New Creek Wind Project 2018 Post-construction Monitoring

Results of April – November 2018 Curtailment Evaluation, Acoustic Bat Monitoring, and Bird and Bat Carcass Surveys

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Prepared for:

New Creek Wind, LLC

Prepared by:

Stantec Consulting Services Inc.
30 Park Drive
Topsham, ME 04086

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Executive Summary

The New Creek Wind Project (Project) began commercial operation in December 2016. This report summarizes results of curtailment evaluation, acoustic bat surveys, and bird and bat carcass monitoring that occurred at the Project between April and November 2018. This second year of monitoring was designed to evaluate the effectiveness and efficiency of a strategic curtailment strategy at reducing bat mortality, characterize conditions during which bats were active at nacelle height, and yield estimates of bird and bat fatality for the Project. The curtailment strategy was designed based on acoustic and weather data recorded at nacelle height throughout the 2017 monitoring period. Accordingly, year 2018 monitoring provided an opportunity to explicitly evaluate predictions made in 2017 regarding the cost and effectiveness of the curtailment strategy.

Curtailment Strategy

The 49 turbines at New Creek were divided into two operational groups for the 2018 monitoring period: 37 turbines were programmed to be feathered (blades pitched to prevent turbine rotation) under a strategic curtailment strategy based on site-specific bat data collected in 2017, and the remaining 12 turbines were to be feathered below the manufacturer's cut-in speed of 3 m/s. The curtailment strategy raised the cut-in speed to 5.5 m/s between 1 April and 30 June, 6.0 m/s between 1 July and 30 September, 5.0 m/s during October, and 4.0 m/s between 1 and 15 November. Curtailment was implemented between sunset and sunrise, whenever temperatures exceeded 5 degrees C, during each seasonal period. Based on 2017 acoustic monitoring at nacelle height, we predicted that this strategy would protect 77% of bat activity from turbine operation. We predicted that the feathering-below-normal cut-in strategy would protect 20% of bat activity from turbine operation.

Curtailment criteria were met for an average of 5,170 out of 14,588 time periods (35%) at night between 1 April and 15 November among the 37 curtailed turbines. Turbine RPM was less than 1 for an average of 4,690 (91%) of the periods when conditions were met, indicating successful implementation of the curtailment plan. Wind speed was less than 3 m/s for an average of 1,583 out of 14,625 time periods (11%) at night between 1 April and 15 November among the 12 turbines that were to be feathered below 3.0 m/s. However, RPM was less than 1 for only 662 (42%) of these periods meeting shutdown criteria, and further analysis indicated similar turbine operation between day and night. Accordingly, these 12 turbines represented operational controls during the 2018 monitoring period.

Acoustic Monitoring

Acoustic bat detectors were deployed at 10 of 49 project turbines and recorded a total of 12,051 bat passes during 1,356 detector-nights surveyed between 9 May and 15 November. Nine of the detectors operated properly for most of the monitoring period, while 1 detector (on Turbine 39) malfunctioned for most of the study period. Hoary bats (*Lasiurus cinereus*) accounted for 47% (n = 3,880) of recorded bat passes that were identified to species or species group (n = 8,315), with eastern red (*Lasiurus borealis*) and silver-haired bats (*Lasionycteris noctivagans*) accounting for 25% and 19% of identified passes, respectively. Only 9 passes were identified as *Myotis* species, occurring only at 2 detectors. Seasonal

patterns in activity varied among species, with hoary bats and eastern red bats most active during August and silver-haired bats most active in September. Tri-colored bats (*Perimyotis subflavus*) accounted for only 2% of identified passes and were detected most often in August and September. Big brown bats (*Eptesicus fuscus*) were detected most frequently in late August and accounted for 4% of identified passes. Although species presence varied among nights, overall timing of bat activity showed similar patterns among detectors and species groups, with most activity occurring during the first few hours past sunset.

Bat activity showed clear relationships with temperature and wind speed measured at corresponding turbine nacelles, with 99% of passes for which weather data were available (n = 11,929) occurring when temperature was greater than 10° C and 61% of passes occurring at wind speeds less than 4.5 m/s. Considering temperature and wind speed together, bat activity occurred disproportionally during calm, warm conditions, and few bat passes were recorded during times with higher wind speeds or cooler temperatures. Also, results suggested an apparent interaction between the effects of temperature and wind speed on bat activity, with activity during windy conditions occurring primarily at warmer temperatures.

Curtailed turbines with operating bat detectors (n = 5) were effectively curtailed (conditions met and RPM < 1) during periods when 79 to 90% of recorded bat passes were detected. The control turbines with operating bat detectors (n = 4) were inactive (RPM < 1) during periods when 11 to 24% of bat activity occurred. Overall, the curtailment strategy protected 84.4% of bats recorded during the monitoring period, indicating that the strategy was more protective of bats than predicted based on 2017 data. Overall, 17.7% of bats detected at control turbines were not exposed to turbine operation.

Bird and Bat Carcass Monitoring and Fatality Estimates

Stantec searched all 25 odd numbered Project turbines at a weekly interval between 7 May and 14 November, conducting a total of 683 turbine searches during 135 days on-site. Individual turbines were searched on 24 to 28 occasions during the survey period. Searchers found 27 bat and 7 bird carcasses during standardized searches, and an additional 8 bat and 5 bird carcasses incidentally. Most carcasses were fresh (fatality estimated to have occurred the previous night), although searchers occasionally found carcasses estimated to be several days up to a week old. No federally listed bird or bat species were found during the survey period. Hoary bats (n = 20), eastern red bats (n = 8), and silver-haired bats (n = 4) accounted for 57%, 23%, and 11% of bat carcasses. Together, these long-distance migratory species accounted for 91% of bat carcasses, with big brown bats accounting for 6% of carcasses and tri-colored bats accounting for the remaining 3%. Bird carcasses represented 9 species, with no more than 2 of any single species found.

Ground conditions remained favorable for searching (short, sparse vegetation) throughout the monitoring period. Searcher efficiency was estimated to be 42% for bats and 67% for birds. Searcher efficiency estimates for bats were based almost entirely on mouse surrogates, which are typically more cryptic than bat carcasses, so we suspect that actual searcher efficiency for bats was higher, as documented in 2017 monitoring. Good ground visibility may have also contributed to the high scavenging rates documented throughout the monitoring period. Based on log-logistic model, which was most appropriate based on site-specific trials, carcass persistence was less than 1 day for birds and bats, with an estimated 16% of bat carcasses and 20% of bird carcasses persisting through the search interval. Taking into account searcher efficiency, carcass persistence, search interval, and density-weighted area correction factor, based on the Huso estimator, we obtained an estimated overall bird fatality rate of 3.19 birds/turbine (95% CI 1.90–5.34), combining the two operational groups (estimated bird fatality rates did not differ significantly between groups). Estimated bat fatality rate did differ significantly between operational groups, with a rate of 3.66 bats/turbine (95% CI 2.02–7.21) for curtailed turbines and 38.19 bats/turbine (95% CI 20.95–75.68) for control turbines. We included incidental carcasses found at search turbines in our estimates, and because bat searcher efficiency was likely higher than what was indicated by trials using mouse surrogates, we consider these fatality estimates to represent “worst case” scenarios.

Conclusions

The curtailment strategy in place between 1 April and 15 November 2018 prevented turbine operation during periods in which most acoustic bat activity (86% overall) occurred, resulting in an estimated bat fatality rate 90% lower than that for normally operating control turbines. Overall reductions in fatality were comparable to the amount of avoided bat activity. Our results suggest that the 2018 curtailment strategy effectively maintained low risk to bats throughout the monitoring period. The bat fatality estimate for 12 normally operating turbines was high, demonstrating substantial reductions in risk to bats associated with the curtailment strategy based on site-specific data collected in 2017.

Acoustic monitoring at nacelle height in 2017 provided valuable information for designing a smart curtailment strategy based on site-specific data and continued acoustic and carcass monitoring during 2018 verified the effectiveness of this curtailment program. Our results contribute to a growing body of evidence demonstrating that bat fatality can be maintained at low levels with strategic turbine curtailment, even in regions such as the mid-Atlantic, where risk to bats at wind farms is high. By incorporating multiple survey methods, the 2017 and 2018 monitoring periods provided a foundation of information and means to evaluate this approach to smart curtailment. Comparison of the 2017 and 2018 curtailment strategies indicates that lower cut-in speeds during early summer and late fall, combined with a lower overall cut-in speed during July–September allowed for additional power generation with little if any increased risk to bats.

1.0 INTRODUCTION

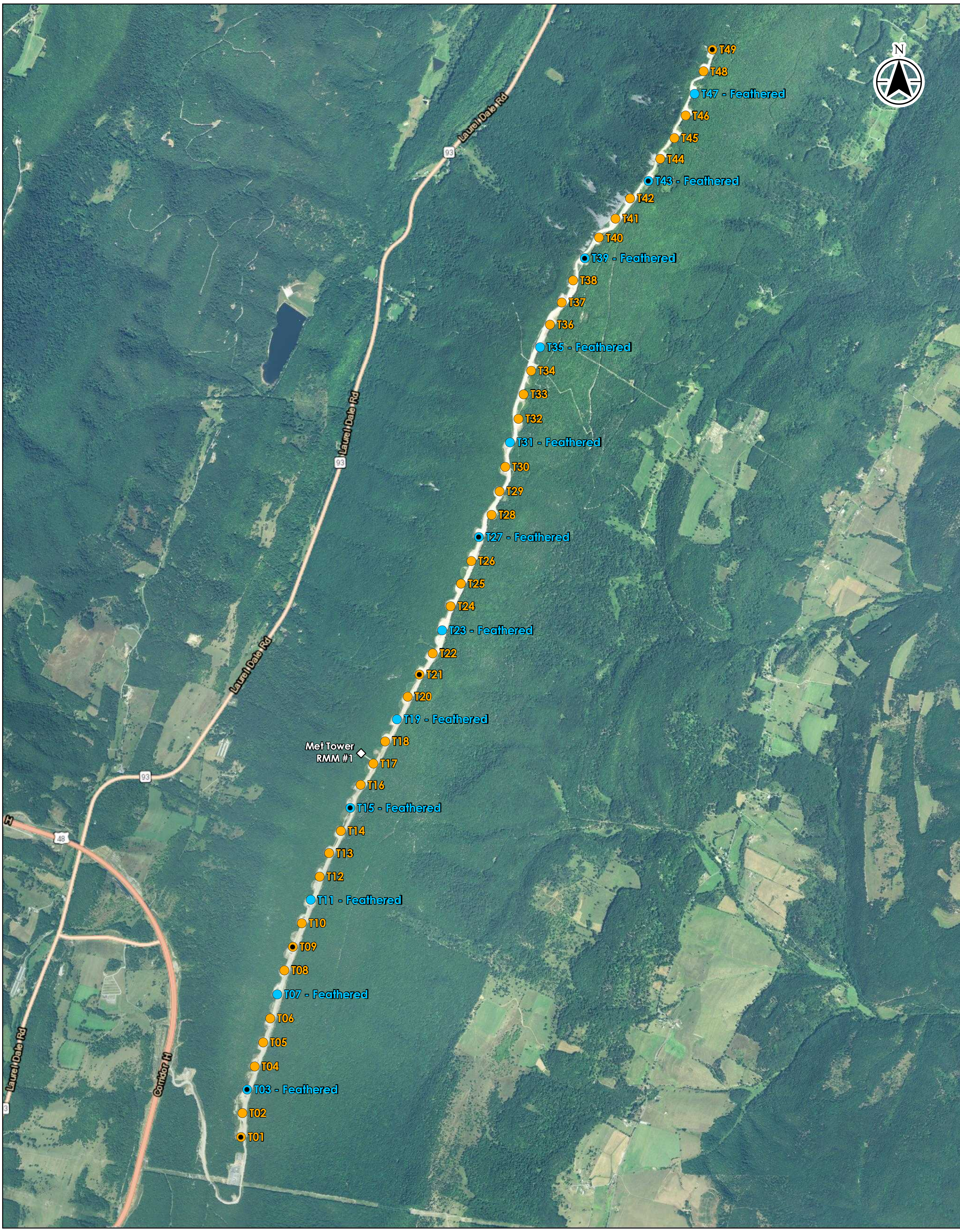
The New Creek Wind Project (Project), operated by New Creek Wind, LLC. (New Creek), an indirect, wholly owned subsidiary of Enbridge Inc. ("Enbridge"), began commercial operation in December 2016. As part of the Bird and Bat Conservation Strategy (BBCS; Stantec 2017) developed for the Project, and as required by the 2009 Public Service Commission of West Virginia order approving Project development, New Creek will conduct at least 1 year and up to 3 years of post-construction bird and bat carcass monitoring. This report summarizes results of the second year of monitoring, which occurred between April and November 2018, and consisted of curtailment evaluation, acoustic bat monitoring, and bird and bat carcass searches. The methods and level of effort for year 2018 monitoring were based on conversations between Stantec Consulting Services Inc. (Stantec), Enbridge, the U.S. Fish and Wildlife Service (USFWS), and West Virginia Division of Natural Resources (WVDNR), and described in the Year 2 Post-construction Monitoring Plan (Monitoring Plan) submitted to agencies in March 2018 and included as Appendix A. Results of eagle point counts, which also occurred through spring 2018 will be summarized and reported separately. Carcass handling and collection associated with the 2018 monitoring period were authorized by a Migratory Bird Special Purpose – Utility Permit issued by the USFWS (permit # MB17012C-0) and a WVDNR Scientific Collecting Permit (permit #2018.262).

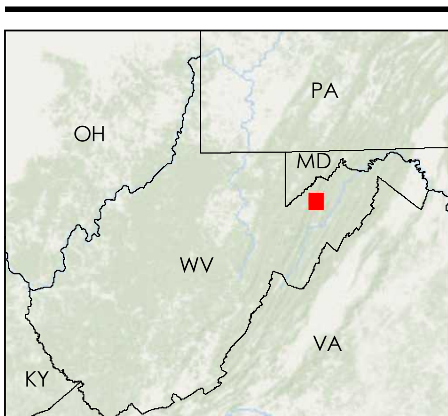
1.1 PROJECT DESCRIPTION

The Project has a production capacity of approximately 100 megawatts (MW) and consists of 49 wind turbines and associated infrastructure located on approximately 11 kilometers (km; 7 miles) of forested ridgeline on New Creek Mountain in Grant County southwest of Keyser, West Virginia (Figure 1-1).

The 45 Gamesa G97 and 4 G90, 2.0 MW turbines have a hub height of 78 meters (m; 256 feet [ft]) and total height of approximately 126 m (413 ft). The 49 turbines are arranged in a single string on the center of the ridge, connected by a single access road. The project connects to a previously existing 500 kilovolt transmission line that crosses the ridge from west to east via a substation at the southern end of the yard and a switchyard operated by Dominion Energy. The Project Operations and Management (O&M) building is located off the west side of ridgeline.

New Creek Mountain is a narrow ridgeline with a southwest-northeast orientation and relatively uniform height of approximately 900 m (2,950 ft) above sea level. Elevations in the surrounding valleys are between 450 and 500 m (1,475 to 1,640 ft), resulting in elevation gradients of approximately 400 to 450 m (1,310 to 1,475 ft) between the ridgeline and the surrounding valleys. The mountain drops steeply in elevation on both the east and west sides and forms a narrow, linear ridge typical of those found in the ridge and valley region of West Virginia. This region, which extends from south-central Pennsylvania to southern West Virginia/Virginia border, is also known as the Allegheny Front. The bedrock of New Creek Mountain consists of sandstone, with rocky talus occupying much of the steep western slope of the mountain. In several places, these rocky talus slopes form large openings without forest canopy, although a short tree canopy covers most of the western slope. The eastern slope is generally less steep and lacks substantial talus fields. Bands of limestone occur near the bottom of both sides of the mountain.





Legend

- 2018 Operational Strategy
- 2018 Mode
- Acoustic Detector Location
- MET Tower

0 1,500 3,000 Feet

1:36,000 (At Original document size of 11x17)

Notes

1. Coordinate System: NAD 1983 UTM Zone 17N
2. Base Map: ESRI ArcGIS Online NAIP imagery web mapping service.

Stantec

Project Location 195601197

Grant County
West Virginia

Prepared by GAC on 2018-03-26
Reviewed by TP on 2018-03-27

Client/Project

New Creek Wind, LLC
New Creek Wind Energy Project

Figure No.

1-1

Title

Project Location Map

Revised: 2019-01-07 By: rmack

Forests on the ridgeline of New Creek Mountain are primarily oak-dominated, with a relatively short canopy of scrub oak (*Quercus ilicifolia*) reaching a maximum height of only 5 to 10 m (16–33 ft) in most areas. Portions of the ridgeline also contain pitch pine (*Pinus rigida*) regeneration, especially along the eastern crest of the ridge. Soils are very thin and dry throughout, with a rocky substrate visible in many areas. Wetlands are limited along the ridgeline, with water generally found only in a small pond at the southern end of the Project area between the substation and transmission lines that cross the ridge from west to east.

1.2 MONITORING OBJECTIVES

As described in the Monitoring Plan, the second year of post-construction monitoring at the Project was designed to document species composition and seasonal patterns in bird and bat mortality at the Project, estimate rates of bird and bat fatality between 1 April and 15 November for turbines operating according to 2 distinct operational strategies, document patterns in bat activity near turbine nacelles using acoustic detectors, and evaluate predictions made based on year 2017 data. Specific objectives included determining:

- Estimated bird and bat fatality rates (per turbine and per MW) for each of 2 operational groups
- Searcher efficiency (percent of carcasses detected by searchers)
- Carcass persistence (length of time carcasses remained in place before being scavenged and/or decomposing)
- Seasonal patterns in bird and bat mortality (e.g., number of carcasses found per month)
- Species composition of bird and bat fatalities
- Species composition, seasonal, and temporal patterns in bat activity at nacelle height using acoustics
- Relationships between bat activity (measured acoustically), temperature, and wind speed at nacelle height
- Relationships between bat mortality and acoustic activity at nacelle height

2.0 METHODS

2.1 TURBINE OPERATION AND CURTAILMENT EVALUATION

Enbridge applied a curtailment strategy based on year 2017 acoustic data to 37 turbines between 1 April and 15 November. This strategy raised the cut-in speed to 5.5 m/s between 1 April and 30 June, 6.0 m/s between 1 July and 30 September, 5.0 m/s during October, and 4.0 m/s between 1 and 15 November. Curtailment was implemented between sunset and sunrise, whenever temperatures exceeded 5 degrees C, during each seasonal period. Whenever curtailment conditions were met, turbine blades were fully feathered to prevent turbine rotation. The remaining 12 turbines were intended to be feathered below the normal cut-in speed of 3.0 m/s, although these turbines were inadvertently operated without restriction throughout the monitoring period, effectively serving as operational controls. This was determined at the end of the monitoring period when reviewing turbine operation and weather data.

Turbine rotor speed, wind speed, and temperature were recorded at turbine nacelles for each of the 49 turbines at 10-minute intervals throughout the monitoring period. Stantec coded each 10-minute period as meeting or not meeting the curtailment conditions as designed. This represented the time periods during which turbines should have been curtailed. We determined whether turbines were in fact curtailed during these periods based on 10-minute RPM, defining 1 RPM as the maximum threshold for curtailment. We differentiated night versus day based on sunset and sunrise times calculated for the location of each turbine using R Package RAtmosphere (version 1.1). We estimated potential energy generation for every 10-minute period for which we had wind speed data using a power curve provided by New Creek. Estimated energy losses associated with curtailment were calculated by summing estimated power generation for time periods in which turbine RPM was less than 1 and curtailment conditions were met.

2.2 ACOUSTIC MONITORING

2.2.1 Acoustic Detector Deployment

Enbridge deployed acoustic bat detectors on the nacelles of 10 wind turbines (evenly distributed among the two treatment groups) to document bat activity in the turbine rotor zone, characterize relationships between bat activity and weather conditions, and determine the amount of bat activity exposed to turbine operation versus protected by the curtailment treatments. Full-spectrum (Wildlife Acoustics SM4) echolocation detectors were fixed to nacelle-mounted anemometer masts and were oriented facing away from the rotor (Figure 2-1). Detectors were programmed to operate continuously from 30 minutes before sunset to 30 minutes after sunrise and were powered by 12-volt battery systems charged by small solar panels. Enbridge or Gamesa staff inspected detectors when possible during the survey period to offload data and check that detectors were operating properly.

Figure 2-1. Photo of acoustic bat detector (in green box) mounted on the nacelle of Turbine 1 at the New Creek Wind Project (photo from 2017).

2.2.2 Acoustic Data Analysis and Summary

Recorded audio files were converted to zero-crossing format using Kaleidoscope Pro software (version 3.1.7) and visually inspected in AnalookW software (version 4.2g) to distinguish bat passes from static or other ultrasonic noise. Stantec technicians trained in identifying bat call sequences inspected each zero-crossing file and assigned them to a species category based on parameters such as minimum frequency, slope, time between calls, and the profile of frequency versus time, comparing recorded passes to reference libraries of acoustic bat calls. A Stantec biologist reviewed species category assignments as a quality assurance/quality control of the identification process. This method of visual analysis and comparison to reference libraries, although subjective and dependent on the skill of the analysts, can produce accurate identification (O'Farrell et al. 1999, O'Farrell and Gannon 1999). In Stantec's experience, visual identification is less prone than auto-classification software to mistaking bat passes for recordings of unusual ultrasonic noises (as can be expected for nacelle-mounted detectors).

Bat passes were classified to species whenever possible, and then assigned to one of the 5 following species groups:

- Unknown (UNKN) – All call sequences with less than 5 calls, or poor-quality sequences (those with indistinct call characteristics or background static). These sequences were further identified as either "high frequency unknown" (HFUN) for sequences with a minimum frequency above ~30 kHz, or "low frequency unknown" (LFUN) for sequences with a minimum frequency below ~30 kHz.
- Myotis (MYSP) – Bats of the genus Myotis that in West Virginia include little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis* [federally threatened]), eastern small-footed bat (*Myotis leibii*), and Indiana bat (*Myotis sodalis* [federally endangered]). While there are some general characteristics believed to be distinctive for the species in this genus that occur in West Virginia, these characteristics are not sufficiently consistent to be relied upon for species identification at all times.
- Eastern red bat/tri-colored bat (RBTB) – Eastern red bats (*Lasiurus borealis*, LABO) and tri-colored bats (*Perimyotis subflavus*, PESU). These 2 species can produce distinctive calls. However, significant overlap in the call pulse shape, frequency range, and slope can also occur. In West Virginia, evening bats (*Nycticeius humeralis*) would also be included in this species group.
- Big brown/silver-haired bat (BBSH) – Big brown bats (*Eptesicus fuscus*, EPFU) and silver-haired bats (*Lasionycteris noctivagans*, LANO). The call signatures of these species commonly overlap and are included as 1 species group in this report. In the unlikely event that fragments of Virginia big-eared bats (*Corynorhinus virginianus* [federally endangered] were recorded, they would likely be assigned to this group as they overlap in frequency with feeding buzzes of big brown bats)
- Hoary bat (HB) – Hoary bats (*Lasiurus cinereus*, HB). Calls of hoary bats can usually be distinguished from those of big brown and silver-haired bats by minimum frequency extending below 20 kHz and/or by hook-shaped calls varying widely in minimum frequency across a sequence.

This method of species group identification represents a conservative approach to bat call identification, minimizing the potential of mis-identifying call sequences. All recorded call sequences were included in the species group structure. Since some species sometimes produce calls unique only to that species, all calls were identified to the lowest possible taxonomic level before being assigned to a species group. Tables and figures in the body of this report will reflect those species groups. In addition, since species-specific identification did occur in some cases, each species group will also be briefly discussed with respect to potential species composition of recorded call sequences.

Stantec compiled nightly tallies of detected bat passes and determined overall and monthly detection rates (number of passes/detector-night) for the entire sampling period for each detector. Because bat activity levels are highly variable among individual nights and individual hours (Hayes 1997, Arnett et al. 2006), detection rates were summarized on both temporal scales. Nightly detection rates were summarized by detector for the entire sampling period. Hourly detection rates were summarized by hour after sunset, as recommended by Kunz et al. (2007).

Temperature and wind speed measured at the corresponding nacelles were determined for the 10-minute period in which every bat pass occurred. This information was used to document conditions during which bats were most active (and, therefore, at the greatest risk of collision). Turbine RPM was also determined at the time each bat pass occurred to document what proportion of bat activity was "exposed" to turbine operation. The proportion of curtailed 10-minute intervals (RPM < 1) during which bat activity occurred was calculated as a measure of the effectiveness of each curtailment strategy at reducing risk to bats, as described below.

2.3 BAT ACTIVITY AND TURBINE OPERATION

For each turbine with an acoustic bat detector, Stantec determined the number of bat passes recorded during each 10-minute period by aligning timestamps for bat passes (rounded to 10-minute intervals) and weather data, then determined the proportion of passes that occurred during periods when curtailment conditions were met (simulated avoidance) and when turbines were curtailed (conditions met and RPM < 1; actual avoidance). Similarly, we predicted energy loss (power generation potential during periods when curtailment conditions were met) and actual energy loss (conditions met and generation potential when RPM < 1) for each turbine with an acoustic detector.

We used this information to calculate the predicted avoidance (percent of bat passes occurring when curtailment conditions were met) and estimated energy loss (power generation potential during periods when curtailment conditions were met) for each detector/turbine and operational strategy as a measure of its relative efficiency and effectiveness.

2.4 STANDARDIZED CARCASS MONITORING

Standardized carcass monitoring occurred on a weekly basis at all 25 odd numbered Project turbines between 7 May and 14 November 2018. Turbine searches were conducted within the area cleared (full plot searches) at all 25 odd numbered turbines.

2.4.1 Search Area Mapping and Management

Results from recent mortality monitoring studies indicate that most bird and bat carcasses fall within a distance equal to or less than 50% of the maximum height of turbines (Kerns and Kerlinger 2004; Arnett et al. 2005; Fiedler et al. 2007; Young et al. 2009; Jain et al. 2007, 2008, 2009a b; Piorkowski and O'Connell 2010). Most bat fatalities fall within 30 m to 40 m of turbines (Kerns and Kerlinger 2004, Johnson et al. 2003)[1]. Based on these results, the full plot search area for each of the 25 project turbines targeted the cleared area around each turbine up to a 90 m x 90 m square area centered at the base of turbine towers. Rocky talus slopes, rubble, densely vegetated areas, and other ground cover types that prohibited effective or safe searching conditions were excluded from searchable areas. Stantec mapped the extent of the searchable area for each turbine using a Global Positioning System (GPS) unit (Trimble Geo-XH).

Typically, mowing or other similar vegetation management is conducted periodically to improve visibility of the ground and maximize searcher efficiency, which in turn improves the precision of mortality estimates (Sonnenburg and Erickson 2010). However, vegetation remained sparse throughout the 2018 monitoring period, such that mowing was not required (Figure 2-2).

Figure 2-2. Photo of ground conditions and hoary bat carcass (centered in photo) at Turbine 11 at the New Creek Wind Project, 27 August 2018.

2.4.2 Carcass Search Methods

Prior to conducting carcass surveys, Enbridge obtained a “Migratory Bird Special Purpose Utility Permit – Wind” from the USFWS (permit # MB17012C-0) that named its employees and contractors as sub-permittees. Stantec was issued a Scientific Collecting Permit from the WVDNR (permit # 2018.262) that

[1]During avian and bat mortality monitoring at the Buffalo Ridge wind facility in Minnesota in which all areas within 50 m (164 ft) of turbines were searched, only 1 of 184 bats were found greater than 30 m (98 ft) from a turbine.

listed Stantec and Enbridge personnel as permittees. Surveyors were trained on the proper handling of injured birds and bats if they were found. Any individual handling live bats was required to maintain an up-to-date rabies vaccination.

Parallel search transects spaced at 4 m (13 ft) intervals were oriented north-to-south (magnetic) within searchable areas (see Section 2.4.1 Search Area Mapping and Management) at each turbine. Transects were marked using temporary flagging and fluorescent marking paint. Searchers visually scanned the ground on either side of the transacts, walking at an approximate speed of 30 to 50 m per minute, resulting in approximate 25 to 60minute search times per full plot turbine depending on the size of searchable area and survey conditions. Surveyors temporarily marked the location of any bird or bat carcasses found during the search using flagging tape.

After each turbine search, the surveyor returned to any marked carcasses and recorded relevant data as described below. A photograph was taken of the carcass before it was moved. Carcasses were collected in individual re-sealable plastic bags, labeled with a unique identification number according to the date and turbine where they were found. Carcasses were stored in a designated freezer at the Enbridge O&M building throughout the monitoring period for use during searcher efficiency and carcass persistence (bias) trials. Carcasses not used for on-site bias trials were provided to the WVDNR at the end of the monitoring period.

All intact bird and bat carcasses or remnants of scavenged carcasses (e.g., a cluster of feathers representing more than a molt, or a patch of skin and bone) were documented as fatalities. Carcasses found incidentally within the Project area, either by surveyors or other site personnel, were also documented and collected.

The following information was recorded for each carcass found by the surveyors:

- Date, time, turbine number, and surveyor
- Search type during which carcass was found (i.e., turbine search or incidentally)
- Distance and azimuth (magnetic) of carcass from tower
- Ground cover type, height, and condition (i.e., wet, dry) where carcass was found
- Carcass species identification, age (juvenile or adult), sex, and reproductive condition (to the extent possible)
- Carcass condition (estimated number of days since death, if they were live/injured, intact or scavenged and/or level of scavenging activity)
- Evidence of scavenger activity (e.g., tracks or scat) near of the carcass

Allowed under the conditions of the state and federal collection permits, efforts would have been made to bring injured animals to the closest licensed wildlife rehabilitator able to take that species. A list of local, currently licensed wildlife rehabilitators capable of accepting regional bird and bat species was developed and provided to searchers. The closest rehabilitation facility is the Avian Conservation Center of Appalachia in Morgantown, West Virginia.

Carcasses were retained for subsequent use in validation trials (see Sections 2.4.3 Searcher Efficiency Trials and 2.4.4 Carcass Persistence Trials), unless they were a rare species, in which case they were to be retained for confirmation of identity. All *Myotis* bats were to be provided to WVDNR for inspection, identification verification, and submission to a lab for genetic testing if deemed necessary by agency personnel. The WVDNR and USFWS were to be notified within 48 hours if a suspected or confirmed Indiana bat (*Myotis sodalis*) carcass or any other federally threatened or endangered bird or bat species was found.

2.4.3 Searcher Efficiency Trials

Searcher efficiency rates are variable among studies at wind facilities in the United States and are largely dependent on ground cover conditions. Searcher recovery rates have ranged from 25% to 56% for small carcasses, and as high as 100% for large carcasses (Arnett et al. 2005, Erickson et al. 2003, Jain et al. 2007). Trials were conducted to estimate searcher efficiency rates.

Trials targeted the placement of up to 100 carcasses over the course of the monitoring period. Trial carcasses were used for multiple trials if they remained in good condition. Multiple trials were conducted throughout the survey period at arbitrary intervals to account for changes in ground cover conditions. On trial days, between 1 and 4 carcasses were placed at random distances from turbine towers and in a variety of cover types per turbine at one or more turbines scheduled to be searched that day.

Small, medium, and large bird carcasses (preferably of native species) and bat carcasses (as carcass availability allowed), in varying stages of decomposition were marked discreetly so that trial carcasses were able to be distinguished from actual fatalities without the surveyor's knowledge. Although searcher efficiency was not estimated separately for carcasses of varying sizes, carcasses used in searcher efficiency trials were, to the extent possible, representative of the range of sizes of birds and bats found on site during mortality surveys. To the extent that was feasible (i.e., carcasses are in good condition and bat carcasses do not show signs of White-Nose Syndrome); carcasses found during mortality searches at the Project were used in trials. If an insufficient number of carcasses from the Project were available, surrogates for native birds (e.g., juvenile quail) were used. Surveyors being tested were unaware of trial dates and locations. The trial coordinator placed carcasses at random beneath a search turbine on the evening before, or in the early morning immediately preceding, a turbine search, and made every effort to leave no evidence of trial set-up (i.e., vehicle or foot prints in wet grass or mud). The trial coordinator recorded the following information for each carcass placed:

- Date, time of set-up, trial coordinator
- Turbine number
- Carcass identification
- Carcass distance and direction from tower
- Ground cover type and vegetation height where carcass was placed

After searches were completed on trial days, the trial coordinator determined how many trial carcasses were recovered and how many were possibly scavenged, and then removed unobserved carcasses. The presence of the carcass (i.e., availability for detection) was determined immediately following the completion of each searcher efficiency trial.

Searcher efficiency rate is expressed as the proportion of carcasses found by searchers (the number of carcasses found by searchers divided by the total number of carcasses placed during searcher efficiency trials). Estimated searcher efficiency and confidence intervals were calculated using the Huso software, as described below.

2.4.4 Carcass Persistence Trials

Trials were conducted to estimate the percentage of carcasses that were removed by scavengers prior to recovery by surveyors, or the carcass persistence rate. Carcasses in fresh condition were used in trials and were marked discreetly to differentiate them from actual fatalities. As with the Searcher Efficiency trials, juvenile quail carcasses (surrogate for birds) and bat carcasses found on site (and in as fresh condition as possible) were used for carcass persistence trials. Although carcass persistence was not estimated separately for carcasses of varying sizes, carcasses used in carcass persistence trials were, to the extent possible, representative of the range of sizes of birds and bats found on site during mortality surveys. Trials were spaced out over the course of the survey year to account for seasonal changes of scavenger activity.

Carcasses were placed at multiple turbines throughout the monitoring area (no more than 1 carcass per turbine) and checked daily for 14 days. On each day the carcass was checked, surveyors indicated whether the carcass was present (intact, or partially scavenged but readily detectable) or absent (completely removed, or with so few feathers or tissue that they are not readily detectable). Carcasses present at the end of the 14-day trial period were collected and disposed. The following additional information was recorded on standardized datasheets for each trial carcass:

- Date, time of set-up, trial coordinator
- Turbine number
- Carcass identification
- Carcass distance and direction from tower
- Ground cover type and vegetation height where carcass was placed
- Detailed notes describing any scavenging and evidence of scavenger identification

2.4.5 Fatality Estimate Methods

Estimates of total bird and bat fatalities for the entire survey period were generated using the Huso Estimator (Huso 2010, Huso et al. 2012). Separate estimates were generated for each curtailment mode. Fatality estimates are based on:

- Number of carcasses found per turbine (including incidentals found within the survey area but excluding incidentals found beyond the survey transects)
- Searcher efficiency rate, expressed as the percentage of carcasses recovered during searcher efficiency trials
- Carcass persistence rate, expressed as the length of time a carcass is estimated to remain at a turbine and be available for detection by the searchers
- Proportion of searchable area below each turbine
- Distribution of carcasses within search areas

The Huso Estimator is a method that was developed in 2010 based on Thompson (1992). The specific objectives of the Huso Estimator are to attempt to accurately estimate actual bird and bat fatality based on observer detection rates and carcass persistence, and to provide a measure of precision associated with the estimates. The estimator was designed to estimate per-turbine fatality based on a total-site estimate; it was not designed to estimate fatality at individual turbines. A detailed description of the Huso Estimator is available in Huso 2010 and Huso et al. 2012. The Huso Estimator software[2] is run with the statistical program R (R Development Core Team 2011). The formula for Huso's model is, as expressed in Strickland et al. (2011):

- (C) is expressed as the product of the actual number killed (*F*), the proportion of carcasses remaining to be found ($\hat{r}$), and the probability of detection (P_{det})
- $\bar{t}$ is the average carcass removal time
- P_{det} is the probability of detection given that carcass remains
- $\tilde{I}$ is the effective search interval
- $\hat{\pi}$ is the probability of carcass availability and detection
- $\hat{s}$ is estimated searcher efficiency rate expressed as the percentage of carcasses recovered during searcher efficiency trials (*p* in Huso model output)
- $\hat{r}$ is estimated carcass persistence rate (r in Huso model output), expressed as the proportion of carcasses estimated to remain during an average persistence interval and available for detection by the searchers

$$C = Frp$$

$$\tilde{I} = -\log(0.01) * \bar{t}$$

$$\hat{s} = \min\left(1, \frac{\tilde{I}}{I}\right)$$

$$\hat{r} = \frac{\bar{t} * \left(1 - e^{\frac{I}{\bar{t}}}\right)}{I}$$

$$\hat{\pi} = P_{det} * \hat{s} * \hat{r}$$

When the size of search plots is limited, it is likely only a fraction of carcasses occurring at a turbine (i) will occur within the searchable area (Huso 2010). Therefore, π(i) is the product of the proportion of fatalities at turbine (i) that is within the searchable area of a plot and probability of including (i) in the sample.

Accounting for 'Carcass Overflow'

The Huso Estimator assumes carcass equilibrium between search intervals, where all carcasses are either found by searchers or scavenged prior to the next search (Manuela Huso pers. comm.). The Huso

[2] Huso estimator software and supporting documentation is available for download at http://pubs.usgs.gov/ds/729/

Estimator assumes a zero probability of searchers observing a carcass on a subsequent search if it was missed on the first search. However, field data indicate that some carcasses that persist for longer than the search interval are found during subsequent searches. To account for this bias (which results in overestimates of fatality), Huso recommends that only those carcasses killed since the previous search (based on stage of decomposition) be input into the model to estimate fatality. The proportion of older carcasses are separately accounted for in the measurement of searcher efficiency (i.e., if searcher efficiency is determined to be 50% then there is a 50% probability of a carcass being missed on the first search). Therefore, only those carcasses aged 7 days or less were input into the fatality model based on the weekly search interval, as is typically done for this type of analysis. It can be difficult to determine exact time of fatality (e.g., between a carcass that is aged greater than or less than 7 days). Therefore, if a carcass's age was questionable, it was included in the fatality model as aged 7 days or less.

Area Corrections

Because turbine towers may not be centered within turbine clearings, and carcasses may land over unsearched areas, the empirical distribution of bird and bat carcass fall distances were determined to apply a density-weighted proportion area searched (DWP) correction in the model. Area corrections were based on methods proposed by Jain et al. (2009a; modified from Fiedler et al. 2007). The proportion of the total birds and bats found during searches were determined per 10 m concentric distance increments radiating out to 63 m (the maximum search radius) from tower bases. The proportion of the area that was searchable (i.e., not cut off by forest edge) within each of these distance bands was determined. The percent area searched per distance band was multiplied by the proportion of bird and bat carcasses found within each distance band to find a DWP value per distance band. The DWP value for each band was summed to find a DWP value for each turbine, for birds and bats separately. Turbine-specific DWP values were input into the model for each bird and bat carcass found. This DWP analysis provides a per-turbine adjustment for the total number of bird and bat carcasses that would have been found within a 63-m radius of the turbine, had that entire area been available to be searched. It should be noted that a small density of carcasses found does not allow for a robust estimate of DWP. For example, if one bat carcasses is found in an outer ring of a search plot, and a small proportion of this ring was searchable, this one bat will inflate the estimate of the number of carcasses that may have occurred within this ring, when the actual distribution of bats indicates that the number of bat carcasses actually drops off in the outer portions of plots.

For the Huso Estimator to calculate estimates of fatality for birds and bats separately, a sample size of at least 10 bird and 10 bat carcasses for both the searcher efficiency and carcass persistence trials is required. Further, there must be a sample size of at least 10 bird or bat carcasses per covariate (e.g., season, carcass size, ground cover type) for other covariates to be incorporated into the model (e.g., to estimate fatality per season, per carcass size, per visibility class).

The results of searcher efficiency trials were categorized as "1" (if the trial carcass was found) and "0" (if trial carcass was not found). These values are distributed as binary random variables within the model, with 'Found' indicated by the highest numeric value. A generalized linear model of the binary response was fit to the data, with a modeled response of $\log^e$ (odds of observing a carcass = $\log^e$ (p/1-p)).

The results of carcass persistence trials were input into the model, based on the following trial outcomes:

- Carcass gone at first check on ‘Day 1’ of trial, left censoring = 2
- Carcass still present (visible) on last day of trial, right censoring = 0
- Carcass was removed between checks, interval censoring = 3

Carcass persistence times are modeled with a log-linear parametric accelerated failure time model and are assumed to follow a probability distribution. When persistence time is not known, or is censored, the model is appropriately modified.

Each time the model is run, one of the following distributions of carcass persistence must be selected by the user for the model: exponential, loglogistic, lognormal, or Weibull. Huso recommends running trials of the dataset with each distribution to compare values of AIC (Akaike Information Criterion), the measure of the relative goodness of fit of the model, where k is the number of parameters in the statistical model, and L is the maximized value of the likelihood function for the estimated model.

$$AIC = 2k - \ln(L)$$

The preferred distribution for the dataset is the one with the minimum AIC value.

Thompson (1992) provides a formula for the calculations of variance when the variables of the model (i.e., carcass detectability and persistence) are known. However, because detection bias, persistence bias, and proportion of carcasses within search areas are estimated, Huso uses a bootstrapped estimate of variance based on methods proposed by Erickson et al. 2004, where the fatality adjustment (π) and total fatality (m) are calculated for each bootstrapped sample. The analysis uses 5,000 bootstrap resample iterations, as recommended by Huso et al. (2012). The alpha value was defined as 0.05; therefore, all confidence intervals will be calculated at 95%.

2.4.6 Bat Fatality and Acoustic Activity

Because all turbines were curtailed to substantially reduce bat mortality, the sample size of bat carcasses was insufficient to allow daily (nightly) analyses of bat activity versus number of carcasses. To determine whether the amount of bat activity exposed to turbine operation had a statistically significant relationship to bat fatality, we modeled the number of bat carcasses found per search (calculated for each turbine with an acoustic detector) as a function of the number or recorded bat passes adjusted for survey effort using a linear model.

3.0 RESULTS

3.1 TURBINE OPERATIONS AND CURTAILMENT EVALUATION

Turbine operational data (generator speed, temperature, wind speed) were available for 245 nights for all turbines. The complete dataset of turbine operation data consisted of 1,550,788 10-minute data points collected between 1 April and 16 November 2018. Turbines do not respond immediately to changing conditions, as reflected by comparing the number of 10-minute periods when curtailment conditions were met to the number of periods when conditions were met and turbines were curtailed (RPM was less than 1). Curtailment criteria were met for an average of 5,170 out of 14,588 time periods (35%) at night between 1 April and 15 November among the 37 curtailed turbines. Turbine RPM was less than 1 for an average of 4,690 (91%) of the periods when conditions were met, indicating successful implementation of the curtailment plan (Figure 3-1). The amount of predicted and actual curtailment varied among turbines according to the curtailment treatment to which turbines were assigned and conditions present at individual turbines (Table 3-1).

Wind speed was less than 3 m/s for an average of 1,583 out of 14,625 time periods (11%) at night between 1 April and 15 November among the 12 turbines in the feathered group. However, RPM was less than 1 for only 662 (42%) of these periods meeting shutdown criteria, suggesting that the strategy was not implemented as designed (Figure 3-1). We determined that these turbines were operating identically during the day and night, indicating that the feathering strategy had not been implemented as designed. Accordingly, these 12 turbines represented operational controls during the 2018 monitoring period (Table 3-1). The number of curtailed periods increased steadily between April and September, then decreased in October and November (Figure 3-2).

Table 3-1. Number of 10-minute periods per turbine during which curtailment conditions were met, and during which turbines were curtailed (RPM < 1), New Creek Wind Project, 2018

Turbine	Treatment	# 10-minute Periods				Curtailed/ Conditions Met (%)
		Total	Night Only	Conditions Met	Curtailed	
Turbine 1	Curtailed	31,380	14,364	7,423	6,748	90.90
Turbine 2	Curtailed	31,440	14,417	7,692	7,060	91.78
Turbine 3	Control	32,101	14,644	2,748	1,174	42.72
Turbine 4	Curtailed	31,295	14,349	7,144	6,598	92.35
Turbine 5	Curtailed	32,056	14,643	6,814	6,238	91.54
Turbine 6	Curtailed	32,008	14,644	6,309	5,748	91.10
Turbine 7	Control	32,035	14,644	1,814	843	46.47
Turbine 8	Curtailed	32,054	14,644	6,082	5,624	92.46
Turbine 9	Curtailed	31,828	14,586	5,190	4,750	91.52
Turbine 10	Curtailed	31,995	14,644	5,194	4,639	89.31
Turbine 11	Control	32,054	14,644	1,339	589	43.98
Turbine 12	Curtailed	32,027	14,644	4,980	4,540	91.16
Turbine 13	Curtailed	31,980	14,644	4,506	4,105	91.10
Turbine 14	Curtailed	31,350	14,440	4,317	3,932	91.08
Turbine 15	Control	31,941	14,623	1,430	623	43.56
Turbine 16	Curtailed	31,493	14,535	4,901	4,496	91.73
Turbine 17	Curtailed	31,934	14,643	4,466	4,059	90.88
Turbine 18	Curtailed	31,172	14,623	4,829	4,292	88.87
Turbine 19	Control	32,025	14,644	1,306	588	45.02
Turbine 20	Curtailed	31,900	14,643	4,749	4,357	91.74
Turbine 21	Curtailed	31,828	14,575	4,635	4,235	91.37
Turbine 22	Curtailed	32,021	14,643	4,795	4,387	91.49
Turbine 23	Control	31,961	14,643	1,524	636	41.73
Turbine 24	Curtailed	31,948	14,636	5,118	4,642	90.69
Turbine 25	Curtailed	31,507	14,598	4,870	4,433	91.02
Turbine 26	Curtailed	31,813	14,572	5,010	4,423	88.28
Turbine 27	Control	31,035	14,630	1,523	647	42.48
Turbine 28	Curtailed	31,915	14,639	5,182	4,722	91.12
Turbine 29	Curtailed	30,915	14,640	5,406	4,769	88.21
Turbine 30	Curtailed	31,982	14,640	5,559	5,024	90.37
Turbine 31	Control	30,824	14,639	1,549	663	42.80
Turbine 32	Curtailed	31,947	14,639	4,653	4,156	89.31
Turbine 33	Curtailed	31,925	14,635	4,823	4,380	90.81
Turbine 34	Curtailed	31,518	14,632	4,618	4,167	90.23
Turbine 35	Control	30,304	14,501	1,231	500	40.61
Turbine 36	Curtailed	30,317	14,525	4,460	4,101	91.95
Turbine 37	Curtailed	30,802	14,636	4,415	3,938	89.19
Turbine 38	Curtailed	30,972	14,632	4,387	3,988	90.90
Turbine 39	Control	32,059	14,638	1,738	503	28.94
Turbine 40	Curtailed	31,949	14,638	4,565	4,110	90.03
Turbine 41	Curtailed	32,043	14,635	4,595	4,160	90.53
Turbine 42	Curtailed	32,104	14,637	4,655	4,191	90.03
Turbine 43	Control	32,024	14,636	1,326	544	41.02
Turbine 44	Curtailed	31,723	14,635	4,775	4,357	91.24
Turbine 45	Curtailed	31,994	14,623	4,763	4,335	91.01
Turbine 46	Curtailed	31,925	14,636	5,328	4,884	91.66
Turbine 47	Control	31,373	14,615	1,464	636	43.44
Turbine 48	Curtailed	30,987	14,635	5,092	4,372	85.86
Turbine 49	Curtailed	31,005	14,209	4,977	4,573	91.88

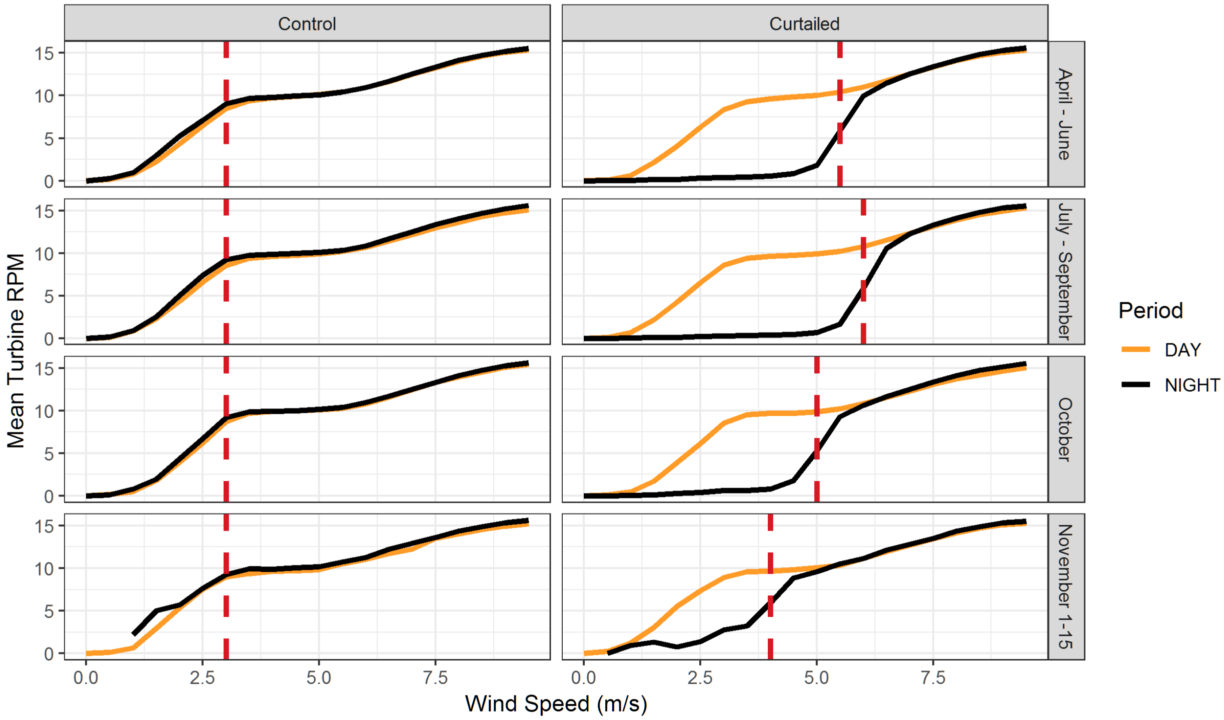


Figure 3-1. Mean turbine RPM by operational treatment, time period, and time of year and associated cut-in speed (vertical red line) for the New Creek Wind Project, 2018.

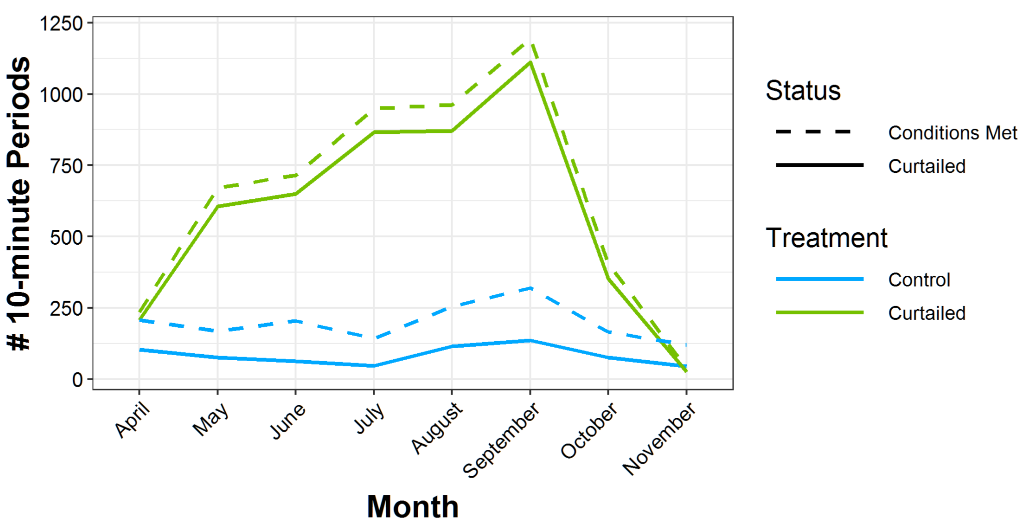


Figure 3-2. Monthly number of periods meeting curtailment conditions (conditions met) and curtailed (RPM <1) by treatment, New Creek Wind Project, 2018.

3.2 ACOUSTIC MONITORING

Acoustic bat detectors were deployed at 10 of 49 project turbines and recorded a total of 12,051 bat passes during 1,356 detector-nights surveyed between 9 May and 15 November. Detectors could not be checked as often as initially anticipated due to limited availability of operations staff authorized to climb turbines, resulting in inability to replace malfunctioning units and loss of most data from Turbine 33 and almost all data from Turbine 39 (Table 3-2). Nevertheless, the remaining 8 detectors operated properly for most nights, providing good coverage of the full seasons during which bat activity is expected to occur. Bat detectors recorded a total of 12,051 bat passes during this period, yielding an overall activity level of 8.9 passes per detector night (DN). The 8 detectors with more than 100 detector nights, recorded between 1,114 to 2,572 bat passes, with corresponding activity rates ranging from 6.0 passes per DN at Turbine 43 to 17.0 passes per DN at Turbine 1 (Table 3-2).

Table 3-2. Acoustic survey effort and results, New Creek Wind Project, 2018

Turbine	Survey Dates	Calendar Nights	Detector Nights (DN)	Bat Passes	Rate (passes per DN)	Maximum Passes per Night
Turbine 1	June 18 – November 15	151	151	2,572	17.03	152
Turbine 3	June 18 – November 15	151	125	1,466	11.73	116
Turbine 9	June 19 – November 10	145	145	1,339	9.23	67
Turbine 15	May 11 – November 15	189	189	1,175	6.22	66
Turbine 21	May 16 – November 15	184	184	1,447	7.86	86
Turbine 27	May 9 – November 15	191	191	1,289	6.75	72
Turbine 33	May 24 – November 15	176	36	258	7.17	45
Turbine 39	May 19 – November 15	181	2	12	6.00	11
Turbine 43	May 14 – November 15	186	186	1,114	5.99	56
Turbine 47	June 22 – November 15	147	147	1,379	9.38	82
Total		1,701	1,356	12,051	8.89	-

Of the 12,051 recorded bat passes, Stantec identified 8,315 (69%) to species or species group and categorized the remainder as high frequency or low frequency unknown passes. Hoary bats were the most commonly identified species at all detectors. Overall, hoary bats accounted for 46.66% of passes identified to species or group (Table 3-3). Eastern red and silver-haired bats accounted for 24.82% and 18.78% of identified passes, respectively. Together, these 3 long-distance migratory species accounted for 90.25% of passes identified to species or species group, with this pattern occurring consistently among detectors. Only 9 passes were identified as *Myotis* species, with activity occurring at only 2 turbines.

Table 3-3. Species composition of recorded bat activity, New Creek Wind Project, 2018

Turbine	Big brown/ silver-haired			Hoary bat	Myotis	Eastern Red/ Tri-colored Bat			Unknown		Total
	Big Brown	Silver-haired	BBSH			Eastern Red	Tri-colored	RBTB	High Frequency	Low Frequency	
Turbine 1	78	335	52	854	0	428	24	3	235	563	2,572
Turbine 3	34	149	46	546	1	248	14	1	129	298	1,466
Turbine 9	21	179	24	451	0	258	9	4	120	273	1,339
Turbine 15	30	158	23	373	0	203	19	11	106	252	1,175
Turbine 21	52	228	82	385	8	247	19	1	104	321	1,447
Turbine 27	41	149	34	444	0	238	35	5	92	251	1,289
Turbine 33	0	20	1	51	0	67	1	0	43	75	258
Turbine 39	0	2	0	3	0	0	0	0	0	7	12
Turbine 43	17	142	21	354	0	186	8	1	97	288	1,114
Turbine 49	50	199	24	419	0	189	12	4	146	336	1,379
Total	**323**	**1,561**	**307**	**3,880**	**9**	**2,064**	**141**	**30**	**1,072**	**2,664**	**12,052**

Seasonal patterns in activity varied among species, with hoary bats and eastern red bats most active during August and silver-haired bats most active in September (Figure 3-3). Tri-colored bats accounted for only 2% of identified passes and were detected most often in August and September. Big brown bats were detected most frequently in late August and accounted for 4% of identified passes. Although species presence varied among nights, overall timing of bat activity showed similar patterns among detectors and species groups, with most activity occurring during the first few hours past sunset (Figure 3-4). Appendix B includes plots of overall species composition, nightly bat activity and detector operation, and timing of bat activity recorded at each turbine.

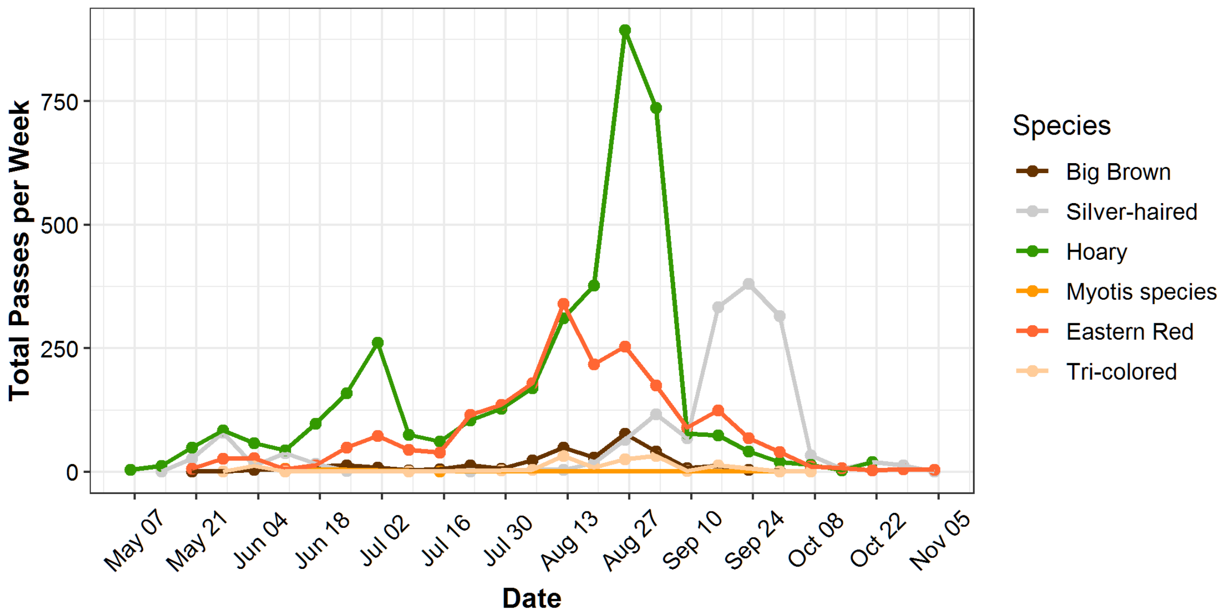


Figure 3-3. Total bat passes identified to species per week, New Creek Wind Project, 2018

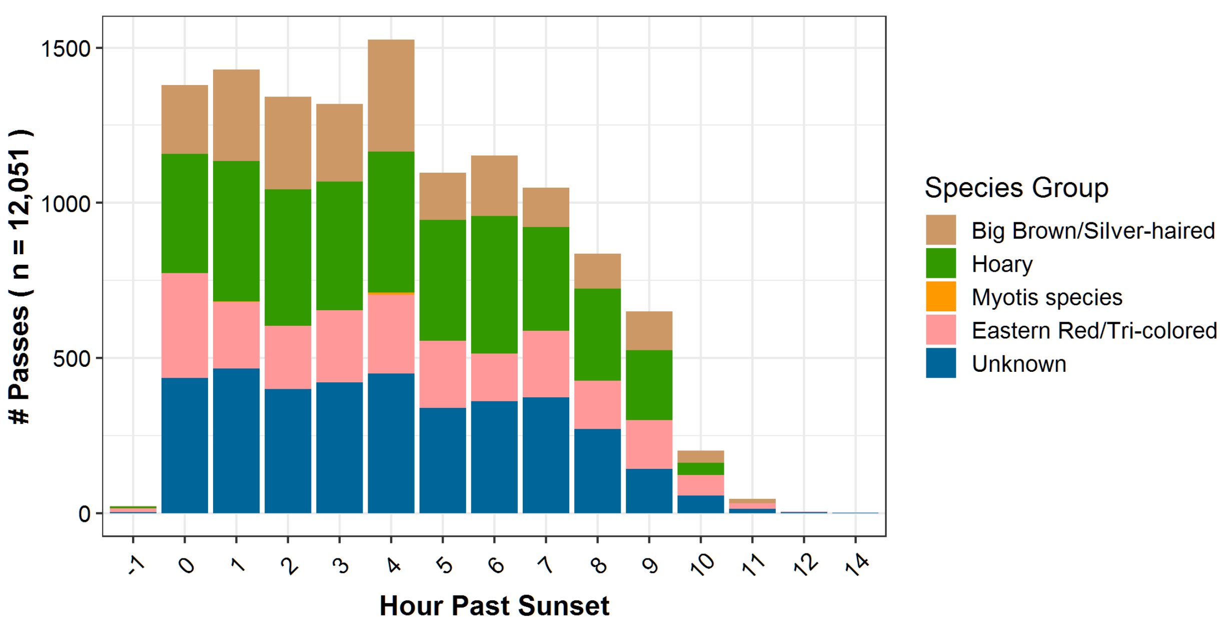


Figure 3-4. Overall timing of bat activity recorded at turbine nacelles, New Creek Wind Project, 2018

3.2.1 Bat Activity and Weather

Bat activity showed clear relationships with temperature and wind speed measured at corresponding turbine nacelles, with 99% of passes for which weather data were available (n = 11,929) occurring when temperature was greater than 10° C and 61% of passes occurring at wind speeds less than 4.5 m/s (Figure 3-5, Figure 3-6). Considering temperature and wind speed together, bat activity occurred disproportionally during calm, warm conditions, and few bat passes were recorded during times with higher wind speeds or cooler temperatures (Figure 3-7). Also, Figure 3-7 suggests an apparent interaction between the effects of temperature and wind speed on bat activity, with activity during windy conditions occurring primarily at warmer temperatures.

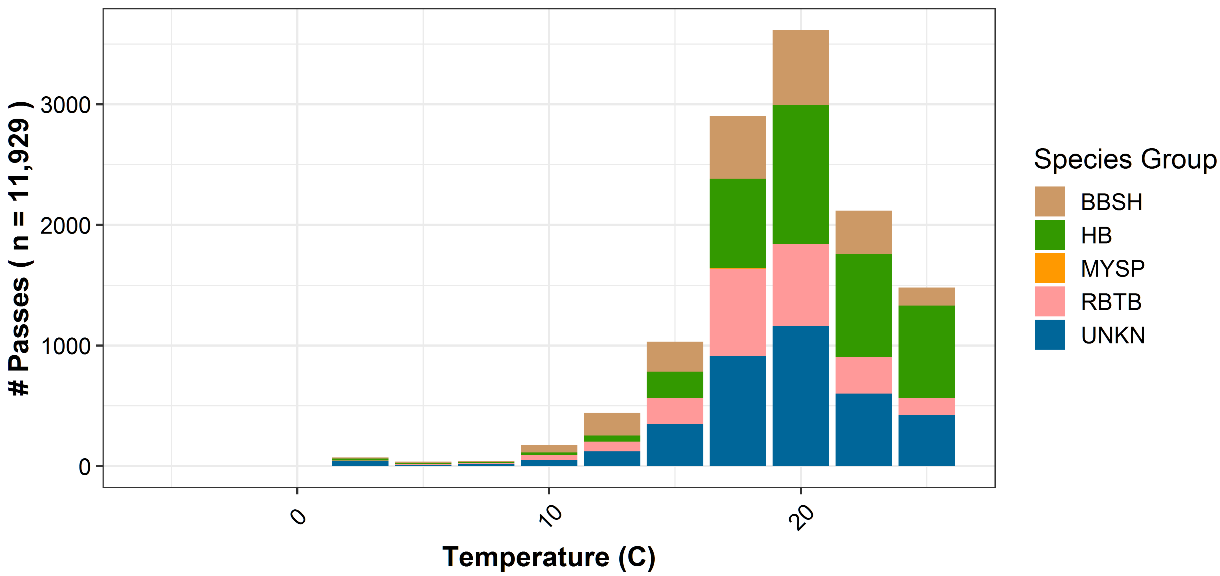


Figure 3-5. Bat activity by temperature bin (2.5 degrees C) recorded at turbine nacelles, New Creek Wind Project, 2018

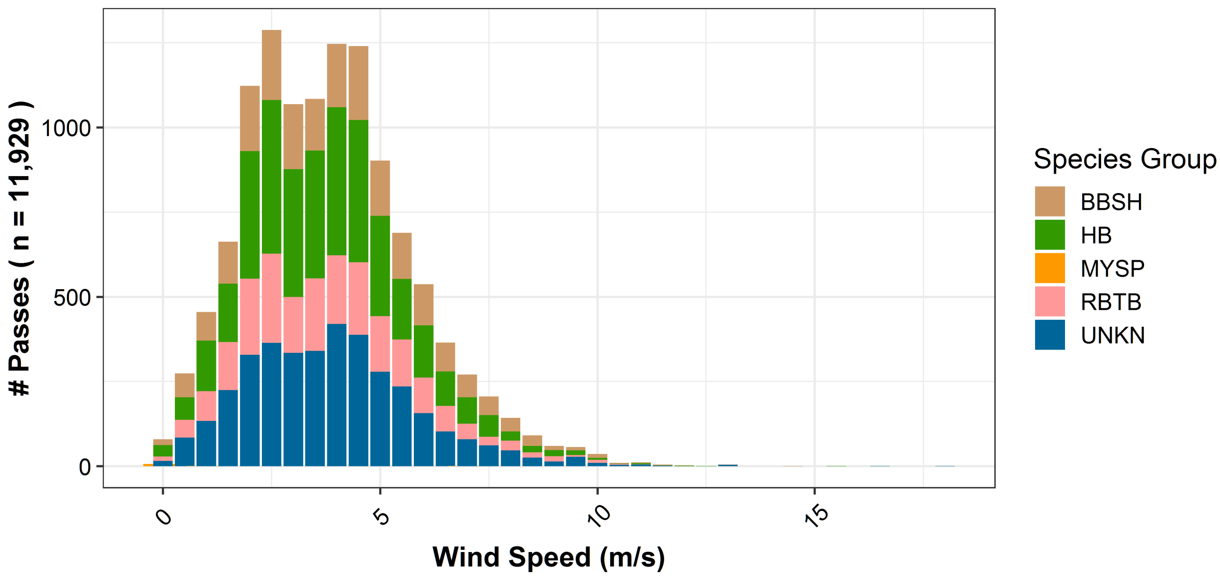


Figure 3-6. Bat activity by wind speed bin (0.5 m/s) recorded at turbine nacelles, New Creek Wind Project, 2018

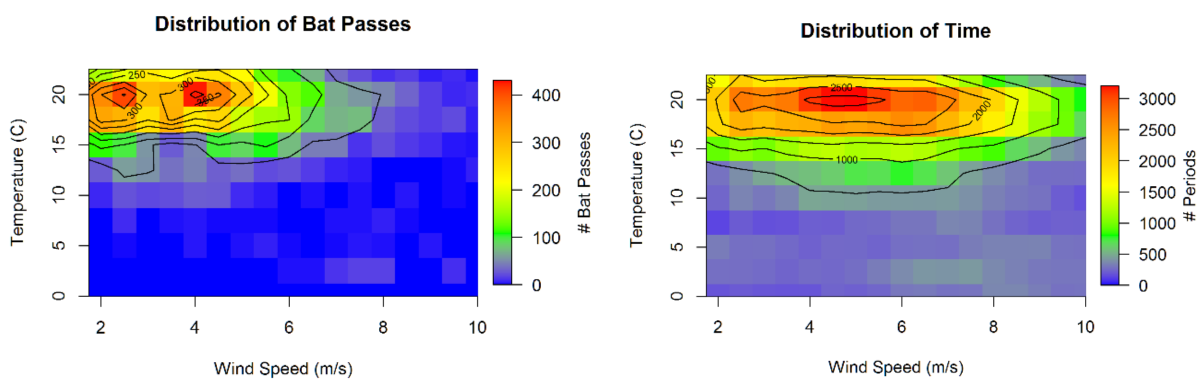


Figure 3-7. Distribution of bat passes (left) and time periods (right) as a function of wind speed and temperature based on nacelle-mounted acoustic detectors, New Creek Wind Project, 2018

3.2.2 Bat Activity, Turbine Operation, and Energy Loss

Curtailed turbines with operating bat detectors (n = 5) were effectively curtailed (conditions met and RPM < 1) during periods when 79 to 90% of recorded bat passes were detected. The control turbines with operating bat detectors (n = 4) were inactive (RPM < 1) during periods when 11 to 24% of bat activity occurred. Overall, the curtailment strategy protected 84.4% of bats recorded during the monitoring period, indicating that the strategy was more protective of bats than predicted based on 2017 data. Overall, 17.7% of bats detected at control turbines were not exposed to turbine operation (Table 3-4).

By treatment, avoidance ranged from 79.2 to 89.7% among curtailed turbines and 11.1 to 24.5 among control turbines (Table 3-4). Simulated avoidance (passes occurring when curtailment conditions were met) versus actual avoidance (passes occurring when curtailment conditions were met and RPM < 1) were closely aligned for turbines in the curtailment group, but differed for the control group as outlined above (Figure 3-8). The predicted energy loss (potential energy production during time periods when curtailment conditions were met) was lower than actual energy loss (potential energy production during time periods when RPM < 1) for curtailed turbines (Figure 3-8). As designed, the curtailment program avoided a consistent proportion of bat activity between May and September, with a higher proportion of bat activity (but lower overall number of bat passes) exposed to operation in October and November (Figure 3-9). Figure 3-9 also shows that seasonal patterns in bat activity were similar among control and curtailed groups, with slightly more bat activity detected at turbines in the curtailed group, although exposure of bats to turbine operation was substantially higher for the control group, peaking in August.

Table 3-4. Simulated avoidance (passes recorded when curtailment conditions were met) versus actual avoidance (passes recorded when RPM < 1) of bat activity at nacelle height, New Creek Wind Project, 2018

Treatment	Turbine	# Passes with Weather and Turbine Operation Data	Simulated Avoidance (%)	Conditions Met and RPM < 1 (%)	RPM < 1 (All Conditions)
Control	Turbine 3	1,444	40.30	20.57	21.19
	Turbine 15	1,153	39.72	24.54	29.40
	Turbine 27	1,276	27.19	11.13	11.52
	Turbine 43	1,107	29.35	14.27	14.80
Control Total		4,980	34.38	17.67	19.24
Curtailed	Turbine 1	2,553	91.34	89.70	90.64
	Turbine 9	1,319	82.18	79.23	81.96
	Turbine 21	1,442	84.04	82.04	83.77
	Turbine 33	258	84.10	82.95	83.72
	Turbine 49	1,364	85.11	82.26	84.38
Curtailed Total		6,936	86.60	84.40	86.09

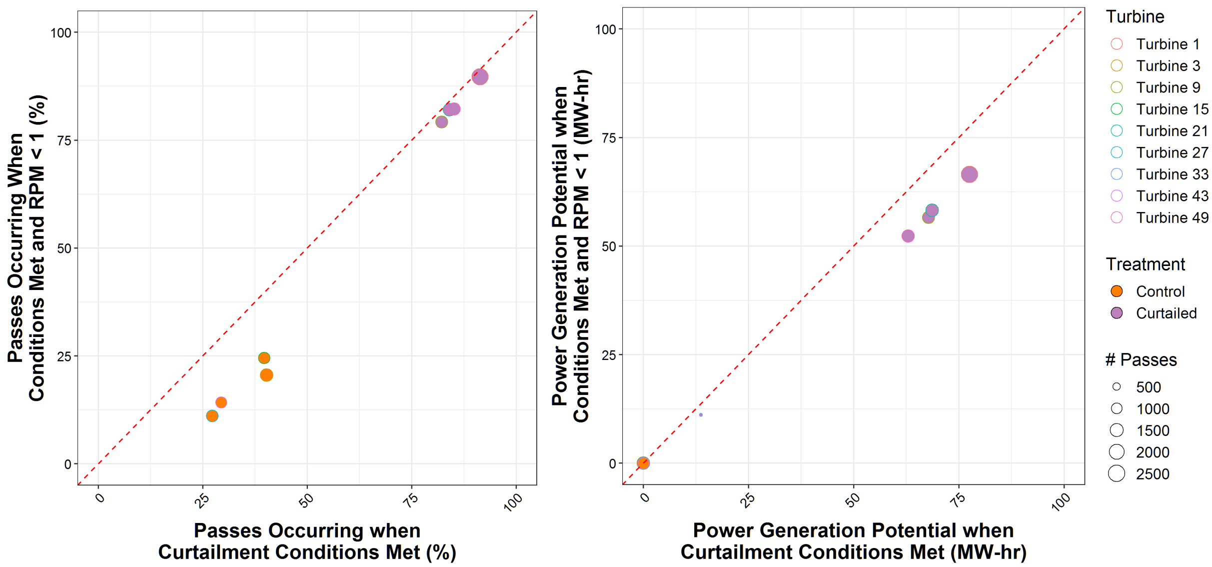


Figure 3-8. Simulated (conditions met) and actual (conditions met and RPM < 1) avoidance of bat activity (left) and power loss (right), New Creek Wind Project, 2018

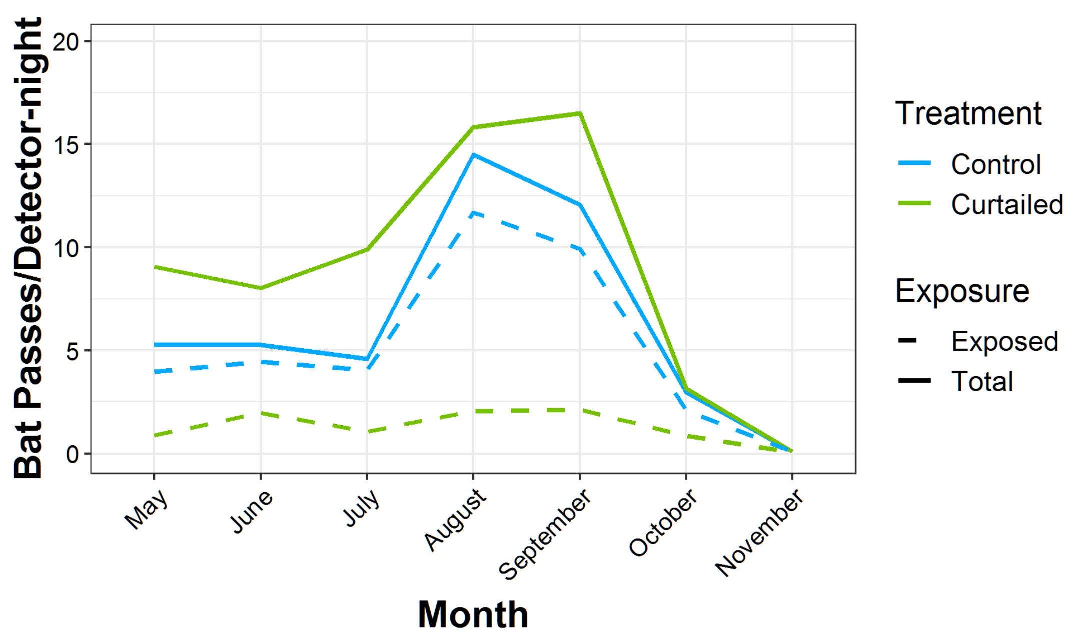


Figure 3-9. Total and exposed (occurring when turbine RPM > 1) bat activity by month and treatment, adjusted for survey effort based on 9 nacelle-mounted acoustic detectors at the New Creek Wind Project during 2018

Detectors in the curtailment group (n=5) recorded bat activity during 3,859 of 47,110 (8.2%) surveyed 10-minute periods and were curtailed during 3,135 (81%) of these periods with bat activity. Additionally, these turbines were curtailed for 14,772 additional periods during which no bat activity occurred (Table 3-5). Accordingly, bat activity occurred during 17.5% of curtailed periods. The 4 detectors on control turbines recorded bat activity during 3,114 of 48,225 (6.5%) surveyed 10-minute periods, with turbine RPM exceeding 1 during 83.5% of these periods (Table 3-5).

We evaluated energy loss and avoided bat activity for each turbine equipped with bat detectors based on simulations of when curtailment should have been occurring (curtailment conditions met) and when turbines were actually curtailed (curtailment conditions met and RPM < 1), demonstrating close alignment between predicted and measured avoidance of bat activity for the curtailed turbines (Figure 3-10). The isolated green triangle represents Turbine 33, for which data were only available during the month of August. The other four points are likely more representative of power loss and avoidance over the full monitoring period. Mean simulated power loss (energy potential when curtailment conditions were met) was 58.1 MW-hrs for these four turbines and mean actual energy loss (energy potential when curtailment conditions were met and RPM < 1) was 48.97 MW-hr.

Table 3-5. Number of time periods per turbine with and without bat activity during which turbines were rotating above or below 1 RPM, New Creek Wind Project, 2018

Treatment	Turbine	Periods w/ Acoustic Data	Bat Activity Recorded			Bat Activity Not Recorded		
			RPM < 1	RPM > 1	Total	RPM < 1	RPM > 1	Total
Control	Turbine 3	8,654	158	712	870	504	7,280	7,784
	Turbine 15	13,200	159	560	719	735	11,746	12,481
	Turbine 27	13,348	95	711	806	601	11,941	12,542
	Turbine 43	13,023	99	620	719	455	11,849	12,304
	Control, Combined	48,225	511	2,603	3,114	2,295	42,816	45,111
Curtailed	Turbine 1	10,834	1,170	173	1,343	4,329	5,162	9,471
	Turbine 9	10,381	579	174	753	3121	6507	9,628
	Turbine 21	12,830	635	179	814	3,505	8,511	12,016
	Turbine 33	2,419	151	37	188	742	1,489	2,231
	Turbine 49	10,646	600	161	761	3,075	6,810	9,885
	Curtailed, Combined	47,110	3,135	724	3,859	14,772	28,479	43,251

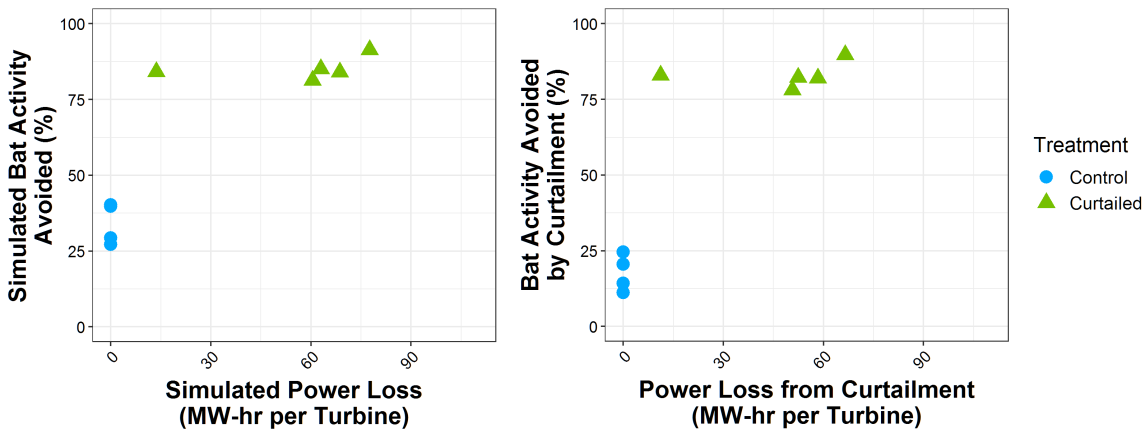


Figure 3-10. Simulated and actual power loss and avoidance of bat activity associated with each curtailment treatment implemented at the New Creek Wind Project during 2018, based on 9 turbines with nacelle-mounted acoustic detectors.

3.3 BIRD AND BAT FATALITY SURVEYS

Stantec conducted a total of 683 turbine searches during 135 days on-site between 7 May and 14 November 2018. Stantec searched all 25 odd numbered turbines at a 7-day interval unless the schedule was disrupted by hazards such as lightning or blade icing or construction/repair work that prevented safe access to a turbine. In such cases, turbine searches were typically made up during the day following the interruption. Stantec surveyors were on site Monday through Friday throughout the monitoring period. Individual turbines were searched on 24 to 28 occasions during the survey period. The average search time among the 25 study turbines ranged from 30 to 33.2 minutes with an overall average of 30.8 minutes.

Stantec found 27 bat and 7 bird carcasses during standardized searches at the 25 study turbines, and an additional 7 bat and 2 bird carcasses incidentally at those turbines. We also found 1 bat and 3 bird carcasses incidentally at non-study turbines. Including incidentals, Stantec found 0 to 7 bat carcasses and 0 to 2 bird carcasses per turbine (Table 3-6). Most carcasses were fresh (fatality estimated to have occurred the previous night), although searchers occasionally found carcasses estimated to be several days up to a week old. Appendix C includes details of all carcasses found during the 2018 monitoring period.

Table 3-6. Survey effort per turbine, curtailment treatment assignments, and bird and bat carcasses (incidentals in parentheses) found at each turbine at the New Creek Wind Project between 4 May and 14 November 2018

Turbine	Treatment	# Searches	Bat	Bird
1	Curtailed	28	1	0
2	Curtailed	0	0	(1)
3	Control	28	4	1
5	Curtailed	28	0	2
6	Curtailed	0	(1)	0
7	Control	27	3	0
9	Curtailed	27	1	0
11	Control	28	4 (2)	0
12	Curtailed	0	0	(1)
13	Curtailed	28	(1)	1
14	Curtailed	0	0	(1)
15	Control	28	3	(1)
17	Curtailed	27	0	2
19	Control	27	6 (1)	0
21	Curtailed	28	0	0
23	Control	28	1 (1)	0
25	Curtailed	28	0	0
27	Control	26	(2)	0
29	Curtailed	26	0	0
31	Control	24	1	0
33	Curtailed	28	0	0
35	Control	27	0	0
37	Curtailed	27	0	0
39	Control	27	2	0
41	Curtailed	28	0	0
43	Control	28	0	1
45	Curtailed	28	1	0
47	Control	27	0	(1)
49	Curtailed	27	0	0
Total		**683**	**27 (8)**	**7 (5)**

3.3.1 Seasonal and Spatial Fatality Patterns

Bat carcasses were found between 4 May and 18 October and bird carcasses were found between 15 May and 16 October 2018. By month, most bat carcasses were found in August (n = 10; 30.3%), and carcasses were found during every month except November (Table 3-7; Figure 3-11). Bird carcasses were found in every month except June and November, with 1 to 3 carcasses found per month (Figure 3-11).

No more than 1 bat carcass was found per turbine during an individual search, except on 31 August when 2 hoary bats were found at Turbine 19. No more than 1 bird carcass was found per turbine search. Bat carcasses were found between 4 and 48 m from turbines, and bird carcasses were found between 2 and 48 m from turbines (Figure 3-12). There were also 3 incidental bird carcasses found outside the search area beyond 60 m. Appendix D includes a map of each turbine showing the extent of searchable area and location of all bird and bat carcasses.

Table 3-7. Carcasses found per month per treatment at the New Creek Wind Project between 4 May and 14 November 2018

Treatment	Month	# Bat Carcasses	# Bird Carcasses
Control	May	4	0
	June	3	0
	July	4	1
	August	9	0
	September	9	2
	October	1	1
	November	0	0
Curtailed	May	3	3
	June	1	0
	July	0	0
	August	1	3
	September	0	0
	October	0	2
	November	0	0
Total		**35**	**12**

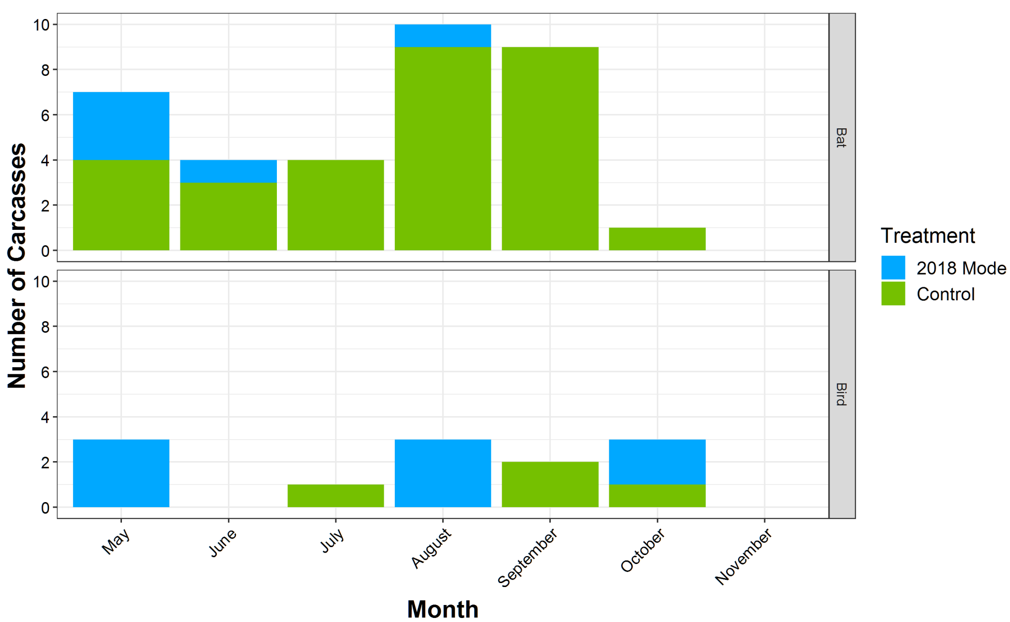


Figure 3-11. Bat and bird carcasses found per month (including incidentals) at the New Creek Wind Project from 4 May–14 November 2018

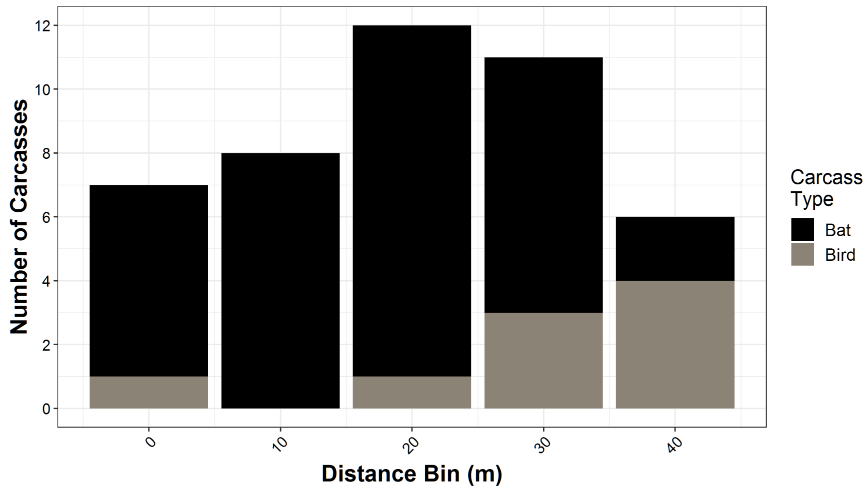


Figure 3-12. Bat and bird carcasses found within survey plots according to distance from turbine (including incidentals) at the New Creek Wind Project from 4 May to 14 November 2018

3.3.2 Species Composition

Including all carcasses found in 2018 at the 25 study turbines and a few non-study turbines (incidentals), 35 bat and 12 bird carcasses were collected at the Project. Five bat species were documented: big brown bat, eastern red bat, silver-haired bat, hoary bat, and tri-colored bat (Table 3-8). Long-distance migratory species accounted for 91.42% of bat carcasses found in 2018. No *Myotis* species bats were found. Of the 35 total bat carcasses, 25 (71.4%) were male, 2 (5.7%) were female, and 8 (22.9%) were of unknown sex. Nine bird species were found at the Project (Table 3-9). Two warblers that could not be identified to species were found (Table 3-9). No threatened or endangered bird or bat species were found during 2018 surveys.

Table 3-8. Species composition of bat carcasses (incidentals bounded by parentheses) found at the New Creek Wind Project between 4 May–14 November 2018

Common Name	Species	Total	Percent
big brown bat	*Eptesicus fuscus*	2	5.71%
eastern red bat	*Lasiurus borealis*	7 (1)	22.86%
hoary bat	*Lasiurus cinereus*	15 (6)	60.00%
silver-haired bat	*Lasionycteris noctivagans*	2 (1)	8.57%
tri-colored bat	*Perimyotis subflavus*	1	2.86%
Total		27 (8)	100%

Table 3-9. Species composition of bird carcasses (incidentals bounded by parentheses) found by at the New Creek Wind Project between 4 May–14 November 2018

Common Name	Species	Total	Percent
Acadian flycatcher	*Empidonax virescens*	(1)	8.33%
black-billed cuckoo	*Coccyzus erythropthalmus*	1	8.33%
blackpoll warbler	*Setophaga striata*	1	8.33%
osprey	*Pandion haliaetus*	1	8.33%
red-tailed hawk	*Buteo jamaicensis*	1 (1)	16.67%
ruffed grouse	*Bonasa umbellus*	1	8.33%
scarlet tanager	*Piranga olivacea*	1	8.33%
Tennessee warbler	*Oreothlypis peregrina*	(1)	8.33%
unidentified warbler	*Parulidae (gen,sp)*	1 (1)	16.67%
yellow-billed cuckoo	*Coccyzus americanus*	(1)	8.33%
Total		7 (5)	100%

3.3.3 Searcher Efficiency Trials

Stantec conducted searcher efficiency trials using 36 bat/mouse carcasses and 39 juvenile quail carcasses during the 2018 monitoring period. Bat trials consisted of 1 bat carcass found on site and 35 mouse surrogates purchased from a lab supply company. Bird trials consisted of juvenile quail obtained from a lab supply company to serve as surrogates for bird carcasses, as there were few usable bird carcasses available for the 2018 monitoring period.

During trials, carcasses were placed in a representative sample of available ground cover conditions, and at variable distances and azimuths from turbines to accurately represent the range of ground cover types and conditions present at searched turbines. Trials were conducted on 11 separate occasions, with carcasses placed at 23 of the 25 searched turbines. Searchers found 15 bat/mouse trial carcasses (41.66%) and 26 quail trial carcasses (66.66%) during the 2018 monitoring period (Table 3-10).

Table 3-10. Searcher efficiency trial results with mean searcher efficiency by type and confidence intervals generated by the Huso estimator

Category	# Trials	# Found	Mean Searcher Efficiency (95% CI)
Bats	36	15	0.42 (0.25–0.58)
Birds	39	26	0.67 (0.51–0.82)

3.3.4 Carcass Persistence Trials

Stantec conducted 102 carcass persistence trials during the 2018 monitoring period using 56 bat/mouse carcasses and 46 bird and quail carcasses in good condition. Carcass persistence trials occurred at each of the 25 searched turbines and were started on 11 separate occasions between 21 May and 22 October 2018, each lasting 14 days. Of the 102 carcasses placed, 64 (62.74%) were removed on the first day of the trial period, 100 (98%) were removed by day 7, and 102 (100%) were removed before day 14 of the trial period. Carcasses were removed by scavengers between day 1 and day 11 of trials. No bat or bird carcasses remained throughout the entire 14-day trial period.

Estimated carcass persistence ranged from 0.45 to 1.25 for bats and 0.91 to 1.44 for birds among models evaluated using the Huso estimator, with the log-logistic model having the lowest AICc value for bats and birds (Table 3-11). Based on this model bat carcasses persisted for 0.5 (0.2–0.8) days, with the proportion of carcasses estimated to persist through the search interval of 0.16 (0.08–0.23). Corresponding numbers for birds were an estimated carcass persistence of 0.91 (0.6–1.24) days and estimated proportion of carcasses remaining through the search interval of 0.2 (0.14–0.26) (Table 3-11).

Table 3-11. Estimated carcass persistence and associated confidence intervals for birds and bats based on each model within the Huso estimator

Type	# Trials	Model	AICc	Δ AICc	Carcass Persistence Estimate in Days (95% CI)	Proportion Carcasses Persisting through Search Interval (95% CI)
Bats	56	log-logistic	119.95	–	0.5 (0.2–0.8)	0.16 (0.08–0.23)
		lognormal	120.43	0.48	0.45 (0.14–0.76)	0.16 (0.06–0.24)
		Weibull	121.34	1.39	0.68 (0.24–1.21)	0.16 (0.06–0.24)
		exponential	134.11	4.16	1.25 (0.78–1.93)	0.18 (0.11–0.27)
Birds	46	log-logistic	123.98	–	0.91 (0.6–1.24)	0.2 (0.14–0.26)
		lognormal	124.65	0.67	0.88 (0.49–1.24)	0.2 (0.12–0.27)
		Weibull	126.77	2.79	1.24 (0.78–1.77)	0.2 (0.13–0.26)
		exponential	126.86	2.88	1.44 (0.93–2.14)	0.2 (0.13–0.29)

Stantec deployed automatic game cameras at selected trials occasionally during the 2018 monitoring period and recorded videos of American crows (*Corvus brachyrhynchos*), common ravens (*Corvus corax*), and turkey vultures removing carcasses. Cameras also documented activity of other potential scavengers including Skunk and Opossums, although none were observed removing carcasses.

3.3.5 Estimated Fatality Rates

Stantec estimated fatality rates for birds and bats separately, using the Huso estimator, for each of the curtailment treatment. Bird fatality rates were also estimated for all turbines combined using the Huso estimator. Fatality estimates were based on the number of bird and bat carcasses found within search areas during standardized searches and incidentally at the 25 study turbines, excluding carcasses found during initial transect sweeps at the beginning of the monitoring period. Confidence intervals for bird mortality estimates overlapped among both treatments, indicating a lack of a significant difference in mortality estimates among treatments (Table 3-12).

Estimated fatality rates for the 7 May to 14 November 2018 monitoring period were 3.66 (95% CI 2.02–7.21) bats per curtailed turbine and 38.19 (95% CI 20.95–75.68) bats per control turbine, and 3.19 (95% CI 1.9–5.34) birds per turbine, for all turbines combined (Table 3-12). Extrapolating these estimates to the corresponding number of turbines in each operational group for the whole project suggest that 594 bat (95% CI 326–1,175) and 156 bird (95% CI 93–262) fatalities occurred at the Project during the 2018 monitoring period. For bats, 77% of estimated bat fatality would be attributable to the 12 control turbines.

Table 3-12. Fatality estimates for birds and bats at New Creek and for each curtailment treatment based on year 2018 monitoring data

Type	Carcass Persistence Model	Treatment	# Turbines	# Carcasses	Per-turbine Estimate (95% CI)	Per-MW Estimate (95% CI)
Bats	log-logistic	Curtailed	13	3	3.66 (2.02–7.21)	1.83 (1.01–3.6)
		Control	12	29	38.19 (20.95–75.68)	19.10 (10.48–37.84)
Birds	log-logistic	Curtailed	13	5	3.93 (2.46–6.38)	1.97 (1.23–3.19)
		Control	12	3	2.38 (0.97–4.27)	1.19 (0.48–2.14)
		Combined	25	8	3.19 (1.9–5.34)	1.6 (0.95–2.67)

*Carcasses found incidentally outside survey plots (n = 2 birds), found incidentally at non-surveyed turbines (n = 1 bat, 2 birds), and found outside of survey period (n = 2 bats) were omitted from the dataset used to estimate bird and bat fatality.

3.3.6 Bat Fatality and Acoustic Activity

Stantec found 11 bat carcasses at the 8 turbines with acoustic datasets representing most of the monitoring period. Based on these turbines, the total number of bat carcasses found per turbine search was significantly higher at turbines with higher levels of acoustic data (Figure 3-13). An insufficient sample size of bat carcasses was available for more detailed analyses of bat activity versus fatality (e.g., nightly analyses).

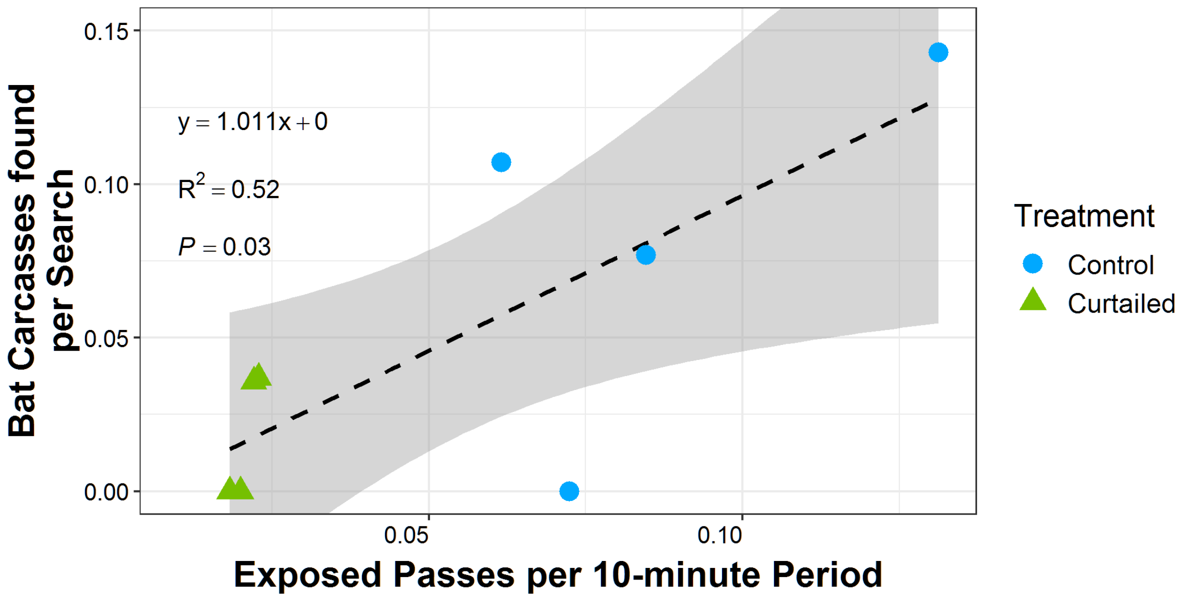


Figure 3-13. Relationship between bat activity (passes per 10-minute period) and fatality (carcasses found per search) for the 8 turbines with operating acoustic detectors, New Creek Wind Project, 2018

4.0 DISCUSSION

The second year of acoustic bat and carcass monitoring provided an opportunity to test the ability of a strategic curtailment strategy, designed based on data collected in 2017, to reduce bat fatality and avoid risk to rare species. Although initially intended to compare this strategy to a minimally restrictive strategy that would have feathered turbines below manufacturer's cut-in speed (3.0 m/s), the 2018 monitoring period also enabled a direct comparison of curtailed and fully operating control turbines. The collection of acoustic bat and fatality data facilitated comparisons of empirical fatality estimates as well as evaluations as to the degree to which the curtailment strategy avoided bat activity, and the accuracy of predictions based on 2017 data. The monitoring period also provided a second empirical estimate of bird fatality for the project, and an opportunity to evaluate whether bird fatality rates differed between curtailed and normally operating turbines.

The bat fatality estimate for curtailed turbines in 2018 was within the 95% CI limits of the combined estimate for four similar curtailment periods implemented in 2017, each of which had a higher maximum cut-in speeds than the 2018 curtailment program (Table 4-1). By contrast, the bat fatality estimate for normally operating (control) turbines was substantially higher, demonstrating the effectiveness of each of the 2017 and 2018 curtailment programs at reducing fatality rates to a low level despite high baseline fatality risk. Bird fatality rates did not appear affected by curtailment in 2017 or 2018, with relatively low fatality rates for each operational scenario tested between the two years.

Table 4-1. Selected bird and bat fatality estimates for comparison between 2017 and 2018 monitoring periods.

Year	Estimator/Carcass Persistence Model	Treatment	Estimated bats/turbine (95% CI)	Estimated birds/turbine (95% CI)
2017	Huso/log-logistic	Curtailed, Combined Treatments	2.63 (1.82–3.89)	1.02 (0.77–1.4)
2018	Huso/log-logistic	Curtailed	3.66 (2.02–7.21)	–
		Control	38.19 (20.95–75.68)	–
		Combined	–	3.19 (1.9–5.34)

Power loss associated with curtailment depends largely on conditions present during a given year. However, mean estimated energy loss for the 2018 curtailment mode in 2018 was less than that estimated for any of the 4 curtailment strategies implemented in 2017, while effectiveness in terms of reduced bat fatality rate and avoidance of bat activity was even higher in 2018 than 2017. This strongly supports the assertion that curtailment can be made more efficient while remaining highly effective at avoiding risk to bats.

Bat and bird fatality is difficult to estimate with precision, particularly when small numbers of carcasses are found, as is often the case when curtailment strategies are in place. Most carcasses found during 2018 were at the control turbines, with only 3 carcasses found at curtailed turbines. In addition to the effectiveness of curtailment at reducing the number of carcasses, high carcass scavenging rates at the Project resulted in short carcass persistence times and low carcass retention (proportion of carcasses remaining between searches). Short carcass persistence relative to search interval suggests that a substantial number of bird and bat carcasses were likely removed by scavengers before they could be found by searchers. The surveyor once again noted frequent presence of bird scavengers (mostly raven, crow, and turkey vulture) and recorded multiple videos of trial carcasses being removed by birds. Carcass detection, reflected by searcher efficiency trials, was comparable for birds between 2017 and 2018, although estimated searcher efficiency for bats was lower in 2018 than in 2017. We attribute the lower 2018 estimate for bats primarily to the composition of trial carcasses consisting almost entirely of mice in 2018, whereas bat carcasses were used for most trials in 2017. Based on anecdotal comparison, mice are considerably more difficult to see on the ground than bat carcasses because they have smaller surface area and lack wings, which often make bat carcasses more visible by casting shadows and presenting a color contrast. Also, the same individual was conducting searches both years, and the height and thickness of vegetation was similar between years.

However, variable carcass persistence and imperfect carcass detection are both accounted for within the Huso estimator, and although short carcass persistence contributed to relatively large range in confidence intervals, estimates were sufficiently precise to demonstrate the substantial and significant difference between control and curtailed turbines. We also included incidental carcasses in our fatality estimates which should mean that our estimates represent a “worst case scenario” given available data. Indeed, estimating bat fatality using 2017 versus 2018 searcher efficiency results would reduce the estimates for control turbines from 38.17 to 22.5 and curtailed turbines from 3.66 to 2.16. Importantly, fatality estimates scale evenly between treatments when using different searcher efficiency datasets, such that the estimated effectiveness of curtailment remains unchanged.

As was the case in 2017, nacelle-mounted acoustic detectors provided valuable data enabling us to document the effectiveness of curtailment on a fine temporal scale during the 2018 monitoring period. Although bat detectors do not record collisions and cannot provide a count of bats in the surveyed airspace, the metric of exposed bat activity appears to provide a robust and accurate measure of risk of fatality. Monitoring during 2017 and 2018 documented significant (and similar) relationships between bat fatality and exposed activity. Also, the relative species composition of exposed bat activity and fatality were very similar during both years. Perhaps more importantly, the relationship between bat activity and weather conditions (temperature and wind speed) was similar between 2017 and 2018, allowing accurate prediction of the effectiveness of a curtailment strategy between years.

The estimated bird fatality rate (combined treatments) and bat fatality rate for curtailed turbines were low compared to similar studies conducted in the region (Figure 4-1, Figure 4-2). However, the bat estimate for normally operating control turbines was among the higher estimates for projects in West Virginia, confirming the conclusion made in 2017 that low bat fatality rates during the first year of monitoring were primarily the result of turbine curtailment. Appendix E includes data used to generate Figures 4-1 and 4-2 and provides associated references.

The goal of curtailment at the Project remains to avoid potential impacts to federally rare bat species and substantially reduce fatality rates of more vulnerable long-distance migratory bat species. By combining nacelle-height acoustic monitoring and low intensity carcass monitoring, the second year of monitoring has demonstrated how site-specific data can be used to tailor a strategic curtailment program that maintains fatality at an acceptably low level while resulting in substantially less energy loss than curtailment programs implementing high (e.g., 6.0 – 6.9 m/s) cut-in speeds across the entire spring, summer, and fall. The 2018 curtailment program effectively prevented turbine operation during 91% of periods in which curtailment conditions were met. The corresponding value for treatments in 2017 was ~73%, indicating an improvement in the method of programming the curtailment parameters. Improvements in curtailment implementation combined with seasonal cut-in speeds that more closely matched trends in bat activity allowed the 2018 curtailment strategy to be more efficient than any of the strategies tested in 2017 while remaining similarly protective of bats, based on independent metrics of fatality estimates and avoided acoustic activity. Acoustic and operational data from 2017 and 2018 will be used to design a long-term smart curtailment plan to be implemented during subsequent years.

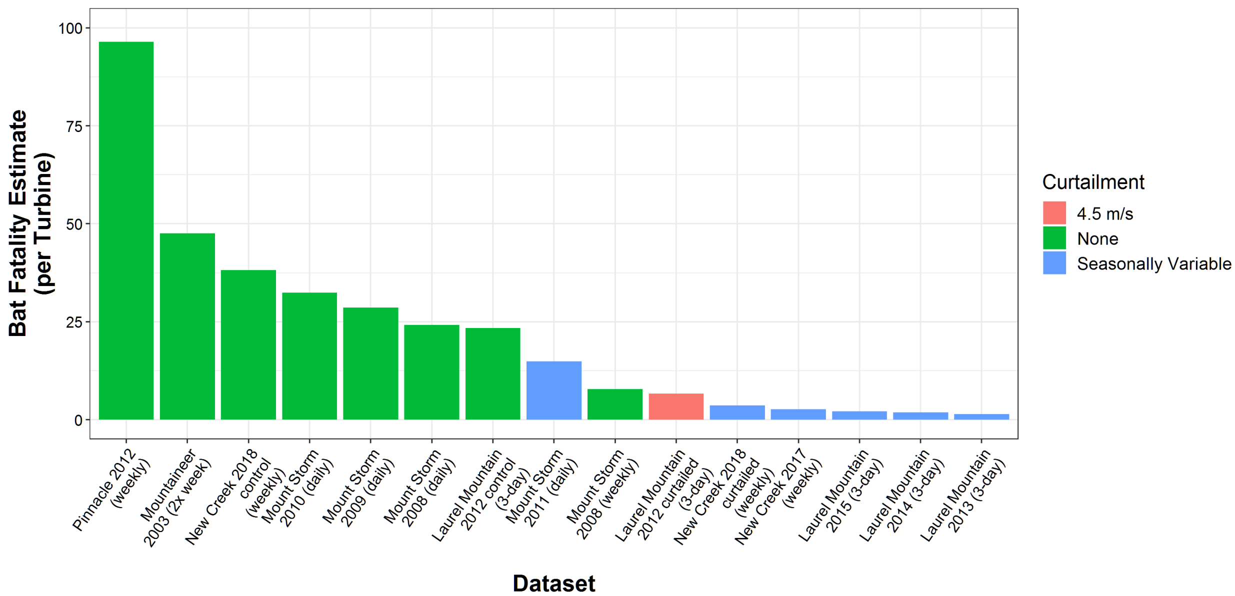


Figure 4-1. New Creek bat fatality estimates compared to publicly available estimates from West Virginia Wind projects

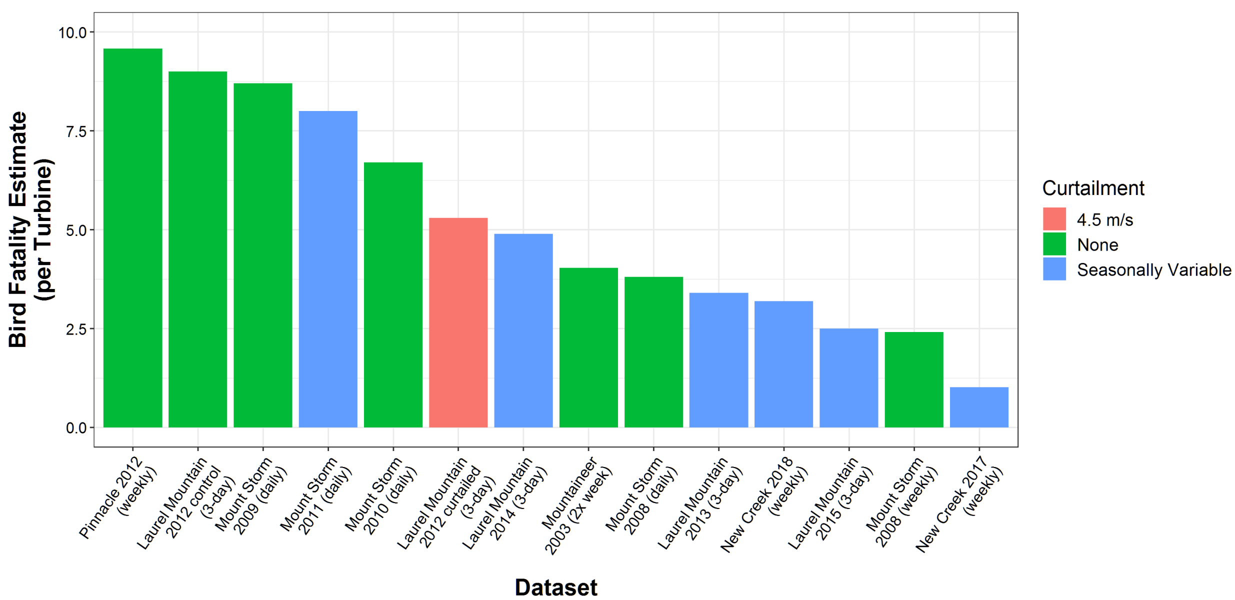


Figure 4-2. New Creek bird fatality estimates compared to publicly available estimates from West Virginia Wind projects

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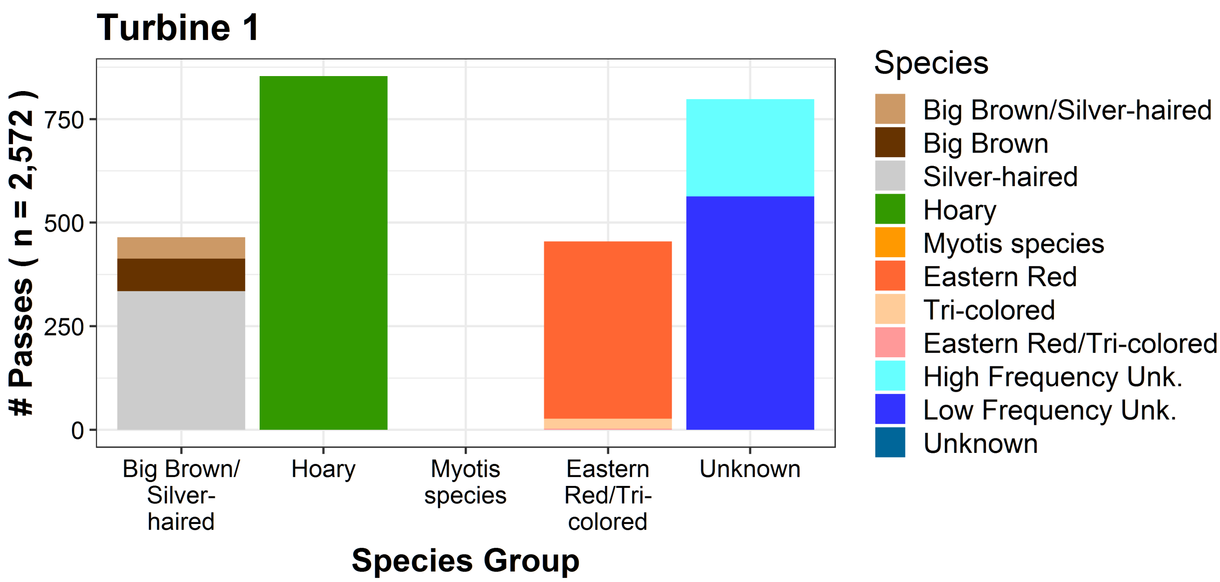
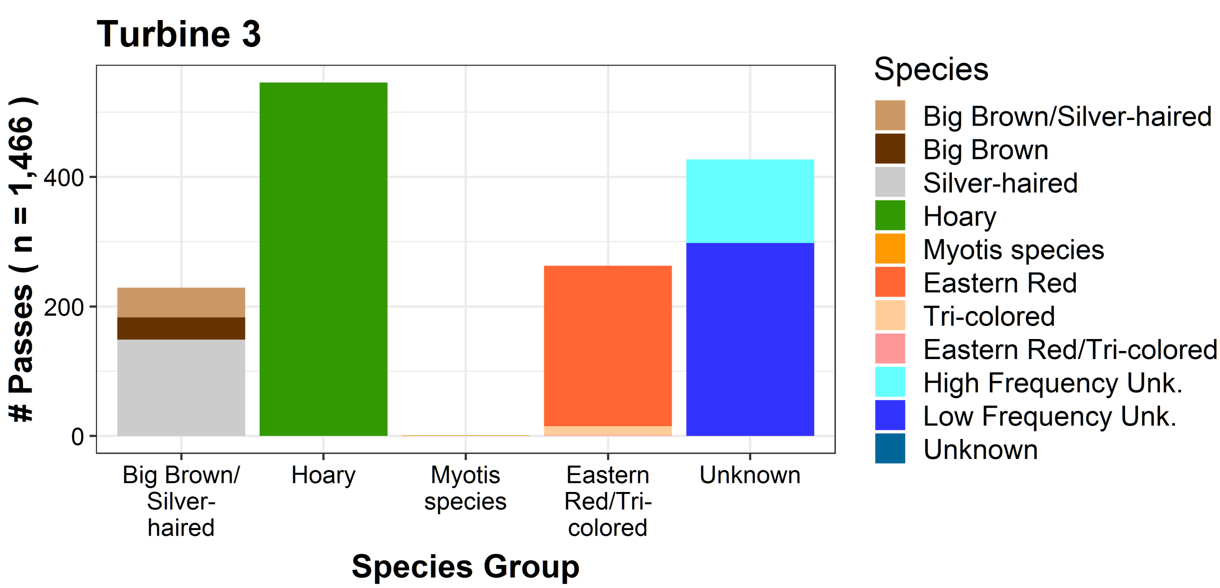
APPENDICES

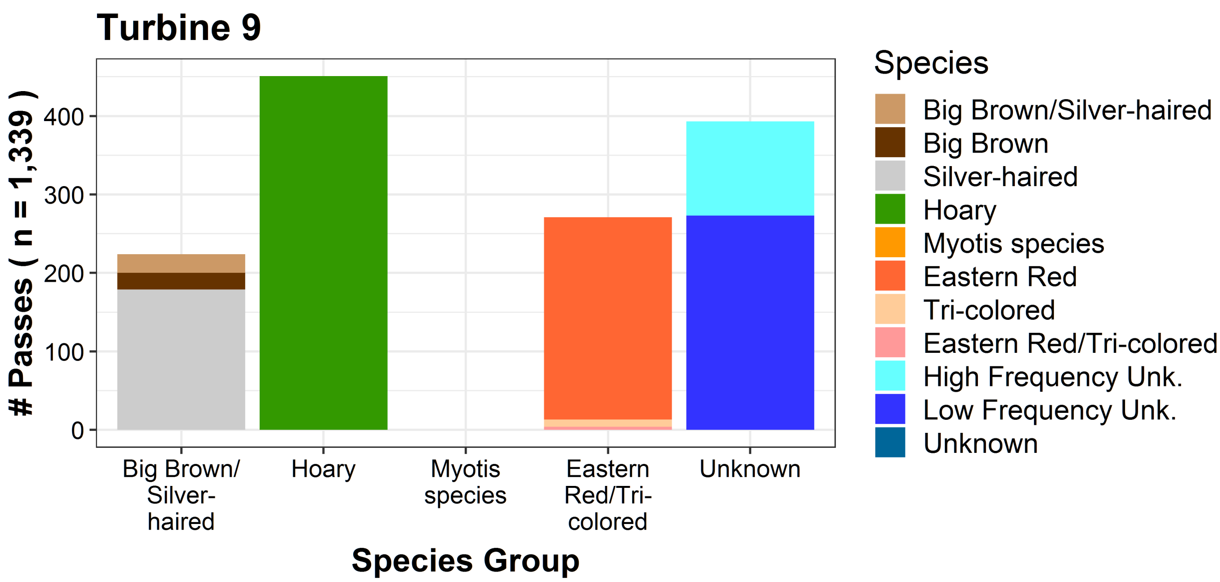
APPENDIX A NEW CREEK WIND PROJECT 2018 POST-CONSTRUCTION MONITORING PLAN

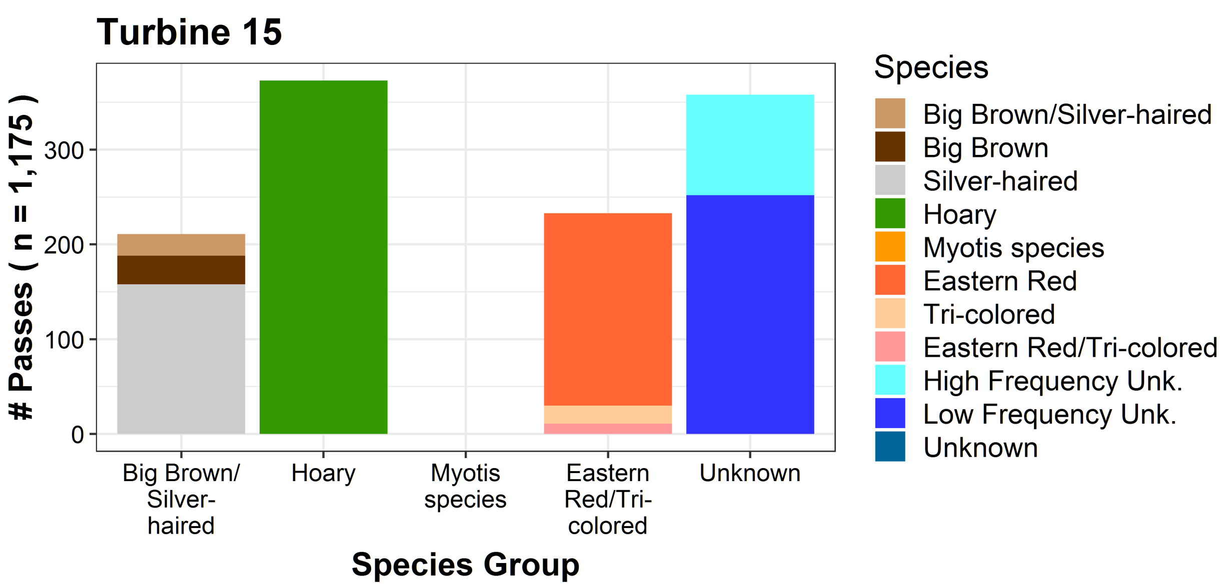
APPENDIX B ACOUSTIC BAT SURVEY RESULTS BY TURBINE

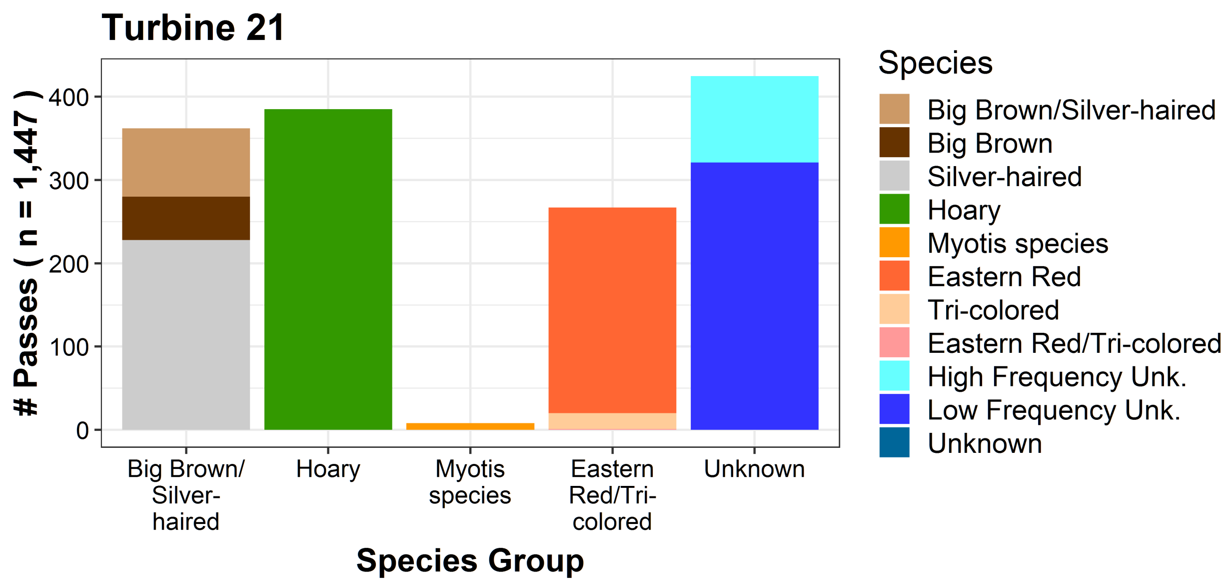
Appendix B Figure 1. Species composition of bat activity detected by turbine, New Creek Wind Project, 2018

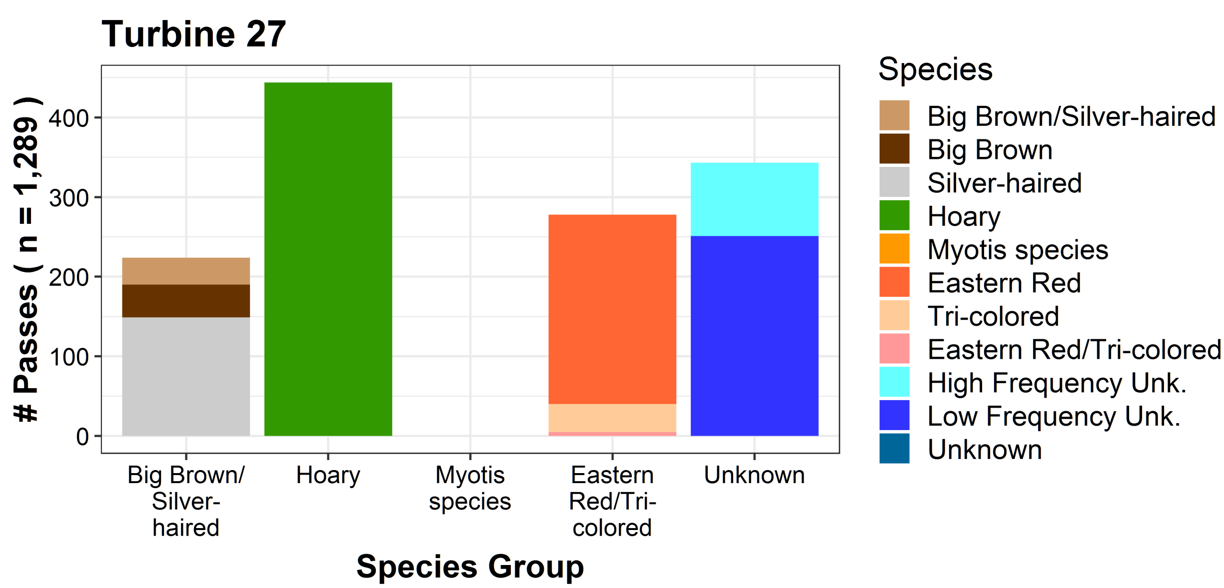


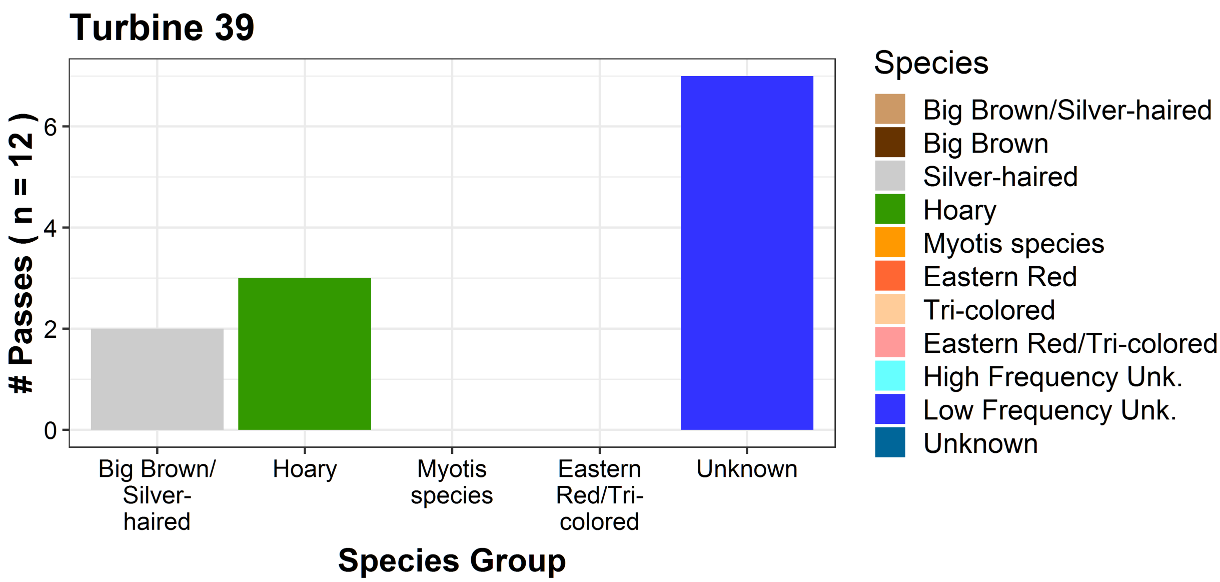


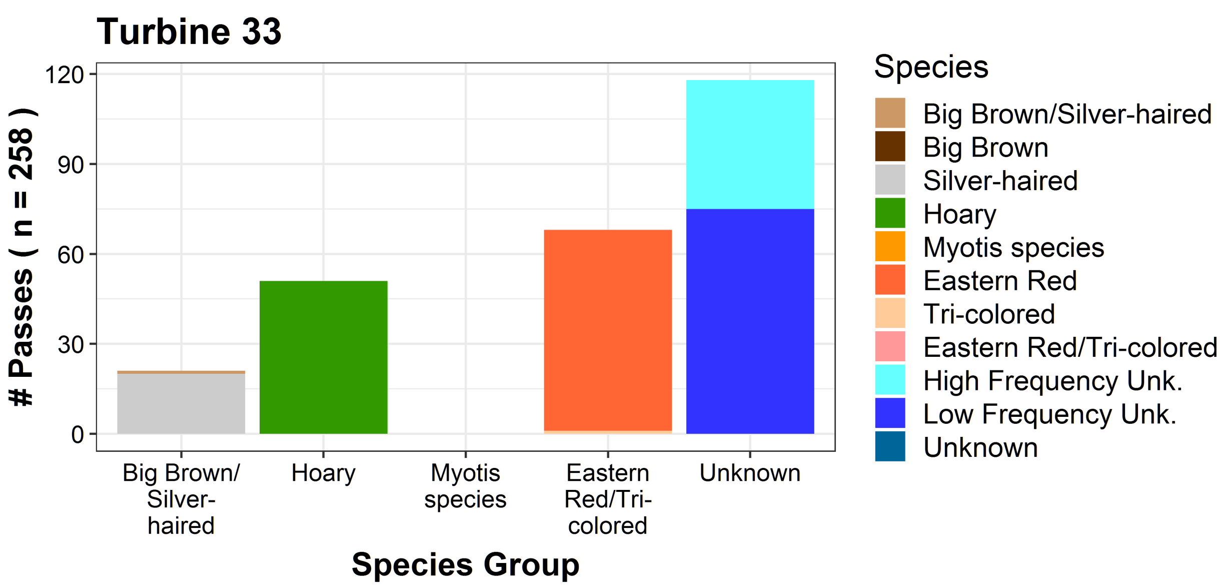

Turbine 9
Passes (n = 1,339)
400
300
200
100
0
Big Brown/
Silver-
haired
Hoary
Myotis
species
Eastern
Red/Tri-
colored
Unknown
Species Group
Species
Big Brown/Silver-haired
Big Brown
Silver-haired
Hoary
Myotis species
Eastern Red
Tri-colored
Eastern Red/Tri-colored
High Frequency Unk.
Low Frequency Unk.
Unknown

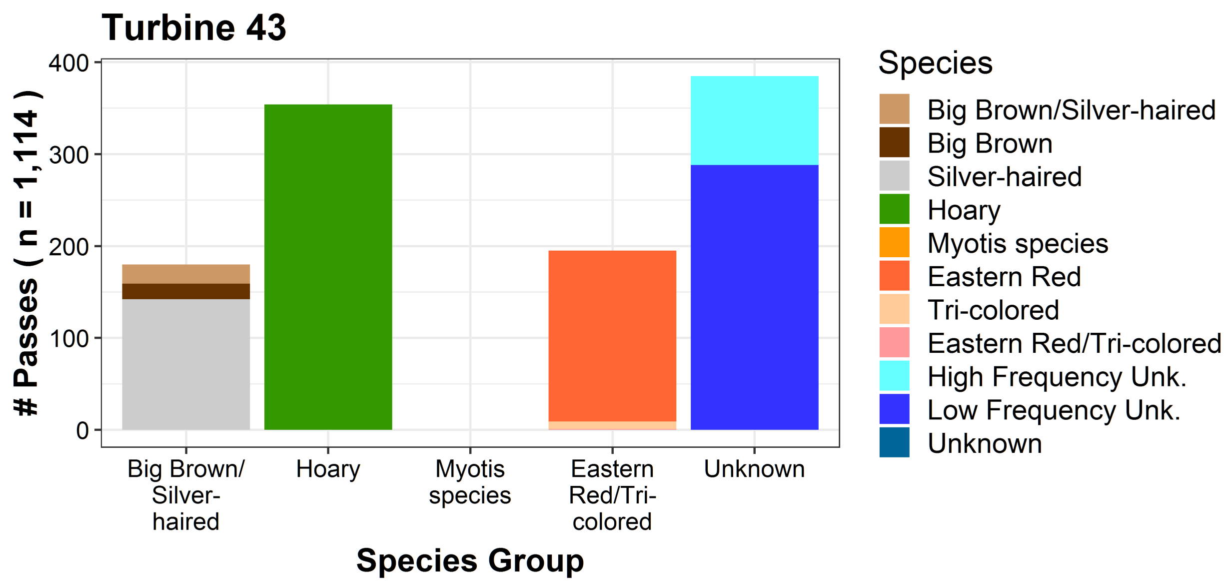

Turbine 15
Passes (n = 1,175)
300
200
100
0
Big Brown/
Silver-
haired
Hoary
Myotis
species
Eastern
Red/Tri-
colored
Unknown
Species Group
Species
Big Brown/Silver-haired
Big Brown
Silver-haired
Hoary
Myotis species
Eastern Red
Tri-colored
Eastern Red/Tri-colored
High Frequency Unk.
Low Frequency Unk.
Unknown

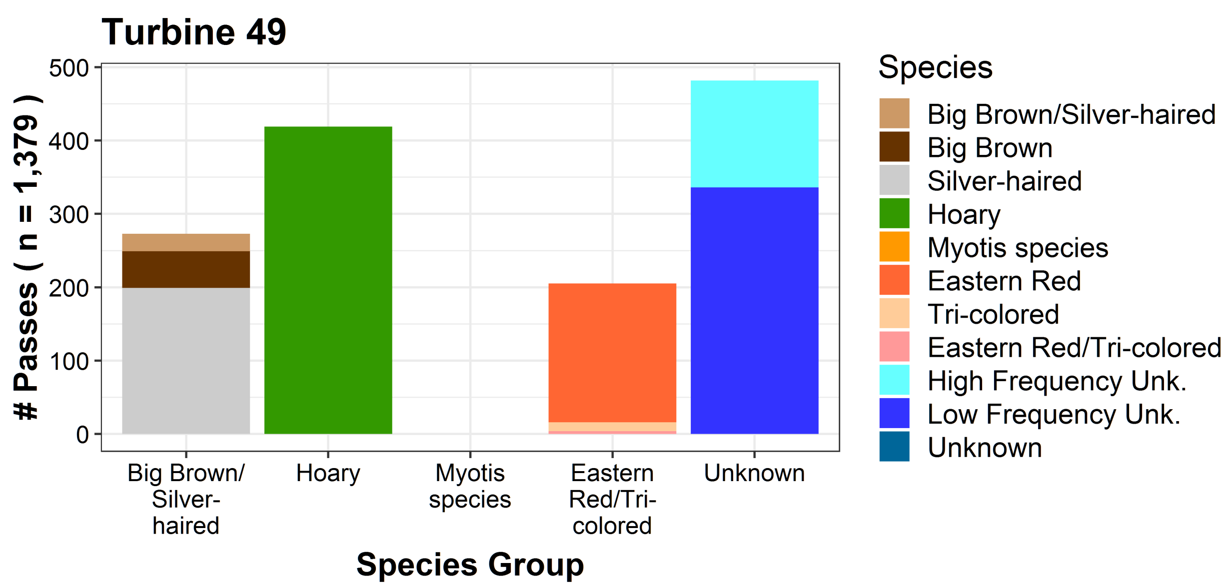

Turbine 21
Passes (n = 1,447)
400
300
200
100
0
Big Brown/ Silver- haired
Hoary
Myotis species
Eastern Red/Tri- colored
Unknown
Species Group
Species
Big Brown/Silver-haired
Big Brown
Silver-haired
Hoary
Myotis species
Eastern Red
Tri-colored
Eastern Red/Tri-colored
High Frequency Unk.
Low Frequency Unk.
Unknown


Turbine 27
Passes (n = 1,289)
400
300
200
100
0
Big Brown/ Silver- haired
Hoary
Myotis species
Eastern Red/Tri- colored
Unknown
Species Group
Species
Big Brown/Silver-haired
Big Brown
Silver-haired
Hoary
Myotis species
Eastern Red
Tri-colored
Eastern Red/Tri-colored
High Frequency Unk.
Low Frequency Unk.
Unknown

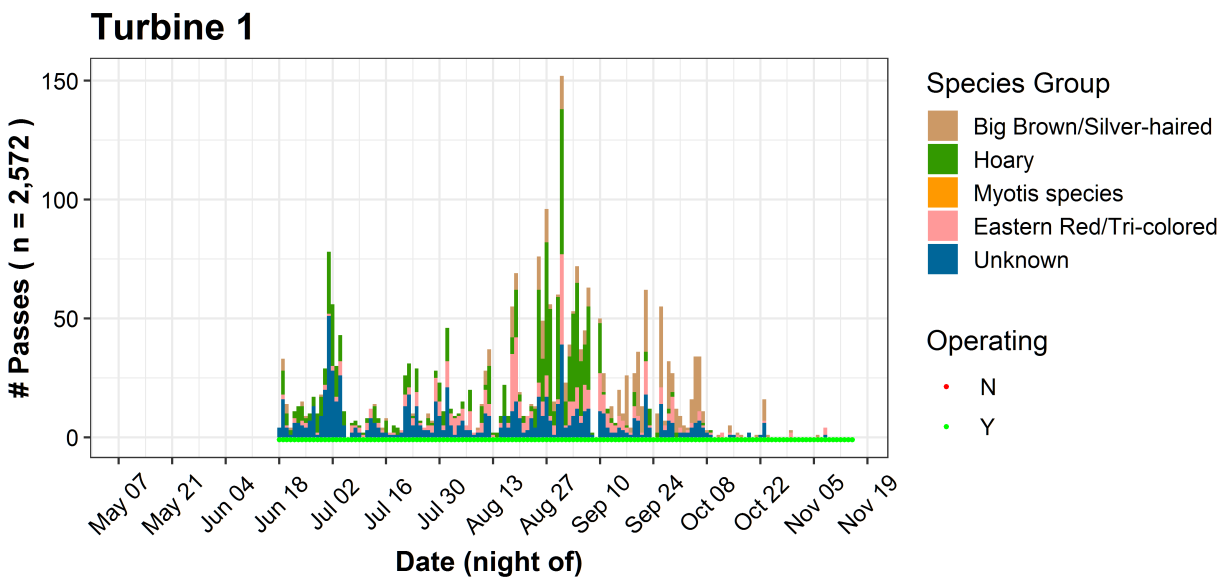

Turbine 39
Passes (n = 12)
0
2
4
6
Big Brown/ Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Species Group
Species
Big Brown/Silver-haired
Big Brown
Silver-haired
Hoary
Myotis species
Eastern Red
Tri-colored
Eastern Red/Tri-colored
High Frequency Unk.
Low Frequency Unk.
Unknown

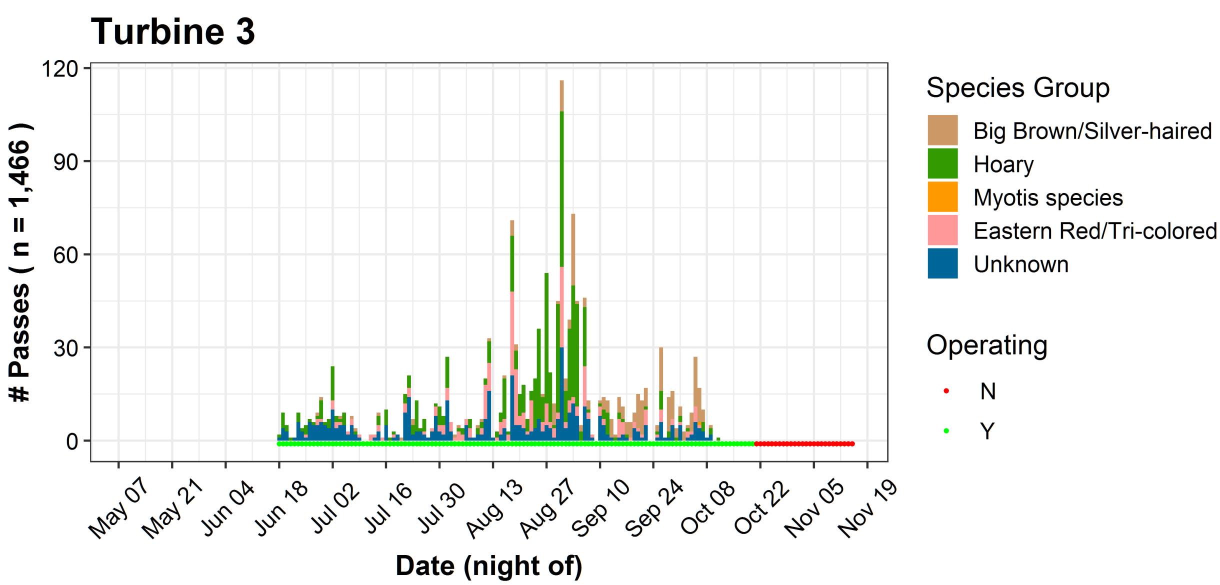

Turbine 33
Passes (n = 258)
0
30
60
90
120
Big Brown/ Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Species Group
Species
Big Brown/Silver-haired
Big Brown
Silver-haired
Hoary
Myotis species
Eastern Red
Tri-colored
Eastern Red/Tri-colored
High Frequency Unk.
Low Frequency Unk.
Unknown

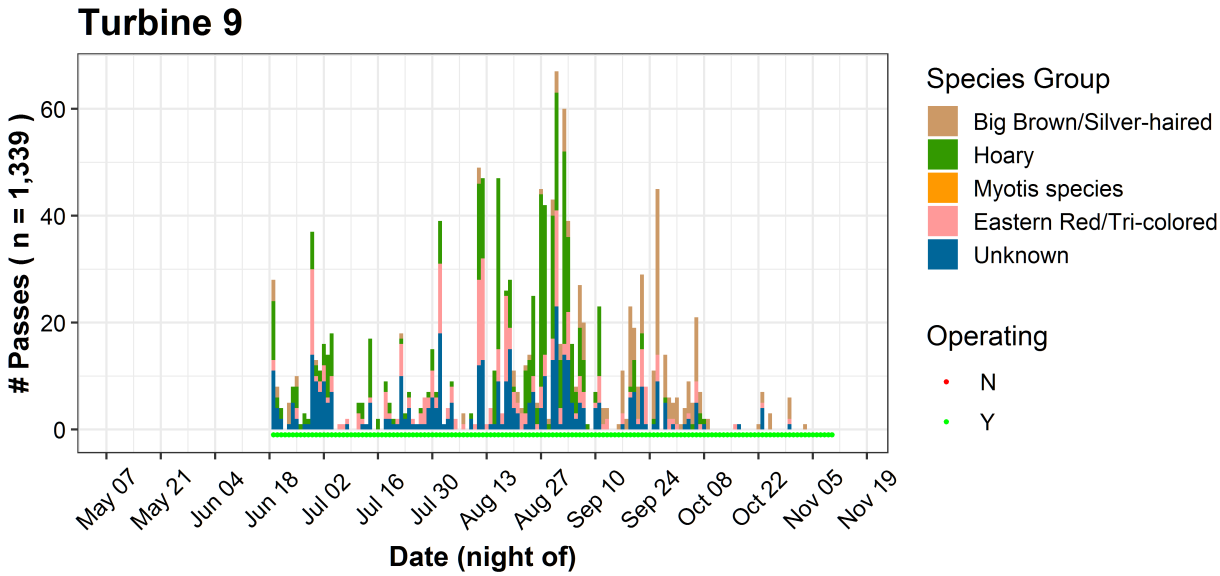

Turbine 43
Passes (n = 1,114)
400
300
200
100
0
Big Brown/ Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Species Group
Species
Big Brown/Silver-haired
Big Brown
Silver-haired
Hoary
Myotis species
Eastern Red
Tri-colored
Eastern Red/Tri-colored
High Frequency Unk.
Low Frequency Unk.
Unknown

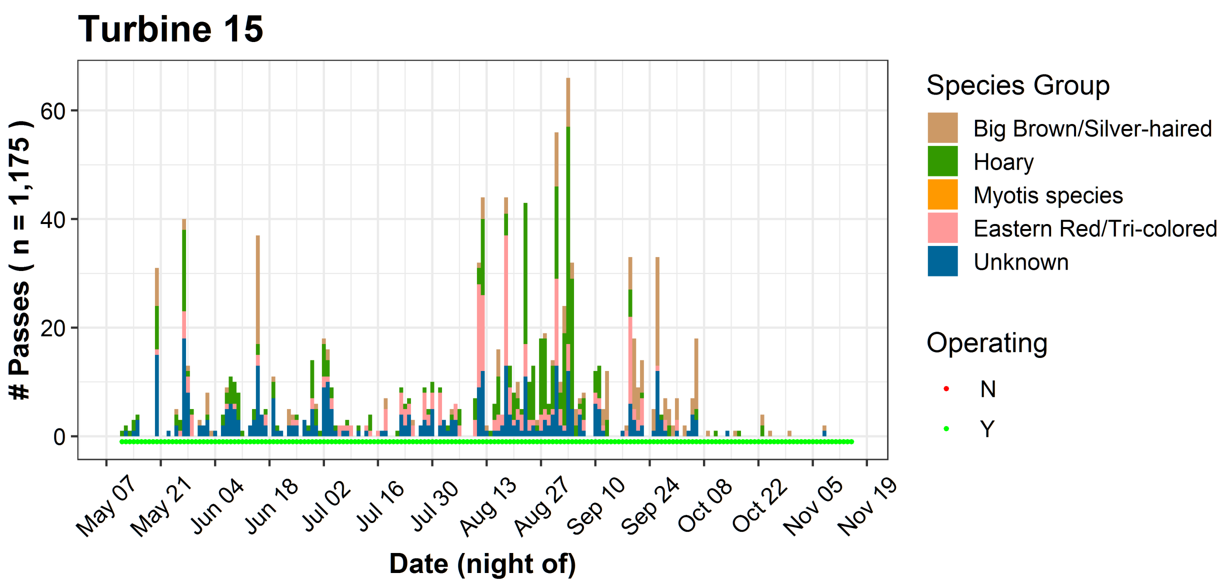

Turbine 49
Passes (n = 1,379)
500
400
300
200
100
0
Big Brown/ Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Species Group
Species
Big Brown/Silver-haired
Big Brown
Silver-haired
Hoary
Myotis species
Eastern Red
Tri-colored
Eastern Red/Tri-colored
High Frequency Unk.
Low Frequency Unk.
Unknown

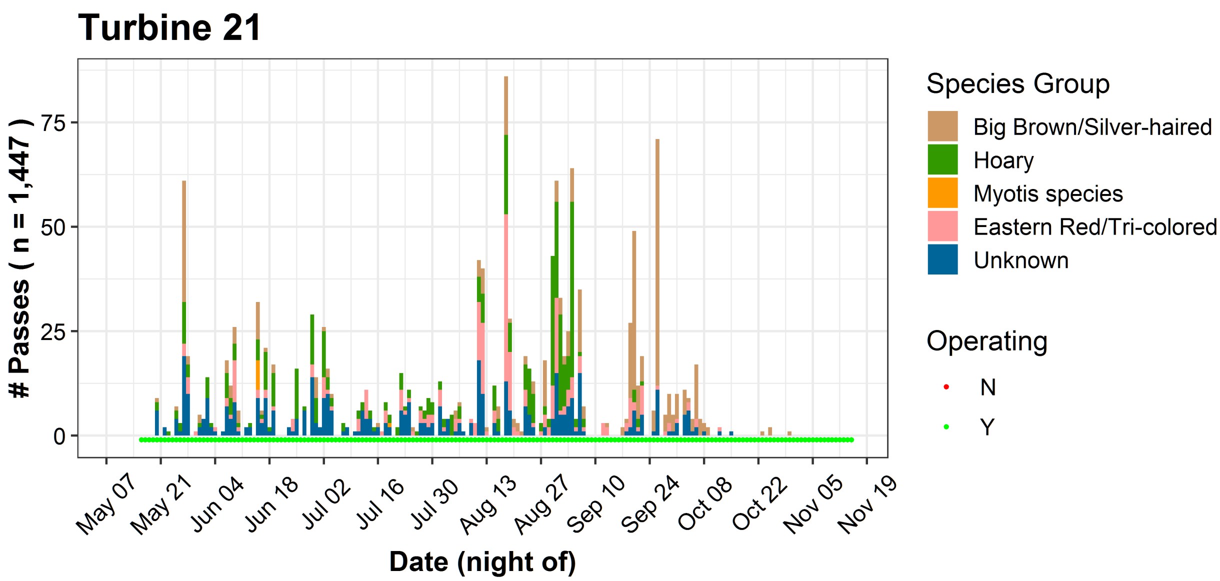
Appendix B Figure 2. Nightly bat activity and detector operation by turbine, New Creek Wind Project, 2018

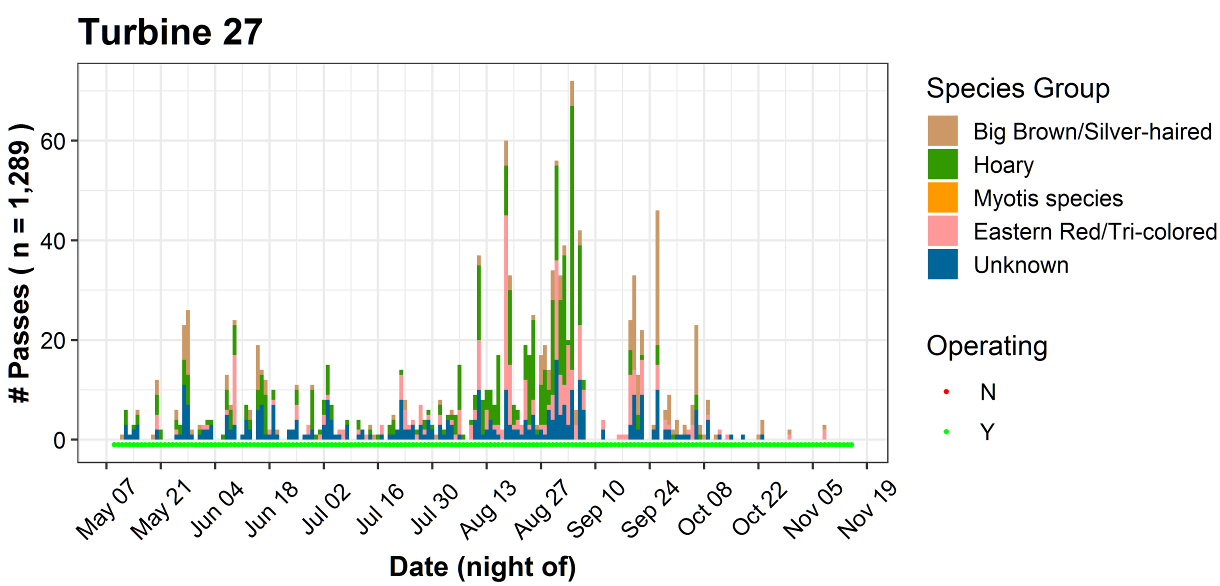


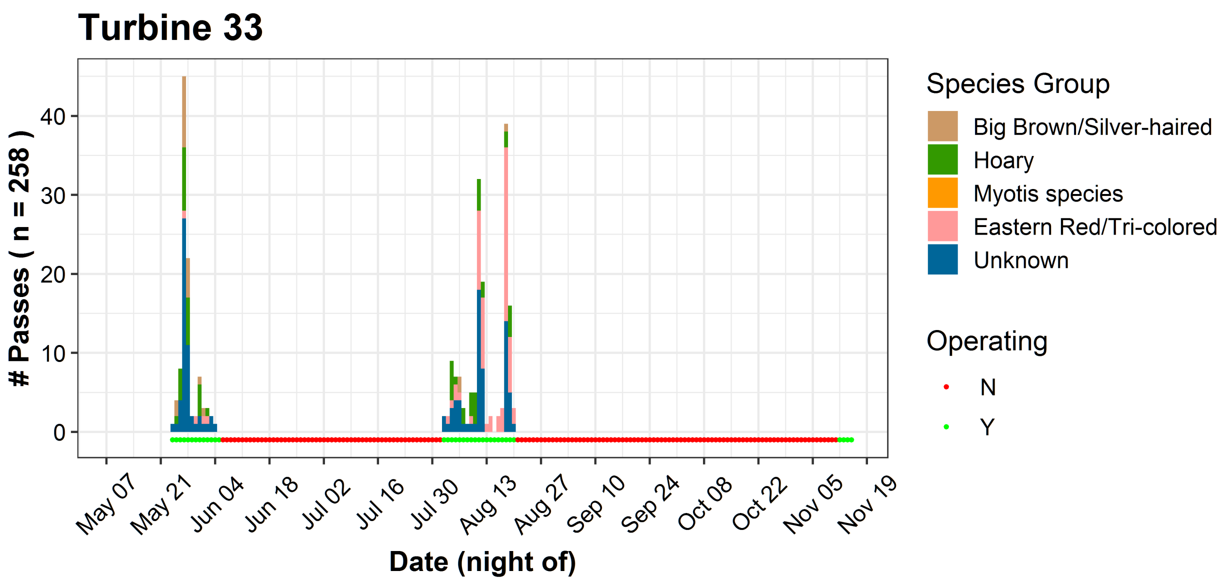


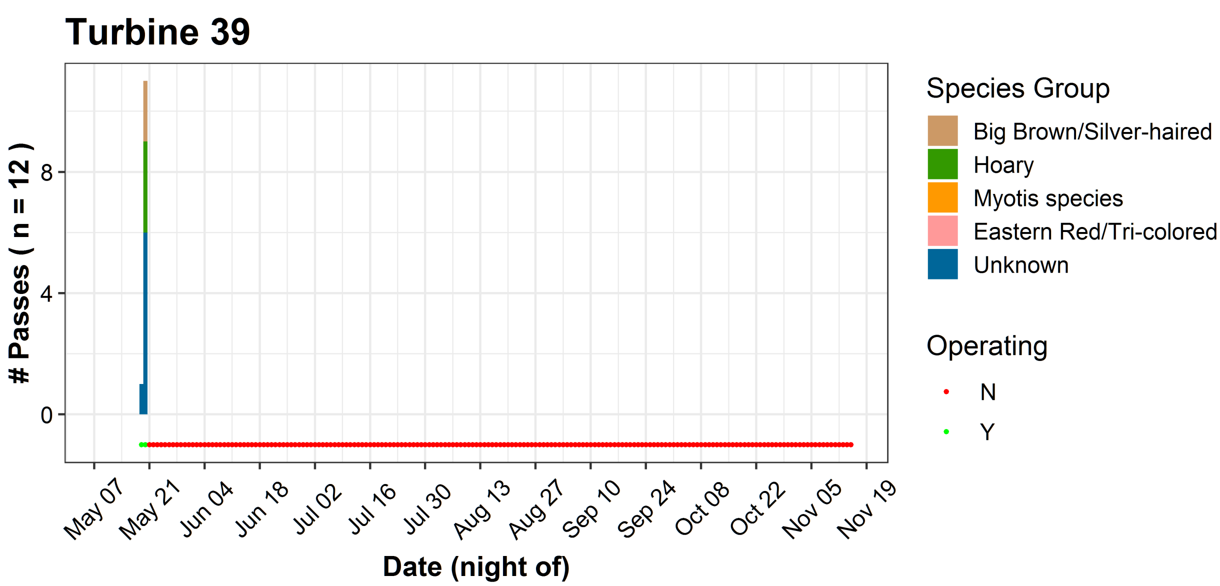

Turbine 9
Passes (n = 1,339)
0
20
40
60
May 07
May 21
Jun 04
Jun 18
Jul 02
Jul 16
Jul 30
Aug 13
Aug 27
Sep 10
Sep 24
Oct 08
Oct 22
Nov 05
Nov 19
Date (night of)
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Operating
N
Y

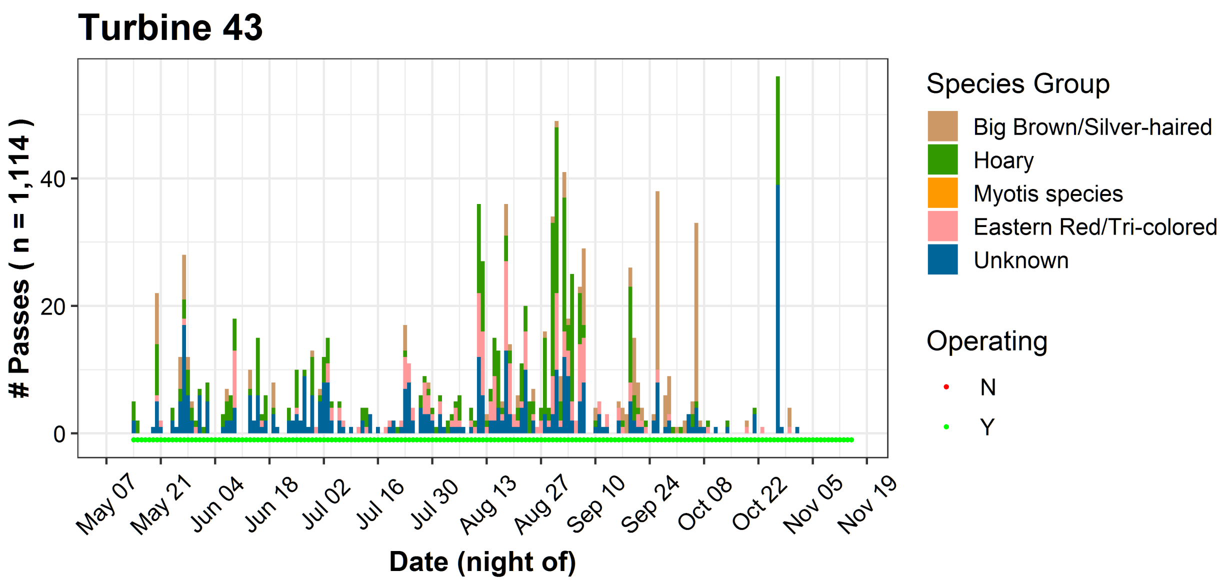

Turbine 15
Passes (n = 1,175)
0
20
40
60
May 07
May 21
Jun 04
Jun 18
Jul 02
Jul 16
Jul 30
Aug 13
Aug 27
Sep 10
Sep 24
Oct 08
Oct 22
Nov 05
Nov 19
Date (night of)
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Operating
N
Y


Turbine 21
Passes (n = 1,447)
Date (night of)
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Operating
N
Y

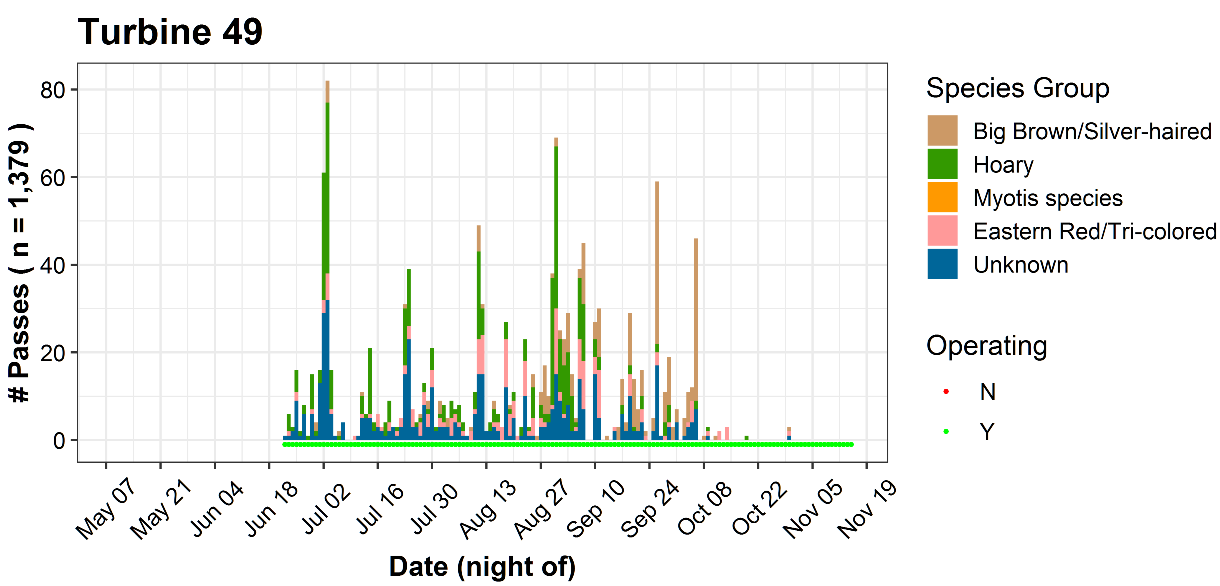

Turbine 27
Passes (n = 1,289)
Date (night of)
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Operating
N
Y


Turbine 33
Passes (n = 258)
0
10
20
30
40
May 07
May 21
Jun 04
Jun 18
Jul 02
Jul 16
Jul 30
Aug 13
Aug 27
Sep 10
Sep 24
Oct 08
Oct 22
Nov 05
Nov 19
Date (night of)
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Operating
N
Y


Turbine 39
Passes (n = 12)
0
4
8
May 07
May 21
Jun 04
Jun 18
Jul 02
Jul 16
Jul 30
Aug 13
Aug 27
Sep 10
Sep 24
Oct 08
Oct 22
Nov 05
Nov 19
Date (night of)
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Operating
N
Y

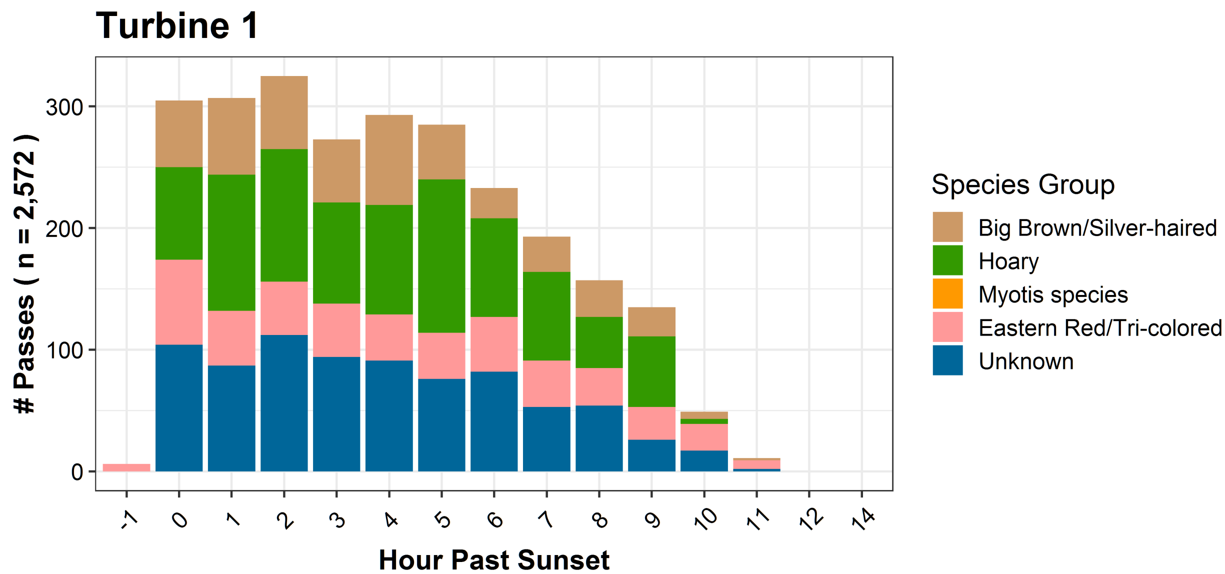


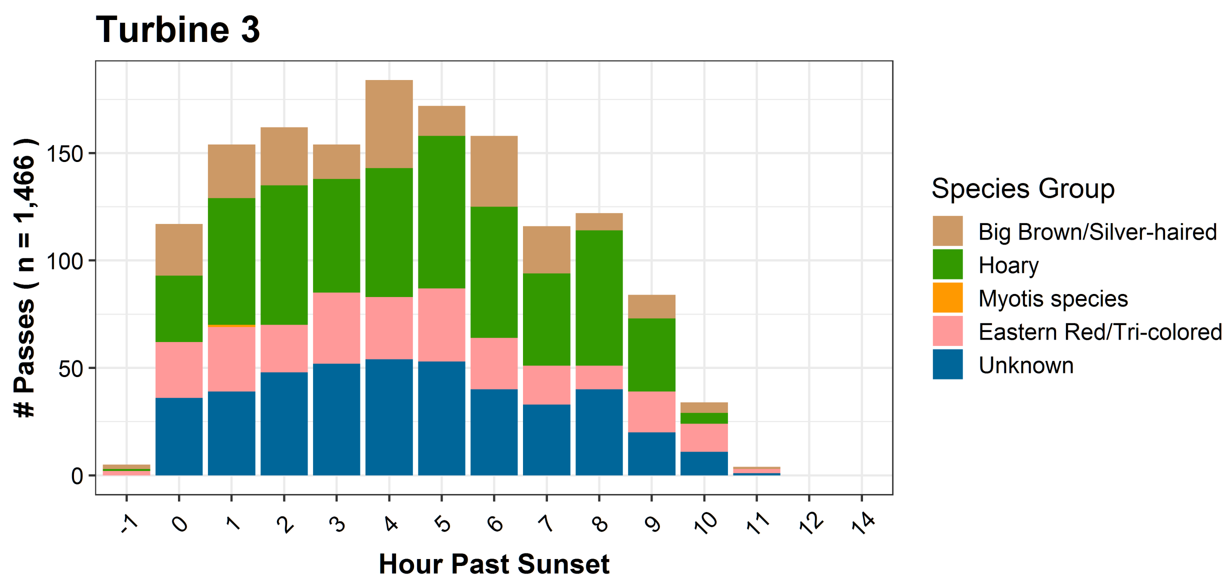
Turbine 43
Passes (n = 1,114)
0
20
40
May 07
May 21
Jun 04
Jun 18
Jul 02
Jul 16
Jul 30
Aug 13
Aug 27
Sep 10
Sep 24
Oct 08
Oct 22
Nov 05
Nov 19
Date (night of)
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Operating
N
Y

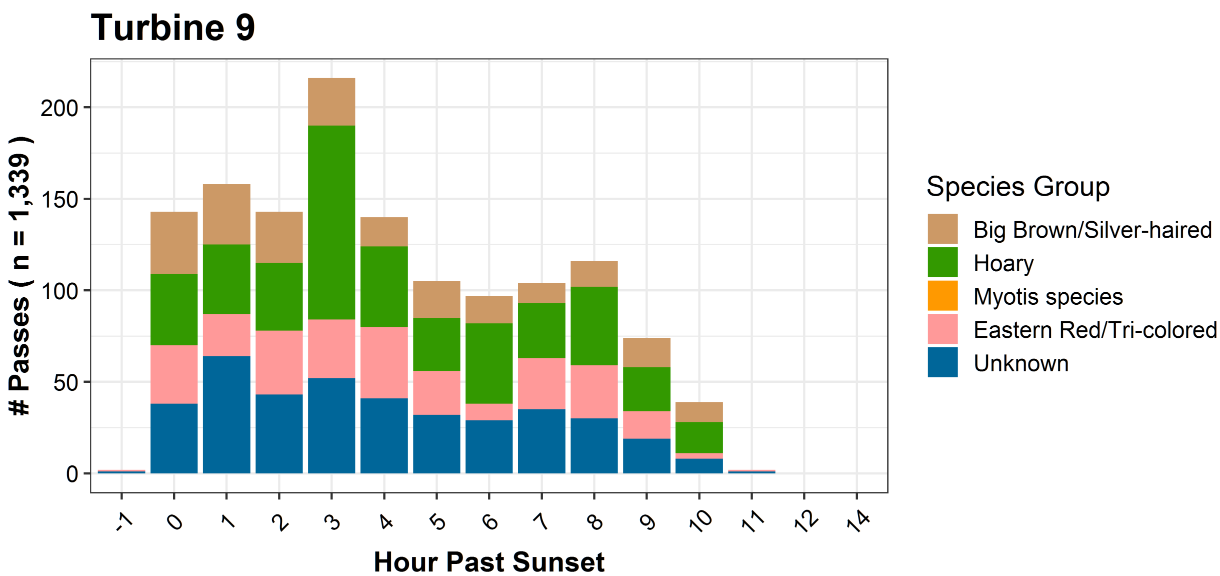


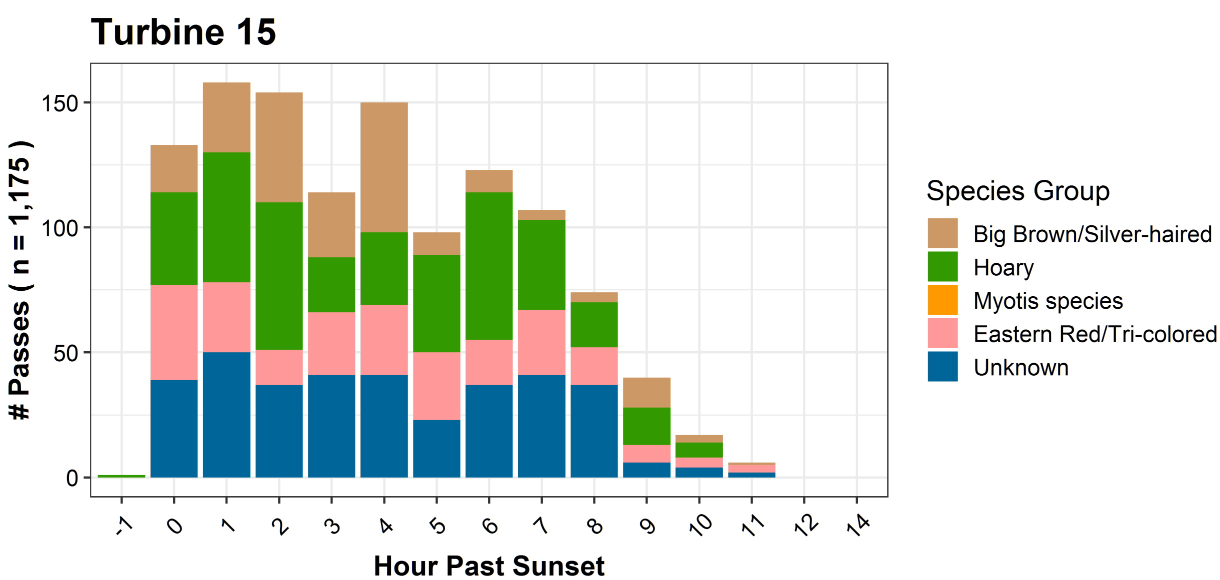
Turbine 49
Passes (n = 1,379)
0
20
40
60
80
May 07
May 21
Jun 04
Jun 18
Jul 02
Jul 16
Jul 30
Aug 13
Aug 27
Sep 10
Sep 24
Oct 08
Oct 22
Nov 05
Nov 19
Date (night of)
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown
Operating
N
Y

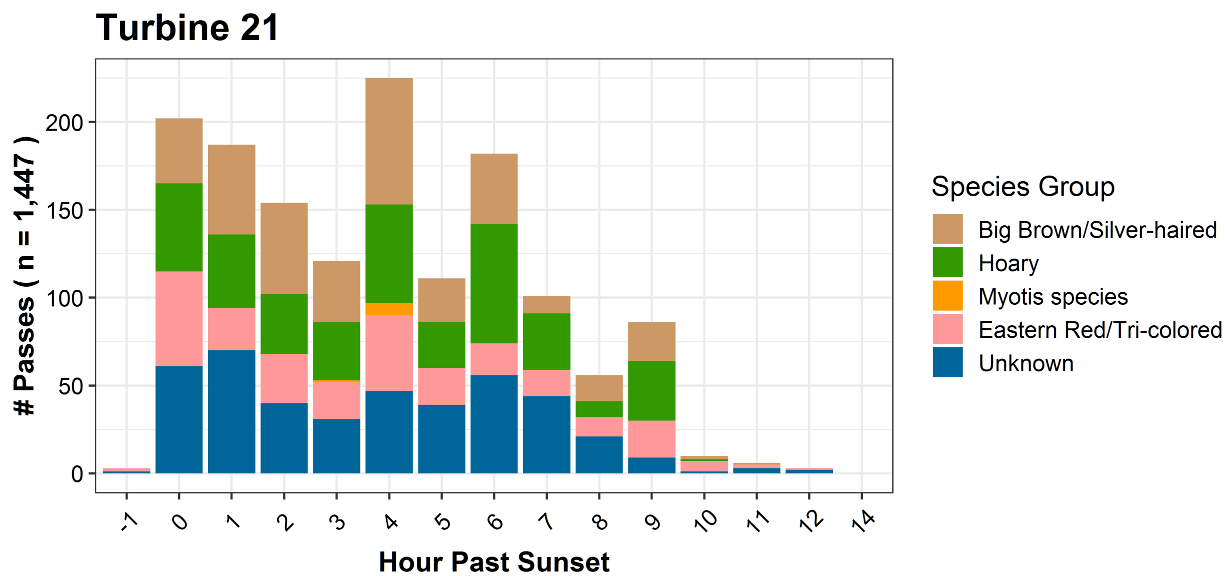
Appendix B Figure 3. Overall hourly timing bat activity by species group for each turbine, New Creek Wind Project, 2018

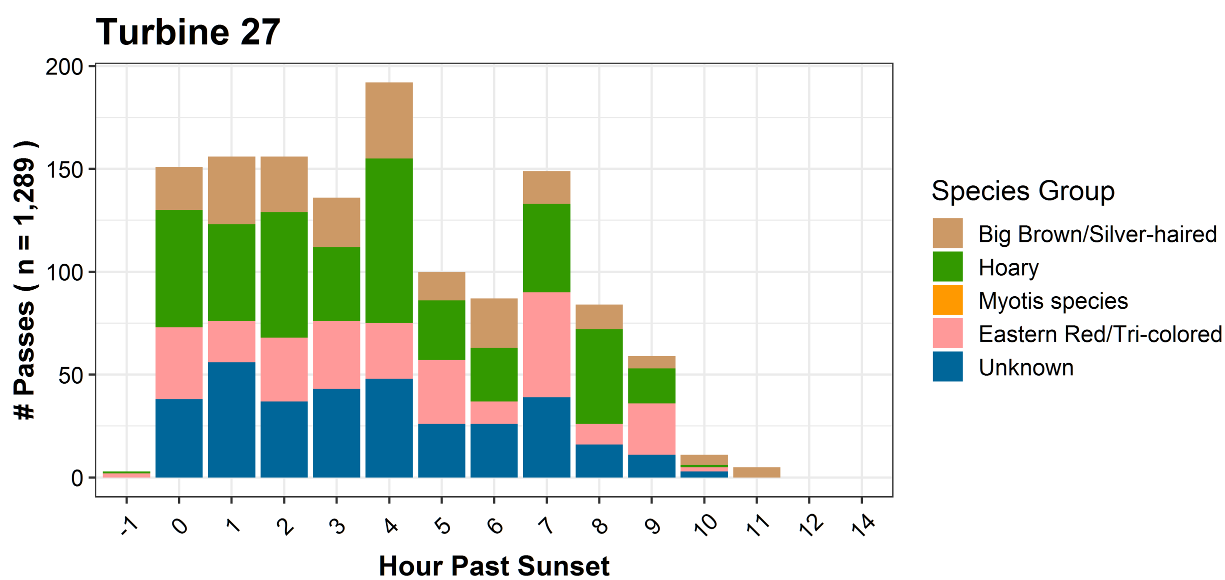


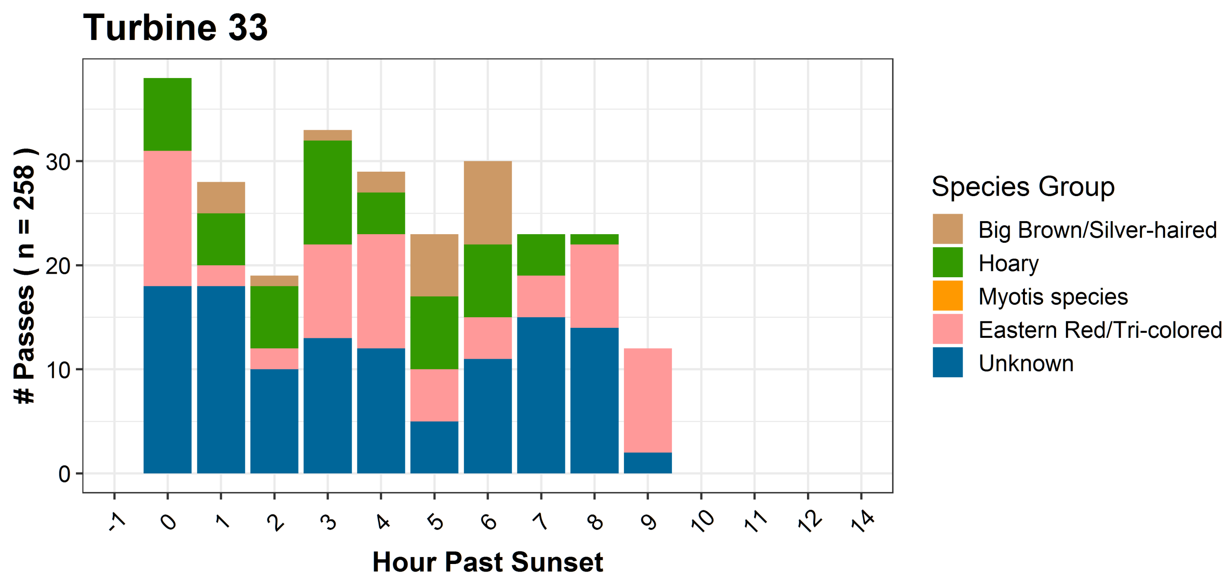


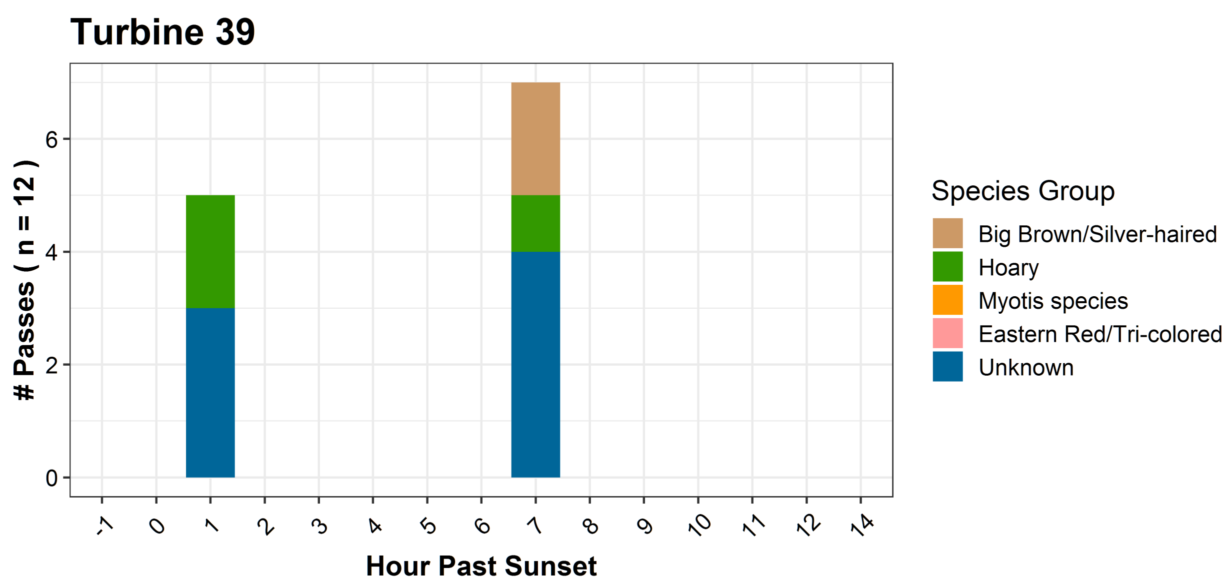

Turbine 9
Passes (n = 1,339)
200
150
100
50
0
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hour Past Sunset
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown

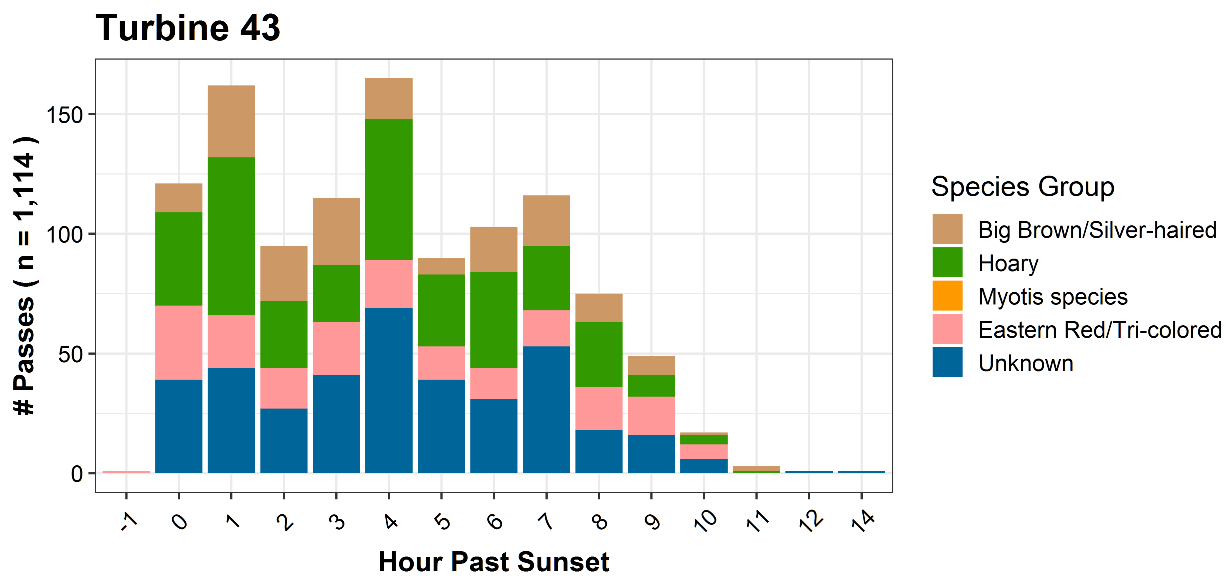

Turbine 15
Passes (n = 1,175)
150
100
50
0
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hour Past Sunset
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown

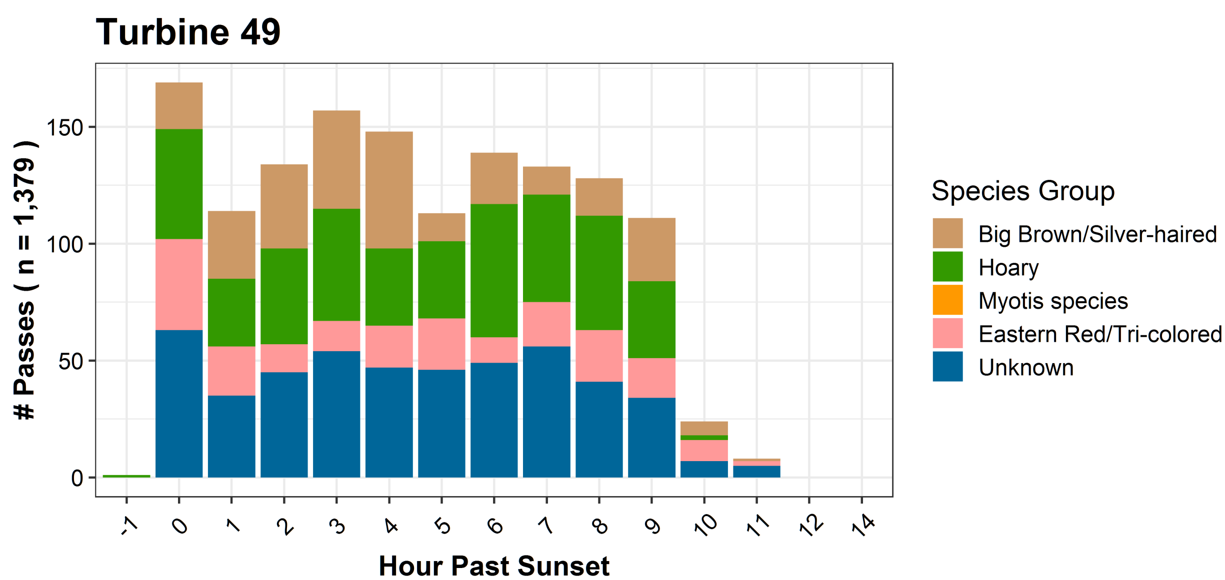

Turbine 21
Passes (n = 1,447)
0
50
100
150
200
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hour Past Sunset
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown


Turbine 27
Passes (n = 1,289)
0
50
100
150
200
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hour Past Sunset
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown


Turbine 33
Passes (n = 258)
0
10
20
30
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hour Past Sunset
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown


Turbine 39
Passes (n = 12)
0
2
4
6
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hour Past Sunset
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown


Turbine 43
Passes (n = 1,114)
150
100
50
0
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hour Past Sunset
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown


Turbine 49
Passes (n = 1,379)
150
100
50
0
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
14
Hour Past Sunset
Species Group
Big Brown/Silver-haired
Hoary
Myotis species
Eastern Red/Tri-colored
Unknown

APPENDIX C 2018 BIRD AND BAT CARCASS DATA

Carcass ID	How Found	Date	Type	Common Name	Species	Surveyor	Turbine	Distance from Turbine (m)	Azimuth from Turbine (°)	Ground Cover	Transect	Condition	Forearm Length (mm; bats)	Sex	Age	Estimated Time Since Fatality
20180504t13-01	Sweep	04-May-18	Bat	silver-haired bat	Lasionycteris noctivagans	DTB	T13	8	4	Bare Ground	1e	Dessicated	38.8	Unknown	Adult	> 2 Weeks
20180505t19-01	Sweep	05-May-18	Bat	hoary bat	Lasiurus cinereus	DTB	T19	24	144	Bare Ground	3e	Fresh	52.64	Male	Adult	Last Night
20180507t01-01	Search	07-May-18	Bat	hoary bat	Lasiurus cinereus	DTB	T01	30	100	Bare Ground	8e	Fresh	53.2	Male	Adult	Last Night
20180514t23-01	Incidental	14-May-18	Bat	hoary bat	Lasiurus cinereus	DTB	T23	27	132	Bare Ground	6e	Fresh	54.9	Male	Adult	Last Night
20180515t13-01	Search	15-May-18	Bird	black-billed cuckoo	Coccyzus erythropthalmus	DTB	T13	42	146	Grassland	6e	Fresh	n/a	Unknown	Adult	Last Night
20180515t06-01	Incidental	15-May-18	Bat	hoary bat	Lasiurus cinereus	DTB	T06	37	76	Bare Ground	9e	Fresh	50.4	Unknown	Adult	Last Night
20180516t05-01	Search	16-May-18	Bird	scarlet tanager	Piranga olivacea	DTB	T05	37	177	Grassland	1e	Decomposing - Early Flesh Mostly Present	n/a	Male	Adult	2-3 Days
20180521t27-01	Incidental	21-May-18	Bat	hoary bat	Lasiurus cinereus	DTB	T27	31	78	Bare Ground	9e	Fresh	54.8	Unknown	Adult	Last Night
20180529t11-01	Search	29-May-18	Bat	hoary bat	Lasiurus cinereus	DTB	T11	27	155	Bare Ground	3e	Decomposing - Early Flesh Mostly Present	56	Male	Adult	2-3 Days
20180531t17-01	Search	31-May-18	Bird	unidentified warbler	Parulidae (gen, sp)	DTB	T17	40	242	Bare Ground	10w	Decomposing - late Flesh Mostly Absent	n/a	Unknown	Unknown	4-7 Days
20180601t19-01	Search	01-Jun-18	Bat	hoary bat	Lasiurus cinereus	DTB	T19	16	338	Bare Ground	2w	Decomposing - Early Flesh Mostly Present	53.24	Unknown	Adult	4-7 Days
20180608t39-01	Search	08-Jun-18	Bat	hoary bat	Lasiurus cinereus	DTB	T39	4	288	Grassland	1w	Fresh	52.08	Male	Adult	Last Night
20180615t09-01	Search	15-Jun-18	Bat	hoary bat	Lasiurus cinereus	DTB	T09	12	116	Grassland	3e	Fresh	52.4	Male	Adult	Last Night
20180620t15-01	Search	20-Jun-18	Bat	hoary bat	Lasiurus cinereus	DTB	T15	6	169	Bare Ground	1e	Fresh	52.73	Male	Adult	Last Night
20180710t03-01	Search	10-Jul-18	Bat	hoary bat	Lasiurus cinereus	DTB	T03	12	254	Bare Ground	4w	Decomposing - late Flesh Mostly Absent	52.5	Unknown	Adult	4-7 Days
20180710t03-02	Search	10-Jul-18	Bird	osprey	Pandion haliaetus	DTB	T03	30	10	Grassland	2e	Decomposing - Early Flesh Mostly Present	n/a	Unknown	Adult	2-3 Days
20180724t03-01	Search	24-Jul-18	Bat	hoary bat	Lasiurus cinereus	DTB	T03	5	175	Bare Ground	1e	Fresh	54.16	Male	Adult	Last Night
20180727t19-01	Search	27-Jul-18	Bat	eastern red bat	Lasiurus borealis	DTB	T19	14	10	Bare Ground	1e	Decomposing - late Flesh Mostly Absent	40.67	Unknown	Adult	4-7 Days
20180731t03-01	Search	31-Jul-18	Bat	eastern red bat	Lasiurus borealis	DTB	T03	36	234	Grassland	8w	Fresh	40.21	Male	Adult	Last Night
20180806t11-01	Search	06-Aug-18	Bat	big brown bat	Eptesicus fuscus	DTB	T11	15	200	Bare Ground	2w	Decomposing - Early Flesh Mostly Present	45.09	Male	Adult	2-3 Days
20180813t27-01	Incidental	13-Aug-18	Bat	hoary bat	Lasiurus cinereus	DTB	T27	48	173	Bare Ground	1e	Fresh	52.63	Unknown	Adult	Last Night
20180814t11-01	Search	14-Aug-18	Bat	eastern red bat	Lasiurus borealis	DTB	T11	28	304	Grassland	8w	Decomposing - Early Flesh Mostly Present	40.16	Unknown	Unknown	4-7 Days
20180815t05-01	Search	15-Aug-18	Bird	red-tailed hawk	Buteo jamaicensis	DTB	T05	48	102	Grassland	11e	Decomposing - Early Flesh Mostly Present	n/a	Unknown	Adult	4-7 Days
20180815t02-01	Incidental	15-Aug-18	Bird	red-tailed hawk	Buteo jamaicensis	DTB	T02	48	205	Bare Ground	8w	Decomposing - late Flesh Mostly Absent	n/a	Unknown	Adult	4-7 Days
20180820t39-01	Search	20-Aug-18	Bat	tri-colored bat	Perimyotis subflavus	DTB	T39	14	116	Grassland	5e	Fresh	33.88	Male	Adult	Last Night

Carcass ID	How Found	Date	Type	Common Name	Species	Surveyor	Turbine	Distance from Turbine (m)	Azimuth from Turbine (°)	Ground Cover	Transect	Condition	Forearm Length (mm; bats)	Sex	Age	Estimated Time Since Fatality
20180827t11-01	Search	27-Aug-18	Bat	hoary bat	Lasiurus cinereus	DTB	T11	23	106	Bare Ground	6e	Fresh	54.03	Male	Adult	Last Night
20180829t45-01	Search	29-Aug-18	Bat	eastern red bat	Lasiurus borealis	DTB	T45	24	58	Grassland	6e	Fresh	40.06	Male	Adult	Last Night
20180829t11-01	Incidental	29-Aug-18	Bat	hoary bat	Lasiurus cinereus	DTB	T11	32	96	Bare Ground	7e	Fresh	54.1	Male	Adult	Last Night
20180830t07-01	Search	30-Aug-18	Bat	big brown bat	Eptesicus fuscus	DTB	T07	6	75	Grassland	2e	Decomposing - late Flesh Mostly Absent	48.72	Male	Adult	4-7 Days
20180830t17-01	Search	30-Aug-18	Bird	blackpoll warbler	Setophaga striata	DTB	T17	28	184	Bare Ground	1w	Decomposing - Early Flesh Mostly Present	n/a	Unknown	Adult	4-7 Days
20180831t19-01	Search	31-Aug-18	Bat	hoary bat	Lasiurus cinereus	DTB	T19	17	60	Grassland	4e	Fresh	56	Male	Adult	Last Night
20180831t19-02	Search	31-Aug-18	Bat	hoary bat	Lasiurus cinereus	DTB	T19	34	87	Bare Ground	8e	Fresh	53.84	Male	Adult	Last Night
20180904t23-01	Search	04-Sep-18	Bat	hoary bat	Lasiurus cinereus	DTB	T23	15	352	Grassland	1w	Fresh	55.68	Male	Adult	Last Night
20180905t15-01	Search	05-Sep-18	Bat	hoary bat	Lasiurus cinereus	DTB	T15	27	62	Grassland	7e	Fresh	53.48	Female	Adult	Last Night
20180907t19-01	Search	07-Sep-18	Bat	eastern red bat	Lasiurus borealis	DTB	T19	27	334	Bare Ground	4w	Fresh	39.43	Male	Adult	Last Night
20180911t03-01	Search	11-Sep-18	Bat	eastern red bat	Lasiurus borealis	DTB	T03	38	72	Bare Ground	10e	Fresh	42.69	Male	Adult	Last Night
20180911t11-01	Incidental	11-Sep-18	Bat	eastern red bat	Lasiurus borealis	DTB	T11	9	313	Bare Ground	4w	Fresh	37.68	Male	Adult	Last Night
20180912t15-01	Search	12-Sep-18	Bat	hoary bat	Lasiurus cinereus	DTB	T15	34	335	Grassland	4w	Fresh	55.3	Male	Adult	Last Night
20180914t47-01	Incidental	14-Sep-18	Bird	yellow-billed cuckoo	Coccyzus americanus	DTB	T47	31	325	Bare Ground	9w	Fresh	n/a	Unknown	Adult	Last Night
20180921t19-01	Search	21-Sep-18	Bat	silver-haired bat	Lasionycteris noctivagans	DTB	T19	23	262	Bare Ground	7w	Fresh	40.24	Male	Adult	Last Night
20180921t15-01	Incidental	21-Sep-18	Bird	tennessee warbler	Oreothlypis peregrina	DTB	T15	64	46	Bare Ground	Road	Fresh	n/a	Unknown	Adult	Last Night
20180924t31-01	Search	24-Sep-18	Bat	silver-haired bat	Lasionycteris noctivagans	DTB	T31	22	276	Bare Ground	6w	Fresh	43.24	Female	Adult	Last Night
20180927t07-01	Search	27-Sep-18	Bat	eastern red bat	Lasiurus borealis	DTB	T07	20	192	Grassland	2w	Fresh	39.09	Male	Adult	Last Night
201810002t43-01	Search	02-Oct-18	Bird	ruffed grouse	Bonasa umbellus	DTB	T43	2	144	Bare Ground	1e	Feather Spot	n/a	Unknown	Unknown	4-7 Days
20181008t12-01	Incidental	08-Oct-18	Bird	acadian flycatcher	Empidonax virescens	DTB	T12	52	60	Bare Ground	Road	Fresh	n/a	Unknown	Adult	Last Night
20181016t14-01	Incidental	16-Oct-18	Bird	unidentified warbler	Parulidae (gen, sp)	DTB	T14	66	70	Bare Ground	Road	Decomposing - late Flesh Mostly Absent	n/a	Unknown	Unknown	4-7 Days
20181018t07-01	Search	18-Oct-18	Bat	silver-haired bat	Lasionycteris noctivagans	DTB	T07	42	74	Bare Ground	11e	Fresh	42.17	Male	Adult	Last Night

APPENDIX D NEW CREEK TURBINE MAPS

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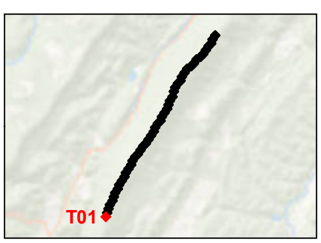

Legend
- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

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Project Location
Grant County, West Virginia
195601490
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Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
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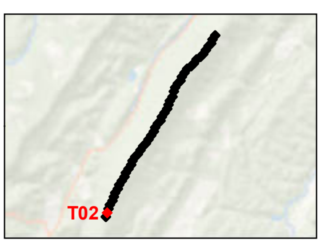
Figure No.
1

Title
Turbine 1 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).



Legend
- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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New Creek Wind Energy Project
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Figure No.
2

Title
Turbine 2 Search Area

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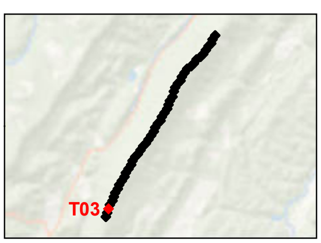

Legend
- Bat Carcass Location
- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

0 80 Feet
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Client/Project
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New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
3

Title
Turbine 3 Search Area

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack

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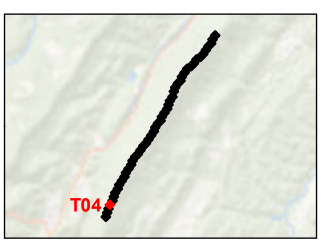

Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

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New Creek Wind Energy Project
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Figure No.
4

Title
Turbine 4 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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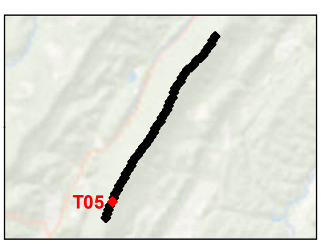

Legend

- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

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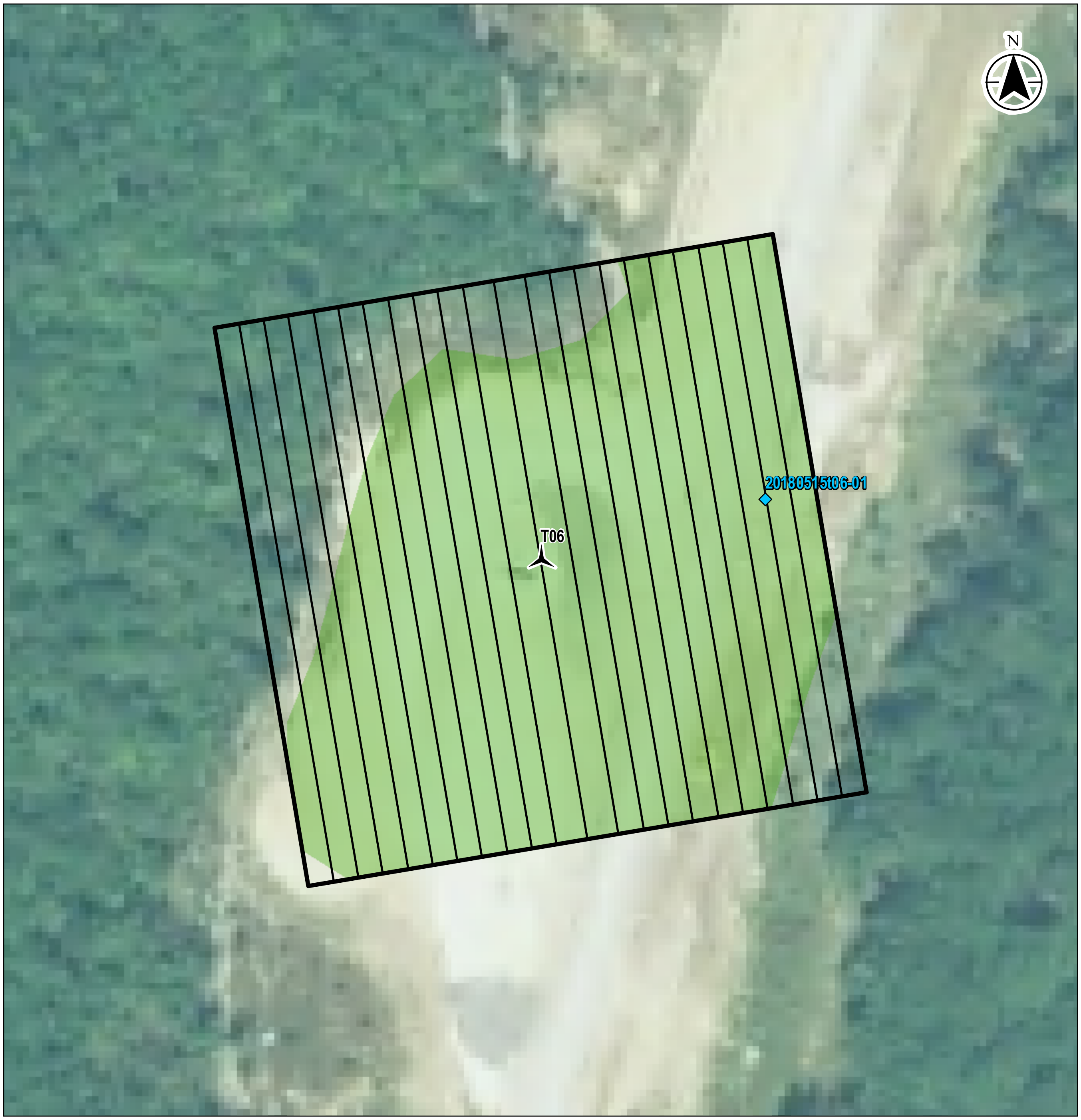
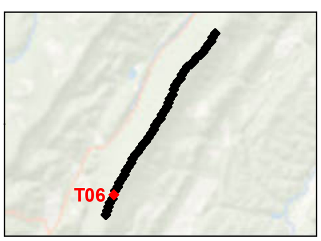
Figure No.
5

Title
Turbine 5 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).





Legend
- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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Figure No.
6

Title
Turbine 6 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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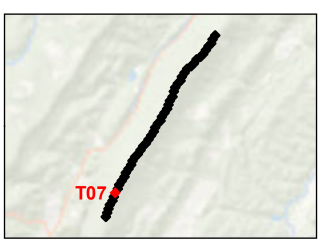

Legend
- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

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Figure No.
7

Title
Turbine 7 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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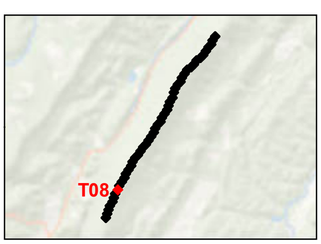

Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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Figure No.
8

Title
Turbine 8 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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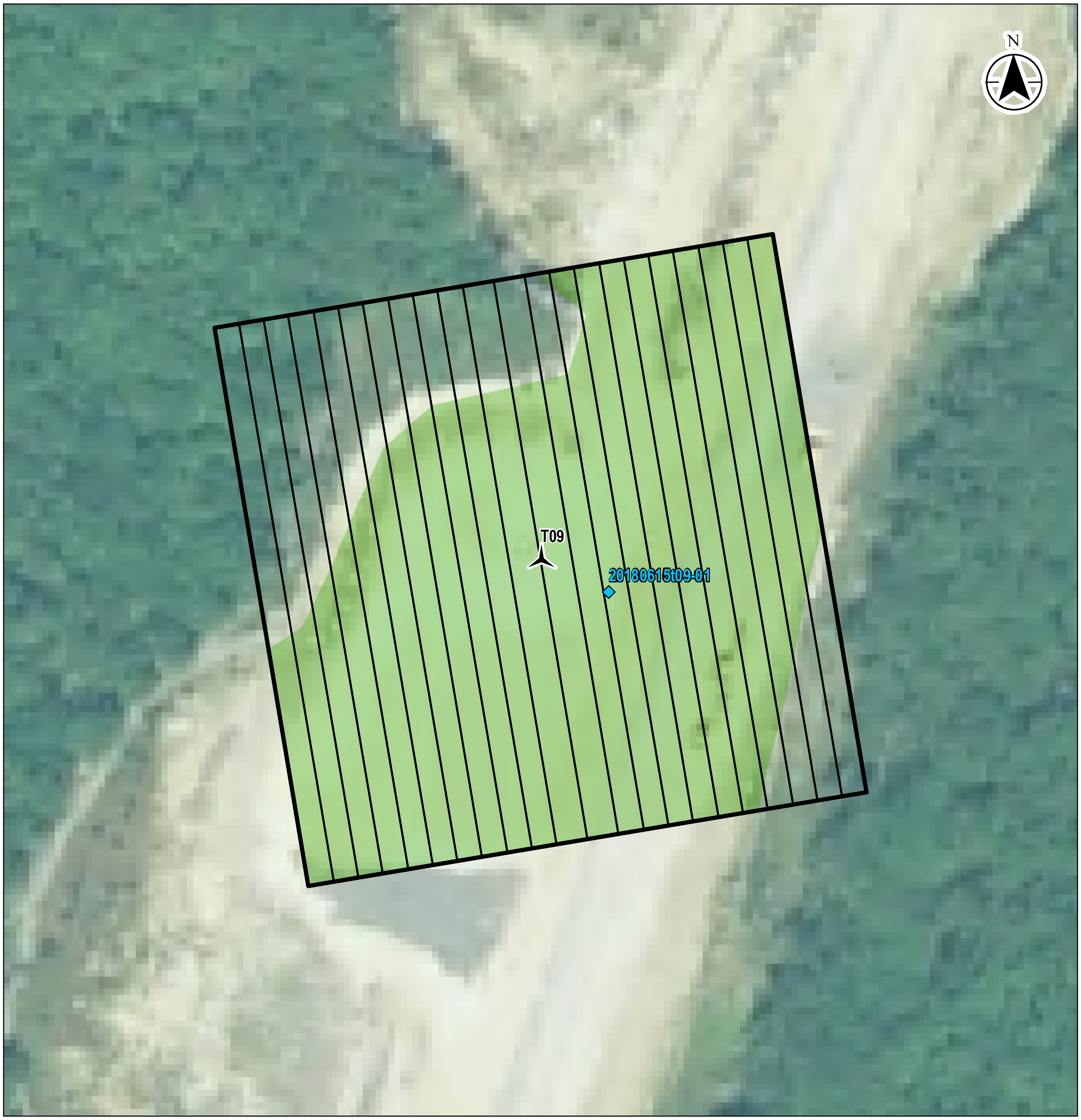

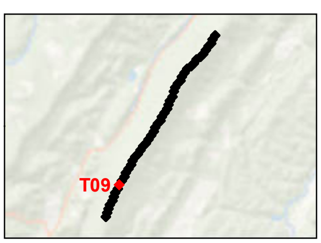

Legend

- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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Client/Project
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Figure No.
9

Title
Turbine 9 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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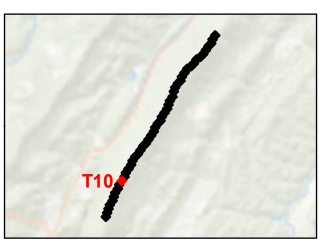

Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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Client/Project
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Figure No.
10

Title
Turbine 10 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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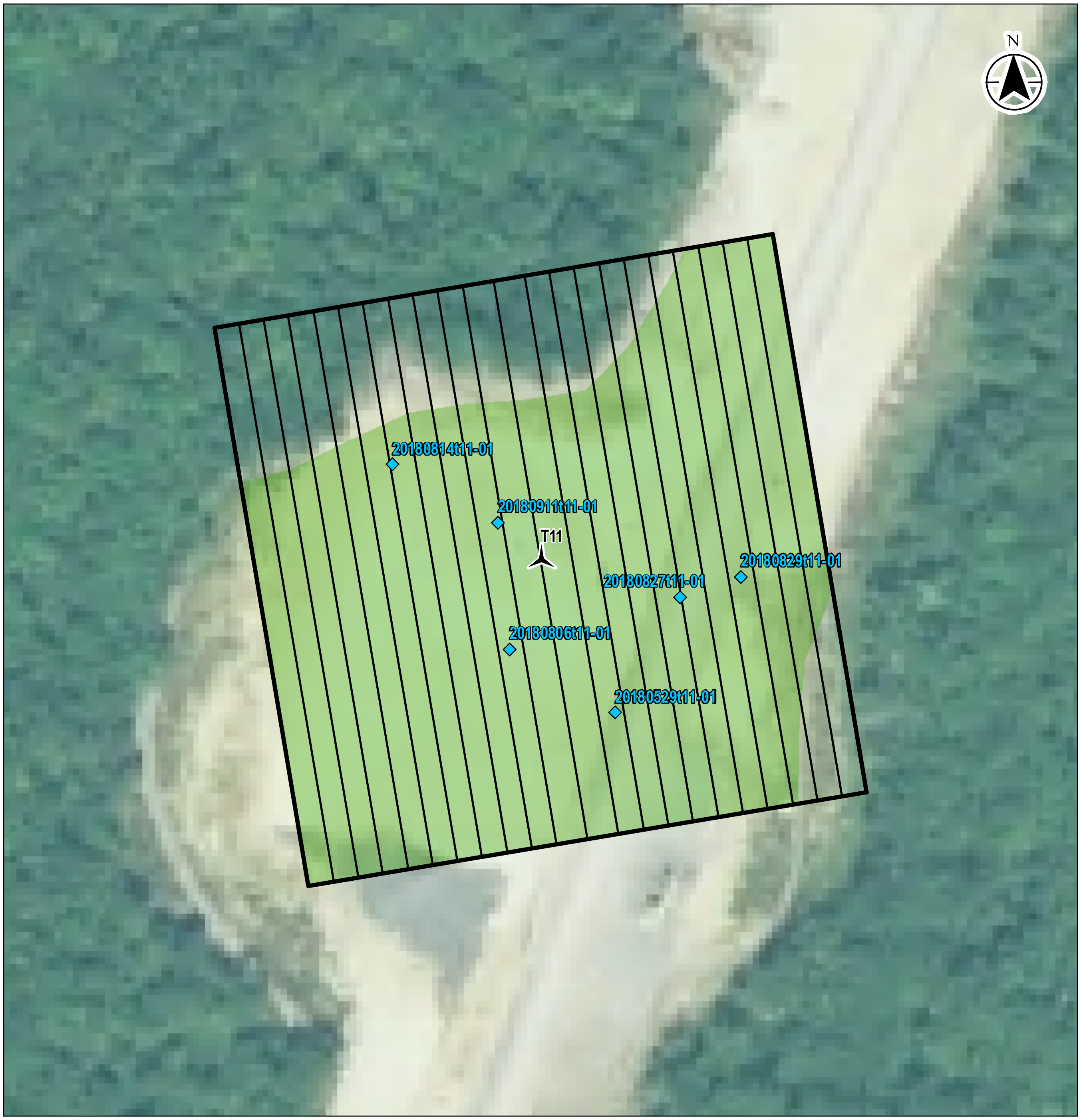

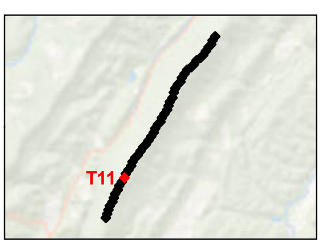

Legend
- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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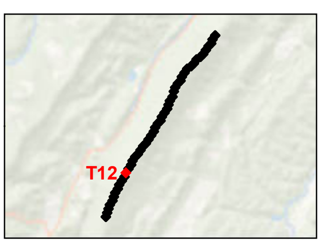
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
11

Title
Turbine 11 Search Area



Legend

- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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New Creek Wind Energy Project
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Figure No.
12

Title
Turbine 12 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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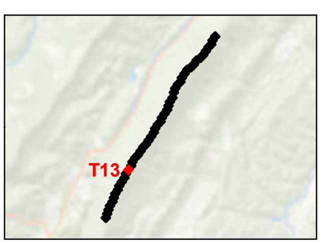

Legend

- Bat Carcass Location
- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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Feet
1:960 (at original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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2018 Post-Construction Survey

Figure No.
13

Title
Turbine 13 Search Area

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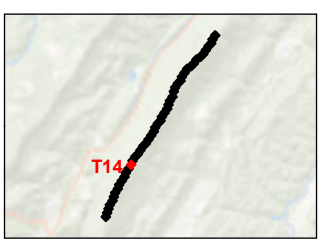

Legend

- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

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Client/Project
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New Creek Wind Energy Project
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Figure No.
14

Title
Turbine 14 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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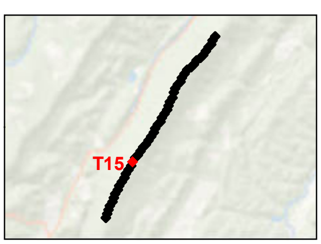

Legend

- Bat Carcass Location
- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

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Project Location
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New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
15

Title
Turbine 15 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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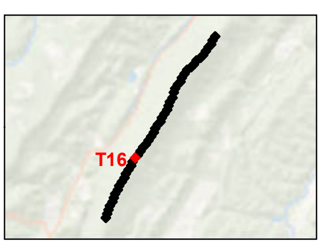

Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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Stantec

Project Location 195601490
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Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
16

Title
Turbine 16 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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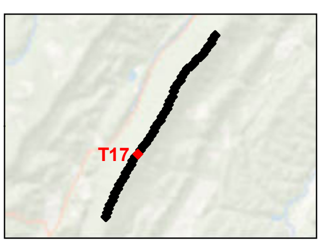

Legend

- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

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Client/Project
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2018 Post-Construction Survey

Figure No.
17

Title
Turbine 17 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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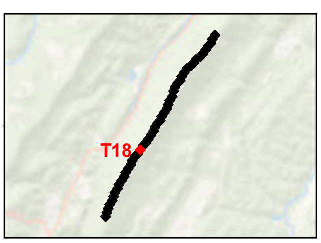

Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
18

Title
Turbine 18 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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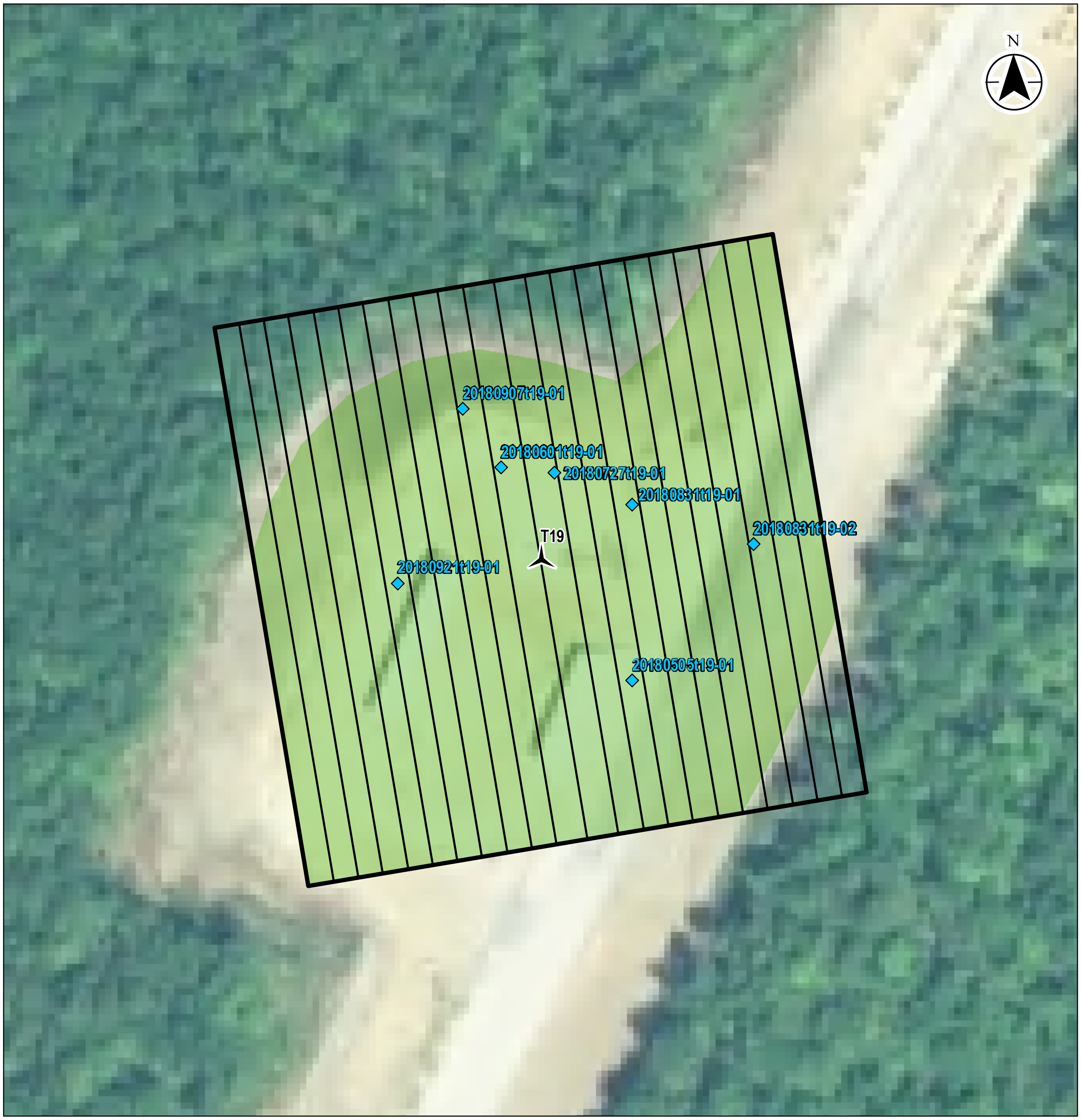

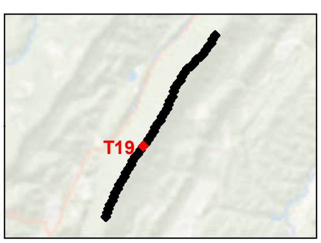

Legend
- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location: Grant County, West Virginia
195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
19

Title
Turbine 19 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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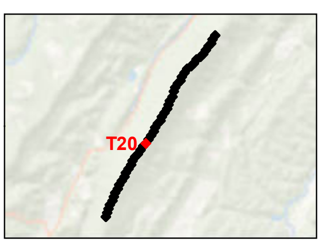


Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

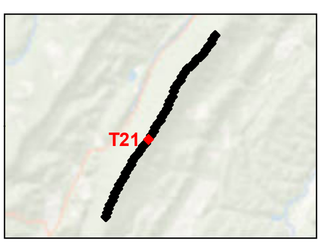
195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
20

Title
Turbine 20 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).



Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80
Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
21

Title
Turbine 21 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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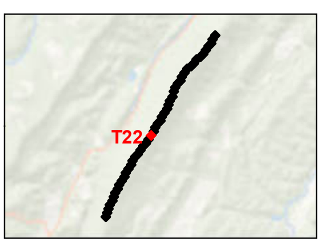


Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

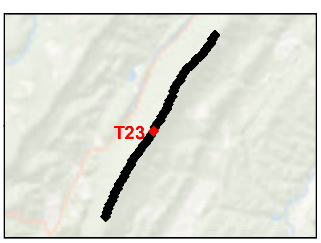
195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
22

Title
Turbine 22 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).



Legend

- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80
Feet

1:960 (at original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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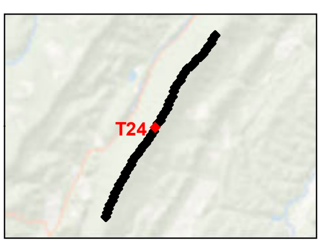
Project Location 195601490
Grant County, West Virginia
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
23

Title
Turbine 23 Search Area

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack



Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

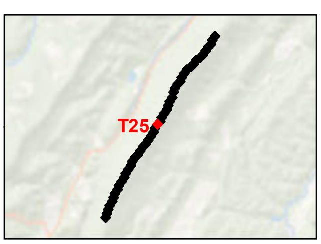
195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
24

Title
Turbine 24 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).



Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
25

Title
Turbine 25 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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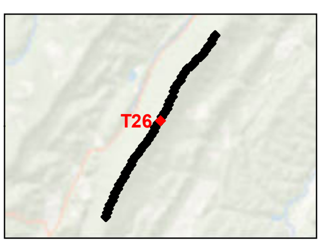


Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

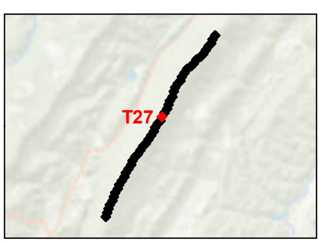
195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
26

Title
Turbine 26 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).



Legend
- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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Project Location 195601490
Grant County, West Virginia
Prepared by REM on 2019-01-07
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Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
27

Title
Turbine 27 Search Area

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack

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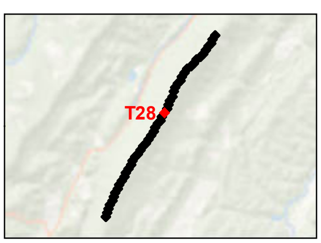

Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
28

Title
Turbine 28 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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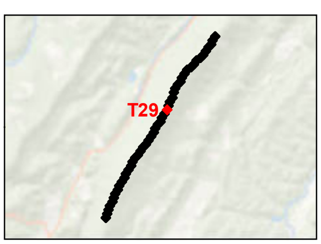

Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
29

Title
Turbine 29 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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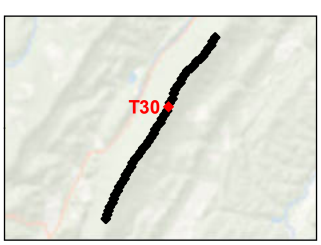

Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80
Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia
195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
30

Title
Turbine 30 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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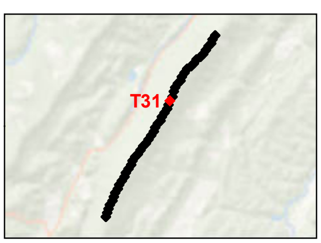


Legend

- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

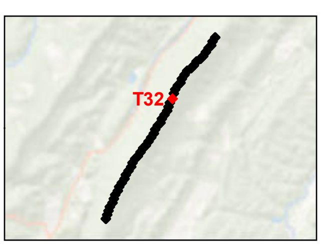
Project Location 195601490
Grant County, West Virginia
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
31

Title
Turbine 31 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).



Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location 195601490
Grant County, West Virginia
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
32

Title
Turbine 32 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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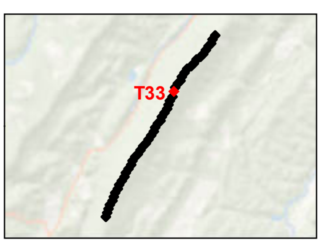


Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location: Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

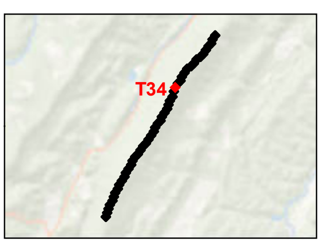
Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
33

Title
Turbine 33 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack



Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

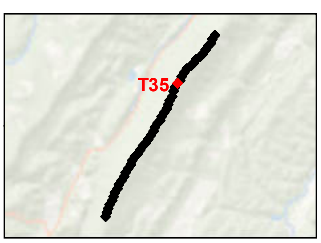
Project Location 195601490
Grant County, West Virginia
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
34

Title
Turbine 34 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).



Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
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Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
35

Title
Turbine 35 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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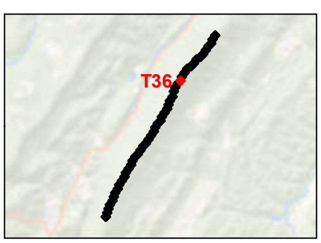

Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location 195601490
Grant County, West Virginia
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
36

Title
Turbine 36 Search Area

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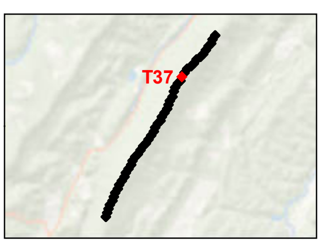

Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

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Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
37

Title
Turbine 37 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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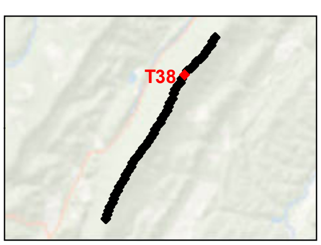

Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
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Stantec

Project Location
Grant County, West Virginia

195601490
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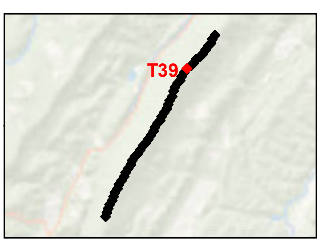
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
38

Title
Turbine 38 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).



Legend
- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location 195601490
Grant County, West Virginia
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Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

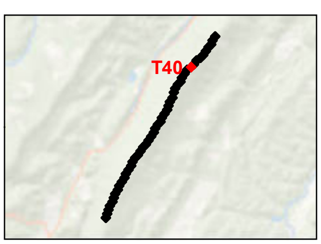
Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
39

Title
Turbine 39 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack



Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

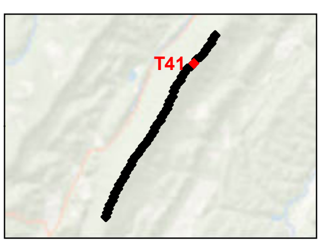
Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
40

Title
Turbine 40 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack



Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location 195601490
Grant County, West Virginia
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
41

Title
Turbine 41 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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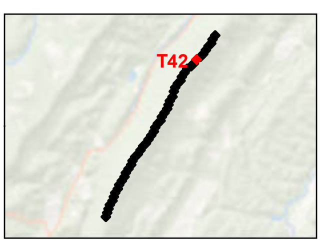

Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
42

Title
Turbine 42 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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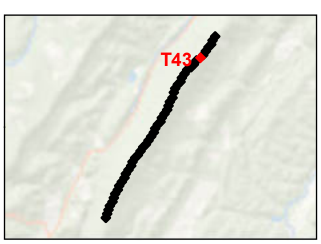

Legend
- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
43

Title
Turbine 43 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

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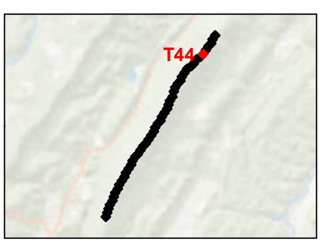


Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

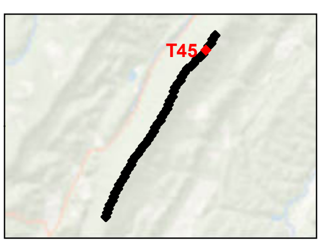
Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
44

Title
Turbine 44 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd   Revised: 2019-01-31 By: rmack



Legend

- Bat Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

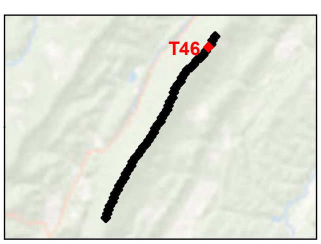
Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
45

Title
Turbine 45 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack



Legend
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet
1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

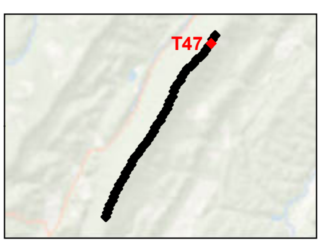
Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
46

Title
Turbine 46 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack



Legend
- Bird Carcass Location
- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

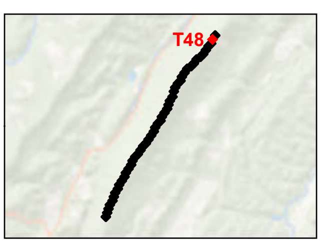
Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
47

Title
Turbine 47 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd   Revised: 2019-01-31 By: rmack



Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
Quality Review by KWH on 2019-01-08
Technical Review by TSP on 2019-01-21

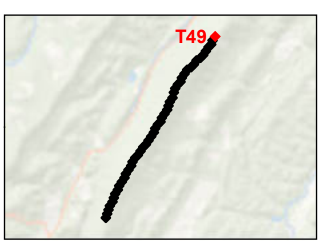
Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
48

Title
Turbine 48 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

V:\1956\active\195601490\03_data\gis_cad\gis\MXDs\AvianBat\PCM\01490_01_CarcassLocations.mxd Revised: 2019-01-31 By: rmack



Legend

- Turbine Location
- Survey Transect
- Survey Grid Area
- Search Area

0 80 Feet

1:960 (at original document size of 8.5x11)

Stantec

Project Location
Grant County, West Virginia

195601490
Prepared by REM on 2019-01-07
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Client/Project
New Creek Wind, LLC
New Creek Wind Energy Project
2018 Post-Construction Survey

Figure No.
49

Title
Turbine 49 Search Area

Notes
1. Coordinate System: NAD 1983 UTM Zone 17N
2. Orthoimagery: NAIP 2016
3. Survey grid area and carcass azimuths measured from magnetic north (approximate declination 9.603°).

APPENDIX E PUBLICLY AVAILABLE FATALITY ESTIMATES FOR WEST VIRGINIA WIND PROJECTS

Site	Year	Dataset	Survey Period	Estimated Bat Fatality (per turbine)	Estimated Bird Fatality (per turbine)	Search Interval	Estimator	Curtailment	Reference
Mount Storm	2008	2008 (daily)	July 18 - October 17	24.21	3.81	daily	Erickson	None	Young, D.P., W.P. Erickson, K. Bay, S. Normani, W. Tidhar. 2009. Mount Storm Wind Energy Facility, Phase 1: Post-construction Avian and Bat Monitoring. Prepared for: NedPower Mount Storm, LLC.
Mount Storm	2008	2008 (weekly)	July 18 - October 17	7.76	2.41	weekly	Erickson	None	Young, D.P., W.P. Erickson, K. Bay, S. Normani, W. Tidhar. 2009. Mount Storm Wind Energy Facility, Phase 1: Post-construction Avian and Bat Monitoring. Prepared for: NedPower Mount Storm, LLC.
Mount Storm	2009	2009 (daily)	March - June; July - October	28.6	8.7	daily	Erickson	None	cited in Young, D., C. Nations, M. Lout, and K. Bay. 2013. 2012 Post-construction Monitoring Study Criterion Wind Project Garrett County, Maryland
Mount Storm	2010	2010 (daily)	April - July; July - October	32.4	6.7	daily	Erickson	None	cited in Young, D., C. Nations, M. Lout, and K. Bay. 2013. 2012 Post-construction Monitoring Study Criterion Wind Project Garrett County, Maryland
Mount Storm	2011	2011 (daily)	July 16 - October 15	14.9	8	daily	Erickson	Seasonally Variable	cited in Young, D., C. Nations, M. Lout, and K. Bay. 2013. 2012 Post-construction Monitoring Study Criterion Wind Project Garrett County, Maryland
Mountaineer	2003	2003 (2x week)	April 4 - November 11	47.53	4.04	2x per week	Shoenfeld	None	Kerns, J., and P. Kerlinger. 2004. A study of bird and bat collision fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia, USA: annual report for 2003.
Pinnacle	2012	2012 (weekly)	March 1 - November 30	96.47	9.58	weekly	unknown	None	Hein, C.D., A. Prichard, T. Mabee, M.R. Shirmacher. 2013. Avian and Bat Post-construction Monitoring at the Pinnacle Wind Farm, Mineral County, West Virginia, 2012. Prepared for Edison Mission Energy.
Laurel Mountain	2012	2012 curtailed (3-day)	August 15 - October 31, 2011; April 1 - July 31, 2012	6.6	5.3	3-day	Shoenfeld	4.5 m/s	Stantec. 2013. Fall 2011 and Spring/Summer 2012 Post-construction Monitoring Data Report for the Laurel Mountain Wind Energy Project in Randolph and Barbour Counties, West Virginia. Prepared for AES Laurel Mountain Wind, LLC.
Laurel Mountain	2012	2012 control (3-day)	August 15 - October 31, 2011; April 1 - July 31, 2012	23.4	9	3-day	Shoenfeld	None	Stantec. 2013. Fall 2011 and Spring/Summer 2012 Post-construction Monitoring Data Report for the Laurel Mountain Wind Energy Project in Randolph and Barbour Counties, West Virginia. Prepared for AES Laurel Mountain Wind, LLC.
Laurel Mountain	2013	2013 (3-day)	April 1 - November 15	1.4	3.4	3-day	Shoenfeld	Seasonally Variable	Stantec. 2015. 2014 Bird and Bat Post-construction Monitoring Report - Laurel Mountain Wind Energy Project
Laurel Mountain	2014	2014 (3-day)	April 1 - November 15	1.9	4.9	3-day	Shoenfeld	Seasonally Variable	Stantec. 2015. 2014 Bird and Bat Post-construction Monitoring Report - Laurel Mountain Wind Energy Project
Laurel Mountain	2015	2015 (3-day)	April 1 - November 15	2.1	2.5	3-day	Shoenfeld	Seasonally Variable	Stantec. 2016. 2015 Bird and Bat Post-construction Monitoring Report - Laurel Mountain Wind Energy Project
New Creek	2017	2017 (weekly)	April 17 - November 15	2.63	1.02	weekly	Huso	Seasonally Variable	Stantec. 2018. New Creek Wind Project 2017 Post-construction Monitoring. Prepared for New Creek Wind, LLC.