	> Month	0	0
	Unknown	4	3.6
Large birds	Last night	2	13.3
	2-3 days	4	26.7
	4-7 days	1	6.7
	7-14 days	5	33.3
	>2 week	0	0
	> Month	1	6.7
	Unknown	2	13.3
Small birds	Last night	2	9.1
	2-3 days	9	40.9
	4-7 days	6	27.3
	7-14 days	4	18.2
	>2 week	0	0
	> Month	0	0
	Unknown	1	4.5

Searcher Efficiency

A total of 130 carcasses (50 bats, 40 large birds, and 40 small birds) were placed in the survey area for searcher efficiency trials during the first year of monitoring. Logistic regression was used to model searcher efficiency. Model selection was based on corrected Akaike's Information Criterion, hereafter referred to as AICc. Seasonal estimates are only provided if season was included in the top model selected. The overall searcher efficiency rate for bats was 89.8%. The searcher efficiency rate for large birds was 97.5%, and 76.9% for small birds (Table G3).

Carcass Removal

A total of 133 carcasses (50 bats, 48 large birds, and 35 small birds) were placed throughout the project area for carcass removal trials during the first year of monitoring. The Huso method 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 various variables. The mean carcass removal time was 5.26 days for bats, 6.86 days for small birds, and 18.76 days for large birds (Table G3).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, raptors, small birds, and all birds, and 90% confidence intervals were calculates when at least five casualties were found (Table G3). The overall adjusted bat fatality rate was 6.13 bats/MW/year. The bird fatality rate was 1.79 birds/MW/year, which consisted of 1.54 small birds/MW/year and 0.25 large birds/MW/year. The adjusted raptor fatality estimate was 0.04 raptors/MW/year (Table G3). A complete list of casualties discovered at the Rolling Hills Wind Energy Facility is found in Table G4.

Table G3. The point estimates and bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Overall			
	Mean	90% Confidence Interval	
		Lower	Upper
Search Area Adjustment			
Bats	13.48	-	-
Large birds	11.28	-	-
Small birds	16.95	-	-
Observer Detection Rate			
Bats	0.90	0.82	0.96
Large birds	0.97	0.92	1.00
Small birds	0.77	0.65	0.88
Mean Carcass Removal Time (days)			
Bats	5.26	3.84	7.26
Large birds	18.76	13.10	27.39
Small birds	6.86	4.68	9.96
Average Probability of Carcass persistence Through Search Interval With Effective Interval Adjustments			
Bats	0.53	0.45	0.61
Large birds	0.74	0.66	0.81
Raptors	0.63	-	-
Small birds	0.56	0.46	0.65
Observed Carcass Counts Per Turbine			
Bats	0.49	0.41	0.59
Large birds	0.04	0.02	0.06
Raptors	0.01	-	-
Small birds	0.09	0.06	0.12
Average Probability that Carcass Available and Detected			
Bats	0.48	0.40	0.56
Large birds	0.72	0.64	0.80
Raptors	0.61	-	-
Small birds	0.43	0.33	0.53
Overall Adjusted Fatality Estimates (Fatalities/Turbine/Year)			
	Mean	**90% Confidence Interval**	
		Lower Limit	**Upper Limit**
Bats	14.10	10.99	18.08
Large birds	0.57	0.22	1.01
Raptors	0.10	-	-
Small birds	3.54	2.16	5.36
All birds	4.11	2.64	6.04
Overall Adjusted Fatality Estimates (Fatalities/MW/Year)			
	Mean	**90% Confidence Interval**	
		Lower Limit	**Upper Limit**
Bats	6.13	4.78	7.86
Large birds	0.25	0.10	0.44
Raptors	0.04	-	-
Small birds	1.54	0.94	2.33
All birds	1.79	1.15	2.63

Table G4. Complete carcass listing for the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Survey Type[1]	Condition
			Bats			
4/15/2015	silver-haired bat	120	35	carcass search	40m Trans	intact
4/28/2015	eastern red bat	13	27	carcass search	RandP	scavenged
5/5/2015	evening bat	143	0	carcass search	RandP	injured
5/6/2015	evening bat	80	44	carcass search	RandP	intact
5/13/2015	hoary bat	186	49	carcass search	RandP	intact
5/27/2015	eastern red bat	106	7	carcass search	RandP	scavenged
5/27/2015	evening bat	122	15	carcass search	RandP	scavenged
5/28/2015	hoary bat	157	5	carcass search	RandP	scavenged
7/1/2015	big brown bat	91	0	carcass search	RandP	scavenged
7/2/2015	eastern red bat	62	0	carcass search	RandP	intact
7/2/2015	big brown bat	172	37	carcass search	RandP	scavenged
7/3/2015	eastern red bat	190	4	carcass search	RandP	intact
7/8/2015	eastern red bat	119	20	carcass search	RandP	scavenged
7/9/2015	hoary bat	156	32	carcass search	RandP	scavenged
7/16/2015	big brown bat	17	46	carcass search	RandP	scavenged
7/16/2015	big brown bat	55	32	carcass search	RandP	scavenged
7/16/2015	hoary bat	153	34	carcass search	RandP	intact
7/17/2015	hoary bat	134	1	carcass search	RandP	intact
7/17/2015	eastern red bat	141	6	carcass search	RandP	intact
7/17/2015	hoary bat	172	0	incidental find	RandP	injured
7/22/2015	big brown bat	5	7	carcass search	RandP	intact
7/22/2015	eastern red bat	8	5	carcass search	RandP	scavenged
7/22/2015	eastern red bat	8	56	carcass search	RandP	scavenged
7/22/2015	hoary bat	12	7	carcass search	RandP	scavenged
7/22/2015	hoary bat	156	45	carcass search	RandP	intact
7/23/2015	hoary bat	25	20	carcass search	RandP	scavenged
7/23/2015	hoary bat	26	8	carcass search	RandP	scavenged
7/23/2015	hoary bat	55	2	carcass search	RandP	scavenged
7/23/2015	eastern red bat	63	34	carcass search	RandP	intact
7/23/2015	big brown bat	75	6	carcass search	RandP	NA
7/23/2015	hoary bat	108	2	carcass search	RandP	intact
7/23/2015	hoary bat	126	5	carcass search	RandP	injured
7/23/2015	big brown bat	136	2	carcass search	RandP	scavenged
7/23/2015	hoary bat	167	8	carcass search	RandP	scavenged
7/23/2015	evening bat	183	24	carcass search	RandP	NA
7/30/2015	eastern red bat	77	3	carcass search	RandP	intact
7/30/2015	eastern red bat	148	52	carcass search	RandP	scavenged
7/31/2015	big brown bat	71	8	carcass search	RandP	intact
7/31/2015	eastern red bat	90	39	carcass search	RandP	scavenged
7/31/2015	eastern red bat	110	22	carcass search	RandP	scavenged
7/31/2015	hoary bat	126	4	carcass search	RandP	scavenged
7/31/2015	big brown bat	159	18	carcass search	RandP	scavenged
7/31/2015	eastern red bat	168	33	carcass search	RandP	scavenged
7/31/2015	hoary bat	185	34	carcass search	RandP	scavenged
7/31/2015	big brown bat	186	5	carcass search	RandP	scavenged
7/31/2015	evening bat	189	3	carcass search	RandP	scavenged
8/1/2015	hoary bat	165	10	carcass search	RandP	scavenged
8/1/2015	big brown bat	179	5	carcass search	RandP	intact
8/1/2015	eastern red bat	179	50	carcass search	RandP	scavenged
8/1/2015	eastern red bat	180	8	carcass search	RandP	intact
8/1/2015	big brown bat	193	2	carcass search	RandP	intact
8/5/2015	big brown bat	31	23	carcass search	RandP	intact
8/5/2015	eastern red bat	33	45	carcass search	RandP	intact
8/5/2015	big brown bat	52	1	incidental find	RandP	scavenged
8/5/2015	hoary bat	157	11	carcass search	RandP	intact
8/5/2015	eastern red bat	159	9	carcass search	RandP	intact
8/5/2015	hoary bat	173	27	carcass search	RandP	intact
8/6/2015	eastern red bat	15	1	carcass search	RandP	scavenged
8/6/2015	evening bat	28	6	carcass search	RandP	scavenged

Table G4. Complete carcass listing for the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Survey Type[1]	Condition
8/6/2015	big brown bat	29	6	carcass search	RandP	intact
8/6/2015	hoary bat	64	9	carcass search	RandP	intact
8/6/2015	eastern red bat	75	5	carcass search	RandP	intact
8/6/2015	hoary bat	75	8	carcass search	RandP	intact
8/6/2015	big brown bat	89	1	carcass search	RandP	scavenged
8/6/2015	big brown bat	102	4	carcass search	RandP	scavenged
8/6/2015	silver-haired bat	144	8	carcass search	RandP	intact
8/6/2015	eastern red bat	146	4	carcass search	RandP	scavenged
8/6/2015	eastern red bat	165	5	carcass search	RandP	scavenged
8/6/2015	eastern red bat	178	18	carcass search	RandP	scavenged
8/6/2015	eastern red bat	178	18	carcass search	RandP	scavenged
8/7/2015	big brown bat	48	5	carcass search	RandP	scavenged
8/11/2015	eastern red bat	78	5	carcass search	RandP	scavenged
8/11/2015	hoary bat	86	11	carcass search	RandP	scavenged
8/11/2015	hoary bat	97	16	carcass search	RandP	scavenged
8/13/2015	hoary bat	15	70	carcass search	RandP	scavenged
8/13/2015	hoary bat	18	19	carcass search	RandP	scavenged
8/13/2015	hoary bat	40	31	carcass search	RandP	intact
8/13/2015	eastern red bat	139	12	carcass search	RandP	scavenged
8/13/2015	evening bat	139	8	carcass search	RandP	scavenged
8/13/2015	big brown bat	157	6	carcass search	RandP	scavenged
8/13/2015	eastern red bat	162	45	carcass search	RandP	scavenged
8/13/2015	hoary bat	170	5	carcass search	RandP	intact
8/13/2015	hoary bat	177	4	carcass search	RandP	scavenged
8/19/2015	hoary bat	8	22	carcass search	RandP	intact
8/19/2015	eastern red bat	58	4	carcass search	RandP	intact
8/19/2015	tricolored bat	60	10	carcass search	RandP	intact
8/20/2015	hoary bat	139	11	carcass search	RandP	scavenged
8/20/2015	big brown bat	170	10	carcass search	RandP	scavenged
8/21/2015	hoary bat	80	36	carcass search	RandP	scavenged
8/26/2015	eastern red bat	18	2	carcass search	RandP	intact
8/27/2015	tricolored bat	141	1	carcass search	RandP	intact
8/27/2015	big brown bat	146	1	carcass search	RandP	scavenged
8/27/2015	hoary bat	161	43	carcass search	RandP	dismembered
8/27/2015	eastern red bat	173	3	carcass search	RandP	scavenged
8/27/2015	eastern red bat	180	1	incidental find	RandP	intact
9/1/2015	eastern red bat	82	1	carcass search	RandP	dismembered
9/1/2015	eastern red bat	100	4	carcass search	RandP	scavenged
9/1/2015	eastern red bat	101	32	carcass search	RandP	intact
9/1/2015	eastern red bat	110	21	carcass search	RandP	scavenged
9/1/2015	eastern red bat	116	1	carcass search	RandP	intact
9/1/2015	hoary bat	119	7	carcass search	RandP	intact
9/2/2015	hoary bat	128	4	carcass search	RandP	scavenged
9/2/2015	hoary bat	152	23	carcass search	RandP	scavenged
9/2/2015	eastern red bat	156	23	carcass search	RandP	scavenged
9/2/2015	eastern red bat	178	20	carcass search	RandP	scavenged
9/3/2015	hoary bat	66	14	carcass search	RandP	scavenged
9/9/2015	hoary bat	10	0	carcass search	RandP	scavenged
9/9/2015	hoary bat	138	12	carcass search	RandP	scavenged
9/9/2015	big brown bat	140	8	incidental find	NA	intact
9/10/2015	eastern red bat	137	2	incidental find	NA	scavenged
9/10/2015	hoary bat	137	5	incidental find	NA	dismembered
9/10/2015	eastern red bat	170	8	carcass search	RandP	scavenged
9/10/2015	hoary bat	190	26	carcass search	RandP	scavenged
9/16/2015	hoary bat	78	86	carcass search	RandP	dismembered
9/16/2015	eastern red bat	161	71	carcass search	RandP	scavenged
9/16/2015	silver-haired bat	179	6	carcass search	RandP	scavenged
9/17/2015	hoary bat	58	0	carcass search	RandP	intact
9/17/2015	hoary bat	73	4	carcass search	RandP	injured
9/22/2015	silver-haired bat	153	5	carcass search	RandP	intact

Table G4. Complete carcass listing for the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Survey Type[1]	Condition
9/25/2015	big brown bat	171	31	carcass search	RandP	intact
9/25/2015	eastern red bat	172	22	carcass search	RandP	intact
9/29/2015	big brown bat	114	5	carcass search	RandP	scavenged
9/29/2015	eastern red bat	126	41	carcass search	RandP	dismembered
9/30/2015	eastern red bat	73	51	carcass search	RandP	scavenged
9/30/2015	eastern red bat	119	86	carcass search	RandP	scavenged
9/30/2015	silver-haired bat	119	90	carcass search	RandP	scavenged
10/8/2015	eastern red bat	168	3	carcass search	RandP	scavenged
10/22/2015	eastern red bat	13	1	carcass search	RandP	intact
Birds						
12/8/2014	house sparrow	53	5	carcass search	RandP	intact
12/11/2014	American white pelican	117	42	incidental find	NA	scavenged
12/23/2014	unidentified falcon	108	74	carcass search	40m Trans	feather spot
1/7/2015	European starling	159	3	carcass search	RandP	intact
1/15/2015	red-tailed hawk	18	20	carcass search	100m Scan	intact
2/26/2015	European starling	151	0	carcass search	RandP	intact
3/16/2015	turkey vulture	147	17	carcass search	20m Trans	scavenged
3/17/2015	northern bobwhite	91	78	carcass search	20m Trans	feather spot
3/17/2015	turkey vulture	115	105	carcass search	20m Trans	scavenged
3/17/2015	dark-eyed junco	84	87	carcass search	20m Trans	intact
3/17/2015	dark-eyed junco	130	110	carcass search	20m Trans	intact
3/17/2015	dark-eyed junco	130	109	carcass search	20m Trans	intact
3/25/2015	red-tailed hawk	10	55	carcass search	RandP	intact
4/6/2015	red-tailed hawk	66	34	carcass search	100m Scan	dismembered
4/14/2015	American coot	48	47	carcass search	40m Trans	intact
4/14/2015	American coot	170	12	carcass search	RandP	intact
4/16/2015	red-winged blackbird	147	38	carcass search	20m Trans	dismembered
4/17/2015	eastern meadowlark	100	6	incidental find	NA	intact
4/21/2015	blue-winged teal	148	11	carcass search	RandP	dismembered
4/22/2015	blue-winged teal	192	9	carcass search	RandP	intact
4/28/2015	unidentified flycatcher	3	40	carcass search	100m Scan	scavenged
4/29/2015	American coot	52	8	carcass search	RandP	dismembered
4/30/2015	upland sandpiper	119	38	carcass search	RandP	intact
5/5/2015	turkey vulture	111	27	carcass search	RandP	scavenged
5/5/2015	turkey vulture	172	34	carcass search	RandP	scavenged
5/12/2015	yellow-throated vireo	118	4	carcass search	RandP	intact
5/20/2015	turkey vulture	87	16	carcass search	RandP	intact
5/20/2015	American redstart	31	61	carcass search	RandP	NA
5/27/2015	northern bobwhite	42	5	carcass search	RandP	feather spot
5/27/2015	horned lark	169	6	carcass search	RandP	intact
6/18/2015	turkey vulture	152	32	carcass search	RandP	scavenged
6/25/2015	cedar waxwing	8	3	carcass search	RandP	scavenged
6/26/2015	red-winged blackbird	172	1	carcass search	RandP	intact
7/3/2015	hairy woodpecker	167	4	carcass search	RandP	scavenged
7/9/2015	American robin	58	0	carcass search	RandP	dismembered
7/10/2015	horned lark	61	6	carcass search	RandP	NA
7/17/2015	unidentified shorebird	111	0	carcass search	RandP	scavenged
7/22/2015	cliff swallow	3	2	carcass search	RandP	scavenged
7/23/2015	cliff swallow	28	16	carcass search	RandP	scavenged
7/30/2015	ring-necked pheasant	121	1	carcass search	RandP	dismembered
7/31/2015	mourning dove	185	2	carcass search	RandP	scavenged
8/6/2015	ring-necked pheasant	110	2	carcass search	RandP	scavenged
8/6/2015	dickcissel	4	0	carcass search	RandP	intact
8/19/2015	killdeer	79	69	incidental find	NA	intact
8/19/2015	cliff swallow	39	11	carcass search	RandP	scavenged
8/19/2015	American robin	58	1	carcass search	RandP	feather spot
8/26/2015	unidentified falcon	124	40	carcass search	RandP	feather spot
8/27/2015	turkey vulture	172	26	carcass search	RandP	scavenged
9/1/2015	mourning dove	79	2	carcass search	RandP	intact
9/2/2015	western meadowlark	11	1	carcass search	RandP	scavenged

Table G4. Complete carcass listing for the Rolling Hills Wind Energy Facility; Adair, Adams, and Cass counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Survey Type[1]	Condition
9/9/2015	northern waterthrush	145	39	carcass search	RandP	intact
9/16/2015	ring-necked pheasant	109	2	carcass search	RandP	dismembered
9/22/2015	yellow-billed cuckoo	15	28	carcass search	RandP	scavenged
9/30/2015	unidentified empidonax	2	46	carcass search	RandP	intact
9/30/2015	pine warbler	6	84	carcass search	RandP	scavenged
10/1/2015	red-tailed hawk	88	1	carcass search	RandP	dismembered
10/22/2015	brown-headed cowbird	11	38	carcass search	RandP	scavenged
10/27/2015	turkey vulture	73	14	carcass search	RandP	scavenged
10/29/2015	American goldfinch	139	2	carcass search	RandP	dismembered

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix H: Summary of Fatality Monitoring Surveys Conducted at the Victory Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Victory Wind Energy Facility consists of 66 GE 1.5 SLE SSB pitch 1.5-megawatt turbines for a nameplate capacity of 99 MW. The facility is located across approximately 18,129 acres (28 mi^2) in Carroll and Crawford counties in west-central Iowa. The facility is located approximately 2.5 miles west of Westside, Iowa. The Victory facility is located in the Steeply Rolling Loess Prairies Level 4 Ecoregion. According to the National Land Cover Database, the landscape predominantly consists of cropland (91.2%). Developed land (5.1%) and pasture/hay (3.0%) are the next most common land cover types. Grassland, open water, deciduous forest, emergent wetlands, and barren land each account for less than 1% of the project area.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 2,666 road and pad searches were conducted at Victory during 41 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

Twenty-one bats and 13 birds were found on standardized road and pad search areas or incidentally at Victory (Table H1). Four bat species were found, and approximately 86% of carcasses were either hoary bat or eastern red bat. European starling was the only identified species found twice, each remaining bird species was only found once. No bat or bird species listed by the state or under the Endangered Species Act were found, and *Myotis* bats were not found at the facility (Table H1).

Most bat carcasses included in the analysis were found within 50 meters of turbines, and most bird carcasses included in the analysis were found within 10 meters of turbines (Figures H1 and H2). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at Victory (Figures H3 and H4). Most bat fatalities were found from mid-July to early September, while most birds were found in the fall (Figures H5 and H6). The relatively high unadjusted number of bird fatalities per turbine on March 12, 2015, was one bird found on a day when only nine turbines were searched (Figure H6).

Table H1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
hoary bat	7	43.8	1	33.3	1	50.0	9	42.9
eastern red bat	6	37.5	2	66.7	1	50.0	9	42.9
big brown bat	2	12.5	0	0	0	0	2	9.5
silver-haired bat	1	6.3	0	0	0	0	1	4.8
Overall Bats	**16**	**100**	**3**	**100**	**2**	**100**	**21**	**100**
Birds								
European starling	1	16.7	0	0	1	20.0	2	15.4
unidentified passerine	1	16.7	1	50.0	0	0	2	15.4
Franklin's gull	1	16.7	0	0	0	0	1	7.7
house wren	1	16.7	0	0	0	0	1	7.7
northern flicker	1	16.7	0	0	0	0	1	7.7
western meadowlark	1	16.7	0	0	0	0	1	7.7
American robin	0	0	1	50.0	0	0	1	7.7
American coot	0	0	0	0	1	20.0	1	7.7
house sparrow	0	0	0	0	1	20.0	1	7.7
ring-necked pheasant	0	0	0	0	1	20.0	1	7.7
ruddy duck	0	0	0	0	1	20.0	1	7.7
Overall Birds	**6**	**100**	**2**	**100**	**5**	**100**	**13**	**100**

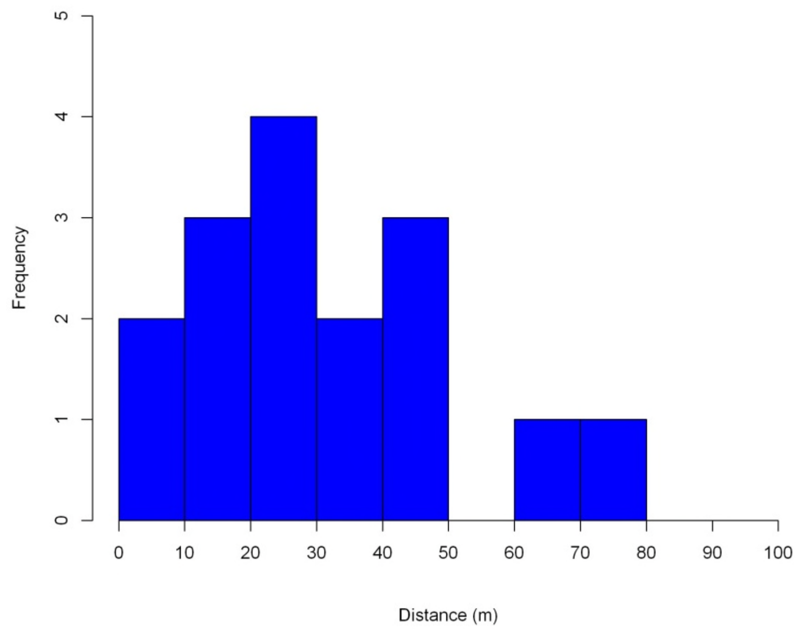

Figure H1. Distance from the turbine for bat carcasses included in the analysis for the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

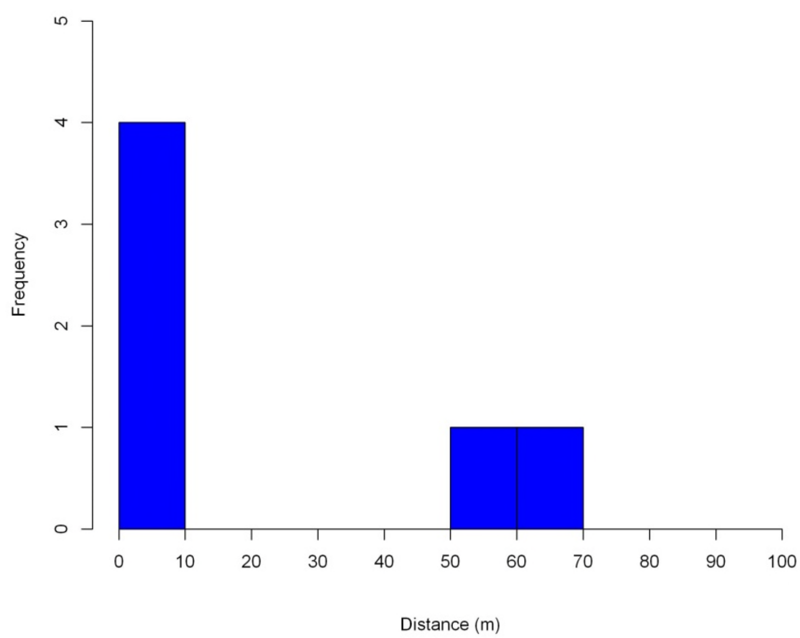

Figure H2. Distance from the turbine of bird carcasses included in the analysis for the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

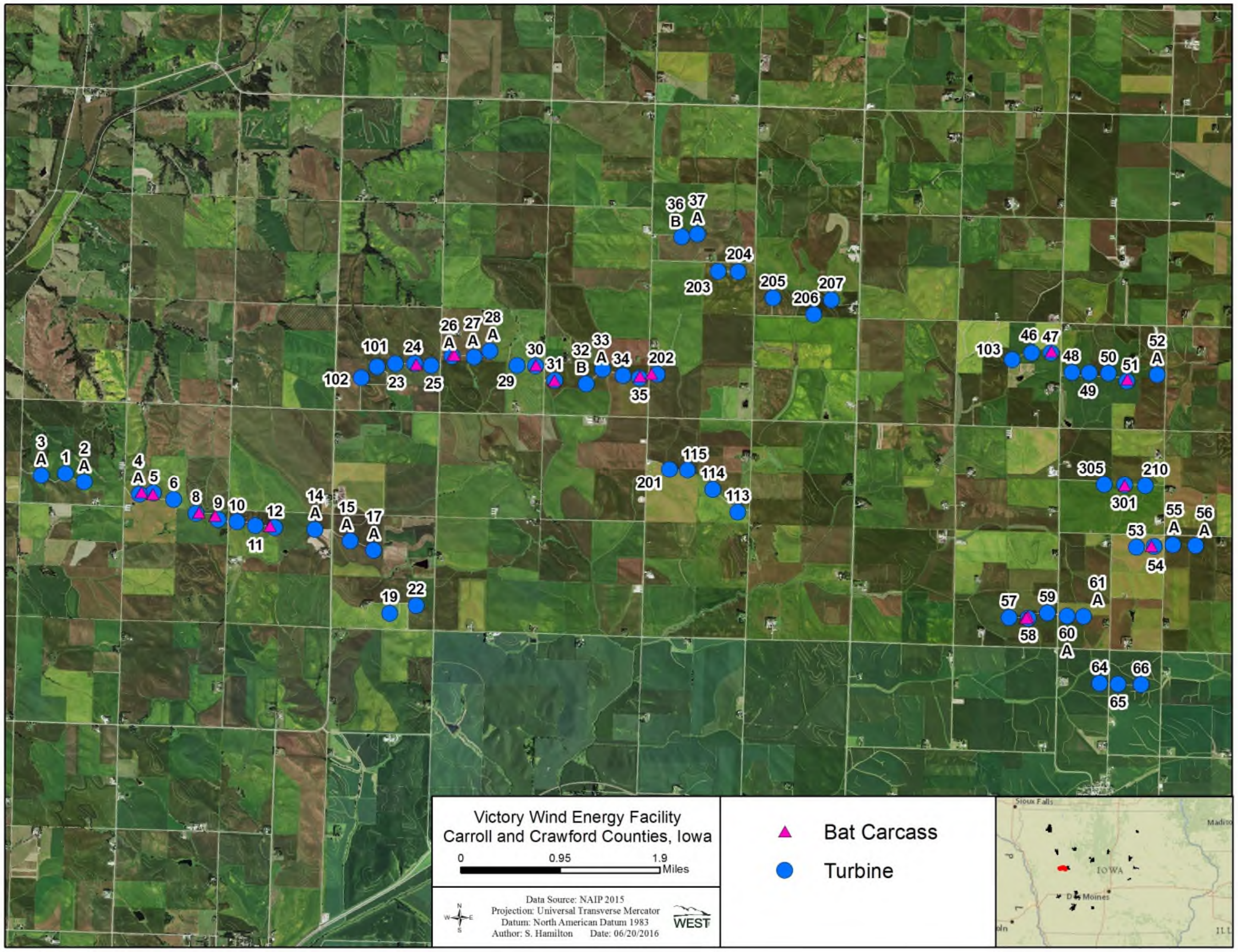

Figure H3. Location of all bat carcasses found during scheduled searches or incidentally at the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, from December 1, 2014, to November 15, 2015.

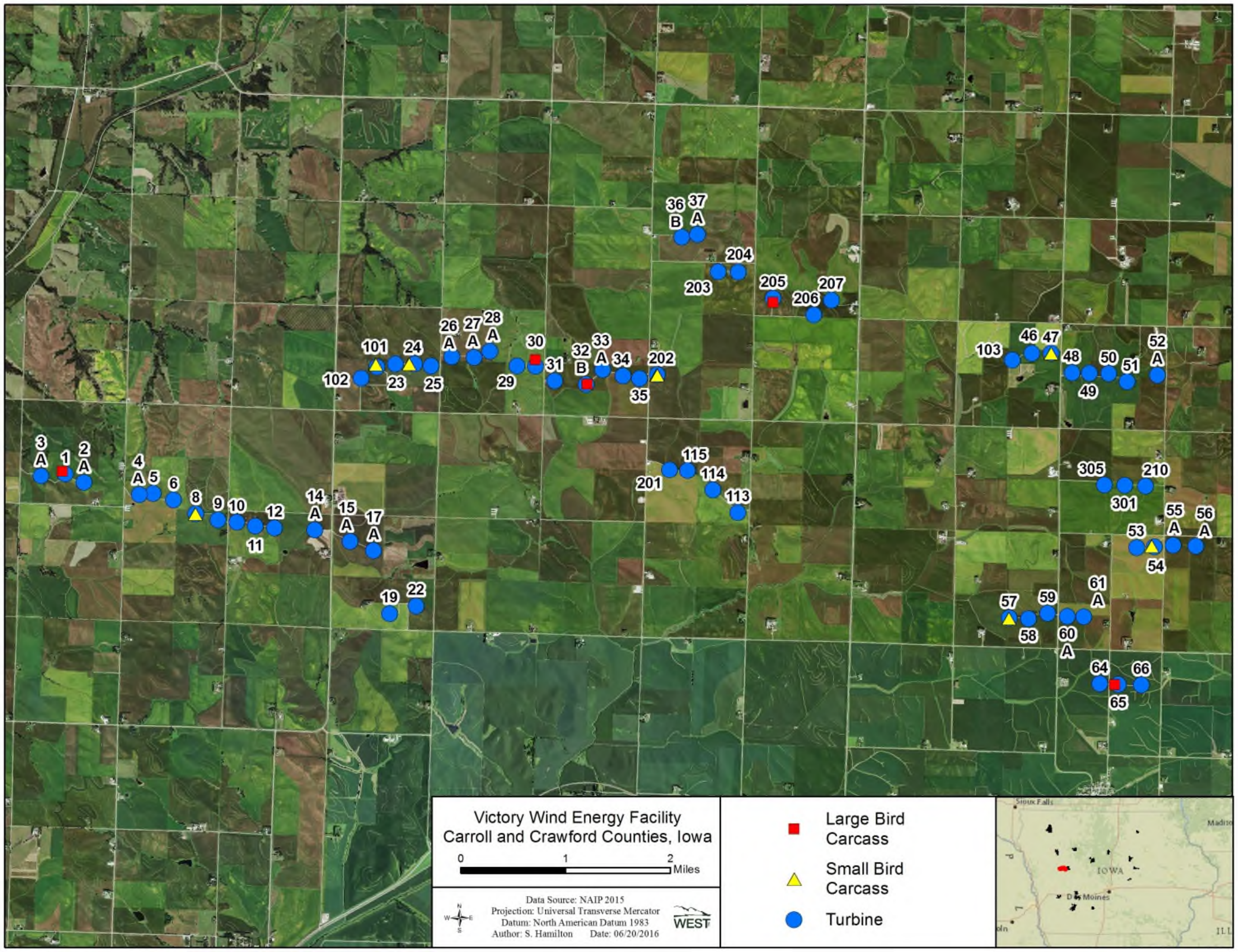

Figure H4. Location of all bird carcasses found during scheduled searches or incidentally at the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, from December 1, 2014, to November 15, 2015.

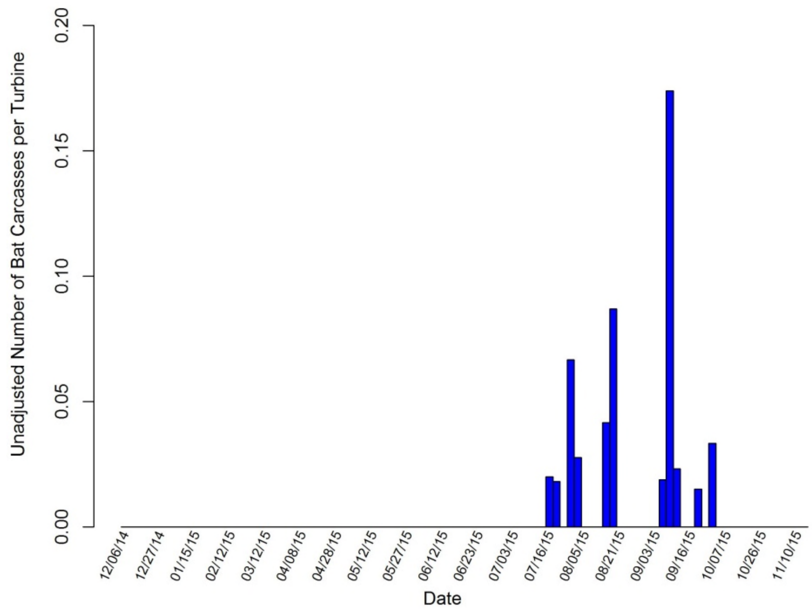

Figure H5. Timing of bat carcasses included in the analysis for the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, from December 1, 2014, to November 15, 2015.

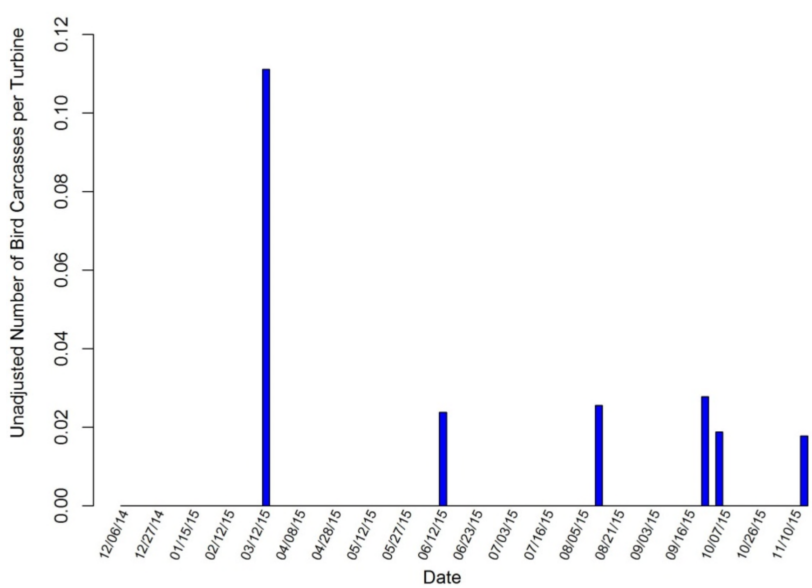

Figure H6. Timing of bird carcasses included in the analysis for the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Victory, the majority of bat carcasses (78.9%) were found within seven days of the estimated time of death (Table H2). All large bird carcasses were estimated to have been found within three days of death, and 85.7% of small birds were estimated to have been found within two weeks of death (Table H2). Whether carcasses were included in analysis was based on the specific search interval for the turbine where the carcass was found. If the estimated time since death of the carcass was more recent than the previous search of the turbine the carcass was found, the carcass was included in the fatality estimate. If the estimated time since death was greater than the most recent search of the turbine the carcass was found, 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). Three bat carcasses and two bird carcasses were excluded from the analysis for having been found outside of the search interval. All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table H2. estimated time of death for carcasses found at the Victory Wind Energy Facility from December 1, 2014, to November 12, 2015.

Type	Estimated Time of Death	Number of Carcasses	Percent Composition (%)
Bats	Last night	7	36.8
	2-3 days	4	21.1
	4-7 days	4	21.1
	7-14 days	3	15.8
	>2 week	1	5.3
	> Month	0	0
	Unknown	0	0
Large birds	Last night	1	50.0
	2-3 days	1	50.0
	4-7 days	0	0
	7-14 days	0	0
	>2 week	0	0
	> Month	0	0
	Unknown	0	0
Small birds	Last night	2	28.6
	2-3 days	0	0
	4-7 days	2	28.6
	7-14 days	2	28.6
	>2 week	0	0
	> Month	0	0
	Unknown	1	14.3

Searcher Efficiency

A total of 135 carcasses (50 bats, 40 large birds, and 45 small birds) were placed in the survey area for searcher efficiency trials during the first year of monitoring. Logistic regression was used to model searcher efficiency. Model selection was based on Corrected Akaike's Information Criterion, hereafter referred to as AICc. Seasonal estimates are only provided if season was included in the top model selected. The searcher efficiency rate for bats was 0.77 or 77.1%. The searcher efficiency rate for large birds was 92.5%, and 77.8% for small birds (Table H3).

Carcass Removal

A total of 135 carcasses (50 bats, 50 large birds, and 35 small birds) were placed in the project area for carcass removal trials during the first year of monitoring. The Huso method 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 various variables. The mean carcass removal time was 2.53 days for bats, 8.11 days for small birds and 14.56 days for large birds (Table A3).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, and all birds, and 90% confidence intervals were calculated when at least five casualties were found (Table A3). Fatality estimates were not calculated for raptors because no raptors were found on search plots during the study period. The fatality estimates are adjusted based on the corrections for carcass removal, observer detection bias, and the density-weight area correction. The overall adjusted bat fatality rate was 6.48 bats/MW/year. For all birds combined, the adjusted fatality rate was 1.52 birds/MW/year, which was comprised of 1.27 small birds/MW/year and 0.26 large birds/MW/year (Table A3). A complete list of casualties discovered at the Victory Wind Energy Facility is found in Table H4.

Table H3. The point estimates and bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, from December 1, 2014, to November 15, 2015.

	Overall		
	Mean	90 % Confidence Interval	
		Lower	Upper
Search Area Adjustment			
Bats	10.29	-	-
Large birds	9.21	-	-
Small birds	13.74	-	-
Observer Detection Rate			
Bats	0.77	0.67	0.87
Large birds	0.92	0.85	0.97
Small birds	0.78	0.67	0.89
Mean Carcass Removal Time (days)			
Bats	2.53	1.95	3.16
Large birds	14.56	10.53	19.66
Small birds	8.11	5.62	11.97
Average Probability of Carcass persistence Through Search Interval With Effective Interval Adjustments			
Bats	0.34	0.28	0.40
Large birds	0.79	-	-
Small birds	0.59	-	-
Observed Carcass Counts Per Turbine			
Bats	0.24	0.12	0.38
Large birds	0.03	-	-
Small birds	0.06	-	-
Average Probability that Carcass Available and Detected			
Bats	0.26	0.21	0.32
Large birds	0.73	-	-
Small birds	0.46	-	-
Overall Adjusted Fatality Estimates (Fatalities/Turbine/Year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	9.72	4.55	16.49
Large birds	0.39	-	-
Small birds	1.90	-	-
All birds	2.28	0.85	4.48
Overall Adjusted Fatality Estimates (Fatalities/MW/year)			
	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	6.48	3.03	10.99
Large birds	0.26	-	-
Small birds	1.27	-	-
All birds	1.52	0.57	2.99

Table H4. Complete carcass listing for the Victory Wind Energy Facility, Carroll and Crawford counties, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
			Bats			
7/16/2015	hoary bat	51	30	carcass search	RandP	intact
7/22/2015	eastern red bat	30	14	carcass search	RandP	intact
7/22/2015	eastern red bat	31	7	carcass search	RandP	intact
7/30/2015	hoary bat	58	31	carcass search	RandP	scavenged
7/30/2015	hoary bat	58	42	carcass search	RandP	scavenged
7/31/2015	hoary bat	5	29	carcass search	RandP	scavenged
7/31/2015	eastern red bat	24	29	carcass search	RandP	scavenged
7/31/2015	hoary bat	202	79	carcass search	RandP	NA
8/13/2015	eastern red bat	4	40	carcass search	RandP	intact
8/20/2015	eastern red bat	47	18	carcass search	RandP	NA
8/20/2015	hoary bat	47	15	carcass search	RandP	intact
8/21/2015	hoary bat	8	35	carcass search	RandP	intact
8/21/2015	eastern red bat	35	28	carcass search	RandP	intact
9/4/2015	eastern red bat	26	41	carcass search	RandP	intact
9/10/2015	hoary bat	54	43	carcass search	RandP	intact
9/10/2015	big brown bat	58	26	carcass search	RandP	intact
9/10/2015	big brown bat	58	29	carcass search	RandP	intact
9/10/2015	eastern red bat	301	5	carcass search	RandP	intact
9/12/2015	hoary bat	26	13	carcass search	RandP	intact
9/26/2015	eastern red bat	9	76	carcass search	RandP	intact
10/1/2015	silver-haired bat	12	69	incidental find	RandP	scavenged
			Birds			
12/11/2014	European starling	101	62	incidental find	20m Trans	intact
2/6/2015	ring-necked pheasant	30	100	incidental find	NA	scavenged
3/12/2015	European starling	57	4	carcass search	RandP	dismembered
4/14/2015	ruddy duck	65	55	carcass search	RandP	intact
4/21/2015	American coot	32	12	incidental find	RandP	intact
6/12/2015	unidentified passerine	202	3	carcass search	RandP	NA
7/22/2015	unidentified passerine	54	45	carcass search	RandP	feather spot
7/22/2015	American robin	202	7	carcass search	RandP	intact
8/12/2015	house wren	47	2	carcass search	RandP	intact
9/30/2015	northern flicker	205	64	carcass search	RandP	scavenged
10/6/2015	western meadowlark	8	0	carcass search	RandP	intact
10/6/2015	house sparrow	24	73	carcass search	RandP	NA
11/12/2015	Franklin's gull	1	60	carcass search	RandP	intact

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix I: Summary of Fatality Monitoring Surveys Conducted at the Walnut Wind Energy Facility from December 1, 2014, to November 15, 2015

PROJECT DESCRIPTION

MidAmerican's Walnut Wind Facility consists of 102 GE 1.5 SLE Salem pitch 1.5-megawatt turbines for a nameplate capacity of 153 MW. The facility is located across approximately 20,409 acres (32 mi^2) in Pottawattamie County in western Iowa. The Walnut facility is located near Walnut, Iowa. The facility is located in the Steeply Rolling Loess Prairies Level 4 Ecoregion. According to the National Land Cover Database, the landscape predominantly consists of cropland (86.0%). Developed land (7.0%) and pasture/hay (5.5%) are the next most common land cover types. Grassland, deciduous forests, open water, woody wetlands, and emergent wetlands each accounted for less than 2% of land cover in the project area.

ROAD AND PAD SURVEY RESULTS

Survey Effort

A total of 3,982 road and pad searches were conducted at Walnut during 40 visits from December 1, 2014, to November 15, 2015.

Description of Observed Carcasses

Seventy-nine bats and 13 birds were found on standardized road and pad search areas or incidentally at Walnut (Table I1). Of the five bat species found, hoary and eastern red bats (30 and 29, respectively) were found most frequently. Of the 10 unique species found on standardized road and pad searches or incidentally, European starling was the only bird species found twice. No federal or state listed bat or bird species were found, and no *Myotis* bats were found. (Table I1).

Most bat carcasses included in the analysis were found within 50 meters of turbines, while bird carcasses were distributed throughout the 100-meter plot (Figures I1and I2). There were no apparent spatial patterns in the location of bat or bird carcasses relative to environmental features at Walnut (Figures I3 and I4). Most bat fatalities were found from early August to mid-September, while most birds were found in either the spring or fall (Figures I5 and I6).

Table I1. Total number and species composition of bat and bird carcasses discovered during road and pad searches and incidentally at the Walnut Wind Energy Facility, Pottawattamie County, Iowa, from December 1, 2014, to November 15, 2015.

Species	Carcasses Included in Analysis		Carcasses Found Outside of Search Interval		Incidentals Found Off Plot		Total	
	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)	Total	Percent Composition (%)
Bats								
hoary bat	28	41.2	2	25.0	0	0	30	38.0
eastern red bat	22	32.4	4	50.0	3	100	29	36.7
big brown bat	14	20.6	2	25.0	0	0	16	20.3
evening bat	2	2.9	0	0	0	0	2	2.5
silver-haired bat	2	2.9	0	0	0	0	2	2.5
Overall Bats	**68**	**100**	**8**	**100**	**3**	**100**	**79**	**100**
Birds								
European starling	2	16.7	0	0	0	0	2	15.4
chipping sparrow	1	8.3	0	0	0	0	1	7.7
golden-crowned kinglet	1	8.3	0	0	0	0	1	7.7
hermit thrush	1	8.3	0	0	0	0	1	7.7
horned lark	1	8.3	0	0	0	0	1	7.7
lark sparrow	1	8.3	0	0	0	0	1	7.7
mourning dove	1	8.3	0	0	0	0	1	7.7
sedge wren	1	8.3	0	0	0	0	1	7.7
unidentified small bird	1	8.3	0	0	0	0	1	7.7
unidentified kinglet	1	8.3	0	0	0	0	1	7.7
unidentified warbler	1	8.3	0	0	0	0	1	7.7
vesper sparrow	0	0	1	100	0	0	1	7.7
Overall Birds	**12**	**100**	**1**	**100**	**0**	**0**	**13**	**100**

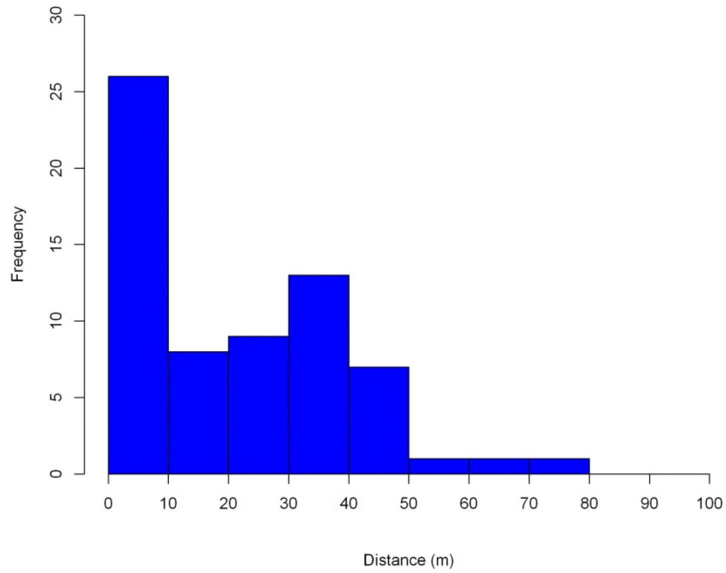

Figure I1. Distance from the turbine for bat carcasses included in the analysis for the Walnut Wind Energy Facility, Pottawattamie County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

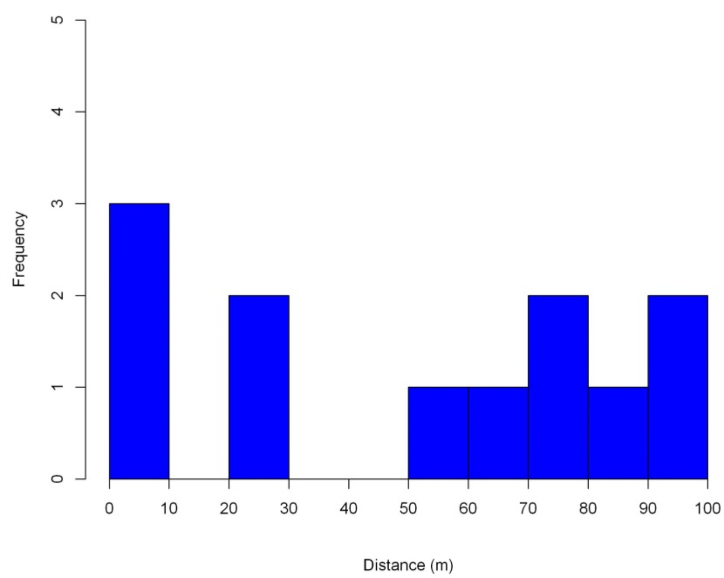

Figure I2. Distance from the turbine for bird carcasses included in the analysis for the Walnut Wind Energy Facility, Pottawattamie County, Iowa, during road and pad surveys conducted from December 1, 2014, to November 15, 2015.

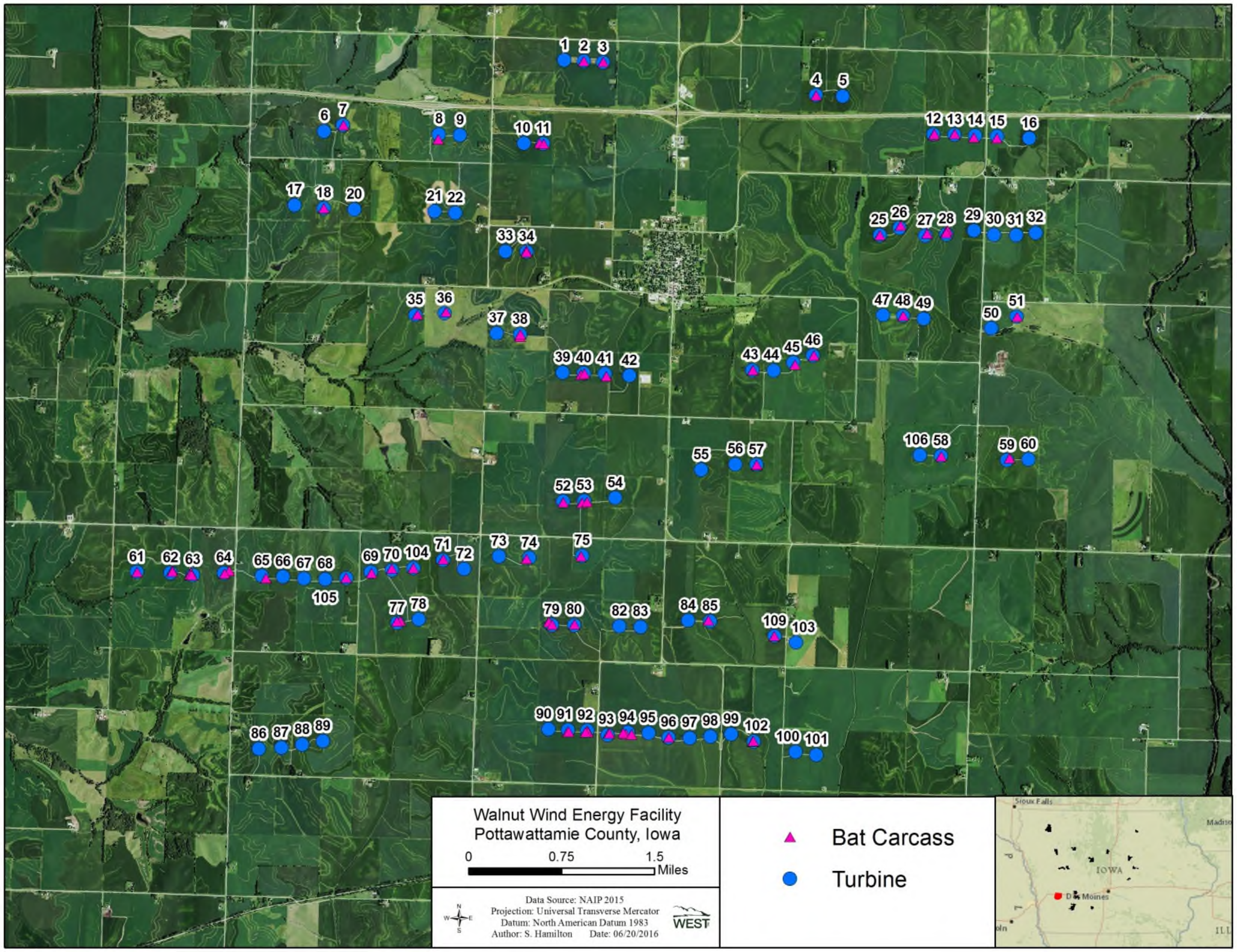

Figure I3. Location of all bat carcasses found during scheduled searches or incidentally at the Walnut Wind Energy Facility, Pottawattamie County, Iowa, from December 1, 2014, to November 15, 2015.

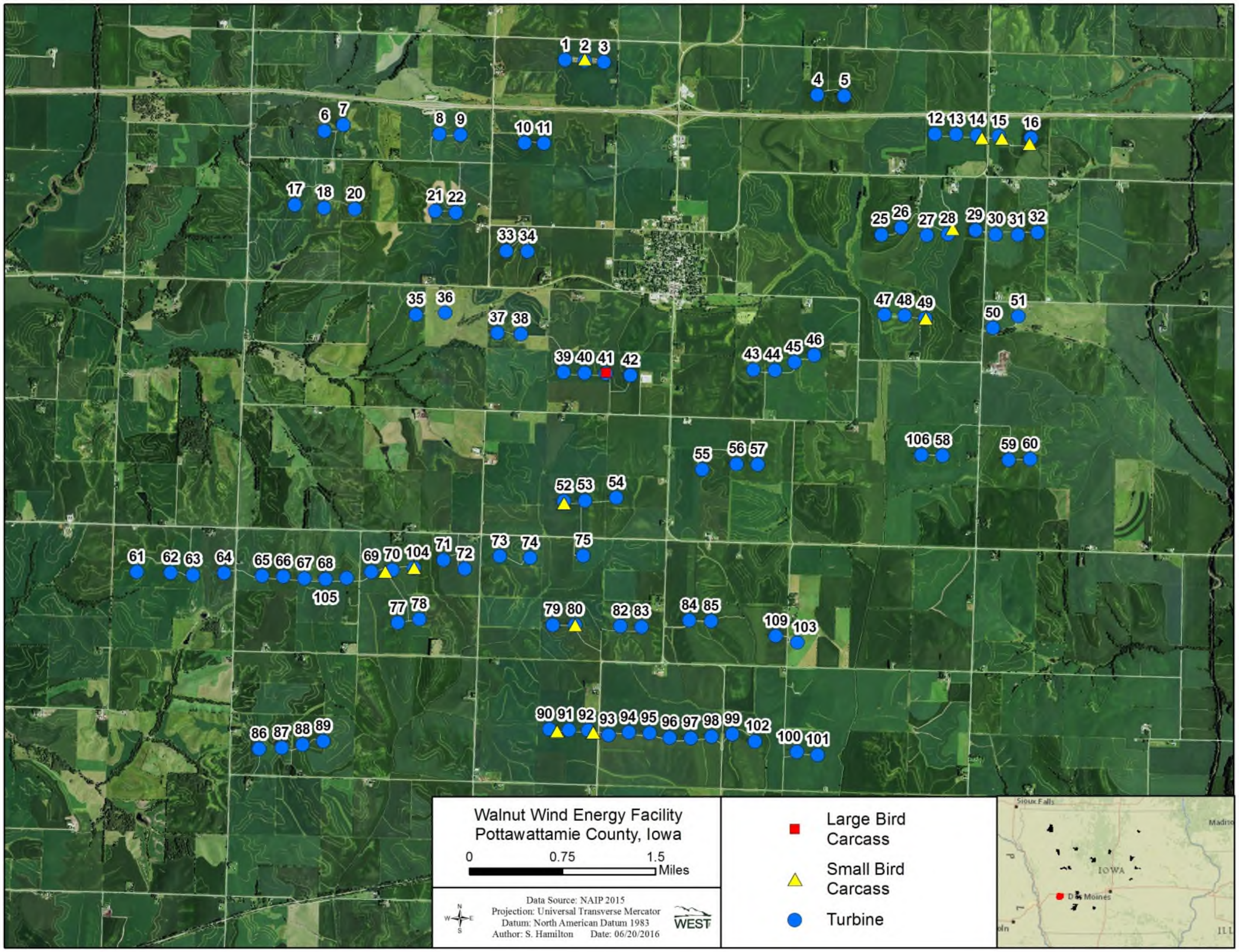

Figure I4. Location of all bird carcasses found during scheduled searched or incidentally at the Walnut Wind Energy Facility, Pottawattamie County, Iowa, from December 1, 2014, to November 15, 2015.

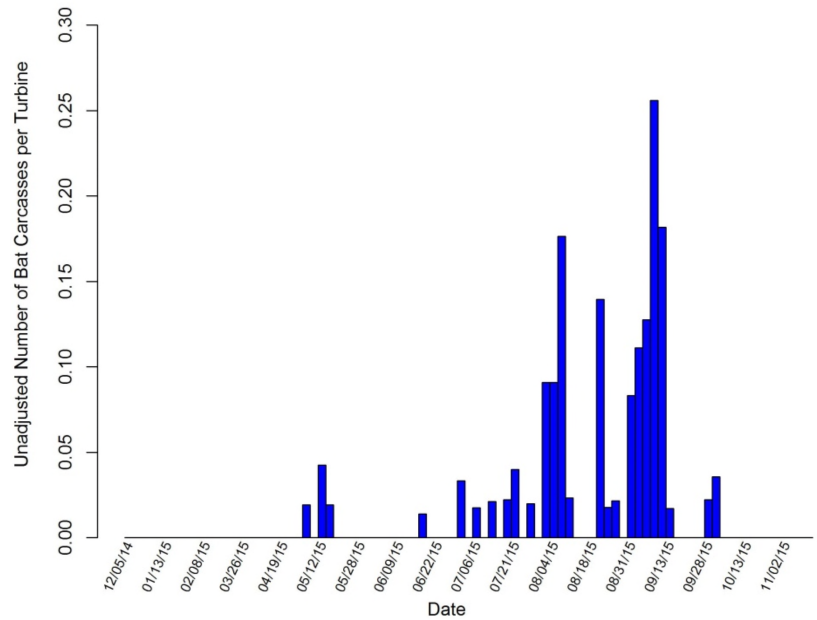

Figure I5. Timing of bat carcasses included in the analysis for the Walnut Wind Energy Facility, Pottawattamie County, Iowa, from December 1, 2014, to November 15, 2015.

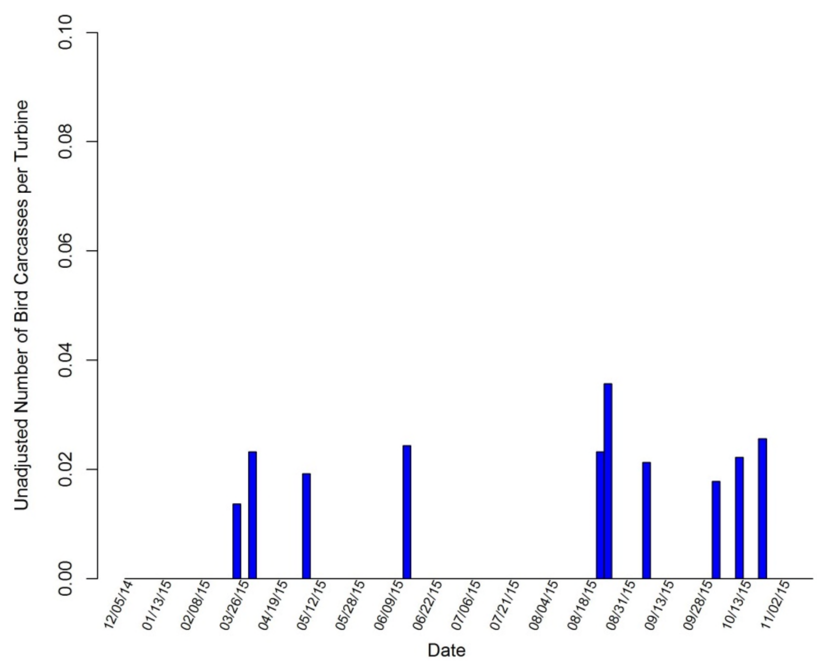

Figure I6. Timing of bird carcasses included in the analysis for the Walnut Wind Energy Facility, Pottawattamie County, Iowa, from December 1, 2014, to November 15, 2015.

Fatality Estimation

Censored Carcasses

The Huso method requires that carcasses are censored, or otherwise not used in the analysis, when estimated to have been dead longer than the search interval (i.e., before the previous search). At Walnut, the majority of bat carcasses (92.1%) were found within seven days of the estimated time of death (Table I2). The only large bird found was estimated to have died between four and seven days prior. Approximately 92% of small birds were estimated to have been found within one week of death (Table I2). Whether carcasses were included in analysis was based on the specific search interval for the turbine where the carcass was found. If the estimated time since death of the carcass was more recent than the previous search of the turbine where the carcass was found, then the carcass was included in the fatality estimate. If the estimated time since death was greater than the most recent search of the turbine the carcass was found, 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). Eight bat carcasses and one bird carcass were excluded from the analysis for having been found outside of the search interval (Table I1). All other carcasses found on search plots, whether found incidentally or during a scheduled search, were included in the analysis.

Table I2. Estimated time of death for carcasses found at the Walnut Wind Energy Facility from December 1, 2014, to November 15, 2015.

Type	Estimated Time of Death	Number of fatalities	Percent composition (%)
Bats	Last night	31	40.8
	2-3 days	20	26.3
	4-7 days	19	25.0
	7-14 days	4	5.3
	>2 week	0	0
	> Month	0	0
	Unknown	2	2.6
Large birds	Last night	0	0
	2-3 days	0	0
	4-7 days	1	100
	7-14 days	0	0
	>2 week	0	0
	> Month	0	0
	Unknown	0	0
Small birds	Last night	3	25.0
	2-3 days	7	58.3
	4-7 days	1	8.3
	7-14 days	0	0
	>2 week	0	0
	> Month	0	0
	Unknown	1	8.3

Searcher Efficiency

A total of 130 carcasses (50 bats, 40 large birds, and 40 small birds) were placed in the search area for searcher efficiency trials during the first year of monitoring. Logistic regression was used to model searcher efficiency. Model selection was based on corrected Akaike's Information Criterion, hereafter referred to as AICc. The searcher efficiency rate for bats ranged from 78.0% in the summer to 100% in the spring. The searcher efficiency rate for small birds was 95% in the summer to 100% in spring; for large birds, searcher efficiency ranged 99% in summer and fall to 100% in spring (Table I3).

Carcass Removal

A total of 131 carcasses (48 bats, 50 large birds, and 33 small birds) were placed in the project area for carcass removal trials during the first year of monitoring. The Huso method 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 various variables. For bats, carcass removal rates ranged from 2.62 days in the summer to 1.20 days in the fall (Table I3). Large and small bird removal rates followed the same seasonal pattern as bats. The summer carcass removal time for large birds was 5.43 days and 2.49 days in the fall. Small bird carcass removal time ranged from 4.65 days in the summer to 2.14 days in the fall (Table I3).

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, and all birds, and 90% confidence intervals were calculated when at least five casualties were found (Table I3). Fatality estimates were not calculated for raptors because no raptors were found on search plots during the study period. The overall adjusted bat fatality rate was 21.69 bats/MW/year. For all birds combined, the adjusted fatality rate was 2.88 birds/MW/year, which consisted of 0.15 large birds/MW/year and 2.73 small birds/MW/year (Table I3). A complete list of casualties discovered at the Walnut Wind Energy Facility is found in Table I4.

Table I3. The point estimates and bootstrap lower and upper limit of the 90% Confidence Intervals for bat and bird fatality rate estimation at the Walnut Wind Energy Facility, Pottawattamie County, Iowa, from December 1, 2014, to November 15, 2015.

	Spring			Summer			Fall		
	Mean	90 % Confidence Interval		Mean	90% Confidence Interval		Mean	90% Confidence Interval	
		Lower	Upper		Lower	Upper		Lower	Upper
Search Area Adjustment									
Bats	11.69	-	-	11.69	-	-	11.69	-	-
Large birds	10.02	-	-	10.02	-	-	10.02	-	-
Small birds	14.70	-	-	14.70	-	-	14.70	-	-
Observer Detection Rate									
Bats	1.00	1.00	1.00	0.78	0.64	0.92	0.87	0.75	0.97
Large birds	1.00	1.00	1.00	0.99	0.95	1.00	0.99	0.97	1.00
Small birds	1.00	1.00	1.00	0.95	0.83	1.00	0.97	0.92	1.00
Carcass Removal Time (days)									
Bats	2.10	1.39	3.07	2.62	1.94	3.46	1.20	0.83	1.72
Large birds	4.34	2.92	6.50	5.43	3.68	8.33	2.49	1.64	4.20
Small birds	3.72	2.37	5.43	4.65	3.44	6.31	2.41	1.49	3.25
Average Probability of Carcass Persistence Through Search Interval With Effective Interval Adjustment									
Bats	0.37	-	-	0.48	0.39	0.58	0.27	0.20	0.35
Large birds	-	-	-	-	-	-	0.46	-	-
Small birds	0.42	-	-	0.60	-	-	0.37	0.28	0.51
Observed Carcass Counts Per Turbine									
Bats	0.03	-	-	0.05	0.02	0.09	0.59	0.46	0.72
Large birds	-	-	-	-	-	-	0.01	-	-
Small birds	0.04	-	-	0.01	-	-	0.06	0.03	0.10
Average Probability of Carcass Availability and Detected									
Bats	0.37	-	-	0.38	0.28	0.48	0.24	0.16	0.32
Large birds	-	-	-	-	-	-	0.45	-	-
Small birds	0.42	-	-	0.57	-	-	0.37	0.27	0.49
Adjusted Fatality Estimates (Fatalities/Turbine/Season)									
Bats	0.93	-	-	1.53	0.57	2.95	30.08	20.18	44.85
Large birds	-	-	-	-	-	-	0.22	-	-
Small birds	1.42	-	-	0.25	-	-	2.43	0.91	4.37

Overall Adjusted Fatality Estimates (Fatalities/Turbine/Year)

	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	32.54	22.64	47.50
Large birds	0.22	-	-
Small birds	4.10	2.24	6.49
All birds	4.32	2.38	6.77

Overall Adjusted Fatality Estimates (Fatalities/MW/Year)

	Mean	90% Confidence Interval	
		Lower Limit	Upper Limit
Bats	21.69	15.09	31.67
Large birds	0.15	-	-
Small birds	2.73	1.50	4.33
All Birds	2.88	1.59	4.51

Table I4. Complete carcass listing for the Walnut Wind Energy Facility, Pottawattamie County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
Bats						
5/4/2015	silver-haired bat	57	0	carcass search	RandP	intact
5/12/2015	hoary bat	15	25	carcass search	RandP	intact
5/12/2015	evening bat	28	18	carcass search	RandP	intact
5/18/2015	evening bat	96	9	carcass search	RandP	NA
6/16/2015	eastern red bat	63	12	carcass search	RandP	scavenged
6/30/2015	hoary bat	45	33	carcass search	RandP	NA
7/6/2015	eastern red bat	69	14	carcass search	RandP	scavenged
7/13/2015	eastern red bat	34	2	carcass search	RandP	scavenged
7/20/2015	eastern red bat	36	20	carcass search	RandP	NA
7/20/2015	eastern red bat	62	36	carcass search	RandP	NA
7/20/2015	eastern red bat	64	66	carcass search	RandP	scavenged
7/21/2015	hoary bat	12	13	carcass search	RandP	scavenged
7/21/2015	eastern red bat	28	31	carcass search	RandP	scavenged
7/21/2015	eastern red bat	51	0	carcass search	RandP	scavenged
7/24/2015	big brown bat	38	NA	incidental find	RandP	scavenged
7/29/2015	hoary bat	41	36	carcass search	RandP	scavenged
7/30/2015	hoary bat	28	45	carcass search	RandP	scavenged
7/30/2015	eastern red bat	58	0	carcass search	RandP	scavenged
8/3/2015	eastern red bat	53	43	carcass search	RandP	scavenged
8/3/2015	eastern red bat	70	16	carcass search	RandP	scavenged
8/3/2015	eastern red bat	75	18	carcass search	RandP	scavenged
8/4/2015	big brown bat	26	36	carcass search	RandP	scavenged
8/4/2015	big brown bat	27	32	carcass search	RandP	intact
8/4/2015	big brown bat	46	8	carcass search	RandP	scavenged
8/5/2015	big brown bat	61	1	carcass search	RandP	scavenged
8/5/2015	hoary bat	63	27	carcass search	RandP	scavenged
8/5/2015	big brown bat	64	5	carcass search	RandP	scavenged
8/5/2015	eastern red bat	92	2	carcass search	RandP	scavenged
8/5/2015	big brown bat	102	40	carcass search	RandP	scavenged
8/5/2015	big brown bat	102	4	carcass search	RandP	scavenged
8/5/2015	big brown bat	105	5	carcass search	RandP	scavenged
8/7/2015	big brown bat	57	NA	incidental find	RandP	intact
8/9/2015	big brown bat	104	6	carcass search	RandP	scavenged
8/10/2015	big brown bat	79	4	carcass search	RandP	scavenged
8/19/2015	hoary bat	11	46	carcass search	RandP	scavenged
8/19/2015	hoary bat	53	37	carcass search	RandP	scavenged
8/19/2015	hoary bat	62	22	carcass search	RandP	intact
8/19/2015	hoary bat	63	35	carcass search	RandP	intact
8/19/2015	eastern red bat	65	61	carcass search	RandP	intact
8/19/2015	hoary bat	71	9	carcass search	RandP	scavenged
8/20/2015	hoary bat	43	6	carcass search	RandP	scavenged
8/24/2015	hoary bat	11	3	carcass search	RandP	scavenged
8/24/2015	big brown bat	77	42	carcass search	RandP	scavenged
8/25/2015	eastern red bat	12	7	carcass search	RandP	scavenged
8/31/2015	eastern red bat	18	0	carcass search	RandP	scavenged
8/31/2015	eastern red bat	34	19	carcass search	RandP	scavenged
8/31/2015	big brown bat	38	35	carcass search	RandP	scavenged
8/31/2015	hoary bat	52	17	carcass search	RandP	scavenged
8/31/2015	eastern red bat	74	46	carcass search	RandP	scavenged
9/1/2015	eastern red bat	3	7	carcass search	RandP	scavenged
9/1/2015	hoary bat	4	7	carcass search	RandP	scavenged
9/1/2015	big brown bat	28	30	carcass search	RandP	scavenged
9/1/2015	hoary bat	59	38	carcass search	RandP	scavenged
9/1/2015	eastern red bat	93	34	carcass search	RandP	scavenged
9/1/2015	eastern red bat	93	24	carcass search	RandP	scavenged
9/7/2015	hoary bat	7	4	carcass search	RandP	scavenged
9/7/2015	big brown bat	8	38	carcass search	RandP	intact
9/7/2015	eastern red bat	35	26	carcass search	RandP	intact
9/7/2015	hoary bat	40	44	carcass search	RandP	intact

Table I4. Complete carcass listing for the Walnut Wind Energy Facility, Pottawattamie County, Iowa, from December 1, 2014, to November 15, 2015.

Date	Common Name	Turbine Number	Distance from Turbine	Type of Find	Search Type[1]	Condition
9/7/2015	hoary bat	53	43	carcass search	RandP	intact
9/7/2015	hoary bat	77	4	carcass search	RandP	scavenged
9/8/2015	hoary bat	2	0	carcass search	RandP	intact
9/8/2015	hoary bat	13	5	carcass search	RandP	scavenged
9/8/2015	eastern red bat	14	28	carcass search	RandP	scavenged
9/8/2015	hoary bat	25	3	carcass search	RandP	scavenged
9/8/2015	silver-haired bat	48	0	carcass search	RandP	scavenged
9/8/2015	hoary bat	79	2	carcass search	RandP	scavenged
9/8/2015	eastern red bat	80	4	carcass search	RandP	intact
9/8/2015	hoary bat	85	20	carcass search	RandP	scavenged
9/8/2015	hoary bat	91	28	carcass search	RandP	scavenged
9/8/2015	eastern red bat	92	24	carcass search	RandP	scavenged
9/8/2015	hoary bat	92	36	carcass search	RandP	scavenged
9/9/2015	hoary bat	94	3	carcass search	RandP	scavenged
9/9/2015	eastern red bat	109	3	carcass search	RandP	scavenged
9/13/2015	hoary bat	40	9	carcass search	RandP	scavenged
9/13/2015	eastern red bat	91	28	carcass search	RandP	scavenged
9/28/2015	hoary bat	63	47	carcass search	RandP	NA
9/29/2015	eastern red bat	94	71	carcass search	RandP	scavenged
9/29/2015	eastern red bat	94	52	carcass search	RandP	intact
			Birds			
3/22/2015	European starling	2	24	carcass search	RandP	intact
4/5/2015	golden-crowned kinglet	28	90	carcass search	RandP	intact
4/5/2015	European starling	80	8	carcass search	RandP	intact
5/4/2015	chipping sparrow	90	95	carcass search	RandP	scavenged
6/10/2015	lark sparrow	49	0	carcass search	RandP	scavenged
8/3/2015	vesper sparrow	104	3	carcass search	RandP	scavenged
8/19/2015	horned lark	70	103	incidental find	RandP	intact
8/20/2015	unidentified small bird	14	68	carcass search	RandP	dismembered
8/20/2015	unidentified warbler	92	71	carcass search	RandP	scavenged
9/7/2015	mourning dove	41	4	carcass search	RandP	scavenged
9/29/2015	unidentified kinglet	16	74	carcass search	RandP	scavenged
10/12/2015	hermit thrush	52	25	carcass search	RandP	scavenged
10/21/2015	sedge wren	15	52	carcass search	RandP	scavenged

[1]RandP = road and pad search, 20m Trans = 20-meter transect search, and 40m Trans = 40-meter transect search, 100m scan = 100-m visual scan

Appendix J: Adjusted Bat Fatality Rates for Each of the Nine MidAmerican Facilities Studied from December 1, 2014, to November 15, 2015, Calculated Using the Shoenfeld Estimator

Table J1. Adjusted fatality rates (fatalities/megawatt/year) at the MidAmerican facilities studied from December 1, 2014, to November 15, 2015, calculated using the Shoenfeld Estimator.[1]

Facility	Bats		
	Estimate	90% Confidence Interval	
Adair	6.85	4.16	10.15
Carroll	12.25	6.82	25.95
Eclipse	10.11	4.33	17.8
Lundgren	27.86	19.35	29.84
Macksburg	37.2	23.07	53.94
Morning Light	22.93	10.9	38.27
Rolling Hills	5.52	3.74	6.12
Victory	6.83	2.96	9.85
Walnut	10.34	7.05	15.56

[1] Shoenfeld estimates used bat/mouse searcher efficiency and small bird carcass removal rates, annulus area correction, and included fatalities out to 100 meters.

2015-2016 Post-Construction Fatality Monitoring: Bat-Focused Surveys

MidAmerican Energy Company Iowa Wind Energy Portfolio:

Adams, Century, Charles City, Highland, Intrepid, Laurel, Lundgren, Macksburg, Pomeroy, Rolling Hills, Vienna I, Vienna II, and Wellsburg
November 2015 – November 2016

Confidential Commercial Information – Protected from disclosure under the Freedom of Information Act, Including exemptions (b)(4) and (b)(7)

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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).

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. 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).

During the 2015-2016 study year, post-construction fatality monitoring was conducted at 13 MidAmerican Energy facilities (Adams, Century, Charles City, Highland, Intrepid, Laurel, Lundgren, Macksburg, Rolling Hills, Pomeroy, Vienna I, Vienna II, and Wellsburg; 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 13 facilities between November 16, 2015 and November 16, 2016. Eagle-focused study design survey data for 2015-2017 will be presented in a separate report. The results of the 2014-2015 bat-focused surveys and 2014-2016 eagle-focused surveys have been reported separately (Bay et al. 2016a, 2016b).

Table 1. MidAmerican Energy Company's Iowa Wind 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 (This Report)						
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
2016-2017 Fatality Monitoring Study						
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

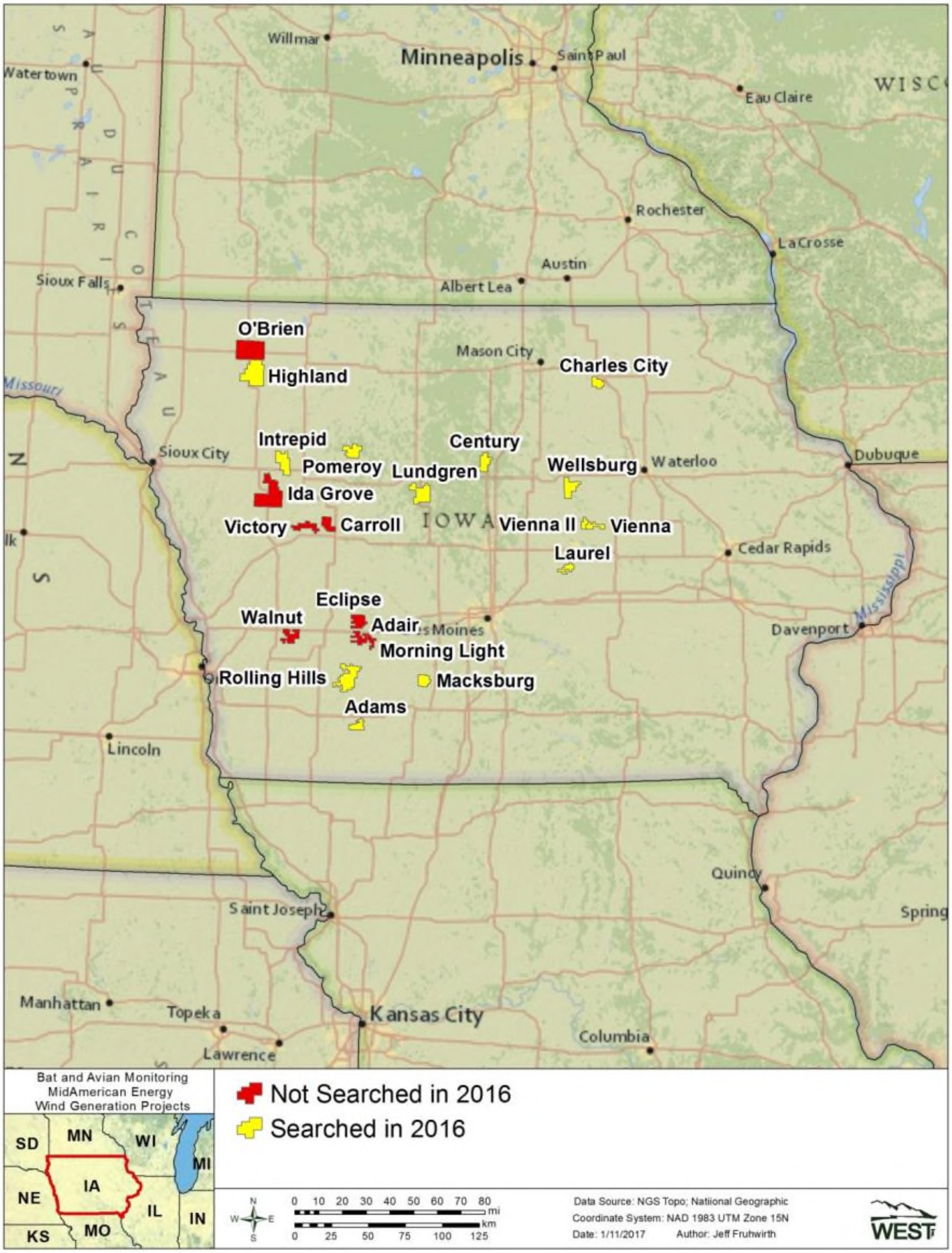

Figure 1. Locations of MidAmerican Energy Company's Iowa Wind Energy Projects.

Study Area

The Laurel, Macksburg, and Rolling Hills facilities are located in the Rolling Loess Prairies Level 4 Ecoregion (U.S. Environmental Protection Agency [USEPA] 2016). The Adams facility is located in both the Rolling Loess Prairies and the Steeply Rolling Loess Prairies Level 4 Ecoregion. The Vienna I, Vienna II, and Wellsburg facilities are located in the Rolling Loess Prairies and Eastern Iowa and Minnesota Drift Level 4 Ecoregions. The Charles City facility is located in the Eastern Iowa and Minnesota Drift Level 4 Ecoregion. The Highland and Intrepid facilities are located in the Loess prairies Level 4 Ecoregion. The Century, Lundgren, and Pomeroy Facilities are located in the Des Moines Lobe Level 4 Ecoregion.

Adams, Century, Charles City, Highland, Intrepid, Laurel, Lundgren, Pomeroy, Vienna I, Vienna II, and Wellsburg 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). The landcover at Rolling Hills and Macksburg is a combination of cropland and pasture/hay (USGS NLCD 2011, Homer et al. 2015).

METHODS

The purpose of this report 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 removal trials, and (4) statistical analysis.

Standardized Carcass Searches

Standardized carcass searches were conducted at all turbines in each of the 13 facilities to determine the observed number of bat and bird carcasses. Trained field technicians conducted searches from November 16, 2015, through November 16, 2016, at all facilities except Adams, where searches were conducted from May 16 to November 16, 2016. Searches were conducted approximately every other week during winter (November 16 to March 15) and approximately twice per week in the spring (March 16 to May 14), summer (May 15 to July 16), and fall (July 17 to November 16).

The majority of searches were conducted on road and pads, as adjacent agricultural activities reduce ground visibility outside the graveled areas for much of the year. In winter, all turbines were searched using road and pad plots. During the rest of the year, standardized search plots included a combination of approximately 80% road and pad plots and 20% searches at cleared square plots (full plots), with plot size varying by facility (Table 2). Searchers walked at a rate of approximately 80 meters (m; 262 feet [ft]) per minute, regardless of plot type.

Table 2. Number of Turbines in each Treatment Group (Road/Pad Plots; 60x60-Meter [M], 100x100-M, or 200x200-M Full Plot Transects) during the Bat-Focused Fatality Monitoring from March 16, 2016, to November 16, 2016, at MidAmerican Energy Company's Iowa Wind Energy Portfolio.

Facility	# 60x60-M Plots	# 100x100-M Plots	# 200x200-M Plots	# Road/Pad Plots	Total # Turbines
Adams	7	7	0	50	64
Century	15	15	0	115	145
Charles City	0	0	10	40	50
Highland	22	22	0	170	214
Intrepid	13	13	0	96	122
Laurel	6	6	0	40	52
Lundgren	11	0	10	86	107
Macksburg	0	0	10	41	51
Pomeroy	19	19	0	146	184
Rolling Hills	20	20	0	153	193
Vienna I	5	5	0	35	45
Vienna II	2	2	0	15	19
Wellsburg	6	6	0	48	60
Total	**126**	**115**	**30**	**1,035**	**1,306**

Road and Pad Searches

The 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 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 (Bay et al. 2016a).

Transect Searches

Transect carcass searches were conducted on cleared plots to allow for surveys to cover a larger proportion of the area underneath turbines. Transect searches were conducted within square plots centered on the turbine (Figure 3) at approximately 20% of all searched turbines (Table 2). Generally, cleared full plots were 100x100-m at half of the cleared-plot turbines and 60x60-m (197x197-ft) at the remaining half of cleared-plot turbines. To accommodate concurrent research conducted by the University of Iowa, and at the request of the Iowa Department of Natural Resources (IDNR) and USFWS, transect surveys were conducted within 200x200-m (656x656-ft) plots at three facilities: Macksburg, Lundgren, and Charles City. The 200x200-m plots replaced the smaller cleared plots (first the 100x100-m plots, then the 60x60-m plots) at these facilities (Table 2). Plot selection was based on landowner participation and randomized within the subset of suitable plots with landowner consent.

Searchers walked staked transects while scanning the area on both sides of each transect for carcasses. 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. The planned transect width for searches was 10 m (33 ft); however, transect width was decreased in the event of low visibility due to vegetation growth on the plots.

Figure 2. Example of a Road and Pad Search Plot Used for Bat-Focused Surveys at the MidAmerican Energy Company's Iowa Wind Energy Portfolio.

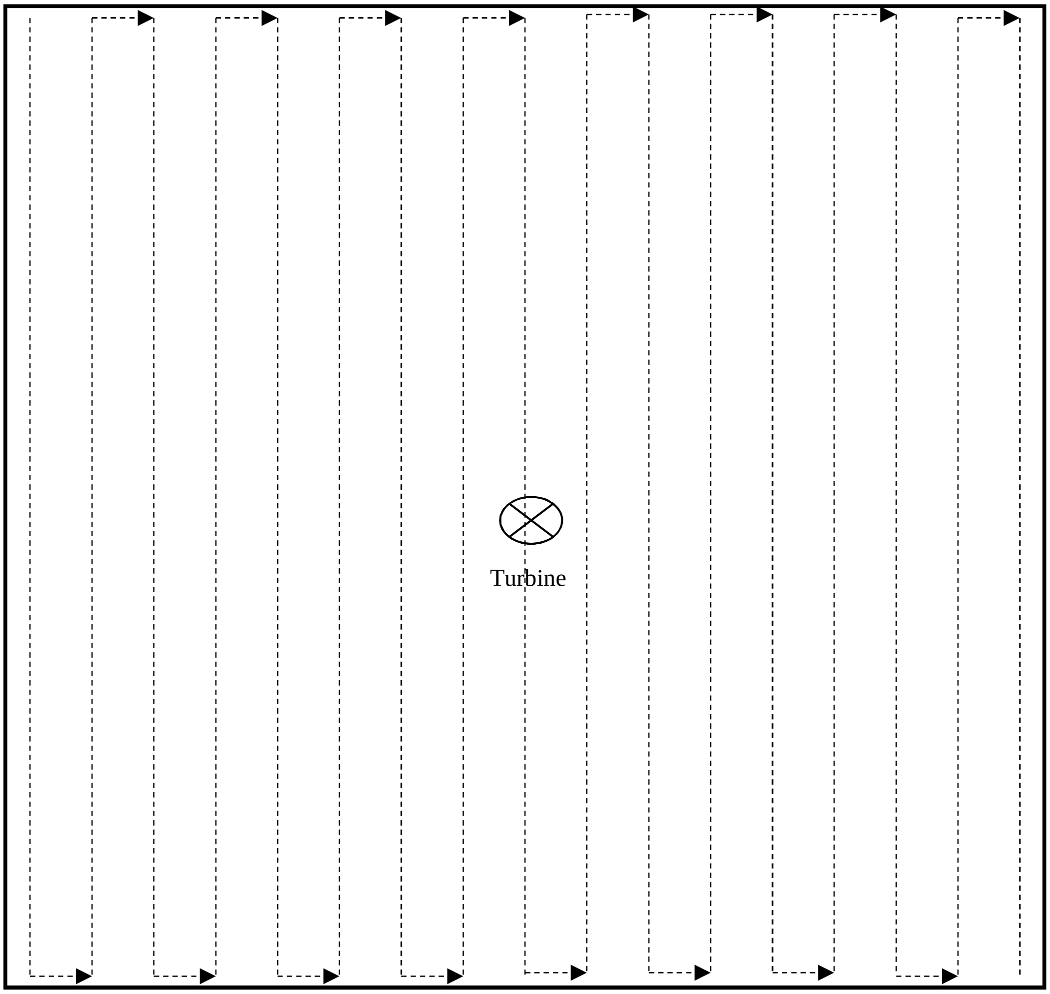

Figure 3. Schematic of a Full Survey Plot (Not to Scale). Transects were Typically Spaced 10 Meters Apart.

<u>Data Collected</u>

During each turbine search, the following data were recorded: date, start time, end time, observer initials, type of search (e.g., road and pad, 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.

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.

<u>Disposition of Carcasses</u>

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 removal trials. The intact state-listed owl species found were also used in the bias trials. Bald eagle (*Haliaeetus leucocephalus*) carcasses were collected and stored on-site until they were retrieved by or delivered to state or federal agencies. Bat carcasses were collected, placed in a freezer bag, labeled with a freezer tag, and placed in a freezer on-site.

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.

Wildlife salvage/collection permits held by WEST for the collection of bats, issued by the IDNR, were amended to include the counties in which surveys were conducted. Dissemination of data collected under this permit occurred as described in the permit conditions.

<u>Searcher Efficiency Trials</u>

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, and bat), and, when appropriate, by season (spring, summer, fall, and winter) and/or plot type. 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 efficiency trials for bats were conducted in spring, summer, and fall. At each facility, approximately 20 bat carcasses or surrogate mice were placed for searcher efficiency trials in spring, and approximately 50 bat or surrogate mice were used in each summer and fall search periods. When bat carcasses were unavailable, or available in low numbers, brown or black mice were used as surrogates. Only non-*Myotis* bat species

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

were used for searcher efficiency trials. Approximately 10 small bird and 10 large bird carcasses were placed in winter, and 20 small bird carcasses and 20 large bird carcasses were placed at each facility during each remaining season, for a total of 120 bird carcasses per facility. Actual numbers placed at each facility can be found in Appendices A-M. 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*), chukar (*Alectoris chukar*), and juvenile ring-necked pheasants (*Phasianus colchicus*) 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.

<u>Carcass Removal Trials</u>

The objective of carcass removal 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 removal studies were conducted every one to two weeks to cover all seasons and distribute carcasses evenly across the study period. Estimates of carcass removal 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 removal rates at each facility, approximately 10 bat carcasses or surrogates were used during the spring season and approximately 50 bat carcasses or surrogates were used during summer and fall, for approximately 110 total bat or surrogate carcasses at each facility. If bat carcasses were not available in sufficient numbers, brown or black mice were used as surrogates for bats in carcass removal trials. Only non-*Myotis* bat species were used for carcass removal trials. Approximately 10 small bird carcasses and 10 large bird carcasses were placed within the search areas, during the winter and spring seasons. Approximately 20 small bird carcasses and 20 large bird carcasses were placed during the summer and fall seasons, for a total of 100 bird carcasses per facility. Bird carcasses consisted of species similar to those used in the searcher efficiency trials. The number of carcasses placed were increased from the first year of study to allow for comparison between the cleared plots and road/pad plots.

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 study carcass. Personnel conducting carcass searches monitored the trial birds over a 30-day period according to the following schedule as closely as possible. Carcasses were checked every day for the first four days, then on day seven, day 10, day 14, day 20, and day 30. This schedule varied depending on weather and coordination with other survey work. At the end of the 30-day period, any evidence of the carcasses that remained was removed. Remains of intact diurnal raptors, owls, or vultures found during scheduled searches and used for carcass removal trials were marked and left in the field at the end of the 30-day 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 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® MSSQL 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 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. Removal 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 removal trials;

3. Searcher efficiency, expressed as the proportion of planted carcasses found by searchers during searcher efficiency 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) all birds, (2) small birds, (3) large birds, (4) diurnal raptors[2], and (5) bats. The total number of carcasses in each group listed above was estimated by adjusting for carcass removal and searcher efficiency bias via a fatality estimator model. The Huso (Huso 2011, Huso et al. 2012) estimator 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.)

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

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

$\hat{\hat{I}}_i$ 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

[2] Diurnal raptors include kites, accipiters, buteos, eagles, falcons, northern harriers, and osprey. Eagles would be included in the diurnal raptor estimate if they were found on a search area. Eagle-specific carcass estimates for the eagle-focused study design will be presented in a separate memo after the second winter surveys.

described above); however, carcasses were excluded from the analyses when they met three 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); and
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 (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 Removal Rates

Estimates of carcass removal rates were used to adjust carcass counts for removal bias. Carcass removal 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 (bat, small bird, and large bird), exponential, log-logistic, lognormal, and Weibull distributions were fit (and parameterized according to Therneau (Threrneau and Grambsch 2000, Therneau 2015), and the best model was selected using a combination of AICc (Burnham and Anderson 2002) and model parsimony.

Area Correction Calculation

The area correction for the estimate 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-m-wide annuli centered on the turbine, r is the maximum search radius, $p(j)$ is the fraction of the j^{th} annulus that was searched (calculated in GIS), and $F(j)$ is the proportion of all carcasses expected within the j^{th} annulus. $F(j)$ are 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 R Development Core Team [2016] and Yee [2010]) to carcass distances from turbines, and choosing the best-supported distribution through AICc. Truncation bounds for the density distributions are set at zero meters (i.e., carcasses cannot be negative distance from turbines) and at the maximum search radius from the turbine to account for carcasses that may fall beyond the plot boundary. Fits are obtained using a weighted maximum likelihood approach (Khokan et al. 2013), where the weight for each observed carcass distance is 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 accounts for carcass detection probabilities that vary systematically with distance from turbines.

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

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

For the Adams Wind Facility, which did not have monitoring for the complete year, the annual estimates are scaled up. This scaling is based on the average proportion of the season(s) estimates to the annual estimates at neighboring facilities with complete data. The neighboring facilities used are Walnut, Eclipse, Adair, Morning Light, and Rolling Hills.

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

RESULTS

All 1,306 turbines within the 13 facilities were searched, for a total of 85,531 searches on road and pad plots; 8,700 searches on 60-m full plots; 8,423 on 100-m full plots; and 2,267 searches on 200-m full plots (Table 3). A total of 2,301 bats and 691 birds were found during standardized carcass surveys or incidentally by operations staff or by field technicians conducting other tasks on site (Table 4). Detailed summaries of the post-construction fatality monitoring surveys conducted at each of the 13 facilities are included in Appendices A through M.

Table 3. Survey Effort, by Season and Plot Type, during the 2015-2016 Bat-Focused Fatality Monitoring at MidAmerican Energy Company's Iowa Wind Energy Facilities.

Plot Type	Winter		Spring		Summer		Fall	
	Visits	Surveys	Visits	Surveys	Visits	Surveys	Visits	Surveys
Road/Pad	96	8,402	240	18,016	273	20,149	533	38,964
60-m Full	0	0	197	1,986	227	2,246	443	4,468
100-m Full	0	0	179	1,915	210	2,232	409	4,276
200-m Full	0	0	60	558	63	589	124	1,120

Bat Carcasses

A total of 2,301 bat carcasses were found between November 16, 2015, and November 16, 2016, of which 1,885 were included in the analysis (Table 4). Among those carcasses excluded from the analysis, 34 were found outside of the search plots and one was found during the clearing search. A total of 376 bats were excluded from analysis because their estimated time since death occurred outside the search interval (Table 4).

Eight species of bat were found. One live and presumed injured bat could not be identified, as it flew away before sufficient photographs for identification could be obtained. Considering all bats found, the species most commonly found were eastern red bat (*Lasiurus borealis*; 38.9%) and hoary bat (*L. cinereus*; 33.9%; Table 4). Thirty-nine little brown bats (*Myotis lucifugus*; 1.7%) and 27 tricolored bats (*Perimyotis subflavus*; 1.2%) were found (Table 4). One Indiana bat (*M. sodalis*) was found and the identification was confirmed via DNA testing (Table 4). The Indiana bat is listed as endangered under the federal Endangered Species Act (ESA) and is also listed as endangered by the IDNR (2016). No northern long-eared bats were found.

The majority of bats included in the analysis were found relatively close to the turbine, with about half found within 10 m of the turbine. Nearly all bats (97.9%) were found within 60 m of a turbine (Figure 4). Most carcasses were found between mid-July and late August (Figure 5). All bats were found between March 23 and October 24, 2016. The highest rates of bats found per search occurred between mid-July and early October; 88.3% of bats were found during this time (Figure 5).

Table 4. Total Number of Carcasses and the Composition (% Comp) of Carcasses Discovered during Bat-Focused Fatality Monitoring at the MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

	Casualties Included		Casualties Off Plot		Clearing Search Casualties		Casualties Censored		Total	
Species	Total	% Comp	Total	% Comp	Total	% Comp	Total	% Comp	Total	% Comp
Bat										
eastern red bat	701	37.1	12	35.3	0	0	181	48.1	894	38.9
hoary bat	659	34.9	11	32.4	1	100	109	29.0	780	33.9
big brown bat	227	12.0	8	23.5	0	0	41	10.9	276	12.0
silver-haired bat	204	10.8	3	8.8	0	0	23	6.1	230	10.0
evening bat	42	2.2	0	0	0	0	11	2.9	53	2.3
little brown bat	32	1.7	0	0	0	0	7	1.9	39	1.7
tricolored bat	23	1.2	0	0	0	0	4	1.1	27	1.2
Indiana bat	1	0.1	0	0	0	0	0	0	1	<0.1
unidentified bat	1	0.1	0	0	0	0	0	0	1	<0.1
Overall Bats	**1,890**	**100**	**34**	**100**	**1**	**100**	**376**	**100**	**2,301**	**100**
Bird										
golden-crowned kinglet	56	10.6	0	0	0	0	6	7.3	62	9.0
ruby-crowned kinglet	35	6.7	1	1.4	0	0	7	8.5	43	6.2
killdeer	31	5.9	3	4.2	2	18.2	4	4.9	40	5.8
Nashville warbler	18	3.4	0	0	0	0	0	0	18	2.6
European starling	17	3.2	4	5.6	0	0	1	1.2	22	3.2
red-eyed vireo	17	3.2	0	0	0	0	0	0	17	2.5
ring-necked pheasant	17	3.2	7	9.7	1	9.1	2	2.4	27	3.9
horned lark	16	3.0	1	1.4	0	0	4	4.9	21	3.0
sedge wren	13	2.5	1	1.4	0	0	1	1.2	15	2.2
yellow-rumped warbler	11	2.1	1	1.4	0	0	0	0	12	1.7
house sparrow	10	1.9	2	2.8	0	0	2	2.4	14	2.0
house wren	10	1.9	0	0	0	0	2	2.4	12	1.7
rock pigeon	10	1.9	2	2.8	0	0	0	0	12	1.7
marsh wren	9	1.7	1	1.4	0	0	0	0	10	1.4
northern bobwhite	9	1.7	0	0	2	18.2	0	0	11	1.6
turkey vulture	9	1.7	7	9.7	0	0	1	1.2	17	2.5
unidentified passerine	9	1.7	0	0	1	9.1	3	3.7	13	1.9
yellow warbler	9	1.7	0	0	0	0	2	2.4	11	1.6
mourning dove	8	1.5	0	0	0	0	3	3.7	11	1.6
black-and-white warbler	7	1.3	0	0	0	0	1	1.2	8	1.2
cliff swallow	7	1.3	0	0	0	0	1	1.2	8	1.2
dickcissel	7	1.3	1	1.4	0	0	1	1.2	9	1.3
American robin	6	1.1	0	0	0	0	1	1.2	7	1.0
Lincoln's sparrow	6	1.1	1	1.4	0	0	0	0	7	1.0
yellow-billed cuckoo	6	1.1	1	1.4	0	0	2	2.4	9	1.3
blue-headed vireo	5	1.0	0	0	0	0	0	0	5	0.7
gray partridge	5	1.0	1	1.4	0	0	1	1.2	7	1.0
gray catbird	5	1.0	0	0	0	0	1	1.2	6	0.9
purple martin	5	1.0	0	0	0	0	0	0	5	0.7
red-winged blackbird	5	1.0	2	2.8	0	0	1	1.2	8	1.2
song sparrow	5	1.0	1	1.4	2	18.2	0	0	8	1.2
swamp sparrow	5	1.0	0	0	0	0	1	1.2	6	0.9

Table 4. Total Number of Carcasses and the Composition (% Comp) of Carcasses Discovered during Bat-Focused Fatality Monitoring at the MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

Species	Casualties Included		Casualties Off Plot		Clearing Search Casualties		Casualties Censored		Total	
	Total	% Comp	Total	% Comp	Total	% Comp	Total	% Comp	Total	% Comp
American kestrel	4	0.8	0	0	0	0	0	0	4	0.6
chipping sparrow	4	0.8	0	0	0	0	0	0	4	0.6
common yellowthroat	4	0.8	1	1.4	0	0	1	1.2	6	0.9
magnolia warbler	4	0.8	1	1.4	0	0	0	0	5	0.7
northern flicker	4	0.8	0	0	0	0	0	0	4	0.6
unidentified empidonax	4	0.8	0	0	0	0	2	2.4	6	0.9
unidentified small bird	4	0.8	0	0	0	0	3	3.7	7	1.0
brown-headed cowbird	3	0.6	0	0	0	0	0	0	3	0.4
clay-colored sparrow	3	0.6	0	0	0	0	2	2.4	5	0.7
dark-eyed junco	3	0.6	0	0	0	0	0	0	3	0.4
field sparrow	3	0.6	0	0	0	0	0	0	3	0.4
northern parula	3	0.6	0	0	0	0	0	0	3	0.4
ovenbird	3	0.6	0	0	0	0	0	0	3	0.4
red-tailed hawk	3	0.6	8	11.1	0	0	3	3.7	14	2.0
tree swallow	3	0.6	0	0	0	0	0	0	3	0.4
unidentified sparrow	3	0.6	1	1.4	0	0	2	2.4	6	0.9
unidentified warbler	3	0.6	0	0	0	0	1	1.2	4	0.6
unidentified wren	3	0.6	0	0	0	0	2	2.4	5	0.7
upland sandpiper	3	0.6	1	1.4	0	0	1	1.2	5	0.7
vesper sparrow	3	0.6	0	0	0	0	1	1.2	4	0.6
American goldfinch	2	0.4	0	0	0	0	0	0	2	0.3
American redstart	2	0.4	1	1.4	0	0	1	1.2	4	0.6
Baltimore oriole	2	0.4	1	1.4	0	0	0	0	3	0.4
blackpoll warbler	2	0.4	0	0	0	0	0	0	2	0.3
brown creeper	2	0.4	0	0	1	9.1	0	0	3	0.4
Canada goose	2	0.4	1	1.4	0	0	0	0	3	0.4
Canada warbler	2	0.4	0	0	0	0	0	0	2	0.3
chimney swift	2	0.4	0	0	0	0	0	0	2	0.3
eastern meadowlark	2	0.4	1	1.4	0	0	0	0	3	0.4
green-winged teal	2	0.4	0	0	0	0	0	0	2	0.3
Lapland longspur	2	0.4	0	0	0	0	0	0	2	0.3
Le Conte's sparrow	2	0.4	0	0	0	0	0	0	2	0.3
palm warbler	2	0.4	1	1.4	0	0	0	0	3	0.4
ruby-throated hummingbird	2	0.4	0	0	0	0	0	0	2	0.3
Tennessee warbler	2	0.4	1	1.4	0	0	2	2.4	5	0.7
wild turkey	2	0.4	0	0	0	0	1	1.2	3	0.4
white-throated sparrow	2	0.4	0	0	0	0	0	0	2	0.3
yellow-throated vireo	2	0.4	1	1.4	0	0	1	1.2	4	0.6
American coot	1	0.2	1	1.4	0	0	0	0	2	0.3
barn swallow	1	0.2	0	0	0	0	1	1.2	2	0.3
black-billed cuckoo	1	0.2	0	0	0	0	0	0	1	0.1
bobolink	1	0.2	1	1.4	0	0	0	0	2	0.3
Brewer's blackbird	1	0.2	0	0	0	0	0	0	1	0.1
black-throated green warbler	1	0.2	0	0	0	0	0	0	1	0.1

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	Casualties Included		Casualties Off Plot		Clearing Search Casualties		Casualties Censored		Total	
Species	**Total**	**% Comp**	**Total**	**% Comp**	**Total**	**% Comp**	**Total**	**% Comp**	**Total**	**% Comp**
blue-winged teal	1	0.2	0	0	0	0	0	0	1	0.1
cedar waxwing	1	0.2	0	0	0	0	0	0	1	0.1
common grackle	1	0.2	3	4.2	0	0	1	1.2	5	0.7
common nighthawk	1	0.2	0	0	0	0	0	0	1	0.1
chestnut-sided warbler	1	0.2	0	0	0	0	0	0	1	0.1
downy woodpecker	1	0.2	0	0	0	0	0	0	1	0.1
eastern kingbird	1	0.2	0	0	0	0	0	0	1	0.1
green heron	1	0.2	0	0	0	0	0	0	1	0.1
indigo bunting	1	0.2	0	0	0	0	0	0	1	0.1
lesser scaup	1	0.2	0	0	0	0	0	0	1	0.1
mallard	1	0.2	1	1.4	0	0	1	1.2	3	0.4
northern waterthrush	1	0.2	0	0	0	0	0	0	1	0.1
orange-crowned warbler	1	0.2	0	0	0	0	1	1.2	2	0.3
pied-billed grebe	1	0.2	0	0	0	0	0	0	1	0.1
rose-breasted grosbeak	1	0.2	0	0	0	0	0	0	1	0.1
red-breasted nuthatch	1	0.2	0	0	0	0	0	0	1	0.1
rough-legged hawk	1	0.2	0	0	0	0	0	0	1	0.1
ring-necked duck	1	0.2	0	0	0	0	0	0	1	0.1
rusty blackbird	1	0.2	0	0	0	0	0	0	1	0.1
ruddy duck	1	0.2	0	0	0	0	0	0	1	0.1
short-eared owl	1	0.2	0	0	1	9.1	0	0	2	0.3
sora	1	0.2	0	0	0	0	0	0	1	0.1
spotted sandpiper	1	0.2	0	0	0	0	0	0	1	0.1
unidentified meadowlark	1	0.2	0	0	0	0	0	0	1	0.1
unidentified raptor	1	0.2	0	0	0	0	0	0	1	0.1
veery	1	0.2	0	0	0	0	0	0	1	0.1
warbling vireo	1	0.2	0	0	0	0	0	0	1	0.1
western meadowlark	1	0.2	0	0	0	0	0	0	1	0.1
yellow-bellied sapsucker	1	0.2	0	0	0	0	0	0	1	0.1
American crow	0	0	1	1.4	0	0	0	0	1	0.1
bald eagle	0	0	2	2.8	0	0	0	0	2	0.3
blue jay	0	0	1	1.4	0	0	0	0	1	0.1
brown thrasher	0	0	0	0	0	0	1	1.2	1	0.1
domestic chicken	0	0	2	2.8	0	0	0	0	2	0.3
eastern wood-pewee	0	0	0	0	0	0	1	1.2	1	0.1
great blue heron	0	0	0	0	0	0	1	1.2	1	0.1
least flycatcher	0	0	1	1.4	0	0	0	0	1	0.1
long-eared owl	0	0	0	0	1	9.1	0	0	1	0.1
unidentified flycatcher	0	0	1	1.4	0	0	1	1.2	2	0.3
unidentified kinglet	0	0	0	0	0	0	1	1.2	1	0.1
unidentified large bird	0	0	2	2.8	0	0	1	1.2	3	0.4
unidentified swallow	0	0	0	0	0	0	1	1.2	1	0.1
Overall Birds	**526**	**100**	**72**	**100**	**11**	**100**	**82**	**100**	**691**	**100**

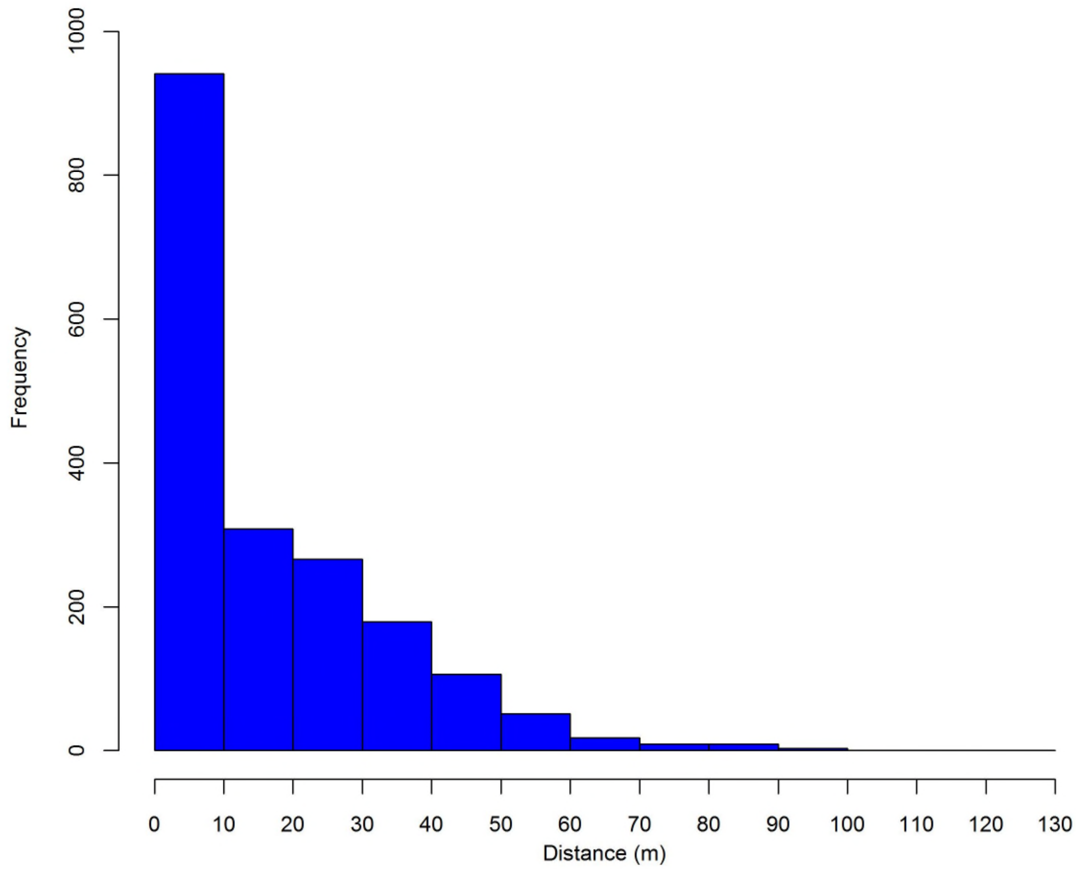

Figure 4. Distance from the Turbine of Bat Carcasses Included in the Analysis for the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

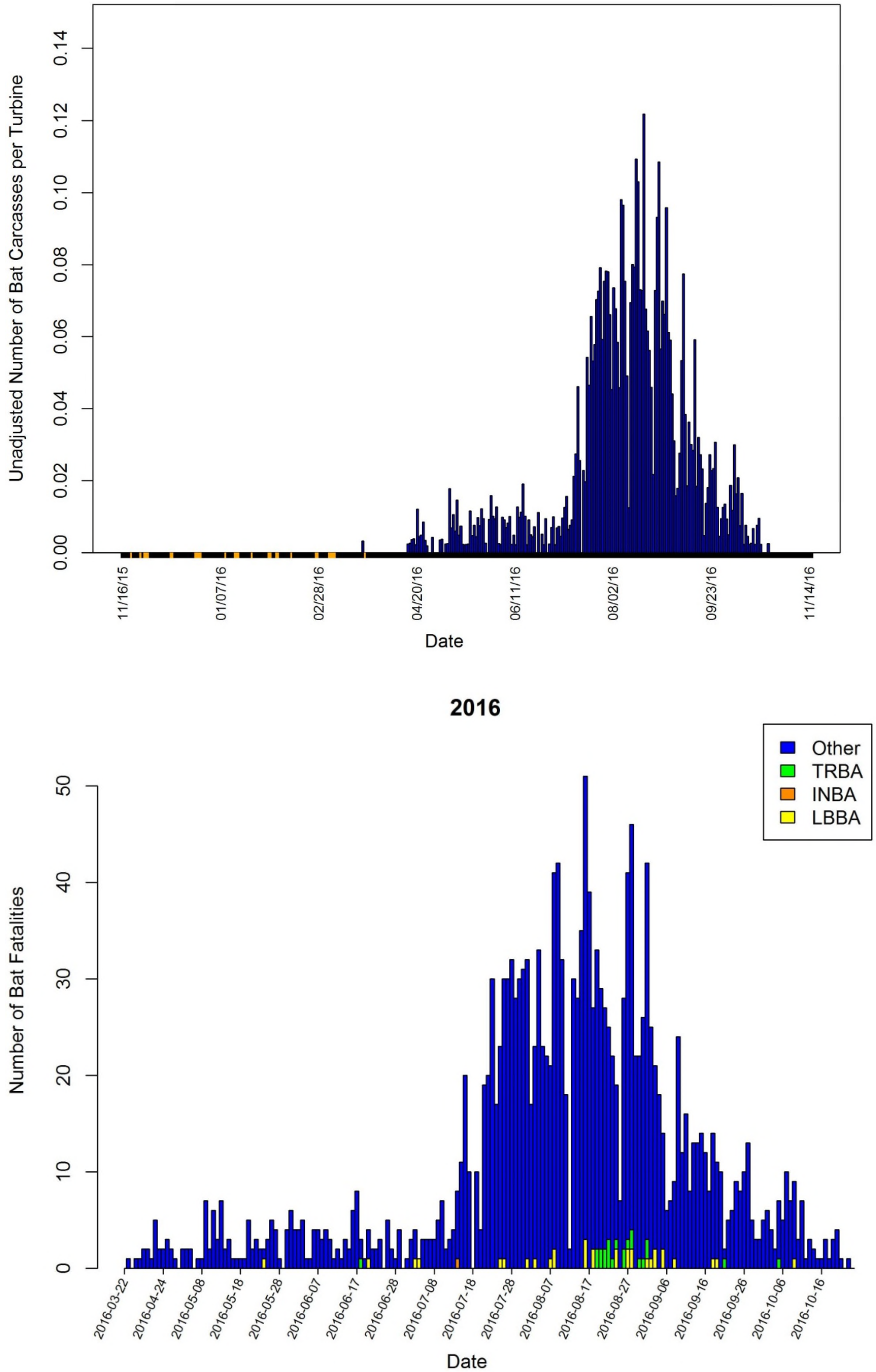

Figure 5 a and b. Timing of Bat Carcasses and Covered-Species Found in Search Areas at the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

Bird Carcasses

A total of 691 bird carcasses representing 106 identifiable species were found during the 2015-2016 fatality monitoring. Seventy-two bird carcasses were found outside designated search areas and were thus excluded from the analyses. Ninety-three bird carcasses were found during the clearing search or had an estimated time of death outside the search interval. The analysis included 526 bird carcasses, representing 98 identifiable species.

Among all bird carcasses found, the most commonly found species were golden-crowned kinglet (*Regulus satrapa*; 9.0%), ruby-crowned kinglet (*Regulus calendula*; 6.2%) and killdeer (*Charadrius vociferus*; 5.8%), accounting for 21% of all bird carcasses (Table 4). Each of the remaining species accounted for less than 4% of bird carcasses found. No bird species listed under the federal ESA were found; however, two bald eagles[3], protected under the Bald and Golden Eagle Protection Act (BGEPA 1940), were found. Bald eagles are also listed as a special concern animal by the IDNR (2016). Two short-eared owls (*Asio flammeus*; state endangered) and one long-eared owl (*Asio otus*; state threatened; IDNR 2016) were also found during 2015-2016 post-construction monitoring.

Of the 22 diurnal raptor carcasses found, nine were included in the analysis (four American kestrels [*Falco sparverius*], three red-tailed hawks [*Buteo jamaicensis*], one rough-legged hawk [*Buteo lagopus*], and one unidentified raptor; Table 4). Ten additional raptor carcasses (eight red-tailed hawks and two bald eagles) were found outside the search area and were therefore not included in this analysis. Three red-tailed hawks were found on plot, but were excluded from the analysis as the estimated time since death was longer than the search interval (Table 4).

Of the bird carcasses included in the analysis, 31% were within 10 m of turbines and 84% were within 60 m (Figure 6). Bird carcasses were found throughout the year, with slight increases in May and from late-September to early October (Figure 7).

[3] Plots differed for eagle-focused surveys. These bald eagle finds will be discussed in the context of the eagle-focused surveys in a separate report.

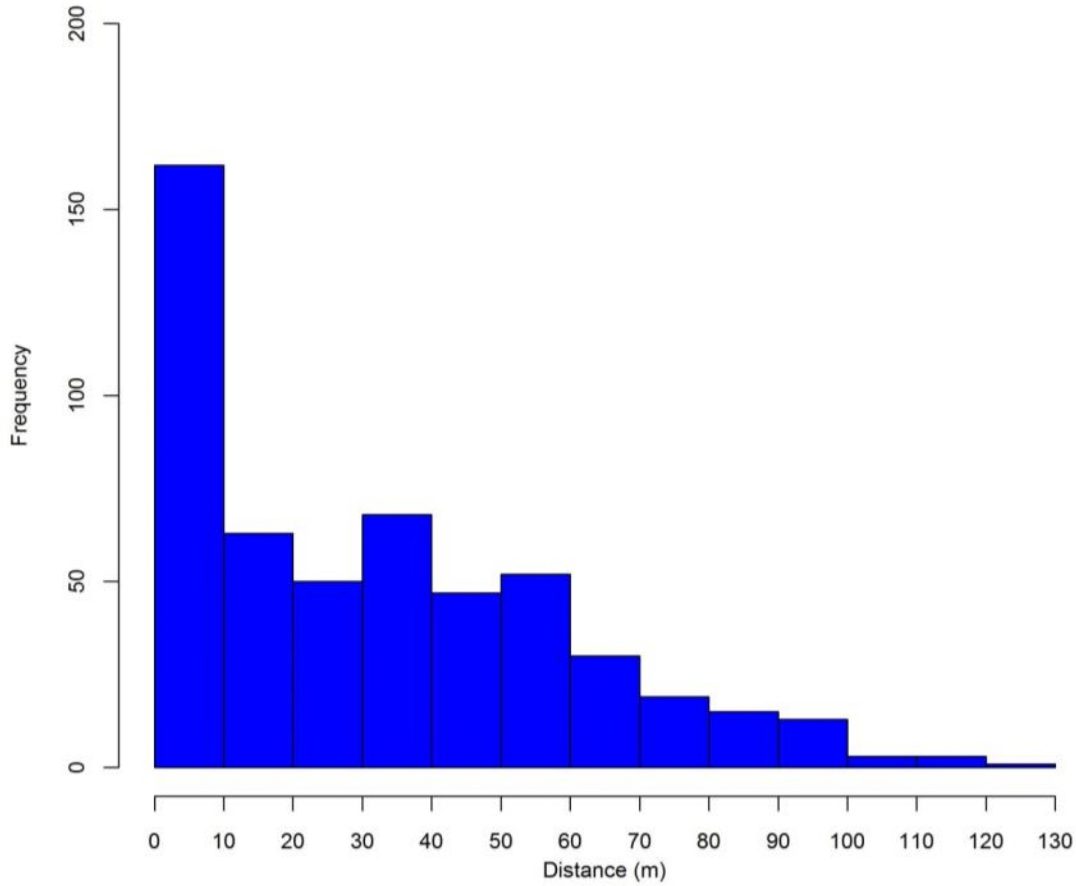

Figure 6. Distance from the Turbine of Bird Carcasses Included in the Analysis for the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

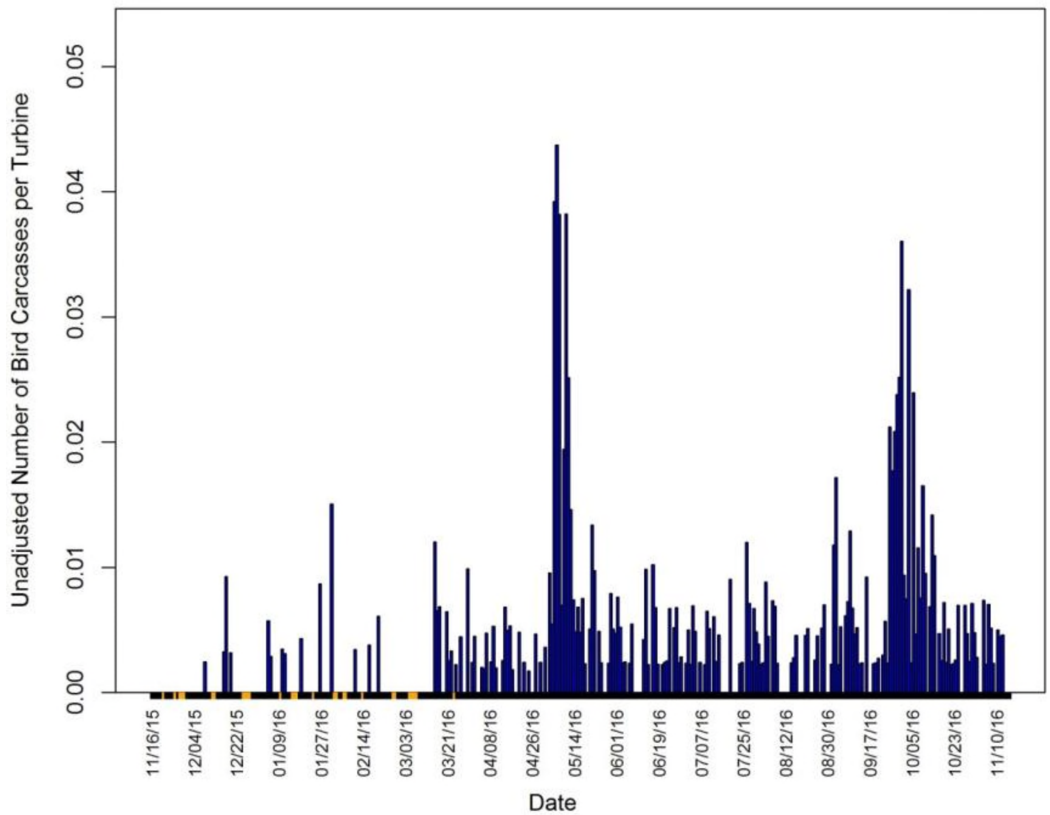

Figure 7. Timing of Bird Carcasses Included in the Analysis for the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016

Searcher Efficiency

Searcher efficiency was modeled using the Huso method (Huso 2011, Huso et al. 2012). Logistic regression was used to model searcher efficiency and model selection was based on AICc. Seasonal estimates were calculated when season was included in the best model, based on the lowest AICc. Searcher efficiency for each facility is presented in Table 5 and described in detail in Appendices A through M.

Table 5. Searcher Efficiency for each of the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016

Size Class	Plot Type	Winter	Spring	Summer	Fall
Adams					
Bats	Road/Pad	-	-	0.86	0.86
	60-m Plot	-	-	0.41	0.41
	100-m Plot	-	-	0.41	0.41
Small Birds	Road/Pad	-	-	0.78	0.78
	60-m Plot	-	-	0.29	0.29
	100-m Plot	-	-	0.29	0.29
Large Birds	Road/Pad	-	-	0.92	0.92
	60-m plot	-	-	0.92	0.92
	100-m Plot	-	-	0.92	0.92

Table 5. Searcher Efficiency for each of the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016

Size Class	Plot Type	Winter	Spring	Summer	Fall
Century					
Bats	Road/Pad	-	0.64	0.64	0.64
	60-m Plot	-	0.15	0.15	0.15
	100-m Plot	-	0.15	0.15	0.15
Small Birds	Road/Pad	0.79	0.79	0.79	0.79
	60-m Plot	-	0.16	0.16	0.16
	100-m Plot	-	0.16	0.16	0.16
Large Birds	Road/Pad	0.98	0.98	0.98	0.98
	60-m Plot	-	0.63	0.63	0.63
	100-m Plot	-	0.63	0.63	0.63
Charles City					
Bats	Road/Pad	-	0.87	0.87	0.87
	200-m Plot	-	0.29	0.29	0.29
Small Birds	Road/Pad	0.68	0.68	0.68	0.68
	200-m Plot	-	0.27	0.27	0.27
Large Birds	Road/Pad	1	1	1	1
	200-m Plot	-	0.73	0.73	0.73
Highland					
Bats	Road/Pad	-	0.8	0.8	0.8
	60-m Plot	-	0.31	0.31	0.31
	100-m Plot	-	0.31	0.31	0.31
Small Birds	Road/Pad	0.83	0.83	0.83	0.83
	60-m Plot	-	0.61	0.61	0.61
	100-m Plot	-	0.61	0.61	0.61
Large Birds	Road/Pad	0.83	0.83	0.83	0.83
	60-m Plot	-	0.83	0.83	0.83
	100-m Plot	-	0.83	0.83	0.83
Intrepid					
Bats	Road/Pad	-	0.74	0.74	0.74
	60-m Plot	-	0.22	0.22	0.22
	100-m Plot	-	0.22	0.22	0.22
Small Birds	Road/Pad	0.78	0.78	0.78	0.78
	60-m Plot	-	0.27	0.27	0.27
	100-m Plot	-	0.27	0.27	0.27
Large Birds	Road/Pad	0.98	0.98	0.98	0.98
	60-m Plot	-	0.62	0.62	0.62
	100-m Plot	-	0.62	0.62	0.62
Laurel					
Bats	Road/Pad	-	0.81	0.63	0.45
	60-m Plot	-	0.45	0.25	0.14
	100-m Plot	-	0.45	0.25	0.14
Small Birds	Road/Pad	1	0.8	0.51	0.54
	60-m Plot	-	0.45	0.18	0.2
	100-m Plot	-	0.45	0.18	0.2
Large Birds	Road/Pad	1	1	1	1
	60-m Plot	-	0.66	0.66	0.66
	100-m Plot	-	0.66	0.66	0.66
Lundgren					
Bats	Road/Pad	-	0.71	0.71	0.71
	60-m Plot	-	0.15	0.15	0.15
	200-m Plot	-	0.15	0.15	0.15
Small Birds	Road/Pad	0.87	0.87	0.87	0.87
	60-m Plot	-	0.2	0.2	0.2
	200-m Plot	-	0.2	0.2	0.2
Large Birds	Road/Pad	1	1	1	1
	60-m Plot	-	0.61	0.61	0.61
	200-m Plot	-	0.61	0.61	0.61

Table 5. Searcher Efficiency for each of the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016

Size Class	Plot Type	Winter	Spring	Summer	Fall
Macksburg					
Bats	Road/Pad	-	0.56	0.69	0.87
	200-m Plot	-	0.04	0.07	0.19
Small Birds	Road/Pad	0.74	0.74	0.74	0.74
	200-m Plot	-	0.26	0.26	0.26
Large Birds	Road/Pad	0.97	0.97	0.97	0.97
	200-m Plot	-	0.63	0.63	0.63
Pomeroy					
Bats	Road/Pad	-	0.25	0.48	0.72
	60-m Plot	-	0.56	0.24	0.12
	100-m Plot	-	0.56	0.24	0.12
Small Birds	Road/Pad	1	0.82	0.52	0.64
	60-m Plot	-	0.46	0.18	0.26
	100-m Plot	-	0.46	0.18	0.26
Large Birds	Road/Pad	0.88	0.88	0.88	0.88
	60-m Plot	-	0.88	0.88	0.88
	100-m Plot	-	0.88	0.88	0.88
Rolling Hills					
Bats	Road/Pad	-	0.5	0.68	0.91
	60-m Plot	-	0.44	0.08	0.32
	100-m Plot	-	0.44	0.08	0.32
Small Birds	Road/Pad	0.79	0.79	0.79	0.79
	60-m Plot	-	0.21	0.21	0.21
	100-m Plot	-	0.21	0.21	0.21
Large Birds	Road/Pad	0.97	0.97	0.97	0.97
	60-m Plot	-	0.73	0.73	0.73
	100-m Plot	-	0.73	0.73	0.73
Vienna I and Vienna II					
Bats	Road/Pad	-	0.59	0.59	0.59
	60-m Plot	-	0.18	0.18	0.18
	100-m Plot	-	0.18	0.18	0.18
Small Birds	Road/Pad	0.73	0.73	0.73	0.73
	60-m Plot	-	0.25	0.25	0.25
	100-m Plot	-	0.25	0.25	0.25
Large Birds	Road/Pad	0.94	0.94	0.94	0.94
	60-m Plot	-	0.69	0.69	0.69
	100-m Plot	-	0.69	0.69	0.69
Wellsburg					
Bats	Road/Pad	-	0.88	0.81	0.66
	60-m Plot	-	0.46	0.32	0.18
	100-m Plot	-	0.46	0.32	0.18
Small Birds	Road/Pad	0.8	0.9	0.9	0.41
	60-m Plot	-	0.56	0.56	0.09
	100-m Plot	-	0.56	0.56	0.09
Large Birds	Road/Pad	0.92	0.92	0.92	0.92
	60-m Plot	-	0.67	0.67	0.67
	100-m Plot	-	0.67	0.67	0.67

Carcass Removal Time

The Huso method 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 different variables. Seasonal estimates were calculated when the model with the lowest AICc included season. The average carcass removal time for each facility is presented in Table 6 and described in detail in Appendices A through M.

Table 6. Average Carcass Removal Time, in Days, for each of the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied Between November 16, 2015, and November 16, 2016. The Distribution used in the Calculation of Carcass Removal Time Varied by Facility.

Size Class	Plot Type	Winter	Spring	Summer	Fall	Combined
Adams						
Bats	All	-	-	4.2	2.4	-
Small Birds	All	-	-	-	-	2.7
Large Birds	All	-	-	-	-	4.1
Century						
Bats	Road/Pad	-	8.1	8.3	4.3	-
	Full Plot	-	4.9	5.0	2.6	-
Small Birds	All	-	-	-	-	10.5
Large Birds	All	-	-	-	-	21.2
Charles City						
Bats	All	-	6.5	3.6	2.1	-
Small Birds	All	-	-	-	-	3.9
Large Birds	All	20.0	4.5	6.7	3.0	-
Highland						
Bats	All	-	4.1	4.1	1.9	-
Small Birds	All	-	-	-	-	4.9
Large Birds	All	-	-	-	-	10.6
Intrepid						
Bats	All	-	16.6	5.6	6.1	-
Small Birds	All	5.5	42.7	2.7	3.6	-
Large Birds	Road/Pad	31.2	13.7	6.3	3.9	-
	Full Plot	-	32.7	15.0	9.2	-
Laurel						
Bats	All	-	5.6	3.9	2.2	-
Small Birds	All	-	-	-	-	4.5
Large Birds	Road/Pad	-	-	-	-	3.7
	Full Plot	-	-	-	-	8.0
Lundgren						
Bats	Road/Pad	-	-	-	-	6.6
	Full Plot	-	-	-	-	3.6
Small Birds	All	-	-	-	-	11.3
Large Birds	Road/Pad	-	-	-	-	17.0
	Full Plot	-	-	-	-	41.8
Macksburg						
Bats	All	-	5.2	2.6	1.8	-
Small Birds	All	9.9	9.5	6.4	1.8	-
Large Birds	All	12.0	15.5	5.5	7.4	-
Pomeroy						
Bats	All	-	8.8	2.5	2.1	-
Small Birds	All	-	-	-	-	3.2
Large Birds	All	22.1	14.7	4.9	3.7	-
Rolling Hills						
Bats	All	-	3.9	2.9	1.3	-
Small Birds	All	5.2	5.6	2.4	1.1	-
Large Birds	All	8.7	7.8	4.0	2.7	-

Table 6. Average Carcass Removal Time, in Days, for each of the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied Between November 16, 2015, and November 16, 2016. The Distribution used in the Calculation of Carcass Removal Time Varied by Facility.

Size Class	Plot Type	Winter	Spring	Summer	Fall	Combined
Vienna I and Vienna II						
Bats	All	-	7.4	8.0	4.5	-
Small Birds	Road/Pad	6.4	4.7	7.9	3.4	-
	Full Plot	-	7.5	12.8	5.5	-
Large Birds	All	-	-	-	-	12.3
Wellsburg						
Bats	All	-	3.9	3.7	1.8	-
Small Birds	All	-	-	-	-	3.2
Large Birds	Road/Pad	7.7	6.5	5.8	1.1	-
	Full Plot	-	21.7	19.4	3.6	-

Search Area Adjustment

Sufficient numbers of bat carcasses were found at each facility 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. There were not sufficient numbers of small or large birds found at each facility to fit facility-specific bird distributions; therefore, area corrections for birds were produced on a fleet-wide basis. The search area adjustment for each facility is presented in Table 7 and described in detail in Appendices A through M.

Table 7. Search Area Adjustment Values for each of the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

Size Class	Plot Type	Winter	Spring	Summer	Fall
Adams					
Bats	Road/Pad	-	-	0.17	0.17
	60-m Plot	-	-	0.55	0.55
	100-m Plot	-	-	0.77	0.77
Small Birds	Road/Pad	-	-	0.08	0.08
	60-m Plot	-	-	0.30	0.30
	100-m Plot	-	-	0.58	0.58
Large Birds	Road/Pad	-	-	0.05	0.05
	60-m plot	-	-	0.22	0.22
	100-m Plot	-	-	0.52	0.52
Century					
Bats	Road/Pad	-	0.16	0.16	0.16
	60-m Plot	-	0.67	0.67	0.67
	100-m Plot	-	0.90	0.90	0.90
Small Birds	Road/Pad	0.08	0.08	0.08	0.08
	60-m Plot	-	0.30	0.30	0.30
	100-m Plot	-	0.58	0.58	0.58
Large Birds	Road/Pad	0.05	0.05	0.05	0.05
	60-m Plot	-	0.22	0.22	0.22
	100-m Plot	-	0.53	0.53	0.53
Charles City					
Bats	Road/Pad	-	0.15	0.15	0.15
	200-m Plot	-	1.00	1.00	1.00
Small Birds	Road/Pad	0.10	0.10	0.10	0.10
	200-m Plot	-	0.99	0.99	0.99
Large Birds	Road/Pad	0.07	0.07	0.07	0.07
	200-m Plot	-	0.97	0.97	0.97

Table 7. Search Area Adjustment Values for each of the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

Size Class	Plot Type	Winter	Spring	Summer	Fall
Highland					
Bats	Road/Pad	-	0.13	0.13	0.13
	60-m Plot	-	0.49	0.49	0.49
	100-m Plot	-	0.86	0.86	0.86
Small Birds	Road/Pad	0.09	0.09	0.09	0.09
	60-m Plot	-	0.30	0.30	0.30
	100-m Plot	-	0.59	0.59	0.59
Large Birds	Road/Pad	0.05	0.05	0.05	0.05
	60-m Plot	-	0.22	0.22	0.22
	100-m Plot	-	0.53	0.53	0.53
Intrepid					
Bats	Road/Pad	-	0.07	0.07	0.07
	60-m Plot	-	0.38	0.38	0.38
	100-m Plot	-	0.92	0.92	0.92
Small Birds	Road/Pad	0.10	0.10	0.10	0.10
	60-m Plot	-	0.30	0.30	0.30
	100-m Plot	-	0.58	0.58	0.58
Large Birds	Road/Pad	0.06	0.06	0.06	0.06
	60-m Plot	-	0.22	0.22	0.22
	100-m Plot	-	0.52	0.52	0.52
Laurel					
Bats	Road/Pad	-	0.17	0.17	0.17
	60-m Plot	-	0.50	0.50	0.50
	100-m Plot	-	0.78	0.78	0.78
Small Birds	Road/Pad	0.11	0.11	0.11	0.11
	60-m Plot	-	0.29	0.29	0.29
	100-m Plot	-	0.58	0.58	0.58
Large Birds	Road/Pad	0.07	0.07	0.07	0.07
	60-m Plot	-	0.21	0.21	0.21
	100-m Plot	-	0.52	0.52	0.52
Lundgren					
Bats	Road/Pad	-	0.16	0.16	0.16
	60-m Plot	-	0.58	0.58	0.58
	200-m Plot	-	1.00	1.00	1.00
Small Birds	Road/Pad	0.07	0.07	0.07	0.07
	60-m Plot	-	0.29	0.29	0.29
	200-m Plot	-	0.99	0.99	0.99
Large Birds	Road/Pad	0.04	0.04	0.04	0.04
	60-m Plot	-	0.22	0.22	0.22
	200-m Plot	-	0.98	0.98	0.98
Macksburg					
Bats	Road/Pad	-	0.35	0.35	0.35
	200-m Plot	-	1.00	1.00	1.00
Small Birds	Road/Pad	0.10	0.10	0.10	0.10
	200-m Plot	-	0.99	0.99	0.99
Large Birds	Road/Pad	0.06	0.06	0.06	0.06
	200-m Plot	-	0.97	0.97	0.97
Pomeroy					
Bats	Road/Pad	-	0.13	0.13	0.13
	60-m Plot	-	0.58	0.58	0.58
	100-m Plot	-	0.94	0.94	0.94
Small Birds	Road/Pad	0.08	0.08	0.08	0.08
	60-m Plot	-	0.30	0.30	0.30
	100-m Plot	-	0.59	0.59	0.59
Large Birds	Road/Pad	0.05	0.05	0.05	0.05
	60-m Plot	-	0.22	0.22	0.22
	100-m Plot	-	0.53	0.53	0.53

Table 7. Search Area Adjustment Values for each of the 13 MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

Size Class	Plot Type	Winter	Spring	Summer	Fall
Rolling Hills					
Bats	Road/Pad	-	0.15	0.15	0.15
	60-m Plot	-	0.61	0.61	0.61
	100-m Plot	-	0.87	0.87	0.87
Small Birds	Road/Pad	0.08	0.08	0.08	0.08
	60-m Plot	-	0.30	0.30	0.30
	100-m Plot	-	0.61	0.61	0.61
Large Birds	Road/Pad	0.05	0.05	0.05	0.05
	60-m Plot	-	0.22	0.22	0.22
	100-m Plot	-	0.55	0.55	0.55
Vienna I					
Bats	Road/Pad	-	0.24	0.24	0.24
	60-m Plot	-	0.65	0.65	0.65
	100-m Plot	-	0.93	0.93	0.93
Small Birds	Road/Pad	0.11	0.11	0.11	0.11
	60-m Plot	-	0.29	0.29	0.29
	100-m Plot	-	0.58	0.58	0.58
Large Birds	Road/Pad	0.07	0.07	0.07	0.07
	60-m Plot	-	0.21	0.21	0.21
	100-m Plot	-	0.52	0.52	0.52
Vienna II					
Bats	Road/Pad	-	0.24	0.24	0.24
	60-m Plot	-	0.63	0.63	0.63
	100-m Plot	-	0.91	0.91	0.91
Small Birds	Road/Pad	0.11	0.11	0.11	0.11
	60-m Plot	-	0.30	0.30	0.30
	100-m Plot	-	0.58	0.58	0.58
Large Birds	Road/Pad	0.07	0.07	0.07	0.07
	60-m Plot	-	0.22	0.22	0.22
	100-m Plot	-	0.52	0.52	0.52
Wellsburg					
Bats	Road/Pad	-	0.20	0.20	0.20
	60-m Plot	-	0.59	0.59	0.59
	100-m Plot	-	0.80	0.80	0.80
Small Birds	Road/Pad	0.09	0.09	0.09	0.09
	60-m Plot	-	0.31	0.31	0.31
	100-m Plot	-	0.60	0.60	0.60
Large Birds	Road/Pad	0.05	0.05	0.05	0.05
	60-m Plot	-	0.23	0.23	0.23
	100-m Plot	-	0.54	0.54	0.54

Adjusted Fatality Estimates

Fatality estimates were calculated for bats, large birds, small birds, and all birds for all 13 facilities in the study (Table 8; Appendices A through M). Diurnal raptor fatality estimates were calculated for Century, Intrepid, Macksburg, Pomeroy, Rolling Hills, Vienna I, and Vienna II, which were the only facilities where raptor carcasses were found on search areas and within the search interval (Table 8). When at least five carcasses were included in the analysis, 90% confidence intervals were calculated. The fatality estimate calculations for each facility are presented in Appendices A through M.

<u>Bats</u>

All-bat fatality estimates at the 13 facilities ranged from 6.25 bats/MW/year at Pomeroy to 18.37 at Intrepid (Table 8). The second highest fatality estimate for bats was at Laurel (14.22 bats/MW/year). Fatality estimates were less than 10 bats/MW/year at Century, Highland, Lundgren, Pomeroy, Rolling Hills, Vienna I, and Wellsburg.

<u>All Birds</u>

The estimated fatality rates for all birds varied across the 13 facilities. All-bird fatality estimates ranged from 1.56 birds/MW/year at Adams to 8.44 at Wellsburg (Table 8).

<u>Large Birds</u>

The estimated fatality rates for large birds were relatively low across all sites. Macksburg had the highest large bird fatality rate (2.65 large birds/MW/year); the remaining facilities had large bird fatality estimates of 1.13 or lower (Table 8).

<u>Raptors</u>

Estimated fatality rates for raptors were calculated for seven sites where raptor carcasses were found on area and within the search interval: Century, Intrepid, Macksburg, Pomeroy, Rolling Hills, Vienna I, and Vienna II. Confidence intervals were not calculated given the low number of carcasses found at each facility. The raptor fatality estimate was highest at Pomeroy (0.19 raptors/MW/year), followed by Rolling Hills (0.08) and Vienna II (0.07; Table 8).

<u>Small Birds</u>

The estimated fatality rates for small birds generally followed the overall bird fatality estimates. The highest small bird estimate was at Wellsburg (7.71 birds/MW/year) and lowest at Adams (1.03; Table 8).

Table 8. Adjusted Fatality Rate Estimate (Fatalities/MW/Year) and 90% Confidence Intervals (CI)[1] at the MidAmerican Energy Company's Iowa Wind Energy Facilities Studied from November 16, 2015, to November 16, 2016.

Facility	Bats		Small Birds		Large Birds		All Birds		Raptors	
	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI	Estimate	90% CI
Adams	10.08	7.54 - 15.42	1.03	0.26 - 2.16	0.53	-	1.56	0.67 - 2.89	-	-
Century	9.07	6.93 - 13.93	2.42	1.56 - 4.18	1.13	0.58 - 1.87	3.54	2.53 - 5.41	0.01	-
Charles City	10.41	7.86 - 14.44	4.06	2.37 - 6.45	0.08	-	4.13	2.43 - 6.54	-	-
Highland	8.63	6.0 - 12.94	1.78	1.22 - 2.35	0.47	0.25 - 0.79	2.25	1.65 - 2.88	-	-
Intrepid	18.37	8.55 - 31.90	2.13	1.31 - 3.22	0.80	0.31 - 1.56	2.93	1.96 - 4.17	0.02	-
Laurel	14.22	9.66 - 24.54	2.46	1.20 - 4.54	0.50	0.15 - 1.06	2.96	1.61 - 5.25	-	-
Lundgren	8.80	7.04 - 12.44	3.05	1.93 - 4.21	0.32	0.02 - 0.94	3.37	2.21 - 4.68	-	-
Macksburg	10.79	7.91 - 16.38	2.29	1.23 - 3.69	2.65	0.89 - 5.82	4.94	2.93 - 8.16	0.02	-
Pomeroy	6.25	4.84 - 10.25	1.86	1.07 - 2.78	0.90	0.43 - 1.59	2.76	1.82 - 3.97	0.19	-
Rolling Hills	6.30	5.02 - 9.01	2.61	1.79 - 4.19	0.86	0.47 - 1.48	3.48	2.57 - 5.21	0.08	-
Vienna I	9.09	6.70 - 13.74	5.08	3.23 - 8.14	0.62	0.15 - 1.30	5.70	3.76 - 8.72	0.03	-
Vienna II	10.28	5.97 - 19.36	2.74	0.75 - 6.33	0.83	-	3.57	1.45 - 7.13	0.07	-
Wellsburg	12.30	9.20 - 19.84	7.71	4.49 - 13.10	0.73	0.22 - 1.51	8.44	5.18 - 13.94	-	-

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

DISCUSSION AND IMPACT ASSESSMENT

The approach outlined by the Huso method (Huso 2011, Huso et al. 2012) 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 removal rates, and search area. It is hypothesized that scavenging could change through time at a given site and must be accounted for when attempting to estimate fatality rates. This was accounted for by conducting scavenging trials throughout the year and, when appropriate, calculating estimates of carcass removal by season. Searcher efficiency rates were also estimated throughout the study period to account for any biases associated with changes in conditions; similarly, seasonal searcher efficiency was used to calculate fatality estimates, when appropriate.

Given the primary objective of this survey effort, and the generally low bird mortality across all 13 facilities, discussion of bird mortality will focus only on bird species listed under the ESA, by the IDNR, or protected under the BGEPA.

Bat Carcasses

Landscape and habitat context have both been proposed as hypotheses to explain bat carcasses at wind energy facilities. For example, in the eastern U.S., clear cutting into the forested ridges on which some wind energy facilities are built is 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, the relatively large numbers of bat carcasses reported in Wisconsin (Gruver et al. 2009; BHE Environmental 2010, 2011) and Illinois (Good et al. 2013b, 2013a) indicate that an open landscape is no guarantee of low mortality. The landscape across the Iowa facilities varies somewhat, but row crops typically dominate the landscape, with two facilities containing a mix of pasture/hay and row crops (Rolling Hills and Macksburg).

All-bat fatality rates among the 13 facilities varied considerably, with nearly a three-fold difference between the site with the lowest estimate (Pomeroy) and the site with the highest estimate (Intrepid). Species composition of carcasses at the Iowa wind energy facilities was similar to that at most other wind energy facilities, in that most bat carcasses (73.8%) were from three migratory tree bat species: hoary bat, eastern red bat, and silver-haired bat (*Lasionycteris noctivagans*). The timing of bat fatalities occurred during the likely period when pups are dispersing and bats are migrating through the study area.

Species of Interest

One Indiana bat carcass, a state-listed (IDNR 2016) and federally listed species under the ESA, was found at Turbine 16 of the Macksburg project (Figure 8). The sex of the Indiana bat carcass will be determined through future testing.

Two bald eagles (BGEPA; state special concern species), one long-eared owl (state threatened), and two short-eared owls (state endangered) were found. One bald eagle was found at the Highland wind energy facility (Appendix D), and one was found at the Charles City facility (Appendix C). The bald eagle fatalities are discussed in detail in the 2016-2017 eagle report. The long-eared owl was found at the Lundgren facility (Appendix G), and both short-eared owls were found at the Vienna I facility (Appendix K).

CONFIDENTIAL BUSINESS INFORMATION

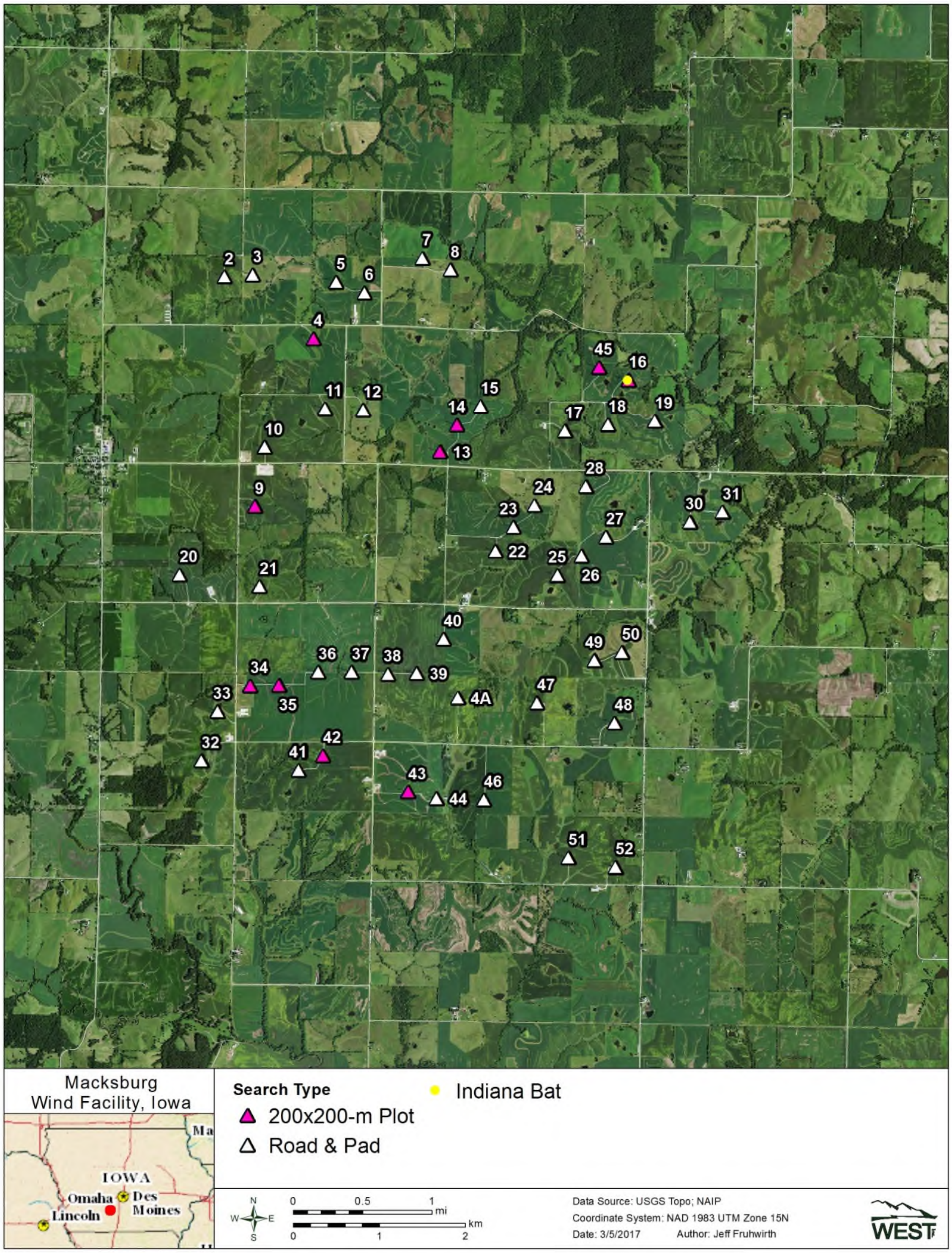

Figure 8. Location of the Indiana Bat Found at the Macksburg Wind Facility.

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2014-2016 Post-Construction Fatality Monitoring: Eagle-focused Carcass Searches

MidAmerican Energy Company Iowa Wind Energy Portfolio: Carroll, Victory, Lundgren, Walnut, Rolling Hills, Adair, Eclipse, Morning Light, and Macksburg

Draft Report
December 2014 – March 2016

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INTRODUCTION

MidAmerican Energy Company (MidAmerican) is developing a comprehensive avian and bat conservation program for its wind power facilities in Iowa, in coordination with the U.S. Fish and Wildlife Service (USFWS) and the Iowa Department of Natural Resources (IDNR). As part of the comprehensive conservation program, MidAmerican requested that Western EcoSystems Technology, Inc. (WEST) conduct standardized post-construction fatality monitoring at their 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).

During the 2014-2016 study period, post-construction fatality monitoring was conducted at nine MidAmerican facilities: Adair, Carroll, Eclipse, Lundgren, Macksburg, Morning Light, Rolling Hills, Victory, and Walnut (Table 1, Figure 1). This report provides site-specific data collected using the eagle-focused study design at these nine facilities between December 4, 2014, and March 15, 2016.

The primary objective of the eagle specific post-construction monitoring presented in this report was to gather data useful in quantifying fatality estimates for eagles. A secondary objective was to gather data to support the Habitat Conservation Plan (MidAmerican, in prep.) and National Environmental Policy Act (NEPA) process in application for an Incidental Take Permit (ITP). 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 this objective include:

- Compare the searcher efficiency across three search methods for eagle fatalities;
- Determine carcass removal rates for large birds comparable to eagles, and;
- Determine the area viewable from the visual scan searches.

The following report presents the data collected during the eagle monitoring surveys and associated bias trials at the nine facilities listed above. In addition to this study, ten additional MidAmerican facilities are being studied from 2015 to 2017 using the same methods. Combined data from the 2014-2016 and 2015-2017 studies through May 2016 is being used in the HCP using different analytical methods to estimate potential take of bald eagles and will support a comprehensive analysis of potential take for the entire MidAmerican Iowa wind energy portfolio.

Table 1. MidAmerican's Iowa Wind Energy Portfolio, including facility specifications.

Facility Name	County	Project Area (Square Miles)	Project Area (Acres)	Number of Turbines	Turbine Size (MW)	Total Project (MW)
Facilities included in the 2014-2016 Fatality Monitoring Study (This report)						
Adair	Adair/Cass	27	17,354	76	2.3	174.8
Carroll	Carroll	25	16,241	100	1.5	150.0
Eclipse	Audubon/Guthrie	31	20,046	87	2.3	200.1
Lundgren	Webster	52	33,189	107	2.3	251.0
Macksburg	Madison	22	14,367	51	2.3	119.6
Morning Light	Adair	13	8,176	44	2.3	101.2
Rolling Hills	Adair/Adams/Cass	69	44,294	193	2.3	443.9
Victory	Carroll/Crawford	28	18,129	66	1.5	99.0
Walnut	Pottawattamie	32	20,409	102	1.5	153.0
Operational Facilities to be Studied in 2015-2017						
Century	Hamilton/Wright	28	17,831	145	1.5/1.0	200.0
Charles City	Floyd	18	11,666	50	1.5	75.0
Highland	O'Brien	85	54,660	214	2.3	495.0
Intrepid	Sac/Buena Vista	43	27,735	122	1.5/1.0	175.5
Laurel	Marshall	16	10,241	52	2.3	119.6
Pomeroy	Pocahontas	34	21,798	184	1.5/2.3	286.4
Vienna	Marshall/Tama	15	9,536	45	2.3	105.6
Vienna II	Marshall	11	6,970	19	2.3	44.6
Wellsburg	Grundy	36	22,979	60	2.3	140.8
Adams[a]	Adams	21	13,199	64	2.4	154.3
Planned Facilities						
Ida Grove	Ida	103	65,963	134	1.8/2.3	301.6
O'Brien	O'Brien	92	58,992	104	2.3/2.4	250.3

[a] Adams was under construction during the time period of this study, but became operational in early 2016.

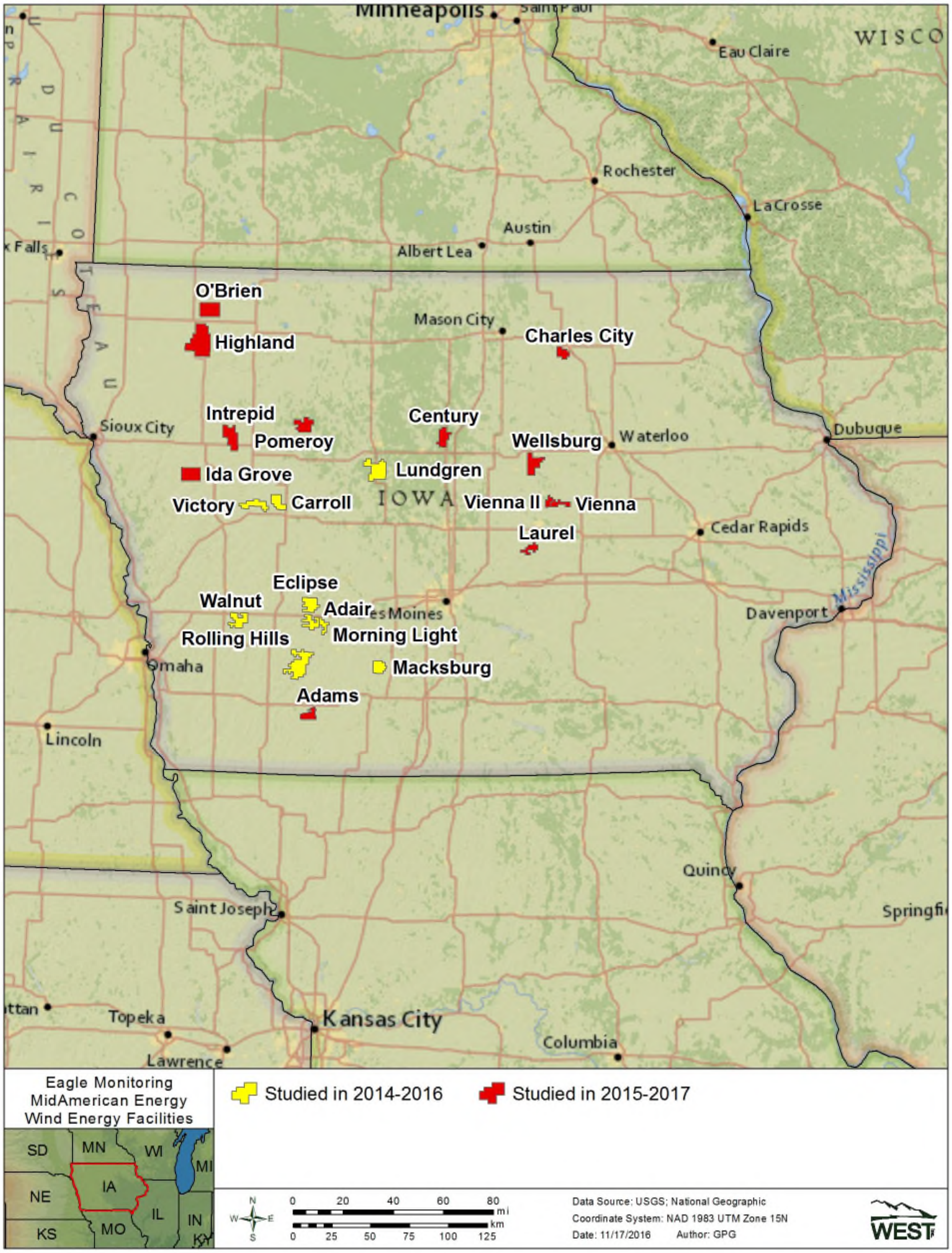

Figure 1. Locations of the existing and planned facilities in the Iowa MidAmerican Wind Energy Portfolio

STUDY AREA

The Adair, Morning Light, Rolling Hills, and Macksburg facilities are located in the Rolling Loess Prairies Level 4 Ecoregion, while the Eclipse facility straddles both the Rolling Loess Prairies and Steeply Rolling Loess Prairies Level 4 Ecoregions. The Victory and Walnut facilities are located in the Steeply Rolling Loess Prairies Level 4 Ecoregion, and the Carroll facility straddles the Des Moines Lobe and Steeply Rolling Loess Prairies Level 4 Ecoregions. The Lundgren Facility is located in the Des Moines Lobe Level 4 Ecoregion.

According to the U.S. Geological Survey National Land Cover Database, the Adair, Morning Light, Eclipse, Carroll, Victory, Walnut, and Lundgren landscapes predominately consist of cropland (i.e., corn and soybeans). The land cover at Rolling Hills and Macksburg is a combination of cropland and pasture/hay.

METHODS

The methods of the post-construction monitoring study are organized into four primary components: (1) standardized carcass searches, (2) searcher efficiency trials, (3) carcass removal trials, and (4) visible area delineations.

Standardized Carcass Searches

To determine the observed number of eagle carcasses, standardized carcass searches were conducted from December 4, 2014, to May 15, 2015, and from November 15, 2015, to March 15, 2016, at each of the nine facilities. This timeframe 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 searches for eagle searches discussed below were conducted immediately following the road and pad searches for bats and other bird species (WEST 2015). All carcasses found during these searches were documented.

Eagle carcass searches were conducted at 100% of turbines in both study periods. From December 4, 2014, to April 22, 2015, eagle carcass searches were conducted at all turbines and split into three treatments: 70% of turbines were searched using visual scans, 15% of turbines were searched using transects 20 m apart, and 15% of turbines were searched using transect 40 m apart (see description of each method below). These three “treatments” were used to determine the most effective search method. Due to landowner concerns about crop damage from pedestrian traffic in newly planted fields, all carcass searches were conducted using visual scans from April 22, to May 15, 2015. Carcass searches were conducted once every four weeks during the first study period (December 4, 2014, to May 15, 2015). For the second study period (November 15, 2015, to March 15, 2016), only visual scans were conducted, and 100% of turbines were searched every two weeks. The search interval was adjusted to a shorter period to help improve the estimates, given the surrogate species used in the carcass removal trials were being removed faster than the search interval.

Visual Scans

Visual scan carcass searches were conducted within a 100-m 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. All carcasses were documented in the manner described below, regardless of the distance from turbine.

Transect Carcass searches

Transect carcass searches were conducted at 30% of turbines within 200 by 200 meter square plots (m; 656 x 656 feet [ft]) centered on the turbine (Figure 2). Searchers walked staked transects while scanning the area on both sides of the transect for carcasses. Half of transect carcass search turbines (15% of the total turbines) were searched with 40 m transect spacing and the other half (15% of the total turbines) with 20 m transect spacing.

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), 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, 2-3 days). Digital photographs were taken of the carcass, any visible injuries (e.g., broken wing), and surrounding habitat.

Carcass Handling

The USFWS was notified when eagle carcasses were located for further collection and handling instruction. Carcasses found outside the search area were documented in a similar fashion as those found within standardized search areas. All other carcasses were treated as described in Bay et al. 2016.

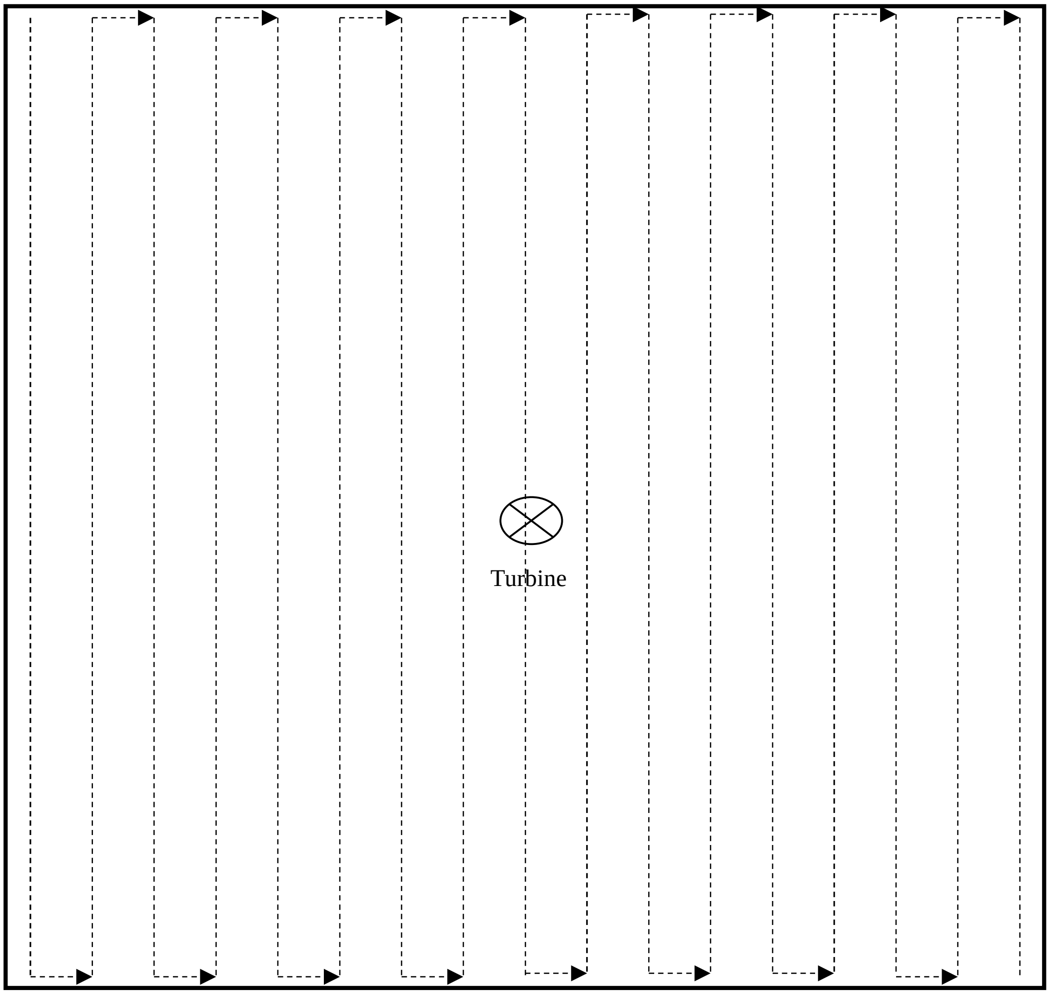

Figure 2. Schematic of transects within a full survey plot (not to scale).

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 carcass searches occurred. 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.

Surrogates for eagle carcasses were fully-feathered turkey (*Meleagris gallopavo*) decoys (“decoys”). 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. Searchers were not informed when searcher efficiency trials were being conducted, nor where trial decoys were placed. The number and location of the searcher efficiency decoys found during the carcass survey was recorded. The number of decoys available for detection during each trial was determined immediately after the trial by the person responsible for distributing the decoys.

From December 4, 2014, to May 15, 2015, approximately 10 searcher efficiency trials[1] were conducted at each facility and in each plot type: 100-m radius scans, 200x200-m plot 20-m width transects, and 200x200-m plot 40-m width transects. Combined, approximately 30 decoys were used to assess searcher efficiency for eagle-specific carcass searches at each of the nine facilities. From November 15, 2015, to March 15, 2016, approximately 20 searcher efficiency trials were conducted within the 100-m radius plots at each facility during the second study period. No transect searches were conducted during the second study period.

Carcass Removal Trials

The objective of carcass removal 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 removal studies were conducted approximately monthly to cover all seasons. Estimates of carcass removal are used to adjust the total number of carcasses found for those removed from the search area prior to searches, thereby correcting for removal bias.

During the first study period (December 4, 2014, to May 15, 2015), approximately 10 carcass removal trials per facility were placed in representative habitat, but at a distance of at least 200 m from turbines to avoid increasing risk to scavenging eagles and raptors potentially attracted to the carcass. Approximately 20 trial carcasses were placed within search plots during the second study period (November 15, 2015, to March 15, 2016).[2]

Surrogates for eagle carcasses consisted of adult ring-necked pheasants (*Colchicus phasianus*), and/or adult mallards (*Anas platyrhynchos*). In addition, if found during searches, remains of intact diurnal raptor and owl carcasses were marked for carcass removal trials and observed in the same manner as the surrogate species. The number of observed raptor carcasses found during the first winter and spring was not enough to allow for an accurate raptor carcass removal rate to be calculated. Therefore, MidAmerican conferred with the USFWS to obtain additional raptor carcasses to be used to test differences in carcass removal rates between the surrogate species and actual raptors. The USFWS Rock Island Field Office had a source of raptor carcasses available from the O'Hare Airport so, in addition, USFWS provided MidAmerican with 24 red-tailed hawk (*Buteo jamaicensis*) carcasses that were used in the trials at these nine facilities between November 15, 2015, and March 15, 2016; the red-tailed hawks were placed in addition to the scheduled trial carcasses.

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[1] When the transect carcass searches were discontinued before the completion of survey period due to landowner concerns, a round of transect decoy placements were missed resulting in difference in the number placed at each plot type.

[2] The study protocol was adjusted in the second study period, after which carcass removal trials were conducted on search plots to provide more representative removal rates based on the concern that nearby areas such as adjacent to roads may provide easier access to the trial carcasses by scavengers compared to carcasses on survey plots.

The red-tailed hawk carcasses provided by the USFWS were added to the carcass removal trials to allow for a better understanding of the difference in removal rates between the standard surrogates, discussed above, and raptor species. Previous results from other studies have shown that raptor carcasses last much longer than the standard surrogates and particularly gamebirds such as pheasants (Urquhart et al. 2015 and Hallingstad et al. 2016), although the availability of raptor carcasses was limited and sample sizes were often small. Carcass removal rates based on raptors rather than the standard surrogate species will likely decrease the correction associated with carcass removal bias when calculating raptor fatality rates. As such, the overall eagle fatality estimate should improve, as raptor species such as red-tailed hawk better represent actual removal rates of eagles. Carcass removal trials using red-tailed hawks and additional raptors provided by the USFWS are ongoing at the additional ten facilities being studied through early 2017.

Trial surrogate carcasses were dropped from shoulder height and allowed to land in a natural posture to simulate a true turbine related fatality; carcasses found during scheduled searches and observed for carcass removal trials were marked and left undisturbed in the field. Each trial carcass was marked discreetly with a black zip-tie around the leg to identify it as a study carcass. Personnel conducting carcass searches monitored the trial birds 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. 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 30-day period, any evidence of the placed trial carcasses that remained was removed. The remains of the diurnal raptors and owls found during scheduled searches that still persisted at the end of the 30-day period were monitored for an additional 30 days. At the end of the 60-day period, any remains of these diurnal raptors or owls were spray painted and left in the field.

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 maps. Turbine-specific paper maps were 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 (Figure 3).

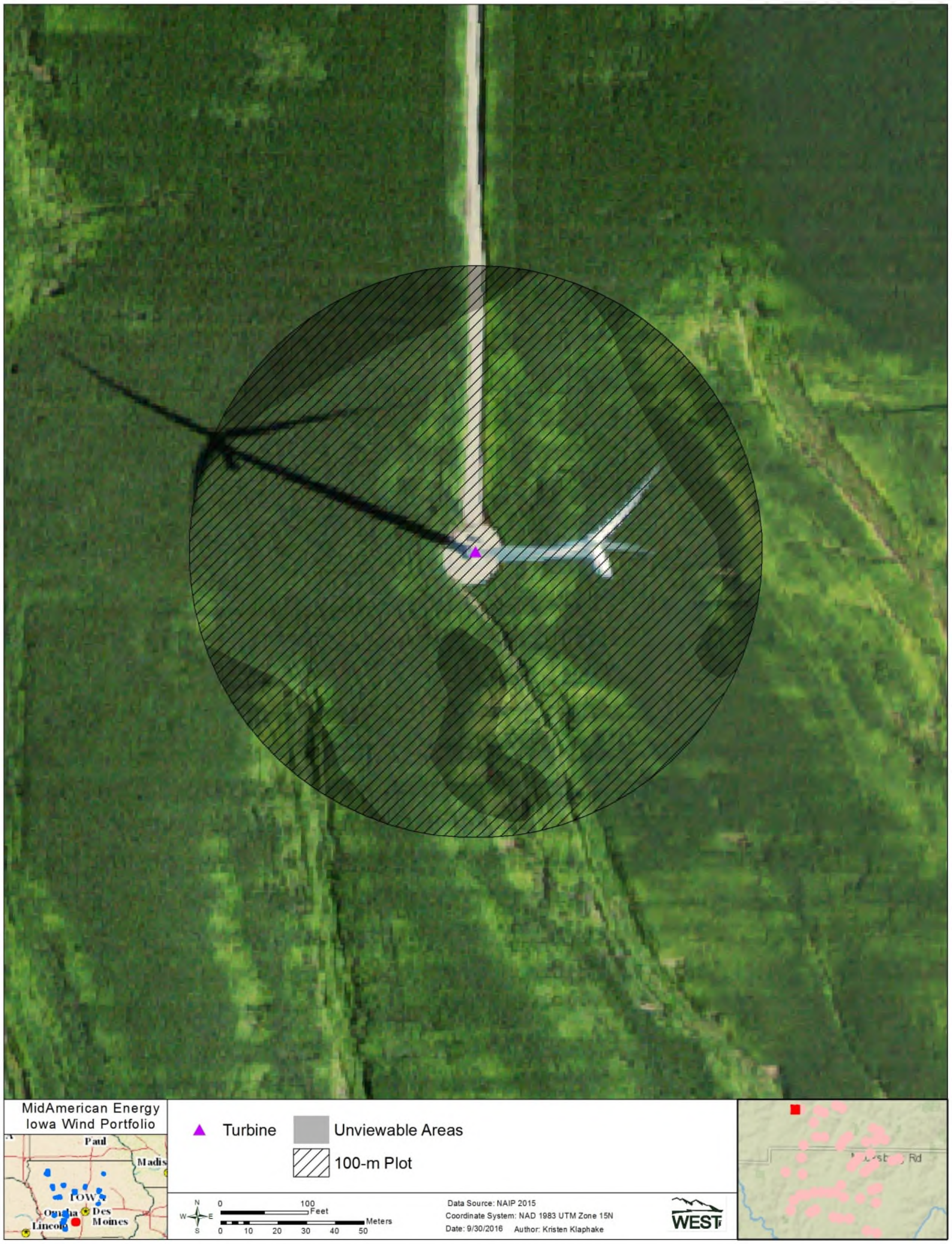

Figure 3. An example of the 100-m search plot and digitized unviewable area.

Data Management and Bias Modeling

Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field 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® ACCESS 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 QA/QC and data analysis. All data forms, field notebooks, and electronic data files were retained for reference.

Fatality Rate Estimation

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 using the ratio of trial carcasses found over the total number of trial carcasses available to be found. Searcher efficiency was estimated for transect searches conducted in 2014/2015, eagle scan searches conducted in 2014-2015, all searches in 2014/2015, all searches in 2015/2016, and all searches in 2014-2016. For fatality estimation, searcher efficiency rates were estimated using a logistic regression, with season as a potential covariate. The logistic model models the natural logarithm of the odds of finding an available carcass as function of the above covariates. The best model was selected using Akaike information criterion (AICc) with a correction for finite sample sizes (Burnham and Anderson 2002).

Estimation of Carcass Removal Rates

Estimates of carcass removal rates were obtained using interval censored survival regression (Therneau 2015, Therneau and Grambsch 2000). A single covariate, season, was used in the analysis. Model selection was used to determine the best fitting distribution. Exponential, log-logistic, lognormal, and Weibull distributions were fit and the best model was selected using AICc (Burnham and Anderson 2002).

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 826 turbines within the nine facilities were searched during both study periods. From December 4, 2014, to May 15, 2015, a total of 599 searches of 200x200-m square plots were conducted using a 20-m transect width, 628 searches of the square plots were conducted using a 40-m transect width, and 3,578 visual scan searches were conducted within a 100-m radius plot around each turbine (Table 2). From November 15, 2015, to March 15, 2016, a total of 5,478 100-m visual scans were completed (Table 2).

A total of two bald eagles (*Haliaeetus leucocephalus*) were found at the nine facilities during this period: one each at Macksburg (found during standardized carcass searches) and Carroll (found incidentally). The bald eagle carcass found at Macksburg on December 4, 2014, was initially left in field, and the location was marked with blue pin flags. After receiving direction for carcass handling from the USFWS, a WEST technician placed the eagle carcass in the freezer at the Macksburg operations and maintenance (O&M) facility. On December 12, 2014, the carcass was delivered to Mr. Drew Becker from the USFWS near Iowa City, Iowa, where he took possession of the carcass. The bald eagle carcass found at Carroll on March 10, 2015, was initially found by a contract maintenance technician that stayed with the carcass until the WEST technician came and marked the carcass with blue pin flags and left it in the field. WEST later received direction for carcass handling from the USFWS and the carcass was placed in the freezer at the Carroll O&M facility. Upon further instruction from Mr. Drew Becker of the USFWS, a WEST technician transported the carcass to Springbrook State Park, in Grimes, Iowa, where Mr. Justin Mays of the USFWS took possession of the carcass.

Table 2. Eagle carcass search effort, by survey treatment, for each of the nine MidAmerican facilities studied from December 4, 2014, to March 15, 2016.

Facility	Study period 1: December 4, 2014 – May 15, 2015			Study period 2: November 15, 2015 – March 15, 2016
	20-meter Transects	40-meter Transects	100-meter Scans	100-meter Scans
Adair	53	57	335	565
Carroll	84	90	426	656
Eclipse	64	62	374	558
Lundgren	80	80	481	677

Table 2. Eagle carcass search effort, by survey treatment, for each of the nine MidAmerican facilities studied from December 4, 2014, to March 15, 2016.

Facility	Study period 1: December 4, 2014 – May 15, 2015			Study period 2: November 15, 2015 – March 15, 2016
	20-meter Transects	40-meter Transects	100-meter Scans	100-meter Scans
Macksburg	37	40	258	388
Morning Light	31	34	164	321
Rolling Hills	134	137	794	1,401
Victory	50	50	296	441
Walnut	66	78	450	741
All Facilities	**599**	**628**	**3,578**	**5,748**

Searcher Efficiency

Searcher efficiency for the two-study period effort across all nine facilities was 0.80 (Table 3). In the first study period, searcher efficiency was similar for the 20-m transect (0.78), 40-m transect (0.71), and the 100-m scan carcass searches (0.67). Searches in the second study period (2015-2016) consisted of only visual scans, and the searcher efficiency rate was 0.92 (Table 3). Searcher efficiency rates for each facility are reported in Appendix A.

Table 3. Fleet-wide searcher efficiency for the nine MidAmerican facilities studied between December 4, 2014, and March 15, 2016.

Survey Type	Date Range	# Placed	#Available	Found	Searcher Efficiency Rate
20-m Transect	2014-2015	90	83	65	0.78
40-m Transect	2014-2015	85	82	58	0.71
100-meter Scans	2014-2015	105	81	54	0.67
Study Period 1 – All Searches	2014-2015	280	246	177	0.72
Study Period 2 – All Searches	2015-2016	180	151	139	0.92
All Searches	**2014-2016**	**460**	**397**	**316**	**0.80**

Carcass Removal Time

Upon analysis of carcass removal trials, it was determined that there was no significant difference between carcass removal rates of large birds surrogate carcasses (chukars [*Alectoris chukar*] and rock pigeons [*Columba livia*]) (see Bay et al. 2016) and the eagle surrogate carcasses (ring-necked pheasants and mallards); therefore, large bird data were pooled with the surrogate species and raptor data to provide a larger sample size for calculating carcass removal rates. The number and type of species used at each facility are presented in Table 4.

The number of red-tailed hawks and other raptor species available were limited during this preliminary analysis, so the data were combined with the other surrogates species. The preliminary trend suggested that, in most cases, raptors lasted longer than the other species. Additional data were available for the draft HCP (in preparation), given the inclusion of the other nine facilities that were studied in 2016, which allowed for raptor-specific carcass removal rates to be calculated and used in the take estimates that are presented the draft HCP.

Table 4. The species [a] and number used for the carcass removal trials, for each of the nine MidAmerican facilities studied between December 4, 2014, and March 15, 2016.

Facility	CHUK	COHA	MALL	RNPH	ROPI	RTHA	SEOW	SSHA	Total
Adair	2	1	0	20	13	3	0	0	**39**
Carroll	10	0	1	19	5	5	0	0	**40**
Eclipse	5	0	0	19	10	2	1	1	**38**
Lundgren	3	0	0	27	14	3	0	0	**47**
Macksburg	2	0	0	21	21	5	0	0	**49**
Morning Light	0	0	0	20	12	2	0	0	**34**
Rolling Hills	0	0	5	12	25	3	0	0	**45**
Victory	8	0	0	20	7	2	0	0	**37**
Walnut	2	0	0	23	9	2	0	0	**36**

[a] CHUK = chukar (*Alectoris chukar*); COHA = Cooper's hawk (*Accipiter cooperii*); MALL = mallard (*Anas platyrhynchos*); RNPH = ring-necked pheasant (*Colchicus phasianus*); ROPI = rock pigeon (*Columba livia*); RTHA = red-tailed hawk (*Buteo jamaicensis*); SEOW = short-eared owl (*Asio flammeus*); SSHA = sharp-shinned hawk (*Accipiter striatus*)

Generally, carcass removal rates were similar for both winters and spring, with the exception of Carroll and Walnut, where spring had faster removal rates (Table 5). Carcass removal rates ranged from 7.88 to 35.76 days at all facilities across winter and spring (Table 5). Carcass removal model selection for each facility is reported in Appendix B.

Table 5. Average eagle carcass removal time, in days, for each of the nine MidAmerican facilities studied between December 4, 2014, and March 15, 2016.

Facility	Season	Removal Rate[a]
Adair	Winter/Spring	12.05
	Winter	35.76
Carroll	Spring	10.94
Eclipse	Winter/Spring	18.12
Lundgren	Winter/Spring	12.05
Macksburg	Winter/Spring	12.06
Morning Light	Winter/Spring	16.07
Rolling Hills	Winter/Spring	15.10
Victory	Winter/Spring	18.34
	Winter	19.10
Walnut	Spring	7.88

[a]Parameterization was according to Therneau (2015).

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. Area correction values for each facility ranged from 0.75 to 0.93 percent (Table 6).

Table 6. Area corrections values for 100-m scan plots at each of the nine MidAmerican facilities studied from December 4, 2014, to March 15, 2016.

Facility	Number of Turbines	Area Correction
Adair	76	0.83
Carroll	100	0.89
Eclipse	87	0.91
Lundgren	107	0.93
Macksburg	51	0.75
Morning Light	44	0.92
Rolling Hills	193	0.89
Victory	66	0.82
Walnut	102	0.87

DISCUSSION

During the first study period, the study was designed to enable a comparison of searcher efficiency using three different search treatments: visual scans, transect searches using a 20-m transect width, and transect searches using a 40-m transect width. In April 2015, landowners expressed concerns over potential crop damage from pedestrian traffic in newly planted fields. As a result, all searches from April 22 to May 15, 2015, were conducted using visual scans, and transect searcher efficiency trials scheduled during that period could not be completed, thereby reducing the searcher efficiency trial sample size. A statistical comparison of searcher efficiency across the three treatments would not produce reliable results due to the reduced sample size. Despite this unanticipated change in study design, the results of searcher efficiency trials indicate that searcher efficiency was similar between transect searches and visual scans. In fact, during the second study period, when only visual scans were conducted, searcher efficiency rates were greater than 90%. We believe these high searcher efficiency rates during the second study period are associated with an increase in field technician experience and familiarity with the search area and method. In addition, eagle carcasses and the decoy used for the trials are large, and are therefore believed to be relatively easy to find when scanning across a viewshed.

Review of the searcher efficiency and carcass removal rates as well as the area correction results presented here show that the methods used in this study are adequate for collecting data for use in estimating fatality rates of eagles and other large birds, such as other raptors. For example, search efficiency estimates were relatively high (greater than 65%), suggesting that the majority of eagle carcasses would be found during visual scans. In addition, the majority of all scan plots were visible, again suggesting likely high detection rate for eagles – a relatively large carcass. The carcass removal rate during the winter and spring was fairly slow suggesting that, on average, at least half of carcasses persisted long enough that searchers would have an opportunity to find them. These factors all influence estimates of fatality rates, and the values determined in this study will help improve precision of eagle take estimates.

During the study periods reported here, two bald eagle carcasses were found at the first nine facilities studied. These fatalities, in addition to the information on searcher efficiency, carcass removal times, and area correction, will provide the foundation for a data-driven HCP and NEPA process. Preliminary eagle fatality estimates for all of the MidAmerican wind projects expected to be operational by 2017 have been calculated and are provided in the draft HCP currently under preparation. Additionally, searcher efficiency, carcass removal times, and area correction calculations are useful in designing long-term monitoring plans and future management strategies as outlined in the HCP. The information from this study, when combined with data from the studies at the other ten facilities being studied between 2015 and 2017, will ultimately be incorporated into the final HCP and NEPA documents.

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Appendix A: Searcher Efficiency Estimates at Each of the Nine MidAmerican Wind Energy Facilities Studied from December 4, 2014, to March 15, 2016

Appendix A. Fleet-wide searcher efficiency for each of the nine MidAmerican facilities studied between December 4, 2014, and March 15, 2016.

Facility	Survey Type	Date Range	# Placed	#Available	# Found	Searcher Efficiency Rate
Adair	20-m Transect	2014-2015	10	6	4	0.67
	40-m Transect	2014-2015	10	10	5	0.50
	100-meter Scans	2014-2015	10	4	4	1.00
	Study period 1 – All Searches	2014-2015	30	20	13	0.65
	Study period 2 – All Searches	2015-2016	20	15	15	1.00
	All Searches	2014-2016	50	35	28	0.80
Carroll	20-m Transect	2014-2015	11	11	11	1.00
	40-m Transect	2014-2015	9	9	8	0.89
	100-meter Scans	2014-2015	10	8	7	0.88
	Study period 1 – All Searches	2014-2015	30	28	26	0.93
	Study period 2 – All Searches	2015-2016	20	17	15	0.88
	All Searches	2014-2016	50	45	41	0.91
Eclipse	20-m Transect	2014-2015	4	3	1	0.33
	40-m Transect	2014-2015	6	5	5	1.00
	100-meter Scans	2014-2015	20	15	9	0.60
	Study period 1 – All Searches	2014-2015	30	23	15	0.65
	Study period 2 – All Searches	2015-2016	20	17	14	0.82
	All Searches	2014-2016	50	40	29	0.73
Lundgren	20-m Transect	2014-2015	10	10	9	0.90
	40-m Transect	2014-2015	10	10	8	0.80
	100-meter Scans	2014-2015	10	10	7	0.70
	Study period 1 – All Searches	2014-2015	30	30	24	0.80
	Study period 2 – All Searches	2015-2016	20	17	16	0.94
	All Searches	2014-2016	50	47	40	0.85
Macksburg	20-m Transect	2014-2015	10	10	5	0.50
	40-m Transect	2014-2015	10	8	5	0.63
	100-meter Scans	2014-2015	10	4	1	0.25
	Study period 1 – All Searches	2014-2015	30	22	11	0.50
	Study period 2 – All Searches	2015-2016	20	14	12	0.86
	All Searches	2014-2016	50	36	23	0.64
Morning Light	Transect	2014-2015	10	9	6	0.67
		2014-2015	10	10	4	0.40
	100-meter Scans	2014-2015	10	8	5	0.63
	Study period 1 – All Searches	2014-2015	30	27	15	0.56
	Study period 2 – All Searches	2015-2016	20	20	18	0.90
	All Searches	2014-2016	50	47	33	0.70
Rolling Hills	20-m Transect	2014-2015	15	15	12	0.80
	40-m Transect	2014-2015	15	15	11	0.73
	100-meter Scans	2014-2015	10	9	4	0.44
	Study period 1 – All Searches	2014-2015	40	39	27	0.69
	Study period 2 – All Searches	2015-2016	20	14	14	1.00

Appendix A. Fleet-wide searcher efficiency for each of the nine MidAmerican facilities studied between December 4, 2014, and March 15, 2016.

Facility	Survey Type	Date Range	# Placed	#Available	# Found	Searcher Efficiency Rate
	All Searches	2014-2016	60	53	41	0.77
Victory	20-m Transect	2014-2015	10	10	9	0.90
	40-m Transect	2014-2015	10	10	9	0.90
	100-meter Scans	2014-2015	10	10	8	0.80
	Study period 1 – All Searches	2014-2015	30	30	26	0.87
	Study period 2 – All Searches	2015-2016	20	20	18	0.90
	All Searches	2014-2016	50	50	44	0.88
Walnut	20-m Transect	2014-2015	10	9	8	0.89
	40-m Transect	2014-2015	5	5	3	0.60
	100-meter Scans	2014-2015	15	13	9	0.69
	Study period 1 – All Searches	2014-2015	30	27	20	0.74
	Study period 2 – All Searches	2015-2016	20	17	17	1.00
	All Searches	2014-2016	50	44	37	0.84

Appendix B: Carcass Removal Trial Model Selection for Each of the MidAmerican Wind Energy Facilities Studied from December 4, 2014, to March 15, 2016

Appendix B. Carcass removal model selection for each MidAmerican wind energy facility studied from December 4, 2014 to March 15, 2016. The selected model is in bold font.

Facility	Covariates	Distribution	Scale	AICc
Adair	**Seasons Combined**	**loglogistic**	**1.02**	**170.05**
	Seasons Combined	lognormal	1.71	170.14
	Seasons Combined	weibull	1.40	171.85
	Winter, Spring	lognormal	1.71	172.12
	Winter, Spring	loglogistic	1.03	172.36
	Winter 1, Spring, Winter 2	loglogistic	0.99	173.14
	Winter 1, Spring, Winter 2	lognormal	1.68	173.26
	Seasons Combined	exponential	1.00	173.93
	Winter, Spring	weibull	1.40	174.16
	Winter 1, Spring, Winter 2	weibull	1.40	175.55
	Winter, Spring	exponential	1.00	176.12
	Winter 1, Spring, Winter 2	exponential	1.00	177.41
Carroll	Winter, Spring	lognormal	1.39	175.04
	Winter, Spring	loglogistic	0.82	175.30
	Winter, Spring	**exponential**	**1.00**	**175.53**
	Winter, Spring	weibull	1.16	176.91
	Winter 1, Spring, Winter 2	lognormal	1.39	177.33
	Winter 1, Spring, Winter 2	exponential	1.00	177.53
	Winter 1, Spring, Winter 2	loglogistic	0.82	177.75
	Seasons Combined	lognormal	1.51	178.20
	Seasons Combined	loglogistic	0.90	178.87
	Winter 1, Spring, Winter 2	weibull	1.15	179.18
	Seasons Combined	weibull	1.28	182.20
	Seasons Combined	exponential	1.00	182.90
Eclipse	Seasons Combined	loglogistic	0.62	159.86
	Seasons Combined	**exponential**	**1.00**	**160.13**
	Seasons Combined	weibull	0.93	162.13
	Winter, Spring	loglogistic	0.62	162.22
	Winter, Spring	exponential	1.00	162.33
	Seasons Combined	lognormal	1.13	162.60
	Winter 1, Spring, Winter 2	loglogistic	0.61	164.23
	Winter 1, Spring, Winter 2	exponential	1.00	164.42
	Winter, Spring	weibull	0.93	164.45
	Winter, Spring	lognormal	1.13	164.82
	Winter 1, Spring, Winter 2	weibull	0.92	166.63
	Winter 1, Spring, Winter 2	lognormal	1.12	167.02
Lundgren	**Seasons Combined**	**loglogistic**	**0.63**	**203.18**
	Winter, Spring	loglogistic	0.61	203.43
	Seasons Combined	lognormal	1.09	204.17
	Winter, Spring	lognormal	1.06	204.43
	Winter 1, Spring, Winter 2	loglogistic	0.59	204.52
	Winter, Spring	exponential	1.00	205.47
	Winter 1, Spring, Winter 2	lognormal	1.05	206.15
	Seasons Combined	exponential	1.00	206.21
	Winter 1, Spring, Winter 2	exponential	1.00	206.81
	Winter, Spring	weibull	0.92	207.33
	Seasons Combined	weibull	0.96	208.29
	Winter 1, Spring, Winter 2	weibull	0.90	208.55
Macksburg	**Seasons Combined**	**lognormal**	**0.96**	**209.33**
	Seasons Combined	loglogistic	0.56	210.48
	Winter, Spring	lognormal	0.96	211.58
	Seasons Combined	weibull	0.80	212.14
	Winter, Spring	loglogistic	0.56	212.71
	Seasons Combined	exponential	1.00	212.77
	Winter 1, Spring, Winter 2	lognormal	0.95	213.54
	Winter, Spring	weibull	0.79	213.65
	Winter, Spring	exponential	1.00	214.30
	Winter 1, Spring, Winter 2	loglogistic	0.56	214.80
	Winter 1, Spring, Winter 2	weibull	0.79	215.46
	Winter 1, Spring, Winter 2	exponential	1.00	216.05

Appendix B. Carcass removal model selection for each MidAmerican wind energy facility studied from December 4, 2014 to March 15, 2016. The selected model is in bold font.

Facility	Covariates	Distribution	Scale	AICc
Morning Light	**Seasons Combined**	**exponential**	**1.00**	**154.32**
	Seasons Combined	lognormal	1.21	154.55
	Seasons Combined	loglogistic	0.72	154.71
	Winter, Spring	exponential	1.00	156.37
	Seasons Combined	weibull	1.02	156.57
	Winter, Spring	lognormal	1.21	156.96
	Winter, Spring	loglogistic	0.72	157.13
	Winter 1, Spring, Winter 2	exponential	1.00	158.36
	Winter, Spring	weibull	1.02	158.77
	Winter 1, Spring, Winter 2	lognormal	1.20	158.88
	Winter 1, Spring, Winter 2	loglogistic	0.71	159.07
	Winter 1, Spring, Winter 2	weibull	1.01	160.93
Rolling Hills	**Seasons Combined**	**exponential**	**1.00**	**193.65**
	Winter, Spring	exponential	1.00	194.04
	Winter 1, Spring, Winter 2	exponential	1.00	195.12
	Seasons Combined	loglogistic	0.64	195.39
	Seasons Combined	weibull	0.93	195.57
	Winter, Spring	weibull	0.91	195.87
	Winter, Spring	loglogistic	0.63	196.14
	Seasons Combined	lognormal	1.12	196.96
	Winter, Spring	lognormal	1.09	196.96
	Winter 1, Spring, Winter 2	weibull	0.91	197.05
	Winter 1, Spring, Winter 2	loglogistic	0.62	197.22
	Winter 1, Spring, Winter 2	lognormal	1.08	197.72
Victory	**Seasons Combined**	**exponential**	**1.00**	**154.12**
	Winter, Spring	exponential	1.00	154.59
	Seasons Combined	loglogistic	0.72	154.62
	Winter, Spring	loglogistic	0.71	155.82
	Seasons Combined	lognormal	1.26	155.95
	Seasons Combined	weibull	1.01	156.35
	Winter, Spring	lognormal	1.24	156.92
	Winter, Spring	weibull	0.99	156.96
	Winter 1, Spring, Winter 2	exponential	1.00	156.96
	Winter 1, Spring, Winter 2	loglogistic	0.70	158.25
	Winter 1, Spring, Winter 2	lognormal	1.24	159.41
	Winter 1, Spring, Winter 2	weibull	0.99	159.48
Walnut	**Winter, Spring**	**exponential**	**1.00**	**158.13**
	Winter, Spring	lognormal	1.07	159.69
	Winter, Spring	weibull	0.94	160.33
	Winter 1, Spring, Winter 2	exponential	1.00	160.41
	Winter, Spring	loglogistic	0.64	161.13
	Winter 1, Spring, Winter 2	lognormal	1.06	161.76
	Seasons Combined	exponential	1.00	161.81
	Winter 1, Spring, Winter 2	weibull	0.94	162.74
	Seasons Combined	lognormal	1.16	163.16
	Winter 1, Spring, Winter 2	loglogistic	0.64	163.23
	Seasons Combined	loglogistic	0.69	163.67
	Seasons Combined	weibull	1.02	164.03

2015-2017 Post-Construction Fatality Monitoring: Eagle-focused Surveys

MidAmerican Energy Company Iowa Wind Energy Portfolio:

Adams, Century, Charles City, Highland, Intrepid, Laurel, Pomeroy, Vienna I, Vienna II, and Wellsburg

Final Report
November 2015 – March 2017

Confidential Commercial Information – Protected from disclosure under the Freedom of Information Act, Including exemptions (b)(4) and (b)(7)

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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 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 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. A secondary objective is to gather data to support the Habitat Conservation Plan (HCP; MidAmerican, in prep.) 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 carcass removal rates for large birds comparable to eagles;
3. Compare the searcher efficiency and carcass removal rates of raptor carcass and eagle surrogates; and
4. Determine the area viewable from the visual scan searches.

During the 2015-2017 study period, post-construction fatality monitoring was conducted at 10 MidAmerican facilities: Adams, Century, Charles City, Highland, Intrepid, Laurel, Pomeroy, Vienna I, Vienna II, and Wellsburg (Table 1, Figure 1). This report provides site-specific data collected using the eagle-focused study design at these 10 facilities between November 16, 2015, and March 15, 2017. Due to construction and restoration schedules, post-construction monitoring at the Adams facility began May 16, 2016, and will continue through May 15, 2017. In addition to this study, two MidAmerican facilities, Ida Grove and O'Brien, are being studied from March 2017 to March 2018 using the same methods. Combined data from the 2014-2016 and 2015-2017 studies through March 2017 are presented in the HCP using different analytical methods to estimate potential take of bald eagles (*Haliaeetus leucocephalus*) and will support a comprehensive analysis of potential take for the entire MidAmerican Iowa wind energy portfolio.

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

Facility Name	County	Project Area (Square Miles)	Project Area (Acres)	Number of Turbines	Turbine Size (MW)	Total Project (MW)
2014-2016 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 (This Report)						
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						
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

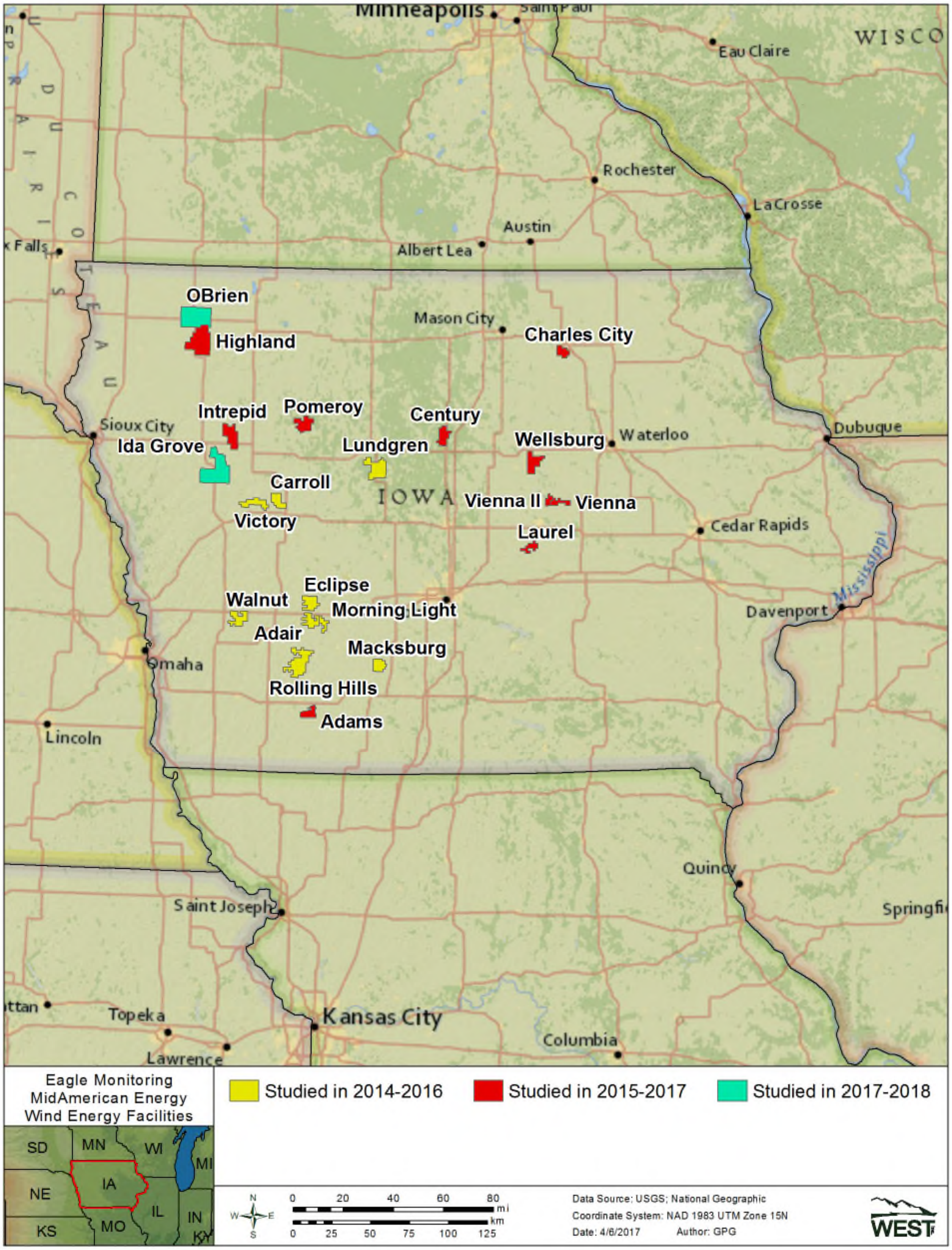

Figure 1. Locations of MidAmerican Energy Company's Iowa Wind Energy Projects.

STUDY AREA

The Laurel facility is located in the Rolling Loess Prairies Level 4 Ecoregion (U.S. Environmental Protection Agency 2016). The Adams facility is located in both the Rolling Loess Prairies and the Steeply Rolling Loess Prairies Level 4 Ecoregions. The Vienna I, Vienna II, and Wellsburg facilities are located in the Rolling Loess Prairies and Eastern Iowa and Minnesota Drift Level 4 Ecoregions. The Charles City facility is located in the Eastern Iowa and Minnesota Drift Level 4 Ecoregion. The Highland and Intrepid facilities are located in the Loess prairies Level 4 Ecoregion. The Century and Pomeroy Facilities are located in the Des Moines Lobe Level 4 Ecoregion.

The landcover at all 10 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 of the post-construction monitoring are organized into four primary components: (1) standardized carcass searches, (2) searcher efficiency trials, (3) carcass removal 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 November 16, 2015, to May 15, 2016, and from November 16, 2016, to March 15, 2017, at nine of the 10 facilities. The Adams facility was under construction in 2015-2016, thus eagle searches at this facility were conducted from November 16, 2016, to March 15, 2017, and will continue through May 15, 2017. 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 discussed below were conducted immediately before the road and pad searches for bats and other bird species (WEST 2015). All carcasses found during these searches were documented; however, only eagle carcasses were included in the analyses for this study.

Eagle carcass searches were completed using visual scans of the area within a 100-meter (m; 2,625-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 at 100% of turbines during both study periods (described above), and searches were conducted once every two weeks. All carcasses 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

The USFWS was notified when eagle carcasses were located for further collection and handling instruction. Carcasses found outside the search area were documented in a similar fashion as those found within standardized search areas. All other carcasses were treated as described in Bay et al. (2016b, 2017).

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 carcass searches occurred. 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.

Approximately 20 searcher efficiency trials were conducted using fully-feathered turkey (*Meleagris gallopavo*) decoy surrogates (decoys) at each facility from November 16, 2015, to May 15, 2016, and again from November 16, 2016, to March 15, 2017, for a total of approximately 40 searcher efficiency trials per facility across the entire study period. In addition, MidAmerican conferred with the USFWS to obtain additional raptor carcasses to be used to test differences in carcass removal rates between the surrogate decoys and actual raptors (described below). The USFWS Rock Island Field Office provided MidAmerican red-tailed hawk (*Buteo jamaicensis*) carcasses from the O'Hare Airport that were used in approximately 150 searcher efficiency trial placements in addition to the scheduled trial decoys.

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. 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 Removal Trials

The objective of carcass removal 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 removal studies were conducted at least monthly between November 16, 2015, and May 15, 2016, and again from November 16, 2016, and March 15, 2017. Estimates of carcass removal are used to adjust the total number of carcasses found for those removed from the search area prior to searches, thereby correcting for removal bias.

Surrogates for eagle carcasses consisted of adult ring-necked pheasants (*Colchicus phasianus*), adult mallards (*Anas platyrhynchos*) and red-tailed hawk, turkey vulture (*Cathartes aura*), and snowy owl (*Bubo scandiacus*) carcasses as provided by the USFWS. A total of 20 ring-necked pheasant or mallard surrogates per facility were placed within the search plots for carcass removal trials between November 16, 2015, and May 15, 2017, with 10 carcasses placed between November 16, 2015, and May 15, 2016, and again from November 16, 2016, to March 15, 2017. In addition, if found during searches, remains of intact diurnal raptor and owl carcasses were marked for carcass removal trials and observed in the same manner as the surrogate species. Using these found carcasses as well as the USFWS provided carcasses, approximately 70 raptor carcass removal trials were placed at these 10 facilities between November 16, 2015, and March 15, 2017.

All carcass removal trial carcasses, except those found during standardized searches, were dropped from shoulder height and allowed to land in a natural posture to simulate a true turbine-related fatality; carcasses found during scheduled searches and observed for carcass removal trials were marked and left undisturbed in the field. Each trial carcass was marked discreetly with a black zip-tie around the leg to identify it as a study carcass. Personnel conducting carcass searches monitored the trial birds 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. 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 30-day period, any evidence of the placed trial carcasses that remained was removed. The remains of the diurnal raptors, turkey vultures, and owls that still persisted at the end of the 30-day period were monitored for an additional 30 days. At the end of the 60-day period, any remains of these diurnal raptors or owls were spray painted and left in the field.

Red-tailed Hawk and Surrogate Bias Trial Comparison

The objective of the red-tailed hawk and surrogate bias trial comparison was to determine if there was a difference in searcher efficiency and carcass removal rates between trials using red-tailed hawks and standard surrogates. To ensure a large enough sample size, we focused red-tailed hawk searcher efficiency trials at three facilities (Highland, Pomeroy, and Century), and red-tailed hawk carcass removal trials were focused at one facility

(Century). Carcass removal trial efforts were conducted from March 16 to May 15, 2016, and from November 16, 2016, and March 15, 2017. Searcher efficiency trials using red-tailed hawk carcasses were conducted throughout this period at Highland and Pomeroy using the several carcasses repeatedly. At Century, red-tailed hawk carcasses were placed for searcher efficiency trials at least monthly between December 2016 and February 2017. These carcasses were then left in the field to complete carcass removal trials as described above.

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 maps. Turbine-specific paper maps were 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 (Figure 2).

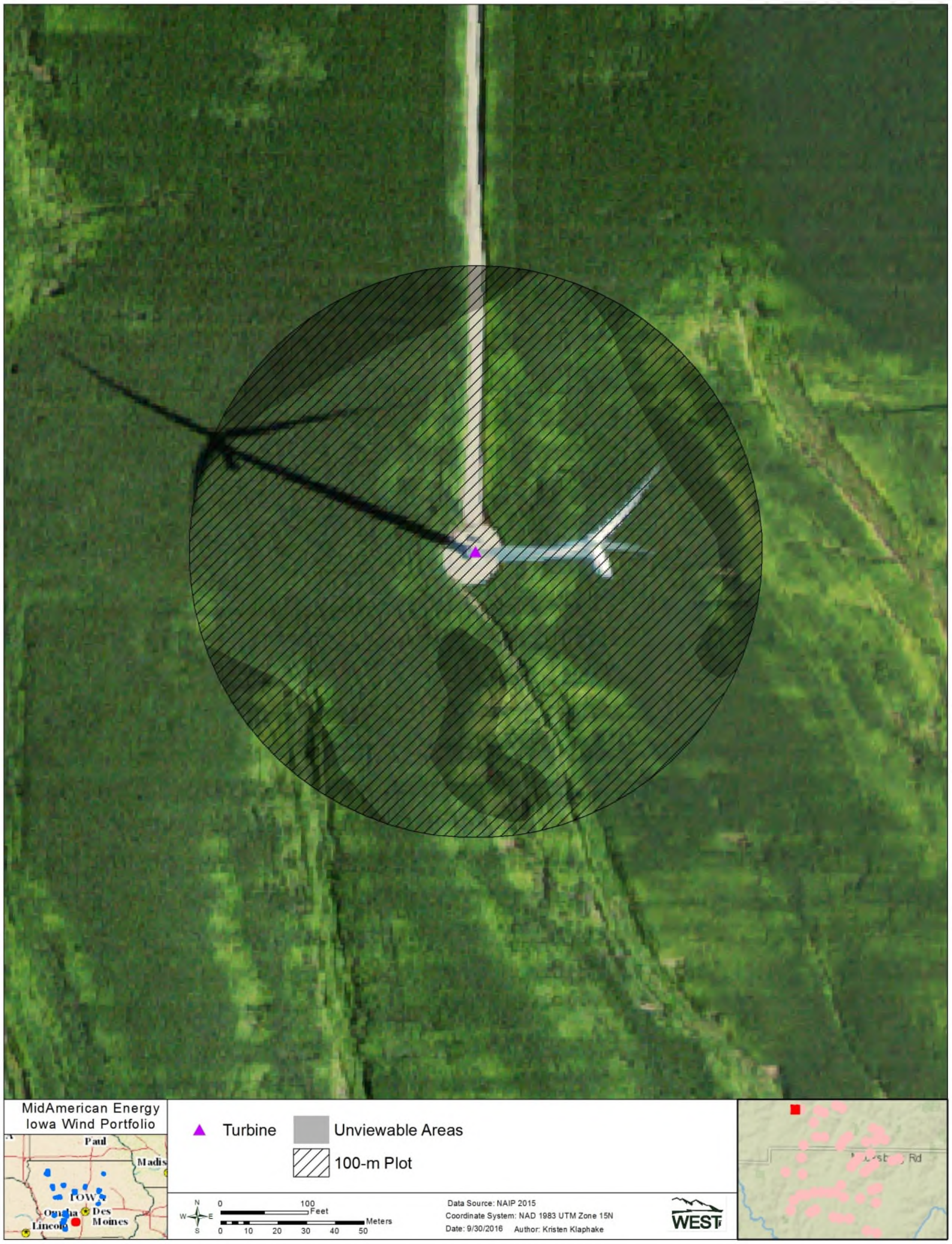

Figure 2. An Example of the 100-meter Search Plot and Digitized Unviewable Area.

Data Management and Bias Modeling

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 all 10 facilities 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. Comparison of searcher efficiency rates between red-tailed hawks and decoys were conducted at three facilities: Century, Pomeroy, and Highland. For this comparison, searcher efficiency rates were estimated using a logistic regression, with surrogate type as a potential covariate. The logistic model models the natural logarithm of the odds of finding an available carcass as 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 Removal Rates

Estimates of carcass removal rates were obtained using interval censored survival regression (Therneau and Lumley 2015, Therneau and Grambsch 2000). A single covariate, season, was used in the analysis. Model selection was used to determine the best fitting distribution. Exponential, log-logistic, lognormal, and Weibull distributions were fit and the best model was selected using AICc and model parsimony (Burnham and Anderson 2002). We followed the same methodology to compare carcass removal rates of red-tailed hawk with standard surrogate species, with two primary differences: 1) the covariate used was surrogate species group (i.e., red-tailed hawk and standard surrogates) and 2) model parsimony was not used, because the objective of the modeling effort was to determine the best fit model, regardless of parsimony.

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 954 turbines within the 10 facilities were searched from November 16, 2016, to March 15, 2017, while the 64-turbine Adams facility was absent from surveys conducted from November 16, 2015, to May 15, 2016, due to ongoing construction and restoration. From November 15, 2015, to March 15, 2016, a total of 6,077 visual scan searches were conducted within a 100-m radius plot around each turbine, and 3,959 scans were conducted from March 15 to May 15, 2016 (Table 2). From November 16, 2016, to March 15, 2017, a total of 7,236 100-m visual scans were completed (Table 2).

Table 2. Eagle Carcass Search Effort for each of the 10 MidAmerican Energy Company's Facilities Studied from November 16, 2015, to March 15, 2017.

Facility	November 16, 2015 – March 15, 2016	March 16 – May 15, 2016	November 16, 2016 – March 15, 2017
Adams	0	0	500
Century	1,077	493	1,136
Charles City	381	200	400
Highland*	1,209	1,010	1,538
Intrepid*	941	549	931
Laurel	400	257	410
Pomeroy*	1,198	899	1,350
Vienna I	313	178	350
Vienna II	137	73	148
Wellsburg	421	300	473
All Facilities	**6,077**	**3,959**	**7,236**

*Spring searches started March 10

A total of three bald eagles were found at the 10 facilities during this study period: two at Highland and one at Charles City. The bald eagle carcass found at Highland on February 17, 2016, was initially found by operation and maintenance personnel, and a WEST field technician was dispatched to process the carcass per WEST's wildlife fatality study protocol. Upon receiving directions for carcass handling from the USFWS, the WEST technician placed the carcass in the freezer at the Highland operations and maintenance facility in Primghar, Iowa.

On Saturday, October 22, 2016, prior to commencing the visual scan searches scheduled to begin November 15, 2016, a WEST technician discovered a bald eagle carcass at Charles City during a standard road and pad search for bats and other birds. The WEST technician processed the carcass per WEST's wildlife fatality study protocol. On Monday, October 24, 2016, the carcass was transported the freezer in the Charles City operations and maintenance facility in Charles City, Iowa following guidance received from the USFWS.

The bald eagle carcass found at Highland on March 7, 2017, was initially found by a WEST technician during a standard visual scan search. The WEST technician processed the carcass per WEST wildlife fatality study protocol and stayed with the carcass in the field until receiving further direction from the USFWS regarding movement of the carcass. WEST later received direction for carcass handling from the USFWS, and the carcass was placed in the freezer at the Highland operation and maintenance facility in Primghar, Iowa.

The bald eagle carcass at Charles City was found when standardized searchers for eagles were not being conducted and the eagle carcass found at Highland on March 7, 2017, was located outside of the search plot. Thus, these two eagle carcasses would be excluded from a fatality estimation rate. No fatality estimation rate was calculated, as take estimates are calculated in MidAmerican's HCP.

Searcher Efficiency

Searcher efficiency for the entire survey effort across all 10 facilities was 0.77 (Table 3). When turkey decoys and raptors were combined, searcher efficiency was higher in winter 2015-2016 (0.91) compared to the spring 2016 (0.74) and winter 2016-2017 (0.72). This pattern is similar for turkey decoys alone. Searcher efficiency for raptors was similar in spring 2016 and winter 2016-2017 (0.55 and 0.54, respectively) and lower in winter 2015-2016 (0.33), which likely reflects the low sample size in winter 2015-2016. Searcher efficiency for raptors was lower than for decoys in all seasons (Table 3). Searcher efficiency rates for each facility are reported in Appendix A.

Table 3. Fleet-wide Searcher Efficiency for the 10 MidAmerican Energy Company's Facilities Studied Between November 16, 2015, and March 15, 2017.

Surrogate Type	Season	Date Range	# Placed	#Available	Found	Searcher Efficiency Rate
Turkey Decoys	Winter 2015-2016	November 16 – March 15	129	123	116	0.94
	Spring 2016	March 16 – May 15	29	28	23	0.82
	Winter 2016-2017	November 16 – March 15	180	178	151	0.85
	Total	**2015-2017**	**338**	**329**	**290**	**0.88**
Raptors	Winter 2015-2016	November 16 – March 15	6	6	2	0.33
	Spring 2016	March 16 – May 15	11	11	6	0.55
	Winter 2016-2017	November 16 – March 15	134	133	72	0.54
	Total	**2015-2017**	**151**	**150**	**80**	**0.53**
Turkey Decoys and Raptor Surrogates	Winter 2015-2016	November 16 – March 15	135	129	118	0.91
	Spring 2016	March 16 – May 15	40	39	29	0.74
	Winter 2016-2017	November 16 – March 15	314	311	223	0.72
	Total	**2015-2017**	**489**	**479**	**370**	**0.77**

Carcass Removal Time

Upon analysis of carcass removal trials, it was determined that there was no significant difference between carcass removal rates of large birds surrogate carcasses (chukars [*Alectoris chukar*] and rock pigeons [*Columba livia*]) and the eagle surrogate carcasses (ring-necked pheasants and mallards; see Bay et al. 2016a); therefore, large bird data were pooled with the eagle surrogate species and raptor data to provide a larger sample size for calculating carcass removal rates. The number and type of species used at each facility are presented in Table 4.

Table 4. The Species[1] and Number used for the Carcass Removal Trials, for each of the 10 MidAmerican Energy Company's Facilities Studied Between November 16, 2015, and March 15, 2017.

Facility	CHUK	COQU	MALL	RNPH	ROPI	RTHA	SEOW	SNOW	TUVU	Total
Adams	0	3	1	7	7	0	0	0	0	18
Century	4	0	1	32	5	35	0	0	0	77
Charles City	4	0	0	20	16	3	0	0	2	45
Highland	0	0	0	24	16	6	0	1	0	51
Intrepid	0	0	0	21	20	6	0	0	0	47
Laurel	0	0	0	20	21	3	0	0	2	46
Pomeroy	0	0	0	21	19	5	0	0	0	45
Vienna I/II	0	0	0	22	22	3	2	0	2	51
Wellsburg	6	0	0	20	16	3	0	0	3	48

[1] CHUK = chukar (*Alectoris chukar*); COQU = common quail (*Coturnix coturnix*); MALL = mallard (*Anas platyrhynchos*); RNPH = ring-necked pheasant (*Colchicus phasianus*); ROPI = rock pigeon (*Columba livia*); RTHA = red-tailed hawk (*Buteo jamaicensis*); SEOW = short-eared owl (*Asio flammeus*); SNOW = snowy owl (*Bubo scandiacus*); TUVU = turkey vulture (*Cathartes aura*)

Generally, carcass removal rates were similar for both winter and spring, with the exception of Laurel, Vienna I/II, and Wellsburg, where winter had faster removal rates (Table 5). Carcass removal rates ranged from 2.51 to 71.68 days at all facilities across winter and spring (Table 5). Carcass removal model selection for each facility is reported in Appendix B.

Table 5. Average Combined Raptor and Eagle Carcass Surrogate Removal Time, in Days, for each of the 10 MidAmerican Energy Company's Facilities Studied Between November 16, 2015, and March 15, 2017.

Facility	Season	Removal Rate1
Adams	Winter	2.51
Century	Winter/Spring	71.68
Charles City	Winter/Spring	15.69
Highland	Winter/Spring	28.08
Intrepid	Winter/Spring	30.77
Laurel	Winter	4.90
	Spring	13.63
Pomeroy	Winter/Spring	24.37
Vienna I/II	Winter	7.39
	Spring	21.99
Wellsburg	Winter	7.81
	Spring	65.36

1. Parameterization was according to Therneau and Lumley (2015).

Red-tailed Hawk and Surrogate Bias Trial Comparison

In winter 2016-2017, we placed a large sample of red-tailed hawk searcher efficiency trials at Century, Highland, and Pomeroy to test whether searcher efficiency varied by surrogate species (i.e., turkey decoy or red-tailed hawk; *see* Appendix A). The lowest AICc value for the three facilities combined included species as a covariate, indicating that searcher efficiency for red-tailed hawk carcasses and turkey decoys was different, and that searcher efficiency was higher for decoys than red-tailed hawks (Table 6). Searcher efficiency rates for turkey decoys were typically higher than for red-tailed hawks, but this pattern was not consistent across the three facilities (Table 7).

Table 6. The Results of Modelling to Determine if Searcher Efficiency Rates Differed between Red-tailed Hawks and Turkey Decoys.

	AICc Values			
Covariates	Century	Highland	Pomeroy	Combined
Species	70.02	82.16	107.18	261.68
No Covariates	68.63	89.48	106.59	262.83

Table 7. Modeled Searcher Efficiency Rates for Turkey Decoys and Red-Tailed Hawks Placed at Century, Highland, Pomeroy, and those Three Facilities Combined.

	Searcher Efficiency Rate			
Eagle Surrogate	Century	Highland	Pomeroy	Combined
Turkey Decoy	0.42	0.90	0.70	0.68
Red-tailed Hawk	0.55	0.53	0.54	0.54

As described in Bay et al (2016a), the number of red-tailed hawks and other raptor species available were limited. Therefore, WEST placed six red-tailed hawks for carcass removal trials at Century during spring 2016 and 29 in winter 2016-2017. WEST concentrated trials at one facility in winter 2016-2017 both to create a large enough sample size and to ensure variation in removal rates across Iowa did not confound the test of differences in surrogate type (i.e., raptors or standard surrogates). The modelling results indicated that carcass removal rates varied by surrogate type, with red-tailed hawk carcasses (95.20 days) remaining available to be found for much longer than standard surrogates (42.12 days; Tables 8 and 9).

Table 8. The Results of Modelling to Determine if Removal Rate Differed between Red-Tailed Hawks and Surrogate Species.

Covariate	Distribution	AICc	Delta AICc
Surrogate Type	Exponential	178.94	0
No Covariates	Exponential	180.4	1.46
Surrogate Type	Weibull	181.07	2.13
No Covariates	Weibull	182.54	3.6
Surrogate Type	Loglogistic	182.59	3.65
No Covariates	Loglogistic	183.47	4.53
No Covariates	Lognormal	185.5	6.56
Surrogate Type	Lognormal	185.51	6.57

Table 9. Carcass removal rates for Red-tailed Hawks and Standard Surrogates at the Century Wind Energy Facility between March 16, 2016, and May 15, 2016, and again from November 16, 2016, to March 15, 2017.

Surrogate Type	Distribution	Removal Rate	Scale
Standard Surrogates	Exponential	42.12	1
Red-tailed Hawk	Exponential	95.20	1

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. Area correction values for each facility ranged from 0.71 to 0.95 percent (Table 10).

Table 10. Area Corrections Values for 100-meter Scan Plots at each of the 10 MidAmerican Energy Company Facilities Studied from November 16, 2015, to March 15, 2017.

Facility	Number of Turbines	Area Correction
Adams	64	0.71
Century	145	0.94
Charles City	50	0.95
Highland	214	0.91
Intrepid	122	0.92
Laurel	52	0.85
Pomeroy	184	0.93
Vienna I	45	0.88
Vienna II	19	0.91
Wellsburg	60	0.93

DISCUSSION

Review of the searcher efficiency and carcass removal rates as well as the area correction results presented here show that the methods used in this study are adequate for collecting data for use in estimating fatality rates of eagles and other large birds. For example, searcher efficiency estimates suggested that the majority of eagle carcasses would be found during visual scans. In addition, the majority of all scan plots were visible, again suggesting likely high detection rate for eagles – a relatively large carcass. The carcass removal rate during the winter and spring was fairly slow at most facilities suggesting that, on average, at least half of carcasses persisted long enough that searchers would have an opportunity to find them. These factors all influence estimates of fatality rates, and the values determined in this study will help improve precision of eagle take estimates.

In an effort to improve bias trial accuracy, we examined the difference in searcher efficiency and carcass removal rates between red-tailed hawk carcasses and surrogate species. For both searcher efficiency and carcass removal, the top model included species as a covariate. Searcher efficiency for the turkey decoys was slightly higher than for red-tailed hawks. This is believed to be the result of two factors: 1) the red-tailed hawk carcasses were smaller than the decoys, and 2) the red-tailed hawk carcasses were previously frozen. Because the red-tailed hawks were frozen, the carcasses become compacted, making them physically smaller than the decoys and thus more difficult to detect. In addition, the frozen feathers lack movement in the wind. Without the additional feather movement, which attracts searcher's attention to the bird, some of these carcasses may be missed during searcher trials. Both factors make it more difficult for searchers to locate the frozen red-tailed hawks relative to the fully feathered turkey decoys. The results of this effort suggest that the fully feathered turkey decoy is an adequate surrogate for eagle carcasses in the field.

Results from other studies have shown that raptor carcasses last much longer than the standard surrogates, particularly gamebirds such as pheasants (Urquhart et al. 2015, Hallingstad et al. 2016). This same pattern was evident at Century, with red-tailed hawk carcasses lasting nearly twice as long as the standard eagle surrogates. These results indicate that there are differences in carcass removal rates between standard surrogates and red-tailed hawks.

During the study periods reported here, three bald eagle carcasses were found at the 10 facilities studied. These fatalities, in addition to the information on searcher efficiency, carcass removal times, and area correction, will provide the foundation for a data-driven HCP and NEPA process. Eagle fatality estimates for all of the MidAmerican wind projects operational by 2017 have been calculated and are provided in the draft HCP. Additionally, searcher efficiency, carcass removal times, and area correction calculations are useful in designing long-term monitoring plans and future management strategies as outlined in the HCP. The information from this study, combined with data from the studies at the nine facilities studied between 2014 and 2016, is incorporated into the final HCP and NEPA documents.

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Appendix A: Searcher Efficiency Estimates, by Surrogate Species and Combined, at Each of the MidAmerican Wind Energy Facilities Studied from November 16, 2015, to March 15, 2017

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Appendix A. Fleet-wide Searcher Efficiency, by Surrogate Type and Combined, for each of the MidAmerican Energy Company's Facilities Studied Between November 16, 2016, and March 15, 2017.

Facility	Surrogate Type	Season	Number Placed	Number Available	Number Found	Searcher Efficiency Rate
Adams	Standard	Winter 2016-2017	20	19	19	1.00
		Overall	20	19	19	1.00
Century	Standard	Winter 2015-2016	15	15	15	1.00
		Spring 2016	5	4	2	0.50
		Winter 2016-2017	20	19	8	0.42
		Overall	40	38	25	0.66
	Raptor	Winter 2016-2017	29	29	16	0.55
		Overall	29	29	16	0.55
	Combined	Winter 2015-2016	15	15	15	1.00
		Spring 2016	5	4	2	0.50
		Winter 2016-2017	49	48	24	0.50
		Overall	69	67	41	0.61
Charles City	Standard	Winter 2015-2016	15	13	13	1.00
		Spring 2016	5	5	3	0.60
		Winter 2016-2017	20	20	20	1.00
		Overall	40	38	36	0.95
Highland	Standard	Winter 2015-2016	15	15	15	1.00
		Spring 2016	1	1	1	1.00
		Winter 2016-2017	20	20	18	0.90
		Overall	36	36	34	0.94
	Raptors	Spring 2016	4	4	3	0.75
		Winter 2016-2017	48	47	25	0.53
		Overall	52	51	28	0.55
	Combined	Winter 2015-2016	15	15	15	1.00
		Spring 2016	5	5	4	0.80
		Winter 2016-2017	68	67	43	0.64
		Overall	88	87	62	0.71
Intrepid	Standard	Winter 2015-2016	15	15	13	0.87
		Spring 2016	3	3	3	1.00
		Winter 2016-2017	20	20	19	0.95
		Overall	38	38	35	0.92
	Raptors	Spring 2016	2	2	0	0.00
		Overall	2	2	0	0.00
	Combined	Winter 2015-2016	15	15	13	0.87
		Spring 2016	5	5	3	0.60
		Winter 2016-2017	20	20	19	0.95
		Overall	40	40	35	0.88
Laurel	Standard	Winter 2015-2016	15	13	13	1.00
		Spring 2016	5	5	4	0.80
		Winter 2016-2017	20	20	17	0.85
		Overall	40	38	34	0.89
Pomeroy	Standard	Winter 2015-2016	15	15	12	0.80
		Winter 2016-2017	20	20	14	0.70
		Overall	35	35	26	0.74
	Raptors	Spring 2016	5	5	3	0.60
		Winter 2016-2017	57	57	31	0.54
		Overall	62	62	34	0.55
	Combined	Winter 2015-2016	15	15	12	0.80
		Spring 2016	5	5	3	0.60
		Winter 2016-2017	77	77	45	0.58
		Overall	97	97	60	0.62

Appendix A. Fleet-wide Searcher Efficiency, by Surrogate Type and Combined, for each of the MidAmerican Energy Company's Facilities Studied Between November 16, 2016, and March 15, 2017.

Facility	Surrogate Type	Season	Number Placed	Number Available	Number Found	Searcher Efficiency Rate
Vienna I/II	Standard	Winter 2015-2016	24	22	23	1.05
		Spring 2016	5	5	5	1.00
		Winter 2016-2017	20	20	18	0.90
		Overall	49	47	46	0.98
	Raptors	Winter 2015-2016	6	6	2	0.33
		Overall	6	6	2	0.33
	Combined	Winter 2015-2016	30	28	25	0.89
		Spring 2016	5	5	5	1.00
		Winter 2016-2017	20	20	18	0.90
		Overall	55	53	48	0.91
Wellsburg	Combined	Winter 2015-2016	15	15	14	0.93
		Spring 2016	5	5	5	1.00
		Winter 2016-2017	20	20	18	0.90
		Overall	40	40	37	0.92

Appendix B: Carcass Removal Trial Model Selection for each of the MidAmerican Wind Energy Facilities Studied from November 16, 2015, to March 15, 2017

Appendix B. Carcass Removal Model Selection for each MidAmerican Wind Energy Company Facility Studied from November 16, 2016, to March 15, 2017. The Selected Model is in Bold Font.

Facility	Covariate	Distribution	AICc	Delta.AICc
Adams	No covariates	**Lognormal**	**27.38**	**0***
	No covariates	Loglogistic	27.85	0.47
	No covariates	Weibull	28.31	0.93
	No covariates	Exponential	30.03	2.65
Century	No covariates	**Exponential**	**195.57**	**0***
	Winter, Spring	Exponential	196.82	1.25
	No covariates	Weibull	197.71	2.14
	No covariates	Loglogistic	198.40	2.83
	Winter 1, Spring, Winter 2	Exponential	198.77	3.20
	Winter, Spring	Weibull	199.02	3.45
	Winter, Spring	Loglogistic	200.09	4.52
	No covariates	Lognormal	200.28	4.71
	Winter 1, Spring, Winter 2	Weibull	201.01	5.44
	Winter 1, Spring, Winter 2	Loglogistic	202.12	6.55
	Winter, Spring	Lognormal	202.34	6.77
	Winter 1, Spring, Winter 2	Lognormal	204.60	9.03
Charles City	No covariates	**Exponential**	**127.42**	**0***
	No covariates	Loglogistic	127.85	0.43
	No covariates	Lognormal	128.51	1.09
	No covariates	Weibull	129.59	2.17
	Winter, Spring	Exponential	129.59	2.17
	Winter, Spring	Loglogistic	130.23	2.81
	Winter 1, Spring, Winter 2	Exponential	130.30	2.88
	Winter, Spring	Lognormal	130.86	3.44
	Winter, Spring	Weibull	131.93	4.51
	Winter 1, Spring, Winter 2	Loglogistic	132.10	4.68
	Winter 1, Spring, Winter 2	Lognormal	132.64	5.22
	Winter 1, Spring, Winter 2	Weibull	132.68	5.26
Highland	Winter, Spring	Exponential	118.07	0
	No covariates	**Exponential**	**118.14**	**0.07***
	Winter 1, Spring, Winter 2	Exponential	118.61	0.54
	Winter, Spring	Loglogistic	119.24	1.17
	Winter, Spring	Lognormal	119.26	1.19
	No covariates	Loglogistic	119.42	1.35
	No covariates	Lognormal	119.56	1.49
	Winter 1, Spring, Winter 2	Lognormal	120.16	2.09
	No covariates	Weibull	120.31	2.24
	Winter, Spring	Weibull	120.31	2.24
	Winter 1, Spring, Winter 2	Loglogistic	120.84	2.77
	Winter 1, Spring, Winter 2	Weibull	120.89	2.82
Intrepid	No covariates	**Exponential**	**112.77**	**0***
	Winter, Spring	Exponential	113.31	0.54
	No covariates	Weibull	114.95	2.18
	Winter, Spring	Loglogistic	115.23	2.46
	No covariates	Loglogistic	115.34	2.57
	Winter, Spring	Weibull	115.55	2.78
	Winter, Spring	Lognormal	115.58	2.81
	No covariates	Lognormal	115.60	2.83
	Winter 1, Spring, Winter 2	Exponential	115.75	2.98
	Winter 1, Spring, Winter 2	Loglogistic	117.81	5.04
	Winter 1, Spring, Winter 2	Weibull	118.18	5.41
	Winter 1, Spring, Winter 2	Lognormal	118.20	5.43

Appendix B. Carcass Removal Model Selection for each MidAmerican Wind Energy Company Facility Studied from November 16, 2016, to March 15, 2017. The Selected Model is in Bold Font.

Facility	Covariate	Distribution	AICc	Delta.AICc
Laurel	Winter, Spring	**Loglogistic**	**132.04**	**0***
	Winter, Spring	Lognormal	132.87	0.83
	Winter 1, Spring, Winter 2	Loglogistic	134.15	2.11
	Winter 1, Spring, Winter 2	Lognormal	134.73	2.69
	Winter, Spring	Exponential	134.94	2.90
	No covariates	Loglogistic	135.57	3.53
	No covariates	Exponential	135.94	3.90
	No covariates	Lognormal	136.60	4.56
	Winter 1, Spring, Winter 2	Exponential	137.16	5.12
	Winter, Spring	Weibull	137.37	5.33
	No covariates	Weibull	138.06	6.02
	Winter 1, Spring, Winter 2	Weibull	139.79	7.75
Pomeroy	No covariates	Lognormal	113.45	0
	No covariates	Loglogistic	114.13	0.68
	No covariates	**Exponential**	**115.07**	**1.62***
	Winter, Spring	Lognormal	115.91	2.46
	No covariates	Weibull	116.05	2.60
	Winter, Spring	Loglogistic	116.61	3.16
	Winter, Spring	Exponential	117.32	3.87
	Winter 1, Spring, Winter 2	Lognormal	118.23	4.78
	Winter, Spring	Weibull	118.40	4.95
	Winter 1, Spring, Winter 2	Loglogistic	118.98	5.53
	Winter 1, Spring, Winter 2	Exponential	119.72	6.27
	Winter 1, Spring, Winter 2	Weibull	120.90	7.45
Vienna I/II	Winter, Spring	Weibull	145.35	0
	Winter, Spring	**Lognormal**	**145.71**	**0.36***
	Winter, Spring	Loglogistic	147.22	1.87
	Winter 1, Spring, Winter 2	Weibull	147.85	2.50
	Winter, Spring	Exponential	147.95	2.60
	Winter 1, Spring, Winter 2	Lognormal	148.15	2.80
	Winter 1, Spring, Winter 2	Loglogistic	149.75	4.40
	Winter 1, Spring, Winter 2	Exponential	150.29	4.94
	No covariates	Weibull	150.75	5.40
	No covariates	Exponential	151.94	6.59
	No covariates	Loglogistic	154.63	9.28
	No covariates	Lognormal	154.88	9.53
Wellsburg	Winter, Spring	**Exponential**	**108.82**	**0***
	Winter 1, Spring, Winter 2	Exponential	110.52	1.70
	Winter, Spring	Weibull	111.09	2.27
	Winter 1, Spring, Winter 2	Weibull	113.05	4.23
	Winter, Spring	Lognormal	113.41	4.59
	Winter, Spring	Loglogistic	113.92	5.10
	Winter 1, Spring, Winter 2	Lognormal	115.39	6.57
	Winter 1, Spring, Winter 2	Loglogistic	115.83	7.01
	No covariates	Loglogistic	126.82	18.00
	No covariates	Lognormal	127.04	18.22
	No covariates	Weibull	127.32	18.50
	No covariates	Exponential	128.25	19.43

Bat Hibernacula Searches in Central Iowa, February/March 2017

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WORKING DOGS for CONSERVATION

Summary:
Determining where bats overwinter is challenging due to the fact that suitable habitat includes not only large caves (where humans searching visually can be quite successful in locating hibernating bats), but also narrow fissures in rock faces where visual inspection is not feasible. Acoustic monitoring is also commonly used, and Working Dogs for Conservation (WD4C) was contracted to explore detection dogs as a means of adding *scent* monitoring to other available methods. To that end, WD4C trained two dogs to the scent of *Myotis* bat species. One dog was fielded in central Iowa February 27 through March 11, and searched eight locations which were considered to by high priority and higher likelihood of containing bat hibernacula (based on the presence of rock outcroppings). The dog demonstrated interest, either through performing her trained alert to "sit" or behaving in ways consistent with "on-target" behavior—in 19 spots along the rock outcroppings. At one location the handler visually confirmed two bats flying out of a fissure where the dog had just demonstrated interest. Such verification was a welcome but unanticipated occurrence, as the nature of searching rock fissures that can't be visually inspected means that the dog's accuracy during deployment can't be quantified, and usually deployment must proceed without verification. This visual confirmation adds veracity to the study, and demonstrates that WD4C's training process conferred the ability to dogs to locate unknown, living, wild bats, in their natural setting.

Training:
Two dogs (Orbee, 9 year old Border collie with seven years of experience on 17 conservation targets; and, Lily, 9 year old yellow Labrador retriever with six years of experience on 16 conservation targets) were trained to *Myotis spp*. bat scent. Training began in Montana on 1 February 2017, with gauze swabs which had been rubbed along the bodies of bats, and in some cases resulting in urine and/or feces on the swab. Swabs were procured by collaborators in Missouri, stored in the freezer, and shipped overnight to Montana. Twenty-four training swab packets consisted of 11 swabs of *Myotis sodalis* (Indiana bat) and 18 samples of *Myotis lucifugus* (Little brown bat). Dogs were intentionally taught to generalize to *Myotis spp*., since the species of highest concern, *Myotis septentrionalis* (Northern long-eared bat) is rare and obtaining adequate samples from only that species would have been untenable, and *Myotis septentrionalis* is known to co-occur with other *Myotis spp*. Furthermore, locating hibernacula of any species of bat would be helpful in identifying suitable habitat, as well as give the dogs more opportunity for success and reinforcement in the field.

From February 1-17, dogs were trained with these swabs in ever-challenging situations. The scent was introduced in the manner which the two experienced dogs are accustomed to learning new scent, in a line-up of four cinder blocks with each containing a clean swab of the same brand as used in bat scent collection. In addition, one bat swab was added to one block. Dogs then sniffed all of the blocks and were immediately rewarded with their toy when they reached the correct block. Soon thereafter, the dogs were asked to perform a "sit" alert after locating the bat scent. An "alert" is a trained behavior that the dog learns to perform once she feels certain she has located target odor and has determined she's as close as possible to it, in order to indicate the target location to the handler. Neither dog showed any difficulty moving among *Myotis lucifugus* and *Myotis septentrionalis* swabs, and they accurately ignored the clean swabs. Training with swabs progressed to out-of-box scenarios by searching in and around buildings, and finally ended in rock fields and scree slopes (see Appendix III for training photos, and other photos of interest).

Once in Iowa, dogs were trained with three *Myotis lucifugus* at Iowa Wildlife Center in and near Ames, Iowa. Dogs were introduced to live bats safely contained in transport containers indoors. Initially, each dog expressed familiarity with the odor, but also had their interest piqued by hearing the live bat moving around in the container, thus were prompted by the handler to "sit". This prompt was conducted only once before the dogs accepted the live target. Indoor training continued by moving the bats containers around a simple room, then hiding among other wildlife in a complex indoor environment.

Up to this point in training, dogs had been able to get their noses to within a few inches of the bat scent before performing their alert. In order to prepare them for deployment reality of only being able to sniff as closely as the rock features and their ability to maneuver along the rocks would allow, we devised distance training set ups. The first apparatus left the bats in their moving containers (1 gallon plastic pail with lid and air holes) and we used a fish aquarium air supply to draw air out of the container and pump it through tubing into vegetation 25' away. Three such apparatus were set up, with one containing bats and the others pumping air from clean buckets. The other distance apparatus was constructed of 2.5" PVC tubing. While the bats safely rested in their bedding material at one end of the apparatus, we could add and remove lengths of tubing at will, and install turns. Dogs would then sniff the distal ends of the apparatus in order to get differing amounts of odor that we could manipulate (though not quantify). Again, we had multiple "blank" sets of tubing with no bats present.

Both dogs initially showed some difficultly in selecting the correct apparatus. Dog Lily was erring on the side of passing over the target, while Orbee was including multiple additional alerts on blank apparatus. However, over a single training session Lily became accurate in her selections.

As a final preparation, dogs were taken to areas of known hibernacula. Lily demonstrated the ability to alert to locations of known presence, without having her nose near the target. At the time, Orbee was not showing a propensity to alert to these locations. While WD4C's experience indicates that with more time and more opportunity and given Orbee's successful and long conservation career, we expect that Orbee would likely be able to excel in these advanced stages of training. But in order to maximize finds and minimize errors, at this point handlers elected to field only Lily.

Field deployment:
From 27 February to 11 March, Lily searched higher priority areas, based on favorable habitat alone (Wild Cat Cave access in Hardin county,and Pammel State Park in Madison county), or favorable habitat that had been previously acoustically monitored (Fallen Rock State Preserve in Hardin county, Dolliver Memorial State Park in Webster county, Ledges State Park in Boone county, Cedar Bluffs Natural Area in Mahaska county, and a roadside area in Madison county; see track maps in Appendix I). Not surprisingly, given previous acoustic "captures" in monitored areas, Lily demonstrated some points of interest in all of these locations. In the unmonitored areas, Lily also demonstrated interest at Wild Cat Cave access in Hardin county, and Pammel State Park. There were 19 areas of interest, as noted in Table 1 (see Appendix II for photos which characterize the interest locations).

Table 1. Daily activity log, areas searched, distance searched, and areas of interest (either alerts or changes of behavior)

Date	Activity/Search Area	County	Abbrev.	Distance (km)	Alerts	Change of behavior (CB)
2/22/2017	Train w/captive live bats					
2/23/2017	Train at areas of known presence					
2/24/2017	Train at areas of known presence					
2/26/2017	Outdoor training with live bats					
2/27/2017	Fallen Rock- Day 1	Hardin	FR	2.0	1	0
2/28/2017	Training at Dolliver	Webster				
2/28/2017	Dolliver Boneyard	Webster	D	1.2	1	1
3/2/2017	Ledges- Day 1	Boone	L	3.8	0	3
3/3/2017	Ledges- Day 2	Boone	L	5.2	0	2
3/5/2017	Ledges- Day 3	Boone	L	1.6	0	0
3/5/2017	Fallen Rock- Day 2	Hardin	FR	2.9	2	2
3/6/2017	Pammel Road side	Madison	PR	1.1	0	1
3/7/2017	Pammel Private Property	Madison	PPP	2.8	0	0
3/9/2017	Pammel Park	Madison	PP	3.2	1	0
3/10/2017	Cedar Bluffs	Mahaska	CB	2.9	2	1
3/11/2017	Wildcat Cave	Hardin	WC	1.9	1	1
				28.6	8	11

Regarding areas of interest, typically an alert is considered more definitive to the handler than a “change of behavior” (or “CB”) because an alert is a choice by the dog to perform a behavior to indicate a find to the handler, whereas changes of behavior are involuntary responses to an odor (e.g. increased tail wagging, forward ear set, change in breathing and sniffing). All alerts begin with changes of behavior, but not all changes of behavior result in an alert. The inability to alert is typically due to the dog being unable to determine precisely from where the scent is emanating, or the scent is faint or differs from what she has encountered previously so that the dog doesn’t feel certain enough to alert. Moreover, alerts are always meant to be performed in response to target odor, while changes of behavior may occur in response to other odors which the dog finds compelling. Through experience, the handler learns to differentiate most changes of behavior that are in response to target odor versus those that are in response to compelling non-target odor.

In the case of this deployment, however, we consider changes of behavior to be nearly equal in veracity to alerts. This assertion is bolstered by one location where the handler visually confirmed bats flying in and out of the fissure selected by Lily. Lily had a strong change of behavior but had not yet alerted to that fissure. This is because the unknown extent of most rock fissures mean that it’s likely that the bat odor is faint or distant. While dogs can be trained to alert to faint or distant odor, this requires repeated training scenarios which mimic this reality in order to encourage the dog to alert, and then reward the dog for this alert behavior which is known to be correct (only alerts for which there is verifiable target presence are rewarded). Repeated rewards result in performance of trained behavior. The handler was able to parlay the bat encounter into a training moment by verbally cueing and then rewarding the alert. But several more of these opportunities would need to occur before the dog could reasonably be expected to confidently perform an alert in all such scenarios.

In addition to Lily’s change of behavior correlating with a confirmed bat sighting, the handler never noticed any obvious non-target activity which would account for the change of behavior (i.e. no rodents, birds, or other obvious distractors were observed at change of behavior locations). At Pammel State Park, the handler found a desiccated dead bat on a rock ledge, to which Lily expressed no interest which indicates that dead bats in fissures would not have elicited on-target changes of behavior. Combined, these experiences indicate that the training process successfully conferred understanding of live bat odor to the dog, and to suggest that changes of behavior and alerts be considered equally in interpreting the outcomes of this study.

Recommendations:

We strongly suggest placing acoustic monitors near points of interest as a means of follow up to dog findings. Acoustic monitor captures would corroborates that dog interest equates to bat presence. If so, we suggest that follow up dog deployment also include areas of suitable habitat which have previously had no acoustic captures in order to determine if dog searches are more sensitive than acoustic monitors. Eventually with repeated corroboration, dogs could be deployed in areas with seemingly less prime habitat to ascertain if researchers and managers are being too selective in what they consider to be likely “batty” areas.

While late-season deployment seems ideal (when most snow has melted so sites are safer, and somewhat active bats create the opportunity where—like this year—handlers may have a serendipitous opportunity to confirm bat presence), early-season deployment may similarly ideal as the bats are entering the sites and ground conditions are still likely to be reasonably safe. Moreover, early season deployment would allow for faster corroboration as follow-up acoustic monitors could be placed in time for spring emergence.

Conclusion:

This effort to locate bat hibernacula represents a strong first deployment which successfully indicated that training process we undertook was successful in conferring the understanding of live bat odor. Areas of dog interest coincide with moderate to high acoustic monitoring captures from previous monitoring sessions. We believe that deploying dogs to previously unmonitored areas, or those which haven’t produced captures in the past, could meaningfully bolster efforts to locate bat hibernacula.

Thanks:
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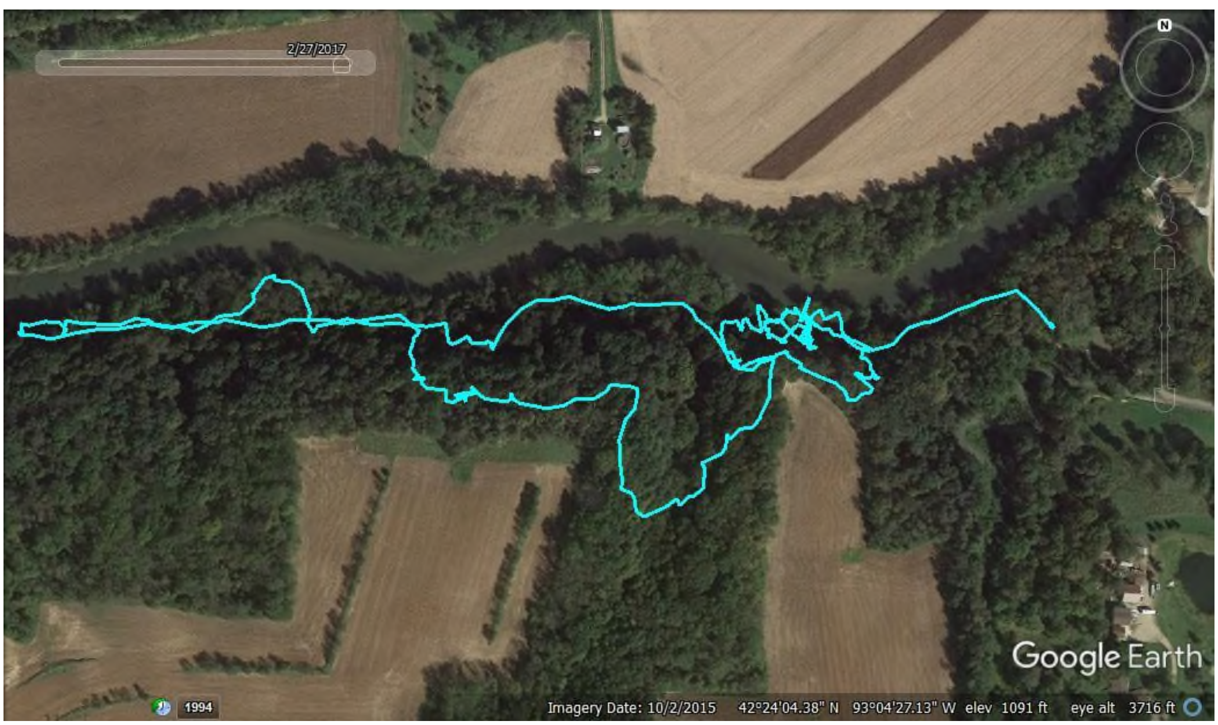
Appendix I. Maps of search areas

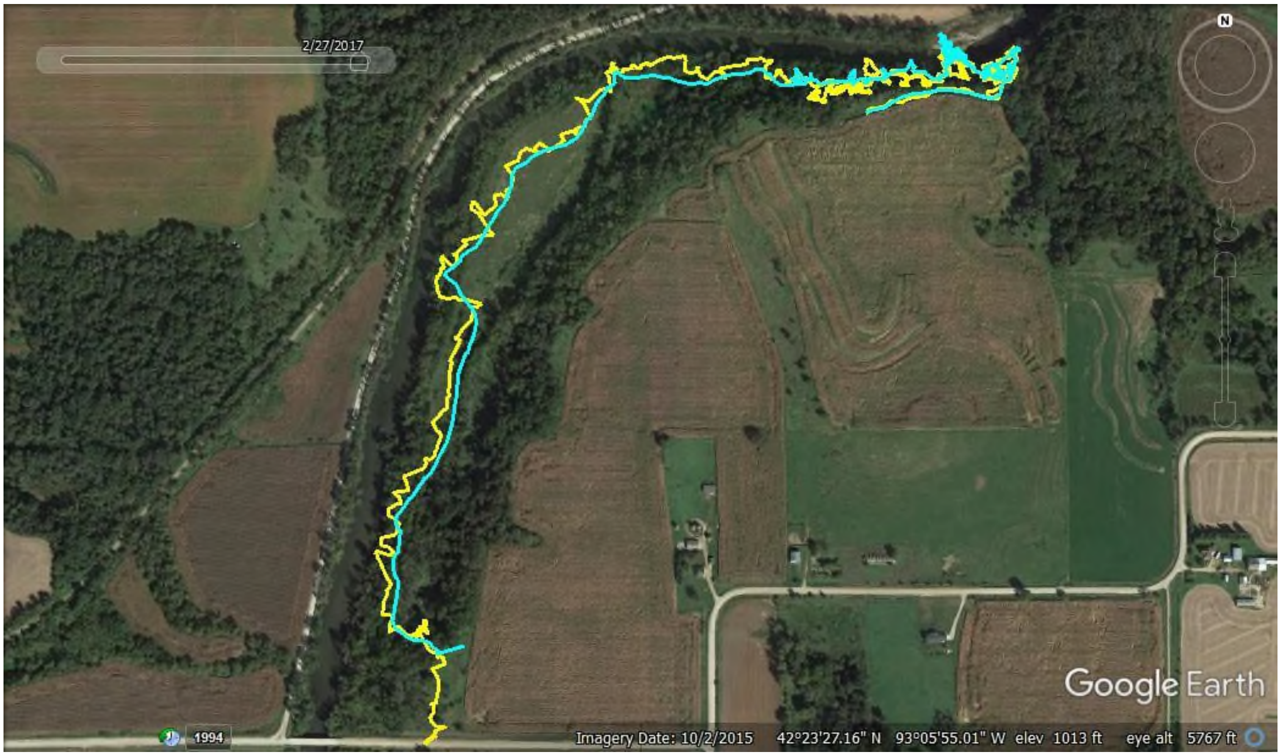
Blue line = handler track

Yellow line = dog track (not always shown)

3/3/2017 and 3/4/2107 Ledges. 5 changes of behavior.

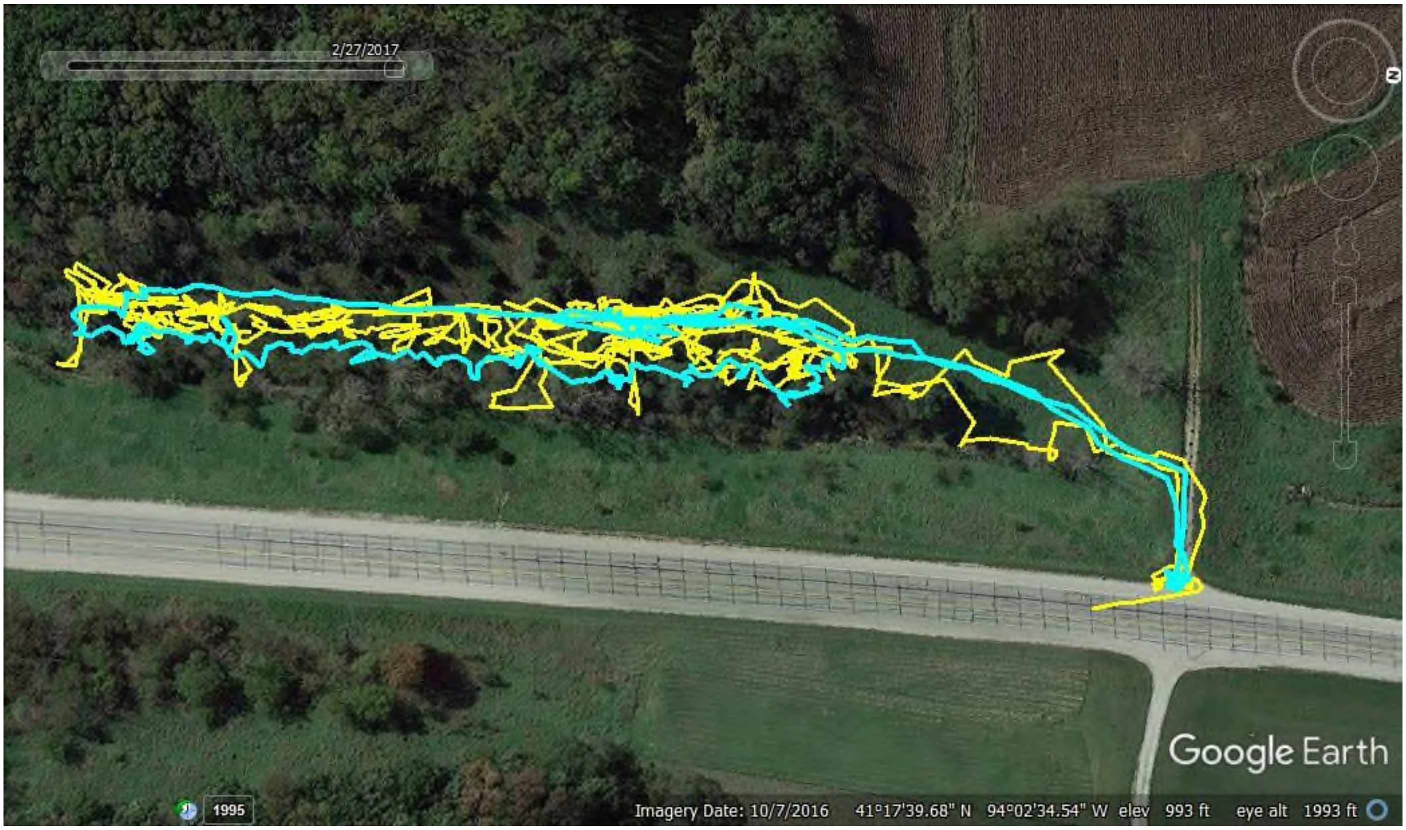


2/27/2017 Fallen Rock. 1 alert.

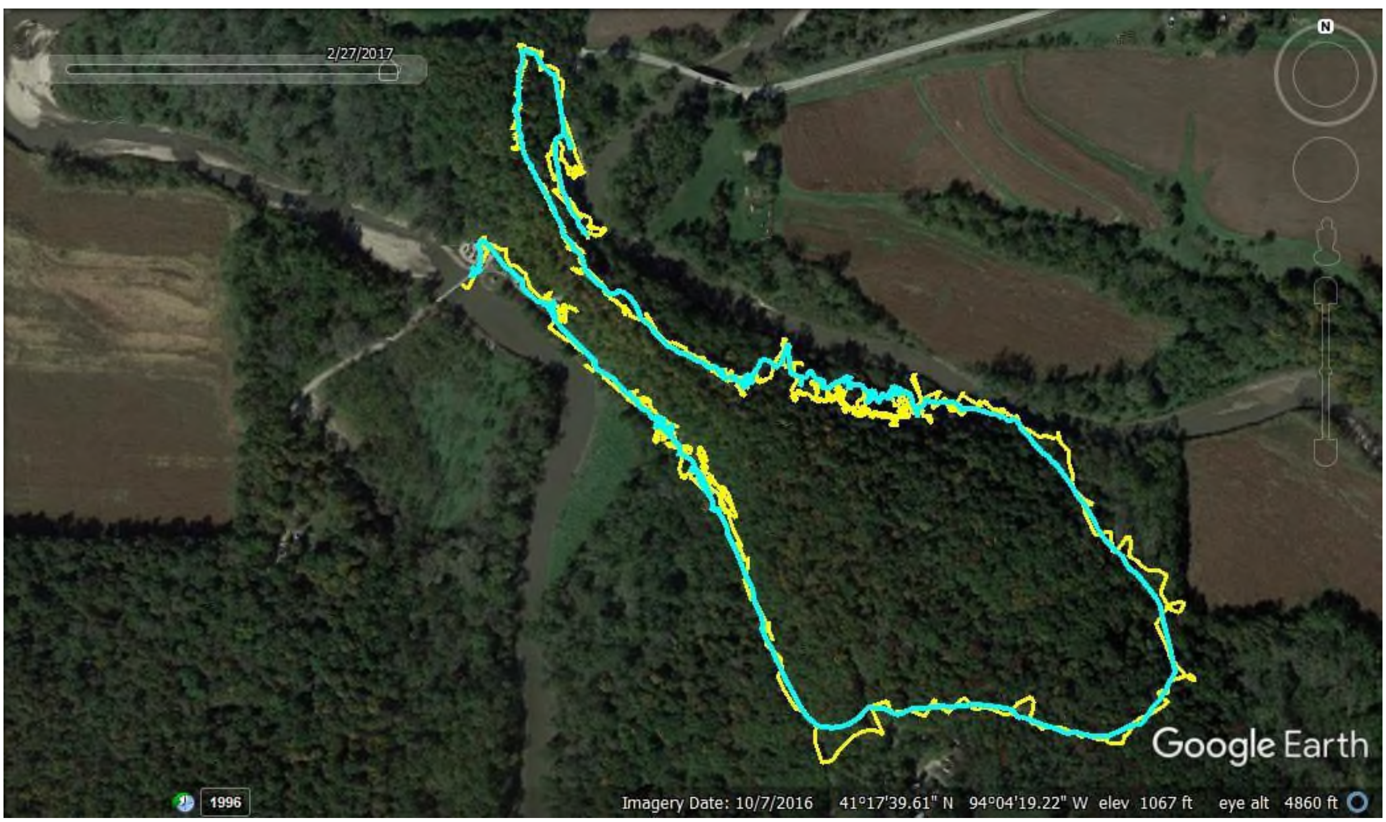


3/5/2017 Fallen Rock second area. 2 alerts, 2 changes of behavior. Bats seen flying at alert location.

2/28/2017. Dolliver. 1 alert, 1 change of behavior (orange).

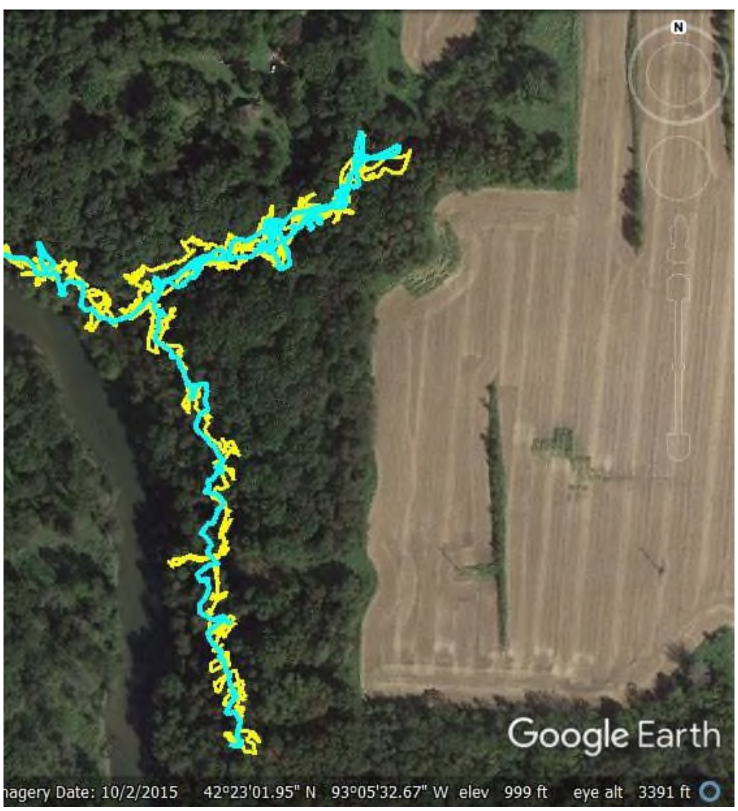


3/6/2017 Pammel road side. 1 change of behavior



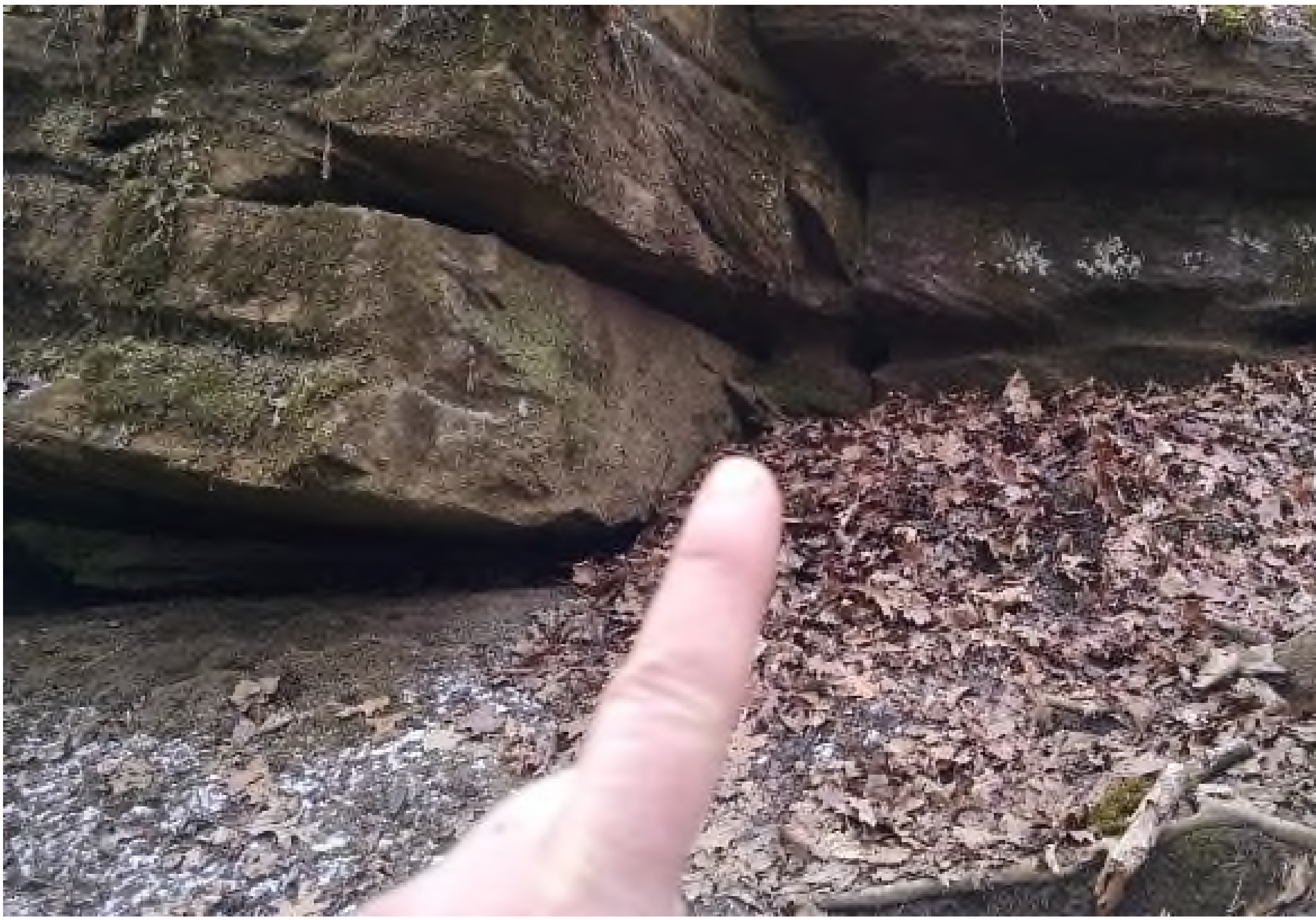
3/9/2017 Pammel State Park. 1 alert.

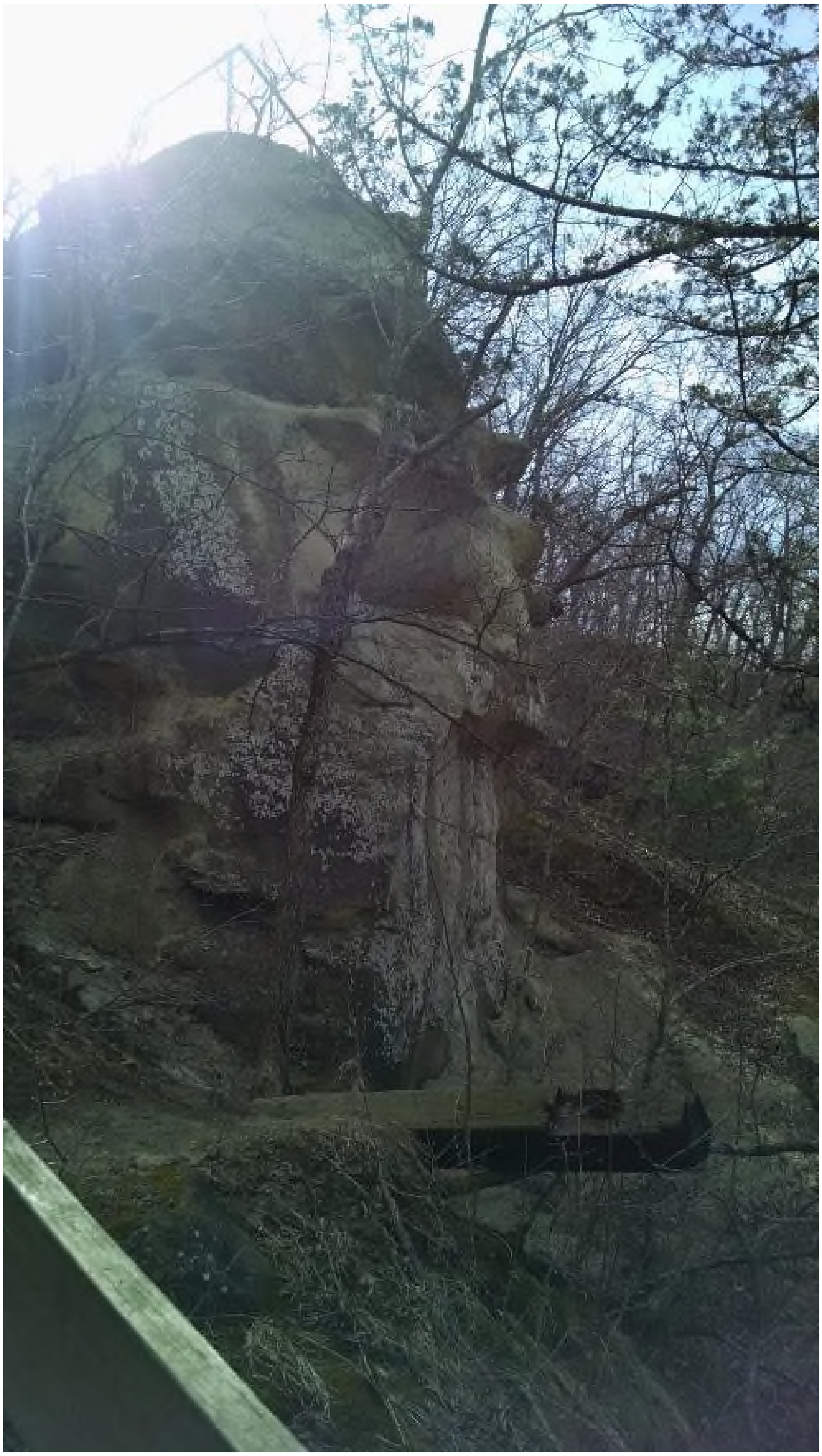
3/10/2017 Cedar Bluffs. 2 alerts, 1 change of behavior location

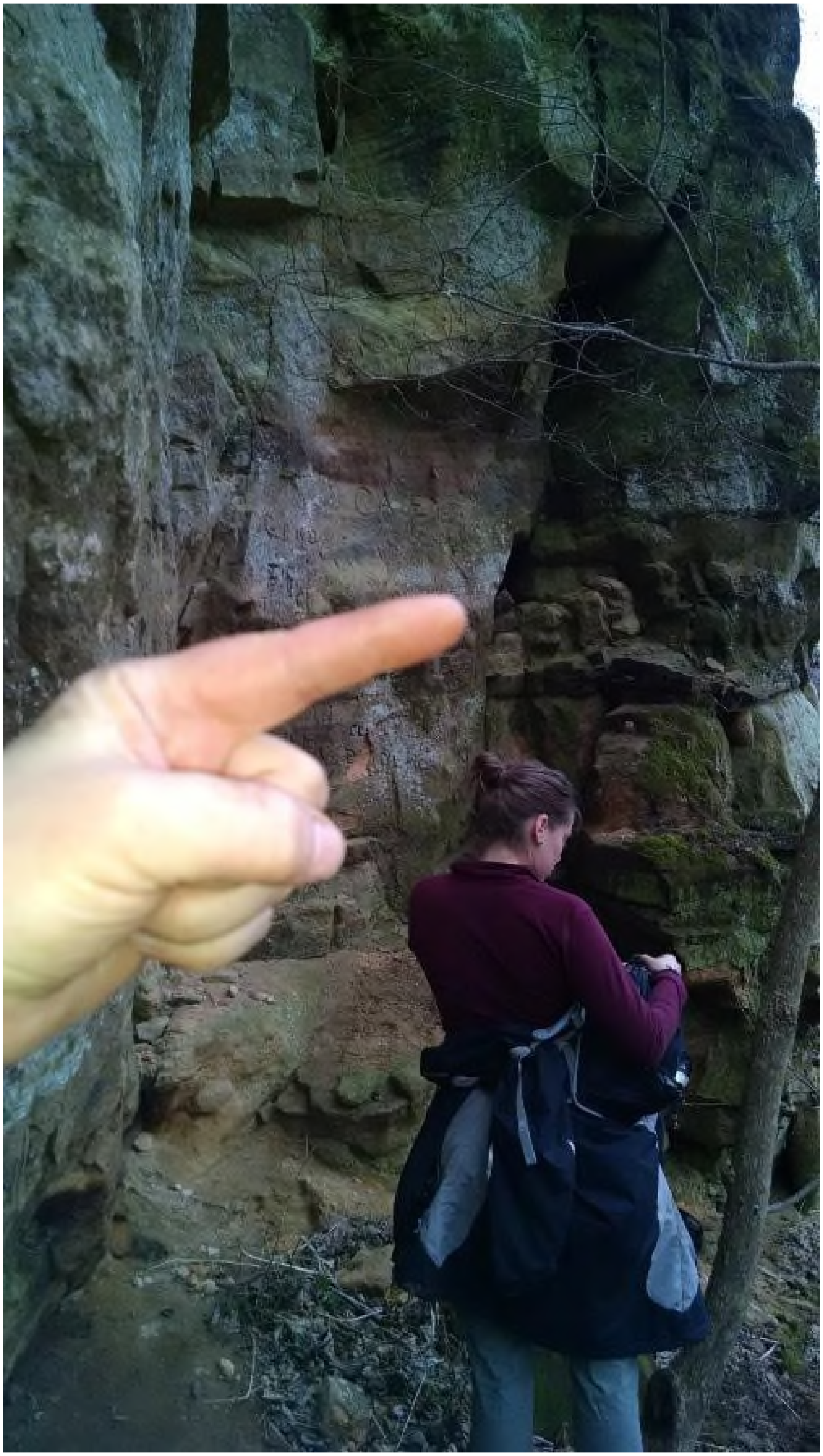


3/11/2017 Wildcat Cave. 1 alert and 1 change of behavior.

Appendix II. Photos of points of interest across all search areas (all photos credit: WD4C)







Appendix III. Photos of training and other interest

Final stages of swab training

Distant scent training apparatus

Distance scent training apparatus. Bat safely contained at large end, dog sniffs opening to the right.

Mountain goat-like agility required in order for the dog to access many areas

"Upsniffing" on hind legs to get a better sniff at overhead scent

More upsniffing

Checking possible small caves

Checking numerous small fissures

Lily checking a slightly larger entrance that humans may be able to look into, but which is hard to access on a steep slope

Terrain presents a challenge in getting to base of formations to ensure dog checks as many places as possible

Ventral close-up of dead bat at Pammel State Park

Dorsal close-up of dead bat at Pammel State Park

Detailed checking of accessible portions of extensive rock structures

Lily checking with handler for instruction from atop the rock structure

Extensive habitat in Dolliver

Extensive quality habitat along river at Wild Cat Cave.

Extensive quality habitat up side ravine at Wild Cat Cave (namesake cave mid-photo on right side).