

# **Bat Acoustic Survey Report for the Crocker Wind Farm Clark County, South Dakota**

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**April 14 – October 27, 2016**



**Prepared for:**

**Crocker Wind Farm, LLC**

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## **EXECUTIVE SUMMARY**

In April 2016, Western EcoSystems Technology, Inc. initiated a bat acoustic survey for the proposed Crocker Wind Farm (Project) in Clark County, South Dakota. The bat acoustic survey conducted at the Project was designed to estimate levels of bat activity throughout the Project during spring, summer, and fall.

Acoustic surveys were conducted using SM3 bat detectors from April 14 to October 27, 2016, at two meteorological tower stations located in agricultural fields. The paired ground and raised met tower stations recorded a combined mean ( $\pm$  standard error) of  $1.84 \pm 0.22$  bat passes per detector-night. Detectors at fixed ground stations recorded 448 bat passes on 265 detector-nights for a mean ( $\pm$  standard error) of  $1.84 \pm 0.23$  bat passes per detector-night. Raised stations recorded a similar number (455) of bat passes on 265 detector nights for a mean of  $1.83 \pm 0.24$  per detector-night.

Low-frequency bat species, such as hoary bats and silver-haired bats, composed nearly 67% of bat passes overall. Four bat species and the *Myotis* group were identified at each of the four full-spectrum SM3 stations using the auto-classifier component of Kaleidoscope 3.1.7. Big brown bats were the least commonly recorded and hoary bats were the most commonly recorded species, present on 31% of detector nights.

Bat activity was also highest in the fall, peaking in early August. Activity during the standardized Fall Migration Period was  $2.80 \pm 0.42$  bat passes per detector-night at ground met tower stations. Most wind energy facilities in the Midwest region have reported fewer than five bat fatalities/megawatt (MW)/year (1.64 – 4.35 bats/MW/year). The results from this study suggest that bat fatality rates at the Project may be fewer than five bats/MW/year, occur mainly in the fall, and mainly be composed of low-frequency species such as hoary bats and silver-haired bats.

## **STUDY PARTICIPANTS**

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## **REPORT REFERENCE**

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## **INTRODUCTION**

Crocker Wind Farm, LLC is considering the development of the Crocker Wind Farm (Project) in Clark County, South Dakota. Crocker Wind Farm, LLC contracted Western EcoSystems Technology, Inc. (WEST) to complete a study of bat activity following the recommendations of the U.S. Fish and Wildlife Service (USFWS) Land-based Wind Energy Guidelines (USFWS 2012a) and Kunz et al. (2007a). WEST conducted acoustic monitoring surveys to estimate levels of bat activity throughout the Project during the spring, summer, and fall. The following report describes the results of acoustic monitoring surveys conducted at the Project between April 14 and October 27, 2016.

## **STUDY AREA**

The proposed Project is approximately 31,131 acres (48.6 square miles) in size and lies just southwest of Bradley, South Dakota, in Clark County (Figure 1, Table 1). The landscape within the Project is flat to rolling with elevation ranges from 1,486.3 – 1,918.6 feet ([ft]; 453 – 585 meters [m]). Historically, the Project's landscape was dominated by grasslands but has since been converted largely to agricultural use with crop production and livestock grazing the primary practices. Trees and shrubs can be found around farmsteads, within planted shelter belts, and along/within drainages. Wetlands and lakes are scattered throughout the Project, with some being man-made.

Hay and pasturelands are the most abundant land cover/land use within the Project, making up nearly 37% of the area, followed by herbaceous plants (33%). The majority of the remaining landscape is comprised of cultivated crops (16%), open water (10%), and developed open space (2%). Small amounts (<0.5%) of deciduous forest, emergent herbaceous wetlands, shrub/scrub, developed low, medium, and high intensity lands, and woody wetlands are also present within the Project (Fry et al. 2011; Figure 1). Common agricultural crops include hay, corn, and soybeans.

Crocker Bat Acoustic Survey

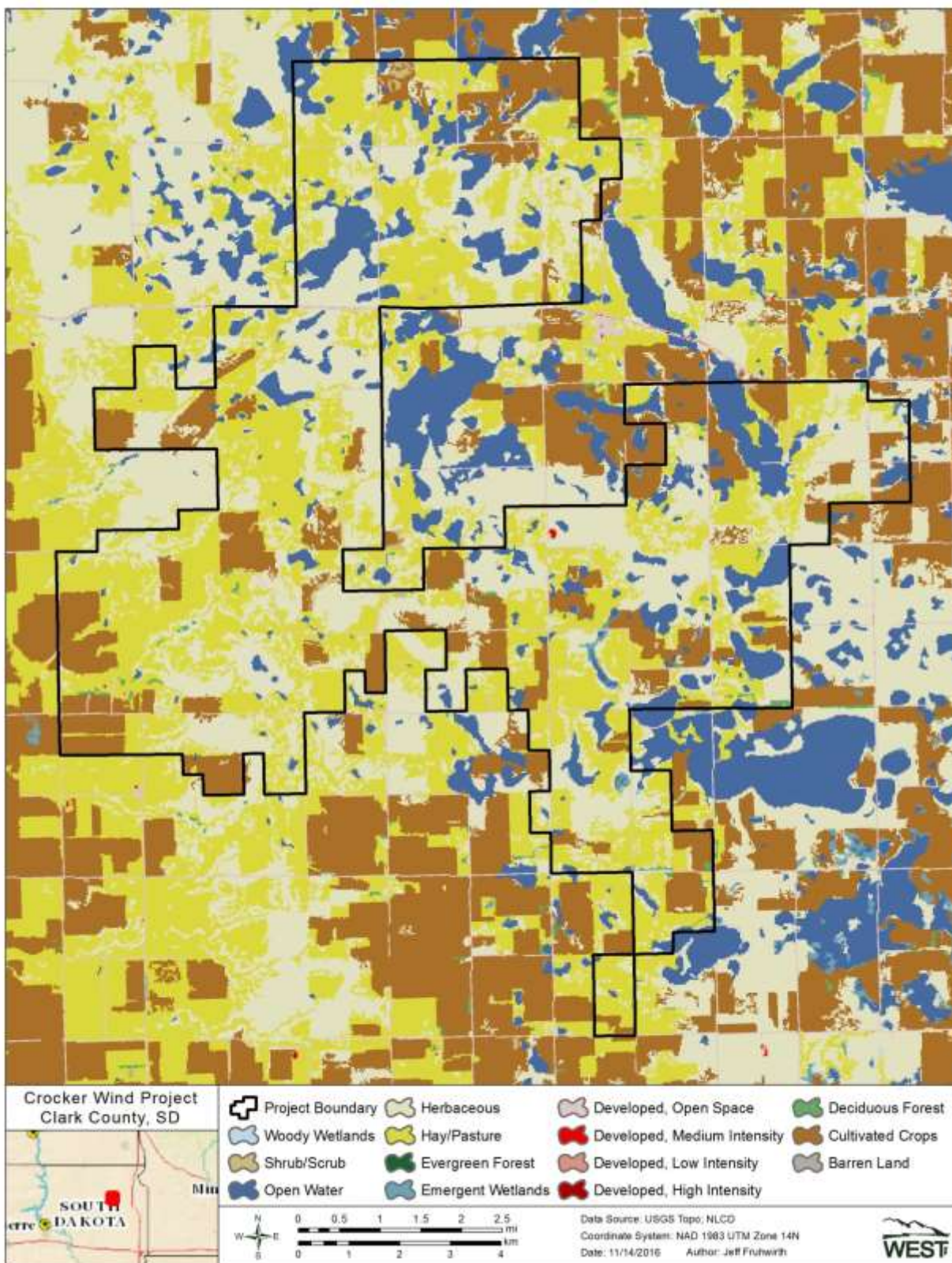


Figure 1. Land cover in the Crocker Wind Farm (USGS NLCD 2001).

**Crocker Bat Acoustic Survey**

**Table 1. Land cover in the Crocker Wind Farm according to the United States Geological Survey National Land Cover Dataset (2001).**

| <b>Land Cover</b>            | <b>Acres</b>    | <b>% Composition</b> |
|------------------------------|-----------------|----------------------|
| Hay/Pasture                  | 11,441.2        | 36.8%                |
| Herbaceous                   | 10,357.0        | 33.3%                |
| Cultivated Crops             | 5,030.2         | 16.2%                |
| Open Water                   | 3,253.6         | 10.5%                |
| Developed, Open Space        | 697.9           | 2.2%                 |
| Deciduous Forest             | 140.5           | 0.5%                 |
| Emergent Herbaceous Wetlands | 103.2           | 0.3%                 |
| Shrub/Scrub                  | 83.4            | 0.3%                 |
| Developed, Low Intensity     | 16.6            | 0.1%                 |
| Developed, Medium Intensity  | 4.2             | 0.0%                 |
| Woody Wetlands               | 2.2             | 0.0%                 |
| Developed, High Intensity    | 1.0             | 0.0%                 |
| <b>Total</b>                 | <b>31,131.1</b> | <b>100.00%</b>       |

**Overview of Bat Diversity**

Six species of bats potentially occur at the Project and all six species are known to have been killed at wind energy facilities (Table 2). *Myotis septentrionalis*, the northern long-eared bat (NLEB), is federally listed as threatened (USFWS 2016); the habitat analysis and summer presence/absence NLEB survey results are covered in a separate report. The NLEB and silver-haired bat are considered rare in the state by the South Dakota Natural Heritage Program (SDGFP 2016, Table 2).

**Table 2. Bat species with potential to occur within the Crocker Wind Farm (IUCN 2009; USFWS 2016 categorized by echolocation call frequency.**

| <b>Common Name</b>                       | <b>Scientific Name</b>           |
|------------------------------------------|----------------------------------|
| <b>High-Frequency (&gt; 30 kHz)</b>      |                                  |
| eastern red bat <sup>1,2</sup>           | <i>Lasiurus borealis</i>         |
| little brown bat <sup>1</sup>            | <i>Myotis lucifugus</i>          |
| northern long-eared bat <sup>1,3,4</sup> | <i>Myotis septentrionalis</i>    |
| <b>Low-Frequency (&lt; 30 kHz)</b>       |                                  |
| big brown bat <sup>1</sup>               | <i>Eptesicus fuscus</i>          |
| silver-haired bat <sup>1,2,4</sup>       | <i>Lasionycteris noctivagans</i> |
| hoary bat <sup>1,2</sup>                 | <i>Lasiurus cinereus</i>         |

<sup>1</sup> species known to have been killed at wind energy facilities;

<sup>2</sup> long-distance migrant;

<sup>3</sup> federally threatened species (USFWS 2016); and

<sup>4</sup> state-listed as rare (SDGPF 2016).

## **White-Nose Syndrome**

Bats that hibernate in North America are being severely impacted by white-nose syndrome (WNS), an infectious mycosis in which bats are infected with a psychrophilic fungus from Europe (*Pseudogymnoascus* [formerly *Geomyces*] *destructans*) that is thought to act as a chronic disturbance during hibernation (USGS 2010; Minnis and Lindner 2013). Infected bats arouse frequently from hibernation, leading to premature loss of fat reserves and atypical behavior, which in turn leads to starvation prior to spring emergence (Boyles and Willis 2010; Reeder et al. 2012; Warnecke et al. 2012). WNS was first discovered in New York State in 2006 and by 2013 had rapidly spread to over 115 caves and mines and is now confirmed in 29 states and the causative fungus has been identified in an additional 3 states. To date, the full WNS has spread north into five Canadian provinces, reaching as far south as Alabama and as far west as Washington (Heffernan 2016). It is estimated that between 5.7 and 6.7 million bats have died as a result of WNS (USFWS 2012b). WNS is the primary reason the USFWS recently listed the NLEB as threatened under the Endangered Species Act (USFWS 2015), and is currently reviewing the status of the little brown bat. Neither WNS nor the causative fungal agent have been detected as of 2016 in South Dakota; however the fungus has been detected in the neighboring states of Minnesota, Iowa, and Nebraska.

## **METHODS**

### **Bat Acoustic Surveys**

WEST conducted acoustic monitoring studies to estimate levels of bat activity throughout the Project during the study period. Although it remains unclear whether baseline acoustic data are adequate to predict post-construction fatality (Hein et al. 2013a), ultrasonic detectors do collect information on the spatial distribution, timing, and species composition that can provide insights into the possible risk of wind development on bats (Kunz et al. 2007a; Britzke et al. 2013) and inform potential mitigation strategies (Weller and Baldwin 2012).

### ***Survey Stations***

Two Song Meter SM3 full-spectrum ultrasonic detectors (hereafter “SM3”; Wildlife Acoustics, Concord, MA) were used during the study. Each SM3 detector is equipped with two microphone ports. The SM3 detectors were placed at meteorological (met) towers with one microphone at ground level (approximately 3 m [10 ft] above ground level) and another at the proposed rotor-swept height (approximately 45 m [148 ft] above ground level; Figure 2). Species activity levels and composition can vary with altitude (Baerwald and Barclay 2009; Collins and Jones 2009; Müller et al. 2013). Therefore, it can be useful to monitor activity at different heights (Kunz et al. 2007b). Ground-based microphones likely detect a more complete sample of the bat species present within the Project, whereas elevated microphones may give a more accurate assessment of risk to bat species flying at rotor swept heights (Kunz et al. 2007b; Müller et al. 2013; but see Amorim et al. 2012). Both met tower stations were located in agricultural habitat (Figure 2) and are representative of potential turbine locations.

The SM3 detectors and external batteries deep-cycle were housed inside large tool-boxes for protection from livestock and wildlife. The ground microphone was raised on polyvinyl chloride (commonly PVC) pole to improve the quality of sound recordings for species identification. Raised SM3 microphones were elevated on met towers using a pulley system. The SM3 microphone is weather resistant, and does not require protection, however, the microphone was oriented parallel to the ground to minimize the potential for rain damage.

Crocker Bat Acoustic Survey

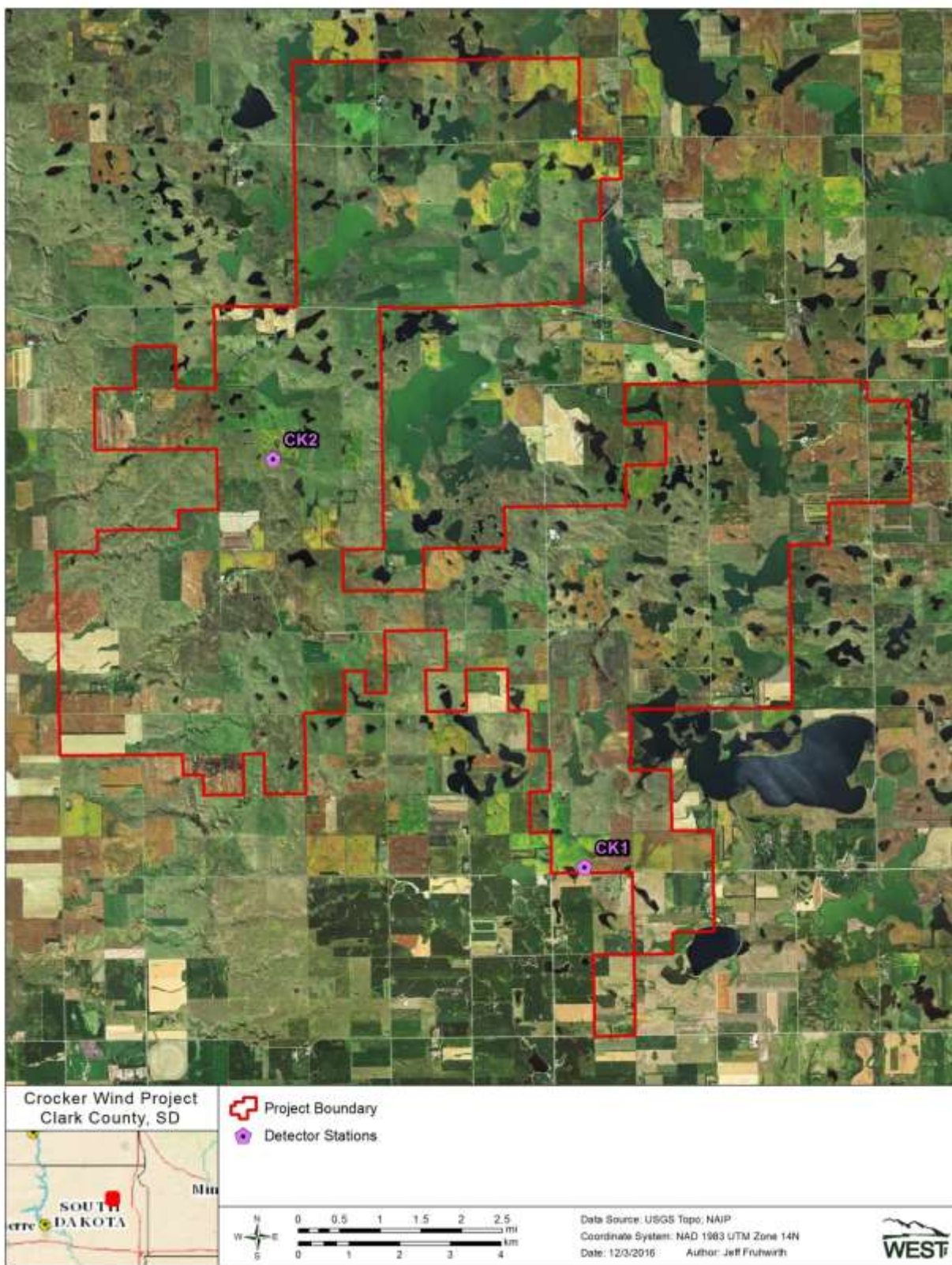


Figure 2. Location of met tower stations in the Crocker Wind Farm.

### ***Survey Schedule***

Bats were surveyed in the Project from April 14 to October 27, 2016, and detectors were programmed to turn on approximately 30 minutes before sunset and turn off approximately 30 minutes after sunrise each night. To highlight seasonal activity patterns, the study was divided into three survey periods: spring (April 14 – May 31), summer (June 1 – July 31), and fall (August 1 – October 27). Mean bat activity was also calculated for a standardized Fall Migration Period (FMP), defined here as July 30 – October 14. The FMP was defined by WEST as a standard for comparison with activity from other wind energy facilities. During this time bats begin moving toward wintering areas, and many species of bats initiate reproductive behaviors (Cryan 2008). This period of increased landscape-scale movement and reproductive behavior is often associated with increased levels of bat fatalities at operational wind energy facilities (Arnett et al. 2008; Arnett and Baerwald 2013).

### **Data Collection and Call Analysis**

The Song Meter SM3 is a full-spectrum bat detector that records complete acoustic waveforms by sampling sound waves at 192 kilohertz (kHz). This high sampling rate enables the detector to record sound amplitude data at all frequencies up to 96 kHz and to make high resolution recordings. The high quality recordings produced by the SM3 detector provide more information for making species identifications than SM3 detectors at the cost of higher data storage requirements and slower data analysis.

Identification of calls was completed with the automated identification feature in program Kaleidoscope 3.1.7 (Wildlife Acoustics, Concord, Massachusetts) using the Bats of North America classifier 2.1.0. It utilizes Hidden Markov Models and other statistical methods known for their application in temporal pattern recognition such as speech analysis, handwriting analysis, and DNA sequencing (Agranat 2012). Despite the capabilities of Kaleidoscope, many bat passes cannot be identified with certainty, either because only call fragments were recorded due to the distance between the bat and microphone or because many bat species produce similar calls with overlapping call characteristics that often cannot be distinguished. The Kaleidoscope output was used to generate a list of species that may have been present in the Project.

The full-spectrum data recorded by the SM3 were also transformed into zero-crossing data using the program Kaleidoscope 3.1.7 (Wildlife Acoustics, Inc., Concord, Massachusetts), allowing data to be viewed in Analook® software as digital sonograms that show changes in echolocation call frequency over time. Frequency versus time displays were used to separate bat calls from other types of ultrasonic noise (e.g., wind, insects, etc.) and to determine the call frequency category.

For each survey location, bat passes were sorted into two groups based on their minimum frequency. High-frequency (HF) bats such as eastern red bats, evening bats, and *Myotis* species have minimum frequencies greater than 30 kHz. Low-frequency (LF) bats such as big brown bats, silver-haired bats, and hoary bats typically emit echolocation calls with minimum

frequencies below 30 kHz. HF and LF species that may occur in the study area are listed in Table 2.

### **Statistical Analysis**

The standard metric used for measuring bat activity is the number of bat passes per detector-night, and this metric was used as an index of bat activity in the project area. A bat pass was defined as a sequence of at least two echolocation calls (pulses) produced by an individual bat with no pause between calls of more than one second (Fenton 1980). A detector-night was defined as one detector operating for one entire night. The terms bat pass and bat call are used interchangeably. Bat passes per detector-night was calculated for all bats, and for HF and LF bats. Bat pass rates represent indices of bat activity and do not represent numbers of individuals. The number of bat passes was determined by an experienced bat biologist using Analook.

The period of peak sustained bat activity was defined as the seven-day period with the highest average bat activity. If multiple seven-day periods equaled the peak sustained bat activity rate, all dates in these seven-day periods were reported. This and all multi-detector averages in this report were calculated as an unweighted average of total activity at each detector.

### **Risk Assessment**

To assess the likelihood of relatively low or relatively high bat fatalities, bat activity recorded in the Project was compared to existing data at other wind energy facilities in the Midwest and Rocky Mountains. Given the relatively small number of publicly available studies and the significant ecological differences between geographically dispersed facilities, the risk assessment is qualitative, rather than quantitative. Among studies measuring both activity and fatality rates, most data were collected during the fall using AnaBat detectors placed near the ground. To make comparisons to the existing publicly available data, this report uses the activity rate recorded at ground-level met tower SM3 stations during the FMP as a standard for comparison with activity data from other wind energy facilities. However, full-spectrum detectors such as the SM3 units used at Crocker typically record more bat passes per detector-night on average than AnaBat (zero-cross) units, so direct comparison between activity rates should be done with caution.

Given the differences in microphone sensitivity and data processing algorithms between full-spectrum and zero-cross detectors, activity levels recorded by SM3 detectors (used at Crocker) are not readily comparable to activity recorded by AnaBat detectors because the two detectors sample a different volume of airspace and process the data differently (Solick et al. 2011, Adams et al. 2012). Although the detection range of ultrasonic detectors depends on a number of factors (e.g., echolocation call characteristics, microphone sensitivity, habitat, the orientation of the bat, atmospheric conditions; Limpens and McCracken 2004), the SM2 detector (similar to the SM3 detector used at Crocker) was shown to detect signals at a greater distance than the zero-cross AnaBat detector (Adams et al. 2012). Under controlled conditions, the detection range for playback of synthetic echolocation calls for 55 kHz signals (HF) was similar for SM2

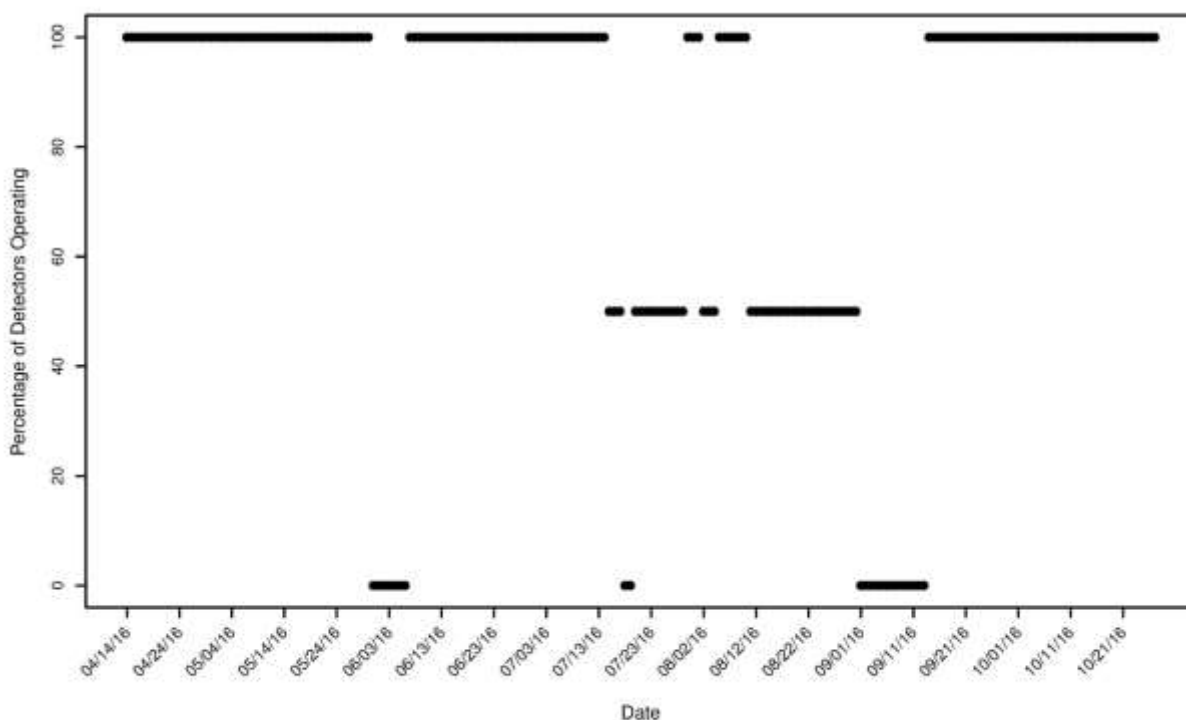
**Crocker Bat Acoustic Survey**

and AnaBat detectors (approximately 7 m [23 ft]), while for 25 kHz signals (LF) the detection range for AnaBat and SM2 detectors was approximately 15 m (49 ft) and 22 m (72 ft), respectively (Adams et al. 2012), meaning that, all else equal, the full-spectrum detector is likely to record more bat calls than the zero-cross detector (i.e., an SM3 unit such as used at Crocker generally would be expected to record higher number of calls per detector night than an AnaBat in the same location).

## RESULTS

### Bat Acoustic Surveys

Bat activity was monitored at two paired sampling locations for a total of 530 detector-nights between April 14 and October 27, 2016 (Table 3). SM3 units were operating for 78.2% of the sampling period (Figure 3). The primary causes of lost data were equipment malfunctions and data transfer errors. SM3 units overall recorded 903 bat passes for a mean of  $1.84 \pm 0.22$  bat passes per detector night (Table 3).

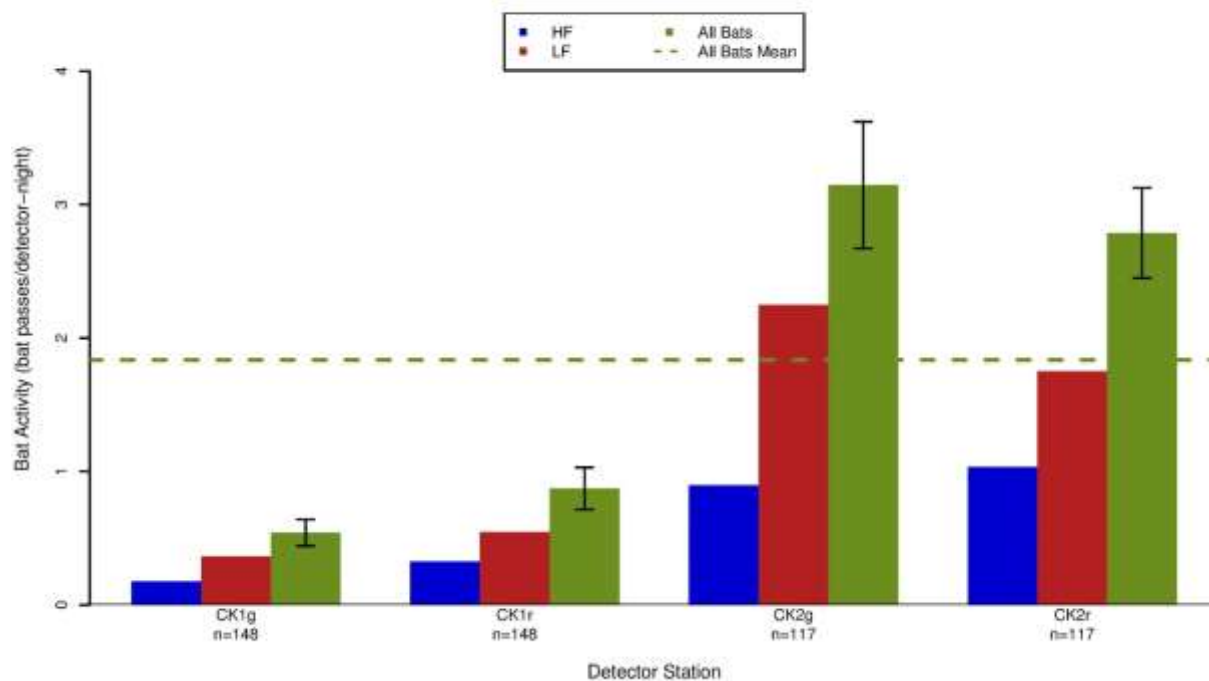


**Figure 3. Operational status of bat microphones (n = 4) operating at the Crocker Wind Farm during each night of the study period April 14 to October 27, 2016.**

**Crocker Bat Acoustic Survey**

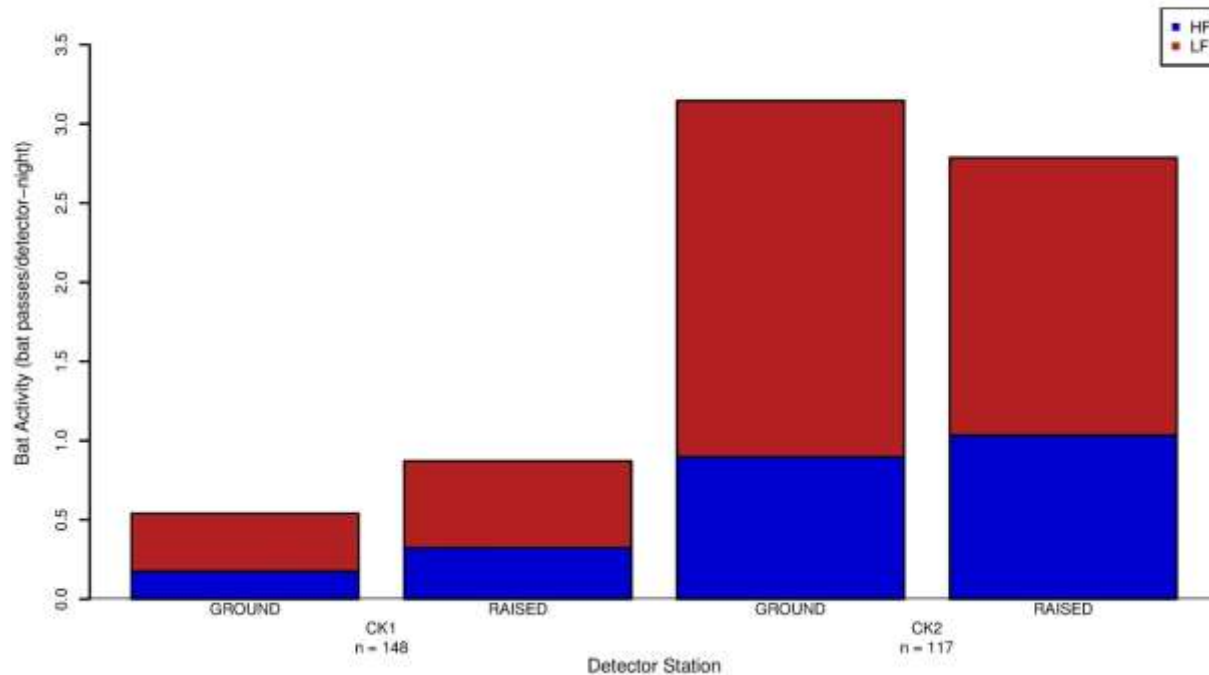
**Spatial Variation**

SM3 units at ground met tower stations recorded 448 bat passes on 265 detector-nights for a mean ( $\pm$  standard error) of  $1.84 \pm 0.23$  bat passes per detector-night. Raised stations recorded similar activity with 455 bat passes on 265 detector-nights for a mean of  $1.83 \pm 0.24$  bat passes per detector-night (Table 3, Figure 4). At the paired stations, the ground detector at station CK1 recorded slightly more bat passes than the raised detector, while the opposite occurred at CK2 (Figure 5). It should be noted that, given the increased detection distance for full-spectrum microphones, it is possible that bats flying near met towers were recorded simultaneously by both ground and raised microphones.



**Figure 4. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at SM3 met tower stations in the Crocker Wind Farm from April 14 to October 27, 2016. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.**

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**Figure 5. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at paired SM3 stations in the Crocker Wind Farm from April 14 to October 27, 2016.**

**Crocker Bat Acoustic Survey**

**Table 3. Results of acoustic bat surveys conducted at met tower stations within the Crocker Wind Farm from April 14 to October 27, 2016. Passes are separated by call frequency: high-frequency (HF) and low-frequency (LF).**

| <b>SM3</b>                             |             |                |                           |                           |                         |                         |                                        |
|----------------------------------------|-------------|----------------|---------------------------|---------------------------|-------------------------|-------------------------|----------------------------------------|
| <b>Station</b>                         | <b>Type</b> | <b>Habitat</b> | <b># of HF Bat Passes</b> | <b># of LF Bat Passes</b> | <b>Total Bat Passes</b> | <b>Detector- Nights</b> | <b>Bat Passes/ Night<sup>***</sup></b> |
| CK1g                                   | ground      | cropland       | 26                        | 54                        | 80                      | 148                     | 0.54 ± 0.10                            |
| CK1r                                   | raised      | cropland       | 48                        | 81                        | 129                     | 148                     | 0.87 ± 0.16                            |
| CK2g                                   | ground      | cropland       | 105                       | 263                       | 368                     | 117                     | 3.15 ± 0.48                            |
| CK2r                                   | raised      | cropland       | 121                       | 205                       | 326                     | 117                     | 2.79 ± 0.34                            |
| <b>Total Ground Met Tower Stations</b> |             |                | <b>131</b>                | <b>317</b>                | <b>448</b>              | <b>265</b>              | <b>1.84 ± 0.23</b>                     |
| <b>Total Raised Met Tower Stations</b> |             |                | <b>169</b>                | <b>286</b>                | <b>455</b>              | <b>265</b>              | <b>1.83 ± 0.24</b>                     |
| <b>Total</b>                           |             |                | <b>300</b>                | <b>603</b>                | <b>903</b>              | <b>530</b>              | <b>1.84 ± 0.22</b>                     |

<sup>\*\*\*</sup> ± bootstrapped standard error.

***Crocker Bat Acoustic Survey***

***Temporal Variation***

Bat activity at both met tower stations was highest in the fall (Table 4; Figure 6). Weekly acoustic activity at met towers was relatively low from April through mid-July, with activity increasing in late July and peaking in early August (9.80 bat passes per detector-night; Table 5). Activity decreased in late August through the end of the study period (Figure 7). At paired stations weekly activity was similar between ground and raised microphones throughout the study period (Figure 8).

**Table 4. The number of bat passes per detector-night recorded at met tower stations in the Crocker Wind Farm during each season in 2016, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).**

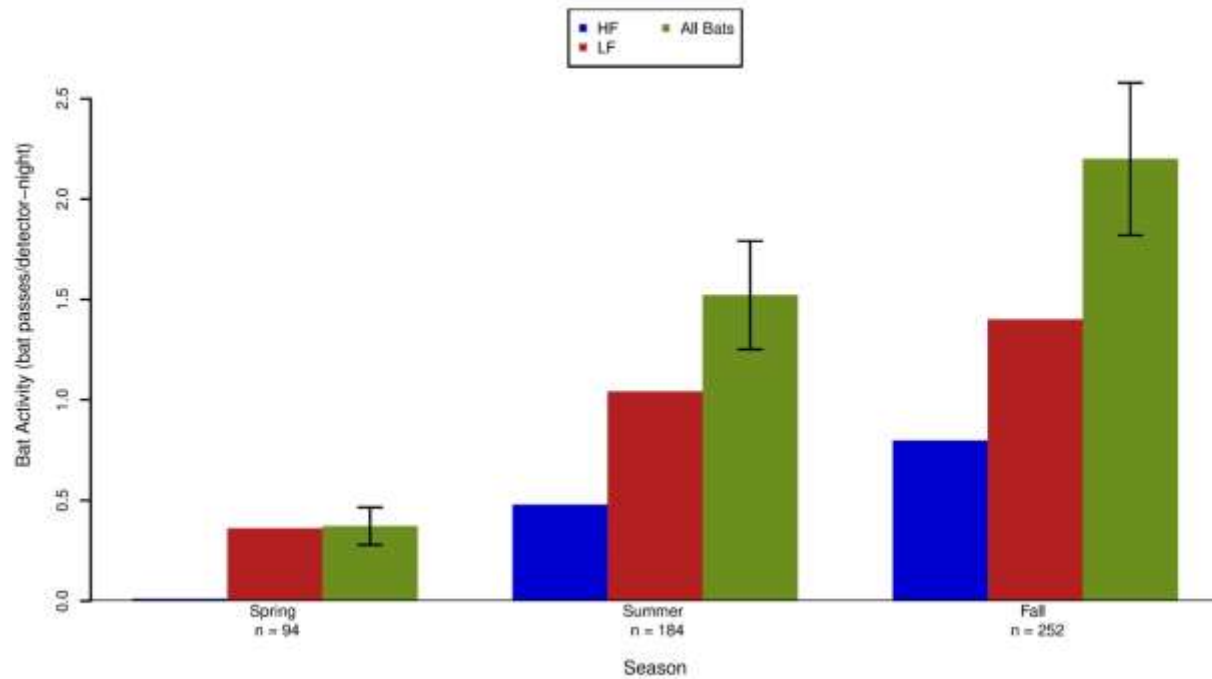
| Station             | Call Frequency | <u>Spring</u>      | <u>Summer</u>      | <u>Fall</u>        | <u>Fall Migration Period</u> |
|---------------------|----------------|--------------------|--------------------|--------------------|------------------------------|
|                     |                | April 14 – May 31  | June 1 – Jul 31    | Aug 1 – Oct 27     | Jul 30 – Oct 14              |
| CK1g                | LF             | 0.38               | 0.26               | 0.43               | 0.51                         |
|                     | HF             | 0.02               | 0.19               | 0.29               | 0.38                         |
|                     | AB             | 0.4                | 0.44               | 0.72               | 0.89                         |
| CK1r                | LF             | 0.34               | 0.47               | 0.78               | 1.04                         |
|                     | HF             | 0                  | 0.14               | 0.72               | 0.91                         |
|                     | AB             | 0.34               | 0.6                | 1.5                | 1.96                         |
| CK2g                | LF             | NA                 | 1.94               | 2.47               | 3.3                          |
|                     | HF             | NA                 | 0.63               | 1.09               | 1.4                          |
|                     | AB             | NA                 | 2.57               | 3.56               | 4.7                          |
| CK2r                | LF             | NA                 | 1.51               | 1.93               | 2.56                         |
|                     | HF             | NA                 | 0.96               | 1.09               | 1.39                         |
|                     | AB             | NA                 | 2.47               | 3.01               | 3.95                         |
| <b>Ground Total</b> | <b>LF</b>      | <b>0.38 ± 0.11</b> | <b>1.10 ± 0.21</b> | <b>1.45 ± 0.25</b> | <b>1.90 ± 0.31</b>           |
|                     | <b>HF</b>      | <b>0.02 ± 0.02</b> | <b>0.41 ± 0.09</b> | <b>0.69 ± 0.13</b> | <b>0.89 ± 0.16</b>           |
|                     | <b>AB</b>      | <b>0.40 ± 0.11</b> | <b>1.51 ± 0.27</b> | <b>2.14 ± 0.34</b> | <b>2.80 ± 0.42</b>           |
| <b>Raised Total</b> | <b>LF</b>      | <b>0.34 ± 0.10</b> | <b>0.99 ± 0.23</b> | <b>1.35 ± 0.25</b> | <b>1.80 ± 0.29</b>           |
|                     | <b>HF</b>      | <b>0.00 ± 0.00</b> | <b>0.55 ± 0.13</b> | <b>0.91 ± 0.17</b> | <b>1.15 ± 0.20</b>           |
|                     | <b>AB</b>      | <b>0.34 ± 0.10</b> | <b>1.54 ± 0.33</b> | <b>2.26 ± 0.39</b> | <b>2.95 ± 0.45</b>           |
| <b>Overall</b>      | <b>LF</b>      | <b>0.36 ± 0.09</b> | <b>1.04 ± 0.20</b> | <b>1.40 ± 0.26</b> | <b>1.85 ± 0.31</b>           |
|                     | <b>HF</b>      | <b>0.01 ± 0.01</b> | <b>0.48 ± 0.10</b> | <b>0.80 ± 0.14</b> | <b>1.02 ± 0.17</b>           |
|                     | <b>AB</b>      | <b>0.37 ± 0.09</b> | <b>1.52 ± 0.27</b> | <b>2.20 ± 0.38</b> | <b>2.88 ± 0.45</b>           |

**Table 5. Periods of peak activity for high-frequency (HF), low-frequency (LF), and all bats at met tower stations in the Crocker Wind Farm for the study period April 14 to October 27, 2016.**

| Species Group | Start Date of Peak Activity | End Date of Peak Activity | Bat Passes per Detector-Night |
|---------------|-----------------------------|---------------------------|-------------------------------|
| HF            | August 1                    | August 7                  | 3.06                          |
| LF            | August 9                    | August 15                 | 6.77                          |
| All Bats      | August 9                    | August 15                 | 9.80                          |

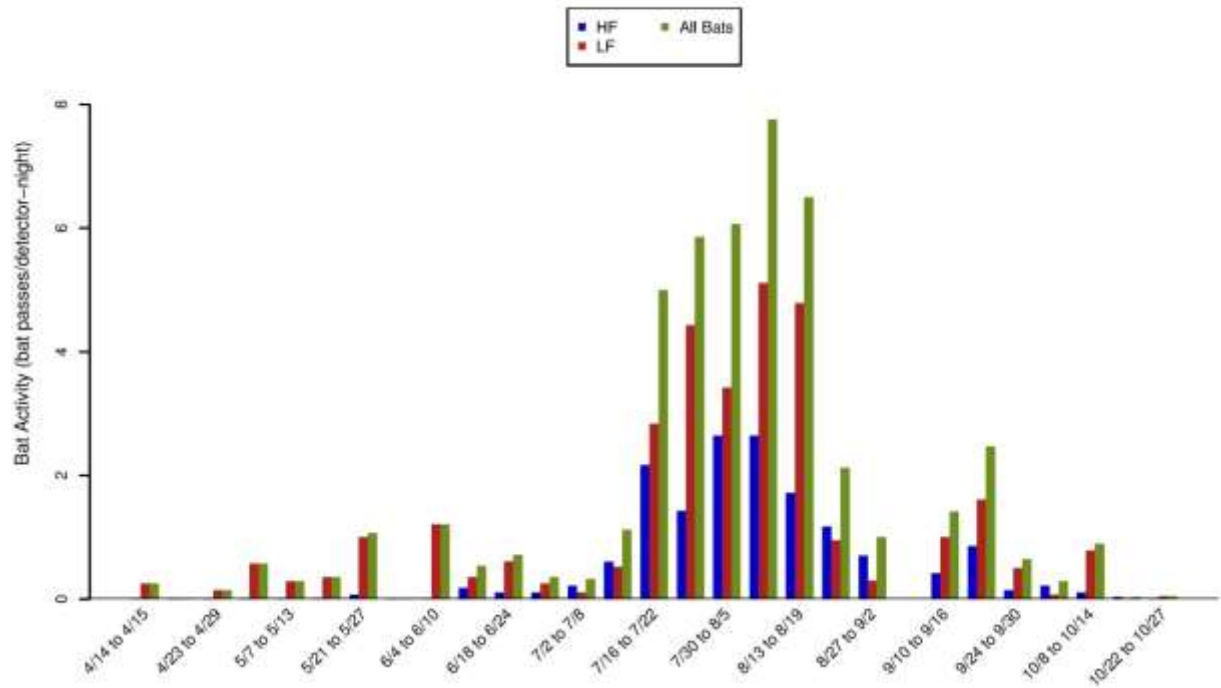
**Crocker Bat Acoustic Survey**

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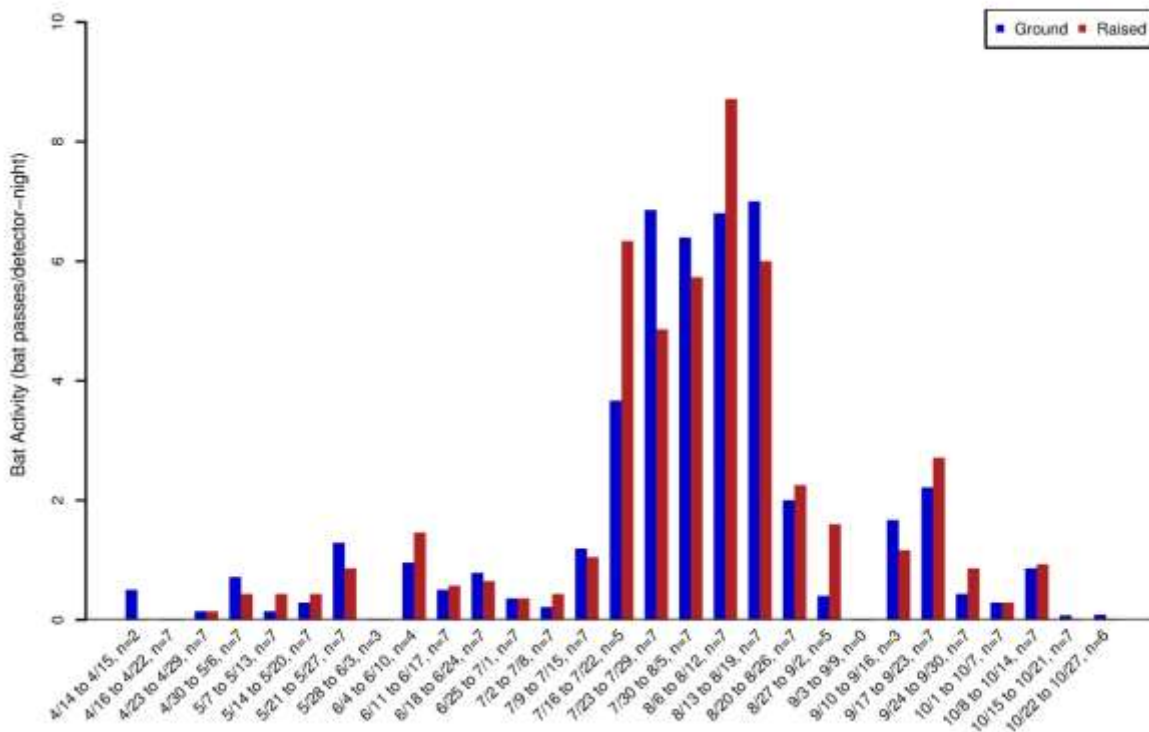
**Figure 6. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at met tower stations in the Crocker Wind Farm from April 14 to October 27, 2016. The bootstrapped standard errors are represented on the 'All Bats' columns.**

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**Figure 7. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at met tower stations in the Crocker Wind Farm for the study period April 14 to October 27, 2016.**

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**Figure 8. Weekly patterns of bat activity recorded by paired SM3 detectors at ground and raised met tower stations in the Crocker Wind Farm from April 14 – October 27, 2016.**

**Species Composition**

Low-frequency bats (e.g., big brown bats, hoary bats, and silver-haired bats; Table 2) were the most commonly recorded species (66.8%) among all stations (Table 3), suggesting that these species are relatively more abundant than HF species in the Project Area. High-frequency bats (e.g., tri-colored bats, eastern red bats, and *Myotis* species) composed 33.2% of bat passes recorded at met tower stations (Table 2, Table 3). Overall and LF bat activity peaked between August 9 and 15 whereas HF bat activity peaked slightly earlier from August 1 – 7 (Table 5, Figure 7).

Four individual bat species and the *Myotis* group were identified at each of the four detectors using the auto-classifier component of Kaleidoscope 3.1.7 (Table 6). The hoary bat was the most frequently recorded species overall, present on 31% of detector-nights, while the big brown bat was the least frequently recorded species overall, present on just 7% of operational detector-nights. *Myotis* group presence was highest at CK2g where this group was present on 24% of detector-nights.

**Table 6. The number (percent) of presence/absence dates for detector-nights with bat species present by station recorded by the SM3 full-spectrum detectors at the Crocker Wind Farm using Kaleidoscope 3.1.7**

| Common Name                         | CK1g    | CK1r    | CK2g    | CK2r    | Total    |
|-------------------------------------|---------|---------|---------|---------|----------|
| <b>High-Frequency (&gt; 30 kHz)</b> |         |         |         |         |          |
| eastern red bat                     | 14 (9)  | 26 (18) | 33 (28) | 30 (26) | 103 (19) |
| <i>Myotis</i> species               | 10 (7)  | 14 (9)  | 28 (24) | 15 (13) | 67 (13)  |
| <b>Low-Frequency (&lt; 30 kHz)</b>  |         |         |         |         |          |
| big brown bat                       | 7 (5)   | 14 (9)  | 11 (9)  | 6 (5)   | 38 (7)   |
| hoary bat                           | 24 (16) | 43 (29) | 48 (41) | 50 (43) | 165 (31) |
| silver-haired bat                   | 29 (20) | 42 (28) | 34 (29) | 31 (26) | 136 (26) |

## DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, ranging from 0 (Chatfield and Bay 2014) to 40.2 bat fatalities/megawatt (MW)/year (Hein et al. 2013a; Appendix A). In 2012, an estimated 600,000 bats died as a result of interactions with wind turbines in the U.S. (Hayes 2013). Proximate causes of bat fatalities are primarily due to collisions with moving turbine blades (Grodsky et al. 2011; Rollins et al. 2012) but to a limited extent may also be caused by barotrauma (Baerwald et al. 2008). The underlying reasons for why bats come near turbines are still largely unknown (Cryan and Barclay 2009). To date, post-construction monitoring studies of wind energy facilities show that a) migratory tree-roosting species (e.g., eastern red bat [*Lasiurus borealis*], hoary bat [*Lasiurus cinereus*], and silver-haired bat [*Lasionycteris noctivagans*]) compose approximately 78% of reported bat fatalities; b) the majority of fatalities occur during the fall migration season (August and September); and c) most fatalities occur on nights with relatively low wind speeds (e.g., < 6.0 m/s; Arnett et al. 2008; Arnett and Baerwald 2013; Arnett et al. 2013).

It is generally expected that pre-construction bat activity is positively related to post-construction bat fatalities (Kunz et al. 2007b). However, to date, relatively few publicly available studies documenting bat passes per detector-night at proposed wind energy facilities are available to compare to publicly available studies reporting bat fatality rates (Appendix A). Given the limited availability of pre- and post-construction data sets, differences in protocols among studies (Ellison 2012), and significant ecological differences between geographically diverse facilities, the relationship between activity and fatalities has not yet been empirically established. Hein et al. (2013a), though Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m and fatality rates for hoary and silver-haired bats across five sites in southern Alberta.

However, on a continental scale, a similar relationship has proven difficult to establish. The relatively few studies that have estimated both pre-construction activity and post-construction fatalities trend toward a positive association between activity and fatality rates, but they lack statistically significant correlations. Hein et al. (2013a) compiled data from wind projects that included both pre- and post-construction data from the same projects, as well as pre- and post-construction data from facilities within the same regions to assess if pre-construction acoustic

activity predicted post-construction fatality rates. Based on data from 12 sites that had both pre- and post-construction data, they did not find a statistically significant relationship ( $p=0.07$ ), although the trend was in the expected direction (i.e., low activity was generally associated with low fatalities and vice-versa). They concluded therefore, that pre-construction acoustic data could not currently predict bat fatalities, but acknowledged that the data set was limited and additional data may indicate a stronger relationship. Therefore, the current approach to assessing the risk to bats requires a qualitative analysis of activity levels, spatial and temporal relationships, species composition, and comparison to regional fatality patterns.

Mean bat activity during the FMP at ground met tower station SM3 detectors ( $2.80 \pm 0.42$  bat passes per detector-night; Table 4) was lower than rates established at other upper Midwest wind projects using AnaBat units (which generally record fewer bat passes). Anabat-derived bat activity rate estimates include the national median (7.68) and the majority of studies available from the Midwest (6.97) and Rocky Mountains (2.2; Appendix A). Although it is expected that bat activity data collected using SM3 detectors is not directly comparable with activity data from the studies in Appendix A, all of which used AnaBat detectors, it is assumed that SM3 detectors would detect more bat calls due to a greater detection distance and the fact that noise from insects or other sources does not inhibit detection of bats for full-spectrum detectors (Adams et al. 2012). Therefore, the activity data collected by SM3 detectors in this study provides a conservative risk assessment, and the fact that even with the SM3 units the bat passes were low indicates a relatively low use site.

Overall bat activity was highest within the Project during the fall peaking in early to mid-August. This timing is close to peak fatality periods for most wind energy facilities in the U.S. (Arnett et al. 2008), and suggests that bat fatalities at the Project will be highest during the fall and may consist largely of migrating individuals.

Activity by LF bat species composed nearly 67% of bat passes recorded in the Project. Hoary and silver-haired bats are usually the most common LF species found during carcass searches (Arnett et al. 2008; Arnett and Baerwald 2013). Activity by HF bats composed approximately 33% of bat passes recorded at all stations, suggesting lower relative abundance of species such as eastern red bats and *Myotis* species. *Myotis* are recorded less commonly than other species as fatalities at most post-construction studies of wind energy facilities (Kunz et al. 2007b; Arnett et al. 2008), with a few notable exceptions (Kerns and Kerlinger 2004; Jain 2005; Brown and Hamilton 2006a; Gruver et al. 2009a). Given that hoary bats, eastern red bats, and silver-haired bats are among the most common bat fatalities at many facilities (Arnett et al. 2008; Arnett and Baerwald 2013), it is expected that these three species would be the most common fatalities at the Project.

The closest operating wind-energy facility to the Project with public post-construction fatality data is the Buffalo Ridge II Wind Facility, located approximately 60 miles from the Project in Brookings County, South Dakota. At Buffalo Ridge II the pre-construction bat activity rate was a relatively low rate of 1.75 bats/detector-night (Derby et al. 2008) and the casualty rate was also relatively low at 2.81 bats/MW/study period (Derby et al. 2012a). Due to the similar low rates of

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pre-construction bat activity, it is possible that Crocker will have similarly low fatality rates, although the habitat at Buffalo Ridge II (primarily corn and soybeans, with limited water features and limited wooded habitat) is somewhat different than Crocker (primarily grassland, with more prevalence of wetlands and open water, also with limited wooded habitat). The pre-construction bat studies completed at the Project will add to the growing body of research regarding the impacts of wind energy development on bats and will provide a valuable comparison to post-construction studies to be completed at Project.

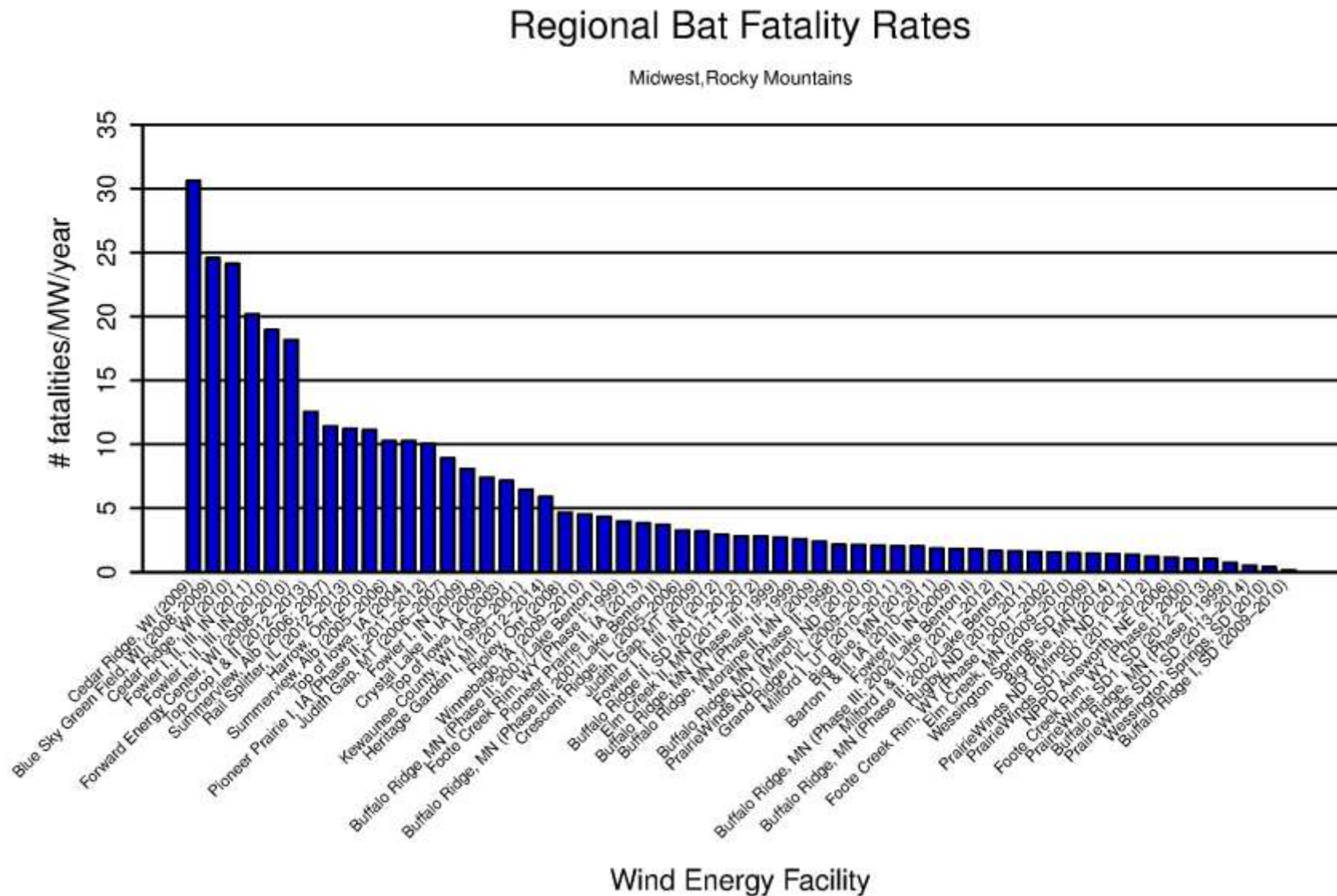


Figure 9. Fatality rates for bats (number of bats per MW per year) from publicly-available wind energy facilities in the Midwest and Rocky Mountains regions of North America.

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**Figure 9. (continued) Fatality rates for bats (number of bats per MW per year) from publicly-available wind energy facilities in the Midwest and Rocky Mountains regions of North America.**

| <b>Data from the following sources</b>           |                                 |                                                  |                        |
|--------------------------------------------------|---------------------------------|--------------------------------------------------|------------------------|
| <b>Project, Location</b>                         | <b>Reference</b>                | <b>Project, Location</b>                         | <b>Reference</b>       |
| Cedar Ridge, WI (09)                             | BHE Environmental 2010          | Elm Creek II, MN (11-12)                         | Derby et al. 2012b     |
| Blue Sky Green Field, WI (08; 09)                | Gruver et al. 2009b             | Buffalo Ridge, MN (Phase III; 99)                | Johnson et al. 2000    |
| Cedar Ridge, WI (10)                             | BHE Environmental 2011          | Buffalo Ridge, MN (Phase II; 99)                 | Johnson et al. 2000    |
| Fowler I, II, III, IN (11)                       | Good et al. 2012                | Moraine II, MN (09)                              | Derby et al. 2010d     |
| Fowler I, II, III, IN (10)                       | Good et al. 2011                | Buffalo Ridge, MN (Phase II; 98)                 | Johnson et al. 2000    |
| Forward Energy Center, WI (08-10)                | Grodsky and Drake 2011          | PrairieWinds ND1 (Minot), ND (10)                | Derby et al. 2011c     |
| Top Crop I & II, IL (12-13)                      | Good et al. 2013a               | Grand Ridge I, IL (09-10)                        | Derby et al. 2010g     |
| Summerview, Alb (06; 07)                         | Baerwald 2008                   | Milford I, UT (10-11)                            | Stantec 2011b          |
| Rail Splitter, IL (12-13)                        | Good et al. 2013b               | Big Blue, MN (14)                                | Fagen Engineering 2015 |
| Harrow, Ont (10)                                 | Natural Resource Solutions 2011 | Barton I & II, IA (10-11)                        | Derby et al. 2011a     |
| Summerview, Alb (05-06)                          | Brown and Hamilton 2006b        | Fowler III, IN (09)                              | Johnson et al. 2010b   |
| Top of Iowa, IA (04)                             | Jain 2005                       | Buffalo Ridge, MN (Phase III; 02/Lake Benton II) | Johnson et al. 2004    |
| Pioneer Prairie I, IA (Phase II; 11-12)          | Chodachek et al. 2012           | Milford I & II, UT (11-12)                       | Stantec 2012b          |
| Judith Gap, MT (06-07)                           | TRC 2008                        | Buffalo Ridge, MN (Phase II; 02/Lake Benton I)   | Johnson et al. 2004    |
| Fowler I, IN (09)                                | Johnson et al. 2010a            | Rugby, ND (10-11)                                | Derby et al. 2011b     |
| Crystal Lake II, IA (09)                         | Derby et al. 2010a              | Foot Creek Rim, WY (Phase I; 01-02)              | Young et al. 2003a     |
| Top of Iowa, IA (03)                             | Jain 2005                       | Elm Creek, MN (09-10)                            | Derby et al. 2010c     |
| Kewaunee County, WI (99-01)                      | Howe et al. 2002                | Wessington Springs, SD (09)                      | Derby et al. 2010f     |
| Heritage Garden I, MI (12-14)                    | Kerlinger et al. 2014           | Big Blue, MN (13)                                | Fagen Engineering 2014 |
| Ripley, Ont (08)                                 | Jacques Whitford 2009           | PrairieWinds ND1 (Minot), ND (11)                | Derby et al. 2012c     |
| Winnebago, IA (09-10)                            | Derby et al. 2010e              | PrairieWinds SD1 (Crow Lake), SD (11-12)         | Derby et al. 2012d     |
| Buffalo Ridge, MN (Phase II; 01/Lake Benton I)   | Johnson et al. 2004             | NPPD Ainsworth, NE (06)                          | Derby et al. 2007      |
| Foot Creek Rim, WY (Phase I; 99)                 | Young et al. 2003a              | Foot Creek Rim, WY (Phase I; 00)                 | Young et al. 2003a     |
| Pioneer Prairie II, IA (13)                      | Chodachek et al. 2014           | PrairieWinds SD1 (Crow Lake), SD (12-13)         | Derby et al. 2013a     |
| Buffalo Ridge, MN (Phase III; 01/Lake Benton II) | Johnson et al. 2004             | Buffalo Ridge, MN (Phase I; 99)                  | Johnson et al. 2000    |
| Crescent Ridge, IL (05-06)                       | Kerlinger et al. 2007           | PrairieWinds SD1 (Crow Lake), SD (13-14)         | Derby et al. 2014      |
| Judith Gap, MT (09)                              | Poulton and Erickson 2010       | Wessington Springs, SD (10)                      | Derby et al. 2011d     |
| Fowler I, II, III, IN (12)                       | Good et al. 2013c               | Buffalo Ridge I, SD (09-10)                      | Derby et al. 2010b     |
| Buffalo Ridge II, SD (11-12)                     | Derby et al. 2012a              |                                                  |                        |

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## **Appendix A: North American Fatality Summary Tables**

**Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.**

| <b>Wind Energy Facility</b>                        | <b>Bat Activity Estimate</b> | <b>Bat Activity Dates</b>   | <b>Fatality Estimate</b> | <b>No. of Turbines</b> | <b>Total MW</b> |
|----------------------------------------------------|------------------------------|-----------------------------|--------------------------|------------------------|-----------------|
| <b>Crocker, SD</b>                                 | <b>2.80 ± 0.42</b>           |                             |                          |                        |                 |
| <b>Rocky Mountains</b>                             |                              |                             |                          |                        |                 |
| Foot Creek Rim, WY (Phase I; 1999)                 | NA                           | NA                          | 3.97                     | 69                     | 41.4            |
| Foot Creek Rim, WY (Phase I; 2000)                 | 2.2 <sup>A</sup>             | 6/15/00-9/1/00              | 1.05                     | 69                     | 41.4            |
| Foot Creek Rim, WY (Phase I; 2001-2002)            | 2.2 <sup>A</sup>             | 6/15/01-9/1/01              | 1.57                     | 69                     | 41.4            |
| Judith Gap, MT (2006-2007)                         | NA                           | NA                          | 8.93                     | 90                     | 135             |
| Judith Gap, MT (2009)                              | NA                           | NA                          | 3.2                      | 90                     | 135             |
|                                                    |                              |                             |                          |                        | 160.5<br>(58.5  |
|                                                    | NA                           | NA                          | 1.67                     | 107                    | phase I;<br>102 |
| Milford I & II, UT (2011-2012)                     |                              |                             |                          |                        | phase II)       |
| Milford I, UT (2010-2011)                          | NA                           | NA                          | 2.05                     | 58                     | 145             |
| Summerview, Alb (2005-2006)                        | NA                           | NA                          | 10.27                    | 39                     | 70.2            |
| Summerview, Alb (2006; 2007)                       | 7.65 <sup>A</sup>            | 07/15/06-07-<br>09/30/06-07 | 11.42                    | 39                     | 70.2            |
| <b>Midwest</b>                                     |                              |                             |                          |                        |                 |
| Barton I & II, IA (2010-2011)                      | NA                           | NA                          | 1.85                     | 80                     | 160             |
| Big Blue, MN (2013)                                | NA                           | NA                          | 2.04                     | 18                     | 36              |
| Big Blue, MN (2014)                                | NA                           | NA                          | 1.43                     | 18                     | 36              |
| Blue Sky Green Field, WI (2008; 2009)              | 7.7 <sup>B</sup>             | 7/24/07-<br>10/29/07        | 24.57                    | 88                     | 145             |
| Buffalo Ridge I, SD (2009-2010)                    | NA                           | NA                          | 0.16                     | 24                     | 50.4            |
| Buffalo Ridge II, SD (2011-2012)                   | 1.75                         | 7/1/08-10/14/08             | 2.81                     | 105                    | 210             |
| Buffalo Ridge, MN (Phase I; 1999)                  | NA                           | NA                          | 0.74                     | 73                     | 25              |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)   | 1.9                          | 6/15/02-9/15/02             | 1.64                     | 143                    | 107.25          |
| Buffalo Ridge, MN (Phase II; 1998)                 | NA                           | NA                          | 2.16                     | 143                    | 107.25          |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)   | 2.2 <sup>A</sup>             | 6/15/01-9/15/01             | 4.35                     | 143                    | 107.25          |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)   | 1.9 <sup>A</sup>             | 6/15/02-9/15/02             | 1.64                     | 143                    | 107.25          |
| Buffalo Ridge, MN (Phase III; 1999)                | NA                           | NA                          | 2.72                     | 138                    | 103.5           |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | 2.2 <sup>A</sup>             | 6/15/01-9/15/01             | 3.71                     | 138                    | 103.5           |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | 1.9 <sup>A</sup>             | 6/15/02-9/15/02             | 1.81                     | 138                    | 103.5           |
| Cedar Ridge, WI (2009)                             | 9.97 <sup>A,B,C,D</sup>      | 7/16/07-9/30/07             | 30.61                    | 41                     | 67.6            |
| Cedar Ridge, WI (2010)                             | 9.97 <sup>A,B,C,D</sup>      | 7/16/07-9/30/07             | 24.12                    | 41                     | 68              |
| Crescent Ridge, IL (2005-2006)                     | NA                           | NA                          | 3.27                     | 33                     | 49.5            |
| Crystal Lake II, IA (2009)                         | NA                           | NA                          | 7.42                     | 80                     | 200             |
| Elm Creek II, MN (2011-2012)                       | NA                           | NA                          | 2.81                     | 62                     | 148.8           |
| Elm Creek, MN (2009-2010)                          | NA                           | NA                          | 1.49                     | 67                     | 100             |
| Forward Energy Center, WI (2008-2010)              | 6.97                         | 8/5/08-11/08/08             | 18.17                    | 86                     | 129             |

**Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.**

| <b>Wind Energy Facility</b>                 | <b>Bat Activity Estimate</b> | <b>Bat Activity Dates</b> | <b>Fatality Estimate</b> | <b>No. of Turbines</b>      | <b>Total MW</b>                 |
|---------------------------------------------|------------------------------|---------------------------|--------------------------|-----------------------------|---------------------------------|
| Fowler I, II, III, IN (2010)                | NA                           | NA                        | 18.96                    | 355                         | 600                             |
| Fowler I, II, III, IN (2011)                | NA                           | NA                        | 20.19                    | 355                         | 600                             |
| Fowler I, II, III, IN (2012)                | NA                           | NA                        | 2.96                     | 355                         | 600                             |
| Fowler I, IN (2009)                         | NA                           | NA                        | 8.09                     | 162                         | 301                             |
| Fowler III, IN (2009)                       | NA                           | NA                        | 1.84                     | 60                          | 99                              |
| Grand Ridge I, IL (2009-2010)               | NA                           | NA                        | 2.1                      | 66                          | 99                              |
|                                             | NA                           | NA                        | 11.13                    | 24 (four 6-turb facilities) | 39.6                            |
| Harrow, Ont (2010)                          |                              |                           |                          |                             |                                 |
| Heritage Garden I, MI (2012-2014)           | NA                           | NA                        | 5.9                      | 14                          | 28                              |
| Kewaunee County, WI (1999-2001)             | NA                           | NA                        | 6.45                     | 31                          | 20.46                           |
| Moraine II, MN (2009)                       | NA                           | NA                        | 2.42                     | 33                          | 49.5                            |
| NPPD Ainsworth, NE (2006)                   | NA                           | NA                        | 1.16                     | 36                          | 20.5                            |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | NA                           | NA                        | 10.06                    | 62                          | 102.3                           |
| Pioneer Prairie II, IA (2013)               | NA                           | NA                        | 3.83                     | 62                          | 102.3                           |
| PrairieWinds ND1 (Minot), ND (2010)         | NA                           | NA                        | 2.13                     | 80                          | 115.5                           |
| PrairieWinds ND1 (Minot), ND (2011)         | NA                           | NA                        | 1.39                     | 80                          | 115.5                           |
| PrairieWinds SD1, SD (2011-2012)            | NA                           | NA                        | 1.23                     | 108                         | 162                             |
| PrairieWinds SD1, SD (2012-2013)            | NA                           | NA                        | 1.05                     | 108                         | 162                             |
| PrairieWinds SD1, SD (2013-2014)            | NA                           | NA                        | 0.52                     | 108                         | 162                             |
| Rail Splitter, IL (2012-2013)               | NA                           | NA                        | 11.21                    | 67                          | 100.5                           |
| Ripley, Ont (2008)                          | NA                           | NA                        | 4.67                     | 38                          | 76                              |
| Rugby, ND (2010-2011)                       | NA                           | NA                        | 1.6                      | 71                          | 149                             |
|                                             | NA                           | NA                        | 12.55                    | 68 (phase I; 132 phase II)  | 300 (102 phase I; 198 phase II) |
| Top Crop I & II (2012-2013)                 |                              |                           |                          |                             |                                 |
| Top of Iowa, IA (2003)                      | NA                           | NA                        | 7.16                     | 89                          | 80                              |
| Top of Iowa, IA (2004)                      | 35.7                         | 5/26/04-9/24/04           | 10.27                    | 89                          | 80                              |
| Wessington Springs, SD (2009)               | NA                           | NA                        | 1.48                     | 34                          | 51                              |
| Wessington Springs, SD (2010)               | NA                           | NA                        | 0.41                     | 34                          | 51                              |
| Winnebago, IA (2009-2010)                   | NA                           | NA                        | 4.54                     | 10                          | 20                              |
| <b>California</b>                           |                              |                           |                          |                             |                                 |
| Alite, CA (2009-2010)                       | NA                           | NA                        | 0.24                     | 8                           | 24                              |
| Alta VIII, CA (2012-2013)                   | NA                           | NA                        | 0                        | 50                          | 150                             |
| Alta Wind I, CA (2011-2012)                 | 4.42 <sup>E</sup>            | 6/26/2009 - 10/31/2009    | 1.28                     | 100                         | 150                             |
| Alta Wind II-V, CA (2011-2012)              | 0.78                         | 6/26/2009 - 10/31/2009    | 0.08                     | 190                         | 570                             |
|                                             | NA                           | NA                        | 0.2                      | 290                         | 720 (150 GE, 570 vestas)        |
| Alta Wind I-V, CA (2013-2014)               |                              |                           |                          |                             |                                 |
| Diablo Winds, CA (2005-2007)                | NA                           | NA                        | 0.82                     | 31                          | 20.46                           |
| Dillon, CA (2008-2009)                      | NA                           | NA                        | 2.17                     | 45                          | 45                              |
| High Winds, CA (2003-2004)                  | NA                           | NA                        | 2.51                     | 90                          | 162                             |

**Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.**

| <b>Wind Energy Facility</b>         | <b>Bat Activity Estimate</b> | <b>Bat Activity Dates</b> | <b>Fatality Estimate</b> | <b>No. of Turbines</b> | <b>Total MW</b> |
|-------------------------------------|------------------------------|---------------------------|--------------------------|------------------------|-----------------|
| High Winds, CA (2004-2005)          | NA                           | NA                        | 1.52                     | 90                     | 162             |
| Montezuma I, CA (2011)              | NA                           | NA                        | 1.9                      | 16                     | 36.8            |
| Montezuma I, CA (2012)              | NA                           | NA                        | 0.84                     | 16                     | 36.8            |
| Montezuma II, CA (2012-2013)        | NA                           | NA                        | 0.91                     | 34                     | 78.2            |
| Mustang Hills, CA (2012-2013)       | NA                           | NA                        | 0.1                      | 50                     | 150             |
| Pinyon Pines I & II, CA (2013-2014) | NA                           | NA                        | 0.04                     | 100                    | NA              |
| Shiloh I, CA (2006-2009)            | NA                           | NA                        | 3.92                     | 100                    | 150             |
| Shiloh II, CA (2009-2010)           | NA                           | NA                        | 2.6                      | 75                     | 150             |
| Shiloh II, CA (2010-2011)           | NA                           | NA                        | 3.8                      | 75                     | 150             |
| Shiloh III, CA (2012-2013)          | NA                           | NA                        | 0.4                      | 50                     | 102.5           |
| Solano III, CA (2012-2013)          | NA                           | NA                        | 0.31                     | 55                     | 128             |
| <b>Northeastern</b>                 |                              |                           |                          |                        |                 |
| Beech Ridge, WV (2012)              | NA                           | NA                        | 2.03                     | 67                     | 100.5           |
| Beech Ridge, WV (2013)              | NA                           | NA                        | 0.58                     | 67                     | 100.5           |
| Casselman Curtailment, PA (2008)    | NA                           | NA                        | 4.4                      | 23                     | 35.4            |
| Casselman, PA (2008)                | NA                           | NA                        | 12.61                    | 23                     | 34.5            |
| Casselman, PA (2009)                | NA                           | NA                        | 8.6                      | 23                     | 34.5            |
| Cohocton/Dutch Hill, NY (2009)      | NA                           | NA                        | 8.62                     | 50                     | 125             |
| Cohocton/Dutch Hills, NY (2010)     | NA                           | NA                        | 10.32                    | 50                     | 125             |
| Criterion, MD (2011)                | NA                           | NA                        | 15.61                    | 28                     | 70              |
| Criterion, MD (2012)                | NA                           | NA                        | 7.62                     | 28                     | 70              |
| Criterion, MD (2013)                | NA                           | NA                        | 5.32                     | 28                     | 70              |
| High Sheldon, NY (2010)             | NA                           | NA                        | 2.33                     | 75                     | 112.5           |
| High Sheldon, NY (2011)             | NA                           | NA                        | 1.78                     | 75                     | 112.5           |
| Kibby, ME (2011)                    | NA                           | NA                        | 0.12                     | 44                     | 132             |
| Lempster, NH (2009)                 | NA                           | NA                        | 3.11                     | 12                     | 24              |
| Lempster, NH (2010)                 | NA                           | NA                        | 3.57                     | 12                     | 24              |
| Locust Ridge, PA (Phase II; 2009)   | NA                           | NA                        | 14.11                    | 51                     | 102             |
| Locust Ridge, PA (Phase II; 2010)   | NA                           | NA                        | 14.38                    | 51                     | 102             |
| Maple Ridge, NY (2006)              | NA                           | NA                        | 11.21                    | 120                    | 198             |
| Maple Ridge, NY (2007)              | NA                           | NA                        | 6.49                     | 195                    | 321.75          |
| Maple Ridge, NY (2007-2008)         | NA                           | NA                        | 4.96                     | 195                    | 321.75          |
| Maple Ridge, NY (2012)              | NA                           | NA                        | 7.3                      | 195                    | 321.75          |
| Mars Hill, ME (2007)                | NA                           | NA                        | 2.91                     | 28                     | 42              |
| Mars Hill, ME (2008)                | NA                           | NA                        | 0.45                     | 28                     | 42              |
| Mount Storm, WV (2009)              | 30.09                        | 7/15/09-10/7/09           | 17.53                    | 132                    | 264             |
| Mount Storm, WV (2010)              | 36.67 <sup>c</sup>           | 4/18/10-10/15/10          | 15.18                    | 132                    | 264             |
| Mount Storm, WV (2011)              | NA                           | NA                        | 7.43                     | 132                    | 264             |
| Mount Storm, WV (Fall 2008)         | 35.2                         | 7/20/08-10/12/08          | 6.62                     | 82                     | 164             |
| Mountaineer, WV (2003)              | NA                           | NA                        | 31.69                    | 44                     | 66              |
| Munnsville, NY (2008)               | NA                           | NA                        | 1.93                     | 23                     | 34.5            |
| Noble Altona, NY (2010)             | NA                           | NA                        | 4.34                     | 65                     | 97.5            |
| Noble Bliss, NY (2008)              | NA                           | NA                        | 7.8                      | 67                     | 100             |

**Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.**

| <b>Wind Energy Facility</b>              | <b>Bat Activity Estimate</b> | <b>Bat Activity Dates</b> | <b>Fatality Estimate</b> | <b>No. of Turbines</b> | <b>Total MW</b> |
|------------------------------------------|------------------------------|---------------------------|--------------------------|------------------------|-----------------|
| Noble Bliss, NY (2009)                   | NA                           | NA                        | 3.85                     | 67                     | 100             |
| Noble Clinton, NY (2009)                 | 1.9                          | 8/1/09-09/31/09           | 4.5                      | 67                     | 100             |
| Noble Chateaugay, NY (2010)              | NA                           | NA                        | 2.44                     | 71                     | 106.5           |
| Noble Clinton, NY (2008)                 | 2.1 <sup>D</sup>             | 8/8/08-09/31/08           | 3.14                     | 67                     | 100             |
| Noble Clinton, NY (2009)                 | 1.9 <sup>D</sup>             | 1/9/09-09/31/09           | 4.5                      | 67                     | 100             |
| Noble Ellenburg, NY (2008)               | NA                           | NA                        | 3.46                     | 54                     | 80              |
| Noble Ellenburg, NY (2009)               | 16.1 <sup>D</sup>            | 8/16/09-09/15/09          | 3.91                     | 54                     | 80              |
| Noble Wethersfield, NY (2010)            | NA                           | NA                        | 16.3                     | 84                     | 126             |
| Pinnacle, WV (2012)                      | NA                           | NA                        | 40.2                     | 23                     | 55.2            |
| Record Hill, ME (2012)                   | 24.6                         | 4/16/12-10/23/12          | 2.96                     | 22                     | 50.6            |
| Record Hill, ME (2014)                   | NA                           | NA                        | 0.55                     | 22                     | 50.6            |
| Rollins, ME (2012)                       | NA                           | NA                        | 0.18                     | 40                     | 60              |
| Stetson Mountain I, ME (2009)            | 28.5; 0.3 <sup>F</sup>       | 7/10/09-10/15/09          | 1.4                      | 38                     | 57              |
| Stetson Mountain I, ME (2011)            | NA                           | NA                        | 0.28                     | 38                     | 57              |
| Stetson Mountain I, ME (2013)            | NA                           | NA                        | 0.18                     | 38                     | 57              |
| Stetson Mountain II, ME (2010)           | NA                           | NA                        | 1.65                     | 17                     | 25.5            |
| Stetson Mountain II, ME (2012)           | NA                           | NA                        | 2.27                     | 17                     | 25.5            |
| Wolfe Island, Ont (July-December 2009)   | NA                           | NA                        | 6.42                     | 86                     | 197.8           |
| Wolfe Island, Ont (July-December 2010)   | NA                           | NA                        | 9.5                      | 86                     | 197.8           |
| Wolfe Island, Ont (July-December 2011)   | NA                           | NA                        | 2.49                     | 86                     | 197.8           |
| <b><i>Pacific Northwest</i></b>          |                              |                           |                          |                        |                 |
| Big Horn, WA (2006-2007)                 | NA                           | NA                        | 1.9                      | 133                    | 199.5           |
| Biglow Canyon, OR (Phase I; 2008)        | NA                           | NA                        | 1.99                     | 76                     | 125.4           |
| Biglow Canyon, OR (Phase I; 2009)        | NA                           | NA                        | 0.58                     | 76                     | 125.4           |
| Biglow Canyon, OR (Phase II; 2009-2010)  | NA                           | NA                        | 2.71                     | 65                     | 150             |
| Biglow Canyon, OR (Phase II; 2010-2011)  | NA                           | NA                        | 0.57                     | 65                     | 150             |
| Biglow Canyon, OR (Phase III; 2010-2011) | NA                           | NA                        | 0.22                     | 76                     | 174.8           |
| Combine Hills, OR (2011)                 | NA                           | NA                        | 0.73                     | 104                    | 104             |
| Combine Hills, OR (Phase I; 2004-2005)   | NA                           | NA                        | 1.88                     | 41                     | 41              |
| Elkhorn, OR (2008)                       | NA                           | NA                        | 1.26                     | 61                     | 101             |
| Elkhorn, OR (2010)                       | NA                           | NA                        | 2.14                     | 61                     | 101             |
| Goodnoe, WA (2009-2010)                  | NA                           | NA                        | 0.34                     | 47                     | 94              |
| Harvest Wind, WA (2010-2012)             | NA                           | NA                        | 1.27                     | 43                     | 98.9            |
| Hay Canyon, OR (2009-2010)               | NA                           | NA                        | 0.53                     | 48                     | 100.8           |
| Hopkins Ridge, WA (2006)                 | NA                           | NA                        | 0.63                     | 83                     | 150             |
| Hopkins Ridge, WA (2008)                 | NA                           | NA                        | 1.39                     | 87                     | 156.6           |
| Kittitas Valley, WA (2011-2012)          | NA                           | NA                        | 0.12                     | 48                     | 100.8           |
| Klondike II, OR (2005-2006)              | NA                           | NA                        | 0.41                     | 50                     | 75              |
| Klondike III (Phase I), OR (2007-2009)   | NA                           | NA                        | 1.11                     | 125                    | 223.6           |
| Klondike IIIa (Phase II), OR (2008-2010) | NA                           | NA                        | 0.14                     | 51                     | 76.5            |
| Klondike, OR (2002-2003)                 | NA                           | NA                        | 0.77                     | 16                     | 24              |

**Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region.**

| <b>Wind Energy Facility</b>              | <b>Bat Activity Estimate</b> | <b>Bat Activity Dates</b> | <b>Fatality Estimate</b> | <b>No. of Turbines</b> | <b>Total MW</b> |
|------------------------------------------|------------------------------|---------------------------|--------------------------|------------------------|-----------------|
| Leaning Juniper, OR (2006-2008)          | NA                           | NA                        | 1.98                     | 67                     | 100.5           |
| Linden Ranch, WA (2010-2011)             | NA                           | NA                        | 1.68                     | 25                     | 50              |
| Marengo I, WA (2009-2010)                | NA                           | NA                        | 0.17                     | 78                     | 140.4           |
| Marengo II, WA (2009-2010)               | NA                           | NA                        | 0.27                     | 39                     | 70.2            |
| Nine Canyon, WA (2002-2003)              | NA                           | NA                        | 2.47                     | 37                     | 48.1            |
| Pebble Springs, OR (2009-2010)           | NA                           | NA                        | 1.55                     | 47                     | 98.7            |
| Stateline, OR/WA (2001-2002)             | NA                           | NA                        | 1.09                     | 454                    | 299             |
| Stateline, OR/WA (2003)                  | NA                           | NA                        | 2.29                     | 454                    | 299             |
| Stateline, OR/WA (2006)                  | NA                           | NA                        | 0.95                     | 454                    | 299             |
| Tuolumne (Windy Point I), WA (2009-2010) | NA                           | NA                        | 0.94                     | 62                     | 136.6           |
| Vansycle, OR (1999)                      | NA                           | NA                        | 1.12                     | 38                     | 24.9            |
| Vantage, WA (2010-2011)                  | NA                           | NA                        | 0.4                      | 60                     | 90              |
| White Creek, WA (2007-2011)              | NA                           | NA                        | 2.04                     | 89                     | 204.7           |
| Wild Horse, WA (2007)                    | NA                           | NA                        | 0.39                     | 127                    | 229             |
| Windy Flats, WA (2010-2011)              | NA                           | NA                        | 0.41                     | 114                    | 262.2           |
| <b>Southeastern</b>                      |                              |                           |                          |                        |                 |
| Buffalo Mountain, TN (2000-2003)         | 23.7 <sup>G</sup>            | NA                        | 31.54                    | 3                      | 1.98            |
| Buffalo Mountain, TN (2005)              | NA                           | NA                        | 39.7                     | 18                     | 28.98           |
| <b>Southern Plains</b>                   |                              |                           |                          |                        |                 |
| Barton Chapel, TX (2009-2010)            | NA                           | NA                        | 3.06                     | 60                     | 120             |
| Big Smile, OK (2012-2013)                | NA                           | NA                        | 2.9                      | 66                     | 132             |
| Buffalo Gap I, TX (2006)                 | NA                           | NA                        | 0.1                      | 67                     | 134             |
| Buffalo Gap II, TX (2007-2008)           | NA                           | NA                        | 0.14                     | 155                    | 233             |
| Red Hills, OK (2012-2013)                | NA                           | NA                        | 0.11                     | 82                     | 123             |
| <b>Southwest</b>                         |                              |                           |                          |                        |                 |
| Dry Lake I, AZ (2009-2010)               | 8.8                          | 4/29/10-11/10/10          | 3.43                     | 30                     | 63              |
| Dry Lake II, AZ (2011-2012)              | 11.5                         | 5/11/11-10/26/11          | 1.66                     | 31                     | 65              |

A = Activity rate was averaged across phases and/or years

B = Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently

C = Activity rate based on data collected from ground-based units excluding reference stations during the spring, summer, and fall seasons

D = Activity rate based on data collected at various heights; all other activity rates are from ground-based units only

E = Average of ground-based detectors at CPC Proper (Phase I) for late summer/fall period only

F= The overall activity rate of 28.5 is from reference stations located along forest edges which may be attractive to bats; the activity rate of 0.3 is from one unit placed on a nacelle

G = Activity rate calculated by WEST from data presented in referenced report

**Appendix A1 (continued). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:**

| Facility                                         | Activity Estimate      | Fatality Estimate      | Facility                                 | Activity Estimate         | Fatality Estimate         |
|--------------------------------------------------|------------------------|------------------------|------------------------------------------|---------------------------|---------------------------|
| Crocker, SD                                      |                        | This study.            |                                          |                           |                           |
| Alite, CA (09-10)                                |                        | Chatfield et al. 2010  | Lempster, NH (09)                        |                           | Tidhar et al. 2010        |
| Alta Wind I, CA (11-12)                          | Solick et al. 2010     | Chatfield et al. 2012  | Lempster, NH (10)                        |                           | Tidhar et al. 2011        |
| Alta Wind I-V, CA (13-14)                        |                        | Chatfield et al. 2014  | Linden Ranch, WA (10-11)                 |                           | Enz and Bay 2011          |
| Alta Wind II-V, CA (11-12)                       | Solick et al. 2010     | Chatfield et al. 2012  | Locust Ridge, PA (Phase II; 09)          |                           | Arnett et al.             |
| Alta VIII, CA (12-13)                            |                        | Chatfield and Bay 2014 | Locust Ridge, PA (Phase II; 10)          |                           | Arnett et al.             |
| Barton I & II, IA (10-11)                        |                        | Derby et al. 2011a     | Maple Ridge, NY (06)                     |                           | Jain et al. 2007          |
| Barton Chapel, TX (09-10)                        |                        | WEST 2011              | Maple Ridge, NY (07)                     |                           | Jain et al. 2009a         |
| Beech Ridge, WV (12)                             |                        | Tidhar et al. 2013b    | Maple Ridge, NY (07-08)                  |                           | Jain et al. 2009d         |
| Beech Ridge, WV (13)                             |                        | Young et al. 2014b     | Maple Ridge, NY (12)                     |                           | Tidhar et al. 2013a       |
| Big Blue, MN (13)                                |                        | Fagen Engineering 2014 | Marengo I, WA (09-10)                    |                           | URS Corporation 2010b     |
| Big Blue, MN (14)                                |                        | Fagen Engineering 2015 | Marengo II, WA (09-10)                   |                           | URS Corporation 2010c     |
| Big Horn, WA (06-07)                             |                        | Kronner et al. 2008    | Mars Hill, ME (07)                       |                           | Stantec 2008a             |
| Big Smile, OK (12-13)                            |                        | Derby et al. 2013b     | Mars Hill, ME (08)                       |                           | Stantec 2009a             |
| Biglow Canyon, OR (Phase I; 08)                  |                        | Jeffrey et al. 2009a   | Milford I, UT (10-11)                    |                           | Stantec 2011b             |
| Biglow Canyon, OR (Phase I; 09)                  |                        | Enk et al. 2010        | Milford I & II, UT (11-12)               |                           | Stantec 2012b             |
| Biglow Canyon, OR (Phase II; 09-10)              |                        | Enk et al. 2011a       | Montezuma I, CA (11)                     |                           | ICF International 2012    |
| Biglow Canyon, OR (Phase II; 10-11)              |                        | Enk et al. 2012b       | Montezuma I, CA (12)                     |                           | ICF International 2013    |
| Biglow Canyon, OR (Phase III; 10-11)             |                        | Enk et al. 2012a       | Montezuma II, CA (12-13)                 |                           | Harvey & Associates 2013  |
| Blue Sky Green Field, WI (08; 09)                | Gruver 2008            | Gruver et al. 2009b    | Moraine II, MN (09)                      |                           | Derby et al. 2010d        |
| Buffalo Gap I, TX (06)                           |                        | Tierney 2007           | Mount Storm, WV (Fall 08)                | Young et al. 2009b        | Young et al. 2009b        |
| Buffalo Gap II, TX (07-08)                       |                        | Tierney 2009           | Mount Storm, WV (09)                     | Young et al. 2009a, 2010b | Young et al. 2009a, 2010b |
| Buffalo Mountain, TN (00-03)                     | Fiedler 2004           | Nicholson et al. 2005  | Mount Storm, WV (10)                     | Young et al. 2010a, 2011b | Young et al. 2010a, 2011b |
| Buffalo Mountain, TN (05)                        |                        | Fiedler et al. 2007    | Mount Storm, WV (11)                     |                           | Young et al. 2011a, 2012b |
| Buffalo Ridge, MN (Phase I; 99)                  |                        | Johnson et al. 2000    | Mountaineer, WV (03)                     |                           | Kerns and Kerlinger 2004  |
| Buffalo Ridge, MN (Phase II; 98)                 |                        | Johnson et al. 2000    | Munnsville, NY (08)                      |                           | Stantec 2009b             |
| Buffalo Ridge, MN (Phase II; 99)                 |                        | Johnson et al. 2000    | Mustang Hills, CA (12-13)                |                           | Chatfield and Bay 2014    |
| Buffalo Ridge, MN (Phase II; 01/Lake Benton I)   | Johnson et al. 2004    | Johnson et al. 2004    | Nine Canyon, WA (02-03)                  |                           | Erickson et al. 2003      |
| Buffalo Ridge, MN (Phase II; 02/Lake Benton I)   | Johnson et al. 2004    | Johnson et al. 2004    | Noble Altona, NY (10)                    |                           | Jain et al. 2011b         |
| Buffalo Ridge, MN (Phase III; 99)                |                        | Johnson et al. 2000    | Noble Bliss, NY (08)                     |                           | Jain et al. 2009e         |
| Buffalo Ridge, MN (Phase III; 01/Lake Benton II) | Johnson et al. 2004    | Johnson et al. 2004    | Noble Bliss, NY (09)                     |                           | Jain et al. 2010a         |
| Buffalo Ridge, MN (Phase III; 02/Lake Benton II) | Johnson et al. 2004    | Johnson et al. 2004    | Noble Chateaugay, NY (10)                |                           | Jain et al. 2011c         |
| Buffalo Ridge I, SD (09-10)                      |                        | Derby et al. 2010b     | Noble Clinton, NY (08)                   | Reynolds 2010a            | Jain et al. 2009c         |
| Buffalo Ridge II, SD (11-12)                     |                        | Derby et al. 2012a     | Noble Clinton, NY (09)                   | Reynolds 2010a            | Jain et al. 2010b         |
| Casselman, PA (08)                               |                        | Arnett et al. 2009b    | Noble Ellenburg, NY (08)                 |                           | Jain et al. 2009b         |
| Casselman, PA (09)                               |                        | Arnett et al. 2010     | Noble Ellenburg, NY (09)                 | Reynolds 2010b            | Jain et al. 2010c         |
| Casselman Curtailment, PA (08)                   |                        | Arnett et al. 2009a    | Noble Wethersfield, NY (10)              |                           | Jain et al. 2011a         |
| Cedar Ridge, WI (09)                             | BHE Environmental 2008 | BHE Environmental 2010 | NPPD Ainsworth, NE (06)                  |                           | Derby et al. 2007         |
| Cedar Ridge, WI (10)                             | BHE Environmental 2008 | BHE Environmental 2011 | Palouse Wind, WA (12-13)                 |                           | Stantec 2013a             |
| Cohocton/Dutch Hill, NY (09)                     |                        | Stantec 2010           | Pebble Springs, OR (09-10)               |                           | Gritski and Kronner 2010b |
| Cohocton/Dutch Hills, NY (10)                    |                        | Stantec 2011a          | Pinnacle, WV (12)                        |                           | Hein et al. 2013b         |
| Combine Hills, OR (Phase I; 04-05)               |                        | Young et al. 2006      | Pinyon Pines I&II, CA (13-14)            |                           | Chatfield and Russo 2014  |
| Combine Hills, OR (11)                           |                        | Enz et al. 2012        | Pioneer Prairie I, IA (Phase II; 11-12)  |                           | Chodachek et al. 2012     |
| Crescent Ridge, IL (05-06)                       |                        | Kerlinger et al. 2007  | Pioneer Prairie II, IA (13)              |                           | Chodachek et al. 2014     |
| Criterion, MD (11)                               |                        | Young et al. 2012a     | PrairieWinds ND1 (Minot), ND (10)        |                           | Derby et al. 2011c        |
| Criterion, MD (12)                               |                        | Young et al. 2013      | PrairieWinds ND1 (Minot), ND (11)        |                           | Derby et al. 2012c        |
| Criterion, MD (13)                               |                        | Young et al. 2014a     | PrairieWinds SD1 (Crow Lake), SD (11-12) |                           | Derby et al. 2012d        |
| Crystal Lake II, IA (09)                         |                        | Derby et al. 2010a     | PrairieWinds SD1 (Crow Lake), SD (12-13) |                           | Derby et al. 2013a        |
| Diablo Winds, CA (05-07)                         |                        | WEST 2006, 2008        | PrairieWinds SD1, SD (13-14)             |                           | Derby et al. 2014         |

**Appendix A1 (continued). Wind energy facilities in North America with comparable activity and fatality data for bats. Data from the following sources:**

| Facility                             | Activity Estimate     | Fatality Estimate                | Facility                             | Activity Estimate | Fatality Estimate          |
|--------------------------------------|-----------------------|----------------------------------|--------------------------------------|-------------------|----------------------------|
| Dillon, CA (08-09)                   |                       | Chatfield et al. 2009            | Rail Splitter, IL (12-13)            |                   | Good et al. 2013b          |
| Dry Lake I, AZ (09-10)               | Thompson et al. 2011  | Thompson et al. 2011             | Record Hill, ME (12)                 | Stantec 2008b     | Stantec 2013b              |
| Dry Lake II, AZ (11-12)              | Thompson and Bay 2012 | Thompson and Bay 2012            | Record Hill, ME (14)                 |                   | Stantec 2015               |
| Elkhorn, OR (08)                     |                       | Jeffrey et al. 2009b             | Red Hills, OK (12-13)                |                   | Derby et al. 2013c         |
| Elkhorn, OR (10)                     |                       | Enk et al. 2011b                 | Ripley, Ont (08)                     |                   | Jacques Whitford 2009      |
| Elm Creek, MN (09-10)                |                       | Derby et al. 2010c               | Rollins, ME (12)                     |                   | Stantec 2013c              |
| Elm Creek II, MN (11-12)             |                       | Derby et al. 2012b               | Rugby, ND (10-11)                    |                   | Derby et al. 2011b         |
| Foot Creek Rim, WY (Phase I; 99)     |                       | Young et al. 2003a               | Shiloh I, CA (06-09)                 |                   | Kerlinger et al. 2009      |
| Foot Creek Rim, WY (Phase I; 00)     | Gruver 2002           | Young et al. 2003a, 2003b        | Shiloh II, CA (09-10)                |                   | Kerlinger et al. 2010      |
| Foot Creek Rim, WY (Phase I; 01-02)  | Gruver 2002           | Young et al. 2003a, 2003b        | Shiloh II, CA (10-11)                |                   | Kerlinger et al. 2013a     |
| Forward Energy Center, WI (08-10)    | Watt and Drake 2011   | Grodsky and Drake 2011           | Shiloh III, CA (12-13)               |                   | Kerlinger et al. 2013b     |
| Fowler I, IN (09)                    |                       | Johnson et al. 2010a             | Solano III, CA (12-13)               |                   | AECOM 2013                 |
| Fowler III, IN (09)                  |                       | Johnson et al. 2010b             | Stateline, OR/WA (01-02)             |                   | Erickson et al. 2004       |
| Fowler I, II, III, IN (10)           |                       | Good et al. 2011                 | Stateline, OR/WA (03)                |                   | Erickson et al. 2004       |
| Fowler I, II, III, IN (11)           |                       | Good et al. 2012                 | Stateline, OR/WA (06)                |                   | Erickson et al. 2007       |
| Fowler I, II, III, IN (12)           |                       | Good et al. 2013c                | Stetson Mountain I, ME (09)          | Stantec 2009c     | Stantec 2009c              |
| Goodnoe, WA (09-10)                  |                       | URS Corporation 2010a            | Stetson Mountain I, ME (11)          |                   | Normandeau Associates 2011 |
| Grand Ridge I, IL (09-10)            |                       | Derby et al. 2010g               | Stetson Mountain I, ME (13)          |                   | Stantec 2014               |
| Harrow, Ont (10)                     |                       | NRSI 2011                        | Stetson Mountain II, ME (10)         |                   | Normandeau Associates 2010 |
| Harvest Wind, WA (10-12)             |                       | Downes and Gritski 2012a         | Stetson Mountain II, ME (12)         |                   | Stantec 2013e              |
| Hay Canyon, OR (09-10)               |                       | Gritski and Kronner 2010a        | Summerview, Alb (05-06)              |                   | Brown and Hamilton 2006b   |
| Heritage Garden I, MI (2012-2014)    |                       | Kerlinger et al. 2014            | Summerview, Alb (06; 07)             | Baerwald 2008     | Baerwald 2008              |
| High Sheldon, NY (10)                |                       | Tidhar et al. 2012a              | Top Crop I & II, IL (12-13)          |                   | Good et al. 2013a          |
| High Sheldon, NY (11)                |                       | Tidhar et al. 2012b              | Top of Iowa, IA (03)                 |                   | Jain 2005                  |
| High Winds, CA (03-04)               |                       | Kerlinger et al. 2006            | Top of Iowa, IA (04)                 | Jain 2005         | Jain 2005                  |
| High Winds, CA (04-05)               |                       | Kerlinger et al. 2006            | Tuolumne (Windy Point I), WA (09-10) |                   | Enz and Bay 2010           |
| Hopkins Ridge, WA (06)               |                       | Young et al. 2007                | Vansycle, OR (99)                    |                   | Erickson et al. 2000       |
| Hopkins Ridge, WA (08)               |                       | Young et al. 2009c               | Vantage, WA (10-11)                  |                   | Ventus 2012                |
| Judith Gap, MT (06-07)               |                       | TRC 2008                         | Wessington Springs, SD (09)          |                   | Derby et al. 2010f         |
| Judith Gap, MT (09)                  |                       | Poulton and Erickson 2010        | Wessington Springs, SD (10)          |                   | Derby et al. 2011d         |
| Kewaunee County, WI (99-01)          |                       | Howe et al. 2002                 | White Creek, WA (07-11)              |                   | Downes and Gritski 2012b   |
| Kibby, ME (11)                       |                       | Stantec 2012a                    | Wild Horse, WA (07)                  |                   | Erickson et al. 2008       |
| Kittitas Valley, WA (11-12)          |                       | Stantec Consulting Services 2012 | Windy Flats, WA (10-11)              |                   | Enz et al. 2011            |
| Klondike, OR (02-03)                 |                       | Johnson et al. 2003              | Winnebago, IA (09-10)                |                   | Derby et al. 2010e         |
| Klondike II, OR (05-06)              |                       | NWC and WEST 2007                | Wolfe Island, Ont (July-December 09) |                   | Stantec Ltd. 2010b         |
| Klondike III (Phase I), OR (07-09)   |                       | Gritski et al. 2010              | Wolfe Island, Ont (July-December 10) |                   | Stantec Ltd. 2011b         |
| Klondike IIIa (Phase II), OR (08-10) |                       | Gritski et al. 2011              | Wolfe Island, Ont (July-December 11) |                   | Stantec Ltd. 2012          |
| Leaning Juniper, OR (06-08)          |                       | Gritski et al. 2008              |                                      |                   |                            |

**Appendix A2. Fatality estimates for North American wind-energy facilities.**

| <b>Project</b>                           | <b>Bat Fatalities<br/>(bats/MW/year)</b> | <b>Predominant Habitat Type</b>     | <b>Citation</b>        |
|------------------------------------------|------------------------------------------|-------------------------------------|------------------------|
| Alite, CA (2009-2010)                    | 0.24                                     | shrub/scrub & grassland             | Chatfield et al. 2010  |
| Alta VIII, CA (2012-2013)                | 0                                        | grassland and riparian              | Chatfield and Bay 2014 |
| Alta Wind I-V, CA (2013-2014)            | 0.2                                      | NA                                  | Chatfield et al 2014   |
| Alta Wind I, CA (2011-2012)              | 1.28                                     | woodland, grassland, shrubland      | Chatfield et al. 2012  |
| Alta Wind II-V, CA (2011-2012)           | 0.08                                     | desert scrub                        | Chatfield et al. 2012  |
| Barton Chapel, TX (2009-2010)            | 3.06                                     | agriculture/forest                  | WEST 2011              |
| Barton I & II, IA (2010-2011)            | 1.85                                     | agriculture                         | Derby et al. 2011      |
| Beech Ridge, WV (2012)                   | 2.03                                     | forest                              | Tidhar et al. 2013     |
| Beech Ridge, WV (2013)                   | 0.58                                     | forest                              | Young et al. 2014      |
| Big Blue, MN (2013)                      | 2.04                                     | agriculture                         | Fagen Engineering 2014 |
| Big Blue, MN (2014)                      | 1.43                                     | agriculture                         | Fagen Engineering 2015 |
| Big Horn, WA (2006-2007)                 | 1.9                                      | agriculture/grassland               | Kronner et al. 2008    |
| Big Smile, OK (2012-2013)                | 2.9                                      | grassland, agriculture              | Derby et al. 2013      |
| Biglow Canyon, OR (Phase I; 2008)        | 1.99                                     | agriculture/grassland               | Jeffrey et al. 2009    |
| Biglow Canyon, OR (Phase I; 2009)        | 0.58                                     | agriculture/grassland               | Enk et al. 2010        |
| Biglow Canyon, OR (Phase II; 2009-2010)  | 2.71                                     | agriculture                         | Enk et al. 2011        |
| Biglow Canyon, OR (Phase II; 2010-2011)  | 0.57                                     | grassland/shrub-steppe, agriculture | Enk et al. 2012        |
| Biglow Canyon, OR (Phase III; 2010-2011) | 0.22                                     | grassland/shrub-steppe, agriculture | Enk et al. 2012        |
| Blue Sky Green Field, WI (2008; 2009)    | 24.57                                    | agriculture                         | Gruver et al. 2009     |
| Buffalo Gap I, TX (2006)                 | 0.1                                      | grassland                           | Tierney 2007           |
| Buffalo Gap II, TX (2007-2008)           | 0.14                                     | forest                              | Tierney 2009           |
| Buffalo Mountain, TN (2000-2003)         | 31.54                                    | forest                              | Nicholson et al. 2005  |
| Buffalo Mountain, TN (2005)              | 39.7                                     | forest                              | Fiedler et al. 2007    |
| Buffalo Ridge I, SD (2009-2010)          | 0.16                                     | agriculture/grassland               | Derby et al. 2010      |
| Buffalo Ridge II, SD (2011-2012)         | 2.81                                     | agriculture, grassland              | Derby et al. 2012      |
| Buffalo Ridge, MN (Phase I; 1996)        | NA                                       | agriculture                         | Johnson et al. 2000    |
| Buffalo Ridge, MN (Phase I; 1997)        | NA                                       | agriculture                         | Johnson et al. 2000    |
| Buffalo Ridge, MN (Phase I; 1998)        | NA                                       | agriculture                         | Johnson et al. 2000    |
| Buffalo Ridge, MN (Phase I; 1999)        | 0.74                                     | agriculture                         | Johnson et al. 2000    |
| Buffalo Ridge, MN (Phase II; 1998)       | 2.16                                     | agriculture                         | Johnson et al. 2000    |
| Buffalo Ridge, MN (Phase II; 1999)       | 2.59                                     | agriculture                         | Johnson et al. 2000    |

**Appendix A2. Fatality estimates for North American wind-energy facilities.**

| <b>Project</b>                                     | <b>Bat Fatalities<br/>(bats/MW/year)</b> | <b>Predominant Habitat Type</b>     | <b>Citation</b>        |
|----------------------------------------------------|------------------------------------------|-------------------------------------|------------------------|
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)   | 4.35                                     | agriculture                         | Johnson et al. 2004    |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)   | 1.64                                     | agriculture                         | Johnson et al. 2004    |
| Buffalo Ridge, MN (Phase III; 1999)                | 2.72                                     | agriculture                         | Johnson et al. 2000    |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | 3.71                                     | agriculture                         | Johnson et al. 2004    |
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | 1.81                                     | agriculture                         | Johnson et al. 2004    |
| Casselman Curtailment, PA (2008)                   | 4.4                                      | forest                              | Arnett et al. 2009     |
| Casselman, PA (2008)                               | 12.61                                    | forest                              | Arnett et al. 2009     |
| Casselman, PA (2009)                               | 8.6                                      | forest, pasture, grassland          | Arnett et al. 2010     |
| Cedar Ridge, WI (2009)                             | 30.61                                    | agriculture                         | BHE Environmental 2010 |
| Cedar Ridge, WI (2010)                             | 24.12                                    | agriculture                         | BHE Environmental 2011 |
| Cohocton/Dutch Hill, NY (2009)                     | 8.62                                     | agriculture/forest                  | Stantec 2010           |
| Cohocton/Dutch Hills, NY (2010)                    | 10.32                                    | agriculture, forest                 | Stantec 2011           |
| Combine Hills, OR (2011)                           | 0.73                                     | grassland/shrub-steppe, agriculture | Enz et al. 2012        |
| Combine Hills, OR (Phase I; 2004-2005)             | 1.88                                     | agriculture/grassland               | Young et al. 2006      |
| Crescent Ridge, IL (2005-2006)                     | 3.27                                     | agriculture                         | Kerlinger et al. 2007  |
| Criterion, MD (2011)                               | 15.61                                    | forest, agriculture                 | Young et al. 2012      |
| Criterion, MD (2012)                               | 7.62                                     | forest, agriculture                 | Young et al. 2013      |
| Criterion, MD (2013)                               | 5.32                                     | forest, agriculture                 | Young et al. 2014      |
| Crystal Lake II, IA (2009)                         | 7.42                                     | agriculture                         | Derby et al. 2010      |
| Diablo Winds, CA (2005-2007)                       | 0.82                                     |                                     | WEST 2006, WEST 2008   |
| Dillon, CA (2008-2009)                             | 2.17                                     | desert                              | Chatfield et al. 2009  |
| Dry Lake I, AZ (2009-2010)                         | 3.43                                     | desert grassland/forested           | Thompson et al. 2011   |
| Dry Lake II, AZ (2011-2012)                        | 1.66                                     | desert grassland/forested           | Thompson and Bay 2012  |
| Elkhorn, OR (2008)                                 | 1.26                                     | shrub/scrub & agriculture           | Jeffery et al. 2009    |
| Elkhorn, OR (2010)                                 | 2.14                                     | shrub/scrub & agriculture           | Enk et al. 2011        |
| Elm Creek II, MN (2011-2012)                       | 2.81                                     | agriculture, grassland              | Derby et al. 2012      |
| Elm Creek, MN (2009-2010)                          | 1.49                                     | agriculture                         | Derby et al. 2010      |
| Foote Creek Rim, WY (Phase I; 1999)                | 3.97                                     | grassland                           | Young et al. 2003b     |

**Appendix A2. Fatality estimates for North American wind-energy facilities.**

| <b>Project</b>                           | <b>Bat Fatalities<br/>(bats/MW/year)</b> | <b>Predominant Habitat Type</b>        | <b>Citation</b>                                 |
|------------------------------------------|------------------------------------------|----------------------------------------|-------------------------------------------------|
| Foote Creek Rim, WY (Phase I; 2000)      | 1.05                                     | grassland                              | Young et al. 2003b                              |
| Foote Creek Rim, WY (Phase I; 2001-2002) | 1.57                                     | grassland                              | Young et al. 2003b                              |
| Forward Energy Center, WI (2008-2010)    | 18.17                                    | agriculture                            | Grodsky and Drake 2011                          |
| Fowler I, II, III, IN (2010)             | 18.96                                    | agriculture                            | Good et al. 2011                                |
| Fowler I, II, III, IN (2011)             | 20.19                                    | agriculture                            | Good et al. 2012                                |
| Fowler I, II, III, IN (2012)             | 2.96                                     | agriculture                            | Good et al. 2013                                |
| Fowler I, IN (2009)                      | 8.09                                     | agriculture                            | Johnson et al. 2010                             |
| Fowler III, IN (2009)                    | 1.84                                     | agriculture                            | Johnson et al. 2010                             |
| Goodnoe, WA (2009-2010)                  | 0.34                                     | grassland and shrub-steppe             | URS 2010a                                       |
| Grand Ridge I, IL (2009-2010)            | 2.1                                      | agriculture                            | Derby et al. 2010                               |
| Harrow, Ont (2010)                       | 11.13                                    | agriculture                            | Natural Resources Solutions<br>Inc. (NRSI) 2011 |
| Harvest Wind, WA (2010-2012)             | 1.27                                     | grassland/shrub-steppe                 | Downes and Gristki 2012                         |
| Hay Canyon, OR (2009-2010)               | 0.53                                     | agriculture                            | Gritski and Kronner 2010a                       |
| Heritage Garden I, MI (2012-2014)        | 5.9                                      | agriculture                            | Curry & Kerlinger 2014                          |
| High Sheldon, NY (2010)                  | 2.33                                     | agriculture                            | Tidhar et al. 2012                              |
| High Sheldon, NY (2011)                  | 1.78                                     | agriculture                            | Tidhar et al. 2012                              |
| High Winds, CA (2003-2004)               | 2.51                                     | agriculture/grassland                  | Kerlinger et al. 2006                           |
| High Winds, CA (2004-2005)               | 1.52                                     | agriculture/grassland                  | Kerlinger et al. 2006                           |
| Hopkins Ridge, WA (2006)                 | 0.63                                     | agriculture/grassland                  | Young et al. 2007                               |
| Hopkins Ridge, WA (2008)                 | 1.39                                     | agriculture/grassland                  | Young et al. 2009                               |
| Judith Gap, MT (2006-2007)               | 8.93                                     | agriculture/grassland                  | TRC 2008                                        |
| Judith Gap, MT (2009)                    | 3.2                                      | agriculture/grassland                  | Poulton and Erickson 2010                       |
| Kewaunee County, WI (1999-2001)          | 6.45                                     | agriculture                            | Howe et al. 2002                                |
| Kibby, ME (2011)                         | 0.12                                     | forest, commercial forest              | Stantec 2012                                    |
| Kittitas Valley, WA (2011-2012)          | 0.12                                     | sagebrush-steppe, grassland            | Stantec 2012                                    |
| Klondike II, OR (2005-2006)              | 0.41                                     | agriculture/grassland                  | NWC and WEST 2007                               |
| Klondike III (Phase I), OR (2007-2009)   | 1.11                                     | agriculture/grassland                  | Gritski et al. 2010                             |
| Klondike IIIa (Phase II), OR (2008-2010) | 0.14                                     | grassland/shrub-steppe and agriculture | Gritski et al. 2011                             |
| Klondike, OR (2002-2003)                 | 0.77                                     | agriculture/grassland                  | Johnson et al. 2003b                            |
| Leaning Juniper, OR (2006-2008)          | 1.98                                     | agriculture                            | Gritski et al. 2008                             |
| Lempster, NH (2009)                      | 3.11                                     | grassland/forest/rocky embankments     | Tidhar et al. 2010                              |

**Appendix A2. Fatality estimates for North American wind-energy facilities.**

| <b>Project</b>                    | <b>Bat Fatalities<br/>(bats/MW/year)</b> | <b>Predominant Habitat Type</b>     | <b>Citation</b>                      |
|-----------------------------------|------------------------------------------|-------------------------------------|--------------------------------------|
| Lempster, NH (2010)               | 3.57                                     | grassland/forest/rocky embankments  | Tidhar et al. 2011                   |
| Linden Ranch, WA (2010-2011)      | 1.68                                     | grassland/shrub-steppe, agriculture | Enz and Bay 2011                     |
| Locust Ridge, PA (Phase II; 2009) | 14.11                                    | grassland                           | Arnett et al. 2010                   |
| Locust Ridge, PA (Phase II; 2010) | 14.38                                    | grassland                           | Arnett et al. 2010                   |
| Maple Ridge, NY (2006)            | 11.21                                    | agriculture/forested                | Jain et al. 2007                     |
| Maple Ridge, NY (2007-2008)       | 4.96                                     | agriculture/forested                | Jain et al. 2009d                    |
| Maple Ridge, NY (2007)            | 6.49                                     | agriculture/forested                | Jain et al. 2009a                    |
| Maple Ridge, NY (2012)            | 7.3                                      | agriculture/forested                | Tidhar et al. 2013                   |
| Marengo I, WA (2009-2010)         | 0.17                                     | agriculture                         | URS 2010b                            |
| Marengo II, WA (2009-2010)        | 0.27                                     | agriculture                         | URS 2010c                            |
| Mars Hill, ME (2007)              | 2.91                                     | forest                              | Stantec 2008b                        |
| Mars Hill, ME (2008)              | 0.45                                     | forest                              | Stantec 2009                         |
| Milford I & II, UT (2011-2012)    | 1.67                                     | desert shrub                        | Stantec Consulting 2012              |
| Milford I, UT (2010-2011)         | 2.05                                     | desert shrub                        | Stantec Consulting 2011              |
| Montezuma I, CA (2011)            | 1.9                                      | agriculture and grassland           | ICF International 2012               |
| Montezuma I, CA (2012)            | 0.84                                     | agriculture and grassland           | ICF International 2013               |
| Montezuma II, CA (2012-2013)      | 0.91                                     | agriculture                         | Harvey & Associates 2013             |
| Moraine II, MN (2009)             | 2.42                                     | agriculture/grassland               | Derby et al. 2010                    |
| Mount Storm, WV (2009)            | 17.53                                    | forest                              | Young et al. 2009a, 2010b            |
| Mount Storm, WV (2010)            | 15.18                                    | forest                              | Young et al. 2010a, 2011             |
| Mount Storm, WV (2011)            | 7.43                                     | forest                              | Young et al. 2011; Young et al. 2012 |
| Mount Storm, WV (Fall 2008)       | 6.62                                     | forest                              | Young et al. 2009b                   |
| Mountaineer, WV (2003)            | 31.69                                    | forest                              | Kerns and Kerlinger 2004             |
| Munnsville, NY (2008)             | 1.93                                     | agriculture/forest                  | Stantec 2009                         |
| Mustang Hills, CA (2012-2013)     | 0.1                                      | grassland and riparian              | Chatfield and Bay 2014               |
| Nine Canyon, WA (2002-2003)       | 2.47                                     | agriculture/grassland               | Erickson et al. 2003                 |
| Noble Altona, NY (2010)           | 4.34                                     | forest                              | Jain et al. 2011a                    |
| Noble Bliss, NY (2008)            | 7.8                                      | agriculture/forest                  | Jain et al. 2009                     |
| Noble Bliss, NY (2009)            | 3.85                                     | agriculture/forest                  | Jain et al. 2010a                    |
| Noble Chateaugay, NY (2010)       | 2.44                                     | agriculture                         | Jain et al. 2011b                    |
| Noble Clinton, NY (2008)          | 3.14                                     | agriculture/forest                  | Jain et al. 2009                     |

**Appendix A2. Fatality estimates for North American wind-energy facilities.**

| <b>Project</b>                              | <b>Bat Fatalities<br/>(bats/MW/year)</b> | <b>Predominant Habitat Type</b> | <b>Citation</b>                                     |
|---------------------------------------------|------------------------------------------|---------------------------------|-----------------------------------------------------|
| Noble Clinton, NY (2009)                    | 4.5                                      | agriculture/forest              | Jain et al. 2010b                                   |
| Noble Ellenburg, NY (2008)                  | 3.46                                     | agriculture/forest              | Jain et al. 2009                                    |
| Noble Ellenburg, NY (2009)                  | 3.91                                     | agriculture/forest              | Jain et al. 2010c                                   |
| Noble Wethersfield, NY (2010)               | 16.3                                     | agriculture                     | Jain et al. 2011c                                   |
| NPPD Ainsworth, NE (2006)                   | 1.16                                     | agriculture/grassland           | Derby et al. 2007                                   |
| Palouse Wind, WA (2012-2013)                | 4.23                                     | agriculture and grassland       | Stantec Consulting 2013                             |
| Pebble Springs, OR (2009-2010)              | 1.55                                     | grassland                       | Gritski and Kronner 2010b                           |
| Pine Tree, CA (2009-2010, 2011)             | NA                                       | grassland                       | BioResource Consultants 2012                        |
| Pinnacle, WV (2012)                         | 40.2                                     | forest                          | Hein et al. 2013                                    |
| Pinyon Pines I & II, CA (2013-2014)         | 0.04                                     | NA                              | Chatfield and Russo 2014                            |
| Pioneer Prairie I, IA (Phase II; 2011-2012) | 10.06                                    | agriculture, grassland          | Chodachek et al. 2012                               |
| Pioneer Prairie II, IA (2013)               | 3.83                                     | agriculture                     | Chodachek et al 2014                                |
| PrairieWinds ND1 (Minot), ND (2010)         | 2.13                                     | agriculture                     | Derby et al. 2011                                   |
| PrairieWinds ND1 (Minot), ND (2011)         | 1.39                                     | agriculture, grassland          | Derby et al. 2012                                   |
| PrairieWinds SD1, SD (2011-2012)            | 1.23                                     | grassland                       | Derby et al. 2012                                   |
| PrairieWinds SD1, SD (2012-2013)            | 1.05                                     | grassland                       | Derby et al. 2013                                   |
| PrairieWinds SD1, SD (2013-2014)            | 0.52                                     | grassland                       | Derby et al. 2014                                   |
| Rail Splitter, IL (2012-2013)               | 11.21                                    | agriculture                     | Good et al 2013                                     |
| Record Hill, ME (2012)                      | 2.96                                     | forest                          | Stantec 2013                                        |
| Record Hill, ME (2014)                      | 0.55                                     | forest                          | Stantec 2015                                        |
| Red Hills, OK (2012-2013)                   | 0.11                                     | grassland                       | Derby et al. 2013                                   |
| Ripley, Ont (2008)                          | 4.67                                     | agriculture                     | Jacques Whitford 2009                               |
| Rollins, ME (2012)                          | 0.18                                     | forest                          | Stantec 2013                                        |
| Rugby, ND (2010-2011)                       | 1.6                                      | agriculture                     | Derby et al. 2011                                   |
| Shiloh I, CA (2006-2009)                    | 3.92                                     | agriculture/grassland           | Kerlinger et al. 2010                               |
| Shiloh II, CA (2009-2010)                   | 2.6                                      | agriculture                     | Curry and Kerlinger 2010,<br>Curry & Kerlinger 2013 |
| Shiloh II, CA (2010-2011)                   | 3.8                                      | agriculture                     | Curry & Kerlinger 2013                              |
| Shiloh III, CA (2012-2013)                  | 0.4                                      | NA                              | Curry & Kerlinger 2013                              |
| Solano III, CA (2012-2013)                  | 0.31                                     | NA                              | AECOM 2013                                          |
| Stateline, OR/WA (2001-2002)                | 1.09                                     | agriculture/grassland           | Erickson et al. 2004                                |
| Stateline, OR/WA (2003)                     | 2.29                                     | agriculture/grassland           | Erickson et al. 2004                                |

**Appendix A2. Fatality estimates for North American wind-energy facilities.**

| <b>Project</b>                           | <b>Bat Fatalities<br/>(bats/MW/year)</b> | <b>Predominant Habitat Type</b>                | <b>Citation</b>                     |
|------------------------------------------|------------------------------------------|------------------------------------------------|-------------------------------------|
| Stateline, OR/WA (2006)                  | 0.95                                     | agriculture/grassland                          | Erickson et al. 2007                |
| Stetson Mountain I, ME (2009)            | 1.4                                      | forest                                         | Stantec 2009                        |
| Stetson Mountain I, ME (2011)            | 0.28                                     | forest                                         | Normandeau Associates 2011          |
| Stetson Mountain I, ME (2013)            | 0.18                                     | forest                                         | Stantec 2014                        |
| Stetson Mountain II, ME (2010)           | 1.65                                     | forest                                         | Normandeau Associates 2010          |
| Stetson Mountain II, ME (2012)           | 2.27                                     | forest                                         | Stantec Consulting 2013             |
| Summerview, Alb (2005-2006)              | 10.27                                    | agriculture                                    | Brown and Hamilton 2006             |
| Summerview, Alb (2006; 2007)             | 11.42                                    | agriculture/grassland                          | Baerwald 2008                       |
| Top Crop I & II (2012-2013)              | 12.55                                    | agriculture                                    | Good et al 2013                     |
| Top of Iowa, IA (2003)                   | 7.16                                     | agriculture                                    | Jain 2005                           |
| Top of Iowa, IA (2004)                   | 10.27                                    | agriculture                                    | Jain 2005                           |
| Tuolumne (Windy Point I), WA (2009-2010) | 0.94                                     | grassland/shrub-steppe, agriculture and forest | Enz and Bay 2010                    |
| Vansycle, OR (1999)                      | 1.12                                     | agriculture/grassland                          | Erickson et al. 2000                |
| Vantage, WA (2010-2011)                  | 0.4                                      | shrub-steppe, grassland                        | Ventus Environmental Solutions 2012 |
| Wessington Springs, SD (2009)            | 1.48                                     | grassland                                      | Derby et al. 2010                   |
| Wessington Springs, SD (2010)            | 0.41                                     | grassland                                      | Derby et al. 2011                   |
| White Creek, WA (2007-2011)              | 2.04                                     | grassland/shrub-steppe, agriculture            | Downes and Gristki 2012             |
| Wild Horse, WA (2007)                    | 0.39                                     | grassland                                      | Erickson et al. 2008                |
| Windy Flats, WA (2010-2011)              | 0.41                                     | grassland/shrub-steppe, agriculture            | Enz et al. 2011                     |
| Winnebago, IA (2009-2010)                | 4.54                                     | agriculture/grassland                          | Derby et al. 2010                   |
| Wolfe Island, Ont (July-December 2009)   | 6.42                                     | grassland                                      | Stantec Ltd. 2010                   |
| Wolfe Island, Ont (July-December 2010)   | 9.5                                      | grassland                                      | Stantec Ltd. 2011b                  |
| Wolfe Island, Ont (July-December 2011)   | 2.49                                     | grassland                                      | Stantec Ltd. 2012                   |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                   | Total # of Turbines | Total MW                 | Tower size (m)                         | Number turbines searches                                                                                                   | Plot Size            | Length of Study | Survey Frequency                                                                            |
|--------------------------------|---------------------|--------------------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------|---------------------------------------------------------------------------------------------|
| Alite, CA (2009-2010)          | 8                   | 24                       | 80                                     | 8                                                                                                                          | 200 m x 200 m        | 1 year          | weekly (spring, fall), bi-monthly (summer, winter)                                          |
| Alta VIII, CA (2012-2013)      | 50                  | 150                      | 90                                     | 12 plots (equivalent to 15 turbines)                                                                                       | 240 x 240 m          | 1 year          | bi-weekly                                                                                   |
| Alta Wind I, CA (2011-2012)    | 100                 | 150                      | 80                                     | 25                                                                                                                         | 120-m radius circle  | 12.5 months     | every two weeks                                                                             |
| Alta Wind II-V, CA (2011-2012) | 190                 | 570                      | 80                                     | 41                                                                                                                         | 120-m radius circle  | 14.5 months     | every two weeks                                                                             |
| Alta Wind I-V, CA (2013-2014)  | 290                 | 720 (150 GE, 570 vestas) | 80                                     | 55 (25 at Alta I, 30 at Alta II-V)                                                                                         | 120 m radius circles | NA              | monthly or bi-weekly                                                                        |
| Barton Chapel, TX (2009-2010)  | 60                  | 120                      | 78                                     | 30                                                                                                                         | 200 m x 200 m        | 1 year          | 10 turbines weekly, 20 monthly                                                              |
| Barton I & II, IA (2010-2011)  | 80                  | 160                      | 100                                    | 35 (9 turbines were dropped in June 2010 due to landowner issues) 26 turbines were searched for the remainder of the study | 200 m x 200 m        | 1 year          | weekly (spring, fall; migratory turbines), monthly (summer, winter; non-migratory turbines) |
| Beech Ridge, WV (2012)         | 67                  | 100.5                    | 80                                     | 67                                                                                                                         | 40 m radius          | 7 months        | every two days                                                                              |
| Beech Ridge, WV (2013)         | 67                  | 100.5                    | 80                                     | 67                                                                                                                         | 40 m radius          | 7.5 months      | every two days                                                                              |
| Big Blue, MN (2013)            | 18                  | 36                       | 78 or 90 (according to Gamesa website) | 18                                                                                                                         | 200m diameter        | NA              | weekly, monthly (Nov and Dec)                                                               |
| Big Blue, MN (2014)            | 18                  | 36                       | 78 or 90 (according to Gamesa website) | 18                                                                                                                         | 200m diameter        | NA              | weekly, monthly (Nov and Dec)                                                               |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                             | Total # of Turbines | Total MW | Tower size (m)     | Number turbines searches | Plot Size     | Length of Study | Survey Frequency                                        |
|------------------------------------------|---------------------|----------|--------------------|--------------------------|---------------|-----------------|---------------------------------------------------------|
| Big Horn, WA (2006-2007)                 | 133                 | 199.5    | 80                 | 133                      | 180 m x 180 m | 1 year          | bi-monthly (spring, fall), monthly (winter, summer)     |
| Big Smile, OK (2012-2013)                | 66                  | 132      | 78                 | 17 (plus one met tower)  | 100 x 100     | 1 year          | weekly (spring, summer, fall), monthly (winter)         |
| Biglow Canyon, OR (Phase I; 2008)        | 76                  | 125.4    | 80                 | 50                       | 110 m x 110 m | 1 year          | bi-monthly (spring, fall), monthly (winter, summer)     |
| Biglow Canyon, OR (Phase I; 2009)        | 76                  | 125.4    | 80                 | 50                       | 110 m x 110 m | 1 year          | bi-monthly (spring, fall), monthly (winter, summer)     |
| Biglow Canyon, OR (Phase II; 2009-2010)  | 65                  | 150      | 80                 | 50                       | 250 m x 250 m | 1 year          | bi-monthly (spring, fall), monthly (winter, summer)     |
| Biglow Canyon, OR (Phase II; 2010-2011)  | 65                  | 150      | 80                 | 50                       | 252 m x 252 m | 1 year          | bi-weekly(spring, fall), monthly (summer, winter)       |
| Biglow Canyon, OR (Phase III; 2010-2011) | 76                  | 174.8    | 80                 | 50                       | 252 m x 252 m | 1 year          | bi-weekly(spring, fall), monthly (summer, winter)       |
| Blue Sky Green Field, WI (2008; 2009)    | 88                  | 145      | 80                 | 30                       | 160 m x 160 m | fall, spring    | daily(10 turbines), weekly (20 turbines)                |
| Buena Vista, CA (2008-2009)              | 38                  | 38       | 45-55              | 38                       | 75-m radius   | 1 year          | monthly to bi-monthly starting in September 2008        |
| Buffalo Gap I, TX (2006)                 | 67                  | 134      | 78                 | 21                       | 215 m x 215 m | 10 months       | every 3 weeks                                           |
| Buffalo Gap II, TX (2007-2008)           | 155                 | 233      | 80                 | 36                       | 215 m x 215 m | 14 months       | every 21 days                                           |
| Buffalo Mountain, TN (2000-2003)         | 3                   | 1.98     | 65                 | 3                        | 50-m radius   | 3 years         | bi-weekly, weekly, bi-monthly                           |
| Buffalo Mountain, TN (2005)              | 18                  | 28.98    | V47 = 65; V80 = 78 | 18                       | 50-m radius   | 1 year          | bi-weekly, weekly, bi-monthly, and 2 to 5 day intervals |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                                       | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches                                                                                                                                                                                                                 | Plot Size     | Length of Study | Survey Frequency                                          |
|----------------------------------------------------|---------------------|----------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------|-----------------------------------------------------------|
| Buffalo Ridge, MN (1994-1995)                      | 73                  | 25       | 37             | 1994:10 plots (3 turbines/plot), 20 addition plots in Sept & Oct 1994, 1995: 30 turbines search every other week (Jan-Mar), 60 searched weekly (Apr, July, Aug) 73 searched weekly (May-June and Sept-Oct), 30 searched weekly (Nov-Dec) | 100 x 100m    | 20 months       | varies. See number turbines searched or page 44 of report |
| Buffalo Ridge, MN (Phase I; 1996)                  | 73                  | 25       | 36             | 21                                                                                                                                                                                                                                       | 126 m x 126 m | 1 year          | bi-monthly (spring, summer, and fall)                     |
| Buffalo Ridge, MN (Phase I; 1997)                  | 73                  | 25       | 36             | 21                                                                                                                                                                                                                                       | 126 m x 126 m | 1 year          | bi-monthly (spring, summer, and fall)                     |
| Buffalo Ridge, MN (Phase I; 1998)                  | 73                  | 25       | 36             | 21                                                                                                                                                                                                                                       | 126 m x 126 m | 1 year          | bi-monthly (spring, summer, and fall)                     |
| Buffalo Ridge, MN (Phase I; 1999)                  | 73                  | 25       | 36             | 21                                                                                                                                                                                                                                       | 126 m x 126 m | 1 year          | bi-monthly (spring, summer, and fall)                     |
| Buffalo Ridge, MN (Phase II; 1998)                 | 143                 | 107.25   | 50             | 40                                                                                                                                                                                                                                       | 126 m x 126 m | 1 year          | bi-monthly (spring, summer, and fall)                     |
| Buffalo Ridge, MN (Phase II; 1999)                 | 143                 | 107.25   | 50             | 40                                                                                                                                                                                                                                       | 126 m x 126 m | 1 year          | bi-monthly (spring, summer, and fall)                     |
| Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)   | 143                 | 107.25   | 50             | 83                                                                                                                                                                                                                                       | 60 m x 60 m   | summer, fall    | bi-monthly                                                |
| Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)   | 143                 | 107.25   | 50             | 103                                                                                                                                                                                                                                      | 60 m x 60 m   | summer, fall    | bi-monthly                                                |
| Buffalo Ridge, MN (Phase III; 1999)                | 138                 | 103.5    | 50             | 30                                                                                                                                                                                                                                       | 126 m x 126 m | 1 year          | bi-monthly (spring, summer, and fall)                     |
| Buffalo Ridge, MN (Phase III; 2001/Lake Benton II) | 138                 | 103.5    | 50             | 83                                                                                                                                                                                                                                       | 60 m x 60 m   | summer, fall    | bi-monthly                                                |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                                       | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches              | Plot Size     | Length of Study      | Survey Frequency                                                                                                                                                                                            |
|----------------------------------------------------|---------------------|----------|----------------|---------------------------------------|---------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Buffalo Ridge, MN (Phase III; 2002/Lake Benton II) | 138                 | 103.5    | 50             | 103                                   | 60 m x 60 m   | summer, fall         |                                                                                                                                                                                                             |
| Buffalo Ridge I, SD (2009-2010)                    | 24                  | 50.4     | 79             | 24                                    | 200 m x 200 m | 1 year               | bi-monthly weekly (migratory), monthly (non-migratory)                                                                                                                                                      |
| Buffalo Ridge II, SD (2011-2012)                   | 105                 | 210      | 78             | 65 (60 road and pad, 5 turbine plots) | 100 x 100m    | 1 year               | weekly (spring, summer, fall), monthly (winter)                                                                                                                                                             |
| Casselman, PA (2008)                               | 23                  | 34.5     | 80             | 10                                    | 126 m x 120 m | 7 months             | daily                                                                                                                                                                                                       |
| Casselman, PA (2009)                               | 23                  | 34.5     | 80             | 10                                    | 126 m x 120 m | 7.5 months           | daily searches                                                                                                                                                                                              |
| Casselman Curtailment, PA (2008)                   | 23                  | 35.4     | 80             | 12 experimental; 10 control           | 126 m x 120 m | 2.5 months           | daily                                                                                                                                                                                                       |
| Castle River, Alb (2001-2002)                      | 60                  | 39.6     | 50             | 60                                    | 50-m radius   | 2 years              | weekly, bi-weekly                                                                                                                                                                                           |
| Castle River, Alb (2001-2002)                      | 60                  | 39.6     | 50             | 60                                    | 50-m radius   | 2 years              | weekly, bi-weekly                                                                                                                                                                                           |
| Cedar Ridge, WI (2009)                             | 41                  | 67.6     | 80             | 20                                    | 160 m x 160 m | spring, summer, fall | daily, every 4 days; late fall searched every 3 days<br>Five turbines were surveyed daily, 15 turbines surveyed every 4 days in rotating groups each day. All 20 surveyed every three days during late fall |
| Cedar Ridge, WI (2010)                             | 41                  | 68       | 80             | 20                                    | 160 m x 160 m | 1 year               |                                                                                                                                                                                                             |
| Cohocton/Dutch Hill, NY (2009)                     | 50                  | 125      | 80             | 17                                    | 130 m x 130 m | spring, summer, fall | daily (5 turbines), weekly (12 turbines)                                                                                                                                                                    |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                           | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches                                      | Plot Size     | Length of Study      | Survey Frequency                                     |
|----------------------------------------|---------------------|----------|----------------|---------------------------------------------------------------|---------------|----------------------|------------------------------------------------------|
| Cohocton/Dutch Hills, NY (2010)        | 50                  | 125      | 80             | 17                                                            | 120 m x 120 m | spring, summer, fall | daily, weekly                                        |
| Combine Hills, OR (Phase I; 2004-2005) | 41                  | 41       | 53             | 41                                                            | 90-m radius   | 1 year               | monthly                                              |
| Combine Hills, OR (2011)               | 104                 | 104      | 53             | 52 (plus 1 MET tower)                                         | 180 m x 180 m | 1 year               | bi-weekly(spring, fall), monthly (summer, winter)    |
| Condon, OR                             | 84                  | n/a      | n/a            | n/a                                                           | n/a           | n/a                  | n/a                                                  |
| Crescent Ridge, IL (2005-2006)         | 33                  | 49.5     | 80             | 33                                                            | 70-m radius   | 1 year               | weekly (fall, spring)                                |
| Criterion, MD (2011)                   | 28                  | 70       | 80             | 28                                                            | 40-50m radius | 7.3 months           | daily                                                |
| Criterion, MD (2012)                   | 28                  | 70       | 80             | 14                                                            | 40-50m radius | 7.5 months           | weekly                                               |
| Criterion, MD (2013)                   | 28                  | 70       | 80             | 14                                                            | 40-50m radius | 7.5 months           | weekly                                               |
| Crystal Lake II, IA (2009)             | 80                  | 200      | 80             | 16 turbines through week 6, and then 15 for duration of study | 100 m x 100 m | spring, summer, fall | 3 times per week for 26 weeks                        |
| Diablo Winds, CA (2005-2007)           | 31                  | 20.46    | 50 and 55      | 31                                                            | 75 m x 75 m   | 2 years              | monthly                                              |
| Dillon, CA (2008-2009)                 | 45                  | 45       | 69             | 15                                                            | 200 m x 200 m | 1 year               | weekly, bi-monthly in winter                         |
| Dry Lake I, AZ (2009-2010)             | 30                  | 63       | 78             | 15                                                            | 160 m x 160 m | 1 year               | bi-monthly (spring, fall), monthly (winter, summer)  |
| Dry Lake II, AZ (2011-2012)            | 31                  | 65       | 78             | 31: 5 (full plot), 26 (road & pad)                            | 160 m x 160 m | 1 year               | twice weekly (spring, summer, fall), weekly (winter) |
| Elkhorn, OR (2008)                     | 61                  | 101      | 80             | 61                                                            | 220 m x 220 m | 1 year               | monthly                                              |
| Elkhorn, OR (2010)                     | 61                  | 101      | 80             | 31                                                            | 220 m x 220 m | 1 year               | bi-monthly (spring, fall), monthly (winter, summer)  |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                             | Total # of Turbines | Total MW | Tower size (m)                     | Number turbines searches                                           | Plot Size                                                   | Length of Study      | Survey Frequency                                                      |
|------------------------------------------|---------------------|----------|------------------------------------|--------------------------------------------------------------------|-------------------------------------------------------------|----------------------|-----------------------------------------------------------------------|
| Elm Creek, MN (2009-2010)                | 67                  | 100      | 80                                 | 29                                                                 | 200 m x 200 m                                               | 1 year               | weekly, monthly                                                       |
| Elm Creek II, MN (2011-2012)             | 62                  | 148.8    | 80                                 | 30                                                                 | 200 x 200m (2 random migration search areas 100 x 100m)     | 1 year               | 20 searched every 28 days, 10 turbines every 7 days during migration) |
| Erie Shores, Ont (2006)                  | 66                  | 99       | 80                                 | 66                                                                 | 40-m radius                                                 | 2 years              | weekly, bi-monthly, 2-3 times weekly (migration)                      |
| Foote Creek Rim, WY (Phase I; 1999)      | 69                  | 41.4     | 40                                 | 69                                                                 | 126 m x 126 m                                               | 1 year               | monthly                                                               |
| Foote Creek Rim, WY (Phase I; 2000)      | 69                  | 41.4     | 40                                 | 69                                                                 | 126 m x 126 m                                               | 1 year               | monthly                                                               |
| Foote Creek Rim, WY (Phase I; 2001-2002) | 69                  | 41.4     | 40                                 | 69                                                                 | 126 m x 126 m                                               | 1 year               | monthly                                                               |
| Forward Energy Center, WI (2008-2010)    | 86                  | 129      | 80                                 | 29                                                                 | 160 m x 160 m                                               | 2 years              | 11 turbines daily, 9 every 3 days, 9 every 5 days                     |
| Fowler I, IN (2009)                      | 162                 | 301      | 78 (Vestas), 80 (Clipper)          | 25                                                                 | 160 m x 160 m                                               | spring, summer, fall | weekly, bi-weekly                                                     |
| Fowler I, II, III, IN (2010)             | 355                 | 600      | Vestas = 80, Clipper = 80, GE = 80 | 36 turbines, 100 road and pads                                     | 80 m x 80 m for turbines ; 40-m radius for roads and pads   | spring, fall         | daily, weekly                                                         |
| Fowler I, II, III, IN (2011)             | 355                 | 600      | Vestas = 80, Clipper = 80, GE = 80 | 177 road and pads (spring), 9 turbines & 168 roads and pads (fall) | turbines (80 m circular plot), roads and pads (out to 80 m) | spring, fall         | daily, weekly                                                         |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                      | Total # of Turbines         | Total MW | Tower size (m)                     | Number turbines searches | Plot Size                                    | Length of Study | Survey Frequency                                                       |
|-----------------------------------|-----------------------------|----------|------------------------------------|--------------------------|----------------------------------------------|-----------------|------------------------------------------------------------------------|
| Fowler I, II, III, IN (2012)      | 355                         | 600      | Vestas = 80, Clipper = 80, GE = 80 | 118 roads and pads       | roads and pads (out to 80 m)                 | 2.5 months      | weekly                                                                 |
| Fowler III, IN (2009)             | 60                          | 99       | 78                                 | 12                       | 160 m x 160 m                                | 10 weeks        | weekly, bi-weekly                                                      |
| Goodnoe, WA (2009-2010)           | 47                          | 94       | 80                                 | 24                       | 180 m x 180 m                                | 1 year          | 14 days during migration periods, 28 days during non-migration periods |
| Grand Ridge I, IL (2009-2010)     | 66                          | 99       | 80                                 | 30                       | 160 m x 160 m                                | 1 year          | weekly, monthly                                                        |
| Harrow, Ont (2010)                | 24 (four 6-turb facilities) | 39.6     | NA                                 | 12 in July, 24 Aug-Oct   | 50-m radius from turbine base                | 4 months        | twice-weekly                                                           |
| Harvest Wind, WA (2010-2012)      | 43                          | 98.9     | 80                                 | 32                       | 180 m x 180 m & 240 m x 240 m                | 2 years         | twice a week, weekly and monthly                                       |
| Hay Canyon, OR (2009-2010)        | 48                          | 100.8    | 79                                 | 20                       | 180 m x 180 m                                | 1 year          | bi-monthly (spring, fall), monthly (winter, summer)                    |
| Heritage Garden I, MI (2012-2014) | 14                          | 28       | 90                                 | 14                       | 120x120 m except one plot that was 280x280 m | 1 years         | weekly (spring, summer, and fall) and bi-weekly (winter)               |
| High Winds, CA (2003-2004)        | 90                          | 162      | 60                                 | 90                       | 75-m radius                                  | 1 year          | bi-monthly                                                             |
| High Winds, CA (2004-2005)        | 90                          | 162      | 60                                 | 90                       | 75-m radius                                  | 1 year          | bi-monthly                                                             |
| Hopkins Ridge, WA (2006)          | 83                          | 150      | 67                                 | 41                       | 180 m x 180 m                                | 1 year          | monthly, weekly (subset of 22 turbines spring and fall migration)      |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                           | Total # of Turbines | Total MW | Tower size (m)                         | Number turbines searches | Plot Size                                      | Length of Study | Survey Frequency                                                                                                        |
|----------------------------------------|---------------------|----------|----------------------------------------|--------------------------|------------------------------------------------|-----------------|-------------------------------------------------------------------------------------------------------------------------|
| Hopkins Ridge, WA (2008)               | 87                  | 156.6    | 67                                     | 41-43                    | 180 m x 180 m                                  | 1 year          | bi-monthly (spring, fall), monthly (winter, summer)                                                                     |
| Jersey Atlantic, NJ (2008)             | 5                   | 7.5      | 80                                     | 5                        | 130 m x 120 m                                  | 9 months        | weekly                                                                                                                  |
| Judith Gap, MT (2006-2007)             | 90                  | 135      | 80                                     | 20                       | 190 m x 190 m                                  | 7 months        | monthly                                                                                                                 |
| Judith Gap, MT (2009)                  | 90                  | 135      | 80                                     | 30                       | 100 m x 100 m                                  | 5 months        | bi-monthly<br>bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)                         |
| Kewaunee County, WI (1999-2001)        | 31                  | 20.46    | 65                                     | 31                       | 60 m x 60 m                                    | 2 years         |                                                                                                                         |
| Kibby, ME (2011)                       | 44                  | 132      | 124                                    | 22 turbines              | 75-m diameter circular plots                   | 22 weeks        | avg 5-day bi-weekly from Aug 15 - Oct 31 and March 16 - May 15; every 4 weeks from Nov 1 - March 15 and May 16 - Aug 14 |
| Kittitas Valley, WA (2011-2012)        | 48                  | 100.8    | 80                                     | 48                       | 100 m x 102 m                                  | 1 year          |                                                                                                                         |
| Klondike, OR (2002-2003)               | 16                  | 24       | 80                                     | 16                       | 140 m x 140 m                                  | 1 year          | monthly                                                                                                                 |
| Klondike II, OR (2005-2006)            | 50                  | 75       | 80                                     | 25                       | 180 m x 180 m                                  | 1 year          | bi-monthly (spring, fall), monthly (summer, winter)                                                                     |
| Klondike III (Phase I), OR (2007-2009) | 125                 | 223.6    | GE = 80; Siemens = 80, Mitsubishi = 80 | 46                       | 240 m x 240 m (1.5MW)<br>252 m x 252 m (2.3MW) | 2 year          | bi-monthly (spring, fall migration), monthly (summer, winter)                                                           |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                             | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches         | Plot Size     | Length of Study | Survey Frequency                                                      |
|------------------------------------------|---------------------|----------|----------------|----------------------------------|---------------|-----------------|-----------------------------------------------------------------------|
| Klondike IIIa (Phase II), OR (2008-2010) | 51                  | 76.5     | GE = 80        | 34                               | 240 m x 240 m | 2 years         | bi-monthly (spring, fall), monthly (summer, winter)                   |
| Lakefield Wind, MN (2012)                | 137                 | 205.5    | 80             | 26                               | 100 m x 100 m | 7.5 months      | 3 times per week bi-monthly (spring, fall), monthly (winter, summer)  |
| Leaning Juniper, OR (2006-2008)          | 67                  | 100.5    | 80             | 17                               | 240 m x 240 m | 2 years         | bi-monthly (spring, fall), monthly (winter, summer)                   |
| Lempster, NH (2009)                      | 12                  | 24       | 78             | 4                                | 120 m x 130 m | 6 months        | daily                                                                 |
| Lempster, NH (2010)                      | 12                  | 24       | 78             | 12                               | 120 m x 130 m | 6 months        | weekly                                                                |
| Linden Ranch, WA (2010-2011)             | 25                  | 50       | 80             | 25                               | 110 m x 110 m | 1 year          | bi-weekly(spring, fall), monthly (summer, winter)                     |
| Locust Ridge, PA (Phase II; 2009)        | 51                  | 102      | 80             | 15                               | 120m x 126m   | 6.5 months      | daily                                                                 |
| Locust Ridge, PA (Phase II; 2010)        | 51                  | 102      | 80             | 15                               | 120m x 126m   | 6.5 months      | daily                                                                 |
| Madison, NY (2001-2002)                  | 7                   | 11.55    | 67             | 7                                | 60-m radius   | 1 year          | weekly (spring, fall), monthly (summer)                               |
| Maple Ridge, NY (2006)                   | 120                 | 198      | 80             | 50                               | 130 m x 120 m | 5 months        | daily (10 turbines), every 3 days (10 turbines), weekly (30 turbines) |
| Maple Ridge, NY (2007)                   | 195                 | 321.75   | 80             | 64                               | 130 m x 120 m | 7 months        | weekly                                                                |
| Maple Ridge, NY (2007-2008)              | 195                 | 321.75   | 80             | 64                               | 130 m x 120 m | 7 months        | weekly                                                                |
| Maple Ridge, NY (2012)                   | 195                 | 321.75   | 80             | 105 (5 turbines, 100 roads/pads) | 100 m x 100 m | 3 months        | weekly                                                                |
| Marengo I, WA (2009-2010)                | 78                  | 140.4    | 67             | 39                               | 180 m x 180 m | 1 year          | bi-monthly (spring, fall), monthly (winter, summer)                   |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                    | Total # of Turbines | Total MW               | Tower size (m) | Number turbines searches | Plot Size                                   | Length of Study      | Survey Frequency                                                                                                                             |
|---------------------------------|---------------------|------------------------|----------------|--------------------------|---------------------------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Marengo II, WA (2009-2010)      | 39                  | 70.2                   | 67             | 20                       | 180 m x 180 m                               | 1 year               | bi-monthly (spring, fall), monthly (winter, summer) daily (2 random turbines), weekly (all turbines): extended plot searched once per season |
| Mars Hill, ME (2007)            | 28                  | 42                     | 80.5           | 28                       | 76-m diameter, extended plot 238-m diameter | spring, summer, fall | weekly: extended plot searched once per season                                                                                               |
| Mars Hill, ME (2008)            | 28                  | 42                     | 80.5           | 28                       | 76-m diameter, extended plot 238-m diameter | spring, summer, fall | weekly: extended plot searched once per season                                                                                               |
| McBride, Alb (2004)             | 114                 | 75                     | 50             | 114                      | 4 parallel transects 120-m wide             | 1 year               | weekly, bi-weekly                                                                                                                            |
| Melancthon, Ont (Phase I; 2007) | 45                  | NA                     | NA             | 45                       | 35m radius                                  | 5 months             | weekly, twice weekly                                                                                                                         |
| Meyersdale, PA (2004)           | 20                  | 30                     | 80             | 20                       | 130 m x 120 m                               | 6 weeks              | daily (half turbines), weekly (half turbines)                                                                                                |
| Milford I & II, UT (2011-2012)  | 107                 | 160.5 (58.5 I, 102 II) | 80             | 43                       | 120x120                                     | NA                   | every 10.5 days                                                                                                                              |
| Milford I, UT (2010-2011)       | 58                  | 145                    | 80             | 24                       | 120x120                                     | NA                   | weekly                                                                                                                                       |
| Montezuma I, CA (2011)          | 16                  | 36.8                   | 80             | 16                       | 105 m radius                                | 1 year               | Weekly and bi-Weekly                                                                                                                         |
| Montezuma I, CA (2012)          | 16                  | 36.8                   | 80             | 16                       | 105 m radius                                | 1 year               | Weekly and bi-Weekly                                                                                                                         |
| Montezuma II, CA (2012-2013)    | 34                  | 78.2                   | 80             | 17                       | 105 m radius                                | 1 year               | Weekly                                                                                                                                       |
| Moraine II, MN (2009)           | 33                  | 49.5                   | 82.5           | 30                       | 200 m x 200 m                               | 1 year               | weekly (migratory), monthly (non-migratory)                                                                                                  |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                  | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches             | Plot Size               | Length of Study      | Survey Frequency                                            |
|-------------------------------|---------------------|----------|----------------|--------------------------------------|-------------------------|----------------------|-------------------------------------------------------------|
| Mount Storm, WV (2009)        | 132                 | 264      | 78             | 44                                   | varied                  | 4.5 months           | weekly (28 turbines), daily (16 turbines)                   |
| Mount Storm, WV (2010)        | 132                 | 264      | 78             | 24                                   | 20 to 60 m from turbine | 6 months             | daily                                                       |
| Mount Storm, WV (2011)        | 132                 | 264      | 78             | 24                                   | varied                  | 6 months             | daily                                                       |
| Mount Storm, WV (Fall 2008)   | 82                  | 164      | 78             | 27                                   | varied                  | 3 months             | weekly (18 turbines), daily (9 turbines)                    |
| Mountaineer, WV (2003)        | 44                  | 66       | 80             | 44                                   | 60-m radius             | 7 months             | weekly, monthly                                             |
| Mountaineer, WV (2004)        | 44                  | 66       | 80             | 44                                   | 130 m x 120 m           | 6 weeks              | daily, weekly                                               |
| Munnsville, NY (2008)         | 23                  | 34.5     | 69.5           | 12                                   | 120 m x 120 m           | spring, summer, fall | weekly                                                      |
| Mustang Hills, CA (2012-2013) | 50                  | 150      | 90             | 13 plots (equivalent to 15 turbines) | 240 x 240 m             | 1 year               | bi-weekly                                                   |
| Nine Canyon, WA (2002-2003)   | 37                  | 48.1     | 60             | 37                                   | 90-m radius             | 1 year               | bi-monthly (spring, summer, fall), monthly (winter)         |
| Nine Canyon II, WA (2004)     | 12                  | 15.6     | 60             | 12                                   | 90 m x 90 m             | 3 months             | once every two weeks                                        |
| Noble Altona, NY (2010)       | 65                  | 97.5     | 80             | 22                                   | 120 m x 120 m           | spring, summer, fall | daily, weekly                                               |
| Noble Altona, NY (2011)       | 65                  | 97.5     | 80             | 22                                   | 120m x 120m             | 2 months             | daily                                                       |
| Noble Bliss, NY (2008)        | 67                  | 100      | 80             | 23                                   | 120 m x 120 m           | spring, summer, fall | daily (8 turbines), 3-day (8 turbines), weekly (7 turbines) |
| Noble Bliss, NY (2009)        | 67                  | 100      | 80             | 23                                   | 120 m x 120 m           | spring, summer, fall | weekly, 8 turbines searched daily from July 1 to August 15  |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                                 | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches                | Plot Size                        | Length of Study      | Survey Frequency                                                                       |
|----------------------------------------------|---------------------|----------|----------------|-----------------------------------------|----------------------------------|----------------------|----------------------------------------------------------------------------------------|
| Noble Bliss/Wethersfield, NY (2011)          | 151                 | 226      | 80             | 48 (24 from each site:12 ag, 12 forest) | road & pad 70 m out from turbine | 2 months             | daily                                                                                  |
| Noble Chateaugay, NY (2010)                  | 71                  | 106.5    | 80             | 24                                      | 120 m x 120 m                    | spring, summer, fall | weekly                                                                                 |
| Noble Clinton, NY (2008)                     | 67                  | 100      | 80             | 23                                      | 120 m x 120 m                    | spring, summer, fall | daily (8 turbines), 3-day (8 turbines), weekly (7 turbines)                            |
| Noble Clinton, NY (2009)                     | 67                  | 100      | 80             | 23                                      | 120 m x 120 m                    | spring, summer, fall | daily (8 turbines), weekly (15 turbines), all turbines weekly from July 1 to August 15 |
| Noble Ellenburg, NY (2008)                   | 54                  | 80       | 80             | 18                                      | 120 m x 120 m                    | spring, summer, fall | daily (6 turbines), 3-day (6 turbines), weekly (6 turbines)                            |
| Noble Ellenburg, NY (2009)                   | 54                  | 80       | 80             | 18                                      | 120 m x 120 m                    | spring, summer, fall | daily (6 turbines), weekly (12 turbines), all turbines weekly from July 1 to August 15 |
| Noble Wethersfield, NY (2010)                | 84                  | 126      | 80             | 28                                      | 120 m x 120 m                    | spring, summer, fall | weekly                                                                                 |
| NPPD Ainsworth, NE (2006)                    | 36                  | 20.5     | 70             | 36                                      | 220 m x 220 m                    | spring, summer, fall | bi-monthly                                                                             |
| Oklahoma Wind Energy Center, OK (2004; 2005) | 68                  | 102      | 70             | 68                                      | 20m radius                       | 3 months (2 years)   | bi-monthly                                                                             |
| Pacific, CA (2012-2013)                      | 70                  | 140      | 78.5           | 20                                      | 126 m radius                     | NA                   | Twice weekly (fall), and biweekly                                                      |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                                 | Total # of Turbines | Total MW | Tower size (m)                                     | Number turbines searches             | Plot Size                                                                | Length of Study | Survey Frequency                                                     |
|----------------------------------------------|---------------------|----------|----------------------------------------------------|--------------------------------------|--------------------------------------------------------------------------|-----------------|----------------------------------------------------------------------|
| Palouse Wind, WA (2012-2013)                 | 58                  | 104.4    | 80, 90, or 105 M (according to the Vestas website) | 19                                   | 120m x 120m                                                              | 1 year          | Monthly (Winter) and Weekly (Spring-Fall)                            |
| Pebble Springs, OR (2009-2010)               | 47                  | 98.7     | 79                                                 | 20                                   | 180 m x 180 m                                                            | 1 year          | bi-monthly (spring, fall), monthly (winter, summer)                  |
| Pine Tree, CA (2009-2010, 2011)              | 90                  | 135      | 65                                                 | 40                                   | 100 m radius                                                             | 1.5 year        | bi-weekly, weekly                                                    |
| Pinnacle, WV (2012)                          | 23                  | 55.2     | 80                                                 | 11                                   | 126 m x 120m                                                             | 9 months        | weekly                                                               |
| Pinnacle Operational Mitigation Study (2012) | 23                  | 55.2     | 80                                                 | 12                                   | 126m x 120m                                                              | 2.5 months      | daily                                                                |
| Pinyon Pines I & II, CA (2013-2014)          | 100                 | NA       | 90                                                 | 25 plots (aprox 31 turbines)         | 240x240 m                                                                | NA              | bi-weekly                                                            |
| Pioneer Prairie II, IA (2013)                | 62                  | 102.3    | 80                                                 | 62                                   | 80x80 m (5 turbines), road and pad within 100 m of turbine (57 turbines) | NA              | weekly                                                               |
| Pioneer Prairie I, IA (Phase II; 2011-2012)  | 62                  | 102.3    | 80                                                 | 62 (57 road/pad) 5 full search plots | 80 x 80m                                                                 | 1 year          | weekly (spring and fall), every two weeks (summer), monthly (winter) |
| Pioneer Trail, IL (2012-2013)                | 94                  | 150.5    | NA                                                 | 50                                   | 80x80m                                                                   | fall, spring    | weekly                                                               |
| Prairie Rose, MN (2014)                      | 119                 | 200      | 80                                                 | 10                                   | 100x100m                                                                 | 6 months        | weekly                                                               |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                        | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches | Plot Size                                                                                                                       | Length of Study | Survey Frequency                                                              |
|-------------------------------------|---------------------|----------|----------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------|
| PrairieWinds SD1, SD (2012-2013)    | 108                 | 162      | 80             | 50                       | 200 x 200m                                                                                                                      | 1 year          | bi-weekly<br>twice monthly                                                    |
| PrairieWinds SD1, SD (2013-2014)    | 108                 | 162      | 80             | 45                       | 200 x 200m                                                                                                                      | 1 year          | (spring, summer, fall), monthly (winter)                                      |
| PrairieWinds ND1 (Minot), ND (2010) | 80                  | 115.5    | 89             | 35                       | minimum of 100 m x 100 m                                                                                                        | 3 seasons       | bi-monthly                                                                    |
| PrairieWinds ND1 (Minot), ND (2011) | 80                  | 115.5    | 80             | 35                       | minimum 100 x 100m                                                                                                              | 3 season        | twice monthly<br>twice monthly                                                |
| PrairieWinds SD1, SD (2011-2012)    | 108                 | 162      | 80             | 50                       | 200 x 200m                                                                                                                      | 1 year          | (spring, summer, fall), monthly (winter)<br>weekly (spring, summer, and fall) |
| Rail Splitter, IL (2012-2013)       | 67                  | 100.5    | 80             | 34                       | 60 m radius                                                                                                                     | 1 year          | and bi-weekly (winter)                                                        |
| Record Hill, ME (2012)              | 22                  | 50.6     | 80             | 22                       | 126.5x126.5                                                                                                                     | 5 months        | three times every two weeks                                                   |
| Record Hill, ME (2014)              | 22                  | 50.6     | 80             | 10                       | varied due to steep terrain and heavily vegetated areas<br>200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer | 4.5 months      | daily for 5 days a week                                                       |
| Red Canyon, TX (2006-2007)          | 56                  | 84       | 70             | 28                       | 200 m x 200 m in fall and winter; 160 m x 160 m in spring and summer                                                            | 1 year          | every 14 days in fall and winter; 7 days in spring, 3 days in summer          |
| Red Hills, OK (2012-2013)           | 82                  | 123      | 80             | 20 (plus one met tower)  | 100 x 100                                                                                                                       | 1 year          | weekly (spring, summer, fall), monthly (winter)                               |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                                  | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches | Plot Size                                                       | Length of Study | Survey Frequency                                                             |
|-----------------------------------------------|---------------------|----------|----------------|--------------------------|-----------------------------------------------------------------|-----------------|------------------------------------------------------------------------------|
| Ripley, Ont (2008)                            | 38                  | 76       | 64             | 38                       | 80 m x 80 m                                                     | spring, fall    | twice weekly for odd turbines; weekly for even turbines.                     |
| Ripley, Ont (2008-2009)                       | 38                  | 76       | 64             | 38                       | 80 m x 80 m                                                     | 6 weeks         | twice weekly for odd turbines; weekly for even turbines.                     |
| Rollins, ME (2012)                            | 40                  | 60       | 80             | 20                       | varied; turbine laydown area and gravel access roads out to 60m | 6 months        | weekly                                                                       |
| Roth Rock, MD (2011)                          | 20                  | 50       | 80             | 10                       | 80m x 80m                                                       | 3 months        | daily                                                                        |
| Rugby, ND (2010-2011)                         | 71                  | 149      | 78             | 32                       | 200 m x 200 m                                                   | 1 year          | weekly (spring, fall; migratory turbines), monthly ( non-migratory turbines) |
| San Geronio, CA (1997-1998; 1999-2000)        | 3000                | n/a      |                | 24.4-42.7                | 50-m radius                                                     | 2 years         | quarterly                                                                    |
| Searsburg, VT (1997)                          | 11                  | 7        | 65             | 11                       | 20- to 55-m radius                                              | spring, fall    | weekly (fall migration)                                                      |
| Sheffield, VT (2012)                          | 16                  | 40       | 80             | 8                        | 126m x 120m                                                     | 3 months        | daily                                                                        |
| Sheffield Operational Mitigation Study (2012) | 16                  | 40       | 80             | 16                       | 126m x 120m                                                     | 4 months        | daily                                                                        |
| High Sheldon, NY (2010)                       | 75                  | 112.5    | 80             | 25                       | 115 m x 115 m                                                   | 7 months        | daily (8 turbines), weekly (17 turbines)                                     |
| High Sheldon, NY (2011)                       | 75                  | 112.5    | 80             | 25                       | 115 m x 115 m                                                   | 7 months        | daily (8 turbines), weekly (17 turbines)                                     |
| Shiloh I, CA (2006-2009)                      | 100                 | 150      | 65             | 100                      | 105-m radius                                                    | 3 years         | weekly                                                                       |
| Shiloh II, CA (2009-2010)                     | 75                  | 150      | 80             | 25                       | 100m radius                                                     | 1 year          | weekly                                                                       |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                      | Total #<br>of<br>Turbines | Total<br>MW | Tower<br>size (m) | Number turbines searches  | Plot Size                             | Length<br>of<br>Study                       | Survey Frequency                                          |
|-----------------------------------|---------------------------|-------------|-------------------|---------------------------|---------------------------------------|---------------------------------------------|-----------------------------------------------------------|
| Shiloh II, CA<br>(2010-2011)      | 75                        | 150         | 80                | 25                        | 100 m radius                          | 1 year                                      | weekly                                                    |
| Shiloh III, CA<br>(2012-2013)     | 50                        | 102.5       | 78.5              | 25                        | 100 m radius                          | NA                                          | weekly                                                    |
| SMUD Solano,<br>CA (2004-2005)    | 22                        | 15          | 65                | 22                        | 60-m radius                           | 1 year                                      | bi-monthly                                                |
| Solano III, CA<br>(2012-2013)     | 55                        | 128         | 80                | 19                        | 100 m radius                          | NA                                          | bi-Weekly                                                 |
| Spruce Mountain,<br>ME (2012)     | 10                        | 20          | 78                | 10                        | 100 m x 100<br>m                      | 7<br>months                                 | weekly                                                    |
| Stateline, OR/WA<br>(2001-2002)   | 454                       | 299         | 50                | 124                       | minimum 126<br>m x 126 m              | 17<br>months                                | bi-weekly, monthly                                        |
| Stateline, OR/WA<br>(2003)        | 454                       | 299         | 50                | 153                       | minimum 126<br>m x 126 m              | 1 year                                      | bi-weekly, monthly                                        |
| Stateline, OR/WA<br>(2006)        | 454                       | 299         | 50                | 39                        | variable<br>turbine strings           | 1 year                                      | bi-weekly                                                 |
| Steel Winds I & II,<br>NY (2012)  | 14                        | 35          | 80                | 8 (1 was just gravel pad) | 120m x 120m                           | 6<br>months                                 | weekly, bi-weekly<br>(November only)                      |
| Steel Winds I, NY<br>(2007)       | 8                         | 20          | 80                | 8                         | 176m x 176m                           | 6.5<br>months                               | every 10 days<br>(spring, fall) every<br>21 days (summer) |
| Stetson Mountain<br>I, ME (2009)  | 38                        | 57          | 80                | 19                        | 76-m<br>diameter                      | 27<br>weeks<br>(spring,<br>summer,<br>fall) | weekly                                                    |
| Stetson Mountain<br>I, ME (2011)  | 38                        | 57          | 80                | 19                        | 79.45x79.45m                          | 6<br>months                                 | weekly                                                    |
| Stetson Mountain<br>I, ME (2013)  | 38                        | 57          | 80                | 19                        | 76 m<br>diameter                      | 6<br>months                                 | weekly                                                    |
| Stetson Mountain<br>II, ME (2010) | 17                        | 25.5        | 80                | 17                        | 74.5x74.5m                            | 6<br>months                                 | weekly (3 turbines<br>twice a week)                       |
| Stetson Mountain<br>II, ME (2012) | 17                        | 25.5        | 80                | 17                        | laydown area<br>and road up<br>to 60m | 6<br>months                                 | weekly                                                    |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                             | Total # of Turbines            | Total MW                           | Tower size (m)             | Number turbines searched | Plot Size                                 | Length of Study        | Survey Frequency                                                                                                                              |
|------------------------------------------|--------------------------------|------------------------------------|----------------------------|--------------------------|-------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Summerview, Alb (2005-2006)              | 39                             | 70.2                               | 67                         | 39                       | 140 m x 140 m                             | 1 year                 | weekly, bi-weekly (May to July, September)                                                                                                    |
| Summerview, Alb (2006; 2007)             | 39                             | 70.2                               | 65                         | 39                       | 52-m radius; 2 spiral transects 7 m apart | summer, fall (2 years) | daily (10 turbines), weekly (29 turbines)                                                                                                     |
| Tehachapi, CA (1996-1998)                | 3300                           | n/a                                | 14.7 to 57.6               | 201                      | 50-m radius                               | 20 months              | quarterly                                                                                                                                     |
| Top Crop I & II (2012-2013)              | 68 (phase I)<br>132 (phase II) | 300 (102 (phase I) 198 (phase II)) | 65 (phase I) 80 (phase II) | 100                      | 61 m radius                               | 1 year                 | weekly (spring, summer, and fall) and bi-weekly (winter)                                                                                      |
| Top of Iowa, IA (2003)                   | 89                             | 80                                 | 71.6                       | 26                       | 76 m x 76 m                               | spring, summer, fall   | once every 2 to 3 days                                                                                                                        |
| Top of Iowa, IA (2004)                   | 89                             | 80                                 | 71.6                       | 26                       | 76 m x 76 m                               | spring, summer, fall   | once every 2 to 3 days<br>monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall |
| Tuolumne (Windy Point I), WA (2009-2010) | 62                             | 136.6                              | 80                         | 21                       | 180 m x 180 m                             | 1 year                 | monthly throughout the year, a sub-set of 10 turbines were also searched weekly during the spring, summer, and fall                           |
| Vansycle, OR (1999)                      | 38                             | 24.9                               | 50                         | 38                       | 126 m x 126 m                             | 1 year                 | monthly                                                                                                                                       |
| Vantage, WA (2010-2011)                  | 60                             | 90                                 | 80                         | 30                       | 240 m x 240 m                             | 1 year                 | monthly, a subset of 10 searched weekly during migration                                                                                      |
| Vasco, CA (2012-2013)                    | 34                             | 78.2                               | 80                         | 34                       | 105 m radius                              | 1 year                 | weekly, monthly                                                                                                                               |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| Project Name                           | Total # of Turbines | Total MW | Tower size (m) | Number turbines searches | Plot Size                         | Length of Study      | Survey Frequency                                                               |
|----------------------------------------|---------------------|----------|----------------|--------------------------|-----------------------------------|----------------------|--------------------------------------------------------------------------------|
| Wessington Springs, SD (2009)          | 34                  | 51       | 80             | 20                       | 200 m x 200 m                     | spring, summer, fall | bi-monthly                                                                     |
| Wessington Springs, SD (2010)          | 34                  | 51       | 80             | 20                       | 200 m x 200 m                     | 8 months             | bi-weekly (spring, summer, fall)                                               |
| White Creek, WA (2007-2011)            | 89                  | 204.7    | 80             | 89                       | 180 m x 180 m & 240 m x 240 m     | 4 years              | twice a week, weekly and monthly                                               |
| Wild Horse, WA (2007)                  | 127                 | 229      | 67             | 64                       | 110 m from two turbines in plot   | 1 year               | monthly, weekly (fall, spring migration at 16 turbines)                        |
| Windy Flats, WA (2010-2011)            | 114                 | 262.2    | 80             | 36 (plus 1 MET tower)    | 180 m x 180 m (120m at MET tower) | 1 year               | monthly (spring, summer, fall, and winter), weekly (spring and fall migration) |
| Winnebago, IA (2009-2010)              | 10                  | 20       | 78             | 10                       | 200 m x 200 m                     | 1 year               | weekly (migratory), monthly (non-migratory)                                    |
| Wolfe Island, Ont (May-June 2009)      | 86                  | 197.8    | 80             | 86                       | 60-m radius                       | spring               | 43 twice weekly, 43 weekly                                                     |
| Wolfe Island, Ont (July-December 2009) | 86                  | 197.8    | 80             | 86                       | 60-m radius                       | summer, fall         | 43 twice weekly, 43 weekly                                                     |
| Wolfe Island, Ont (January-June 2010)  | 86                  | 197.8    | 80             | 86                       | 60-m radius                       | 6 months             | 43 twice weekly, 43 weekly                                                     |
| Wolfe Island, Ont (July-December 2010) | 86                  | 197.8    | 80             | 86                       | 50-m radius                       | 6 months             | 43 twice weekly, 43 weekly                                                     |
| Wolfe Island, Ont (January-June 2011)  | 86                  | 197.8    | 80             | 86                       | 50m radius                        | 6 months             | 43 twice weekly, 43 weekly                                                     |

**Appendix A3. All post-construction monitoring studies, project characteristics, and select study methodology.**

| <b>Project Name</b>                          | <b>Total #<br/>of<br/>Turbines</b> | <b>Total<br/>MW</b> | <b>Tower<br/>size (m)</b> | <b>Number turbines searches</b> | <b>Plot Size</b> | <b>Length<br/>of<br/>Study</b> | <b>Survey Frequency</b>                              |
|----------------------------------------------|------------------------------------|---------------------|---------------------------|---------------------------------|------------------|--------------------------------|------------------------------------------------------|
| Wolfe Island, Ont<br>(July-December<br>2011) | 86                                 | 197.8               | 80                        | 86                              | 50m radius       | 6<br>months                    | 43 twice weekly, 43<br>weekly                        |
| Wolfe Island, Ont<br>(January-June<br>2012)  | 86                                 | 197.8               | NA                        | 86                              | 50 m radius      | NA                             | 1/2 searched twice<br>weekly, 1/2<br>searched weekly |

**Appendix A3 (continued). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:**

| Project, Location                                | Reference                        | Project, Location                          | Reference                     |
|--------------------------------------------------|----------------------------------|--------------------------------------------|-------------------------------|
| Alite, CA (09-10)                                | Chatfield et al. 2010            | Marengo I, WA (09-10)                      | URS Corporation 2010b         |
| Alta Wind I, CA (11-12)                          | Chatfield et al. 2012            | Marengo II, WA (09-10)                     | URS Corporation 2010c         |
| Alta Wind I-V, CA (13-14)                        | Chatfield et al. 2014            | Mars Hill, ME (07)                         | Stantec 2008a                 |
| Alta Wind II-V, CA (11-12)                       | Chatfield et al. 2012            | Mars Hill, ME (08)                         | Stantec 2009a                 |
| Alta VIII, CA (12-13)                            | Chatfield and Bay 2014           | McBride, Alb (04)                          | Brown and Hamilton 2004       |
| Barton I & II, IA (10-11)                        | Derby et al. 2011a               | Melancthon, Ont (Phase I; 07)              | Stantec Ltd. 2008             |
| Barton Chapel, TX (09-10)                        | WEST 2011                        | Meyersdale, PA (04)                        | Arnett et al. 2005            |
| Beech Ridge, WV (12)                             | Tidhar et al. 2013b              | Milford I, UT (10-11)                      | Stantec 2011b                 |
| Beech Ridge, WV (13)                             | Young et al. 2014b               | Milford I & II, UT (11-12)                 | Stantec 2012b                 |
| Big Blue, MN (13)                                | Fagen Engineering 2014           | Montezuma I, CA (11)                       | ICF International 2012        |
| Big Blue, MN (14)                                | Fagen Engineering 2015           | Montezuma I, CA (12)                       | ICF International 2013        |
| Big Horn, WA (06-07)                             | Kronner et al. 2008              | Montezuma II, CA (12-13)                   | Harvey & Associates 2013      |
| Big Smile, OK (12-13)                            | Derby et al. 2013b               | Moraine II, MN (09)                        | Derby et al. 2010d            |
| Biglow Canyon, OR (Phase I; 08)                  | Jeffrey et al. 2009a             | Mount Storm, WV (Fall 08)                  | Young et al. 2009b            |
| Biglow Canyon, OR (Phase I; 09)                  | Enk et al. 2010                  | Mount Storm, WV (09)                       | Young et al. 2009a, 2010b     |
| Biglow Canyon, OR (Phase II; 09-10)              | Enk et al. 2011a                 | Mount Storm, WV (10)                       | Young et al. 2010a, 2011b     |
| Biglow Canyon, OR (Phase II; 10-11)              | Enk et al. 2012b                 | Mount Storm, WV (11)                       | Young et al. 2011a, 2012b     |
| Biglow Canyon, OR (Phase III; 10-11)             | Enk et al. 2012a                 | Mountaineer, WV (03)                       | Kerns and Kerlinger 2004      |
| Blue Sky Green Field, WI (08; 09)                | Gruver et al. 2009b              | Mountaineer, WV (04)                       | Arnett et al. 2005            |
| Buena Vista, CA (08-09)                          | Insignia Environmental 2009      | Munnsville, NY (08)                        | Stantec 2009b                 |
| Buffalo Gap I, TX (06)                           | Tierney 2007                     | Mustang Hills, CA (12-13)                  | Chatfield and Bay 2014        |
| Buffalo Gap II, TX (07-08)                       | Tierney 2009                     | Nine Canyon, WA (02-03)                    | Erickson et al. 2003          |
| Buffalo Mountain, TN (00-03)                     | Nicholson et al. 2005            | Nine Canyon II, WA (04)                    | Erickson et al. 2005          |
| Buffalo Mountain, TN (05)                        | Fiedler et al. 2007              | Noble Altona, NY (10)                      | Jain et al. 2011b             |
| Buffalo Ridge, MN (94-95)                        | Osborn et al. 1996, 2000         | Noble Altona, NY (11)                      | Kerlinger et al. 2011b        |
| Buffalo Ridge, MN (Phase I; 96)                  | Johnson et al. 2000              | Noble Bliss, NY (08)                       | Jain et al. 2009e             |
| Buffalo Ridge, MN (Phase I; 97)                  | Johnson et al. 2000              | Noble Bliss, NY (09)                       | Jain et al. 2010a             |
| Buffalo Ridge, MN (Phase I; 98)                  | Johnson et al. 2000              | Noble Bliss/Wethersfield, NY (11)          | Kerlinger et al. 2011a        |
| Buffalo Ridge, MN (Phase I; 99)                  | Johnson et al. 2000              | Noble Chateaugay, NY (10)                  | Jain et al. 2011c             |
| Buffalo Ridge, MN (Phase II; 98)                 | Johnson et al. 2000              | Noble Clinton, NY (08)                     | Jain et al. 2009c             |
| Buffalo Ridge, MN (Phase II; 99)                 | Johnson et al. 2000              | Noble Clinton, NY (09)                     | Jain et al. 2010b             |
| Buffalo Ridge, MN (Phase II; 01/Lake Benton I)   | Johnson et al. 2004              | Noble Ellenburg, NY (08)                   | Jain et al. 2009b             |
| Buffalo Ridge, MN (Phase II; 02/Lake Benton I)   | Johnson et al. 2004              | Noble Ellenburg, NY (09)                   | Jain et al. 2010c             |
| Buffalo Ridge, MN (Phase III; 99)                | Johnson et al. 2000              | Noble Wethersfield, NY (10)                | Jain et al. 2011a             |
| Buffalo Ridge, MN (Phase III; 01/Lake Benton II) | Johnson et al. 2004              | NPPD Ainsworth, NE (06)                    | Derby et al. 2007             |
| Buffalo Ridge, MN (Phase III; 02/Lake Benton II) | Johnson et al. 2004              | Oklahoma Wind Energy Center, OK (04; 05)   | Piorkowski and O'Connell 2010 |
| Buffalo Ridge I, SD (09-10)                      | Derby et al. 2010b               | Pacific, CA (12-13)                        | Sapphos 2014                  |
| Buffalo Ridge II, SD (11-12)                     | Derby et al. 2012a               | Palouse Wind, WA (12-13)                   | Stantec 2013a                 |
| Casselman, PA (08)                               | Arnett et al. 2009b              | Pebble Springs, OR (09-10)                 | Gritski and Kronner 2010b     |
| Casselman, PA (09)                               | Arnett et al. 2010               | Pine Tree, CA (09-10, 11)                  | BioResource Consultants 2012  |
| Casselman Curtailment, PA (08)                   | Arnett et al. 2009a              | Pinnacle, WV (12)                          | Hein et al. 2013b             |
| Castle River, Alb. (01)                          | Brown and Hamilton 2006a         | Pinnacle Operational Mitigation Study (12) | Hein et al. 2013c             |
| Castle River, Alb. (02)                          | Brown and Hamilton 2006a         | Pinyon Pines I & II, CA (13-14)            | Chatfield and Russo 2014      |
| Cedar Ridge, WI (09)                             | BHE Environmental 2010           | Pioneer Prairie I, IA (Phase II; 11-12)    | Chodachek et al. 2012         |
| Cedar Ridge, WI (10)                             | BHE Environmental 2011           | Pioneer Prairie II, IA (13)                | Chodachek et al. 2014         |
| Cohocton/Dutch Hill, NY (09)                     | Stantec 2010                     | Pioneer Trail, IL (12-13)                  | ARCADIS 2013                  |
| Cohocton/Dutch Hills, NY (10)                    | Stantec 2011a                    | Prairie Rose, MN (14)                      | Chodachek et al. 2015         |
| Combine Hills, OR (Phase I; 04-05)               | Young et al. 2006                | PrairieWinds ND1 (Minot), ND (10)          | Derby et al. 2011c            |
| Combine Hills, OR (11)                           | Enz et al. 2012                  | PrairieWinds ND1 (Minot), ND (11)          | Derby et al. 2012c            |
| Condon, OR                                       | Fishman Ecological Services 2003 | PrairieWinds SD1 (Crow Lake), SD (11-12)   | Derby et al. 2012d            |
| Crescent Ridge, IL (05-06)                       | Kerlinger et al. 2007            | PrairieWinds SD1 (Crow Lake), SD (12-13)   | Derby et al. 2013a            |
| Criterion, MD (11)                               | Young et al. 2012a               | PrairieWinds SD1 (Crow Lake), SD (13-14)   | Derby et al. 2014             |
| Criterion, MD (12)                               | Young et al. 2013                | Rail Splitter, IL (12-13)                  | Good et al. 2013b             |
| Criterion, MD (13)                               | Young et al. 2014a               | Record Hill, ME (12)                       | Stantec 2013b                 |
| Crystal Lake II, IA (09)                         | Derby et al. 2010a               | Record Hill, ME (14)                       | Stantec 2015                  |
| Diablo Winds, CA (05-07)                         | WEST 2006, 2008                  | Red Canyon, TX (06-07)                     | Miller 2008                   |
| Dillon, CA (08-09)                               | Chatfield et al. 2009            | Red Hills, OK (12-13)                      | Derby et al. 2013c            |
| Dry Lake I, AZ (09-10)                           | Thompson et al. 2011             | Ripley, Ont (08)                           | Jacques Whitford 2009         |
| Dry Lake II, AZ (11-12)                          | Thompson and Bay 2012            | Ripley, Ont (08-09)                        | Golder Associates 2010        |
| Elkhorn, OR (08)                                 | Jeffrey et al. 2009b             | Rollins, ME (12)                           | Stantec 2013c                 |
| Elkhorn, OR (10)                                 | Enk et al. 2011b                 | Roth Rock, MD (11)                         | Atwell 2012                   |
| Elm Creek, MN (09-10)                            | Derby et al. 2010c               | Rugby, ND (10-11)                          | Derby et al. 2011b            |
| Elm Creek II, MN (11-12)                         | Derby et al. 2012b               | San Gorgonio, CA (97-98; 99-00)            | Anderson et al. 2005          |
| Erie Shores, Ont. (06)                           | James 2008                       | Searsburg, VT (97)                         | Kerlinger 2002a               |
| Foot Creek Rim, WY (Phase I; 99)                 | Young et al. 2003a               | Sheffield, VT (12)                         | Martin et al. 2013            |

**Appendix A3 (continued). All post-construction monitoring studies, project characteristics, and select study methodology. Data from the following sources:**

| Project, Location                    | Reference                       | Project, Location                           | Reference                           |
|--------------------------------------|---------------------------------|---------------------------------------------|-------------------------------------|
| Foote Creek Rim, WY (Phase I; 00)    | Young et al. 2003a              | Sheffield Operational Mitigation Study (12) | Martin et al. 2013                  |
| Foote Creek Rim, WY (Phase I; 01-02) | Young et al. 2003a              | Shiloh I, CA (06-09)                        | Kerlinger et al. 2009               |
| Forward Energy Center, WI (08-10)    | Grodsky and Drake 2011          | Shiloh II, CA (09-10)                       | Kerlinger et al. 2010               |
| Fowler I, IN (09)                    | Johnson et al. 2010a            | Shiloh II, CA (10-11)                       | Kerlinger et al. 2013a              |
| Fowler I, II, III, IN (10)           | Good et al. 2011                | Shiloh III, CA (12-13)                      | Kerlinger et al. 2013b              |
| Fowler I, II, III, IN (11)           | Good et al. 2012                | SMUD Solano, CA (04-05)                     | Erickson and Sharp 2005             |
| Fowler I, II, III, IN (12)           | Good et al. 2013c               | Solano III, CA (12-13)                      | AECOM 2013                          |
| Fowler III, IN (09)                  | Johnson et al. 2010b            | Spruce Mountain, ME (12)                    | Tetra Tech 2013                     |
| Goodnoe, WA (09-10)                  | URS Corporation 2010a           | Stateline, OR/WA (01-02)                    | Erickson et al. 2004                |
| Grand Ridge I, IL (09-10)            | Derby et al. 2010g              | Stateline, OR/WA (03)                       | Erickson et al. 2004                |
| Harrow, Ont (10)                     | Natural Resource Solutions 2011 | Stateline, OR/WA (06)                       | Erickson et al. 2007                |
| Harvest Wind, WA (10-12)             | Downes and Gritski 2012a        | Steel Winds I, NY (07)                      | Grehan 2008                         |
| Hay Canyon, OR (09-10)               | Gritski and Kronner 2010a       | Steel Winds I & II, NY (12)                 | Stantec 2013d                       |
| Heritage Garden I, MI (12-14)        | Kerlinger et al. 2014           | Stetson Mountain I, ME (09)                 | Stantec 2009c                       |
| High Sheldon, NY (10)                | Tidhar et al. 2012a             | Stetson Mountain I, ME (11)                 | Normandeau Associates 2011          |
| High Sheldon, NY (11)                | Tidhar et al. 2012b             | Stetson Mountain I, ME (13)                 | Stantec 2014                        |
| High Winds, CA (03-04)               | Kerlinger et al. 2006           | Stetson Mountain II, ME (10)                | Normandeau Associates 2010          |
| High Winds, CA (04-05)               | Kerlinger et al. 2006           | Stetson Mountain II, ME (12)                | Stantec 2013e                       |
| Hopkins Ridge, WA (06)               | Young et al. 2007               | Summerview, Alb (05-06)                     | Brown and Hamilton 2006b            |
| Hopkins Ridge, WA (08)               | Young et al. 2009c              | Summerview, Alb (06; 07)                    | Baerwald 2008                       |
| Jersey Atlantic, NJ (08)             | NJAS 2008a, 2008b, 2009         | Tehachapi, CA (96-98)                       | Anderson et al. 2004                |
| Judith Gap, MT (06-07)               | TRC 2008                        | Top Crop I & II, IL (12-13)                 | Good et al. 2013a                   |
| Judith Gap, MT (09)                  | Poulton and Erickson 2010       | Top of Iowa, IA (03)                        | Jain 2005                           |
| Kewaunee County, WI (99-01)          | Howe et al. 2002                | Top of Iowa, IA (04)                        | Jain 2005                           |
| Kibby, ME (11)                       | Stantec 2012a                   | Tuolumne (Windy Point I), WA (09-10)        | Enz and Bay 2010                    |
| Kittitas Valley, WA (11-12)          | Stantec Consulting 2012         | Vansycle, OR (99)                           | Erickson et al. 2000                |
| Klondike, OR (02-03)                 | Johnson et al. 2003             | Vantage, WA (10-11)                         | Ventus Environmental Solutions 2012 |
| Klondike II, OR (05-06)              | NWC and WEST 2007               | Vasco, CA (12-13)                           | Brown et al. 2013                   |
| Klondike III (Phase I), OR (07-09)   | Gritski et al. 2010             | Wessington Springs, SD (09)                 | Derby et al. 2010f                  |
| Klondike IIIa (Phase II), OR (08-10) | Gritski et al. 2011             | Wessington Springs, SD (10)                 | Derby et al. 2011d                  |
| Lakefield Wind, MN (12)              | MPUC 2012                       | White Creek, WA (07-11)                     | Downes and Gritski 2012b            |
| Leaning Juniper, OR (06-08)          | Gritski et al. 2008             | Wild Horse, WA (07)                         | Erickson et al. 2008                |
| Lempster, NH (09)                    | Tidhar et al. 2010              | Windy Flats, WA (10-11)                     | Enz et al. 2011                     |
| Lempster, NH (10)                    | Tidhar et al. 2011              | Winnebago, IA (09-10)                       | Derby et al. 2010e                  |
| Linden Ranch, WA (10-11)             | Enz and Bay 2011                | Wolfe Island, Ont (May-June 09)             | Stantec Ltd. 2010a                  |
| Locust Ridge, PA (Phase II; 09)      | Arnett et al. 2011              | Wolfe Island, Ont (July-December 09)        | Stantec Ltd. 2010b                  |
| Locust Ridge, PA (Phase II; 10)      | Arnett et al. 2011              | Wolfe Island, Ont (January-June 10)         | Stantec Ltd. 2011a                  |
| Madison, NY (01-02)                  | Kerlinger 2002b                 | Wolfe Island, Ont (July-December 10)        | Stantec Ltd. 2011b                  |
| Maple Ridge, NY (06)                 | Jain et al. 2007                | Wolfe Island, Ont (January-June 11)         | Stantec Ltd. 2011c                  |
| Maple Ridge, NY (07)                 | Jain et al. 2009a               | Wolfe Island, Ont (July-December 11)        | Stantec Ltd. 2012                   |
| Maple Ridge, NY (07-08)              | Jain et al. 2009d               | Wolfe Island, Ont (January-June 12)         | Stantec Ltd. 2014                   |
| Maple Ridge, NY (12)                 | Tidhar et al. 2013a             |                                             |                                     |