Bat Activity Studies for the Number Nine Wind Farm Aroostook County, Maine

Final Report
April 28 – October 16, 2014

Prepared for:

EDP Renewables North America

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EXECUTIVE SUMMARY

Number Nine Wind Farm LLC, a subsidiary of EDPR Renewables North America LLC, (EDPR) has proposed a wind energy facility in Aroostook County, Maine, referred to as the Number Nine Wind Farm (Project). In April 2014, Western EcoSystems Technology, Inc. initiated a bat acoustic survey for the proposed Project in Aroostook County, Maine. The bat acoustic survey conducted was designed to estimate levels of bat activity throughout the Project during spring, summer, and fall.

Station-based acoustic surveys were conducted at four meteorological (met) tower stations in successional shrub and grassland surrounded by mixed forest, at two canopy stations facing a canopy clearing and a canopy stream, and at 35 temporary ground stations located throughout the Project and intended to increase spatial coverage of the surveys. AnaBat™ SD1 and SD2 detectors were paired at each met tower. Four detectors were placed near the ground and four were elevated to a height of 40 meters (m; 131 feet [ft]), which was intended to sample bat activity at heights near the typical rotor-sweep zone. Half of the elevated detectors were then lowered to a height of 20 m (66 ft) to comply with Maine survey guidelines (April 2014 revision). Three additional detectors were deployed at "temporary" stations and detectors were rotated to new locations on an average of every 11 days.

The paired AnaBat units placed at met towers recorded 338 bat passes during 1,199 detector-nights. Met tower units recorded a combined mean (± standard error) of 0.25 ± 0.02 bat passes per detector-night. Ground-based detectors at met towers recorded an average bat pass rate of 0.30 ± 0.03 bat passes per detector-night, and raised detectors recorded 0.22 ± 0.03 bat passes per detector-night. The AnaBat units placed at temporary stations recorded 841 bat passes during 392 detector-nights; the average bat activity recorded at bat feature locations was 1.79 ± 0.24 bat passes per detector-night.

Bat activity at met towers varied substantially between seasons, with low activity in the spring (0.11 ± 0.04 bat passes per detector-night) and higher activity in summer (0.26 ± 0.04) and fall (0.32 ± 0.05). At these stations, low-frequency (LF) and high-frequency (HF) bat pass rates peaked during the first week of August. Higher bat activity during the late summer and early fall may be due to the passage of migrating bats and/or to the additional presence of newly volant juveniles on the landscape. Bat activity was higher on average at temporary stations, and seasonal variation followed a different trend. Bat activity rates at temporary stations peaked a month and a half earlier than fixed stations, during the summer from June 5 – June 11 (22.71 bat passes per detector-night). Temporary stations recorded an average of 4.88 ± 0.77 bat passes per detector-night in the summer, 0.81 ± 0.14 bat passes per detector-night in the fall, and a seasonal low of 0.12 ± 0.06 bat passes per detector-night in the spring. Higher summer activity was primarily driven by LF bat calls, as HF bat calls at temporary stations were higher in the fall.

At met tower stations, 90.8% of bat passes were classified as LF (e.g., big brown, hoary, and silver-haired bats), and 9.7% of bat passes were classified as HF (e.g., northern long-eared, eastern red, and little brown bats). Of the HF bat passes, 90.3% were recorded at ground-based stations and 9.68% of HF calls were recorded at two of the raised units. At temporary stations, the vast majority of recorded calls were produced by LF bats (91.3%) and 8.7% of bat passes were from HF-producing bats.

In addition to station-based Anabat surveys, an acoustic transect route was driven 15 times between August 20 and October 14, 2014. A total of 26 call sequences from acoustic transect surveys were recorded and analyzed with qualitative identification and three automated software programs. A total of five species were identified by qualitative identification, including big brown bat (two identifications), eastern red bat (two), silver-haired bat (seven), hoary bat (one), and tri-colored bat (one).

No northern long-eared bats were detected at fixed ground-based detector stations, temporary ground-based detector stations, 20- or 40m raised detectors, canopy-based detectors in a clearing and along a wooded stream corridor, or during driving transects. This result echoes the results from 84 survey locations conducted in July 2014 following USFWS survey guidance, and provides strong evidence of the absence of northern long-eared bats from the project area.

The majority of *Myotis* bat calls were recorded at temporary ground stations associated with bat features. Bat passes were identified by three automated software programs, and species composition was identical among fixed and temporary Anabat stations, but varied among elevated and ground-based detectors. More tree bat species (hoary bats, silver-haired bats, eastern red bats) and tri-colored bats were recorded at raised stations and more low-flying species (little brown bats and big brown bats) were recorded at ground stations.

Bat activity recorded at the Project by fixed ground detectors during the Fall Migratory Period (FMP; 0.44 ± 0.08 bat passes per detector-night) is lower than activity at most facilities in the Northeast. Recorded bat activity was quite low overall at met tower stations and followed seasonal trends similar to other projects in the Midwestern and eastern North America.

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INTRODUCTION

Number Nine Wind Farm LLC, a subsidiary of EDPR Renewables North America LLC, (EDPR) has proposed a wind energy facility in Aroostook County, Maine, referred to as the Number Nine Wind Farm (Project). EDPR contracted Western EcoSystems Technology, Inc. (WEST) to complete a study of bat activity following the Maine Department of Inland Fisheries and Wildlife's (MDIFW) *Wind Power Preconstruction Study Design Recommendations* and WEST's experience conducting similar studies throughout North America and the Northeast. While the study plan calls for WEST to conduct acoustic monitoring surveys to estimate levels of bat activity throughout the Project during spring summer and fall, the following report also describes the results of additional acoustic monitoring surveys conducted at the request of MDIFW in the Project, as well as a summary of species detected during surveys that occurred between April 28 and October 16, 2014.

STUDY AREA

The Project is located in Aroostook County, in northeastern Maine, approximately eight miles (13 kilometers [km]) west of the town of Bridgewater (Figure 1). The Project is located in the Laurentian Plains and Hills Ecoregion in northeastern Maine (USEPA 2007). The Laurentian Plains and Hills are characterized by spruce-fir forests with some patches of deciduous trees. Glacial lakes occur in dense concentrations. Land within the Project is privately owned and the primary land use is timber harvest. Human population in the area is low. Elevations in the Project area range from approximately 500 to 1,700 feet (ft; 152 to 518 meters [m]) above sea level. The dominant vegetation type is mixed spruce-fir and deciduous forest. Common deciduous trees in the Project include maple (*Acer* spp.), beech (*Fagus* spp.), and birch (*Betula* spp).

The Study Area, encompassing the area within a 2-mile (3-km) buffer around the purposed turbine layout (Figure 2), is approximately 132,000 acres (206.7 square miles [mi^2; 535.3 km^2]) and is composed mostly of forest (75.4%; Table 1). Within the forest types are mixed forest (38.2%), deciduous forest (19.2%) and evergreen forest (18.0%; Figure 2). Woody wetland (11.6%) is common throughout the Study Area, but other wetland types (open water [0.5%] and emergent wetlands [0.2%]) are uncommon. Shrub/scrub habitat (10.4%) is common throughout the Study Area due to logging activity that has removed the forest cover. The area and regional forests are transitional and in various stages of growth (from regenerating stands to mature forest) due to past and ongoing commercial logging activity.

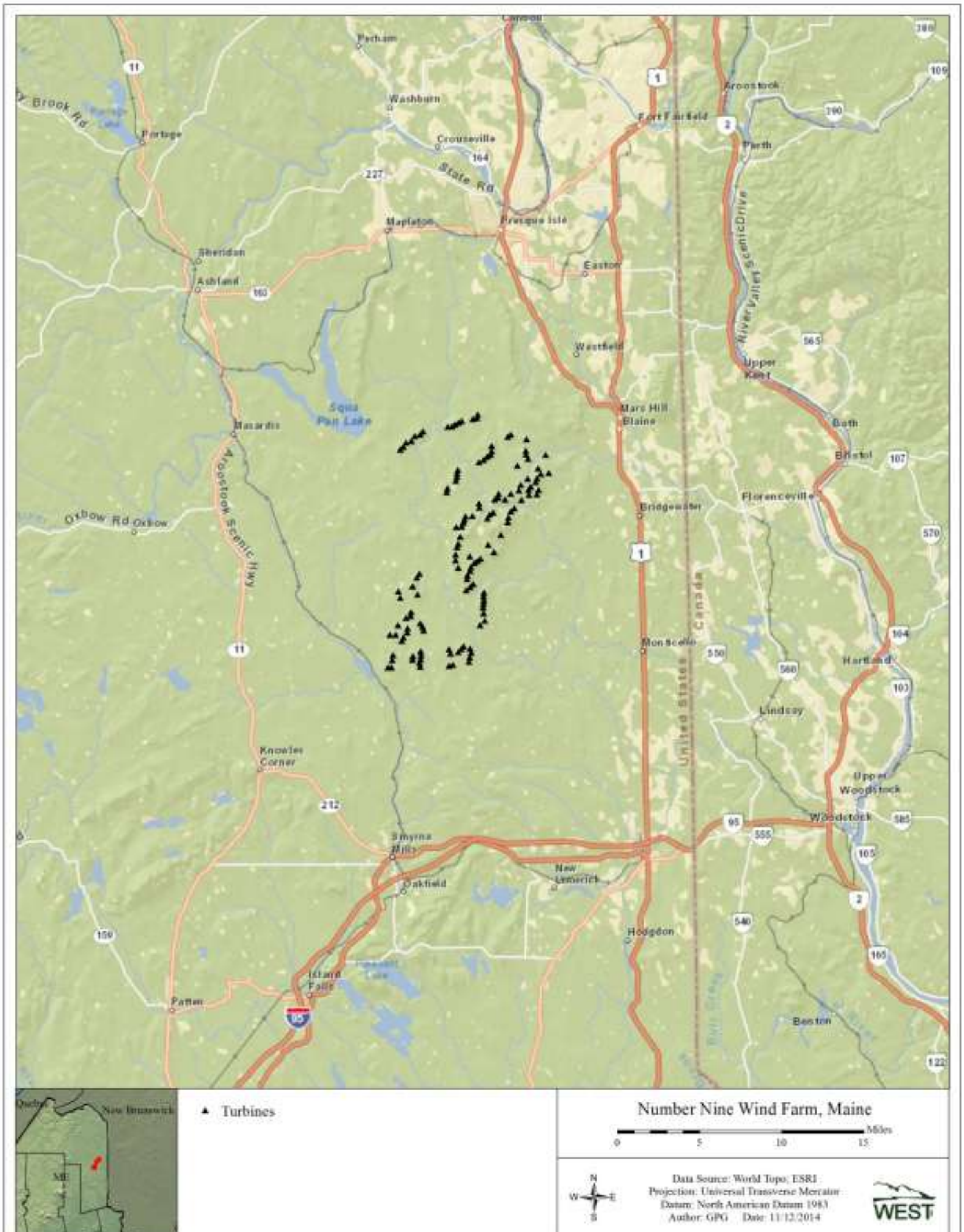

Figure 1. Topographic map showing the location of the Number Nine Wind Farm.

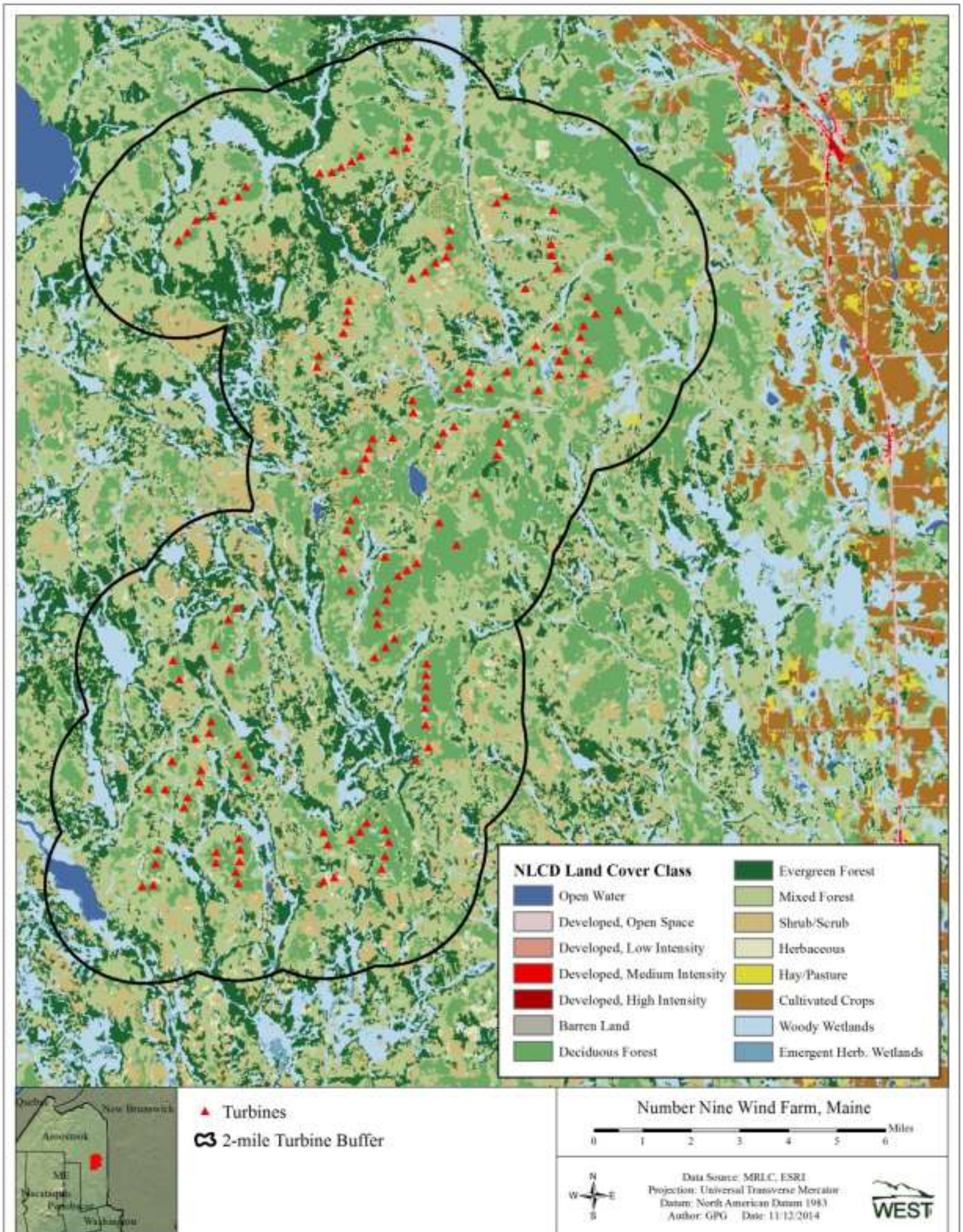

Figure 2. Land cover in the Number Nine Wind Farm (US Geological Survey [USGS] National Land Cover Data [NLCD] 2001).

Table 1. Land cover in the Number Nine Wind Farm according to the United States Geological Survey (USGS) National Land Cover Data (NLCD) (2001).

Land Cover	Square Miles	% Composition
Mixed Forest	78.85	38.2
Deciduous Forest	39.78	19.2
Evergreen Forest	37.13	18.0
Woody Wetlands	24.07	11.6
Shrub/Scrub	21.41	10.4
Herbaceous	2.73	1.3
Barren Land	1.00	0.5
Open Water	0.95	0.5
Emergent Herbaceous Wetlands	0.43	0.2
Developed, Open Space	0.20	0.1
Hay/Pasture	0.11	0.1
Cultivated Crops	0.01	<0.1
Developed, Low Intensity	<0.01	<0.1
Developed, Medium Intensity	<0.01	<0.1
Total	**206.67**	**100**

Overview of Bat Diversity

Seven species of bats potentially occur at the Project (Table 2), none of which are currently listed as endangered in Maine or at the federal level. However, the northern long-eared bat (*Myotis septentrionalis*) is currently proposed to be federally listed (USFWS 2013), and Maine is considering listing the northern long-eared and little brown bats (*M. lucifugus*) as state endangered (C. Todd, MDIFW, pers comm). The eastern small-footed bat (M. leibii) is also proposed to be listed as threatened in Maine. However, that species is not expected to occur in or near the Project.

Table 2. Bat species with potential to occur within the Number Nine Wind Farm (Harvey et al. 1999, BCI 2003) categorized by typical minimum echolocation call frequency.

Common Name	Scientific Name	Four-letter Species Code
High-Frequency (> 30 kHz)		
eastern red bat [1]	*Lasiurus borealis*	*LABO*
little brown bat	*Myotis lucifugus*	*MYLU*
northern long-eared bat [2]	*Myotis septentrionalis*	*MYSE*
tri-colored bat	*Perimyotis subflavus*	*PESU*
Low-Frequency (< 30 kHz)		
big brown bat	*Eptesicus fuscus*	*EPFU*
hoary bat [1]	*Lasiurus cinereus*	*LACI*
silver-haired bat [1]	*Lasionycteris noctivagans*	*LANO*

[1] long-distance migrant
[2] proposed to be listed as federally endangered species (USFWS 2013)

White-Nose Syndrome

Bats that hibernate in North America are being severely impacted by white-nose syndrome (WNS), a disease in which bats are infected with a fungus (*Pseudogymnoascus* [formerly *Geomyces*] *destructans*) that alters bats' physiology during hibernation (USGS 2010, Minnis and Lindner 2013). Compared to uninfected bats, bats with WNS arouse more frequently during hibernation and have higher metabolic rates during bouts of torpor than do uninfected bats, which leads to starvation prior to spring emergence (Boyles and Willis 2010; Reeder et al. 2012; Warnecke et al. 2012, Verant et al. 2014). To date, bat populations in the Northeast have been hard-hit, especially the northern long-eared bat and little brown bat whose ranges overlap with the Study Area. These species have suffered substantial population declines due to WNS (USFWS 2013, Kunz and Reichard 2010).

White-nose syndrome was first discovered in New York in 2006 and has rapidly spread to over 115 caves and mines and is now confirmed in 25 states, although the causative fungus has been identified in an additional three states. White-nose syndrome has spread north into five Canadian provinces, and spread as far south and west as Alabama and Missouri, respectively (Pennsylvania Game Commission [PGC] 2014, White-Nose Syndrome.org 2014). It is estimated that between 5.7 and 6.7 million bats have died as a result of WNS (USFWS 2012). White-nose syndrome is the primary reason the USFWS recently proposed the northern long-eared bat for listing under the Endangered Species Act (ESA; USFWS 2013), and is currently reviewing the status of the little brown bat (Kunz and Reichard 2010).

METHODS

Bat Acoustic Surveys

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

Survey Stations

A total of 10 AnaBat™ SD1 and SD2 ultrasonic bat detectors (Titley Scientific™, Australia) were used during the study. Each AnaBat unit was inside a plastic weather-tight container that had a hole cut in the side through which the microphone extended. Each microphone was encased in a 45-degree angle poly-vinyl chloride (PVC) tube, and holes were drilled in the PVC tube to allow water to drain. Raised AnaBat microphones were elevated on meteorological (met) towers using a pulley system. Standard Bat-Hat weatherproof housing was modified to use a 45-degree angle PVC elbow.

Fixed Stations

Ten AnaBat detectors were used in the fixed station study. AnaBat detectors were paired at each of four met towers (eight detectors total) with one detector at ground level (approximately one m [3.3 ft] above ground level [AGL]) and another fixed to the tower at an elevated point. The four elevated AnaBats were located at 40 m (131 ft) AGL (Figure 3). On July 28, 2014, two elevated AnaBat units, NN1r_40m and NN2r_40m, were lowered from 40 m AGL to 20 m (66 ft) AGL. These were re-named NN1r_20m and NN2r_20m, and these stations remained at 20 m for the duration of the study. On July 28, the paired ground-based detector stations, NN1_g and NN2_g, were re-named NN1g_a and NN2g_a. The other two elevated stations, NN3r and NN4r, remained at 40 m for the entire study. Species activity levels and composition can vary with altitude (Baerwald and Barclay 2009, Collins and Jones 2009, Müeller et al. 2013). Therefore, it can be useful to monitor for activity at different heights (Kunz et al. 2007b). Ground-based detectors likely detect a more complete sample of the bat species present within the project area, whereas elevated detectors may give a more representative assessment of risk to bat species flying at rotor swept heights (Kunz et al. 2007b, Müeller et al. 2013; but see Amorim et al. 2012). The fixed acoustic stations were located primarily in upland areas of shrub and grassland that had been previously clear cut to accommodate met towers. Deciduous forest was the third most common habitat type for the met tower AnaBat sites.

In addition to fixed stations at met towers, two AnaBat detectors were placed in the canopy at a height of approximately 20 m AGL. One station was placed to record bat activity within a canopy clearing near a met towers and the second station was hung in canopy enveloping a stream. These two stations were labeled NNCS for Canopy Stream and NNCC for Canopy Clearing.

<u>Temporary Stations</u>

Three AnaBat units were used at 35 ground-based temporary acoustic monitoring stations to enhance spatial coverage of the Project. Temporary acoustic stations were located approximately 1.5 m (about five ft) AGL, in a variety of habitat types, namely deciduous forest, logging roads, mixed forest and shrub. Locations of temporary stations were selected by an experienced bat biologist (Figure 3). Locations were selected for sampling due to having features that would be likely to concentrate bat activity.

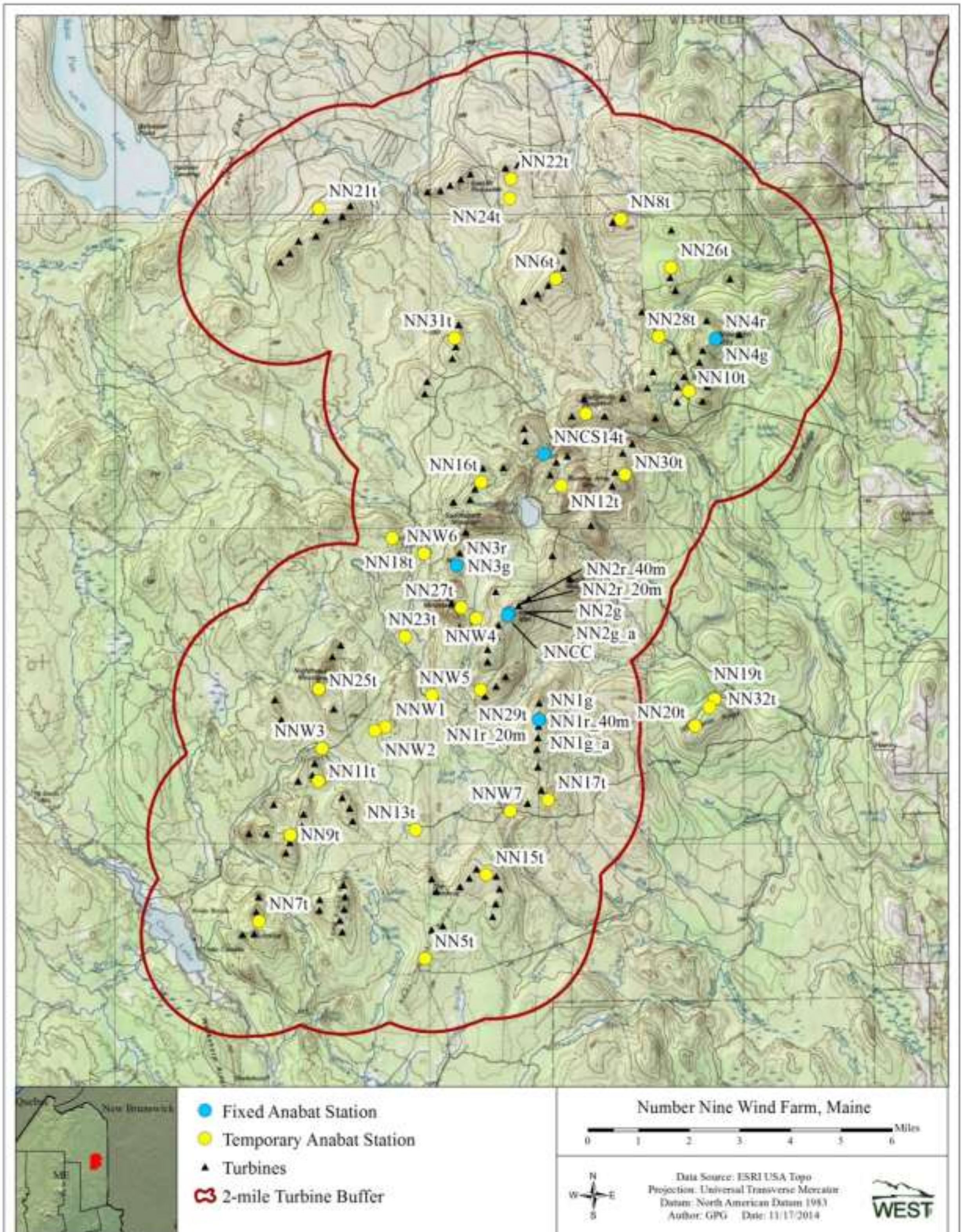

Figure 3. Location of fixed and temporary Anabat stations in the Number Nine Wind Farm. Fixed stations at met towers comprised raised ("r") and ground ("g") stations. Raised stations at NN1 and NN2 included detectors elevated at 40m and 20m heights.

Survey Schedule

Bats were surveyed in the Project from April 28 to October 16, 2014, and detectors were programmed to turn on approximately 30 minutes (min) before sunset and turn off approximately 30 min after sunrise each night. Detectors at fixed stations were programmed to run each night during the study. Detectors located at temporary stations monitored bat activity at specific locations for periods ranging from 6-29 consecutive days (6-day periods were most common, and the average days of deployment for a temporary station was 11).

Bat Acoustic Driving Transect Surveys

A single AnaBat detector was used to conduct bat acoustic driving transect surveys. The AnaBat detector was placed on the roof of a vehicle, pointing directly up toward the sky (90-degree angle from vehicle roof). Sampling began 30 min after sunset and continued until thetransect was complete. Detector sensitivity was set to 7. Bat acoustic transect methodology followed the 2010 guidelines published by the US Army Corps of Engineers (Britzke 2010). A single 34.84 mile (48 km) long transect was identified within the Study Area (Figure 4). The transect route was selected so that no back-tracking was required to complete the survey (Britzke 2010). Surveys along this transect route were completed 15 times between August 20 and October 14, 2014, on nights suitable for bat activity (low wind, lack of precipitation or fog, and warm temperatures), as well as on some nights when temperatures at the start of the transect were below recommended thresholds and/or light precipitation was occurring.

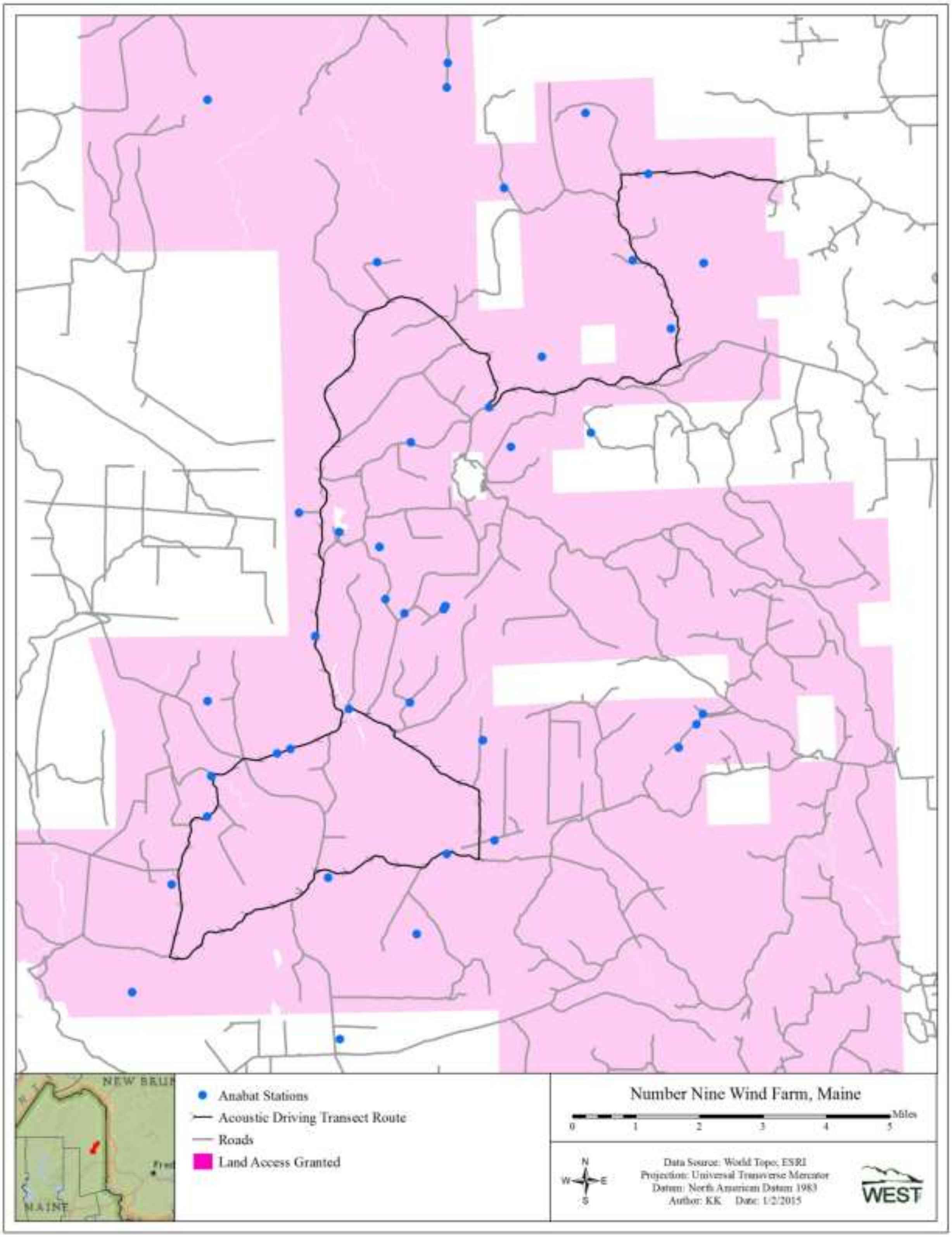

Figure 4. Location of acoustic transect TS1 in the Number Nine Wind Farm. Arrows indicate the direction of travel. Blue dots represent ground-based acoustic monitoring stations and are provided for reference.

Data Collection and Call Analysis

AnaBat detectors use a broadband high-frequency microphone to detect the echolocation calls of bats. Incoming echolocation calls are digitally processed and stored on a high capacity compact flash card. The resulting files can be viewed in appropriate software (e.g., Analook©) 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 and (when possible) the species of bat that generated the calls.

To standardize acoustic sampling effort across the project, AnaBat units were calibrated and sensitivity levels were set to six for fixed and temporary stations and set to seven for acoustic transects (Larson and Hayes 2000), a level that balanced the goal of recording bat calls against the need to reduce interference from other sources of ultrasonic noise (Brooks and Ford 2005).

To assess bat activity levels and provide data comparable with previous studies from other sites, acoustic data (i.e., bat passes) from each survey location were sorted into two groups based on their minimum frequency. High-frequency (HF) echolocation producing bats such as eastern red bats (*Lasiurus borealis*), tri-colored bats (*Perimyotis subflavus*), and *Myotis* species have minimum frequencies greater than 30 kHz. Low-frequency (LF) echolocation producing bats, such as big brown bats (*Eptesicus fuscus*), silver-haired bats (*Lasionycteris noctivagans*), and hoary bats (*Lasiurus cinereus*), typically emit echolocation calls with minimum frequencies below 30 kHz (Table 2). Acoustic station and transect data were run through three automated acoustic identification programs, Bat Call Identification (BCID East; vers. 2.5c), Kaleidoscope (Pro vers. 2.0; Wildlife Acoustics), and EchoClass (vers. 2.0; Britzke and ERDC). This was done primarily to identify any potential northern long-eared bat call sequences, but other species identifications made by the programs were also reviewed by a qualified bat biologist and are reported below. For BCID (Allen and Robbins 2010), we specified that at least five identifiable echolocation pulses needed to be present within a call sequence for identification to species group using BCID, and a minimum Discriminant Probability of 0.5 for Species ID. For Kaleidoscope, the Sensitive/Accurate setting was used to balance sensitivity and accuracy. For both BCID and Kaleidoscope, the species with potential to occur in the project area (Table 2) were included in the analysis. EchoClass does not allow any user input other than selecting the species set that the program assigns calls to. We specified Species Set 2, which includes all species of *Myotis* that may occur within the project area. Following current USFWS guidance (USFWS 2014), all call sequences identified as potential northern long-eared bats by automated programs were visually examined by a qualified bat biologist to determine the identification. Additionally, an experienced bat biologist qualitatively identified all echolocation calls recorded during acoustic transect surveys to species group through visual comparison of qualitative and quantitative echolocation call metrics (e.g., minimum frequency, slope, duration, structure) to known call reference library (Murray et al. 2001, O'Farrell et al. 1999, Yates and Muzika 2006). Calls that could not be assigned to one of these species groups were classified as unknown.

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. The average number of 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 the computer program Analook (©2004, C. Corben).

To highlight seasonal activity patterns, the study was divided into three survey periods: spring (April 28 – May 31), summer (June 1 – July 31), and fall (August 1 – October 16). 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).

The period of peak sustained bat activity was defined as the 7-day period with the highest average bat activity. This and all multi-detector averages in this report were calculated as an unweighted average of total activity at each detector. Bat activity recorded at temporary stations was not sampled at the same location continuously throughout the survey period and was therefore excluded from temporal analyses.

Risk Assessment

To assess potential for bat fatalities, bat activity in the Project was compared to existing data at other wind energy facilities in the Northeast. Among studies measuring both activity and fatality rates data were collected during the fall using AnaBat detectors placed near the ground. This report uses the activity rate recorded at fixed, ground-based detectors during the summer and fall monitoring period as a comparison with activity data from other wind energy facilities. Given the relatively small number of publically available studies and the significant ecological differences between geographically dispersed facilities, the risk assessment is qualitative, rather than quantitative. Additional analyses were designed to assess presence/absence of the northern long-eared bat, a species recently proposed for listing as federally endangered (USFWS 2013).

RESULTS

Bat Acoustic Surveys

Fixed Stations

Bat activity was monitored at 14 fixed acoustic sampling stations for a total of 1,199 detector-nights between April 28 and October 16, 2014. The four ground-based units at each of the four met towers were deployed between April 28 and May 9. The four 40-m raised detectors at each of the four met towers were deployed May 21 and May 22. On July 28, half of the raised detectors (NN1r_40m and NN2r_40m) were lowered to 20 m and renamed NN1r_20m and NN2r_20m. Their paired ground-based detectors were renamed NN1g_a and NN2g_a. NN1r_20m ran from deployment date of July 28 through the end of the study on October 16. However, unit NN2r_20m was only deployed from July 28 through August 25 due to a severed cable. On August 19, 2014, two additional detector stations were deployed near wetlands.

AnaBat units at fixed stations were operating correctly for 90% of the sampling period (Figure 5). Lost detector-nights were attributable to equipment malfunctions and were remedied as soon as possible. Fixed ground station AnaBat detectors recorded 230 bat passes over 680 detector-nights for a mean (± standard error) of 0.30 ± 0.03 bat passes per detector-night. Raised fixed station detectors recorded 108 bat passes over 498 detector nights for a mean of 0.22 ± 0.03 per detector-night. Overall, 338 bat passes were recorded for a mean of 0.25 ± 0.02 bat passes per detector night (Table 3).

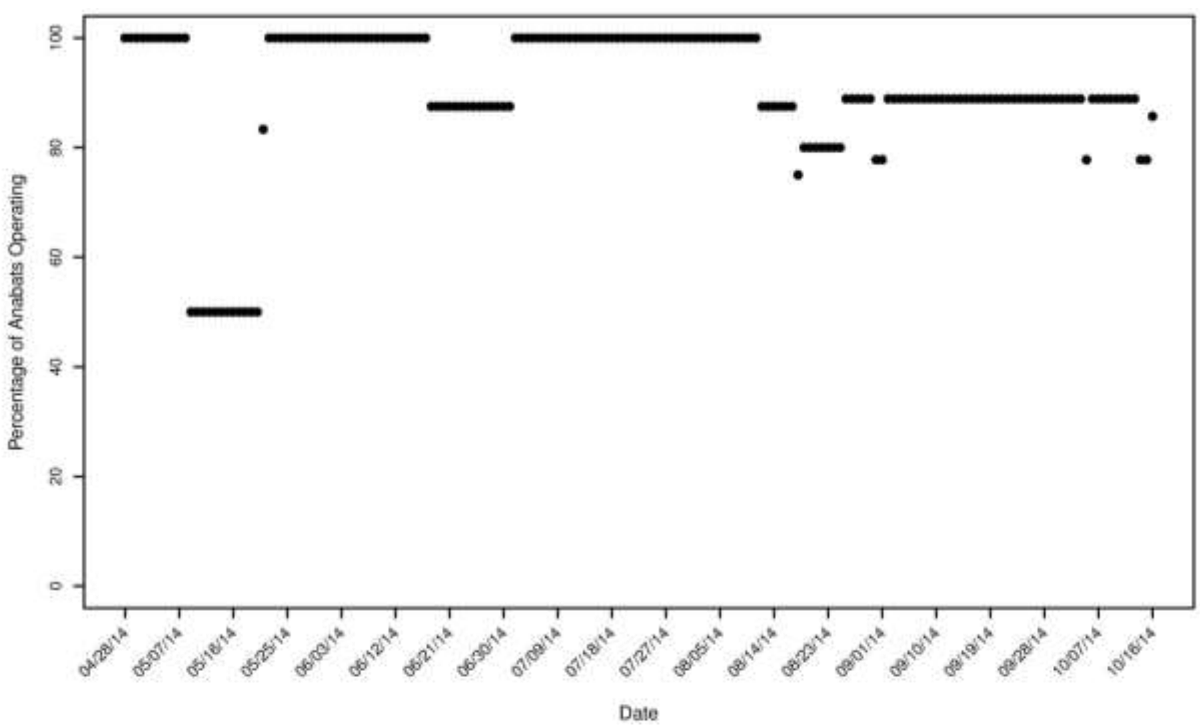

Figure 5. Operational status of fixed bat detectors operating at the Number Nine Wind Farm during each night of the study period April 28 to October 16, 2014.

Table 3. Results of acoustic bat surveys conducted at 14 fixed stations within the Number Nine Wind Farm from April 28 to October 16, 2014. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Anabat Station	Location	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night***
NN1g	ground	1	19	20	91	0.22 ± 0.05
NN1r_40m	raised	0	26	26	67	0.39 ± 0.10
NN1g_a	ground	2	17	19	81	0.23 ± 0.07
NN1r_20m	raised	2	20	22	81	0.27 ± 0.07
NN2g	ground	3	13	16	84	0.19 ± 0.05
NN2r_40m	raised	0	1	1	68	0.01 ± 0.02
NN2g_a	ground	6	25	31	81	0.38 ± 0.11
NN2r_20m	raised	0	0	0	21	0.00 ± 0.00
NN3g	ground	6	78	84	148	0.57 ± 0.10
NN3r	raised	1	21	22	134	0.16 ± 0.04
NN4g	ground	4	36	40	83	0.48 ± 0.11
NN4r	raised	0	37	37	148	0.25 ± 0.05
NNCC	canopy	5	5	10	59	0.17 ± 0.05
NNCS	canopy	1	9	10	53	0.19 ± 0.09
Total Fixed Ground		**28**	**202**	**230**	**680**	**0.30 ± 0.03**
Total Fixed Raised		**3**	**105**	**108**	**498**	**0.22 ± 0.03**
Total		**31**	**307**	**338**	**1199**	**0.25 ± 0.02**
% of Total Calls		**9.2%**	**90.8%**			

*** ± bootstrapped standard error.

Temporary Stations

Bat activity was monitored at 35 temporary acoustic sampling stations for a total of 392 detector-nights between April 28 and October 16, 2014. AnaBat detectors at temporary stations were operating for 100% of the sampling period (Figure 6). A total of 841 bat passes were recorded at temporary acoustic stations for a mean of 1.79 ± 0.24 bat passes per detector-night (Table 4).

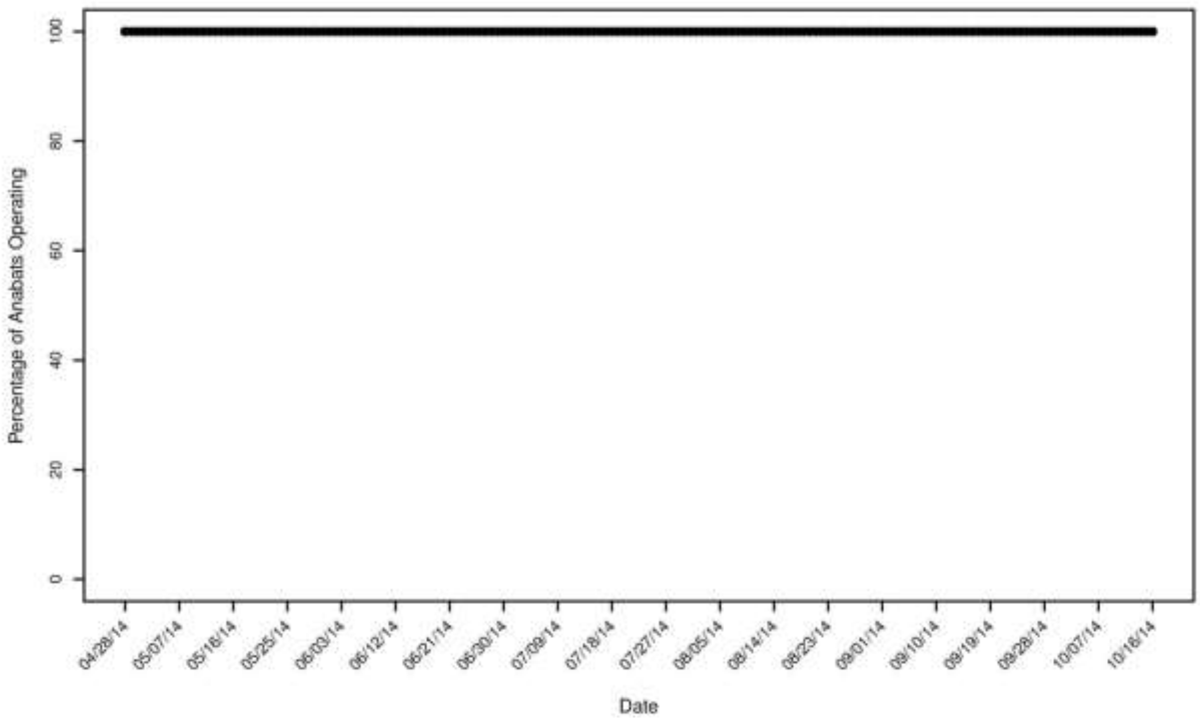

Figure 6. Operational status of temporary bat detectors operating at the Number Nine Wind Farm during each night of the study period April 28 to October 16, 2014.

Table 4. Results of acoustic bat surveys conducted at 35 temporary stations within the Number Nine Wind Farm from April 28 to October 16, 2014. Passes are separated by call frequency: high frequency (HF) and low frequency (LF).

Anabat Station	# of HF Bat Passes	# of LF Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Night*
NN5t	1	5	6	29	0.21 ± 0.08
NN6t	0	2	2	27	0.07 ± 0.05
NN7t	1	16	17	22	0.77 ± 0.25
NN8t	0	2	2	24	0.08 ± 0.08
NN9t	0	299	299	14	21.36 ± 6.91
NN10t	0	20	20	13	1.54 ± 0.45
NN11t	0	11	11	13	0.85 ± 0.27
NN12t	1	8	9	13	0.69 ± 0.22
NN13t	3	110	113	15	7.53 ± 1.95
NN14t	7	106	113	21	5.38 ± 2.25
NN15t	2	106	108	18	6.00 ± 2.25
NN16t	0	0	0	12	0.00 ± 0.00
NN17t	5	3	8	8	1.00 ± 0.18
NN18t	3	0	3	8	0.38 ± 0.29
NN19t	1	5	6	6	1.00 ± NA
NN20t	5	1	6	6	1.00 ± NA
NN21t	3	29	32	9	3.56 ± 1.26
NN22t	4	14	18	9	2.00 ± 0.79
NN23t	1	3	4	9	0.44 ± 0.35
NN24t	0	9	9	9	1.00 ± 0.39
NN25t	2	1	3	6	0.50 ± 0.30
NN26t	2	0	2	6	0.33 ± 0.31

NN27t	0	0	0	6	0.00 ± 0.00
NN28t	0	0	0	6	0.00 ± 0.00
NN29t	0	2	2	8	0.25 ± 0.25
NN30t	0	0	0	8	0.00 ± 0.00
NN31t	2	0	2	7	0.29 ± 0.20
NN32t	0	1	1	9	0.11 ± 0.11
NNW1	6	3	9	9	1.00 ± 0.41
NNW2	2	1	3	6	0.50 ± 0.22
NNW3	4	0	4	6	0.67 ± 0.61
NNW4	11	0	11	8	1.38 ± 0.96
NNW5	7	10	17	7	2.43 ± 1.44
NNW6	0	1	1	6	0.17 ± 0.17
NNW7	0	0	0	9	0.00 ± 0.00
Total Temporary Ground	**73**	**768**	**841**	**392**	**1.79 ± 0.24**
% of Total Calls	**8.7%**	**91.3%**			

* ± bootstrapped standard error.

Spatial Variation

Fixed Stations

Bat activity in the Project was fairly consistent between the fixed ground units and fixed raised units at the four met tower stations and two canopy detectors (Figure 7, Table 3). On average, total bat passes per detector-night activity at fixed ground detectors (0.30 ± 0.03) was similar to fixed raised detectors (0.22 ± 0.03; Figure 8). Bat activity varied among the four met tower locations by 0.38 bat passes per detector night among the raised units and by 0.4 bat passes per detector night among the ground-based units (Table 3). Among ground units, NNCC recorded the lowest number of bat passes per detector-night (0.17 ± 0.05). Units NN2g and NNCS recorded equally low numbers of bat passes per detector night (0.19 ± 0.05 and 0.09, respectively). Among all fixed station detectors, ground-based units NN3g (0.57 ± 0.10) and NN4g (0.48 ± 0.11) recorded the highest levels of acoustic activity. For raised units, NN1r_40m recorded the greatest number of bat passes per detector-night (0.39 ± 0.10) and NN2r_40m recorded the fewest bat passes (0.01 ± 0.02), although the cable may have been damaged even before it was lowered to 20 m AGL. Station NN2r_20m did not record any bat passes (0.00 ± 0.00) during its 21-day deployment, likely due to damage that led to the cable to be severed (Table 3, Figure 7).

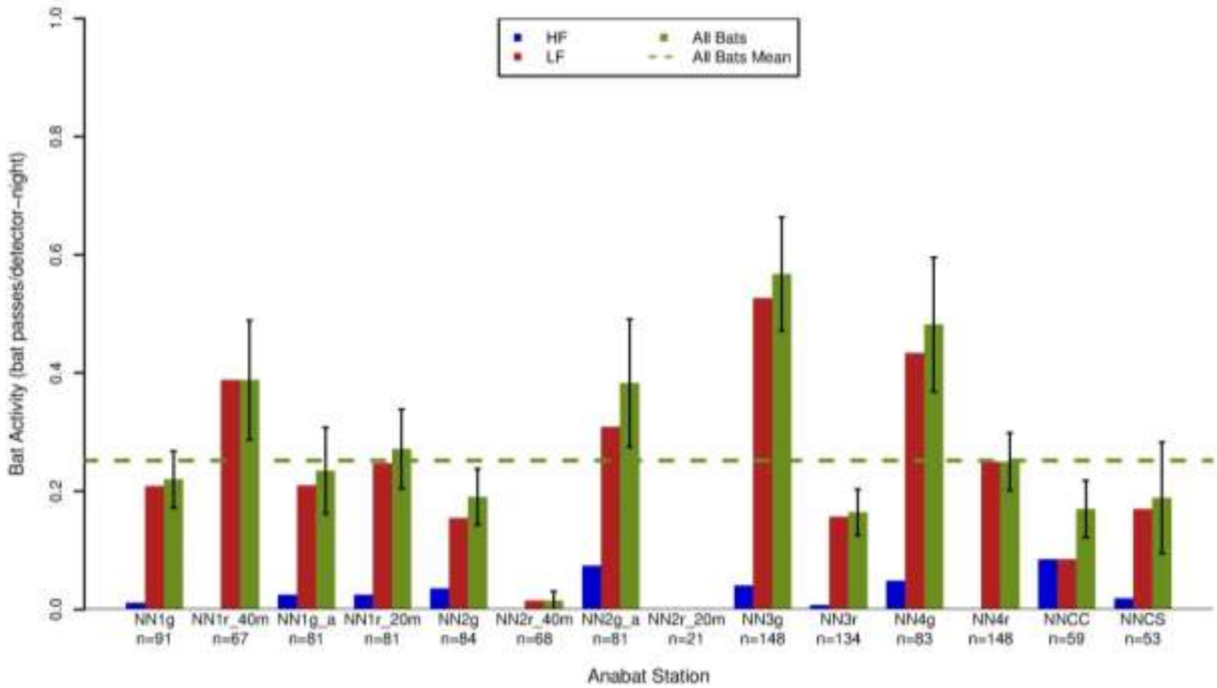

Figure 7. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at fixed AnaBat stations in the Number Nine Wind Farm from April 28 to October 16, 2014. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

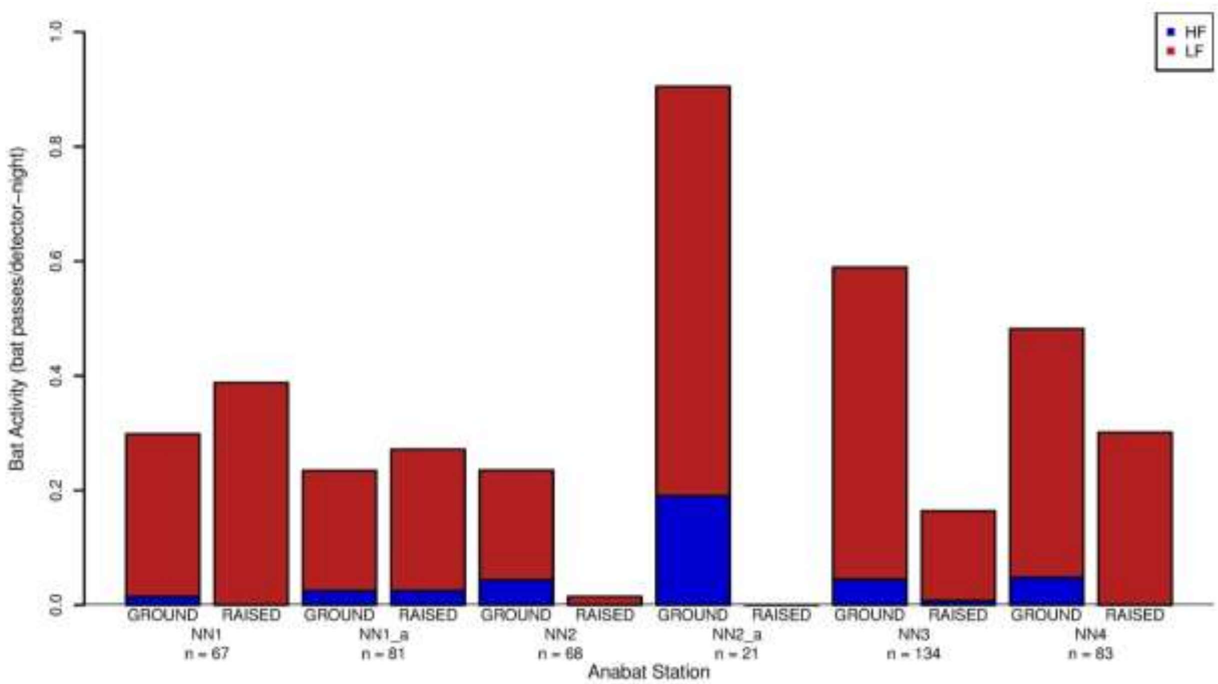

Figure 8. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at paired AnaBat stations in the Number Nine Wind Farm between April 28 and October 16, 2014.

Temporary Stations

Detectors at the 35 temporary stations detected a wider variation of bat pass rates among sites than the fixed stations, ranging from an average of 0.07 ± 0.05 bat passes detected at NN6t to 21.36 ± 6.91 at NN9t (Table 4). Station NN9t recorded a much greater level of activity than all other stations, the second highest bat activity was recorded at NN13t with an average of 7.53 ± 1.95 bat passes per detector-night. Activity at temporary stations was approximately six times higher (1.79 ± 0.24 bat passes per detector-night) compared to fixed ground (0.30 ± 0.03) and fixed raised stations (0.22 ± 0.03; Tables 3 and 4). However, variation among temporary stations was high, with four stations recording relatively high levels of activity (NN13t, NN14t, NN15t, and NN9t). These stations averaged of five or more bat passes per detector-night (Table 4). Five temporary stations recorded no bat passes (NN16t, NN27t, NN28t, NN30t, NNW7), three stations had 2.00 – 3.56 bat passes per detector night (NN22t, NNW5, and NN21t), and the remaining 23 stations recorded little activity with less than 1.54 bat passes per detector-night (Figures 9 and 10, Table 4).

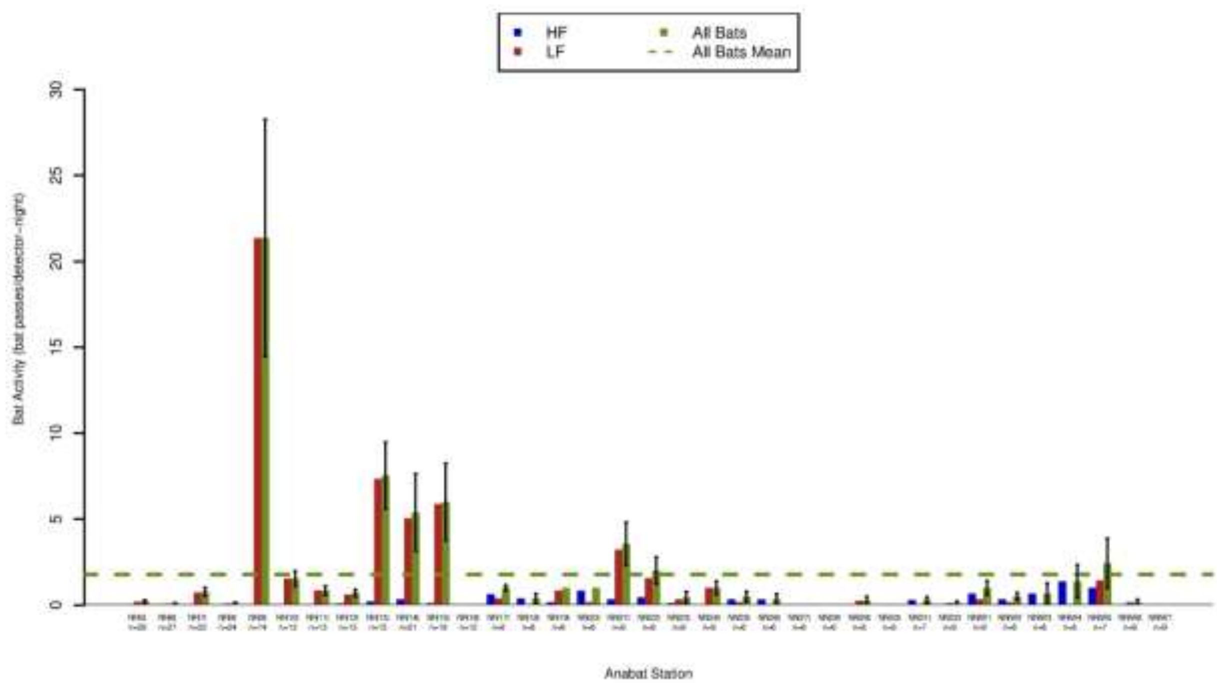

Figure 9. Number of high-frequency (HF) and low-frequency (LF) bat passes per detector-night recorded at temporary AnaBat stations in the Number Nine Wind Farm from April 28 to October 16, 2014. The bootstrapped standard errors are represented by the black error bars on the 'All Bats' columns.

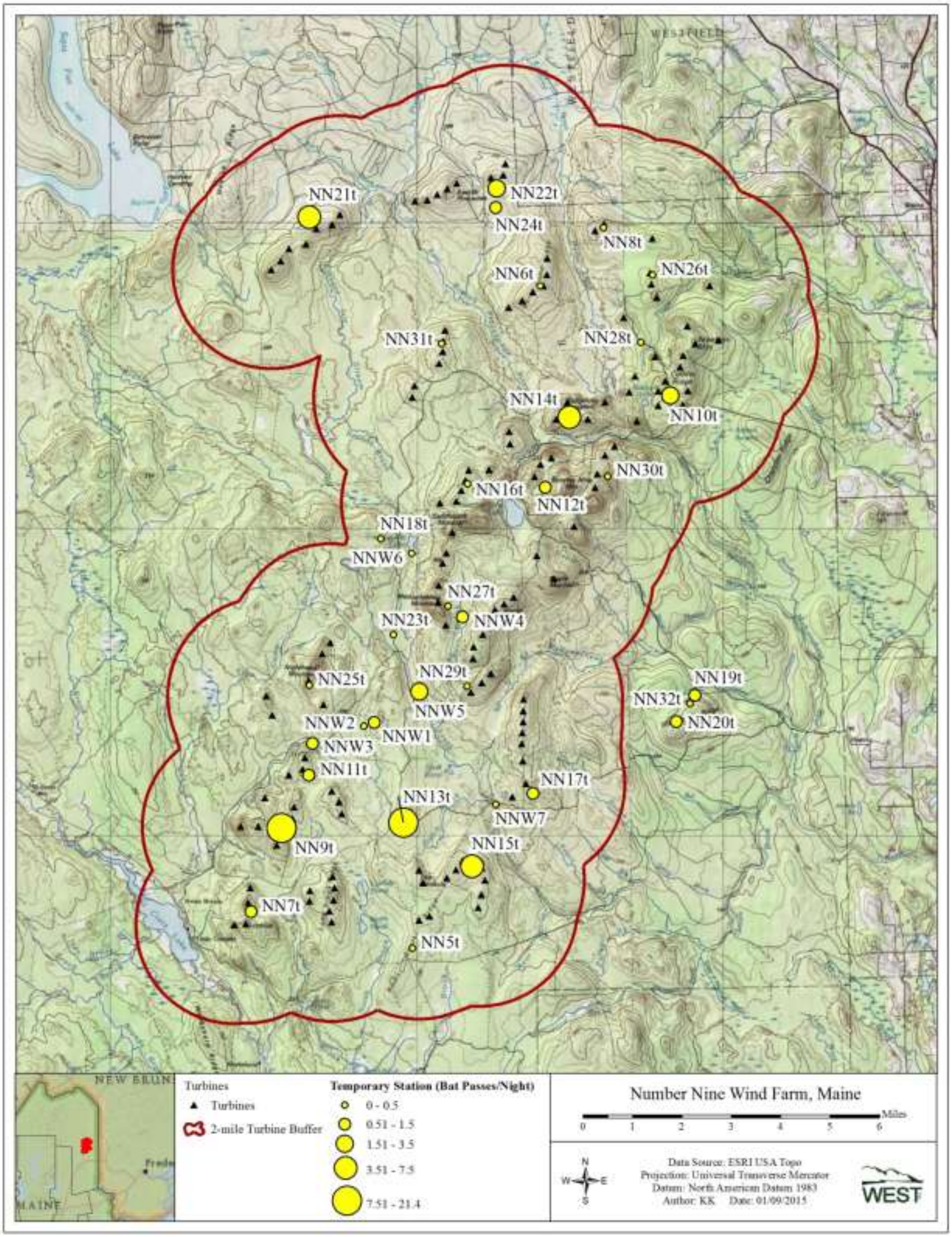

Figure 10. Bat Activity levels (bat passes per detector-night) recorded at temporary AnaBat stations in the Number Nine Wind Farm from April 28 to October 16, 2014.

Temporal Variation

Fixed Stations

Bat activity at fixed stations was relatively low in the spring (0.11 bat passes per detector-night), higher in the summer (0.26 bat passes per detector night), and highest in the fall (0.32 bat passes per detector-night; Table 5, Figure 11). Weekly acoustic activity at fixed stations was low overall; neither ground nor raised units recorded weekly averages above 1.1 bat pass per detector night (Figure 12), though a relative increase in activity was recorded in early July, and from late-July through late-August (Figure 12). Overall bat activity decreased abruptly in mid-September, and remained low until October when bat activity ceased (Figure 12). Bat pass rates were low throughout the study, ranging from 0.02 passes per detector-night in spring to 0.82 bat passes per detector-night in fall (Table 6).

During the Fall Migratory Period (FMP), the period when nearly all bat fatalities have occurred in North America, bat activity levels were low. During the FMP, LF and HF pass rates averaged 0.37 and 0.07 passes per detector-night, respectively, at ground-based stations. Pass rates from elevated stations were lower, with mean LF and HF pass rates of 0.22 and 0.01, respectively (Table 5). Summer LF bat pass rates peaked from June 9 to July 15 (0.54 bat passes per detector-night) and an overall peak in LF bat activity coincided with the fall activity peak from August 6 through August 12 (0.62 bat passes per detector-night; Table 6, Figure 12). High-frequency bat pass rates were very low, with peak weekly averages at or below 0.13 bat passes per detector-night. Overall, HF bat activity peaked during the fall season from August 13 through August 19 (0.13 bat passes per detector night) (Tables 5 and 6, Figure 12).

Table 5. The number of bat passes per detector-night recorded at fixed AnaBat stations in the Number Nine Wind Farm during each season in 2014, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Spring 4/28/2014 to 5/31/2014	Summer 6/1/2014 to 7/31/2014	FMP 7/30/2014 to 10/14/2014	Fall 8/1/2014 to 10/16/2014	Total
NN1g	LF	0	0.33	NA	NA	0.21
	HF	0	0.02	NA	NA	0.01
	AB	0	0.35	NA	NA	0.22
NN1r_40m	LF	0	0.46	NA	NA	0.39
	HF	0	0	NA	NA	0
	AB	0	0.46	NA	NA	0.39
NN2g	LF	0	0.23	NA	NA	0.15
	HF	0.07	0.02	NA	NA	0.04
	AB	0.07	0.25	NA	NA	0.19
NN2r_40m	LF	0	0.02	NA	NA	0.01
	HF	0	0	NA	NA	0
	AB	0	0.02	NA	NA	0.01
NN3g	LF	0.2	0.61	0.52	0.51	0.53
	HF	0.1	0.02	0.05	0.05	0.04
	AB	0.3	0.62	0.57	0.56	0.57
NN3r	LF	0	0.21	0.16	0.14	0.16
	HF	0	0	0.01	0.01	0.01
	AB	0	0.21	0.17	0.16	0.16
NN4g	LF	0.18	0.41	0.92	0.82	0.43

Table 5. The number of bat passes per detector-night recorded at fixed AnaBat stations in the Number Nine Wind Farm during each season in 2014, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Spring 4/28/2014 to 5/31/2014	Summer 6/1/2014 to 7/31/2014	FMP 7/30/2014 to 10/14/2014	Fall 8/1/2014 to 10/16/2014	Total
	HF	0.09	0.02	0.15	0.18	0.05
	AB	0.27	0.43	1.08	1	0.48
NN4r	LF	0.27	0.26	0.23	0.24	0.25
	HF	0	0	0	0	0
	AB	0.27	0.26	0.23	0.24	0.25
NN1g_a	LF	NA	0	0.22	0.22	0.21
	HF	NA	0	0.03	0.03	0.02
	AB	NA	0	0.25	0.25	0.23
NN1r_20m	LF	NA	0.25	0.26	0.25	0.25
	HF	NA	0	0.03	0.03	0.02
	AB	NA	0.25	0.29	0.27	0.27
NN2g_a	LF	NA	0	0.32	0.32	0.31
	HF	NA	0.25	0.08	0.06	0.07
	AB	NA	0.25	0.4	0.39	0.38
NN2r_20m	LF	NA	0	0	0	0
	HF	NA	0	0	0	0
	AB	NA	0	0	0	0
NNCC	LF	NA	NA	0.09	0.08	0.08
	HF	NA	NA	0.09	0.08	0.08
	AB	NA	NA	0.18	0.17	0.17
NNCS	LF	NA	NA	0.17	0.17	0.17
	HF	NA	NA	0.02	0.02	0.02
	AB	NA	NA	0.19	0.19	0.19
Fixed Ground Totals	**LF**	0.10 ± 0.06	0.26 ± 0.04	0.37 ± 0.07	0.35 ± 0.07	
	HF	0.07 ± 0.03	0.05 ± 0.04	0.07 ± 0.03	0.07 ± 0.03	
	AB	0.16 ± 0.07	0.32 ± 0.06	0.44 ± 0.08	0.43 ± 0.07	
Fixed Raised Totals	**LF**	0.07 ± 0.04	0.24 ± 0.06	0.22 ± 0.04	0.21 ± 0.04	
	HF	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01	0.01 ± 0.01	
	AB	0.07 ± 0.04	0.24 ± 0.06	0.23 ± 0.04	0.22 ± 0.04	
Overall	**LF**	0.08 ± 0.04	0.23 ± 0.04	0.29 ± 0.05	0.28 ± 0.05	
	HF	0.03 ± 0.02	0.03 ± 0.02	0.05 ± 0.02	0.05 ± 0.02	
	AB	0.11 ± 0.04	0.26 ± 0.04	0.34 ± 0.05	0.32 ± 0.05	

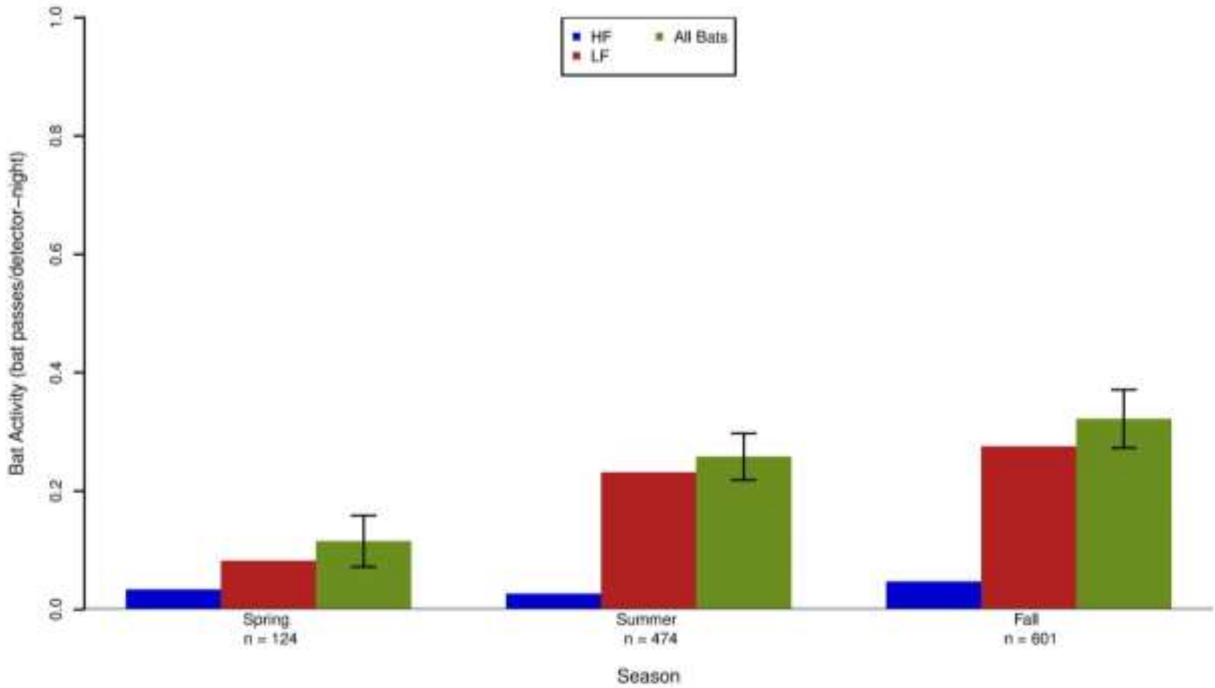

Figure 11. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at fixed stations in the Number Nine Wind Farm from April 28 to October 16, 2014. The bootstrapped standard errors are represented on the 'All Bats' columns.

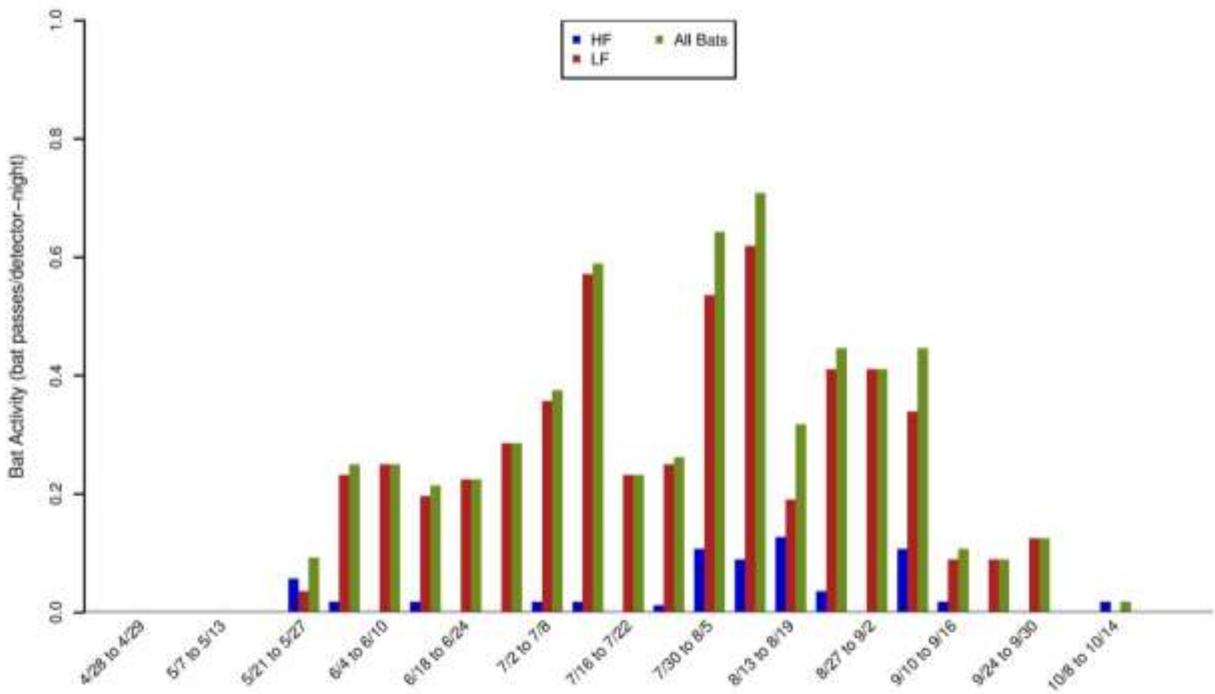

Figure 12. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at fixed stations in the Number Nine Wind Farm for the study period April 28 to October 16, 2014.

Table 6. Periods of seasonal peak activity for high-frequency (HF), low-frequency (LF), and all bats at fixed stations in the Number Nine Wind Farm for the study period April 28 – October 16, 2014.

	Species Groups								
	HF			LF			All Bats		
Season	Start Date of Peak Activity	End Date of Peak Activity	Passes per Detector-Night	Start Date of Peak Activity	End Date of Peak Activity	Passes per Detector-Night	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
Spring	May 15	May 21	0.06	May 21	May 27	0.04	May 21	May 27	0.09
Summer	July 9	July 15	0.02	July 9	July 15	0.54	July 9	July 15	0.59
Fall	August 13	August 19	0.13	August 6	August 12	0.62	August 6	August 12	0..71
Overall	August 13	August 19	0.13	August 6	August 12	0.62	August 6	August 12	0.71
Interest Period	August 13	August 19	0.13	August 6	August 12	0.62	August 6	August 12	0.71

At paired stations (Figure 13), weekly activity was higher at ground detectors throughout the spring, summer, and fall, except for the week of June 11 – June 17, where activity was higher at raised detectors. The ground-based detector activity trended higher toward from July 2 – July 15 and from July 30 – September 9, whereas an increase in pass rates at the raised detectors varied throughout the study period (Figure 13).

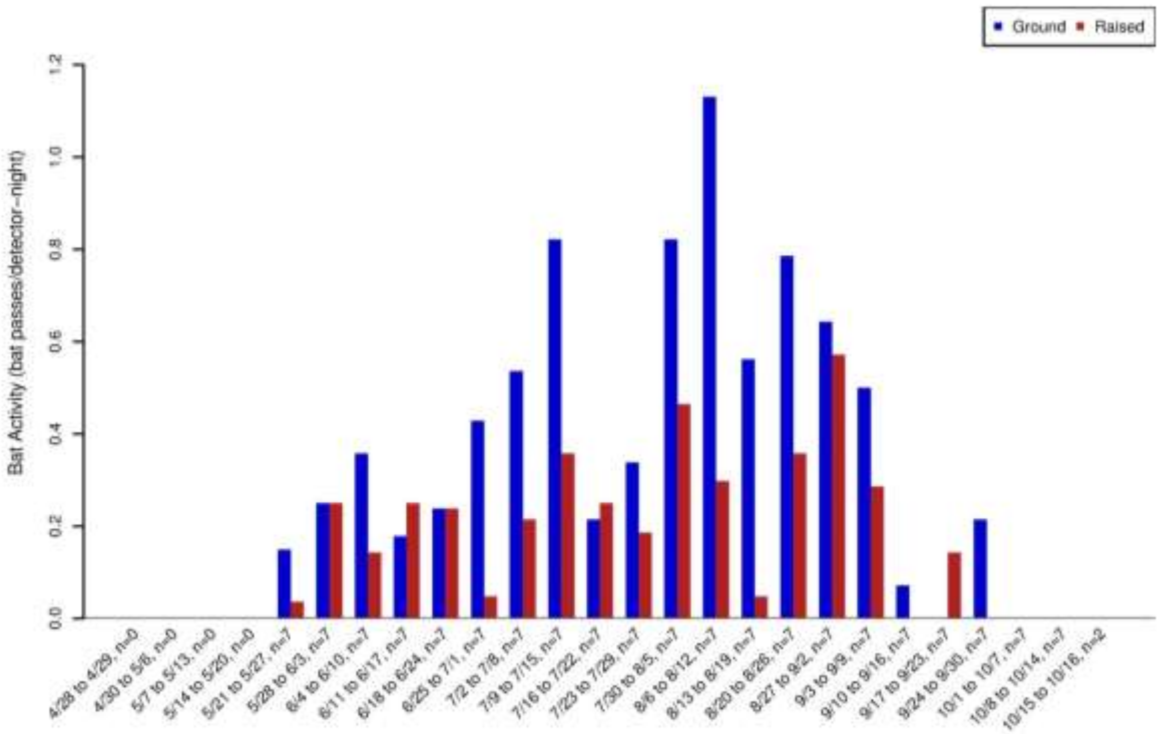

Figure 13. Weekly patterns of bat activity from April 28 to October 16, 2014, at ground and raised met tower stations at the Number Nine Wind Farm.

<u>Temporary Stations</u>

Weekly acoustic activity at temporary stations was higher than fixed stations overall; recording weekly averages ranging from 0.03 – 11.21 bat passes per detector-night (Figure 14), whereas fixed stations did not record any weekly averages above 1.1 bat pass per detector-night (Figure 12). Overall peaks in bat activity occurred earlier at temporary stations than at fixed stations and occurred for shorter durations, peaking from June 5 – June 11, with a total of 22.71 bat passes per detector-night (Table 7), rising again from June 11 – June 18 and again the week of July 9 through July 15 (Figure 14). Unlike fixed stations, bat activity recorded at temporary stations was higher in the summer (4.88 ± 0.77 bat passes per detector-night), followed by low fall activity (0.81 ± 0.14 bat passes per detector-night), and very low spring activity (0.12 ± 0.06 bat passes per detector-night) during which, an HF call was only recorded at station NN5t (Table 8, Figure 15). Low-frequency bat pass rate peaks were the same as the overall peaks, averaging 9.12 – 9.21 bat passes a detector-night in mid-June and 11.21 bat passes per detector-night the week of July 9 (Table 7, Figure 14). High-frequency bat pass rates were low at temporary stations; weekly averages ranged from 0.07 to 0.79 bat passes per detector night for the duration of the sampling period (Figure 14). High-frequency bat passes peaked later than LF and overall bat passes, increasing the week of July 16, August 6, and September 10 – September 23 (Table 7, Figure 14).

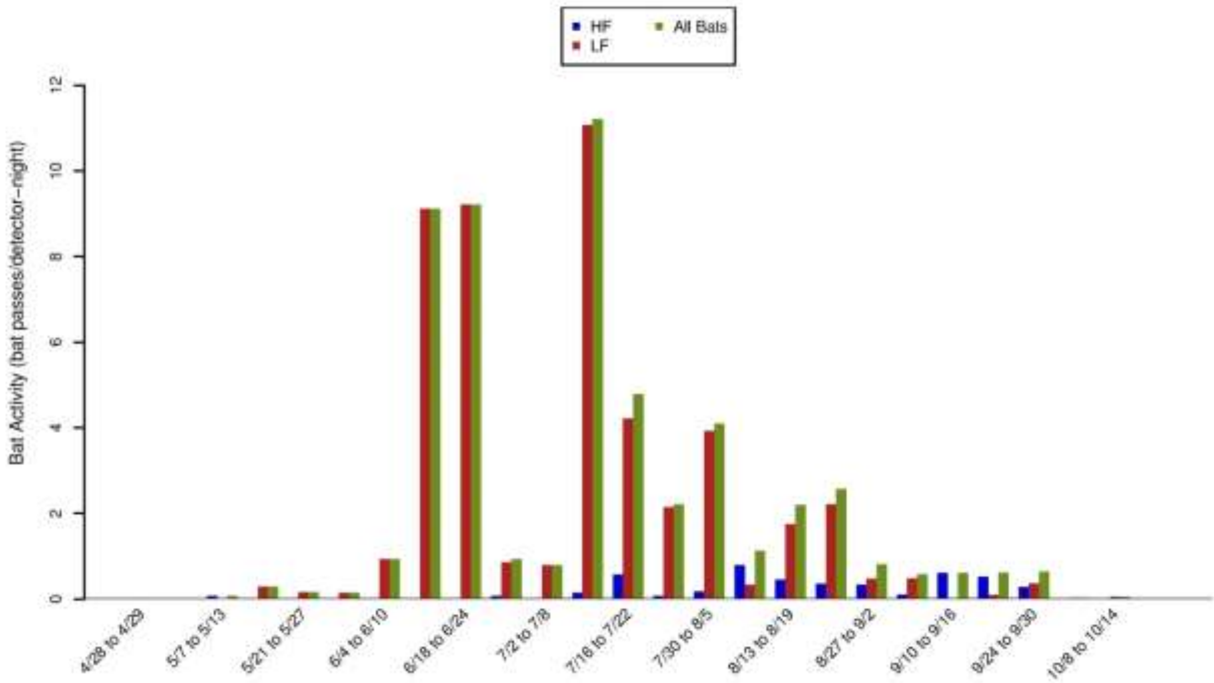

Figure 14. Weekly patterns of bat activity by high-frequency (HF), low-frequency (LF), and all bats at temporary stations in the Number Nine Wind Farm for the study period April 28 to October 16, 2014.

Table 7. Weekly patterns of bat activity from April 28 to October 16, 2014, at temporary stations at the Number Nine Wind Farm.

	Species Group	Start Date of Peak Activity	End Date of Peak Activity	Bat Passes per Detector-Night
Overall	HF	August 10	August 16	0.93
	LF	June 5	June 11	22.71
	All Bats	June 5	June 11	22.71
Interest Period	HF	August 10	August 16	0.93
	LF	August 3	August 9	5.58
	All Bats	August 3	August 9	5.71

Table 8. The number of bat passes per detector-night recorded at temporary stations in the Number Nine Wind Farm during each season in 2014, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Spring 4/28/2014 to 5/31/2014	Summer 6/1/2014 to 7/31/2014	FMP 7/30/2014 to 10/14/2014	Fall 8/1/2014 to 10/16/2014	Total
NN5t	LF	0.17	NA	NA	NA	0.17
	HF	0.03	NA	NA	NA	0.03
	AB	0.21	NA	NA	NA	0.21
NN6t	LF	0.07	NA	NA	NA	0.07
	HF	0	NA	NA	NA	0
	AB	0.07	NA	NA	NA	0.07
NN7t	LF	0.2	1.2	0.43	0.43	0.73
	HF	0	0	0.14	0.14	0.05
	AB	0.2	1.2	0.57	0.57	0.77
NN8t	LF	0	0.18	0	0	0.08
	HF	0	0	0	0	0
	AB	0	0.18	0	0	0.08
NN10t	LF	NA	1.54	NA	NA	1.54
	HF	NA	0	NA	NA	0
	AB	NA	1.54	NA	NA	1.54
NN11t	LF	NA	0.85	NA	NA	0.85
	HF	NA	0	NA	NA	0
	AB	NA	0.85	NA	NA	0.85
NN12t	LF	NA	0.62	NA	NA	0.62
	HF	NA	0.08	NA	NA	0.08
	AB	NA	0.69	NA	NA	0.69
NN13t	LF	NA	7.33	NA	NA	7.33
	HF	NA	0.2	NA	NA	0.2
	AB	NA	7.53	NA	NA	7.53
NN14t	LF	NA	7.07	0	0	5.05
	HF	NA	0.47	0	0	0.33
	AB	NA	7.53	0	0	5.38
NN15t	LF	NA	7.78	6.91	4	5.89
	HF	NA	0.11	0.09	0.11	0.11
	AB	NA	7.89	7	4.11	6
NN16t	LF	NA	0	0	0	0
	HF	NA	0	0	0	0
	AB	NA	0	0	0	0
NN9t	LF	NA	21.36	NA	NA	21.36
	HF	NA	0	NA	NA	0
	AB	NA	21.36	NA	NA	21.36
NN17t	LF	NA	NA	0.38	0.38	0.38
	HF	NA	NA	0.62	0.62	0.62
	AB	NA	NA	1	1	1

Table 8. The number of bat passes per detector-night recorded at temporary stations in the Number Nine Wind Farm during each season in 2014, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Spring 4/28/2014 to 5/31/2014	Summer 6/1/2014 to 7/31/2014	FMP 7/30/2014 to 10/14/2014	Fall 8/1/2014 to 10/16/2014	Total
NN18t	LF	NA	NA	0	0	0
	HF	NA	NA	0.38	0.38	0.38
	AB	NA	NA	0.38	0.38	0.38
NN19t	LF	NA	NA	0.83	0.83	0.83
	HF	NA	NA	0.17	0.17	0.17
	AB	NA	NA	1	1	1
NN20t	LF	NA	NA	0.17	0.17	0.17
	HF	NA	NA	0.83	0.83	0.83
	AB	NA	NA	1	1	1
NN21t	LF	NA	NA	3.22	3.22	3.22
	HF	NA	NA	0.33	0.33	0.33
	AB	NA	NA	3.56	3.56	3.56
NN22t	LF	NA	NA	1.56	1.56	1.56
	HF	NA	NA	0.44	0.44	0.44
	AB	NA	NA	2	2	2
NN23t	LF	NA	NA	0.33	0.33	0.33
	HF	NA	NA	0.11	0.11	0.11
	AB	NA	NA	0.44	0.44	0.44
NN24t	LF	NA	NA	1	1	1
	HF	NA	NA	0	0	0
	AB	NA	NA	1	1	1
NN25t	LF	NA	NA	0.17	0.17	0.17
	HF	NA	NA	0.33	0.33	0.33
	AB	NA	NA	0.5	0.5	0.5
NN26t	LF	NA	NA	0	0	0
	HF	NA	NA	0.33	0.33	0.33
	AB	NA	NA	0.33	0.33	0.33
NN27t	LF	NA	NA	0	0	0
	HF	NA	NA	0	0	0
	AB	NA	NA	0	0	0
NN28t	LF	NA	NA	0	0	0
	HF	NA	NA	0	0	0
	AB	NA	NA	0	0	0
NN29t	LF	NA	NA	0.25	0.25	0.25
	HF	NA	NA	0	0	0
	AB	NA	NA	0.25	0.25	0.25
NN30t	LF	NA	NA	0	0	0
	HF	NA	NA	0	0	0
	AB	NA	NA	0	0	0

Table 8. The number of bat passes per detector-night recorded at temporary stations in the Number Nine Wind Farm during each season in 2014, separated by call frequency: high-frequency (HF), low-frequency (LF), and all bats (AB).

Station	Call Frequency	Spring 4/28/2014 to 5/31/2014	Summer 6/1/2014 to 7/31/2014	FMP 7/30/2014 to 10/14/2014	Fall 8/1/2014 to 10/16/2014	Total
NN31t	LF	NA	NA	0	0	0
	HF	NA	NA	0.29	0.29	0.29
	AB	NA	NA	0.29	0.29	0.29
NN32t	LF	NA	NA	0.14	0.11	0.11
	HF	NA	NA	0	0	0
	AB	NA	NA	0.14	0.11	0.11
NNW1	LF	NA	NA	0.33	0.33	0.33
	HF	NA	NA	0.67	0.67	0.67
	AB	NA	NA	1	1	1
NNW2	LF	NA	NA	0.17	0.17	0.17
	HF	NA	NA	0.33	0.33	0.33
	AB	NA	NA	0.5	0.5	0.5
NNW3	LF	NA	NA	0	0	0
	HF	NA	NA	0.67	0.67	0.67
	AB	NA	NA	0.67	0.67	0.67
NNW4	LF	NA	NA	0	0	0
	HF	NA	NA	1.38	1.38	1.38
	AB	NA	NA	1.38	1.38	1.38
NNW5	LF	NA	NA	1.43	1.43	1.43
	HF	NA	NA	1	1	1
	AB	NA	NA	2.43	2.43	2.43
NNW6	LF	NA	NA	0.17	0.17	0.17
	HF	NA	NA	0	0	0
	AB	NA	NA	0.17	0.17	0.17
NNW7	LF	NA	NA	0	0	0
	HF	NA	NA	0	0	0
	AB	NA	NA	0	0	0
Temporary Ground Totals	**LF**	0.11 ± 0.06	5.32 ± 0.96	0.76 ± 0.17	0.63 ± 0.15	
	HF	0.01 ± 0.01	0.09 ± 0.03	0.35 ± 0.07	0.35 ± 0.07	
	AB	0.12 ± 0.06	5.42 ± 0.96	1.11 ± 0.19	0.99 ± 0.18	
Overall	**LF**	0.11 ± 0.06	4.79 ± 0.77	0.62 ± 0.14	0.52 ± 0.12	
	HF	0.01 ± 0.01	0.09 ± 0.02	0.29 ± 0.06	0.29 ± 0.06	
	AB	0.12 ± 0.06	4.88 ± 0.77	0.91 ± 0.16	0.81 ± 0.14	

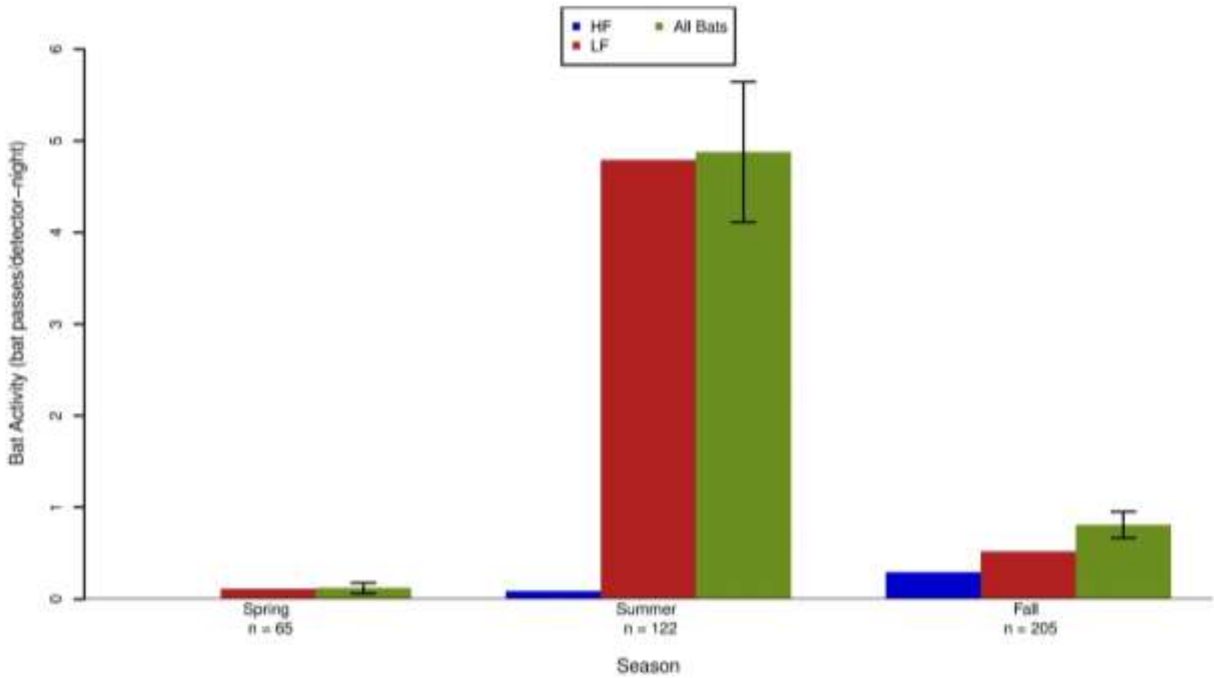

Figure 15. Seasonal bat activity by high-frequency (HF), low-frequency (LF), and all bats at temporary stations in the Number Nine Wind Farm from April 28 to October 16, 2014. The bootstrapped standard errors are represented on the 'All Bats' columns.

Species Composition

Using a combination of quantitative and qualitative identification tools, a total of six species were identified as being present based on their calls: big brown bat, eastern red bat, hoary bat, silver-haired bat, little brown bat, and tri-colored bat. Although potential northern long-eared bat passes were identified by Kaleidoscope at temporary detector stations, these were determined to be false-positive identifications when examined by a trained biologist. There was no difference in species diversity among fixed and temporary stations (Table 9). Using Kaleidoscope, six species were present at both fixed and temporary stations, whereas using BCID, five species were present at both fixed and temporary stations, and using EchoClass, four species were present at both fixed and temporary stations. However, more calls overall, and more individual big brown bat calls, hoary bat calls, and silver-haired bat calls were identified by BCID Species ID software at temporary stations (Table 9). BCID additionally identified more little brown bats at temporary stations, Kaleidoscope classified northern long-eared bats at temporary stations, but, as mentioned above, qualitative identification indicated that the calls had been misidentified by the software and that they were not in fact produced by northern long-eared bats (Table 9).

Table 9. Bat species composition at fixed stations and temporary stations at the Number Nine Wind Farm from April 28 to October 16, 2014.

	Kaleidoscope		BCID		EchoClass	
Species	**Fixed Stations**	**Temporary Stations**	**Fixed Stations**	**Temporary Stations**	**Fixed Stations**	**Temporary Stations**
big brown bat	4	11	4	4	0	1
eastern red bat	8	1	3	1	1	1
hoary bat	215	368	12	134	4	25
silver-haired bat	117	151	66	76	1	5
little brown bat	1	1	1	4	0	0
tri-colored bat	1	0	0	0	1	0
northern long-eared bat	0	0	0	0	0	0
Myotis unknown	0	0	4	5	0	0
unknown spp.	0	0	58	96	0	0
Total	**346**	**535**	**148**	**320**	**7**	**32**
Species Totals	**6**	**6**	**5**	**5**	**4**	**4**

<u>Fixed Stations</u>

At fixed stations, 90.8% of bat passes were classified as LF (e.g., big brown, hoary, and silver-haired bats), and 9.7% of bat passes were classified as HF (e.g., little brown, northern long-eared, eastern red bats; Table 3). Of the HF bat passes, 90.3% were recorded at ground-based stations and 9.68% of HF calls (n = 3) were recorded at two of the raised units (Table 3).

No northern long-eared bat call sequences were identified at fixed stations by any of the three software programs (Table 10). Kaleidoscope identified four species at both ground and raised stations, but BCID identified greater species richness at ground stations (n = 5) than raised (n = 4), whereas EchoClass identified three species at raised detectors and two species at ground detectors (Table 10). The majority of hoary bat calls identified by Kaleidoscope were determined to be noise files after review. There was no difference in species composition among 40-m raised and 20-m raised stations at stations NN1r and NN2r using two of the software programs, but EchoClass identified hoary bats at 40-m raised stations and no species at 20-m raised stations. Both Kaleidoscope and BCID identified a total of two species (hoary bats and silver-haired bats) at 20-m and 40-m stations NN1r and NN2r. More species were identified at the 40-m detector stations that were not changed halfway through the study (NN3r and NN4r) by all three programs (Table 11). All three programs identified eastern red bats and hoary bats at 40-m detector stations NN3r and NN4r; however, BCID and Kaleidoscope also identified silver-haired bats and BCID additionally identified a big brown bat, whereas Kaleidoscope and EchoClass identified a tri-colored bat (Table 11).

Table 10. Bat species composition at ground and raised stations at the Number Nine Wind Farm from April 28 to October 16, 2014.

	Kaleidoscope		BCID		EchoClass	
Species	**Ground Stations**	**Raised Stations**	**Ground Stations**	**Raised Stations**	**Ground Stations**	**Raised Stations**
big brown bat	4	0	2	2	0	0
eastern red bat	0	8	1	2	0	1
hoary bat	13	202	5	7	1	3
silver-haired bat	65	52	54	12	1	0
little brown bat	1	0	1	0	0	0
tri-colored bat	0	1	0	0	0	1
northern long-eared bat	0	0	0	0	0	0
Myotis unknown	0	0	4	0	0	0
unknown spp.	0	0	34	24	0	0
Total	**83**	**263**	**101**	**47**	**2**	**5**
Species Totals	**4**	**4**	**5**	**4**	**2**	**3**

Table 11. Bat species composition at 20-m and 40-m raised meterological (met) tower stations at the Number Nine Wind Farm from April 28 to October 16, 2014.

Species ID Software	Location	LANO	LACI	Unk spp.	PESU	EPFU	LABO	Species Totals
BCID	20 m	2	1	5	0	0	0	2
	40 m	3	5	7	0	0	0	2
	40 m fixed	7	1	12	0	2	2	4
Kaleidoscope	20 m	6	2	0	0	0	0	2
	40 m	2	5	0	0	0	0	2
	40 m fixed	44	195	0	1	0	8	4
EchoClass	20 m	0	0	0	0	0	0	0
	40 m	0	2	0	0	0	0	1
	40m fixed	0	1	0	1	0	1	3

LANO = silver-haired bat (*Lasionycteris noctivagans*); LACI = hoary bat (*Lasiurus cinereus*); Unk. spp. = unknown species; PESU = tri-colored bat (*Perimyotis subflavus*); EPFU = big brown bat (*Eptesicus fuscus*); LABO = eastern red bat (*Lasiurus borealis*)

<u>Temporary Stations</u>

At temporary stations, the vast majority of recorded calls were produced by LF bats (91.3%; Table 4). Overall, only 8.7% of bat calls were from HF bats (Table 4).

Bat Acoustic Driving Transect Surveys

Bat activity and species composition was monitored along an acoustic transect route TS1, which was driven one-way 15 times between August 20 and October 14, 2014. Transect route TS1 was 34.84 miles (56.07 km) long (Figure 4), and the survey vehicle was driven at a speed of 12 – 18 miles per hour (mph; 19 – 29 km per hour [kph]). Duration of acoustic transect surveys varied by 25 min, from one hour and 55 min to two hours and 20 min (Table 12). The single AnaBat SD1 detector used was operational 100% of the survey period and recorded 40 bat passes over 15 transect-nights, or approximately 1.33 bat passes per hour (Table 13). Fewer bat passes were detected by automated call identification programs. EchoClass detected the fewest bat passes, identifying just one silver-haired bat on September 10, and Kaleidoscope identified the highest number of bat passes (n = 31) among automated software programs

(Tables 14 – 16). Whereas acoustic stations provide information about local bat activity and species composition, acoustic transects additionally provide a potential abundance estimate for bat populations that is not possible to collect at acoustic stations, because a single bat can pass in front a stationary microphone multiple times in a night. Few bat passes were recorded along TS1, but because of the speed of the vehicle it is more likely that each of these bat passes represents a unique individual.

Number of bat passes recorded during transects varied from 0 – 11, with an average of 2.67 bat passes per transect-night (Table 12). The greatest number of bat passes were recorded on September 10 (Tables 12 and 14) and the greatest rate of bat passes was eight bat passes/hour recorded during the first hour of sampling on September 10 (Table 12). Among all transect surveys, slightly more bat passes (1.53 bat passes/hour) were recorded during the first hour of sampling than the second (1.13 bat passes/hour; Table 12). Overall, more bat passes per hour were recorded in August (2.0 bat passes/hour) compared to September (1.56 bat passes/hour) and no bat passes were recorded in October (0 bat passes/hour; Table 12). Additionally, no bat passes were recorded from September 14 – 15, the only two nights besides October 6 that were below 40 degrees Fahrenheit (ºF; 4.4 degrees Celsius [ºC]) by the end of the survey (Table 13). Rather than reducing the number of surveys, transects were driven even on nights below 50 ºF (10 ºC) due to temporal constraints of the study that restricted available sampling periods prior to fall. Overall, 70% (n = 28) of bat passes were classified as LF (e.g., big brown, hoary, and silver-haired bats), and 30% (n = 12) of bat passes were classified as HF (e.g., little brown, tri-colored, and eastern red bats; Table 15).

Table 12. Bat passes per hour during 15 sampling sessions along acoustic transect survey route TS1 in the Number Nine Wind Farm for the study period April 20 – October 14, 2014.

Survey Date	Bat Passes Hour 1	Bat Passes Hour 2	Total Bat Passes/Hour
20-Aug	1	5	3
26-Aug	3	0	1.5
27-Aug	0	3	1.5
August Average	**1.33**	**2.67**	**2.00**
2-Sep	2	0	1
3-Sep	3	2	2.5
8-Sep	4	1	2.5
10-Sep	8	3	5.5
14-Sep	0	0	0
15-Sep	0	0	0
22-Sep	0	1	0.5
24-Sep	1	1	1
30-Sep	1	1	1
September Average	**2.11**	**1.00**	**1.56**
1-Oct	0	0	0
6-Oct	0	0	0
14-Oct	0	0	0
October Average	**0**	**0**	**0**
Total	**23**	**17**	
Average	**1.53**	**1.13**	**1.33**

Table 13. Survey dates, time, and nightly weather variables along the acoustic transect survey route TS1 in the Number Nine Wind Farm for the study period April 20 – October 14, 2014.

		Survey Start					Survey End				
Date	Moon Phase	Time	Temp (ºF)	Wind speed (mph)	Moon visible?	% Cloud Cover	Time	Temp (ºF)	Wind speed (mph)	Moon visible?	% Cloud Cover
20-Aug	1/4	20:10	62	0	no	10	22:30	57	0	no	0
26-Aug	new	20:00	67	0	no	10	21:55	66	0	no	0
27-Aug	new	20:00	64	0	no	70	22:00	60	0	no	40
2-Sep	1/2	19:40	70	0-2 SW	no	100	21:40	69	0-2 SW	no	100
3-Sep	1/2	19:40	59	0	yes	20	21:40	55	0	yes	20
8-Sep	full	19:30	50	0	yes	0	21:30	43	0	yes	0
10-Sep	full	19:30	54	0	no	80	21:30	50	0	yes	40
14-Sep	3/4	19:15	48	2-5 NW	no	80	21:15	39	0	no	0
15-Sep	3/4	19:15	44	0 - 2 NW	no	10	21:15	39	0	no	0
22-Sep	new	19:00	48	5-15 W	no	100	21:10	45	5-15 W	no	0
24-Sep	new	19:00	48	0	no	0	21:00	41	0	no	0
30-Sep	1/4	18:45	50	0	no	100	20:45	48	0	no	100
1-Oct	1/2	18:45	50	0	no	90	20:45	44	0	yes	80
6-Oct	full	18:30	46	0	yes	10	20:30	38	0	yes	0
14-Oct	1/4	18:15	59	0	no	20	20:15	51	0	no	0

Table 14. Bat activity during 15 sampling sessions along acoustic transect survey route TS1 in the Number Nine Wind Farm for the study period April 20 – October 14, 2014, using results from three automated software programs and qualitative species identification (ID).

Survey Date	BCID	Kaleidoscope	EchoClass	Qualitative ID Review
20-Aug	2	4	0	6
26-Aug	3	3	0	3
27-Aug	1	3	0	3
2-Sep	2	2	0	2
3-Sep	3	3	0	5
8-Sep	5	4	0	5
10-Sep	8	8	1	11
14-Sep	0	0	0	0
15-Sep	0	0	0	0
22-Sep	0	0	0	1
24-Sep	0	2	0	2
30-Sep	2	2	0	2
1-Oct	0	0	0	0
6-Oct	0	0	0	0
14-Oct	0	0	0	0
Total	**26**	**31**	**1**	**40**
Average	**1.73**	**2.07**	**0.07**	**2.67**

Table 15. Cumulative species count during 15 sampling sessions along acoustic transect survey route TS1 in the Number Nine Wind Farm for the study period April 20 – October 14, 2014, using results from three automated software programs and qualitative species identification (ID).

Species	Kaleidoscope	BCID	EchoClass	Qualitative ID Review
big brown bat	2	0	0	1
silver-haired bat	22	11	1	1
silver-haired/big brown bat	0	0	0	16
eastern red bat	0	0	0	2
hoary bat	3	2	0	6
eastern red/ tri-colored bat	0	0	0	2
little brown bat	3	0	0	1
northern long-eared bat	0	0	0	0
tri-colored bat	1	3	0	1
HF unknown species	0	1	0	6
LF unknown species	0	9	0	4
Total	**31**	**26**	**1**	**40**

Species composition results based on the acoustic transect surveys was identical to that from fixed and temporary station detectors, recording six species: big brown bat, silver-haired bat, hoary bat, eastern red bat, little brown bat, and tri-colored bat (Table 15). No northern long-eared bat sequences were detected by any of the three automated software programs or by qualitative identification (Table 15).

We are unaware of other publicly available pre-construction wind facility acoustic transect to compare these numbers with. However, the overall low rates of detections and species composition of the calls recorded are congruent with the other acoustic data results from this study, suggesting that the fixed and temporary station data provide a faithful accounting of the species composition and relative abundance of bats at this site.

DISCUSSION

Bat fatalities have been discovered at most wind energy facilities monitored in North America, ranging from 0.10 (Tierney 2007) to 39.7 bat fatalities per megawatt (MW) per year (Fiedler et al. 2007; Appendix A). Bat fatalities are largely due to collisions with moving turbine blades (Grodsky et al. 2011, Rollins et al. 2012; but see Baerwald et al. 2008), but 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 in North America show that: a) migratory tree-roosting species (e.g., eastern red bat, hoary bat, and silver-haired bat) compose approximately 78% of reported bat fatalities; b) the majority of fatalities occur during the post-weaning or fall migration season (August and September); and c) and that fatality rates vary among and within regions (Arnett et al. 2008, 2013; Arnett and Baerwald 2013). For example, Arnett and Baerwald (2013) report an apparent latitudinal gradient in bat fatalities in the Northeastern Deciduous Forest region, with fatalities in the higher latitdues (e.g., Maine and eastern Canadian provinces) among the lowest reported (see Appendix A).

It is generally expected that pre-construction bat activity is positively related to post-construction bat fatalities (Kunz et al. 2007b). However, to date, few studies of wind energy facilities which have recorded both bat passes per detector-night and bat fatality rates are available (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, though Baerwald and Barclay (2009) found a significant positive association between pass rates measured at 30 m (98 ft) 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 lack statistically significant correlations between the two. Hein et al. (2013) 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 fixed ground detectors (0.44 ± 0.08 bat passes per detector-night; Table 5) was lower than the national median and the majority of studies available from the Northeast (Appendix A). In addition, estimated fatality rates for bats at wind facilities in Maine have been among the lowest in North America. This suggests that observed bat fatality rates for Project may be very low.

Some research suggests that bat activity in the rotor-swept zone may be more representative of bat exposure to turbines (Baerwald and Barclay 2009). At the Project, bat activity recorded by the raised detectors (0.22 bat passes per detector-night) was lower than at fixed ground detectors (0.30 bat passes per detector-night; Table 3) and substantially lower than the temporary ground detectors (1.79 bat passes per detector-night; Table 4).In addition to greater activity at ground-based detector stations, BCID identified greater species richness at ground-based fixed stations (five species) compared to raised detector stations (four species), although Kaleidoscope identified four species at both ground and raised stations (Table 10).

Species composition based on BCID Species ID software and qualitative identification was identical among fixed and temporary stations (Table 9), and among 40-m raised and 20-m raised stations (Table 11). No northern long-eared bats were detected at fixed ground-based, temporary ground-based, 20- or 40-m raised detectors, canopy-based detectors in clearings or along streams, or during driving transects. This result echoes the results from 84 survey locations conducted in July 2014 following USFWS survey guidance (WEST 2014), and provides strong evidence of the absence of northern long-eared bats from the project area landscape. Overall, station species composition data matched the acoustic transect data, recording the same six species: big brown bat, hoary bat, eastern red bat, silver-haired bat, little brown bat, and tri-colored bat (Table 15). Transects did not record bat passes after the peak-migratory season in late September (Table 12), suggesting that bats had likely left the area and/or had already moved through on the way to winter areas . In addition, no bat passes were recorded on nights with survey ending temperatures below 40º F (Table 13), suggesting that bat activity decreased or ceased at colder temperatures.

Bat activity was highest within the Project during the summer, peaking from June 5 through June 11, and this was driven by LF bat passes recorded at temporary ground stations. This timing is slightly earlier than the beginning peak fatality periods for most wind energy facilities in the US, which is more similar to the timing at fixed ground detector stations that peaked from early August (Table 6). Fixed station data suggest that bat fatalities at the Project may be highest during the late summer to early fall, and may largely consist of migrating individuals.

Activity by HF bat species represented 9.7% of bat passes recorded at fixed stations in the Project (Table 3) and composed a similar amount (8.7%) at temporary stations. Eastern red bats are usually the most common HF species found during carcass searches (Arnett et al. 2008, Arnett and Baerwald 2013). *Myotis* species are detected less commonly than other species in the rotor-swept zone, and generally compose fewer 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 2006b, Gruver et al. 2009). Approximately 90.8% of bat passes recorded at fixed stations and 91.3% of bat passes recorded at temporary stations in the Project were emitted by LF bats, suggesting a high relative abundance of species such as big brown bats, silver-haired bats, and hoary bats (Tables 3 and 4). Low-frequency species may become casualties because they tend to fly at higher altitudes, as demonstrated by their greater prevalence of their echolocation calls that are recorded at raised detectors (Table 3, Figure 7). 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.

Bat activity at Project was generally low compared to rates reported at other projects in Maine and the Northeast (Appendix A). In general, bat activity and fatality rates for the Northeastern region (southeast Canada to West Virginia) have been relatively low, though projects located in the southern portion of the Northeast region also have reported some of the highest fatality rates along in comparison to other regions (Arnett and Baerwald 2013, Hein et al. 2013; Appendix A). In the Northeast region, there appears to be a gradient from north to south, with much higher fatality rates at some of the more southerly locations. For example, projects located at lower latitudes within the Northeast (e.g., in the mid-Atlantic along the ridgelines of the Appalachian Mountains) have consistently had the highest fatality rates for the region and the United States (Kunz et al. 2007b, Arnett et al. 2008). Similarly, bat pass rates recorded at projects in that area of the Northeast are higher than other regions and other parts of the Northeast but it is clear that activity rates can be highly varied depending on location and project (Hein et al. 2013). Acoustic studies in the region have found seasonal variations in bat activity and fatalities for tree-roosting bats that can be followed geographically in a southern direction during the fall migration time period (Johnson et al. 2011).

Given that over half of bat fatality studies in New York, New Hampshire, and Maine report fewer than four bat fatalities/MW/year (Appendix A; Figure 16), it is possible that similar fatality rates could be recorded at the Project. Further, average annual bat fatality rates for Atlantic Canada have been estimated to be 0.26 ± 0.10 bats/turbine (Wind Energy Bird and Bat Monitoring Database 2014). This number would be lower if evaluated on a per MW basis. Publicly available fatality studies conducted in Maine yield estimates of fewer than three fatalities/MW/year. The closest operating wind-energy facility to the Project with public post-construction fatality data is the Mars Hill Wind Farm, located approximately 15 miles (24 km) from the Project. Both projects are located in landscapes dominated by spruce-fir forests, deciduous forest, and mixed forest, with hilly topography. Bat casualty rates at Mars Hill Wind Farm have ranged from 0.45 – 2.91 bats/MW/year for the 2008 and 2007 (pre-WNS) study periods, respectively (Appendix A). While a variety of factors determine bat fatality risk, the existing studies that conducted in Northern New England (Maine and New Hampshire) report relatively low fatality rates in comparison to other Northeastern wind facilities (Appendix A). The nearby Stetson Mountain wind energy facility reported activity rates at bat feature locations during the FMP at 28.5 bat passes per detector-night and fatality estimates of 1.4 bats/MW/year (Appendix A). The activity rate reported for Stetson Mountain is much higher than the highest average rate (0.44 ± 0.08 bat passes per detector-night; Appendix A) recorded during the FMP at the Project (Table 4), suggesting that bat fatality rates for the Project are likely to be lower than those estimated at Stetson Mountain, which would make them among the lowest known. In addition, given that no northern long-eared bats were recorded and very few little brown bat calls were recorded, the risk to *Myotis* bats is expected to be very low as well.

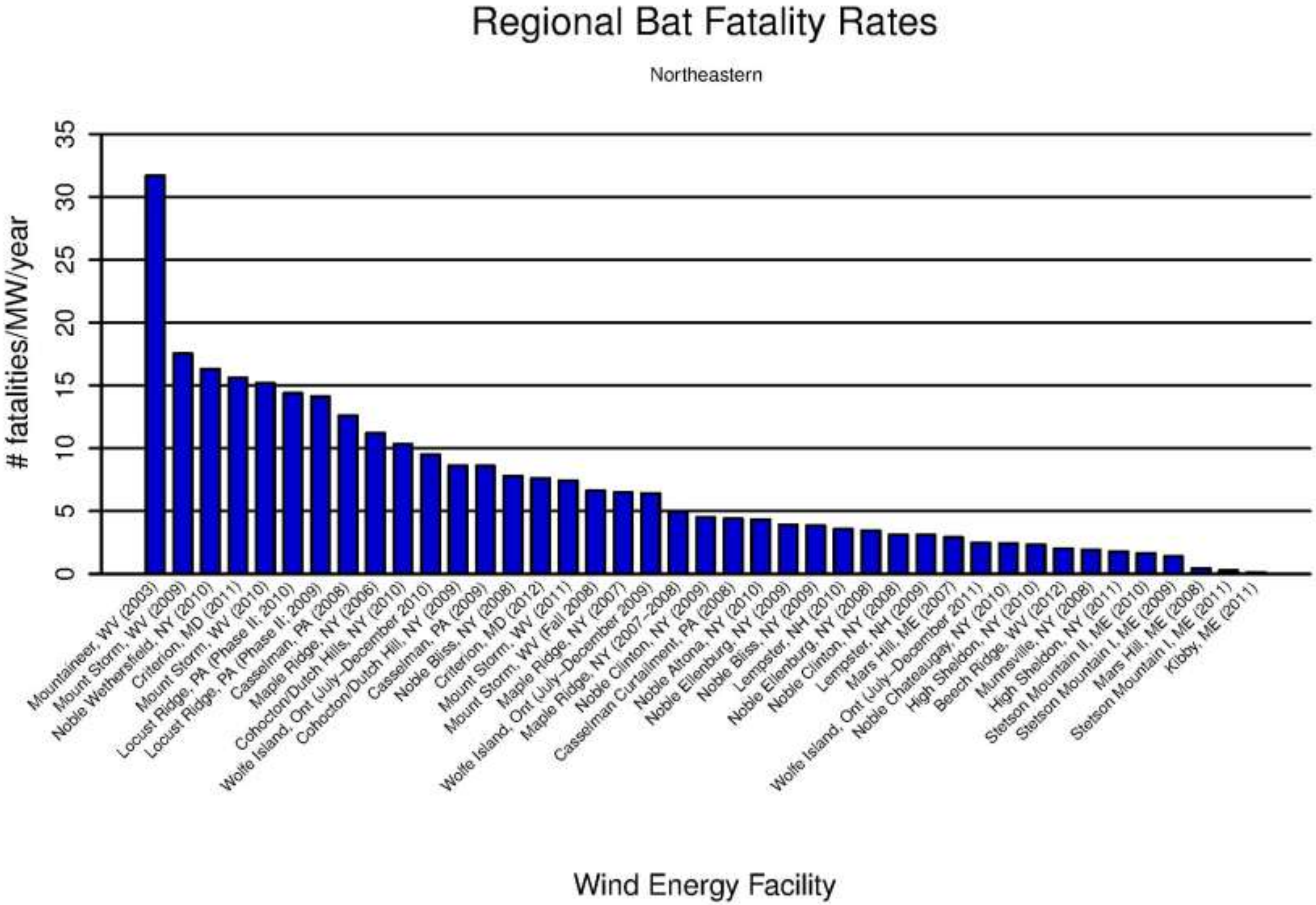

Figure 16. Fatality rates for bats (number of bats per megawatt per year) from publicly available studies at wind energy facilities in the Northeastern region of North America.

Figure 16 (*continued*). Fatality rates for bats (number of bats per megawatt per year) from publicly available studies at wind energy facilities in the Northeastern region of North America.

Data from the following sources:

Wind Energy Facility	Reference	Wind Energy Facility	Reference	Wind Energy Facility	Reference
Mountaineer, WV (03)	Kerns and Kerlinger 2004	Criterion, MD (12)	Young et al. 2013	Lempster, NH (09)	Tidhar et al. 2010
Mount Storm, WV (09)	Young et al. 2009a, 2010b	Mount Storm, WV (11)	Young et al. 2011a, 2012b	Mars Hill, ME (07)	Stantec 2008
Noble Wethersfield, NY (10)	Jain et al. 2011a	Mount Storm, WV (Fall 08)	Young et al. 2009b	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012
Criterion, MD (11)	Young et al. 2012a	Maple Ridge, NY (07)	Jain et al. 2009a	Noble Chateaugay, NY (10)	Jain et al. 2011c
Mount Storm, WV (10)	Young et al. 2010a, 2011b	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b	High Sheldon, NY (10)	Tidhar et al. 2012a
Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011	Maple Ridge, NY (07-08)	Jain et al. 2009d	Beech Ridge, WV (12)	Tidhar et al. 2013
Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011	Noble Clinton, NY (09)	Jain et al. 2010b	Munnsville, NY (08)	Stantec 2009b
Casselman, PA (08)	Arnett et al. 2009a	Casselman Curtailment, PA (08)	Arnett et al. 2009b	High Sheldon, NY (11)	Tidhar et al. 2012b
Maple Ridge, NY (06)	Jain et al. 2007	Noble Altona, NY (10)	Jain et al. 2011b	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Cohocton/Dutch Hills, NY (10)	Stantec 2011	Noble Ellenburg, NY (09)	Jain et al. 2010c	Stetson Mountain I, ME (09)	Stantec 2009c
Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b	Noble Bliss, NY (09)	Jain et al. 2010a	Mars Hill, ME (08)	Stantec 2009a
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Lempster, NH (10)	Tidhar et al. 2011	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Casselman, PA (09)	Arnett et al. 2010	Noble Ellenburg, NY (08)	Jain et al. 2009b	Kibby, ME (11)	Stantec 2012
Noble Bliss, NY (08)	Jain et al. 2009e	Noble Clinton, NY (08)	Jain et al. 2009c		

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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. In cases where publicly available activity estimate data are not available we indicate this with NA.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
	Northeast				
Mountaineer, WV (2003)	NA	NA	31.69	44	66
Mount Storm, WV (2009)	30.09	7/15/09-10/7/09	17.53	132	264
Noble Wethersfield, NY (2010)	NA	NA	16.3	84	126
Criterion, MD (2011)	NA	NA	15.61	28	70
Mount Storm, WV (2010)	36.67[C]	4/18/10-10/15/10	15.18	132	264
Locust Ridge, PA (Phase II; 2010)	NA	NA	14.38	51	102
Locust Ridge, PA (Phase II; 2009)	NA	NA	14.11	51	102
Casselman, PA (2008)	NA	NA	12.61	23	34.5
Maple Ridge, NY (2006)	NA	NA	11.21	120	198
Cohocton/Dutch Hills, NY (2010)	NA	NA	10.32	50	125
Wolfe Island, Ont (July-December 2010)	NA	NA	9.5	86	197.8
Cohocton/Dutch Hill, NY (2009)	NA	NA	8.62	50	125
Casselman, PA (2009)	NA	NA	8.6	23	34.5
Noble Bliss, NY (2008)	NA	NA	7.8	67	100
Criterion, MD (2012)	NA	NA	7.62	28	70
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
Maple Ridge, NY (2007)	NA	NA	6.49	195	321.75
Wolfe Island, Ont (July-December 2009)	NA	NA	6.42	86	197.8
Maple Ridge, NY (2007-2008)	NA	NA	4.96	195	321.75
Noble Clinton, NY (2009)	1.9[D]	8/1/09-09/31/09	4.5	67	100
Casselman Curtailment, PA (2008)	NA	NA	4.4	23	35.4
Noble Altona, NY (2010)	NA	NA	4.34	65	97.5
Noble Ellenburg, NY (2009)	16.1[D]	8/16/09-09/15/09	3.91	54	80
Noble Bliss, NY (2009)	NA	NA	3.85	67	100
Lempster, NH (2010)	NA	NA	3.57	12	24
Noble Ellenburg, NY (2008)	NA	NA	3.46	54	80
Noble Clinton, NY (2008)	2.1[D]	8/8/08-09/31/08	3.14	67	100
Lempster, NH (2009)	NA	NA	3.11	12	24
Mars Hill, ME (2007)	NA	NA	2.91	28	42
Wolfe Island, Ont (July-December 2011)	NA	NA	2.49	86	197.8
Noble Chateaugay, NY (2010)	NA	NA	2.44	71	106.5
High Sheldon, NY (2010)	NA	NA	2.33	75	112.5
Beech Ridge, WV (2012)	NA	NA	2.03	67	100.5
Munnsville, NY (2008)	NA	NA	1.93	23	34.5
High Sheldon, NY (2011)	NA	NA	1.78	75	112.5
Stetson Mountain II, ME (2010)	NA	NA	1.65	17	25.5
Stetson Mountain I, ME (2009)	28.5; 0.3[E]	7/10/09-10/15/09	1.4	38	57
Mars Hill, ME (2008)	NA	NA	0.45	28	42
Stetson Mountain I, ME (2011)	NA	NA	0.28	38	57
Kibby, ME (2011)	NA	NA	0.12	44	132
	Southeast				
Buffalo Mountain, TN (2005)	NA	NA	39.7	18	28.98
Buffalo Mountain, TN (2000-2003)	23.7[F]	NA	31.54	3	1.98

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. In cases where publicly available activity estimate data are not available we indicate this with NA.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
		Midwest			
Cedar Ridge, WI (2009)	9.97[D,G,H]	7/16/07-9/30/07	30.61	41	67.6
Blue Sky Green Field, WI (2008; 2009)	7.7[G]	7/24/07-10/29/07	24.57	88	145
Cedar Ridge, WI (2010)	9.97[D,G,H]	7/16/07-9/30/07	24.12	41	68
Fowler I, II, III, IN (2011)	NA	NA	20.19	355	600
Fowler I, II, III, IN (2010)	NA	NA	18.96	355	600
Forward Energy Center, WI (2008-2010)	6.97	8/5/08-11/08/08	18.17	86	129
Harrow, Ont (2010)	NA	NA	11.13	24 (four 6-turb facilities)	39.6
Top of Iowa, IA (2004)	35.7	5/26/04-9/24/04	10.27	89	80
Pioneer Prairie I, IA (Phase II; 2011-2012)	NA	NA	10.06	62	102.3
Fowler I, IN (2009)	NA	NA	8.09	162	301
Crystal Lake II, IA (2009)	NA	NA	7.42	80	200
Top of Iowa, IA (2003)	NA	NA	7.16	89	80
Kewaunee County, WI (1999-2001)	NA	NA	6.45	31	20.46
Ripley, Ont (2008)	NA	NA	4.67	38	76
Winnebago, IA (2009-2010)	NA	NA	4.54	10	20
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	2.2[H]	6/15/01-9/15/01	4.35	143	107.25
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	2.2[H]	6/15/01-9/15/01	3.71	138	103.5
Crescent Ridge, IL (2005-2006)	NA	NA	3.27	33	49.5
Fowler I, II, III, IN (2012)	NA	NA	2.96	355	600
Elm Creek II, MN (2011-2012)	NA	NA	2.81	62	148.8
Buffalo Ridge II, SD (2011-2012)	NA	NA	2.81	105	210
Buffalo Ridge, MN (Phase III; 1999)	NA	NA	2.72	138	103.5
Buffalo Ridge, MN (Phase II; 1999)	NA	NA	2.59	143	107.25
Moraine II, MN (2009)	NA	NA	2.42	33	49.5
Buffalo Ridge, MN (Phase II; 1998)	NA	NA	2.16	143	107.25
PrairieWinds ND1 (Minot), ND (2010)	NA	NA	2.13	80	115.5
Grand Ridge I, IL (2009-2010)	NA	NA	2.1	66	99
Barton I & II, IA (2010-2011)	NA	NA	1.85	80	160
Fowler III, IN (2009)	NA	NA	1.84	60	99
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.9[H]	6/15/02-9/15/02	1.81	138	103.5
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.9[H]	6/15/02-9/15/02	1.64	143	107.25
Rugby, ND (2010-2011)	NA	NA	1.6	71	149
Elm Creek, MN (2009-2010)	NA	NA	1.49	67	100
Wessington Springs, SD (2009)	NA	NA	1.48	34	51
PrairieWinds ND1 (Minot), ND (2011)	NA	NA	1.39	80	115.5
PrairieWinds SD1 (Crow Lake), SD (2011-2012)	NA	NA	1.23	108	162
NPPD Ainsworth, NE (2006)	NA	NA	1.16	36	20.5
Buffalo Ridge, MN (Phase I; 1999)	NA	NA	0.74	73	25
Wessington Springs, SD (2010)	NA	NA	0.41	34	51
Buffalo Ridge I, SD (2009-2010)	NA	NA	0.16	24	50.4

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. In cases where publicly available activity estimate data are not available we indicate this with NA.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Southern Plains					
Barton Chapel, TX (2009-2010)	NA	NA	3.06	60	120
Big Smile, OK (2012-2013)	NA	NA	2.9	66	132
Buffalo Gap II, TX (2007-2008)	NA	NA	0.14	155	233
Red Hills, OK (2012-2013)	NA	NA	0.11	82	123
Buffalo Gap I, TX (2006)	NA	NA	0.1	67	134
Rocky Mountains					
Summerview, Alb (2006; 2007)	7.65[H]	07/15/06-07-09/30/06-07	11.42	39	70.2
Summerview, Alb (2005-2006)	NA	NA	10.27	39	70.2
Judith Gap, MT (2006-2007)	NA	NA	8.93	90	135
Foote Creek Rim, WY (Phase I; 1999)	NA	NA	3.97	69	41.4
Judith Gap, MT (2009)	NA	NA	3.2	90	135
Foote Creek Rim, WY (Phase I; 2001-2002)	2.2[F,H]	6/15/01-9/1/01	1.57	69	41.4
Foote Creek Rim, WY (Phase I; 2000)	2.2[F,H]	6/15/00-9/1/00	1.05	69	41.4
Southwest					
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
Pacific Northwest					
Biglow Canyon, OR (Phase II; 2009-2010)	NA	NA	2.71	65	150
Nine Canyon, WA (2002-2003)	NA	NA	2.47	37	48.1
Stateline, OR/WA (2003)	NA	NA	2.29	454	299
Elkhorn, OR (2010)	NA	NA	2.14	61	101
White Creek, WA (2007-2011)	NA	NA	2.04	89	204.7
Biglow Canyon, OR (Phase I; 2008)	NA	NA	1.99	76	125.4
Leaning Juniper, OR (2006-2008)	NA	NA	1.98	67	100.5
Big Horn, WA (2006-2007)	NA	NA	1.9	133	199.5
Combine Hills, OR (Phase I; 2004-2005)	NA	NA	1.88	41	41
Linden Ranch, WA (2010-2011)	NA	NA	1.68	25	50
Pebble Springs, OR (2009-2010)	NA	NA	1.55	47	98.7
Hopkins Ridge, WA (2008)	NA	NA	1.39	87	156.6
Harvest Wind, WA (2010-2012)	NA	NA	1.27	43	98.9
Elkhorn, OR (2008)	NA	NA	1.26	61	101
Vansycle, OR (1999)	NA	NA	1.12	38	24.9
Klondike III (Phase I), OR (2007-2009)	NA	NA	1.11	125	223.6
Stateline, OR/WA (2001-2002)	NA	NA	1.09	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
Klondike, OR (2002-2003)	NA	NA	0.77	16	24
Combine Hills, OR (2011)	NA	NA	0.73	104	104
Hopkins Ridge, WA (2006)	NA	NA	0.63	83	150
Biglow Canyon, OR (Phase I; 2009)	NA	NA	0.58	76	125.4
Biglow Canyon, OR (Phase II; 2010-2011)	NA	NA	0.57	65	150
Hay Canyon, OR (2009-2010)	NA	NA	0.53	48	100.8
Klondike II, OR (2005-2006)	NA	NA	0.41	50	75
Windy Flats, WA (2010-2011)	NA	NA	0.41	114	262.2
Vantage, WA (2010-2011)	NA	NA	0.4	60	90
Wild Horse, WA (2007)	NA	NA	0.39	127	229
Goodnoe, WA (2009-2010)	NA	NA	0.34	47	94

Appendix A1. Wind energy facilities in North America with comparable activity and fatality data for bats, separated by geographic region. In cases where publicly available activity estimate data are not available we indicate this with NA.

Wind Energy Facility	Bat Activity Estimate[A]	Bat Activity Dates	Fatality Estimate[B]	No. of Turbines	Total MW
Marengo II, WA (2009-2010)	NA	NA	0.27	39	70.2
Biglow Canyon, OR (Phase III; 2010-2011)	NA	NA	0.22	76	174.8
Marengo I, WA (2009-2010)	NA	NA	0.17	78	140.4
Klondike IIIa (Phase II), OR (2008-2010)	NA	NA	0.14	51	76.5
Kittitas Valley, WA (2011-2012)	NA	NA	0.12	48	100.8
California					
Shiloh I, CA (2006-2009)	NA	NA	3.92	100	150
Shiloh II, CA (2009-2010)	NA	NA	2.72	75	150
High Winds, CA (2003-2004)	NA	NA	2.51	90	162
Dillon, CA (2008-2009)	NA	NA	2.17	45	45
High Winds, CA (2004-2005)	NA	NA	1.52	90	162
Alta Wind I, CA (2011-2012)	4.42[I]	6/26/2009 - 10/31/2009	1.28	100	150
Diablo Winds, CA (2005-2007)	NA	NA	0.82	31	20.46
Alite, CA (2009-2010)	NA	NA	0.24	8	24
Alta Wind II-V, CA (2011-2012)	0.78	6/26/2009 - 10/31/2009	0.08	190	570

A = Bat passes per detector-night
B = Number of fatalities per megawatt per year
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 = 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
F = Activity rate calculated by WEST from data presented in referenced report
G = Activity rate based on pre-construction monitoring; data for all other activity and fatality rates were collected concurrently
H = Activity rate was averaged across phases and/or years
I = Average of ground-based detectors at CPC Proper (Phase I) for late summer/fall period only

Appendix A1 (*continued*). Wind energy facilities in North America with comparable fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Alite, CA (09-10)	NA	Chatfield et al. 2010	Kewaunee County, WI (99-01)	NA	Howe et al. 2002
Alta Wind I, CA (11-12)	Solick et al. 2010b	Chatfield et al. 2012	Kibby, ME (11)	NA	Stantec 2012
Alta Wind II-V, CA (11-12)	Solick et al. 2010b	Chatfield et al. 2012	Kittitas Valley, WA (11-12)	NA	Stantec Consulting Services 2012
Barton I & II, IA (10-11)	NA	Derby et al. 2011a	Klondike, OR (02-03)	NA	Johnson et al. 2003
Barton Chapel, TX (09-10)	NA	WEST 2011	Klondike II, OR (05-06)	NA	NWC and WEST 2007
Beech Ridge, WV (12)	NA	Tidhar et al. 2013	Klondike III (Phase I), OR (07-09)	NA	Gritski et al. 2010
Big Horn, WA (06-07)	NA	Kronner et al. 2008	Klondike IIIa (Phase II), OR (08-10)	NA	Gritski et al. 2011
Big Smile, OK (12-13)	NA	Derby et al. 2013b	Leaning Juniper, OR (06-08)	NA	Gritski et al. 2008
Biglow Canyon, OR (Phase I; 08)	NA	Jeffrey et al. 2009a	Lempster, NH (09)	NA	Tidhar et al. 2010
Biglow Canyon, OR (Phase I; 09)	NA	Enk et al. 2010	Lempster, NH (10)	NA	Tidhar et al. 2011
Biglow Canyon, OR (Phase II; 09-10)	NA	Enk et al. 2011a	Linden Ranch, WA (10-11)	NA	Enz and Bay 2011
Biglow Canyon, OR (Phase II; 10-11)	NA	Enk et al. 2012b	Locust Ridge, PA (Phase II; 09)	NA	Arnett et al. 2011
Biglow Canyon, OR (Phase III; 10-11)	NA	Enk et al. 2012a	Locust Ridge, PA (Phase II; 10)	NA	Arnett et al. 2011
Blue Sky Green Field, WI (08; 09)	Gruver 2008	Gruver et al. 2009	Maple Ridge, NY (06)	NA	Jain et al. 2007
Buffalo Gap I, TX (06)	NA	Tierney 2007	Maple Ridge, NY (07)	NA	Jain et al. 2009a
Buffalo Gap II, TX (07-08)	NA	Tierney 2009	Maple Ridge, NY (07-08)	NA	Jain et al. 2009d
Buffalo Mountain, TN (00-03)	Fiedler 2004	Nicholson et al. 2005	Marengo I, WA (09-10)	NA	URS Corporation 2010b
Buffalo Mountain, TN (05)	NA	Fiedler et al. 2007	Marengo II, WA (09-10)	NA	URS Corporation 2010c
Buffalo Ridge, MN (Phase I; 99)	NA	Johnson et al. 2000	Mars Hill, ME (07)	NA	Stantec 2008
Buffalo Ridge, MN (Phase II; 98)	NA	Johnson et al. 2000	Mars Hill, ME (08)	NA	Stantec 2009a
Buffalo Ridge, MN (Phase II; 99)	NA	Johnson et al. 2000	Moraine II, MN (09)	NA	Derby et al. 2010d
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (Fall 08)	Young et al. 2009b	Young et al. 2009b
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (09)	Young et al. 2009a, 2010b	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase III; 99)	NA	Johnson et al. 2000	Mount Storm, WV (10)	Young et al. 2010a, 2011b	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mount Storm, WV (11)	NA	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Johnson et al. 2004	Mountaineer, WV (03)	NA	Kerns and Kerlinger 2004
Buffalo Ridge I, SD (09-10)	NA	Derby et al. 2010b	Munnsville, NY (08)	NA	Stantec 2009b
Buffalo Ridge II, SD (11-12)	NA	Derby et al. 2012a	Nine Canyon, WA (02-03)	NA	Erickson et al. 2003
Casselman, PA (08)	NA	Arnett et al. 2009a	Noble Altona, NY (10)	NA	Jain et al. 2011b
Casselman, PA (09)	NA	Arnett et al. 2010	Noble Bliss, NY (08)	NA	Jain et al.2009e
Casselman Curtailment, PA (08)	NA	Arnett et al. 2009b	Noble Bliss, NY (09)	NA	Jain et al. 2010a
Cedar Ridge, WI (09)	BHE Environmental 2008	BHE Environmental 2010	Noble Chateaugay, NY (10)	NA	Jain et al. 2011c
Cedar Ridge, WI (10)	BHE Environmental 2008	BHE Environmental 2011	Noble Clinton, NY (08)	Reynolds 2010a	Jain et al. 2009c
Cohocton/Dutch Hill, NY (09)	NA	Stantec 2010	Noble Clinton, NY (09)	Reynolds 2010a	Jain et al. 2010b
Cohocton/Dutch Hills, NY (10)	NA	Stantec 2011	Noble Ellenburg, NY (08)	NA	Jain et al. 2009b
Combine Hills, OR (Phase I; 04-05)	NA	Young et al. 2006	Noble Ellenburg, NY (09)	Reynolds 2010b	Jain et al. 2010c
Combine Hills, OR (11)	NA	Enz et al. 2012	Noble Wethersfield, NY (10)	NA	Jain et al. 2011a
Crescent Ridge, IL (05-06)	NA	Kerlinger et al. 2007	NPPD Ainsworth, NE (06)	NA	Derby et al. 2007
Criterion, MD (11)	NA	Young et al. 2012a	Pebble Springs, OR (09-10)	NA	Gritski and Kronner 2010b
Criterion, MD (12)	NA	Young et al. 2013	Pioneer Prairie I, IA (Phase II; 11-12)	NA	Chodachek et al. 2012
Crystal Lake II, IA (09)	NA	Derby et al. 2010a	PrairieWinds ND1 (Minot), ND (10)	NA	Derby et al. 2011c
Diablo Winds, CA (05-07)	NA	WEST 2006, 2008	PrairieWinds ND1 (Minot), ND (11)	NA	Derby et al. 2012c
Dillon, CA (08-09)	NA	Chatfield et al. 2009	PrairieWinds SD1 (Crow Lake), SD (11-12)	NA	Derby et al. 2012d

Appendix A1 (*continued*). Wind energy facilities in North America with comparable fatality data for bats.

Project, Location	Activity Reference	Fatality Reference	Project, Location	Activity Reference	Fatality Reference
Dry Lake I, AZ (09-10)	Thompson et al. 2011	Thompson et al. 2011	Red Hills, OK (12-13)	NA	Derby et al. 2013c
Dry Lake II, AZ (11-12)	Thompson and Bay 2012	Thompson and Bay 2012	Ripley, Ont (08)	NA	Jacques Whitford 2009
Elkhorn, OR (08)	NA	Jeffrey et a. 2009b	Rugby, ND (10-11)	NA	Derby et al. 2011b
Elkhorn, OR (10)	NA	Enk et al. 2011b	Shiloh I, CA (06-09)	NA	Kerlinger et al. 2009
Elm Creek II, MN (11-12)	NA	Derby et al. 2010c	Shiloh II, CA (09-10)	NA	Kerlinger et al. 2010b
Elm Creek, MN (09-10)	NA	Derby et al. 2012b	Stateline, OR/WA (01-02)	NA	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 99)	NA	Young et al. 2003a	Stateline, OR/WA (03)	NA	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 00)	Gruver 2002	Young et al. 2003a, 2003b	Stateline, OR/WA (06)	NA	Erickson et al. 2007
Foote Creek Rim, WY (Phase I; 01-02)	Gruver 2002	Young et al. 2003a, 2003b	Stetson Mountain I, ME (09)	Stantec 2009c	Stantec 2009c
Forward Energy Center, WI (08-10)	Watt and Drake 2011	Grodsky and Drake 2011	Stetson Mountain I, ME (11)	NA	Normandeau Associates 2011
Fowler I, IN (09)	NA	Johnson et al. 2010a	Stetson Mountain II, ME (10)	NA	Normandeau Associates 2010
Fowler III, IN (09)	NA	Johnson et al. 2010b	Summerview, Alb (05-06)	NA	Brown and Hamilton 2006b
Fowler I, II, III, IN (10)	NA	Good et al. 2011	Summerview, Alb (06; 07)	Baerwald 2008	Baerwald 2008
Fowler I, II, III, IN (11)	NA	Good et al. 2012	Top of Iowa, IA (03)	NA	Jain 2005
Fowler I, II, III, IN (12)	NA	Good et al. 2013	Top of Iowa, IA (04)	Jain 2005	Jain 2005
Goodnoe, WA (09-10)	NA	URS Corporation 2010a	Tuolumne (Windy Point I), WA (09-10)	NA	Enz and Bay 2010
Grand Ridge I, IL (09-10)	NA	Derby et al. 2010g	Vansycle, OR (99)	NA	Erickson et al. 2000
Harrow, Ont (10)	NA	NRSI 2011	Vantage, WA (10-11)	NA	Ventus 2012
Harvest Wind, WA (10-12)	NA	Downes and Gritski 2012a	Wessington Springs, SD (09)	NA	Derby et al. 2010f
Hay Canyon, OR (09-10)	NA	Gritski and Kronner 2010a	Wessington Springs, SD (10)	NA	Derby et al. 2011d
High Sheldon, NY (10)	NA	Tidhar et al. 2012a	White Creek, WA (07-11)	NA	Downes and Gritski 2012b
High Sheldon, NY (11)	NA	Tidhar et al. 2012b	Wild Horse, WA (07)	NA	Erickson et al. 2008
High Winds, CA (03-04)	NA	Kerlinger et al. 2006	Windy Flats, WA (10-11)	NA	Enz et al. 2011
High Winds, CA (04-05)	NA	Kerlinger et al. 2006	Winnebago, IA (09-10)	NA	Derby et al. 2010e
Hopkins Ridge, WA (06)	NA	Young et al. 2007	Wolfe Island, Ont (July-December 09)	NA	Stantec Ltd. 2010b
Hopkins Ridge, WA (08)	NA	Young et al. 2009c	Wolfe Island, Ont (July-December 10)	NA	Stantec Ltd. 2011b
Judith Gap, MT (06-07)	NA	TRC 2008	Wolfe Island, Ont (July-December 11)	NA	Stantec Ltd. 2012
Judith Gap, MT (09)	NA	Poulton and Erickson 2010			

Appendix A2. Bat fatality estimates for North American wind energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Alite, CA (2009-2010)	0.24	Shrub/scrub & grassland	Chatfield et al. 2010
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 I & II, IA (2010-2011)	1.85	Agriculture	Derby et al. 2011a
Barton Chapel, TX (2009-2010)	3.06	Agriculture/forest	WEST 2011
Beech Ridge, WV (2012)	2.03	Forest	Tidhar et al. 2013
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. 2013b
Biglow Canyon, OR (Phase I; 2008)	1.99	Agriculture/grassland	Jeffrey et al. 2009a
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. 2011a
Biglow Canyon, OR (Phase II; 2010-2011)	0.57	Grassland/shrub-steppe, agriculture	Enk et al. 2012b
Biglow Canyon, OR (Phase III; 2010-2011)	0.22	Grassland/shrub-steppe, agriculture	Enk et al. 2012a
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, 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
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
Buffalo Ridge I, SD (2009-2010)	0.16	Agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012a
Casselman, PA (2008)	12.61	Forest	Arnett et al. 2009a
Casselman, PA (2009)	8.6	Forest, pasture, grassland	Arnett et al. 2010
Casselman Curtailment, PA (2008)	4.4	Forest	Arnett et al. 2009b
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

Appendix A2. Bat fatality estimates for North American wind energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Combine Hills, OR (Phase I; 2004-2005)	1.88	Agriculture/grassland	Young et al. 2006
Combine Hills, OR (2011)	0.73	Grassland/shrub-steppe, agriculture	Enz et al. 2012
Crescent Ridge, IL (2005-2006)	3.27	Agriculture	Kerlinger et al. 2007
Criterion, MD (2011)	15.61	Forest, agriculture	Young et al. 2012a
Criterion, MD (2012)	7.62	Forest, agriculture	Young et al. 2013
Crystal Lake II, IA (2009)	7.42	Agriculture	Derby et al. 2010a
Diablo Winds, CA (2005-2007)	0.82	NA	WEST 2006, 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	Jeffrey et al. 2009b
Elkhorn, OR (2010)	2.14	Shrub/scrub & agriculture	Enk et al. 2011b
Elm Creek, MN (2009-2010)	1.49	Agriculture	Derby et al. 2010c
Elm Creek II, MN (2011-2012)	2.81	Agriculture, grassland	Derby et al. 2012b
Foote Creek Rim, WY (Phase I; 1999)	3.97	Grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2000)	1.05	Grassland	Young et al. 2003a
Foote Creek Rim, WY (Phase I; 2001-2002)	1.57	Grassland	Young et al. 2003a
Forward Energy Center, WI (2008-2010)	18.17	Agriculture	Grodsky and Drake 2011
Fowler I, IN (2009)	8.09	Agriculture	Johnson et al. 2010a
Fowler III, IN (2009)	1.84	Agriculture	Johnson et al. 2010b
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
Goodnoe, WA (2009-2010)	0.34	Grassland and shrub-steppe	URS Corporation 2010a
Grand Ridge I, IL (2009-2010)	2.1	Agriculture	Derby et al. 2010g
Harrow, Ont (2010)	11.13	Agriculture	Natural Resource Solutions Inc. (NRSI) 2011
Harvest Wind, WA (2010-2012)	1.27	Grassland/shrub-steppe	Downes and Gritski 2012a
Hay Canyon, OR (2009-2010)	0.53	Agriculture	Gritski and Kronner 2010a
High Sheldon, NY (2010)	2.33	Agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.78	Agriculture	Tidhar et al. 2012b
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. 2009c
Judith Gap, MT (2006-2007)	8.93	Agriculture/grassland	TRC 2008

Appendix A2. Bat fatality estimates for North American wind energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
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 Consulting Services 2012
Klondike, OR (2002-2003)	0.77	Agriculture/grassland	Johnson et al. 2003
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
Leaning Juniper, OR (2006-2008)	1.98	Agriculture	Gritski et al. 2008
Lempster, NH (2009)	3.11	Grasslands/forest/rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	3.57	Grasslands/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. 2011
Locust Ridge, PA (Phase II; 2010)	14.38	Grassland	Arnett et al. 2011
Maple Ridge, NY (2006)	11.21	Agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	6.49	Agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2007-2008)	4.96	Agriculture/forested	Jain et al. 2009d
Marengo I, WA (2009-2010)	0.17	Agriculture	URS Corporation 2010b
Marengo II, WA (2009-2010)	0.27	Agriculture	URS Corporation 2010c
Mars Hill, ME (2007)	2.91	Forest	Stantec 2008
Mars Hill, ME (2008)	0.45	Forest	Stantec 2009a
Moraine II, MN (2009)	2.42	Agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	6.62	Forest	Young et al. 2009b
Mount Storm, WV (2009)	17.53	Forest	Young et al. 2009a, 2010b
Mount Storm, WV (2010)	15.18	Forest	Young et al. 2010a, 2011b
Mount Storm, WV (2011)	7.43	Forest	Young et al. 2011a, 2012b
Mountaineer, WV (2003)	31.69	Forest	Kerns and Kerlinger 2004
Munnsville, NY (2008)	1.93	Agriculture/forest	Stantec 2009b
Nine Canyon, WA (2002-2003)	2.47	Agriculture/grassland	Erickson et al. 2003
Noble Altona, NY (2010)	4.34	Forest	Jain et al. 2011b
Noble Bliss, NY (2008)	7.8	Agriculture/forest	Jain et al. 2009e
Noble Bliss, NY (2009)	3.85	Agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY (2010)	2.44	Agriculture	Jain et al. 2011c
Noble Clinton, NY (2008)	3.14	Agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	4.5	Agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	3.46	Agriculture/forest	Jain et al. 2009b
Noble Ellenburg, NY (2009)	3.91	Agriculture/forest	Jain et al. 2010c

Appendix A2. Bat fatality estimates for North American wind energy facilities.

Project	Bat Fatalities (bats/MW/ year)	Predominant Habitat Type	Citation
Noble Wethersfield, NY (2010)	16.3	Agriculture	Jain et al. 2011a
NPPD Ainsworth, NE (2006)	1.16	Agriculture/grassland	Derby et al. 2007
Pebble Springs, OR (2009-2010)	1.55	Grassland	Gritski and Kronner 2010b
Pioneer Prairie I, IA (Phase II; 2011-2012)	10.06	Agriculture, grassland	Chodachek et al. 2012
PrairieWinds ND1 (Minot), ND (2010)	2.13	Agriculture	Derby et al. 2011c
PrairieWinds ND1 (Minot), ND (2011)	1.39	Agriculture, grassland	Derby et al. 2012c
PrairieWinds SD1 (Crow Lake), SD (2011-2012)	1.23	Grassland	Derby et al. 2012d
Red Hills, OK (2012-2013)	0.11	Grassland	Derby et al. 2013a
Ripley, Ont (2008)	4.67	Agriculture	Jacques Whitford 2009
Rugby, ND (2010-2011)	1.6	Agriculture	Derby et al. 2011b
Shiloh I, CA (2006-2009)	3.92	Agriculture/grassland	Kerlinger et al. 2010a
Shiloh II, CA (2009-2010)	2.72	Agriculture	Kerlinger et al. 2010b
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
Stateline, OR/WA (2006)	0.95	Agriculture/grassland	Erickson et al. 2007
Stetson Mountain I, ME (2009)	1.4	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	0.28	Forested	Normandeau Associates 2011
Stetson Mountain II, ME (2010)	1.65	Forested	Normandeau Associates 2010
Summerview, Alb (2005-2006)	10.27	Agriculture	Brown and Hamilton 2006b
Summerview, Alb (2006; 2007)	11.42	Agriculture/grassland	Baerwald 2008
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. 2010f
Wessington Springs, SD (2010)	0.41	Grassland	Derby et al. 2011d
White Creek, WA (2007-2011)	2.04	Grassland/shrub-steppe, agriculture	Downes and Gritski 2012b
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. 2010e
Wolfe Island, Ont (July-December 2009)	6.42	Grassland	Stantec Ltd. 2010b
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 searched	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 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	NA	41	120-m radius circle	14.5 months	Every two weeks
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)
Barton Chapel, TX (2009-2010)	60	120	78	30	200 m x 200 m	1 year	10 turbines weekly, 20 monthly
Beech Ridge, WV (2012)	67	100.5	80	67	40 m radius	7 months	Every two days
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	NA	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	NA	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	NA	50	252 m x 252 m	1 year	Bi-weekly(spring, fall), 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 searched	Plot Size	Length of Study	Survey Frequency
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		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
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)

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
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
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	138	103.5	50	103	60 m x 60 m	Summer, fall	Bi-monthly
Buffalo Ridge I, SD (2009-2010)	24	50.4	79	24	200 m x 200 m	1 year	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

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
Cedar Ridge, WI (2010)	41	68	80	20	160 m x 160 m	1 year	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
Cohocton/Dutch Hill, NY (2009)	50	125	80	17	130 m x 130 m	Spring, summer, fall	Daily (5 turbines), weekly (12 turbines)
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	NA	NA	NA	NA	NA	NA
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
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)

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
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)
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 III, IN (2009)	60	99	78	12	160 m x 160 m	10 weeks	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

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
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
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
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)
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)
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

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
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)
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
Kewaunee County, WI (1999-2001)	31	20.46	65	31	60 m x 60 m	2 years	Bi-weekly (spring, summer), daily (spring, fall migration), weekly (fall, winter)
Kibby, ME (2011)	44	132	124	22 turbines	75-m diameter circular plots	22 weeks	Avg. 5-day
Kittitas Valley, WA (2011-2012)	48	100.8	80	48	100 m x 102 m	1 year	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
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) 252 m x 252 m (2.3MW)	2 year	Bi-monthly (spring, fall migration), monthly (summer, winter)
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)

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
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
Marengo I, WA (2009-2010)	78	140.4	67	39	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Marengo II, WA (2009-2010)	39	70.2	67	20	180 m x 180 m	1 year	Bi-monthly (spring, fall), monthly (winter, summer)
Mars Hill, ME (2007)	28	42	80.5	28	76-m diameter, extended plot 238-m diameter	Spring, summer, fall	Daily (2 random turbines), weekly (all turbines): extended plot searched once per season

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
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)
Moraine II, MN (2009)	33	49.5	82.5	30	200 m x 200 m	1 year	Weekly (migratory), monthly (non-migratory)
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
Nine Canyon, WA (2002-2003)	37	48.1	60	37	90-m radius	1 year	Bi-monthly (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 searched	Plot Size	Length of Study	Survey Frequency
Noble Altona, NY (2010)	65	97.5	80	22	120 m x 120 m	Spring, summer, fall	Daily, weekly
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
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

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
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)	90	135	65	40	n/a	1 year	Bi-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)
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
PrairieWinds SD1 (Crow Lake), SD (2011-2012)	108	162	80	50	200 x 200m	1 year	Twice monthly (spring, summer, fall), monthly (winter)
Prince Wind Farm, Ont (2006)	126	189	80	38	63-m radius	4 months	Daily, weekly
Prince Wind Farm, Ont (2007)	126	189	80	38 turbines from January 1st - July 8th, 126 turbines from July 9th-October 31st	63- to 45-m radius	10 months	Daily, weekly
Prince Wind Farm, Ont (2008)	126	189	80	126	45m radius	6.5 months	Daily, 3x/week, 2x/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	NA	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 searched	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.
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 Gorgonio, CA (1997-1998; 1999-2000)	3000	n/a	24.4-42.7	NA	50-m radius	2 years	Quarterly
Searsburg, VT (1997)	11	7	65	11	20- to 55-m radius	Spring, fall	Weekly (fall migration)
Shiloh I, CA (2006-2009)	100	150	65	100	105-m radius	3 years	Weekly
Shiloh II, CA (2009-2010)	75	150	33 turbs = 115; 42 turbs = 125	25	100m radius	1 year	Once/week
SMUD Solano, CA (2004-2005)	22	15	65	22	60-m radius	1 year	Bi-monthly
Stateline, OR/WA (2001-2002)	454	299	50	124	minimum 126 m x 126 m	17 months	Bi-weekly, monthly
Stateline, OR/WA (2003)	454	299	50	153	minimum 126 m x 126 m	1 year	Bi-weekly, monthly
Stateline, OR/WA (2006)	454	299	50	39	variable turbine strings	1 year	Bi-weekly
Stetson Mountain I, ME (2009)	38	57	80	19	76-m diameter	27 weeks (spring, summer, fall)	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
Stetson Mountain I, ME (2011)	38	57	80	19	varied	6 months	Weekly
Stetson Mountain II, ME (2010)	17	25.5	80	17	varied	6 months	Weekly (3 turbines twice a week)
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	NA	14.7 to 57.6	201	50-m radius	20 months	Quarterly
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
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
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)

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
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	NA	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
Wolfe Island, Ont (July-December 2011)	86	197.8	80	86	50m radius	6 months	43 twice weekly, 43 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	Klondike II, OR (05-06)	NWC and WEST 2007
Alta Wind I, CA (11-12)	Chatfield et al. 2012	Klondike III (Phase I), OR (07-09)	Gritski et al. 2010
Alta Wind II-V, CA (11-12)	Chatfield et al. 2012	Klondike IIIa (Phase II), OR (08-10)	Gritski et al. 2011
Barton I & II, IA (10-11)	Derby et al. 2011a	Leaning Juniper, OR (06-08)	Gritski et al. 2008
Barton Chapel, TX (09-10)	WEST 2011	Lempster, NH (09)	Tidhar et al. 2010
Beech Ridge, WV (12)	Tidhar et al. 2013	Lempster, NH (10)	Tidhar et al. 2011
Big Horn, WA (06-07)	Kronner et al. 2008	Linden Ranch, WA (10-11)	Enz and Bay 2011
Big Smile, OK (12-13)	Derby et al. 2013b	Locust Ridge, PA (Phase II; 09)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 08)	Jeffrey et al. 2009a	Locust Ridge, PA (Phase II; 10)	Arnett et al. 2011
Biglow Canyon, OR (Phase I; 09)	Enk et al. 2010	Madison, NY (01-02)	Kerlinger 2002b
Biglow Canyon, OR (Phase II; 09-10)	Enk et al. 2011a	Maple Ridge, NY (06)	Jain et al. 2007
Biglow Canyon, OR (Phase II; 10-11)	Enk et al. 2012b	Maple Ridge, NY (07)	Jain et al. 2009a
Biglow Canyon, OR (Phase III; 10-11)	Enk et al. 2012a	Maple Ridge, NY (07-08)	Jain et al. 2009d
Blue Sky Green Field, WI (08; 09)	Gruver et al. 2009	Marengo I, WA (09-10)	URS Corporation 2010b
Buena Vista, CA (08-09)	Insignia Environmental 2009	Marengo II, WA (09-10)	URS Corporation 2010c
Buffalo Gap I, TX (06)	Tierney 2007	Mars Hill, ME (07)	Stantec 2008
Buffalo Gap II, TX (07-08)	Tierney 2009	Mars Hill, ME (08)	Stantec 2009a
Buffalo Mountain, TN (00-03)	Nicholson et al. 2005	McBride, Alb (04)	Brown and Hamilton 2004
Buffalo Mountain, TN (05)	Fiedler et al. 2007	Melancthon, Ont (Phase I; 07)	Stantec Ltd. 2008
Buffalo Ridge, MN (94-95)	Osborn et al. 1996, 2000	Meyersdale, PA (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase I; 96)	Johnson et al. 2000	Moraine II, MN (09)	Derby et al. 2010d
Buffalo Ridge, MN (Phase I; 97)	Johnson et al. 2000	Mount Storm, WV (Fall 08)	Young et al. 2009b
Buffalo Ridge, MN (Phase I; 98)	Johnson et al. 2000	Mount Storm, WV (09)	Young et al. 2009a, 2010b
Buffalo Ridge, MN (Phase I; 99)	Johnson et al. 2000	Mount Storm, WV (10)	Young et al. 2010a, 2011b
Buffalo Ridge, MN (Phase II; 98)	Johnson et al. 2000	Mount Storm, WV (11)	Young et al. 2011a, 2012b
Buffalo Ridge, MN (Phase II; 99)	Johnson et al. 2000	Mountaineer, WV (03)	Kerns and Kerlinger 2004
Buffalo Ridge, MN (Phase II; 01/Lake Benton I)	Johnson et al. 2004	Mountaineer, WV (04)	Arnett et al. 2005
Buffalo Ridge, MN (Phase II; 02/Lake Benton I)	Johnson et al. 2004	Munnsville, NY (08)	Stantec 2009b
Buffalo Ridge, MN (Phase III; 99)	Johnson et al. 2000	Nine Canyon, WA (02-03)	Erickson et al. 2003
Buffalo Ridge, MN (Phase III; 01/Lake Benton II)	Johnson et al. 2004	Noble Altona, NY (10)	Jain et al. 2011b
Buffalo Ridge, MN (Phase III; 02/Lake Benton II)	Johnson et al. 2004	Noble Bliss, NY (08)	Jain et al.2009e
Buffalo Ridge I, SD (09-10)	Derby et al. 2010b	Noble Bliss, NY (09)	Jain et al. 2010a
Buffalo Ridge II, SD (11-12)	Derby et al. 2012a	Noble Chateaugay, NY (10)	Jain et al. 2011c
Casselman, PA (08)	Arnett et al. 2009a	Noble Clinton, NY (08)	Jain et al. 2009c
Casselman, PA (09)	Arnett et al. 2010	Noble Clinton, NY (09)	Jain et al. 2010b
Casselman Curtailment, PA (08)	Arnett et al. 2009b	Noble Ellenburg, NY (08)	Jain et al. 2009b
Castle River, Alb. (01)	Brown and Hamilton 2006a	Noble Ellenburg, NY (09)	Jain et al. 2010c
Castle River, Alb. (02)	Brown and Hamilton 2006a	Noble Wethersfield, NY (10)	Jain et al. 2011a
Cedar Ridge, WI (09)	BHE Environmental 2010	NPPD Ainsworth, NE (06)	Derby et al. 2007
Cedar Ridge, WI (10)	BHE Environmental 2011	Oklahoma Wind Energy Center, OK (04; 05)	Piorkowski and O'Connell 2010
Cohocton/Dutch Hill, NY (09)	Stantec 2010	Pebble Springs, OR (09-10)	Gritski and Kronner 2010b
Cohocton/Dutch Hills, NY (10)	Stantec 2011	Pine Tree, CA (09-10)	BioResource Consultants 2010
Combine Hills, OR (Phase I; 04-05)	Young et al. 2006	Pioneer Prairie I, IA (Phase II; 11-12)	Chodachek et al. 2012
Combine Hills, OR (11)	Enz et al. 2012	PrairieWinds ND1 (Minot), ND (10)	Derby et al. 2011c
Condon, OR	Fishman Ecological Services 2003	PrairieWinds ND1 (Minot), ND (11)	Derby et al. 2012c
Crescent Ridge, IL (05-06)	Kerlinger et al. 2007	PrairieWinds SD1 (Crow Lake), SD (11-12)	Derby et al. 2012d
Criterion, MD (11)	Young et al. 2012a	Prince Wind Farm, Ont (06)	Natural Resource Solutions 2009
Criterion, MD (12)	Young et al. 2013	Prince Wind Farm, Ont (07)	Natural Resource Solutions 2009
Crystal Lake II, IA (09)	Derby et al. 2010a	Prince Wind Farm, Ont (08)	Natural Resource Solutions 2009
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 a. 2009b	Rugby, ND (10-11)	Derby et al. 2011b
Elkhorn, OR (10)	Enk et al. 2011b	San Gorgonio, CA (97-98; 99-00)	Anderson et al. 2005
Elm Creek, MN (09-10)	Derby et al. 2010c	Searsburg, VT (97)	Kerlinger 2002a
Elm Creek II, MN (11-12)	Derby et al. 2012b	Shiloh I, CA (06-09)	Kerlinger et al. 2009
Erie Shores, Ont. (06)	James 2008	Shiloh II, CA (09-10)	Kerlinger et al. 2010b
Foote Creek Rim, WY (Phase I; 99)	Young et al. 2003a	SMUD Solano, CA (04-05)	Erickson and Sharp 2005
Foote Creek Rim, WY (Phase I; 00)	Young et al. 2003a	Stateline, OR/WA (01-02)	Erickson et al. 2004
Foote Creek Rim, WY (Phase I; 01-02)	Young et al. 2003a	Stateline, OR/WA (03)	Erickson et al. 2004
Forward Energy Center, WI (08-10)	Grodsky and Drake 2011	Stateline, OR/WA (06)	Erickson et al. 2007

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
Fowler I, IN (09)	Johnson et al. 2010a	Stetson Mountain I, ME (09)	Stantec 2009c
Fowler III, IN (09)	Johnson et al. 2010b	Stetson Mountain I, ME (11)	Normandeau Associates 2011
Fowler I, II, III, IN (10)	Good et al. 2011	Stetson Mountain II, ME (10)	Normandeau Associates 2010
Fowler I, II, III, IN (11)	Good et al. 2012	Summerview, Alb (05-06)	Brown and Hamilton 2006b
Fowler I, II, III, IN (12)	Good et al. 2013	Summerview, Alb (06; 07)	Baerwald 2008
Goodnoe, WA (09-10)	URS Corporation 2010a	Tehachapi, CA (96-98)	Anderson et al. 2004
Grand Ridge I, IL (09-10)	Derby et al. 2010g	Top of Iowa, IA (03)	Jain 2005
Harrow, Ont (10)	Natural Resource Solutions 2011	Top of Iowa, IA (04)	Jain 2005
Harvest Wind, WA (10-12)	Downes and Gritski 2012a	Tuolumne (Windy Point I), WA (09-10)	Enz and Bay 2010
Hay Canyon, OR (09-10)	Gritski and Kronner 2010a	Vansycle, OR (99)	Erickson et al. 2000
High Sheldon, NY (10)	Tidhar et al. 2012a	Vantage, WA (10-11)	Ventus Environmental Solutions 2012
High Sheldon, NY (11)	Tidhar et al. 2012b	Wessington Springs, SD (09)	Derby et al. 2010f
High Winds, CA (03-04)	Kerlinger et al. 2006	Wessington Springs, SD (10)	Derby et al. 2011d
High Winds, CA (04-05)	Kerlinger et al. 2006	White Creek, WA (07-11)	Downes and Gritski 2012b
Hopkins Ridge, WA (06)	Young et al. 2007	Wild Horse, WA (07)	Erickson et al. 2008
Hopkins Ridge, WA (08)	Young et al. 2009c	Windy Flats, WA (10-11)	Enz et al. 2011
Jersey Atlantic, NJ (08)	NJAS 2008a, 2008b, 2009	Winnebago, IA (09-10)	Derby et al. 2010e
Judith Gap, MT (06-07)	TRC 2008	Wolfe Island, Ont (May-June 09)	Stantec Ltd. 2010a
Judith Gap, MT (09)	Poulton and Erickson 2010	Wolfe Island, Ont (July-December 09)	Stantec Ltd. 2010b
Kewaunee County, WI (99-01)	Howe et al. 2002	Wolfe Island, Ont (January-June 10)	Stantec Ltd. 2011a
Kibby, ME (11)	Stantec 2012	Wolfe Island, Ont (July-December 10)	Stantec Ltd. 2011b
Kittitas Valley, WA (11-12)	Stantec Consulting 2012	Wolfe Island, Ont (January-June 11)	Stantec Ltd. 2011c
Klondike, OR (02-03)	Johnson et al. 2003	Wolfe Island, Ont (July-December 11)	Stantec Ltd. 2012