Appendix F: Bat Resources Reports for Beech Ridge Wind Energy Project

Report F-1. Mist Net Surveys at the Proposed Beech Ridge Wind Farm, Greenbrier County, West Virginia (BHE 2005)

Report F-2. Chiropteran Risk Assessment, Proposed Beech Ridge Wind Energy Generation Facility, Greenbrier and Nicholas Counties, West Virginia (BHE 2006)

Report F-3. Bat Mist Netting and Acoustic Surveys, Beech Ridge Wind Energy Project, Greenbrier and Nicholas Counties, West Virginia (Young and Gruver 2011)

Report F-4. 2012 Post-Construction Carcass Monitoring Study for the Beech Ridge Wind Farm, Greenbrier County, West Virginia, Final Report, April 1 – October 28, 2012 (Tidhar et al. 2013)

Report F-5. Revision of Take Estimate for Beech Ridge Energy Permit (USFWS 2013b)

PN 1664.004 August 2005

MIST NET SURVEYS
AT THE PROPOSED BEECH RIDGE WIND FARM
GREENBRIER COUNTY, WEST VIRGINIA

Prepared for:
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A. Mist Netting Survey Guidelines from the Indiana Bat Recovery Plan

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1.0 INTRODUCTION

Invenergy Wind LLC has proposed construction of a 200 MW wholesale wind energy generation facility along approximately 23 miles of forested Appalachian Mountain ridgelines in Greenbrier County, West Virginia (Figure 1). Invenergy Wind LLC contracted BHE Environmental, Inc. to investigate the summer presence of bats within the Beech Ridge project area. Pursuant to recommendations made by the U.S. Fish and Wildlife Service (USFWS), fifteen sites were surveyed using mist nets between July 22 and July 26, 2005. Seventy-eight bats of six species were captured during this survey. Two additional bats were captured in nets but escaped before being identified. No federally listed species were captured.

2.0 BATS OF THE BEECH RIDGE PROJECT AREA

Thirteen species of bats inhabit West Virginia (Table 1). Except for the gray bat (*Myotis grisescens*), Rafinesque's big eared bat (*Corynorhinus rafinesquii*), and the evening bat (*Nycticieus humeralis*), each of the species has potential to occur in the project area.

West Virginia is generally considered to be outside the range of gray bats (BCI 2005a, WVDNR 2005). There is one record of two gray bats in Hellhole Cave in Pendleton County, which is located two counties north of Greenbrier County (WVDNR 2005, Garton et al. 1993), but there are no other summer or winter records of the species in West Virginia.

The Rafinesque's big-eared bat is also rare in West Virginia. It has been recorded in Fayette (immediately west of Greenbrier County) and Wayne (the westernmost county in West Virginia) counties (Natureserve 2005) and in Collison Cave in Nicholas County (immediately northwest of Greenbrier County) (Garton et al. 1993). However, records are limited to very few individuals.

The evening bat is classified by the WVDNR as SH, historically present in the state. Some range maps for the species exclude West Virginia, with records of the species in the state considered isolated or questionable (BCI 2005b).

The other 10 bat species in West Virginia include year-round residents as well as species present only during certain seasons (Table 1). The Indiana bat (*M. sodalis*) and Virginia big-eared bat (*C. townsendii virginianus*) are federally listed as endangered. Eight species are not federally listed, are not proposed for listing, and are not Candidate species. Although the West Virginia Nongame Wildlife and Natural Heritage Program (NWNHP) tracks populations of rare species, the state of West Virginia does not list species as threatened or endangered, and does not provide special protection to rare species.

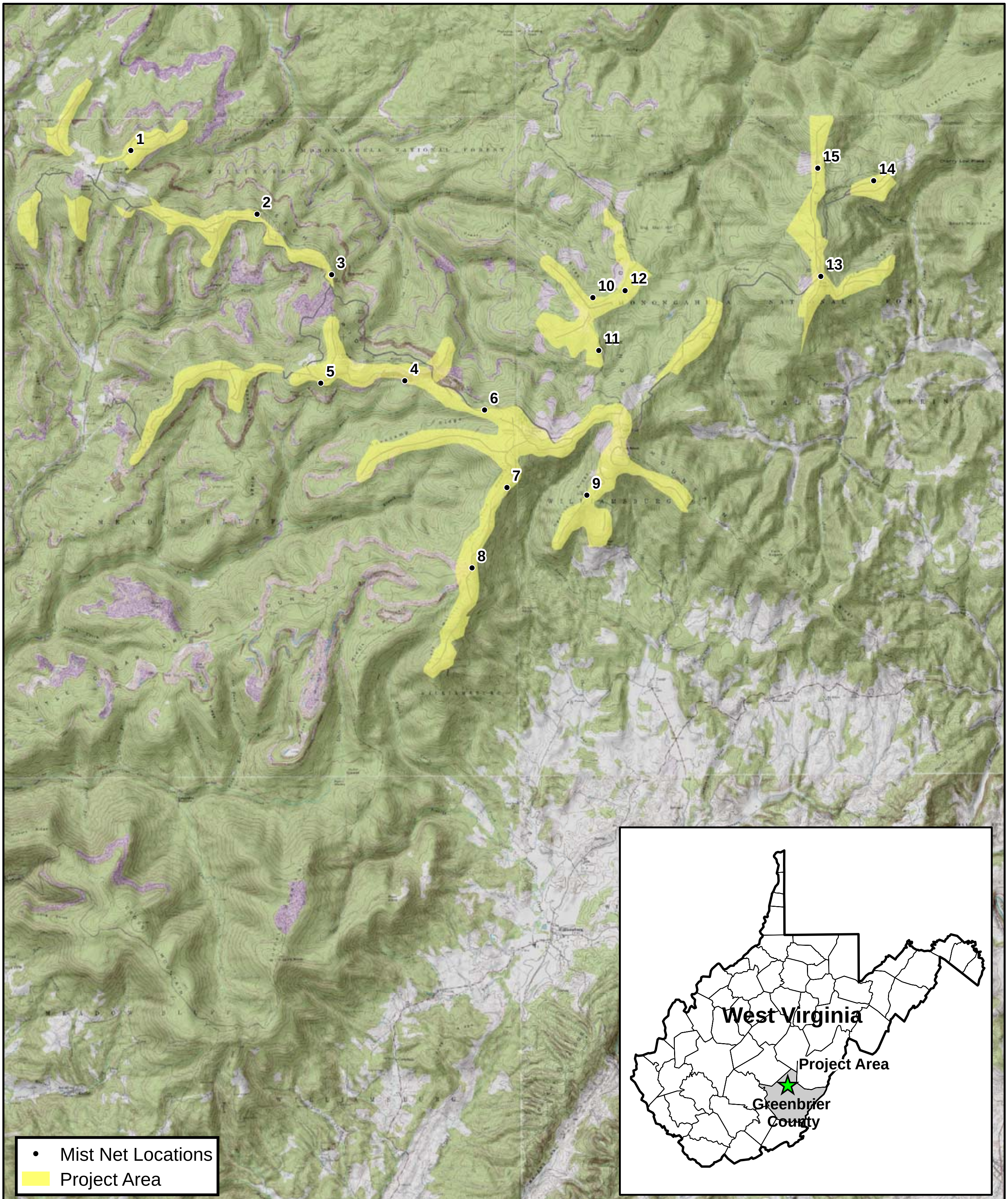

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Figure 1. Locations of fifteen mist net sites at the proposed Beech Ridge wind farm project area, Greenbrier County, West Virginia.

August 2005

Project No. 1664.004

Miles
0.875 0 0.875 1.75

Base Map: 7.5 Minute USGS Topographic Map - Cornstalk, WV, Duo, WV, Fork Mountain, WV, Richwood, WV, Trout, WV, and Williamsburg, WV.

BHE ENVIRONMENTAL

Table 1. Bats potentially present in West Virginia and in the Beech Ridge project area during summer, winter, and spring/fall migration.

Species	**Status**	**Potential Seasonal Presence within Beech Ridge Project Area**			**Identified in Greenbrier County?***
		Summer	**Winter**	**Migration**	
Indiana bat (*Myotis sodalis*)	Federal: endangered WV: S1	Yes	No	Yes	Winter
Virginia big-eared bat (*Corynorhinus townsendii virginianus*)	Federal: endangered WV: S2	Yes	No	Yes**	No
Northern long-eared bat (*Myotis septentrionalis*)	None	Yes	No	Yes	Summer, winter
Eastern small-footed bat (*Myotis lebii*)	Federal: none WV: S1	Yes	Yes	Yes	Summer, winter
Little brown bat (*Myotis lucifugus*)	None	Yes	No	Yes	Summer, winter
Eastern pipistrelle (*Pipistrellus subflavus*)	None	Yes	Yes	Yes	Summer, winter
Big brown bat (*Eptesicus fuscus*)	None	Yes	Yes	Yes**	Summer, winter
Eastern red bat (*Lasiurus borealis*)	None	Yes	Yes	Yes	Summer
Hoary bat (*Lasiurus cinereus*)	None	Yes	Unlikely	Yes	Summer
Silver-haired bat (*Lasyonycteris noctivagans*)	Federal: none WV: S2	No	Yes	Yes	Winter
Gray bat (*Myotis grisescens*)	Federal: endangered WV: SA	No	No	No	No
Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)	Federal: none WV: S1	No	No	No	No
Evening bat (*Nycticeius humeralis*)	Federal: none WV: SH	Unlikely	No	Unlikely	No

*Absence of records in the county likely reflects survey effort and does not indicate absence of the species.
**Species is not migratory, but may be present during spring and fall.
West Virginia NWNHP Rank:

S1 = Five or fewer documented occurrences, or very few individuals remaining in the state. Extremely rare and critically imperiled, or because of factor(s) making the species vulnerable to extirpation.
S2 = Six to twenty documented occurrences, or few individuals remaining in the state. Very rare and imperiled, or ranked because of factor(s) making the species vulnerable to extirpation.
SH = Historically present in the state, not relocated in past 20 years, may be rediscovered.

3.0 METHODS

3.1 SITE SELECTION

Mist net sites were selected during field reconnaissance; site selection was based primarily upon extent of canopy cover and presence of an open flyway. Nets were deployed in areas that provided optimum chance to capture foraging bats (Figure 1).

3.2 MIST NETTING

Mist netting was conducted from July 22-26, 2005, and followed Indiana Bat Recovery Plan guidelines (USFWS 1999, Appendix A). As agreed to in a conversation and subsequent email exchange between BHE and Mr. Frank Pendelton (USFWS, Elkins Field Office), mist nets were to be deployed at fifteen sites within the project area.

Mist net sizes ranged from approximately 20 to 30 ft in height, and were 18 to 42 ft wide with one exception: a third net set was erected at Site No. 13 and measured 10 ft wide by 9 ft high. A net set consisted of two or three nets suspended (horizontally) between two poles. The nets were tiered and raised and lowered with a pulley system (Gardner et al. 1989). Two net sets were erected, and spaced at least 100 ft apart, at fourteen sites. The two net sets were operated for two calendar nights at these fourteen sites, resulting in a total of four net nights for each site surveyed (four net nights per site x fourteen sites = 56 net nights). At Site No. 13, three net sets were operated for two calendar nights, resulting in six net nights. The total for all fifteen sites was 62 net nights of survey. A "net night" is defined as the operation of one net set for one night.

Mist nets were of 2-ply, 50-denier, nylon construction with a mesh size of no larger than 1.5 inches. Hardware (metal poles, pulleys and ropes) similar to that described in Gardner et al. (1989) was used to suspend the nets across flight corridors. Nets were placed so that canopy cover and vegetation created a funneling effect to facilitate capture of bats to the maximum extent practicable. Mist nets were deployed at dusk (approximately 2100 hours) and monitored every 20 minutes for at least five hours from deployment. Temperature, wind speed and direction, percent cloud cover, and moon phase (if visible) typically were recorded approximately every hour during the survey. A standard mercury thermometer was used to record temperature. Wind speed, percent cloud cover, and moon phase were estimated.

3.3 BAT HANDLING PROCEDURES

Upon capture, bats were removed from the nets, identified to species, weighed, measured, and released unharmed at the capture site. The following data were recorded for each bat captured: species, age, sex, reproductive condition, right forearm length

(RFA; to nearest 0.1 millimeter using Vernier calipers), weight (to nearest half gram, using a Pesola® scale), time of capture, and capture height in net. All bats were identified to species based upon distinctive morphological characteristics (e.g., body size, hair color, ear length, tragus shape, presence/absence of a keeled calcar). Adult female bats were classified as reproductive if they were pregnant (determined by palpation of abdomen) or bore signs of nursing young (i.e., lack of hair surrounding the teats). Male bats whose testes were descended into the scrotum were considered reproductive.

4.0 RESULTS

4.1 SITE DESCRIPTIONS

The Beech Ridge project area lies at an average elevation of 3,800 feet above msl and is largely forested, with notable exceptions being corridors cleared for roads. Mist nets were placed in the best available locations within the project area boundary. In most instances, nets were placed across small roads or trails. No stream corridors were present within the ridgeline project area.

Pursuant to conversations with Mr. Frank Pendleton (USFWS, Elkins Field Office) BHE placed mist net sites in areas that 1) provided optimum chance to capture foraging bats, and 2) were distributed as evenly as practicable across the Beech Ridge project area to provide results representative for the entire area (Table 2). Photographs of all net sites are provided in Appendix B.

4.2 BATS CAPTURED

A total of 78 bats (excluding two individuals which escaped before they could be identified), representing six species, was captured at fifteen sites within the project area during 62 net nights of survey between July 22 and July 26, 2005 (Tables 2 and 3). Bats were captured at twelve of fifteen sites; no bats were captured at Site Nos. 4, 5, and 15. The following species were captured:

- little brown bats (*Myotis lucifugus*, n = 22; 28%),
- big brown bats (*Eptesicus fuscus*, n = 17; 22%),
- red bats (*Lasiurus borealis*, n = 13; 16%),
- eastern pipistrelles (*Pipistrellus subflavus*, n = 10; 13%),
- northern long-eared bats (*Myotis septentrionalis*, n = 10 ; 13%), and
- hoary bats (*Lasiurus cinerius*, n = 6; 8%).

No federally listed species were captured during the survey.

Table 2. Description of fifteen mist net sites surveyed at the Beech Ridge project area between July 22 – July 26, 2005.

Mist Net Site No.	Dates Surveyed (2005)	Net Placement	Percent Canopy Closure		Dominant Overstory Species	Dominant Understory Species
			Net Set No. 1	Net Set No. 2		
1	25 Jul– 26 Jul	Two net sets placed over gravel access road	30	10	sugar maple (*Acer saccharum*) paper birch (*Betula papyrifera*) American beech (*Fagus grandifolia*)	sugar maple American beech striped maple (*A. pensylvanicu*m)
2	23 Jul– 24 Jul	Two net sets placed over gravel access road	50	30	sugar maple red maple (*A. rubrum*) northern red oak (*Quercus rubra*)	sugar maple American basswood (*Tilia americana*) sweet birch (*B. lenta*)
3	22 Jul– 23 Jul	Two net sets placed over dirt-covered trail	40	40	sugar maple American beech American elm (*Ulmus americana*)	American beech American basswood black locust (*Robinia pseudoacacia*)
4	23 Jul– 24 Jul	Two net sets placed over upland road	20	20	black locust red pine (*Pinus resinosa*) pin cherry (*Prunus pensyvanica*)	black locust autumn olive (*Eleagnus umbellate*) pin cherry
5	23 Jul– 24 Jul	Two net sets placed over logging road	40	50	sugar maple red maple black cherry (*P. serotina*)	sugar maple red maple black locust
6	23 Jul– 24 Jul	Two net sets placed over upland road	80	80	sugar maple northern red oak American beech	sugar maple American beech yellow birch (*B. allegheniensis*)
7	23 Jul– 24 Jul	Two net sets placed over gravel road	70	70	red maple northern red oak yellow birch	striped maple red maple northern red oak yellow birch
8	24 Jul– 25 Jul	Two net sets placed over gravel road	70	70	red maple northern red oak yellow birch	red maple striped maple northern red oak yellow birch

Mist Net Site No.	Dates Surveyed (2005)	Net Placement	Percent Canopy Closure		Dominant Overstory Species	Dominant Understory Species
9	24 Jul-26 Jul	One net set placed over gravel road; second net set placed over logging road	20-30	20-30	sugar maple yellow birch black locust northern red oak	elderberry (*Sambucus canadensis*) witch hazel (*Hamamelis virginia*) smooth sumac (*Rhus glabra*)
10	24 Jul-25 Jul	Two net sets placed over upland road	80	70	pin cherry striped maple yellow birch	sugar maple American beech tulip poplar (*Liriodendron tulipifera*)
11	25 Jul-26 Jul	Two net sets placed over upland road	20	20	pin cherry sweet birch black locust sugar maple	sweet birch pin cherry sweet maple black locust
12	25 Jul-26 Jul	One net set placed near upland road; second net set placed over gravel road	95	20	sugar maple red maple northern red oak black locust	sugar maple northern red oak black locust staghorn sumac (*R. typhinia*)
13	25 Jul-26 Jul	One net set placed over gravel road; second net set placed over logging road; third net set placed over waterhole	0-70	0-70 at Net Set Nos. 2 and 3	sugar maple northern red oak Allegheny blackberry (*Rubus allegheniensis*) yellow birch	elderberry Allegheny blackberry smooth sumac
14	25 Jul-26 Jul	Two net sets placed over gravel road	10	10	northern red oak red maple big leaf magnolia (*Magnolia macrophylla*)	striped maple pin cherry yellow birch
15	25 Jul-26 Jul	Two net sets placed over wooded trail	75	75	sugar maple red maple yellow birch	red maple yellow birch striped maple mountain maple (*A. spicatum*)

During the survey, air temperatures were within seasonal norms and met the criteria prescribed by the Indiana Bat Recovery Team for conducting mist net surveys. Nightly lows ranged from 50 to approximately 70°F. Occasional light rain fell in the early evening of July 25, but did not interfere with mist netting. Sky conditions were otherwise clear to partly cloudy during the survey.

5.0 DISCUSSION

BHE conducted a mist net survey of the Beech Ridge project area using methods prescribed by the Indiana Bat Recovery Team, at a level of effort recommended by the USFWS for investigating presence of bats within the proposed Beech Ridge wind farm project area. Timing of the survey and conditions in the field were appropriate for investigating presence of bats during the summer. No federally listed species were captured during the survey. Six species, all expected to occur in West Virginia, were captured during the survey. A description of each of these species can be found in the *Chiropteran Risk Assessment: Proposed Beech Ridge Wind Energy Generation Facility, Greenbrier County, West Virginia* (BHE Environmental, Inc 2005).

Capture of reproductively active female and/or juveniles of the following species suggests these species may occupy maternity roosts within or near the project area: little brown bats, big brown bats, eastern pipistrelles, northern long-eared bats, and hoary bats. No juvenile or female eastern red bats were captured during the survey.

Hoary bats and eastern red bats, species which roost in trees, made up approximately 24% of the total bat capture.

Table 3. Bat species captured during the mist net survey of fifteen sites at the proposed Beech Ridge project area, Greenbrier County, West Virginia from July 22–26, 2005.

Species	Juvenile	Adult Male	Adult Female			ESC	Total
			PL	L	NR		
Little brown bat (*Myotis lucifugus*)	4	12	3	0	2	1	22
Northern long-eared bat (*Myotis septentrionalis*)	4	4	2	0	0	0	10
Eastern pipistrelle (*Pipistrellus subflavus*)	1	8	0	0	0	1	10
Big brown bat (*Eptesicus fuscus*)	2	9	4	0	0	2	17
Hoary bat (*Lasiurus cinereus*)	2	3	0	1	0	0	6
Red bat (*Lasiurus borealis*)	0	7	0	0	0	6	13
Unknown	0	0	0	0	0	2	2
Total	13	43	9	1	2	12	80

Abbreviations: post-lactating (PL), lactating (L), non-reproductive (NR), and escaped (ESC)

Table 4. Sites, dates, number of species, and total number captured per site, at the Beech Ridge project area from July 22-26, 2005.

Site	Dates (2005)	Little brown bat (*Myotis lucifugus*)	Northern long eared bat (*Myotis septentrionalis*)	Eastern pipistrelle (*Pipistrellus subflavus*)	Big brown bat (*Eptesicus fuscus*)	Hoary bat (*Lasiurus cinereus*)	Red bat (*Lasiurus borealis*)	Unknown	Total
1	25 Jul–26 Jul	4	1	1	4	0	2	0	12
2	23 Jul–24 Jul	1	0	2	1	0	1	0	5
3	22 Jul–23 Jul	2	3	0	0	0	0	1	6
4	23 Jul–24 Jul	0	0	0	0	0	0	0	0
5	23 Jul–24 Jul	0	0	0	0	0	0	0	0
6	23 Jul–24 Jul	1	0	1	2	0	1	0	5
7	23 Jul–24 Jul	1	0	1	3	0	3	0	8
8	24 Jul–25 Jul	2	0	1	2	0	0	0	5
9	24 Jul-26 Jul	2	1	2	1	0	5	0	11
10	24 Jul–25 Jul	3	1	1	0	0	0	0	5
11	25 Jul–26 Jul	3	2	0	4	4	1	1	15
12	25 Jul–26 Jul	1	0	1	0	1	0	0	3
13	25 Jul–26 Jul	2	1	0	0	0	0	0	3
14	25 Jul–26 Jul	0	1	0	0	1	0	0	2
15	25 Jul–26 Jul	0	0	0	0	0	0	0	0
	Total	22	10	10	17	6	13	2	80

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APPENDIX A

Mist Netting Survey Guidelines from the Indiana Bat Recovery Plan

GUIDELINES FOR MIST NETTING INDIANA BATS

These guidelines were prepared by the Indiana Bat Recovery Team and are presented in the Indiana Bat (*Myotis sodalis*) Revised Recovery Plan (USFWS 1999).

RATIONALE

A typical mist net survey is an attempt to determine presence or probable absence of the species; it does not provide sufficient data to determine population size or structure. Following these guidelines will standardize procedures for mist netting. It will help maximize the potential for capture of Indiana bats at a minimum acceptable level of effort. Although the capture of bats confirms their presence, failure to catch bats does not absolutely confirm their absence. Netting effort as extensive as outlined below usually is sufficient to capture Indiana bats. However, there have been instances in which additional effort was necessary to detect the presence of the species.

NETTING SEASON

15 May - 15 August
These dates define acceptable limits for documenting the presence of summer populations of Indiana bats, especially maternity colonies. Several captures, including adult females and young of the year, indicate that a nursery colony is active in the area. Outside these dates, even when Indiana bats are caught, data should be carefully interpreted. If only a single bat is captured, it may be a transient or migratory individual.

EQUIPMENT

Mist nets - Use the finest, lowest visibility mesh commercially available:

- In the past, this was 1 ply, 40 denier monofilament - denoted 40/1
- Currently, monofilament is not available and the finest on the market is 2 ply, 50 denier nylon - denoted 50/2
- Mesh of approximately 1.5 (1.25 - 1.75) inch

Hardware - No specific hardware is required. There are many suitable systems of ropes and/or poles to hold the nets. See NET PLACEMENT below for minimum heights, habitats, and other netting requirements that affect the choice of hardware. The system of Gardner, et al. (1989) has met the test of time.

NET PLACEMENT

Potential travel corridors such as streams or logging trails typically are the most effective places to net. Place the nets approximately perpendicular across the corridor. Nets should fill the corridor, side to side, and from stream (or ground) level up to the overhanging canopy. A typical set is seven meters high consisting of three or more nets "stacked" on top one another and up to 20 m wide. (Different width nets may be purchased and used as the situation dictates.) Occasionally, it may be desirable to net where there is no good corridor. Take caution to get the nets up into the canopy. The typical equipment described in the section above may be inadequate for these situations, requiring innovation on the part of the observers.

RECOMMENDED NET SITE SPACING

Stream corridors - 1 net site per kilometer of stream.
Non-corridor land tracts - 2 net sites per square kilometer of forested habitat.

MINIMUM LEVEL OF EFFORT

Netting at each site should consist of:

- At least three net nights (unless bats are caught sooner) (one net set up for one night = one net night)
- A minimum of 2 net locations at each site (at least 30 meters apart, especially in linear habitat such as a stream corridor)
- A minimum of 2 nights of netting
- Sample Period: begin at sunset and net for at least 5 hours
- Each net should be checked approximately every 20 minutes
- No disturbance near the nets, other than to check nets and remove bats

WEATHER CONDITIONS

Severe weather adversely affects capture of bats. If Indiana bats are caught during weather extremes, it is probably because they are at the site and active despite inclement weather. On the other hand, if bats are not caught, it may be that there are bats at the site but they may be inactive due to the weather. Negative results combined with any of the following weather conditions throughout all or most of a sampling period are likely to require additional netting:

- Precipitation
- Temperatures below 10ºC
- Strong winds (Use good judgement: moving nets are more likely to be detected by bats.)

MOONLIGHT

There is some evidence that small myotine bats avoid brightly lit areas, perhaps as predator avoidance. It is typically best to set nets under the canopy where they are out of the moon light, particularly when the moon is ½-full or greater.

APPENDIX B

Photographs of Mist Net Sites

Photo 1. Mist Net Site No. 1.

Photo 2. Mist Net Site No. 2.

Photo 3. Mist Net Site No. 3.

Photo 4. Mist Net Site No. 4.

Photo 5. Mist Net Site No. 5.

Photo 6. Mist Net Site No. 6.

Photo 7. Mist Net Site No. 7.

Photo 8. Mist Net Site No. 8.

Photo 9. Mist Net Site No. 9.

Photo 10. Mist Net Site No. 10.

Photo 11. Mist Net Site No. 11.

Photo 12. Mist Net Site No. 12.

Photo 13. Mist Net Site No. 13.

Photo 14. Mist Net Site No. 14.

Photo 15. Mist Net Site No. 15.

June 19, 2006
PN 1664.002.001

CHIROPTERAN RISK ASSESSMENT

PROPOSED BEECH RIDGE WIND ENERGY GENERATION FACILITY GREENBRIER AND NICHOLAS COUNTIES, WEST VIRGINIA

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APPENDIX

1.0 INTRODUCTION

Beech Ridge Energy LLC proposed construction of the 186 MW Beech Ridge wholesale wind energy generation facility along approximately 23 miles (37 km) of forested Appalachian Mountain ridgelines in Greenbrier County, West Virginia (Figure 1). The project will consist of a maximum of 124 1.5-MW turbines placed in a single row along Beech Ridge, Big Ridge, Cold Knob (but not on Cold Knob), Ellis Knob, Old Field, Nunly Mountain, Rockcamp Ridge, and Shellcamp Ridge, at an average elevation of approximately 3,800 ft (1160 meters) above msl. These ridgelines trend northwest-southeast, east-west, north-south, and northeast-southwest (Figure 2a). The project area is located approximately 5 miles (8 km) northwest of the town of Trout, approximately 7 miles (11 km) north-northwest of Williamsburg, and approximately 9 miles (14.5 km) northeast of downtown Rupert, West Virginia. In addition, a transmission line corridor 100 feet wide will extend approximately 8.4 miles (13.5 km) northwest from the turbine strings and into Nicholas County, West Virginia.

The primary easement zones for the turbine strings are owned entirely by MeadWestvaco. Alternative easement areas are under other/mixed ownership. Land use agreements have not been completed in alternate easement zones (Figure 2a). Approximately 6.5 miles (10.5 km) of this corridor are currently forested, and will be cleared of trees for construction of the transmission line (Figure 2b).

Each turbine would include an 80-meter (262 ft) (hub height) tubular tower, and a 77-meter (253 ft) diameter rotor that would turn at a typical operating speed of 17 rpm. Approximately one-third of turbines would be lit with red or white strobes as required by the Federal Aviation Administration. Lighting will be limited to the minimum required by the FAA.

Collisions between bats and manmade structures are well documented. Numerous impacts with television towers, other communication towers, large buildings, powerlines, and fences have been reported, but collisions with wind energy turbine blades appear to occur, in some instances, at much higher rates. Hypotheses concerning the reason(s) for these escalated collision rates were summarized in Arnett (2005):

Linear corridor hypothesis Many species of bats (especially red bats and hoary bats) are known to use linear corridors during migration and while foraging. Wind farms in forested regions can be developed along natural corridors such as ridge tops, or corridors are created when access roads are constructed. Risk of collisions may increase if bats use corridors where wind turbines are located.

Acoustic failure hypothesis Either migrating or foraging bats may fail to acoustically detect wind turbines, particularly moving blades. If the smooth cylindrical turbine masts are not detected by echolocating bats, bats may be killed by collisions with these structures. The functional range of echolocation by North American bats typically varies from 3–5 meters. Migrating bats flying at a velocity of 5 meters/second would have less than a second to respond to the presence of a wind turbine/turbine blade.

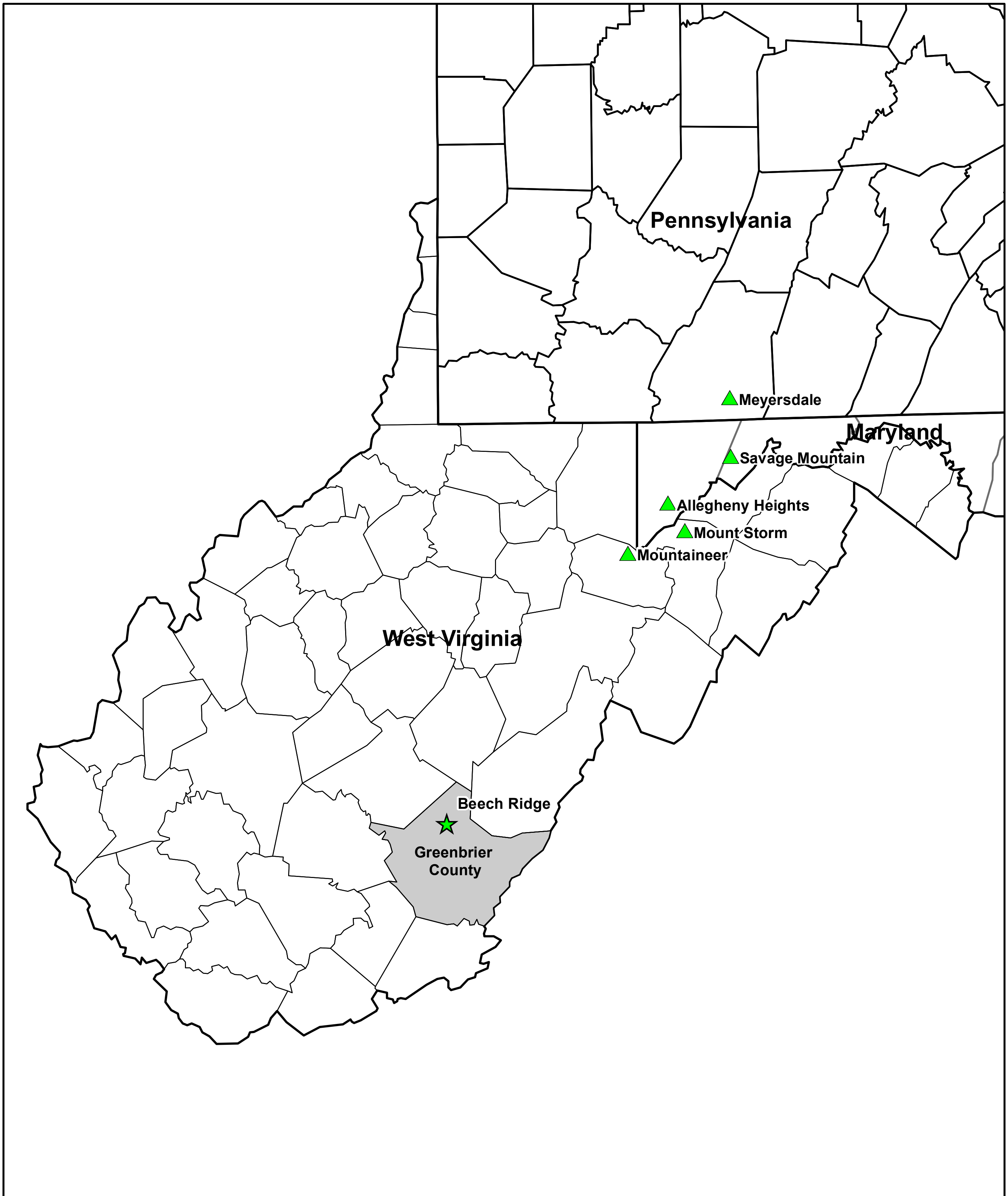

Figure 1: Allegheny Heights, Beech Ridge, Meyersdale, Mountaineer, Mt. Storm, and Savage Mountain Windfarms, Located in Pennsylvania and West Virginia.

Project No. 1664.002

June 2006

BHE ENVIRONMENTAL

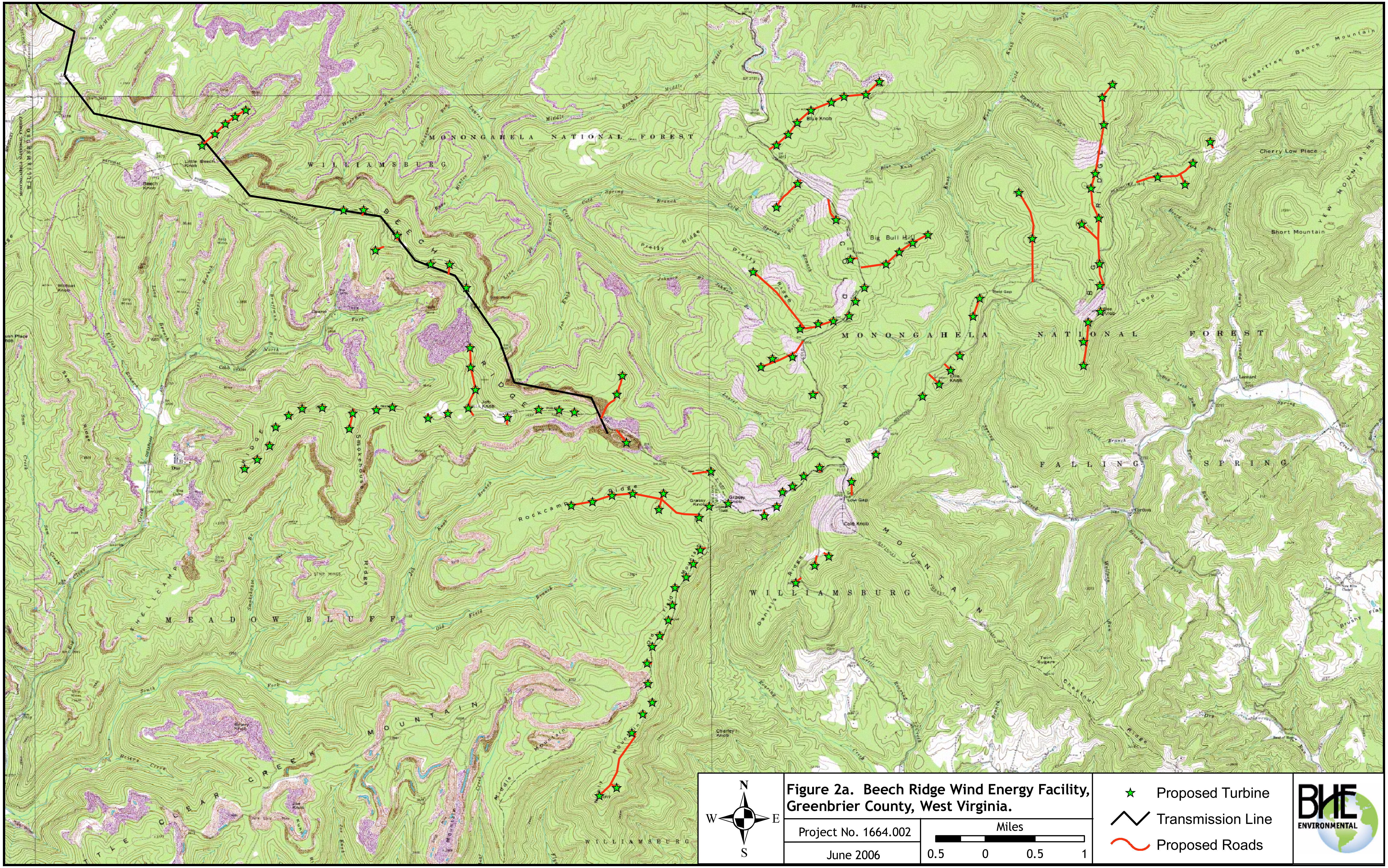

Figure 2a. Beech Ridge Wind Energy Facility, Greenbrier County, West Virginia.

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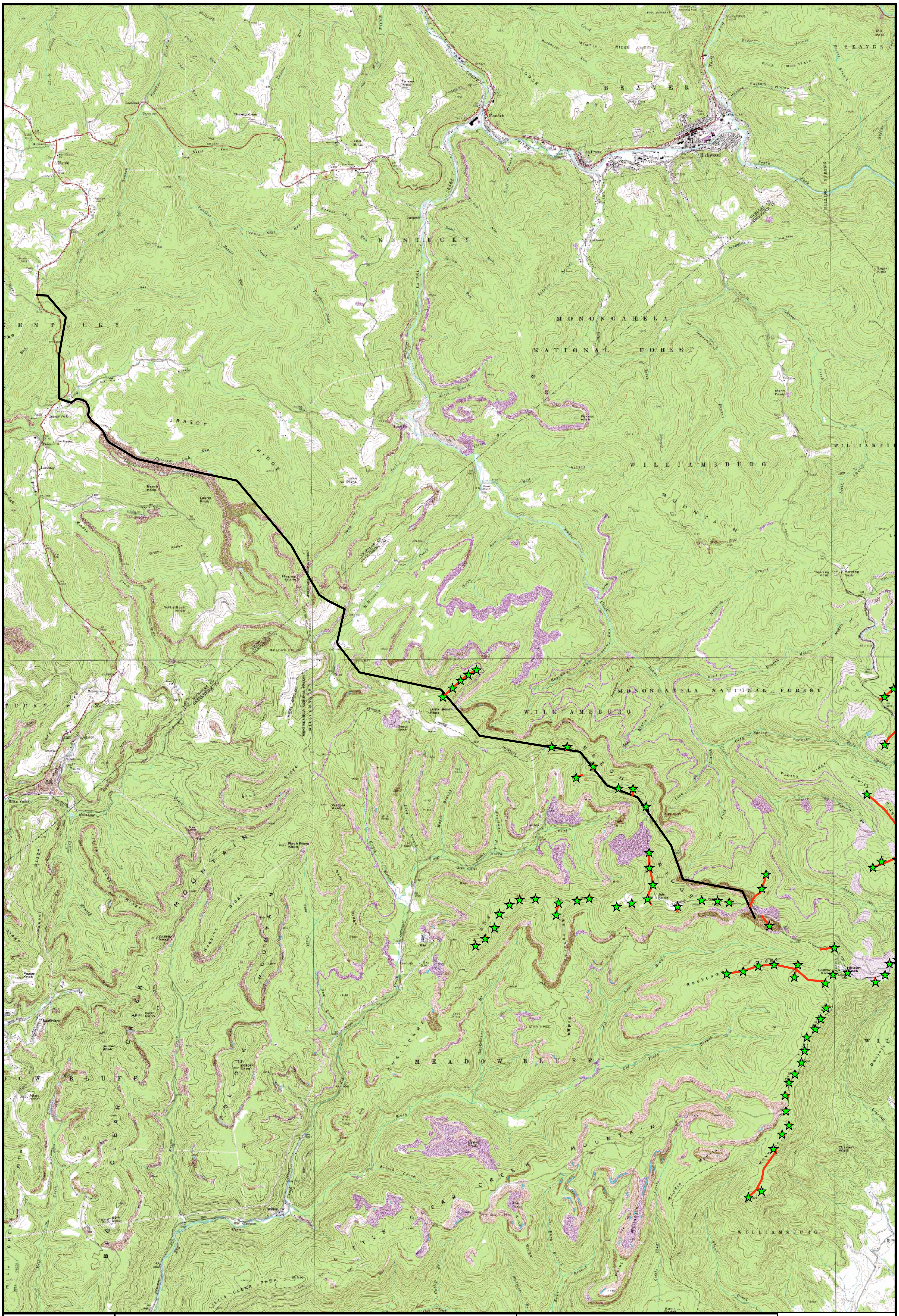

Figure 2b. Beech Ridge transmission line corridor, Greenbrier and Nicholas counties, West Virginia.

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Visual failure hypothesis Rotating rotor blades are subject to motion smear, thus making them difficult for organisms to see and respond appropriately. Bats utilize vision and may fail to visually detect wind turbine rotor blades.

Roost attraction hypothesis Bats may be attracted to wind turbines because the tall, white turbine masts are perceived as potential roosts. During migration in late summer and fall, bats seek shelter during the day, following nighttime travel. Bats may mistake the large, white turbine masts for potential tree roosts, and thus increase their susceptibility to collision at turbines.

Light attraction hypothesis Bats may be attracted to the lights placed on wind turbines. Currently, these lights range from red lights or stroboscopic lights placed on alternate turbines, as recommended by the Federal Aviation Administration. Recent data appear to contraindicate this hypothesis.

Acoustic attraction hypothesis Bats may be attracted to audible and/or ultrasonic sound produced by wind turbines. The uniform constant sounds made by the turbine generator and/or the variable "swishing" sounds made by rotating blades may attract bats and increase their risk of collision.

Motion attraction hypothesis Curious bats may be attracted to the movement of rotating turbine blades. By investigating the moving blades, bats increase their risk of collision.

Insect concentration hypothesis Flying insects rise in altitude with warm daily air masses and may become concentrated, particularly along ridge tops on certain nights. If the activity of migrating and locally foraging bats increases in response to high insect concentrations, the bats increase their exposure to turbine collisions.

Insect attraction hypothesis Flying insects may be attracted to the white turbine masts at night and get trapped in the downstream wake of the rotors. Bats respond to these concentrations of insects in the wake and collide with the turbine blades in the process of feeding.

In evaluating the risk of bat mortality at the Beech Ridge site, it is useful to consider mortalities at other operating utility-scale wind energy facilities on Appalachian ridgelines. The 66 MW Mountaineer site in Tucker County, West Virginia (the only operating wind facility in the state) and the 30 MW Meyersdale site in Somerset County, Pennsylvania are owned and operated by FPL Energy and are within 91 miles (146 km) and 143 miles (230 km) respectively of the Beech Ridge site (Figure 1).

The Buffalo Mountain site is on Tennessee Valley Authority land in Anderson County, Tennessee, approximately 252 miles (406 km) southwest of the proposed Beech Ridge facility. The proposed 186 MW Beech Ridge site is considerably larger than other operating sites on Appalachian ridgelines in regard to number of turbines, acreage, and in total rotor swept area. The highest levels of bat mortality at North American windfarms have been recorded at the three operating sites on forested Appalachian ridgelines.

Three other wind energy sites, significantly smaller than the proposed 186 MW Beech Ridge site, are located nearby in Pennsylvania: Somerset wind farm (six turbines) and Garret Mountain Energy (eight turbines) in Somerset County, and Mill Run in Fayette County. During internet and literature searches, no bat mortality data were discovered for these sites.

A number of other wind power generation sites are permitted in this portion of the Allegheny Mountains (Figure 1):

- a 300 MW New Power site and a 250 MW U.S. Wind Force Site at Mount Storm in Grant County, West Virginia,
- the 67-turbine, 101 MW Allegheny Heights project proposed by Clipper Windpower in Garrett County, Maryland, and
- the 25-turbine, 40 MW Savage Mountain site proposed by U.S. Wind Force in Allegany and Garrett counties, Maryland.

This report documents aspects of the proposed project and similar projects, provides a review of information pertaining to bat mortality at existing wind energy sites, and based upon these data, qualitatively estimates the risk of effects to listed bat species and other bats. We discuss three primary means whereby bats may be affected at the site.

2.0 PROJECT DESCRIPTION

2.1 TURBINES

Beech Ridge proposes installation of up to 124, 1.5 megawatt turbines manufactured by General Electric (model FLE). These turbines have a nominal "cut-in speed" of 3.5 m/s (7.9 mph). That is, winds of 3.5 m/s contain sufficient energy to support the generation of electric power by the turbine. At wind speeds below 3.5 m/s, as measured by an anemometer atop each nacelle, the turbine "primary brake" is applied (i.e., the turbine blades are feathered by orienting the primary surface of each blade parallel to the wind direction). With the primary brake applied the blades will not rotate around the hub, or will rotate very slowly (less than one revolution per minute). Control systems allow the cut-in wind speed to be set independently at each turbine. Wind speeds above 3.5 m/s will result in blade speeds of 17 rpm. If wind speeds at an operating (spinning) turbine drop below the cut-in speed, the primary brake is applied and the blades come to a stop within approximately one minute.

2.2 REGIONAL ECOLOGY AND PHYSIOGRAPHY

The following text describes the ecological region in which the Beech Ridge project occurs. This description is useful in understanding the nature of the area, and in comparing important ecological aspects of the Beech Ridge site to the two other nearby operating wind energy sites - Meyersdale and Mountaineer.

The Beech Ridge project area lies entirely within the Central Appalachian Broadleaf Forest-Coniferous Forest–Meadow Ecological Subregion of the United States (McNab and Avers 1994). Within this Subregion, the proposed project is located in Ecological Section M221B—the

Allegheny Mountains. The Mountaineer and Meyersdale windfarms (as well as the Mount Storm windfarms) are also within the Allegheny Mountain Subregion (Figure 3).

Section M221B comprises part of the Appalachian Plateaus geomorphic province and is a maturely dissected plateau characterized by high, sharp ridges, low mountains, and narrow valleys. Bedrock is covered by residuum on the ridges and mountain tops, colluvium on the slopes, and alluvial materials in the valleys. Devonian shale and siltstone, Mississippian carbonates and sandstones, and Pennsylvanian shale, sandstone, and coal form the bedrock in Section M221B. Sandstone and sturdy carbonates support upland areas and weaker carbonates and shale underlie valleys (USFS 2005).

Ultisols, Inceptisols, and Alfisols are the dominant soil types in Section M221B. The vegetation of Section M221B-Allegheny Mountains can be placed in four broad groups and is influenced by elevation and aspect: red spruce (*Picea rubens*), northern hardwoods, mixed mesophytic, and oak. Red spruce is characteristic above 3,500 ft (1,060 m) and can be interspersed with American beech (*Fagus grandifolia*) and yellow birch (*Betula alleghaniensis*). Beech is more common on northerly aspects, and yellow birch on southerly. The northern hardwood forests include sugar maple (*Acer saccharum*) occurring with beech and black cherry (*Prunus serotina*). Mixed mesophytic forest forms the transition to drier forest types and dominant species include red oak (*Quercus rubra*), basswood (*Tilia americana*), white ash (*Fraxinus americana*), and tulip poplar (*Liriodendron tulipifera*) (USFS 2005).

Precipitation typically averages 45 to 60 in (1,140 to 1,520 mm) per year, approximately 20% to 30% of this being snowfall. Mean annual temperature is approximately 39 to 54°F (4 to 12°C). The growing season ranges from 140 to 160 days, with local variation (USFS 1994).

Within the project area, the predominant soil types belong to the Dekalb-Gilpin very stony complex (Gorman et al. 1972). The project area lies near the center of a larger property that is actively managed for commercial timber. Of the 48,000 acres within 1 km of the site, approximately 79% is characterized as timber greater than 26 years old, 19% is characterized as timber less than 26 years old, and 2% is non-forested (e.g., roads, surface mines). The project area itself is largely forested, with notable exceptions being areas cleared for roads, and other areas affected by commercial timber harvest activities, and historic mining activities. Dominant species include oaks, sugar maple, black cherry, and white ash. Mountain maple (*A. spicatum*) is a common understory/midstory species. Approximately three-quarters of Greenbrier County West Virginia is forested.

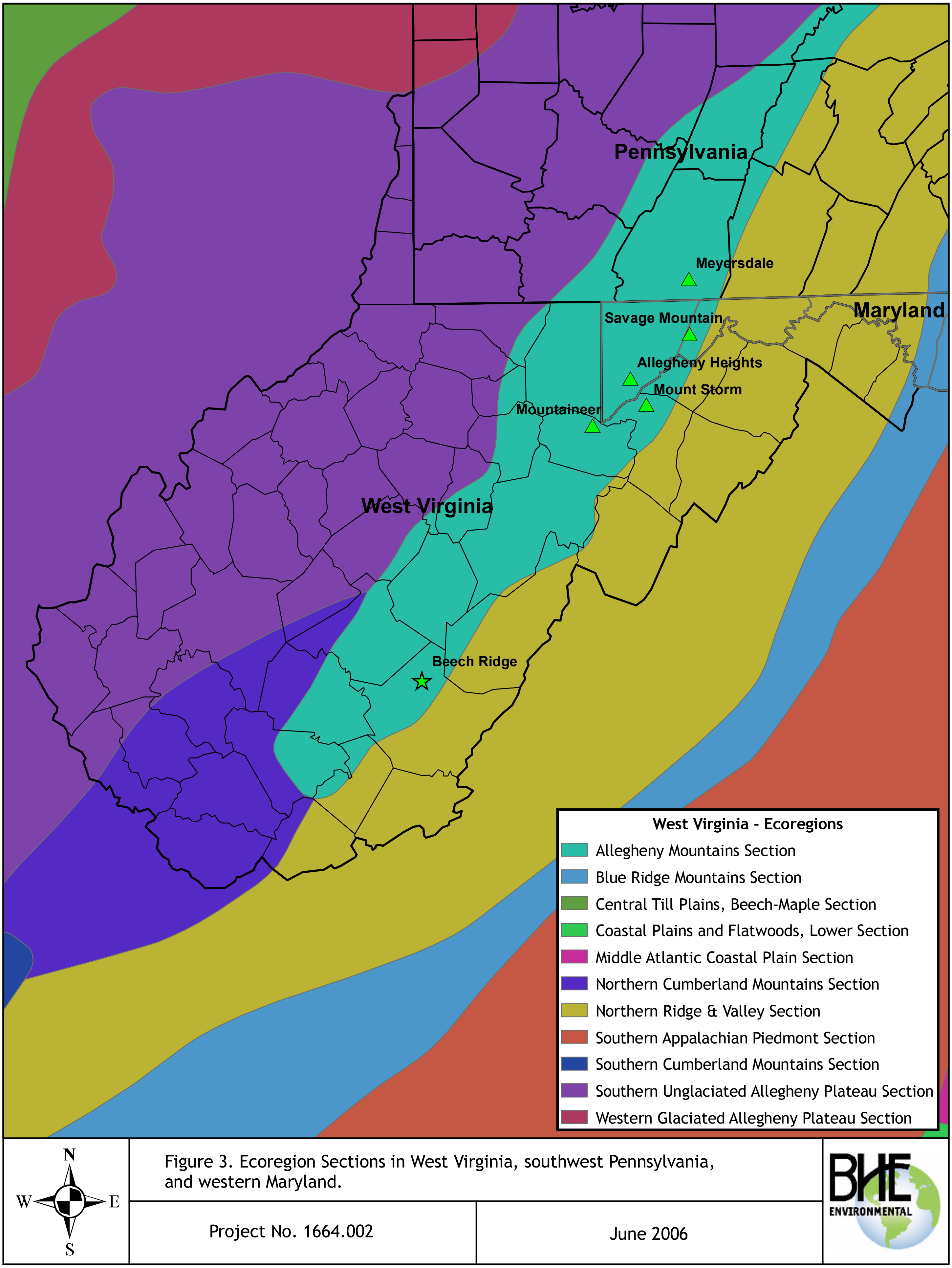

Figure 3. Ecoregion Sections in West Virginia, southwest Pennsylvania, and western Maryland.

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2.3 BATS

Fourteen species of bats have been documented within West Virginia (Table 1). Except for the gray bat (*Myotis grisescens*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), Seminole bat (*Lasiurus seminolus*), and the evening bat (*Nycticieus humeralis*), each of the species has potential to occur in the proposed project area.

The gray bat is extremely rare in West Virginia, which is outside the species' home range (BCI 2005a, WVDNR 2005). There is one record of two gray bats in Hellhole Cave in Pendleton County (WVDNR 2005, Garton et al. 1993), but there are no other summer or winter records of the species in West Virginia. Gray bat occurrences are considered "accidental" within the state.

Only summer populations, apparently all of them bachelor colonies, are known in Virginia (VDGIF 2005). In August 1977, this species was reported from Scott and Lee counties (VDGIF 2005), in the extreme southwest portion of Virginia, over 150 miles (241 km) southwest of the project area. In 1988, a summer colony of about 3,000 gray bats was discovered in Washington County (VDGIF 2005), approximately 110 miles (177 km) southwest of the proposed project area. No winter hibernacula have been identified in Virginia.

Rafinesque's big-eared bats are also rare in West Virginia. The species has been recorded in Fayette and Wayne counties (Natureserve 2005) and in Collison Cave in Nicholas County (Garton et al. 1993). The species is classified as "S1" in West Virginia, indicating five or fewer documented occurrences, or very few individuals remaining in the state. While it has been documented in West Virginia, Kentucky, and Tennessee, and potential habitat exists in caves in southwestern Virginia, the Rafinesque's big-eared bat has not been found in Virginia (VDGIF 2005).

The Seminole bat is represented by a single known occurrence in West Virginia. A specimen was captured in Pendleton County, West Virginia. The species is considered "accidental" in the state.

The evening bat is classified by the WVDNR as S1 (five or fewer documented occurrences, or very few individuals remaining in the state). Some range maps for the species exclude West Virginia, with records of the species in the state considered isolated or questionable (BCI 2005b, C. Stihler pers. comm.).

In Virginia, evening bats are known only from the eastern part of the state in the Coastal Plain and lower Piedmont Provinces (VDGIF 2005). The Virginia Department of Game and Inland Fisheries (VDGIF) indicates known or likely occurrence of the evening bat in Montgomery County, approximately 50 miles (80 km) southeast of the project area; other known or likely occurrences are more distant from Greenbrier County, West Virginia.

Table 1. Bats potentially present in the proposed Beech Ridge project area during summer, winter, and spring/fall migration.

Species	Status	Anticipated Seasonal Presence within Five Miles of Proposed Turbine Strings			Previously Identified in Greenbrier Co.?*
		Summer	Winter	Migration	
Indiana bat (*Myotis sodalis*)	Fed: E WV: S1; VA: E	Yes	No	Yes	Winter
Virginia big-eared bat (*Corynorhinus townsendii virginianus*)	Fed: E WV: S2; VA: E	No	No	Unlikely**	No
Northern long-eared bat (*Myotis septentrionalis*)	None	Yes	Yes	Yes	Summer, winter
Eastern small-footed bat (*Myotis lebii*)	Fed: none WV: S1	Yes	Yes	Yes	Summer, winter
Little brown bat (*Myotis lucifugus*)	None	Yes	Yes	Yes	Summer, winter
Eastern pipistrelle (*Pipistrellus subflavus*)	None	Yes	Yes	Yes	Summer, winter
Big brown bat (*Eptesicus fuscus*)	None	Yes	Yes	Yes**	Summer, winter
Eastern red bat (*Lasiurus borealis*)	None	Yes	No	Yes	Summer
Hoary bat (*Lasiurus cinereus*)	None	Yes	No	Yes	Summer
Silver-haired bat (*Lasyonycteris noctivagans*)	Fed: none WV: S2	No	Yes	Yes	Winter
Gray bat (*Myotis grisescens*)	Fed: E WV: SA	No	No	No	No
Rafinesque's big-eared bat (*Corynorhinus rafinesquii*)	Fed: none WV: S1	No	No	No	No
Seminole bat (*Lasiurus seminolus*)	SA	No	No	No	No
Evening bat (*Nycticeius humeralis*)	Fed: none WV: S1	Unlikely	No	Unlikely	No

*Absence of records in the county may reflect lack of surveys rather than absence of the species.
**Species is a local migrant.
West Virginia NWNHP Rank:
S1 = Five or fewer documented occurrences, or very few individuals remaining in the state. Extremely rare and critically imperiled, or because of factor(s) making the species vulnerable to extirpation.
S2 = Six to twenty documented occurrences, or few individuals remaining in the state. Very rare and imperiled, or ranked because of factor(s) making the species vulnerable to extirpation.
SA = Species occurrences considered accidental or adventive.
Virginia Rank: **E** = Endangered

The other 10 bat species in West Virginia include year-round residents as well as species with potential presence only during certain seasons (Table 1). The Indiana bat (*M. sodalis*) and Virginia big-eared bat (*Corynorhinus townsendii virginianus*) are federally listed as endangered. The remaining eight species are not federally listed as threatened or endangered, are not proposed for listing, and are not Candidate species. The West Virginia Nongame Wildlife and Natural Heritage Program (NWNHP) tracks populations of rare species, however the state of West Virginia does not list species as threatened or endangered. The Indiana bat and Virginia big-eared bat are listed as endangered by the State of Virginia. None of the other bat species potentially present in the project area is listed by the State of Virginia. Descriptions of each species potentially present in the proposed project area are below. In coordination with the USFWS and the West Virginia Department of Natural Resources (WVDNR), BHE surveyed the portion of the project area in which the turbine strings are proposed for the presence of bats during the summer maternity season. Mist nets were erected at 15 sites from July 22 to July 26, 2005, with the survey consisting of 62 net-nights (BHE 2005). Survey procedures followed Indiana Bat Recovery Plan guidelines (USFWS 1999), and the number of survey sites investigated was approved by the USFWS prior to the initiation of field studies.

A total of 78 bats (excluding two individuals which escaped before they could be identified), representing six common species, was captured. No federally listed species were captured during the survey:

- little brown bats (*Myotis lucifugus*, n = 22; 28%),
- big brown bats (*Eptesicus fuscus*, n = 17; 22%),
- red bats (*Lasiurus borealis*, n = 13; 16%),
- eastern pipistrelles (*Pipistrellus subflavus*, n = 10; 13%),
- northern long-eared bats (*Myotis septentrionalis*, n = 10; 13%), and
- hoary bats (*Lasiurus cinereus*, n = 6; 8%).

2.3.1 Indiana Bat (*Myotis sodalis*)

The Indiana bat was listed by the federal government as endangered on March 11, 1967. Populations across the species range (as recorded from counts in hibernacula) have declined since the late 1950s. A principal cause of decline is destruction of hibernacula from collapse, flooding, or vandalism by humans. Suspected contributing factors include loss of suitable summer habitat and contamination by pesticides (USFWS 1999). A recovery plan for Indiana bats was developed in 1983 (USFWS 1983), and revised in 1999 (USFWS 1999).

The Indiana bat is a migratory species found in West Virginia and Virginia year-round (Appendix A). In winter (mid-November through March) Indiana bats hibernate in caves and mines. For the remainder of the year, Indiana bats roost in trees (Barbour and Davis 1969). In April and again in August-September, Indiana bats migrate between winter and summer habitat. Some individuals may travel 300 to 400 miles (483 to 644 km) between summer and winter roosts (USFWS 1999). Others, particularly males, may roost in trees near hibernacula in summer. In Pennsylvania and New York, radiotelemetry studies indicate Indiana bats migrate between 30 and 60 miles (48 and 97 km) (Johnson and Strickland 2004). In Pennsylvania, none of the bats appeared to travel mountain ridge tops, although each of the bats crossed over ridges (Johnson and Strickland 2004). The migrating bats traveled along powerline and pipeline rights-of-way, along highways, and along stream courses (Johnson and

Strickland 2004). Limited recovery records of banded Indiana bats from the Midwest indicate females and some males migrate north in the spring upon emergence from hibernation (USFWS 1999). Migration distances and routes are unknown for Indiana bats inhabiting West Virginia (C. Stihler pers. comm.)

In spring, Indiana bats migrate from hibernacula to forested habitats. Upon emergence from hibernation, Indiana bats are active near the hibernaculum during a period called staging. Spring staging occurs from approximately mid-April through early May. During staging, Indiana bats emerging from hibernation roost in trees, and forage near hibernacula. In Missouri, staging male and female Indiana bats traveled between 1.2 and 6.4 miles (1.9 and 10.3 km) from their hibernaculum nightly (Rommé et al. 2002). Females typically leave caves before males (Humphrey 1978, LaVal and LaVal 1980). Following mid-May emergence from hibernation, a single radio-marked male followed for two weeks traveled 10 miles (16 km) in western Virginia (Hobson and Holland 1995).

Indiana bats typically arrive in summer habitat in early to mid-May. This species roosts under exfoliating bark or in cavities of trees. Pregnant females form maternity colonies that may consist of up to 100 adult bats (USFWS 1999). Male Indiana bats tend to roost singly or in small all-male groups (USFWS 1999). Males may occur in summer anywhere throughout the range of the species, including near hibernacula.

Adults of this species feed exclusively on flying insects. Indiana bats forage most frequently in upland and riparian forests, but they also may forage along wooded edges between forests and croplands, and over fallow fields (Brack 1983, LaVal and LaVal 1980). They frequently use open space over streams as travel corridors.

In August, Indiana bats begin to leave summer habitat and migrate to hibernacula. Autumn swarming occurs from approximately mid-August through September. During swarming, numerous bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in caves during the day (Cope and Humphrey 1977). Indiana bats periodically use tree roosts during fall swarming (Menzel et al. 2001). In Missouri, swarming Indiana bats traveled up to 4 miles (6.4 km) from roost sites (Rommé et al. 2002). In Kentucky, male Indiana bats radiotracked during October traveled up to 1.7 miles (2.7 km) from their roost sites. Kiser and Elliot (1996) found males roosted in trees between 0.5 and 1.5 miles (0.8 and 2.4 km) from the hibernaculum (Kiser and Elliot 1996).

A study by Brack et al. (2002) indicated that potential bat habitat may not be suitable when occurring at higher elevations and latitudes. Higher latitudes and elevations are cooler and wetter than areas at lower latitudes and elevations. Further, daily and seasonal temperatures are more variable at higher latitudes and elevations. These weather-related and climatic characteristics add significantly to the cost of reproduction to individual bats (Brack et al. 2002). As such, bat habitat located at higher latitudes or elevations, such as that found within the project area, may be of a lower quality than otherwise expected.

In West Virginia, most records of Indiana bats are from winter hibernacula (Figure 4). Priority III hibernacula (containing less than 500 Indiana bats) are located in Greenbrier, Monroe, Mercer, Pendleton, Pocahontas, Preston, Randolph, and Tucker counties in West Virginia

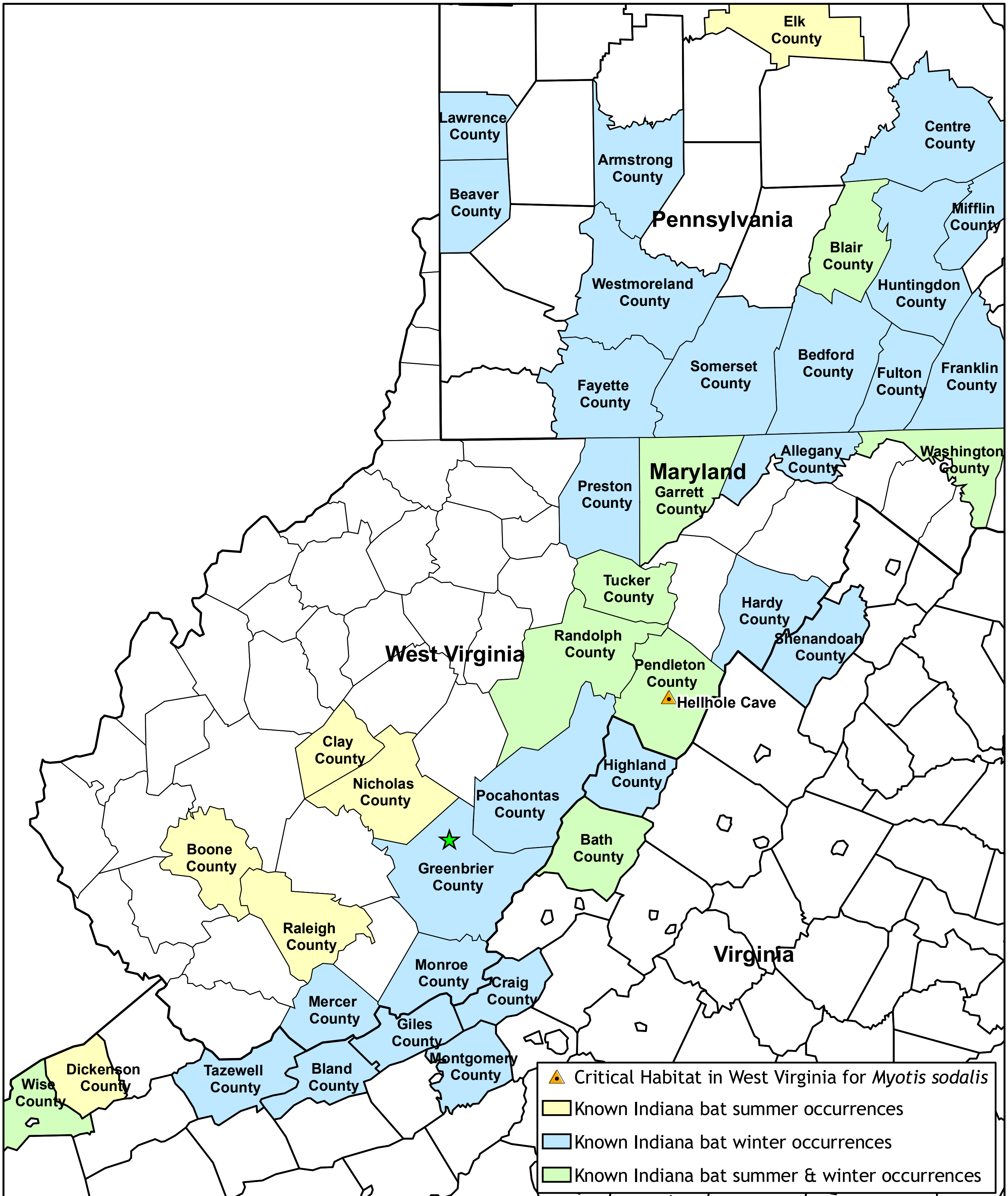

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Figure 4. Counties in which the Indiana bat (*Myotis sodalis*) occurs near the Beech Ridge site.

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(USFWS 1999). There is an historic record of wintering Indiana bats in Hardy County (C. Stihler pers. comm.).

In Greenbrier County, less than 100 Indiana bats have been found in Bob Gee, Organ, Piercy's, and General Davis caves (Garton et al. 1993); potential exists for additional wintering Indiana bats in the many un-surveyed caves within the county.

Only four caves within 10 miles of the proposed turbine sites are know to have, or do support Indiana bats. Bob Gee Cave is the only known (historic) hibernaculum within 5 miles of the proposed turbine sites. This cave is approximately 2.5 miles (4 km) southeast of the nearest proposed turbine site (Figure 5). Nine Indiana bats were found in this cave in 1984, six in 1988, and three in 1990. The most recent surveys in Bob Gee Cave occurred in 2006 and 2002; no Indiana bats were observed. All caves suitable as hibernacula within 5 miles of proposed turbine sites, with exception of one entrance to the Friar's Hole system, were surveyed for the presence of endangered bats in early March 2006. No Indiana bats or other listed bat species were present.

The best available information at this time indicates three caves located between 5 miles and 10 miles from the turbine sites support hibernating Indiana bats. Marthas Cave, located approximately 9 miles northeast of the nearest turbine, contained 196 Indiana bats in the most recent survey (2004). The 2004 count was about 30% lower than the maximum count of 285 documented in 1996. McFerrin Cave was last surveyed in the winter of 1981, when two Indiana bats inhabited the cave. A maximum of 39 Indiana bats have been documented utilizing the cave. McFerrin cave is approximately 6.75 miles south of the nearest proposed turbine site. Snedegars Cave is part of the extensive Friar's Hole Cave System which has over 40 miles of known passages. The most recent survey (2004) found 193 hibernating Indiana bats (Table 2).

There is a museum record for an Indiana bat in Higginbothams Cave No. 1, however the species apparently no longer utilizes the cave. Indiana bats were not present in the cave during any recent surveys (1976, 1981, and 1998). Higginbothams Cave No. 1 is approximately 9 miles southeast of the nearest proposed turbine.

Table 2. Proximity of Indiana bat hibernacula to proposed Beech Ridge turbine sites, and characteristics of Indiana bat populations utilizing the cave.

Cave	Approximate Distance from Nearest Proposed Turbine (miles)	Maximum Population	Maximum Population since 1960	Most Recent Population
Bob Gee Cave	2.75	9 (1984)	9 (1984)	0 (2002)
Snedegars Cave	6	193 (2004)	193 (2004)	193 (2004)
McFerrin Cave	6.75	39 (1952)	2 (1981)	2 (1981)
Marthas Cave	9	285 (1996)	285 (1996)	196 (2004) 181 (2002)

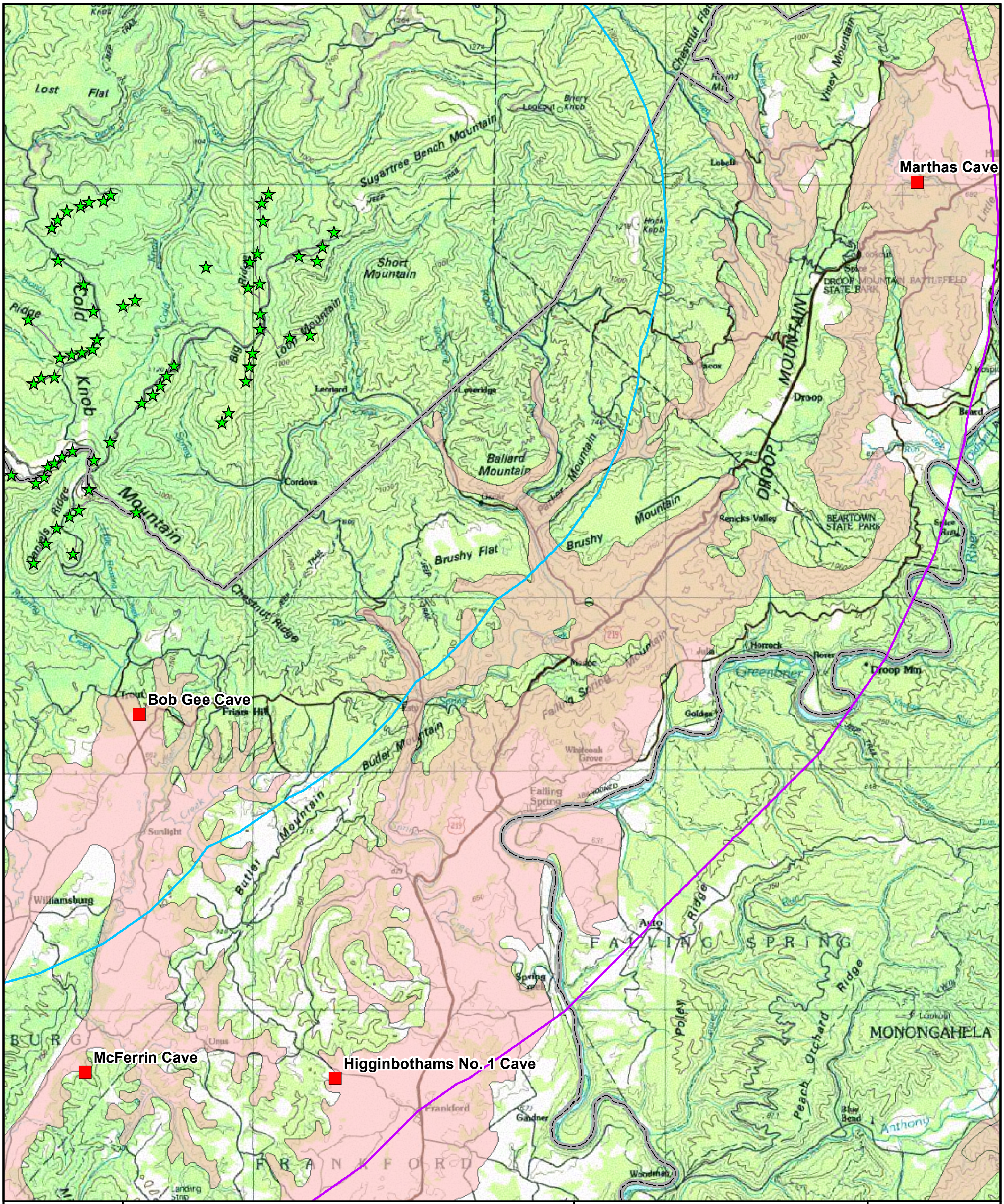

Figure 5. Indiana bat hibernacula near the Beech Ridge site, Greenbrier County, West Virginia.

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Miles

0.875 0 0.875 1.75

☆ Proposed Turbines

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Summer occurrences of Indiana bats in West Virginia have been documented in seven counties, including Nicholas and Clay counties northwest of the proposed turbine sites. These occurrences are of particular interest because these counties are proximate to Greenbrier County, and because the Beech Ridge project is located between these occurrences and the area of karst/caves in central Greenbrier County. The known presence of Indiana bats in Nicholas County and in Clay County is limited to only one male Indiana bat in each county. The Clay County record dates back to 1999, and the Indiana bat in Nicholas County was captured in 2004. Indiana bats captured during summer in Pendleton, Tucker, and Raleigh counties were adult males as well.

Designated Critical habitat for the Indiana bat in West Virginia and Virginia is limited to Hellhole Cave in Pendleton County, approximately 75 miles (121 km) northeast of the project area (Figure 4). Approximately 9,000 Indiana bats, nearly 90% of all Indiana bats inhabiting the state, utilize this hibernaculum (WVDNR 2005).

Indiana bats occur in winter and summer in Tucker, Pendleton, and Randolph counties, West Virginia (USFWS 1999). In 1999, a post-lactating female Indiana bat was captured in Randolph County (Owen et al. 2001). Between 2003 and 2005, reproductive female Indiana bats have been captured in Boone County and tracked to roost trees, providing the first records of Indiana bat maternity colonies in West Virginia (B. Sargent pers. comm.). Boone County is approximately 50 miles (80 km) west of the proposed project area. A reproductive female Indiana bat was also tracked to a roost tree in Tucker County in 2004 (B. Sargent pers. comm.). Tucker County is approximately 70 miles (113 km) north of the project area.

In Virginia, a single Priority III hibernaculum is present in Bath, Montgomery, and Shenandoah counties, and a Priority II hibernaculum is located in Lee and Wise counties in the western tip of Virginia (USFWS 1999). A reproductive female Indiana bat was captured in Lee County, and an individual was captured during summer in Bath County (USFWS 1999). Indiana bats were recently identified during winter in Highland, Craig, Giles, Bland, and Tazewell counties (Indiana Bat Recovery Team pers. comm.).

2.3.2 Virginia Big-Eared Bat (*Corynorhinus townsendii virginianus*)

Virginia big-eared bats were federally listed as endangered in 1979 due to their limited distribution and small population size. A recovery plan for the Ozark big-eared bat and Virginia big-eared bat was approved by the USFWS in 1984 and revised in 1995 (USFWS 1995).

The species is identified as very rare and imperiled in West Virginia. The number of Virginia big-eared bats declined sharply from 1950 through the early 1980s. Much of the decline is attributed to human disturbance at cave roosts. The majority of the population hibernates in only three caves, which makes them highly susceptible to human disturbance (USFWS 1995). However, recent trends suggest a stable or slightly increasing population (Stihler 2003). Range-wide, the total population is estimated at 20,000 (C. Stihler pers. comm.).

The Virginia big-eared bat inhabits a small range centered in northeast West Virginia (Appendix A), including Fayette, Grant, Hardy (historic only), Pendleton, Preston (historic only), Randolph, and Tucker counties, as well as nearby Rockingham, Highland, Bath, Pulaski, Bland, and Tazewell counties in Virginia (Figure 6).

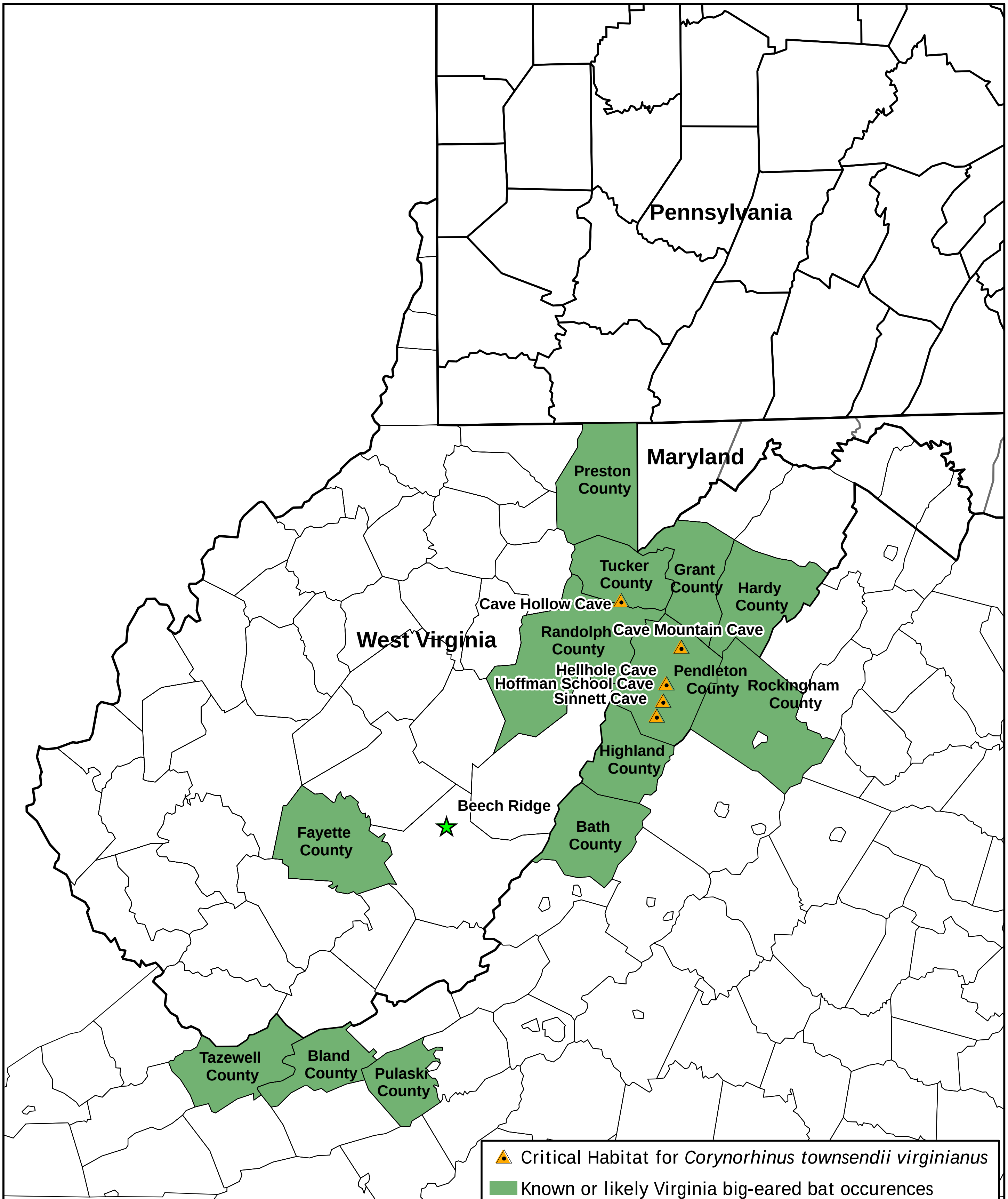

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Figure 6. Counties in which the Virginia big-eared bat (*Corynorhinus townsendii virginianus*) occurs or is likely to occur near the Beech Ridge site.

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Five caves in Tucker and Pendleton counties, West Virginia have been designated as Critical Habitat for this species (Figure 6). The largest known concentration of this species is in Hellhole Cave in Pendleton County, approximately 75 miles (121 km) northeast of the proposed project area. In 2002, 8,566 Virginia big-eared bats were identified in Hellhole Cave (Stihler 2003).

Several males and females were identified during autumn in Fayette County at mine portals approximately 30 miles west-northwest of the proposed turbine sites. Historic records of Virginia big-eared bats hibernating in Hardy and Preston counties exist, but the species has not been identified recently in winter in those counties (C. Stihler pers. comm.).

Virginia big-eared bats have been captured during summer in Pendleton, Tucker, Randolph, Grant, Hardy, and Fayette counties (C. Stihler pers. comm., BHE 1999).

In Virginia, this species has been identified during summer in three caves in Tazewell County, and in another cave in Highland County, and during winter in caves in Bland, Highland, Bath, and Tazewell counties (VDGIF 2005).

Virginia big-eared bats reside year-round in West Virginia and Virginia. They hibernate in colder or well-ventilated parts of caves closest to entrances. Virginia big-eared bats are non-migratory and may use the same cave for winter and summer roosting habitat, although they have been known to travel up to 40 miles (64 km) between seasonal roosts (Barbour and Davis 1969). Caves with known occurrences in Virginia are all located above 1500 feet (457 meters) in elevation (VDGIF 2004). Virginia big-eared bats have also been observed roosting in rock shelters, cracks, and fissures with large entrances and deep passages (Lacki et al. 1993). In 2002, approximately 28 Virginia big-eared bats were observed in the New River Gorge, approximately 30 miles from the project area. During a July 2005 mist net survey conducted to inventory bats where proposed turbines will be located, no Virginia big-eared bats were captured (BHE 2005).

Mating occurs during the fall. In spring, females give birth and raise their young in maternity colonies. Virginia big-eared bats have a high degree of roost site fidelity with females returning to the same maternity colony year after year. Most males roost singly during the summer months (Whitaker and Hamilton 1998), although bachelor colonies have been documented (Stihler 2003). Virginia big-eared bats do not leave their roosts to forage until late in the evening. They have been known to temporarily roost in sheds, trees, and under bridges during the night.

Virginia big-eared bats forage over the forest canopy, along cliff lines, and over grassy fields and pastures (Burford and Lacki 1995, WVDNR 2005, Craig Stihler, pers. comm.). The species has also been captured in mist nets within non-forested rights-of-way through forested areas (e.g., corridors for buried pipelines). A large proportion of their diet consists of small moths and beetles. Radio-telemetry studies indicate these bats travel up to 6.5 miles (10.5 km) from the cave roost to feed. Individual bats often return to the same feeding area night after night.

2.3.3 Northern Long-Eared Bat (*M. septentrionalis*)

The northern long-eared bat ranges from southern Canada and the central and eastern U.S. through northern Florida (Appendix A). It is abundant throughout West Virginia and Virginia and is a year-round resident in both states (Harvey 1992, VDGIF 2005).

The northern long-eared bat is migratory, but usually does not migrate long distances (Whitaker and Hamilton 1998). Northern breeding populations generally move south to winter hibernacula, typically occupying winter habitat beginning in mid-October (Natureserve 2005). In winter (October/November through March/April), this species hibernates in caves and mines. It may hibernate in caves occupied by several other species. Northern-long eared bats occasionally emerge from hibernation and briefly fly around (Whitaker and Hamilton 1998).

In summer, this species typically roosts in trees (under exfoliating bark or in crevices and hollows) and in manmade structures (Harvey 1992, Foster and Kurta 1999). Foster and Kurta (1999) identified northern long-eared bats roosting singly or in small groups that averaged 17 individuals. This species forages along forested hillsides and ridges, often through dense vegetation (Harvey et al. 1999). In Randolph County, West Virginia, northern-long eared bats foraged in upland forests and along road corridors (Owen et al. 2003). The mean home range of reproductive female *M. septentrionalis* was 160 acres (Owen et al. 2003).

This species has been identified in eleven caves in West Virginia, primarily during winter, but occasionally during warmer months (Garton et al. 1993). Northern long-eared bats have been identified in caves in Berkeley, Greenbrier, Pendleton, Randolph, and Tucker counties (Garton et al. 1993). This species is one of the most abundant captured during summer mist net surveys of forested areas, and is abundant at cave entrances during the autumn swarming period (Stihler 2003). The northern long-eared bat has been captured in Greenbrier and Pendleton counties during summer (BHE 1999). In July 2005, 10 northern long-eared bats were captured during a mist net survey conducted within the proposed Beech Ridge site (BHE 2005).

2.3.4 Eastern Small-Footed Bat (*M. leibii*)

The eastern small-footed bat is distributed along the Appalachian Mountains from Southern Maine, Vermont, and New Hampshire to northern Alabama, and west to northern Arkansas (Appendix A). Eastern small-footed bats appear to be sparsely distributed throughout their range, including in West Virginia and Virginia (Barbour and Davis 1969, WVDNR 2005, VDGIF 2005). It occurs in Fayette, Grant, Greenbrier, Hardy, Mercer, Monongalia, Monroe, Morgan, Nicholas, Pendleton, Pocahontas, Preston, Randolph, Tucker, and Webster counties (Natureserve 2005). Eastern small-footed bats have been identified in caves in Greenbrier, Monroe, and Pendleton counties (Garton et al. 1993), and captured during summer in Greenbrier County (BHE 1999). During a July 2005 mist net survey conducted within the Beech Ridge project area, no eastern small-footed bats were captured (BHE 2005). In Virginia, the eastern small-footed bat occurs throughout all counties along the eastern third of the state (VDGIF 2005).

Little is known about the habits of this species. The eastern small-footed bat typically occurs in mountainous regions at elevations ranging from 787 to 3690 feet (240 to 1125 meters). They often are found in eastern deciduous and coniferous forests (Best and Jennings 1997). In summer, eastern small-footed bat may be found roosting in buildings, caves, rock outcrops, and mines (Harvey et al. 1999). This species is often found in late summer with other migrating bats, but migratory behavior of the eastern small-footed bat is not well known (Best and Jennings 1997). In winter, this species hibernates in caves and mines, often in the coldest locations near the entrance (Harvey 1992). The eastern small-footed bat begins hibernation later, and emerges from hibernation earlier, than most other species (Best and Jennings 1997). Hibernation begins late in the fall (mid-November) and individuals usually leave hibernation by March, although it has been noted that they may remain active throughout the winter months (Best and Jennings 1997).

2.3.5 Little Brown Bat (*M. lucifugus*)

The little brown bat is abundant throughout forested areas of the U.S. as far north as Alaska (Appendix A). The species range includes all of West Virginia, and Virginia. It is a year-round resident in both states. Little brown bats are commonly found hibernating in West Virginia caves. Greater than 129,000 little brown bats were counted during hibernacula surveys between 2000 and 2003 (Johnson and Strickland 2004). Little brown bats also utilize other caves in Pendleton County, and caves in Berkeley, Grant, Greenbrier, Monroe, Monongalia, Randolph, and Tucker counties (Garton et al. 1993). Among the counties in which little brown bats have been captured during summer are Greenbrier and Pendleton (BHE 1999). In July 2005, 22 little brown bats were captured during a mist net survey conducted within the Beech Ridge project site (BHE 2005).

This species is especially associated with humans, often forming nursery colonies in buildings, attics, and other manmade structures (Harvey et al. 1999). These colonies are often close to a lake or stream. Males are likely solitary in the summer months (Harvey et al. 1999). In late August and early September, little brown bats prepare for hibernation, and may swarm at the entrance of caves or mines (Whitaker and Hamilton 1998). Migration between summer and winter roosts may be short distances or several hundred miles (Fenton and Barclay 1980, Whitaker and Hamilton 1998). The timing of migration and hibernation depends upon local weather conditions, with northern populations hibernating from September to early May, and southern populations hibernating from November to March (Fenton and Barclay 1980). Little brown bats typically hibernate in caves and mines, and hibernacula are typically not used as summer roosts (Harvey et al. 1999, Whitaker and Hamilton 1998).

Little brown bats often forage over water where their diet consists of aquatic insects, including mosquitoes, mayflies, midges, and caddisflies. Foraging also occurs over forest trails, cliff faces, meadows, and farmland where they consume a wide variety of insects (Harvey et al. 1999).

2.3.6 Eastern Pipistrelle (*Pipistrellus subflavus*)

The eastern pipistrelle occurs in the eastern U.S., including all of West Virginia and Virginia (Barbour and Davis 1969, VDGIF 2005). This species appears abundant throughout its range. Summer and winter ranges are identical. The eastern pipistrelle is present year-round throughout West Virginia and Virginia. It is frequently found in West Virginia caves, though rarely in large numbers (Garton et al. 1993). The eastern pipistrelle has been identified in caves in Berkely, Grant, Greenbrier, Jefferson, Mercer, Mineral, Monongalia, Monroe, Pendleton, Pocahontas, Preston, Randolph, and Tucker counties (Garton et al. 1993). Among the counties in which eastern pipistrelles have been captured in summer is Greenbrier County (BHE 1999). In July 2005, 10 eastern pipistrelles were captured during a mist net survey conducted within the proposed site (BHE 2005). In summer, eastern pipistrelles have been found roosting in foliage and, rarely, in buildings. They may roost singly or in colonies of up to 30 bats (Barbour and Davis 1969). In winter, eastern pipistrelles hibernate in mines, quarries, caves, and rock crevices.

2.3.7 Big Brown Bat (*Eptesicus fuscus*)

The big brown bat is common throughout North America (Appendix A). It ranges throughout the United States from Alaska and Canada to Mexico and South America. Big brown bats do not migrate; there appears to be no difference in range from summer to winter (Barbour and Davis 1969). The big brown bat is found throughout West Virginia and Virginia year-round (Harvey 1992, VDGIF 2005). It roosts in rock crevices, expansion joints of bridges and dams, hollow trees, and manmade structures. Big brown bats have been found in caves in Greenbrier, Hardy, Monroe, Pendleton, Tucker, and Randolph counties, West Virginia (Garton et al. 1993). Maternity colonies containing several hundred individuals have been recorded from attics, barns, and other manmade buildings (Harvey 1992). Among the West Virginia counties in which big brown bats have been captured during summer are Greenbrier and Pendleton (BHE 1999). In July 2005, 17 big brown bats were captured during a mist net survey conducted within the proposed site (BHE 2005).

2.3.8 Red Bat (*Lasiurus borealis*)

The red bat is found from southern Canada, throughout the U.S., to Mexico and Central America (Barbour and Davis 1969). It is common in the midwest and central states, and is present throughout West Virginia and Virginia (Appendix A, Harvey 1992, VDGIF 2005, Whitaker and Hamilton 1998). During winter, male red bats are more commonly found in northern areas, while females are more often found in southern areas (Cryan 2003). There is no clear segregation of the genders during summer (Cryan 2003).

Red bats are migratory; however, migration patterns are poorly understood. Red bats inhabiting the eastern U.S. are likely to move south in the fall. In winter, red bats may hibernate in tree foliage for short periods, but arouse and forage during warm nights. Red bats have been captured in Greenbrier County in summer (BHE 1999). In July 2005, 13 red bats were captured during a mist net survey conducted within the proposed site (BHE 2005). No winter records of red bat occurrences were available, but it is likely red bats are present throughout West Virginia and the western portion of Virginia during winter.

Like most lasiurids, *Lasiurus borealis* typically roosts in tree foliage. Individual red bats may use several roost sites. Red bats hang from branches or leaf petioles and are camouflaged by leaves. Adults are solitary, but females and young roost together until young become volant.

2.3.9 Hoary Bat (*L. cinereus*)

The hoary bat is widespread throughout the U.S., but in eastern regions, the species distribution varies seasonally (Whitaker and Hamilton 1998). Breeding individuals are known from Canada south to Arkansas, Louisiana, and Georgia (Barbour and Davis 1969). The range of the hoary bat includes all of West Virginia (Harvey et al. 1999). Maps of hoary bat distribution in Virginia vary, but the species is consistently depicted in the western third of the state (Whitaker and Hamilton 1998, VDGIF 2005). It appears that the genders are separate during summer, with females inhabiting the northeast region (Cryan 2003, Whitaker and Hamilton 1998). Reproductive females are found in the northeast as far south as Pennsylvania and Indiana (Whitaker and Hamilton 1998). Female hoary bats give birth between mid-May and early July (Cryan 2003). Hoary bats have been captured in Greenbrier County in summer (see BHE 1999). In July 2005, six hoary bats were captured during a mist net survey conducted within the proposed site (BHE 2005).

In August, this species moves south to winter habitat in southeastern and southwestern states, the Caribbean, and Central and South America (Cryan 2003, Whitaker and Hamilton 1998). In the eastern U.S., hoary bats winter in northern Florida and southern Georgia, Alabama, Louisiana, and South Carolina (Whitaker and Hamilton 1998). Hoary bats apparently migrate in groups, with large numbers passing through an area over several nights in spring and fall (Whitaker and Hamilton 1998, Natureserve 2005). Females precede males in spring migration. In the north, some may hibernate rather than migrate (Whitaker 1980). Hoary bats migrate north from March through April (Whitaker and Hamilton 1998).

Hoary bats roost in foliage of deciduous or coniferous trees (Barbour and Davis 1969). The species generally is solitary except during migration and when young accompany females (Mumford and Whitaker 1982).

2.3.10 Silver-Haired Bat (*Lasyonycteris noctivagans*)

The silver-haired bat is common in forested areas throughout much of North America, although it is characterized as a northern species (Whitaker and Hamilton 1998). In the east, the silver-haired bat occurs from Maine and Wisconsin south to Mississippi, Alabama and Georgia (Whitaker and Hamilton 1998). However, the species is migratory and this range includes both summer and winter habitat. This species is typically found in parts of its range containing older stands of coniferous or mixed coniferous and deciduous forests (BCI 2002). Silver-haired bats are found primarily along the mountainous eastern border of West Virginia, in Pendleton, Pocahontas, Randolph, Tucker counties, and in Wayne County on the western boarder (Natureserve 2005). No silver-haired bats were captured during the July 2005 mist net survey in the project area (BHE 2005). This species may be found throughout Virginia (VDGIF 2005).

In spring, silver-haired bats in the eastern U.S. disperse east and north from winter habitat (Cryan 2003). Silver-haired bats roost almost exclusively in tree cavities, often switching roosts throughout the maternity season (BCI 2002). In the east, young are born primarily in Canada, Michigan, and the northeastern states (Whitaker and Hamilton 1998). Silver-haired bats typically are solitary, but may congregate in small maternity colonies usually numbering fewer than 10 individuals (Whitaker and Hamilton 1998).

Silver-haired bats migrate south in September and October and winter primarily south of the Ohio River in southeastern and eastern states, including West Virginia and Virginia (Whitaker and Hamilton 1998). Females are thought to migrate farther than males, and it is possible males remain in winter habitat year-round (Whitaker and Hamilton 1998). During migration, silver-haired bats were found roosting in trees along a ridge (Whitaker and Hamilton 1998). Typical winter roosts for this species include trees, buildings, wood piles, and rock crevices (Harvey et al. 1999). Occasionally silver-haired bats will hibernate in caves or mines, especially in northern regions of their range. Silver-haired bats have been found in caves in Greenbrier and Pendleton counties (Garton et al. 1993).

Though they are highly dependent upon older forest areas for roosts, silver-haired bats feed predominantly in disturbed areas such as small clearings and along roadways or streams (BCI 2002, Whitaker and Hamilton 1998). The silver-haired bat typically leaves the roost and begins to forage relatively late, with major foraging activity peaks 3 and 7 to 8 hours after sunset (Natureserve 2005). In southeastern Virginia and northeastern North Carolina, silver haired bats were active throughout the year, including during winter evenings when air temperature was 13ºC or more (Natureserve 2005).

2.4 CAVES

Between March 2 and March 7, 2006, BHE surveyed caves near the proposed Beech Ridge wind energy site (BHE 2006). Methods and results of our surveys were described in a report provided to Invenergy, the USFWS, and the West Virginia DNR (BHE 2006), and are summarized here. Prior to field work, BHE queried available literature, in particular: Davies, W. 1965. *Caverns of West Virginia*. West Virginia Geological and Economic Survey, Morgantown, WV; and Storrick, G. 1992. *The Caves and Karst Hydrology of Southern Pocahontas County and the Upper Spring Creek Valley*. West Virginia Speleological Survey, Reston, VA; coordinated with the West Virginia DNR; the Natural Resources Analysis Center at West Virginia University; and Mr. Bill Balfour, a speleological authority in the project area. BHE developed a GIS database identifying approximately 140 known caves within 5 miles of proposed turbine locations. We report this number as an approximation because our compilation of data from numerous sources may include undetected duplications. We focused our attention on caves within 5 miles of turbine locations because previous studies indicate Indiana bat activity during swarming (prior to hibernation) and staging (after hibernation) is concentrated within 5 miles of hibernacula. All caves within 5 miles of the project site occur in a southwest to northeast trending band, south and east of the proposed turbine locations.

Based upon information available prior to our field survey, we concluded 115 (82%) of the 140 caves within 5 miles of the turbine sites did not provide suitable winter habitat for Indiana bats or Virginia big-eared bats. These caves are less than 100 feet in length, and presumably, temperatures in these small caves would closely reflect ambient air temperatures, fluctuating too widely to support hibernating bats. Additionally, these caves would reach temperatures below freezing, which are fatal to hibernating bats. Twenty-four caves were evaluated in the field. One cave was not evaluated.

Of the 24 caves evaluated in the field, the entrances and/or portions of the interiors of 12 caves were inspected and found to be unsuitable for use by Indiana bats or Virginia big-eared bats. Entrances to these caves were blocked, or the caves exhibited evidence of flooding to the ceiling:

1. DePriest Cave No. 2
2. Roadside Cave
3. Jarvis Collapsed Dome Cave
4. Mashed Finger Well
5. Hanging Tree Cave
6. Little Bird Cave
7. McCoy Thunderdome Cave
8. Bore Hole
9. Wolfe's Blowhole
10. Dogwood Sink Cave
11. McCoy's Thunderdome South
12. Miller's Cave No. 1

Twelve other caves, including Bob Gee Cave, a historic Indiana bat hibernaculum, were surveyed and data were collected including number and species of bats present, characteristics of the cave entrance, floor and ceiling temperatures, nature of air flow, and amount of water within the cave.

1. Bob Gee Cave
2. Thrasher Cave
3. Roaring Creek Cave
4. Carr Branch Cave
5. Ben's No. 5/Smokehole Cave
6. Williamson Cave No. 2
7. Windmill Water Cave
8. Bransford's Cave
9. Casteret Cave
10. Portal Cave
11. Knight Saltpeter Cave
12. Cadle Cave

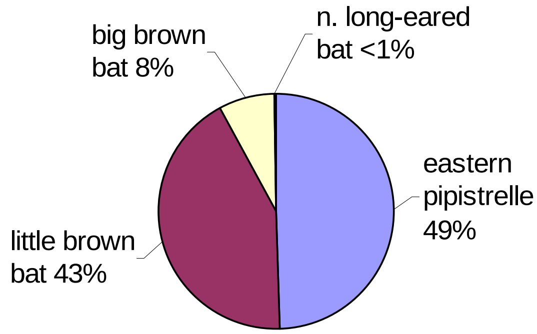
The timing of our survey, although later than the more typical December or January hibernacula survey window, was appropriate given the purpose of the survey. Temperatures at cave entrances ranged from -4ºC to 7ºC, and ceiling temperatures at the back of surveyed caves ranged from -1ºC to 10ºC. The torpid nature of bats we encountered was typical of bats observed during winter surveys.

The Friar's Hole Cave System has nine known primary entrances, only one of which is within 5 miles of proposed turbine locations (approximately 4.5 miles). Indiana bats are not known to inhabit the cave near this entrance, commonly called the "Friar's Hole Entrance." In the last 16 years (since 1990) a maximum of 193 Indiana bats has been identified in the Friar's Hole system, in the portion known as Snedegar's Cave. Two entrances to Snedegar's Cave are identified, one between 5 and 6 miles from proposed turbine sites, and one between 6 and 7 miles from the locations.

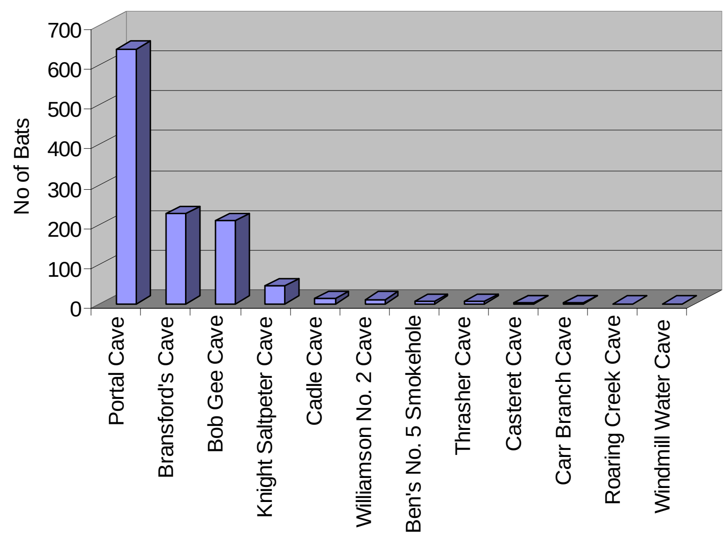
Four entrances to the Friar's Hole Cave System are between 5 and 6 miles from the turbine sites, and four are between 6 and 7 miles from the sites. Investigations of the cave interior using any of the nine entrances requires passage through water and other difficult caving conditions. We have not confirmed which, if any, of these passages flood to the ceiling. The system includes nearly 45 miles of mapped passage, including some areas as much as 618 feet below ground surface. Survey of the massive system for the presence of Indiana bats or Virginia big-eared bats was not completed during our survey.

No Indiana bats, Virginia big-eared bats, or other federally-listed or otherwise rare or uncommon species were identified in any of the 12 caves surveyed in March 2006. Four bat species were observed (in descending order of occurrence):

- eastern pipistrelle (n=566),
- little brown bat (n=490),
- big brown bat (n=86), and
- northern long-eared bat (n=3).



Of the 12 caves BHE surveyed intensively, Portal Cave, located between 4 and 5 miles from the nearest proposed turbine location, contained the greatest number of bats (n=637); followed by Bransford's Cave (located between 3 and 4 miles from turbine locations, n=224); and Bob Gee Cave (located between 2 and 3 miles from turbine locations, n=206). Seven caves contained 50 or fewer bats and no bats were found in two of the 12 caves.



In summary, all caves within 5 miles of the nearest proposed turbine site which we believed to have at least some potential to support hibernating bats (with the exception of the Friar's Hole entrance to the Friar's Hole Cave System) were surveyed during early March 2006. Only common bat species were present in the caves. No Indiana bats were present in Bob Gee Cave during our 2006 survey (nor during the previous survey completed in 2002).

3.0 POTENTIAL EFFECTS OF THE BEECH RIDGE FACILITY TO BATS

Construction and operation of the Beech Ridge wind energy facility presents concerns regarding impacts to bats through three primary avenues:

- Bats may be killed by colliding with moving turbine blades.
- Construction of the turbines and associated appurtenances may degrade habitat quality through the removal of trees.
- Bats may be disturbed to the extent of being displaced by operating turbines.

3.1 BAT MORTALITY AT WIND ENERGY SITES

Much of the information available regarding mortality caused by collisions with moving turbine blades is contained in technical reports completed for wind site owners/developers, is unpublished, and often difficult to obtain. Anecdotal information can be found in numerous studies intended to address avian impacts, although these data are suspect in that study methods were not designed to detect bat mortality.

As of winter 2004, studies conducted specifically to investigate bat mortality had been conducted at six wind energy facilities across the United States: four studies in the Northwest, two in the Rocky Mountains, four in the upper Midwest, and three in the East. Average mortality ranged from 1.2 to 47.5 bats killed per turbine per year. Methods used in these studies varied; mortality estimates were adjusted in many cases for the biases presented by searcher efficiency and removal of carcasses by scavengers. Bat mortality has been anecdotally recorded at other wind sites as well.

Documented bat kills at North American wind energy sites have been highest in the east (Appalachian Mountains), moderate in the Midwest, and lowest in the western states. In most cases, documented mortality was low – less than five bats per turbine per year. Mortality exceeding 10 bats per turbine per year has been identified at only four sites: Mountaineer (West Virginia), Meyersdale (Pennsylvania), Buffalo Mountain (Tennessee), and Top of Iowa (Iowa). Nationwide, more than 99% of fatalities documented as of the winter of 2004 (Johnson 2004) have been of six species in the United States, with hoary bats accounting for nearly one-half of all mortality:

- hoary bat (47.1%),
- eastern red bat (25.4%),
- silver-haired bat (11.8%),
- eastern pipistrelle (7.7%),
- little brown bat (5.6%), and
- big brown bat (1.8%).

So called “migratory bats” or “tree bats” (hoary bat, eastern red bat, silver-haired bat) account for over 84% of known fatalities. Bats that roost (winter and or summer) caves, sometimes referred to as “cave bats,” comprise the remaining approximately 16%.

Although mortality has been documented in all months when bats are not hibernating, a significant majority of mortality has been documented in mid July through mid October during the post-maternity dispersal from summer habitat to winter habitat. Documented mortality is highest between approximately July 15 through September 15. The near absence of mortality during the spring migration period is unexplained. Similarly, mortality is very low during the summer maternity period, even when substantial numbers of bats are present at wind energy sites. In a study in Minnesota, researchers found bat activity as measured by ultrasound detectors was not correlated with bat mortality (Johnson et al. 2003a).

The sites at which the highest mortality has been documented occur at approximately 2760 ft (840 m) above msl (Meyersdale), and 3363 ft (1025 m) above msl (Mountaineer). Both of these sites are on forested Appalachian Mountain ridgelines. At this time the greatest risk of bat mortalities is expected at sites on forested Appalachian Mountain ridgelines.

The presence of FAA-approved lighting on towers has been the subject of speculation regarding bat mortality. Studies completed in 2004 at Mountaineer found no significant difference in mortality at lit and unlit towers. Similar results were documented at the Klondike wind facility in Washington State (Johnson et al. 2003b).

Most of the 10 species of bats likely to be present during some portion of the year at Beech Ridge have been killed at one or more operating wind energy sites. No fatalities of federally listed bat species have been documented at wind energy sites in the United States. Based upon results of mortality monitoring completed to date, we expect hoary bats and eastern red bats to account for the majority of bat kills at Beech Ridge. These two species accounted for most of the mortality in turbine searches conducted in 2004 at Meyersdale (73%), and Mountaineer (58%), and in 2003 at Mountaineer (61%).

Concurrent studies at Meyersdale and Mountaineer in 2004 showed a positive correlation in the timing of bat fatalities, indicating a regional phenomenon such as weather may affect mortality. Nights with average wind speeds exceeding 6 meters per second [13.4 mph]) were associated with extremely low observed bat fatalities, while the highest fatality rates were associated with low wind speed (less than 4 meters per second [8.9 mph]). High mortality rates were also associated with low relative humidity, higher temperature, and higher barometric pressure; conditions documented after weather fronts passed through the study areas (Arnett 2005).

Little information exists upon which to base conclusions regarding the biological significance of bat mortality at wind energy facilities. For instance, do the numbers of bats killed represent a meaningful proportion of the populations of these bat species? Unfortunately, total population estimates do not exist for any of the species killed at wind sites to date.

Reasonably accurate estimates exist for the federally endangered Indiana bat, one of the most uncommon North American species. No federally listed bat species has been identified during bat mortality studies at wind sites; we mention the size of the population of this species for context only. The most current censuses (2005) yielded a range wide population of 458,000 Indiana bats in existence. The population of Virginia big-eared bats is also reasonably well known, and was recently estimated at approximately 18,400 individuals (Currie 2000), and at 20,000 individuals (C. Stihler pers. comm.). Populations of species that have been killed at wind energy sites are much more common than these two listed species, and may be one or more orders of magnitude higher.

3.2 BAT COLLISION MORTALITY AT BEECH RIDGE

Specific pre-construction techniques/protocols that accurately predict chiropteran mortality at wind sites do not exist. Post construction mortality monitoring remains the best source for these data. However, comparison of the Beech Ridge site to other nearby similar sites with known mortality is a useful approach.

The highest levels of bat mortality documented to date have occurred at the two wind energy sites nearest Beech Ridge. There are substantial similarities in the Ecoregion, topography, elevation, geographic location, and other aspects of the Mountaineer, Meyersdale, and Beech Ridge sites (Table 3). Wind energy sites with lower mortality (e.g., the Lincoln site in Kewaunee County, Wisconsin; the Buffalo Ridge site in Minnesota; or the Foote Creek Rim site in Wyoming) are located in midwest or western states, are commonly located on flat terrain, and have been constructed in agricultural areas or other non-forested sites (e.g., short grass prairie/sagebrush, pasture).

Based upon published and unpublished information available at this time, the similarities in the projects discussed in Table 3, and the anticipated similarity in the behavior of bats at these same sites, we believe it likely mortality at the Beech Ridge site will be similar to that at the Mountaineer and Meyersdale sites. Studies completed between July 31 and September 13, 2004 at the Mountaineer and Meyersdale sites found a daily kill rate of 0.9 bats and 0.6 bats per turbine, respectively. These kill rates are representative of the peak period of mortality (fall migration period) rather than the entire year. Application of the mean of these daily kill rates, adjusted for rotor swept area, yields a predicted daily kill rate for the Beech Ridge site *during fall migration* of 0.9 bats per turbine, or a daily facility-wide total *during fall migration* of 112 bats (0.9 bats per turbine x 124 turbines).

If *annual* kill estimates (47.53 bats per turbine) based upon post-construction monitoring in 2003 at the Mountaineer site (FPL Energy 2004) are applicable to the Beech Ridge site, *annual* facility-wide mortality at Beech Ridge, adjusted for rotor swept area, can be predicted at 6746 bats. Due to the proposed number of turbines at Beech Ridge (124) relative to Meyersdale (20) and Mountaineer (44), the Beech Ridge facility may have a larger annual kill than the two other facilities combined.

Other than the two federally listed species that may occur in the project area, bat species that may suffer mortality at Beech Ridge are widely dispersed in the United States and a substantial portion of each species population will not forage in, roost in, travel through, or migrate over the Beech Ridge site.

The proposed Beech Ridge site originally presented the potential for concern in that it was thought to be proximate to Indiana bat and/or Virginia big-eared bat hibernacula, and was assumed to be located in an area used by Indiana bats and Virginia big-eared bats in the summer (Figure 7). However, surveys completed during the summer and winter (BHE 2005, BHE 2006) did not detect local presence of either species.

Table 3. Attributes of the Beech Ridge and Mountaineer, West Virginia; and Meyersdale, Pennsylvania wind energy sites.

Feature	Beech Ridge (Greenbrier Co., WV)	Mountaineer (Tucker Co., WV)	Meyersdale (Somerset Co., PA)
EcoRegion (Section)	Allegheny Mountains	Allegheny Mountains	Allegheny Mountains
Topographic position	Ridgelines	Ridgeline	Ridgeline
Approximate average elevation (above msl)	1160 m (3,800 ft)	1025 m (3,363 ft)	840 m (2,756 ft)
Vegetative cover	Towers to be placed in openings cleared in forest cover	Towers placed in openings cleared in forest cover	Towers placed in openings cleared in forest cover
No. of turbines	124 (1.5-MW)	44 (1.5-MW)	20 (1.5-MW)
Turbine string(s)	Single string on ~37 km of numerous ridgelines oriented primarily NW to SE, E to W, N to S, and NE to SW	Single 8.8 km string along generally SW to NE crest of Backbone Mountain	Single 3.8 km string generally SW to NE along ridgeline
Hub height	80 m (262 ft)	70 m (230 ft)	80 m (262 ft)
Rotor diameter	77 m (253 ft)	72 m (236 ft)	72 m (236 ft)
Max. rotor height	119 m (390 ft)	106 m (343 ft)	116 m (381 ft)
Min. rotor height	42 m (138 ft)	34 m (112 ft)	44 m (144 ft)
Rotor swept area	4,657 m^2 per turbine 577,468 m^2 total	4,071 m^2 per turbine 179,124 m^2 total	4,071 m^2 per turbine 81,420 m^2 total
Rotor RPM	17	17	17
Turbine cut in speed	3.5 meters per second (8 miles per hour)	4 meters per second (9 miles per hour)	4 meters per second (9 miles per hour)
Lighting	Red or white strobes on one third of turbines	L-864 red strobes on one third of turbines	L-864 red strobes on one third of turbines
Bat species in the region (bats listed for Mountaineer and Meyersdale are those species detected in mortality searches. Percent of total detected mortality is indicated).	Hoary bat Eastern red bat Eastern pipistrelle Big brown bat Silver-haired bat Little brown bat N. long-eared bat Eastern small-footed bat Indiana bat Virginia big-eared bat	Hoary bat (33.7%) Eastern pipistrelle (24.6%) Eastern red bat (24.1%) Little brown bat (9.8%) Silver-haired bat (4.8%) Big brown bat (2.5%) Unidentified sp (0.5%)	Hoary bat (45.4%) Eastern red bat (27.5%) Eastern pipistrelle (8.0%) Big brown bat (6.9%) Silver-haired bat (5.7%) Little brown bat (2.7%) N. long-eared bat (0.7%) Unidentified Myotis (0.5%)

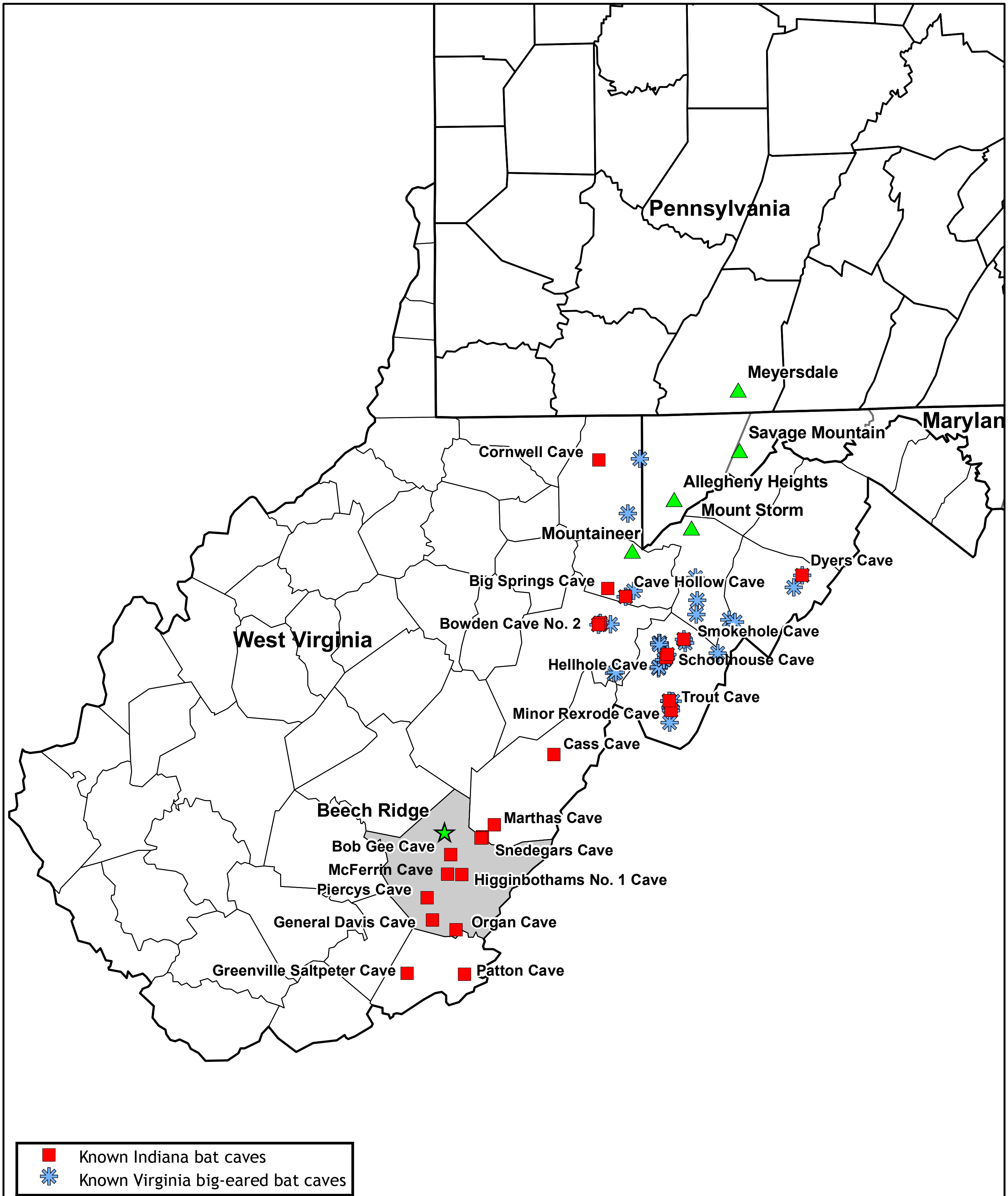


Figure 7. Indiana bat hibernacula and Virginia big-eared bat caves in West Virginia near the Beech Ridge site.

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June 2006

BHE ENVIRONMENTAL

The Beech Ridge site is within a group of counties, generally extending southwest to northeast, in which Indiana bats hibernate. Counties in which summer occurrences of the species have been documented are immediately west and east of Greenbrier County (Figure 4). Summer occurrences have been documented in Randolph, Tucker, and Pendleton counties north of Beech Ridge. With Indiana bat hibernacula in Greenbrier County (Figure 5), and in other nearby counties (Figure 7) male Indiana bats may be present in the county during summer. Considering known proximate locations of summer and winter occurrences of Indiana bats, it is reasonable to presume individuals of this species move through Greenbrier County in spring and fall. It is unlikely female and juvenile Indiana bats will occupy the project area during summer. Thermal conditions in the project are less than ideal, and may be entirely unsuitable, for use by females and young (Brack et al. 2002).

The chance of collisions between Indiana bats and turbine blades during the summer is low. Indiana bats, even if present, are likely to be rare in the project area, and are likely to be active at heights largely below the rotor swept area. Studies completed to date have documented very low mortality during summer months, even when concurrent mist net surveys and or ultrasound acoustic detection devices indicate the presence of substantial numbers of bats. Chances of mortality during migration, especially during the fall, may be higher.

Virginia big-eared bats do not migrate, or migrate locally - with movements between summer and winter caves generally less than 40 miles (64 km). Most of Fayette County, West Virginia and most of Bath County, Virginia, in which the species has been documented, is within 40 miles (64 km) of the Beech Ridge project site. If the species utilizes caves near the project area, for instance in the area of karst south of the site, Virginia big-eared bats may occur in the project area during spring or fall. No signs of summer or winter presence of Virginia big-eared bats were identified in caves within 5 miles of the nearest turbine during surveys completed in early 2006 (BHE 2006).

The chance of fatalities of this species is considered very low. Surveys completed during the summer and winter (BHE 2005, BHE 2006) did not detect local presence of the species. The species has not been documented in Greenbrier County.

3.3 HABITAT DEGRADATION AT BEECH RIDGE

The USFWS is routinely consulted regarding potential impacts to federally listed bat species associated with a wide variety of projects in the eastern United States. Their concerns commonly focus upon habitat modifications near hibernacula and maternity caves, and modification of forested habitat in nearly any location within the range of potentially affected species. Where such habitat modifications occur, the Service recommends project-specific consultation.

Removal of forested habitat may affect summer maternity habitat of the Indiana bat, and the Service routinely requires mist net surveys to characterize the summer presence of this species in project areas. If forest removal in occupied Indiana bat summer habitat occurs, there is commonly substantial concern regarding the potential for direct mortality. A single maternity tree may support 100 or more adult female Indiana bats and their young.

Trees within approximately 55 meters (180 ft) of each tower will be cleared, yielding approximately 2.3 acres (0.9 ha) of cleared area per tower, and 285 acres (115 ha) at tower sites project-wide. Pre-construction presence/absence surveys were completed in 2005 along the proposed turbine sites; no Indiana bats were captured. Similar surveys will be completed at 12 mist net sites in summer 2006 along forested portions of the proposed transmission corridor. As during previous surveys of the project area, the survey intensity for this effort has been coordinated and approved by the USFWS.

The transmission line corridor extending northwest from the turbine strings will require the clearing of approximately 128 forested acres. For purposes of the conclusions in this document, we have assumed mist net surveys along the transmission corridor will not detect the presence of Indiana bats or Virginia big-eared bats.

In terms of forest habitat utilized by other bat species that may utilize the project area, it is important to consider this project in the context of forest habitat present in the local area. Greenbrier County includes approximately 1023 mi^2, 75% of which is forested (Griffith and Widmann 2003). The proposed project will remove approximately 400 acres of forest (less than 0.08% of the forest in the county) and is therefore exceedingly unlikely to constitute a significant loss in the habitat available to bats that utilize forested habitat.

Based upon the best available information, including almost exclusively negative results of summer mist net surveys for Indiana bats in West Virginia, and the elevation of the Beech Ridge site, the likelihood of an Indiana bat maternity colony in the project area is very low. However, considering the proximity of the project area to known and potential hibernacula, there is perhaps potential for presence of male Indiana bats roosting and or foraging within the project area during summer, and migrating/staging/swarming individuals utilizing the project area during spring and fall. There is one historic hibernaculum within 5 miles (8 km) (Bob Gee Cave), three active hibernacula (McFerrin Cave, Martha's Cave, and Snedegars Cave) between 5 and 10 miles (8 and 16 km) of the site, and one historic hibernaculum (Higginbotham Cave No. 1) between 5 and 10 miles (8 and 16 km) of the site. The site generally lies within a band of counties in which Indiana bats occur in the winter (or winter and summer), and is just to the east of two, and northeast of two West Virginia counties in which Indiana bats occur in the summer (Figure 4). These summer occurrences are limited to a single male Indiana bat in each county.

Virginia big-eared bats have not been identified utilizing caves within 10 miles (16 km) of the project site, or anywhere in Greenbrier County. Because these bats travel up to approximately 6.5 miles (10.5 km) from their roost cave to feed, and because there are no caves utilized by this species near the project area, the likelihood of Virginia big-eared bats being present in the project area in the summer is very low. Removal of forest vegetation as proposed for this project is unlikely to affect this species.

3.4 DISTURBANCE AND DISPLACEMENT OF BATS AT BEECH RIDGE

Speculations have been made concerning the potential disturbance of bats by operating wind energy facilities, and the potential for resulting displacement from otherwise suitable habitat. Data do not exist to dismiss the risk of such disturbance or displacement, but preliminary information now available supports the conclusion that wind turbines and their blades do not substantially disturb/displace bats. In 2004 at the Mountaineer and Meyersdale wind sites, bats were commonly observed foraging in forest openings at turbine sites. Thermal imaging equipment was used to investigate bat behavior near wind towers. Bats landed on towers, foraged near rotating blades, pursued rotating blades, and flew in patterns that appeared to indicate purposeful collision avoidance. The presence of bats near operating turbines was also documented at the Buffalo Ridge site in Minnesota (Johnson et al. 2003a), and the Buffalo Mountain site in Tennessee.

4.0 POST CONSTRUCTION MONITORING AND ADAPTIVE MANAGEMENT TESTING

Beech Ridge Energy LLC is proposing post-construction bat mortality monitoring, and the testing of adaptive management techniques to mitigate this mortality. This monitoring and integrated testing of adaptive management strategies would be completed over a three-year period, and would be comprised of (1) an initial one-year baseline monitoring program including standardized carcass searches, scavenging assessments, observer-bias evaluations. Additionally, the studies will include the collection of meteorological data to assess correlations between wind speed, wind direction, other meteorological factors, and bat fatality. The year of baseline data collection will be followed by two-years of continued monitoring coupled with testing of adaptive management strategy(s).

As part of this effort, Beech Ridge Energy LLC will form a Technical Committee, the purpose of which will be to provide ongoing technical input throughout the development and implementation of the Post Construction Monitoring Plan and the Adaptive Management Plan. Membership on the Technical Committee may be filled by Beech Ridge Energy LLC personnel, and a representative of the Public Service Commission, the USFWS, the WVDNR, the Bat Wind Energy Cooperative, and an established state-wide environmental organization. It is the intention of Beech Ridge Energy LLC to share post construction bat mortality data, exclusive of proprietary information, with members of the Technical Committee.

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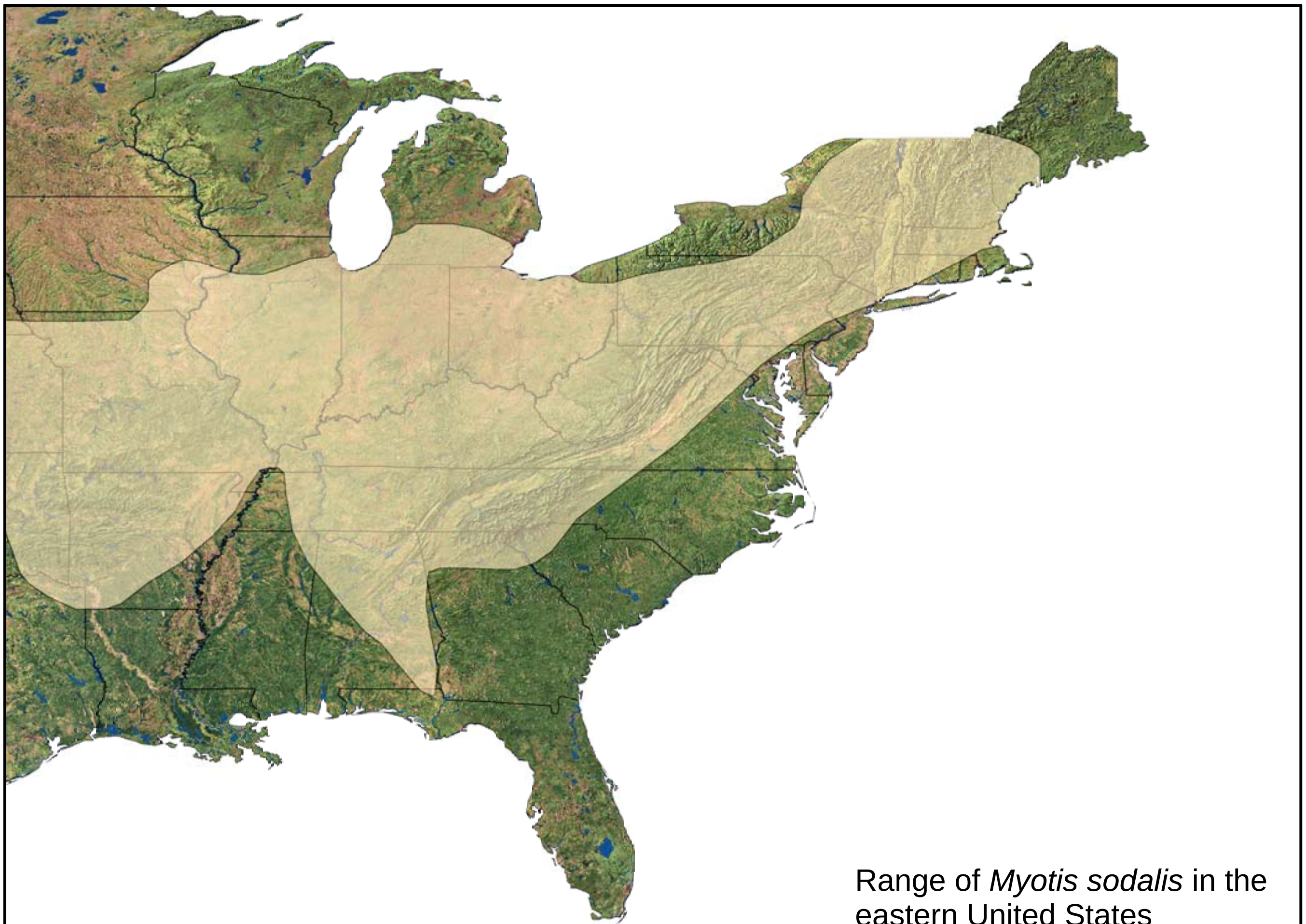
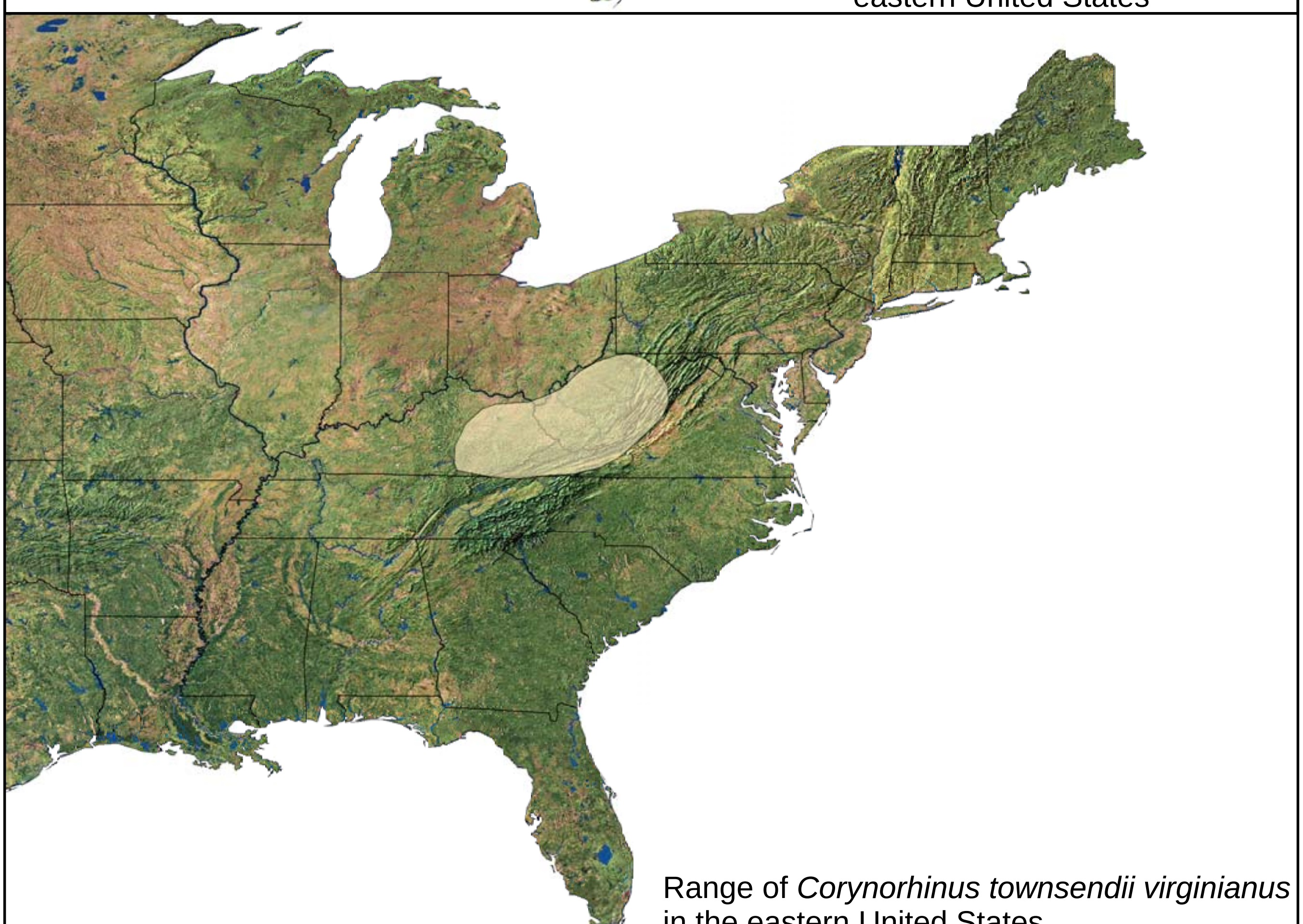
APPENDIX A

Bats of the Beech Ridge Project Area – Range Maps



Range of *Myotis sodalis* in the eastern United States



Range of *Corynorhinus townsendii virginianus* in the eastern United States

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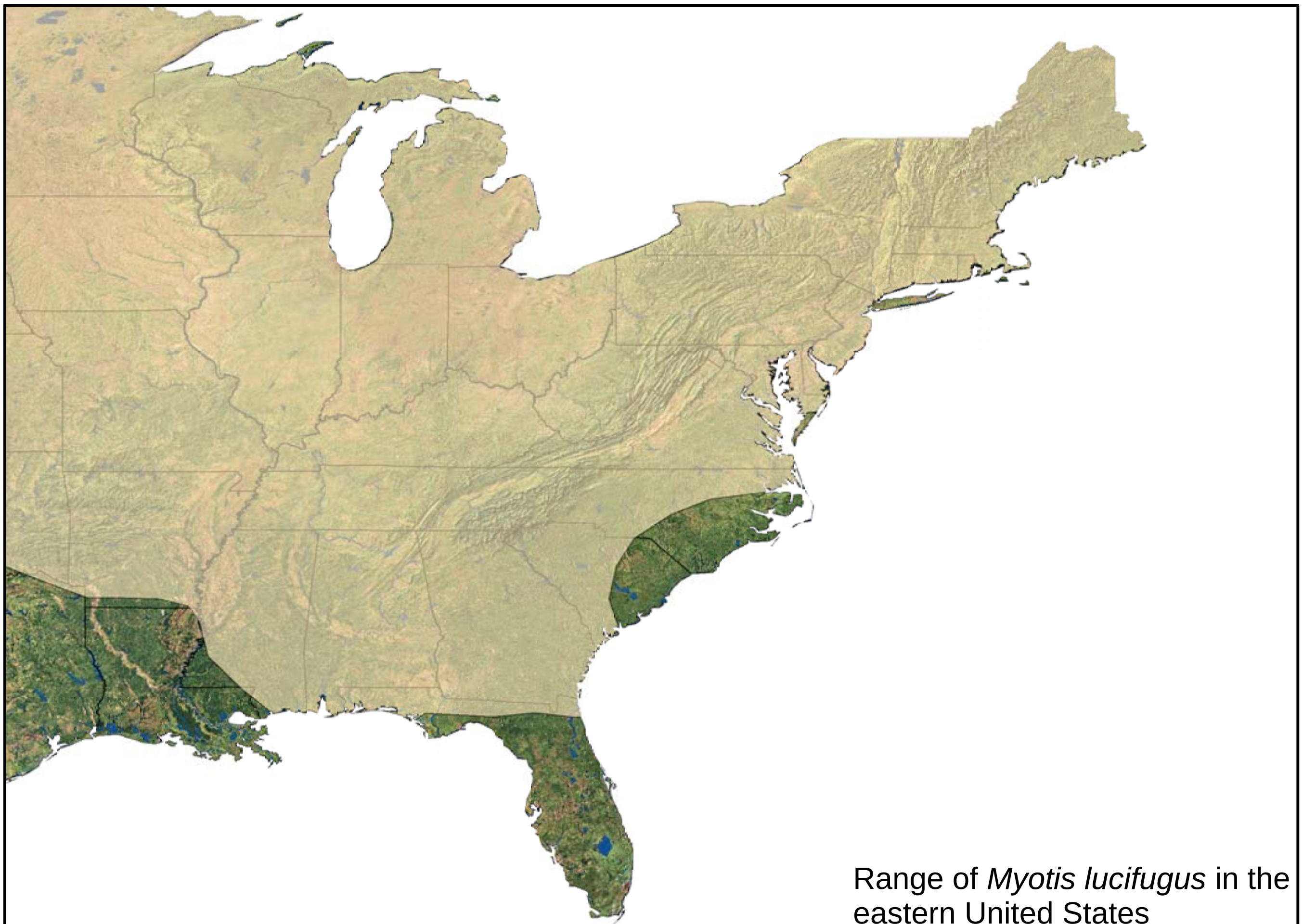

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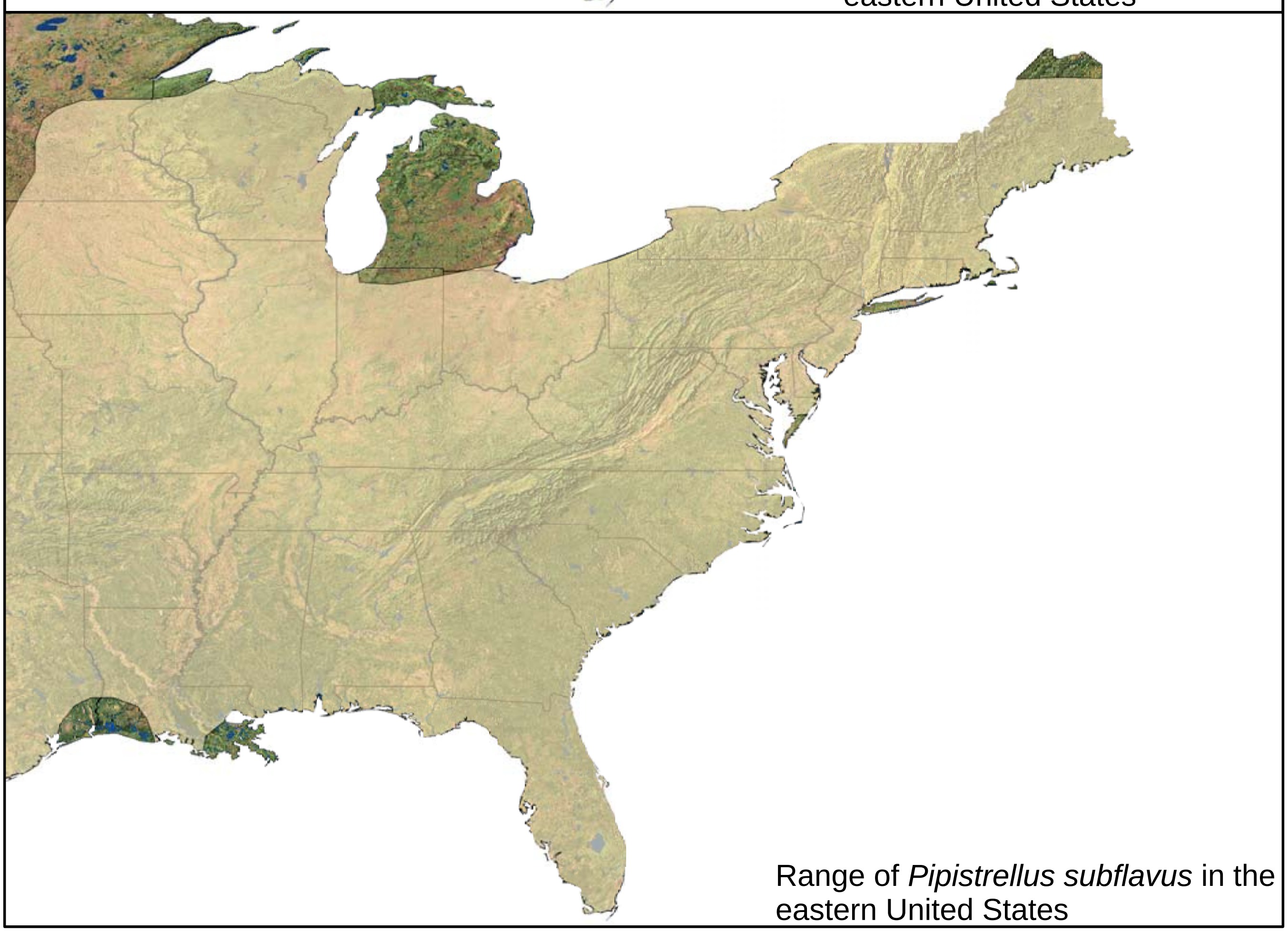

Range of *Pipistrellus subflavus* in the eastern United States

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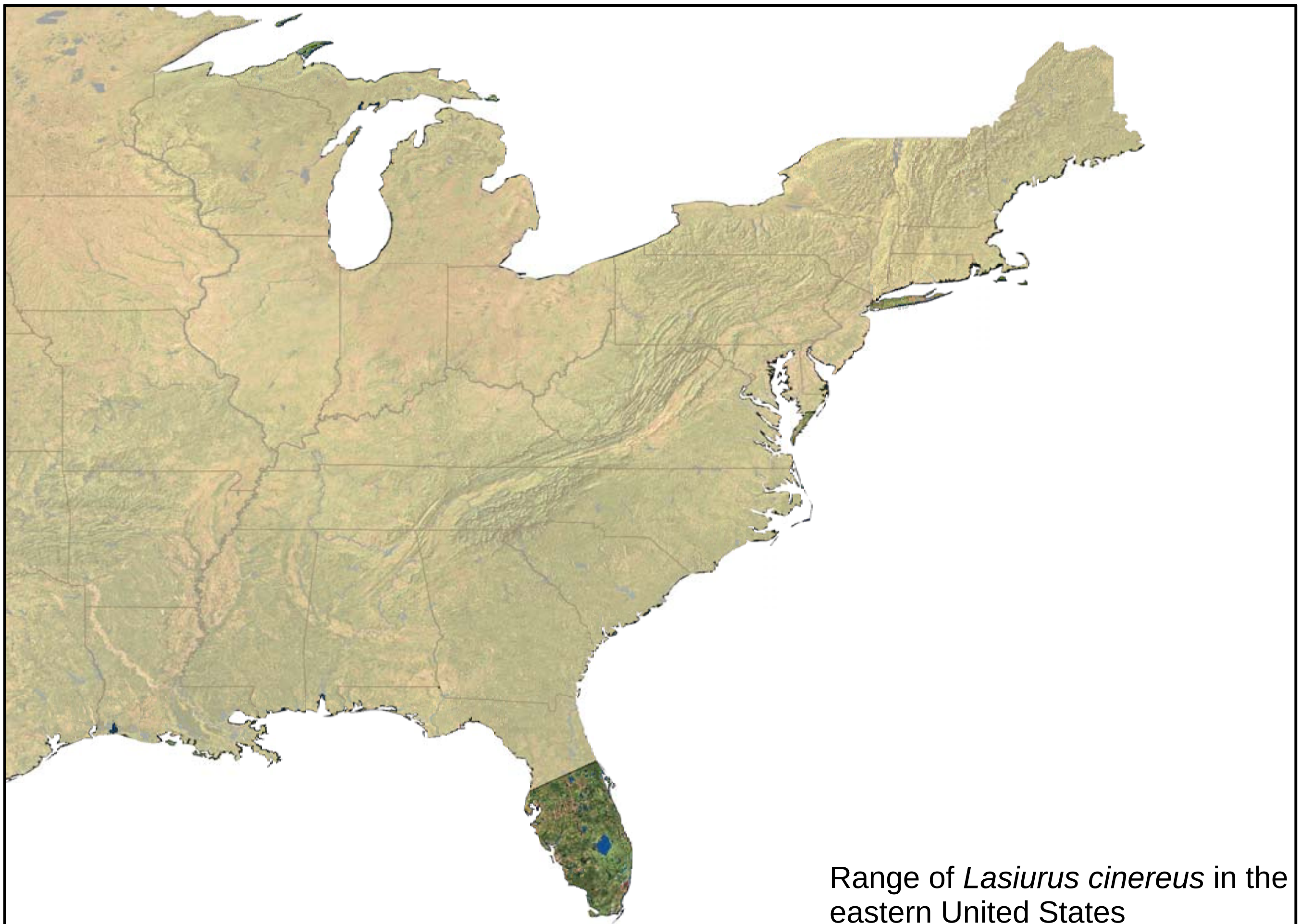
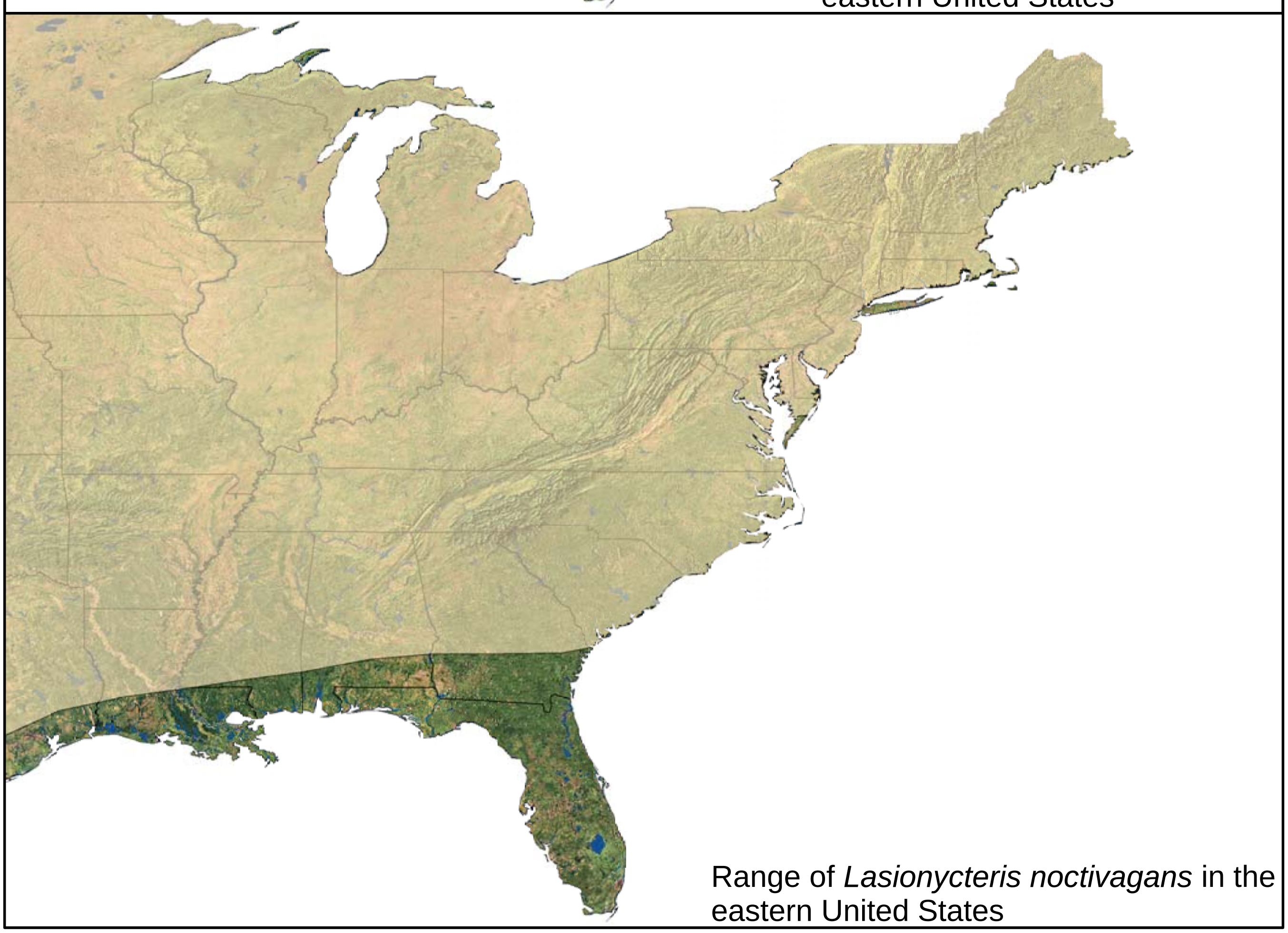


Range of *Lasiurus cinereus* in the eastern United States



Range of *Lasionycteris noctivagans* in the eastern United States

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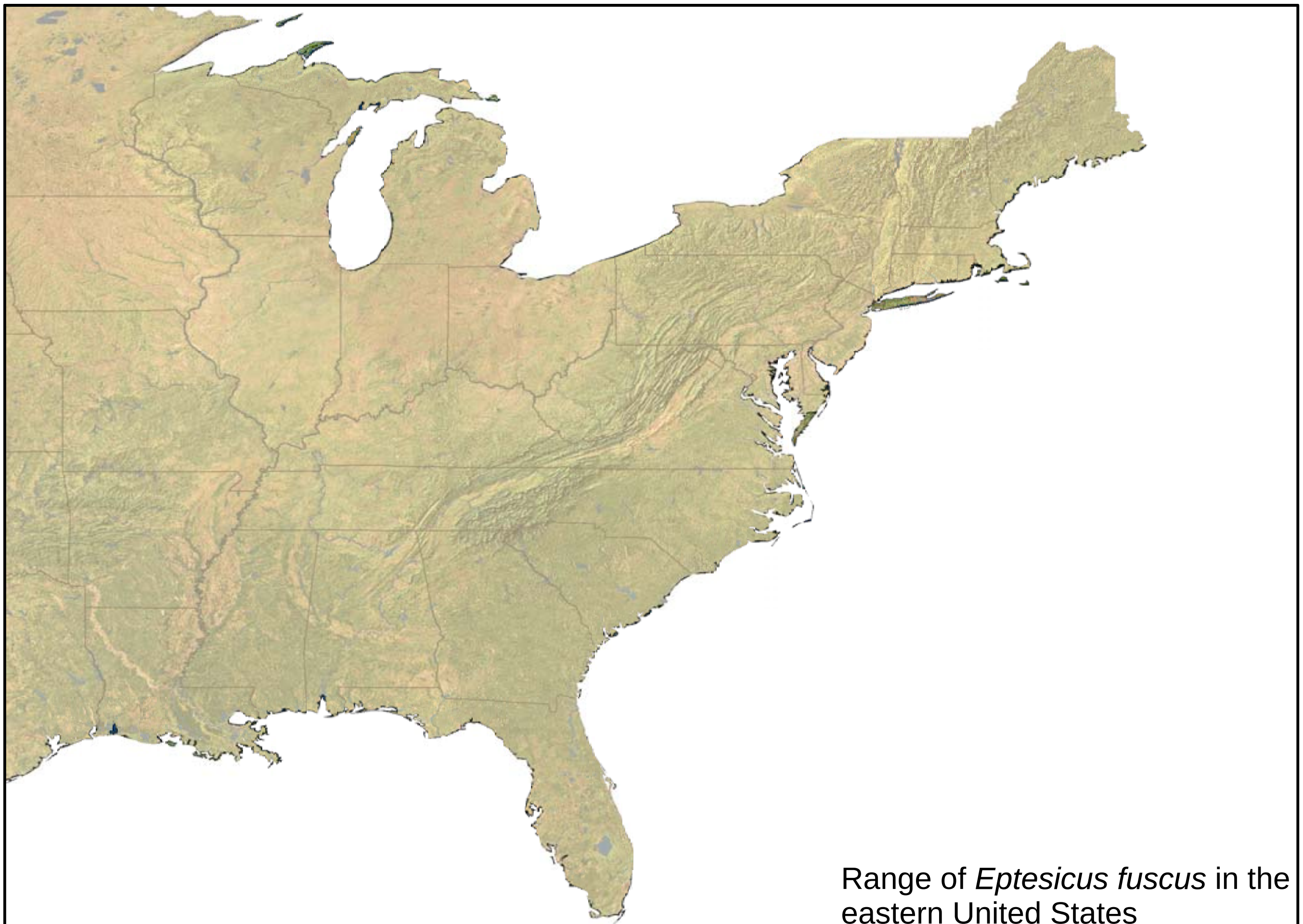
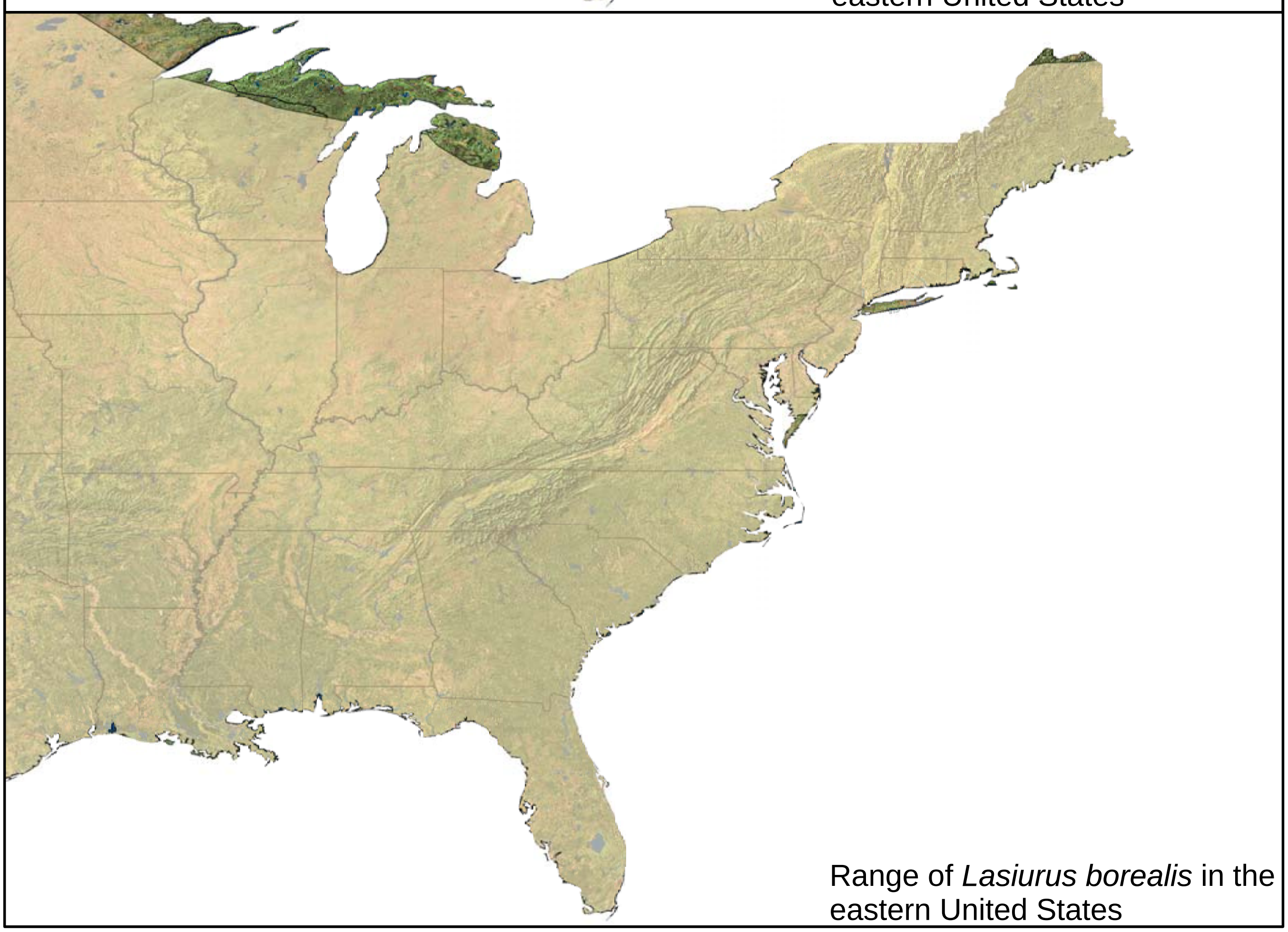


Range of *Eptesicus fuscus* in the eastern United States



Range of *Lasiurus borealis* in the eastern United States

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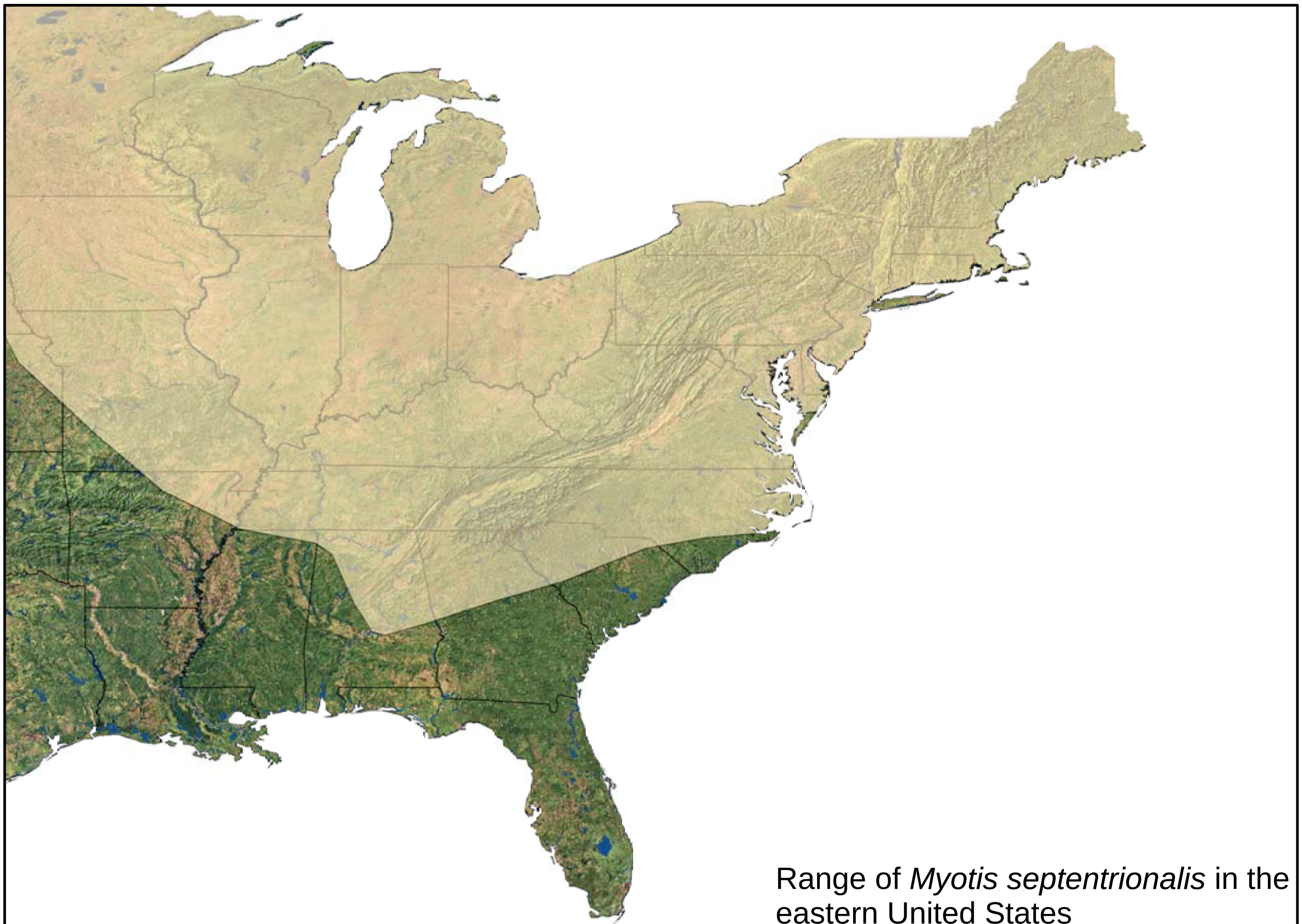
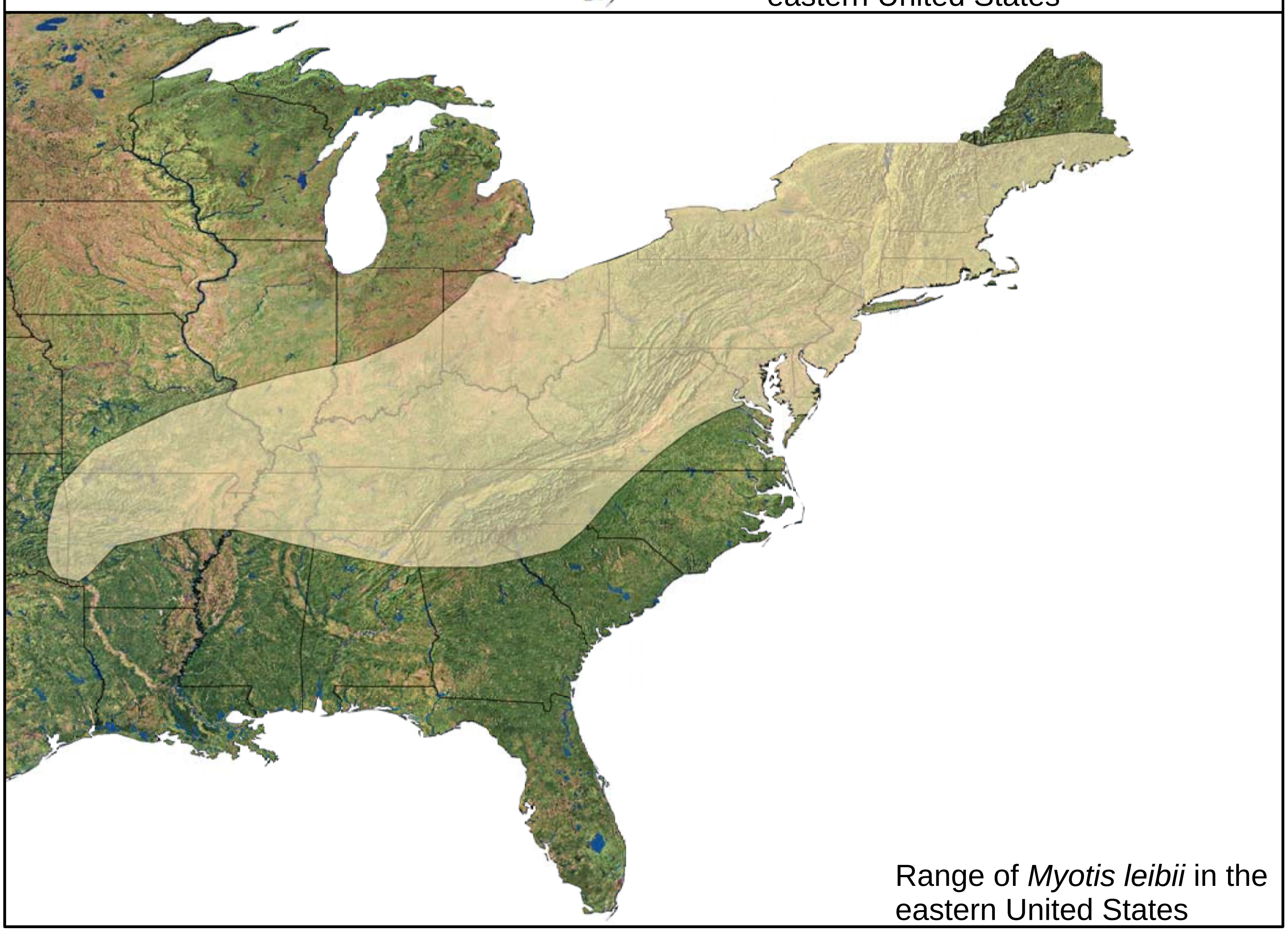


Range of *Myotis septentrionalis* in the eastern United States



Range of *Myotis leibii* in the eastern United States

Bat Range data obtained from - http://www.natureserve.org/getData/mammalMaps.jsp (06/21/2005)

Bat Mist Netting and Acoustic Surveys
Beech Ridge Wind Energy Project
Greenbrier and Nicholas Counties, West Virginia

Revised – June 27, 2011

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1.0 Introduction and Background Information

Currently, Beech Ridge Energy, LLC (BRE) is working collaboratively with the U.S. Fish and Wildlife Service (USFWS) to develop an application for an Incidental Take Permit (ITP) pursuant to Section 10 of the Endangered Species Act (ESA) that would cover BRE's Beech Ridge Wind Energy Project (Project), located in Greenbrier and Nicholas Counties, West Virginia. Integral to the application, BRE is developing a habitat conservation plan (HCP) in accordance with applicable guidance and regulations (USFWS and NMFS 1996, USFWS and NOAA 2000). The proposed covered activities in the HCP include operation, maintenance, and decommissioning of the existing 67 turbines and associated infrastructure and construction, operation, maintenance, and decommissioning of up to 33 additional turbines and associated infrastructure at the Project.

The USFWS requested that BRE conduct additional surveys for bats at the Project site in order to compare data from previous site study results, and to provide additional information for the HCP including bat use and occurrence at the Project site during the summer and fall seasons. BRE developed a scope of work for the studies with input from USFWS (Carter 2010) and West Virginia Department of Natural Resources (WVDNR) (Stihler 2010 pers. comm.) to address the request and to insure the HCP and ITP are based upon the best available scientific information as required by the ESA.

BRE conducted mist-net surveys for bats at 15 net sites within the then proposed Project site from July 22-26, 2005. The surveys resulted in the capture of 78 bats of six species (see BHE 2005). BRE also conducted mist net surveys for bats at 12 net sites along the proposed 14.5 mile transmission line right-of-way, including six locations within one mile of proposed turbine sites, from June 12-22, 2006. The surveys resulted in the capture of 42 bats of five species (see BHE 2006). No Indiana bats (*Myotis sodalis*) or Virginia big-eared bats (*Corynorhinus townsendii virginianus*) were captured during either survey.

The primary objective for the current study was to provide additional information about bat species composition, occurrence, and activity at the Project site during the summer and fall seasons (WEST 2010). The purpose of netting during the summer and fall was to provide data on presence/probable absence of Indiana bats and Virginia big-eared bats during the summer maternity season and during the fall migration and swarming period (Carter 2010). The primary objective for acoustic surveys was to assess temporal patterns in bat activity in the project area. A secondary objective of the acoustic survey was to screen the data for the potential presence of Indiana bat and provide more general results for other bat species that occur at the site.

2.0 Methods

The 2010 summer and fall field surveys consisted of mist-netting surveys for bats within the existing project area and the area proposed for the 33-turbine expansion and acoustic surveys for bats using AnaBat acoustic bat detectors within the existing project area and near mist-net sites.

2.1 Mist-Net Survey

The mist-net survey effort was determined in consultation with the USFWS (Carter 2010). The USFWS guidelines recommend that two net sites be surveyed for every square-kilometer (247 acres [100 hectares, ha); one net site per 123 acres [50 ha]) of habitat impact for determining presence or probable absence of Indiana bats[1]. The Project has been reduced in size since the 2005 and 2006 site surveys from 123 turbines to a 100-turbine project. The total disturbance for the Project facilities once complete (all 100 turbines), including both temporary and life-of-project disturbance, will be approximately 356 acres[2] (144 ha). The level of mist-netting survey effort recommended by the USFWS guidelines for the size of this Project is four total net sites. In order to meet the survey objectives and to assess the presence/probable absence of Indiana bats and Virginia big-eared bats at the Project site, it was determined that eight net sites would be established over the existing Project area, and that an additional six net sites be established over the area proposed for the additional 33 turbines (14 total net sites). This level of survey effort is more than three times the effort recommended by the USFWS guidelines for a 356-acre (144-ha) project and was determined to be sufficient to provide coverage given the number of acres and linear extent of the project (Carter 2010). This survey effort is consistent with previous studies at the Project and, similar to the previous studies, was

[1] The USFWS mist-netting guideline recommendations state that nets should be set near "[s]treams and other linear corridors - one net site per kilometer of stream or corridor; non-corridor study areas – two net sites per square kilometer of habitat (USFWS 2007)." The Project does not clearly fit into either method of determining mist-netting effort. The Project area is not a linear corridor but a discontinuous series of small turbine strings constructed in an area where there are multiple ridgelines (see Figure 1). The Project is constructed on top of ridges where there are no streams. Total linear distance of new disturbance was not easily calculated because portions of the project were constructed adjacent to existing roads that support the current land use and the turbine strings are not one continuous row. Turbines were constructed in smaller cleared areas adjacent to existing roads. Given uncertainties regarding the appropriate level of survey effort, the proposed survey effort was vetted with the USFWS and increased beyond that recommended by the USFWS guidelines (2007) based on total disturbance to insure that adequate coverage was achieved and equivalent to the previous studies in 2005 and 2006 despite the reduction in the overall project size.

[2] Note: the estimated amount of temporary disturbance has since been revised to 343 acres (139 ha), but this did not affect the methods used in this study.

determined in consultation with USFWS and WVDNR.

The mist-net survey for bats was conducted using methods described in the USFWS Indiana Bat Mist-netting Guidelines (USFWS 2007). The survey was conducted by a permitted biologist for Indiana bat capture surveys and with a valid West Virginia State scientific collecting permit. All permit conditions were followed including the most current white-nose syndrome (WNS) decontamination procedures.
Net site locations were determined in the field by qualified biologists with extensive experience netting for bats and permitted for Indiana bat capture. Net sites were established throughout the existing Project and in areas of proposed construction (Figure 1). Mist-net site selection focused on the wooded habitat and ecotones associated with the forested areas, as well as water sources where available. Specific net sites were selected based on the suitability for netting, habitat characteristics, distribution across the project area, topography, and the ability to funnel or direct bats to the selected netting locations.

Each net site had a minimum of two separate net sets and was erected approximately one-half hour prior to sunset. Net sets consisted of single nets 8.5 feet (~2.6 m) to triple-high nets 25.5 feet (~7.8 m) ranging from 18 to 60 feet (~6 to 18 m) in length and depended on the net site characteristics (e.g., canopy height). Individual net sets were placed in three basic configurations: blocking trails/roads/flyways, over water, or jutting from the edge of a block of forest into an open area. Trail and flyway net sets were placed to give optimum coverage in the selected flyway. The ends of the nets were set back into the woods, making it difficult for bats to fly around the nets. Triple-high net sets were used to reach as high into the canopy as possible. Net sets over water were set to catch bats either coming in for a drink or foraging over the water. Nets over water were placed in V, N, or W shapes to obstruct bats' access to the water.

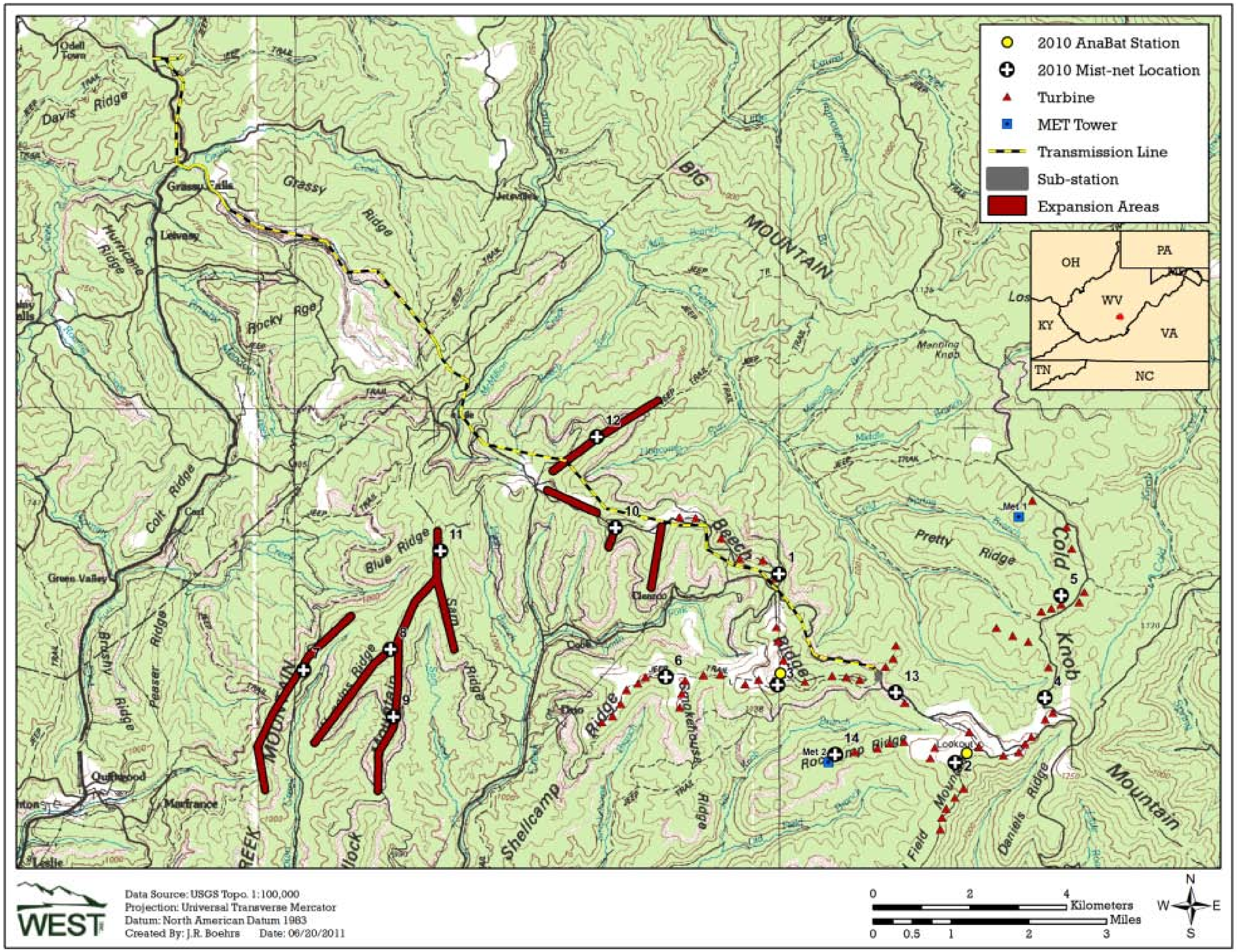


Figure 1. Mist-net and AnaBat survey locations within the Beech Ridge wind energy project and proposed expansion area.

Each net site was surveyed for two consecutive nights, unless interrupted by weather events, in which case the site was surveyed for a third night. Nets were monitored approximately every 15 minutes for at least five hours after sunset, weather permitting, as described in the guidelines, and captured bats were removed and processed as soon as they were detected. Data recorded included, net of capture, height of capture, time of capture, species, age, sex, reproductive condition, weight, forearm length, and wing damage index. Efforts were made to conduct the netting survey on nights with no precipitation, warm temperatures, and low winds according to conditions defined in the guidelines. Most nets were set under canopy cover or there was cloud cover which minimized potential effects on capture rate due to moon light.

2.2 AnaBat Acoustic Survey

A passive acoustic survey using AnaBat SD1 acoustic detectors (Titley Electronics Pty Ltd., NSW, Australia) at two turbines (Figure 1) was conducted from mid-July through mid-November. The methods used were based on recommendations for study of wind project sites (Anderson et al. 1999, Arnett et al. 2006, Kunz et al. 2007) and followed the most effective known measures for orienting and weatherproofing the AnaBat recommended in Britzke et al. 2010.

AnaBat detectors record bat echolocation calls with a broadband microphone. Calls are recorded to a compact flash memory card with large storage capacity. The AnaBat detectors were placed inside plastic weather-tight containers with a hole cut in the side of the container for the microphone to extend through. Microphones were encased in PVC tubing with drain holes that curved skyward at 45 degrees outside the container to minimize the potential for water damage due to rain and insure optimal detection of bat calls. This method of orienting and weatherproofing AnaBat detectors has been shown to provide greater rates of detection and highest call quality compared to other measures (Britzke et al. 2010).

Four AnaBat units were deployed at two turbines, one in the eastern half and one in the western half of the Project (Figure 1). At each turbine, one AnaBat was deployed at ground level, near the base of the turbine, and the second AnaBat was mounted on top of the turbine nacelle, approximately 262 feet (80 m) above ground level (agl). The ground-based unit containers were raised approximately 3 feet (1 m) off the ground to lift the unit above ground vegetation and minimize potential echo interference.

The AnaBat units were programmed to run continuously each night beginning a minimum of one hour before sunset and ending a minimum of one hour after sunrise.

Data stored on the compact flash cards were downloaded approximately every two weeks and checked to insure the AnaBat units were functioning properly.

In addition to the four AnaBat detectors at turbines, two additional AnaBat detectors were used to investigate bat activity near mist-net sites by deploying the units at ground level within approximately 164 (50 m) of a mist-net site on each night of netting. The detectors were operated during the mist-net survey effort, from approximately sunset to the end of the netting survey period, and remained fixed (i.e., the AnaBat detector was not moved) for the sampling period each night.

The AnaBat data were analyzed to investigate temporal changes in bat activity within the Project. The unit of activity for the acoustic analysis was the number of bat passes (Hayes 1997). The total number of bat passes per detector-night was used as an index of bat activity in the Project. Bat pass data represented levels of bat activity rather than the numbers of individuals present because individuals cannot be differentiated by calls. A pass, or bat call, was defined as a continuous series of two or more call notes produced by an individual bat with no pauses between call notes of more than one second (White and Gehrt 2001, Gannon et al. 2003). The number of bat passes was determined by downloading the data files to a computer and tallying the number of echolocation passes recorded using AnalookW 3.8.13 (Corben 2010). Total number of passes was standardized for effort by dividing by the number of nights the detector was operating (detector-night). Bat calls were classified as either high-frequency calls (> 40 kHz), mid-frequency (30-40 kHz), or low-frequency calls (< 30 kHz) by using the minimum frequency for any give call as displayed by the Analook software. High frequency calls are generally made by small bats (e.g. *Myotis* sp.) while lower frequency calls are generally made by larger bats [e.g. silver-haired bat (*Lasionycteris noctivagans*), big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*)]. Data determined to be noise (produced by a source other than a bat) or call notes that did not meet the pre-specified criteria to be termed a bat pass were removed from the data prior to analysis.

2.2.1 Quantitative Analysis of Echolocation Data

Echolocation call sequences were subjected to quantitative analysis in two ways. Calls sequences were examined with a discriminant function analysis (DFA) intended to classify echolocation call sequences to species. Based on a library of known calls[3] (Table 1), WEST developed a discriminant function (DF) model that used values from 11 parameters of echolocation call sequences (Table 2). Developing a DF model

[3] Call library provided by Dr. Lynn Robbins, and collected by him and students, including Eric Britzke, between 1997 and 2008.

involves statistically determining functions that maximally separate (i.e., discriminate) two or more groups based on a set of variables that are measured on individuals in the groups. Each function is constructed as a linear combination of the measured variables, and each is designed to be uncorrelated with the other functions. Once the model is developed, parameters from unknown echolocation calls are submitted to the model, which probabilistically determines the species match that is most likely, subject to the species being in the model. Species were excluded if they are not known to occur in the area (Table 1). The DFA produces a posterior discriminant probability (PDP), or the probability that an unknown call sequence was correctly classified, subject to the constraints of model error. To improve prediction accuracy during the analysis it was specified that a PDP of 0.99 or better was required to make a species identification. Echolocation sequences that had PDPs < 0.99 were classified as "Other". To increase prediction accuracy, we used a filter[4] to remove low quality and incomplete calls and to specify a minimum number of calls (or pulses) per sequence. After applying this filter, 1,481 call sequences were available to be used in the DFA.

As a group, bats in the genus *Myotis* can be difficult to differentiate based on echolocation calls. For example, calls of the Indiana bat and the more common little brown bat and northern Myotis can be especially difficult to differentiate. Because of similarity of echolocation between Indiana and the more common Myotis bats, these species tend to have higher rates of misclassification as one another during modeling attempts (Britzke et al. 2002, Britzke et al. 2011). Because of the ambiguity associated with Indiana bat echolocation calls, a second quantitative screening tool was used to provide increased confidence in classifications. The second method involved using a filter in the software used to view and label AnaBat echolocation call data (Analook v4.9j; Corben 2010). The filter[5] itself was developed by Dr. Eric Britzke for the USFWS and Kentucky Department of Fish and Wildlife Services (KDFWS). This "Britzke" filter is not intended to provide independent evidence of presence, but rather is used to guide decisions on where to conduct mist-net surveys and the need for additional mist-net surveys at a site (USFWS & KDFWR 2007). However, using this second quantitative screen provides additional support for Indiana bat classifications when both screens identify the same call in an echolocation file as consistent with Indiana bat echolocation characteristics. A third screen used to provide added confidence was to qualitatively review the data, and this approach is outlined below in Section 2.2.1.

[4] Based on the noise filter described in USFWS & KDFWR (2007), but requiring at least 5 pulses with bandwidth of 10 kHz or greater.
[5] Filter parameters and protocol available in USFWS & KDFWR (2007).

For other species, DFA results were used to determine the proportion of nights at each AnaBat detector that a species was detected at least once. This was done because the number of echolocation passes does not provide an index to the number of individuals present, only the amount of activity or use of the area by bats.

Table 1. Summary of bat call data used to develop the DF model

Species		Number of Files	Mean Number Calls per File	Within Range?	In DF Model?
Big brown bat	*Eptesicus fuscus*	110	33.2	Y	Y
Eastern red bat	*Lasiurus borealis*	46	34.7	Y	Y
Hoary bat	*Lasiurus cinereus*	32	22.8	Y	Y
Silver-haired bat	*Lasionycteris noctivagans*	34	23.2	Y	Y
Gray bat	*Myotis grisescens*	62	57.9	N	N
Eastern small-footed bat[1]	*Myotis leibii*	12	37.5	Y	Y
Little brown bat	*Myotis lucifugus*	68	38.3	Y	Y
Northern long-eared bat	*Myotis septentrionalis*	50	36.9	Y	Y
Indiana bat	*Myotis sodalis*	93	37.6	Y	Y
Evening bat [1]	*Nycticeius humeralis*	15	26.0	N	N
Tri-colored bat	*Perimyotis subflavus*	118	27.9	Y	Y

[1] Low number of reference files (N <15) suggests that results for this species are subject to a high degree of uncertainty; however, all the results should be interpreted with caution (see Section 4.2).

Table 2. Description of call parameters extracted in Analook and used in the DF model.

Parameter	Description	Units
Dur	Pulse duration	Milliseconds (ms)
Fc	Characteristic frequency	kilohertz (kHz)
Fk	Frequency at knee (inflection point)	kHz
Fmax	Maximum frequency of pulse	kHz
Fmean	Mean frequency of pulse	kHz
Fmin	Minimum frequency of the pulse	kHz
varFmin	Variance in mean Fmin	kHz
S1	Initial slope of pulse	Octaves per second (OPS)
Sc	Characteristic slope of the pulse	OPS
Tk	Time to knee	ms

2.2.1 Qualitative Analysis of Echolocation Data (for Indiana bat Calls)

In addition to the Britzke filter and DFA analyses, all 12,431 calls recorded during 2010 were examined qualitatively by WEST's Indiana bat biologist, Dr. Kevin Murray, who scanned the sequences for calls with visual characteristics (e.g., duration, slope, general appearance) consistent with Indiana bat. Those sequences that Dr. Murray deemed to have met the criteria and thus may have been produced by Indiana bat were noted. Qualitative analysis also included Dr. Murray's review of call sequences that were identified by one or both of the quantitative screens as Indiana bat calls. This was done to minimize false positives that arise from instances in which the quantitative screens select certain pulses as potential Indiana bats in sequences that are either inconsistent with known Indiana bat calls or were clearly produced by a different species. Review and vetting of the output from predictive models is strongly recommended by those whose models attempt to probabilistically determine bat species identification (e.g., Joe Sczewczak, Humboldt State University, pers. comm).

3.0 Results

3.1 Mist-Net Survey

The summer mist-net survey was conducted between July 27 and August 9, 2010 (Sanders Environmental 2010a). Precipitation events on the night of July 31 interrupted either the first or second night of netting at three sites. These three sites were netted for a third night to insure that the minimum survey time (5 hours per night) was achieved (see Sanders Environmental 2010a for details on netting time per site). No netting occurred on the nights of August 4 and 5 due to rain.

Two-hundred and nine bats of seven species were captured (Table 3). No Indiana bats or Virginia big-eared bats were captured during the summer survey. Over all net sites, all nights, and all species, on average approximately 15 bats were captured per net site (Table 3).

The most common species in terms of numbers and distribution during the summer was red bat (*Lasiurus borealis*) which comprised more than 35% of all bats captured (Table 3). Seventy-four red bats were captured and this species was caught at 13 of the 14 net sites (~93%). On average 5.3 red bats were captured per night during the summer netting. The most common *Myotis* captured during the summer was little brown bat (*Myotis lucifugus*), which comprised slightly more than 24% of all bats captured (Table 3). Fifty-one little brown bats were captured at 12 of 14 net sites (~86%).

Table 3. Summary of bat captures during the summer mist-net survey

Site	Little brown bat	Northern long-eared bat	Eastern small-footed bat	Big brown bat	Tri-colored bat	Red bat	Hoary bat	Total
1	1	7	2			5		15
2	4	1	2	1	2	4		14
3		6				1		7
4	11	2	1	3		6		23
5	4				4	4		12
6		2				2		4
7	7	5	4	3	1	18		38
8	4	2		4				10
9	1	5		1	2	1		10
10	2	1						11
11	10	5	2	2	4	17		40
12	4	1	1	6		4	1	17
13	2					3		5
14	1				1	1		3
Total	51	37	12	20	14	74	1	209
Percent of total	24.4%	17.7%	5.7%	9.6%	6.7%	35.4%	0.5%	
Average per site	3.6	2.6	0.9	1.4	1.0	5.3	0.1	14.9

The fall mist-net survey was conducted between September 13 and September 24, 2010 (Sanders Environmental 2010b). No netting was interrupted due to precipitation during the fall study period. One-hundred and fifteen bats of eight species were captured (Table 4). No Indiana or Virginia big-eared bats were captured during the fall survey. Over all net sites, all nights, and all species, on average approximately 8 bats were captured per net site (Table 4).

Table 4. Summary of bat captures during the fall mist-net survey

Site	Little brown bat	Northern long-eared bat	Eastern small-footed bat	Big brown bat	Tri-colored bat	Red bat	Hoary bat	Silver-haired bat	Total
1		6				7			14
2						1			1
3		2				3			5
4	4		5		1	5		1	16
5	2	2				11			15
6	2					1			3
7	3			1		2			6
8		1				2			3
9									0
10	1	1				2			4
11		3	3		1	5			12
12		1				3			4
13	2	6	3		2	11	2	6	32
14				1					1
Total	14	22	11	2	4	53	3	7	116
Percent of total	12.1%	19.0%	9.5%	1.7%	3.4%	45.7%	2.6%	6.0%	
Average per site	1.0	1.6	0.8	0.1	0.3	3.8	0.2	0.5	8.3

The most common species in terms of numbers and distribution was red bat which comprised more than 45% of all bats captured (Table 4). Fifty-three red bats were captured and this species was caught at 12 of the 14 net sites (~86%). On average 3.8 red bats were captured per night during the fall netting. The most common *Myotis* captured during the fall was northern long-eared bat (*Myotis septentrionalis*), which comprised 19% of all bats captured. Twenty-two northern long-eared bats were captured at 8 of 14 net sites (~57%).

During the summer netting, 65% of the bats captured were adults (26% females and 39% males), 28% were juveniles and for 7% age and sex were not determined (Table 5; Sanders Environmental 2010a). Signs of reproduction were noted in adult females of five species: northern long-eared bat, little brown bat, eastern small-footed bat (*Myotis leibeii*), red bat, and big brown bat (Sanders Environmental 2010a). Juveniles were captured of six species: northern long-eared bat, little brown bat, eastern small-footed bat, red bat, tri-colored bat (*Perimyotis subflavus*), and big brown bat (Table 5).

Table 5. Composition of bat species captured during the summer mist-net survey

Species	Juvenile	Adult Male	Adult Female	ND	Total
Little brown bat	12	29	8	2	51
Northern long-eared bat	19	15	3	0	37
Eastern small-footed bat	1	3	8	0	12
Red bat	17	23	23	11	74
Hoary bat	0	1	0	0	1
Tri-colored bat	5	7	1	1	14
Big brown bat	5	4	11	0	20
Total	59	82	54	14	209
Percent of Total	28%	39%	26%	7%	

ND = not determined

During the fall netting, 36% of the bats captured were adults (9% females and 27% males), 58% were juveniles, and for 6% age and sex were not determined (Table 6; Sanders Environmental 2010b). Juveniles were captured of all eight species captured: northern long-eared bat, little brown bat, eastern small-footed bat, red bat, tri-colored bat, big brown bat, hoary bat, and silver-haired bat (Table 6).

Table 6. Composition of bat species captured during the fall mist-net survey

Species	Juvenile	Adult Male	Adult Female	ND	Total
Little brown bat	8	4	2	0	14
Northern long-eared bat	14	4	2	1	21
Eastern small-footed bat	4	1	6	0	11
Red bat	30	18	0	6	53
Hoary bat	1	2	0	0	3
Tri-colored bat	3	0	1	0	4
Big brown bat	1	1	0	0	2
Silver-haired bat	6	1	0	0	7
Total	67	31	11	7	116
Percent of Total	58%	27%	9%	6%	

ND = not determined

3.2 AnaBat Acoustic Survey

Acoustic monitoring occurred from July 21 to November 15, 2010 for a total of 433 detector-nights over all four AnaBat detectors. During the study period the AnaBat detectors operated 91.7% of the time (433 out of 472 possible detector-nights). The nacelle-based units operated 100% of the nights and the ground-based units operated 83.5% of the nights. The primary reason for missed sampling nights at the ground-based units was due to disturbance of the detectors by black bear(s). A secondary reason for missed sampling nights at the ground-based units was power malfunction that was suspected to have been caused by damage to the equipment from bears. The overall quality of the data as measured by the proportion of bat calls to noise files was good indicating that the AnaBat detectors operated effectively and with little interference. For the four AnaBat detectors between 74% and 89% of the files recorded were bat calls (Table 7).

Table 7. Proportion of bat call files to all files recorded for the fixed AnaBat detectors.

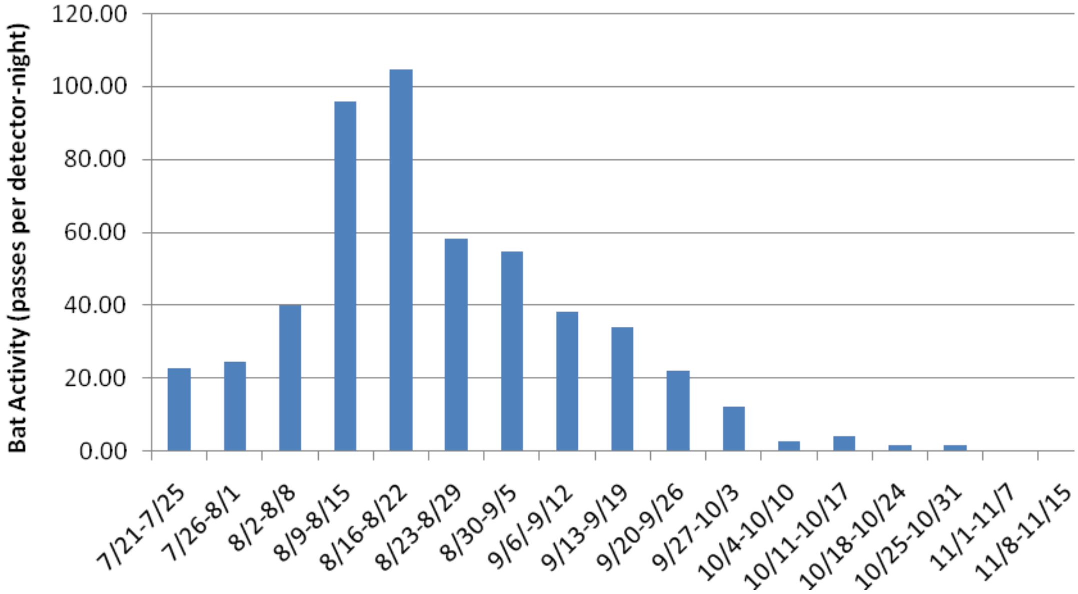
Location	Number of files recorded	Number of bat call files	Proportion
A17g	8762	7675	0.88
A17h	1138	1015	0.89
G5g	5861	4670	0.80
G5h	1294	963	0.74
	17055	14323	0.83

g = mounted near the ground, h = mounted on the nacelle

For all detectors, the mean bat activity for the period was 33.08 bat passes per detector-night. On a weekly basis, the high was approximately 104.64 passes per detector-night during week of August 16, and a low of 0.04 passes per detector-night during week of November 1 (Figure 2). The highest overall activity occurred on August 16 (203.75 passes), and the three highest nights occurred between August 16 and August 22 (Figure 3; Appendix A).

The ground-based AnaBat at each turbine recorded between 5 and 10 times more bat passes than the AnaBat on the turbine nacelle (Figure 4). When divided by echolocation type, high-frequency calls were the most abundant call type at ground level AnaBats and low-frequency calls were most abundant at the nacelle level AnaBats (Figure 5).

Figure 2. Weekly bat activity over all AnaBat detectors.



Week	LF	MF	HF	All Bats
7/21-7/25	5.79	7.46	9.38	22.63
7/26-8/1	3.43	5.68	15.29	24.39
8/2-8/8	12.00	13.04	14.96	40.00
8/9-8/15	22.04	36.43	37.29	95.75
8/16-8/22	15.25	36.00	53.39	104.64
8/23-8/29	16.93	24.21	17.04	58.18
8/30-9/5	16.21	19.82	18.86	54.89
9/6/-9/12	10.61	9.71	17.75	38.07
9/13-9/19	15.71	8.18	10.18	34.07
9/20-9/26	10.07	5.89	6.11	22.07
9/27-10/3	4.43	4.82	3.11	12.36
10/4-10/10	1.41	0.82	0.50	2.73
10/11-10/17	1.05	1.86	1.14	4.05
10/18-10/24	0.52	0.24	0.76	1.52
10/25-10/31	0.19	0.57	0.71	1.48
11/1-11/7	0.00	0.04	0.00	0.04
11/8-11/15	0.00	0.14	0.19	0.33
Totals	**8.67**	**11.18**	**13.22**	**33.08**

Figure 3. Nightly bat activity over all AnaBat detectors.

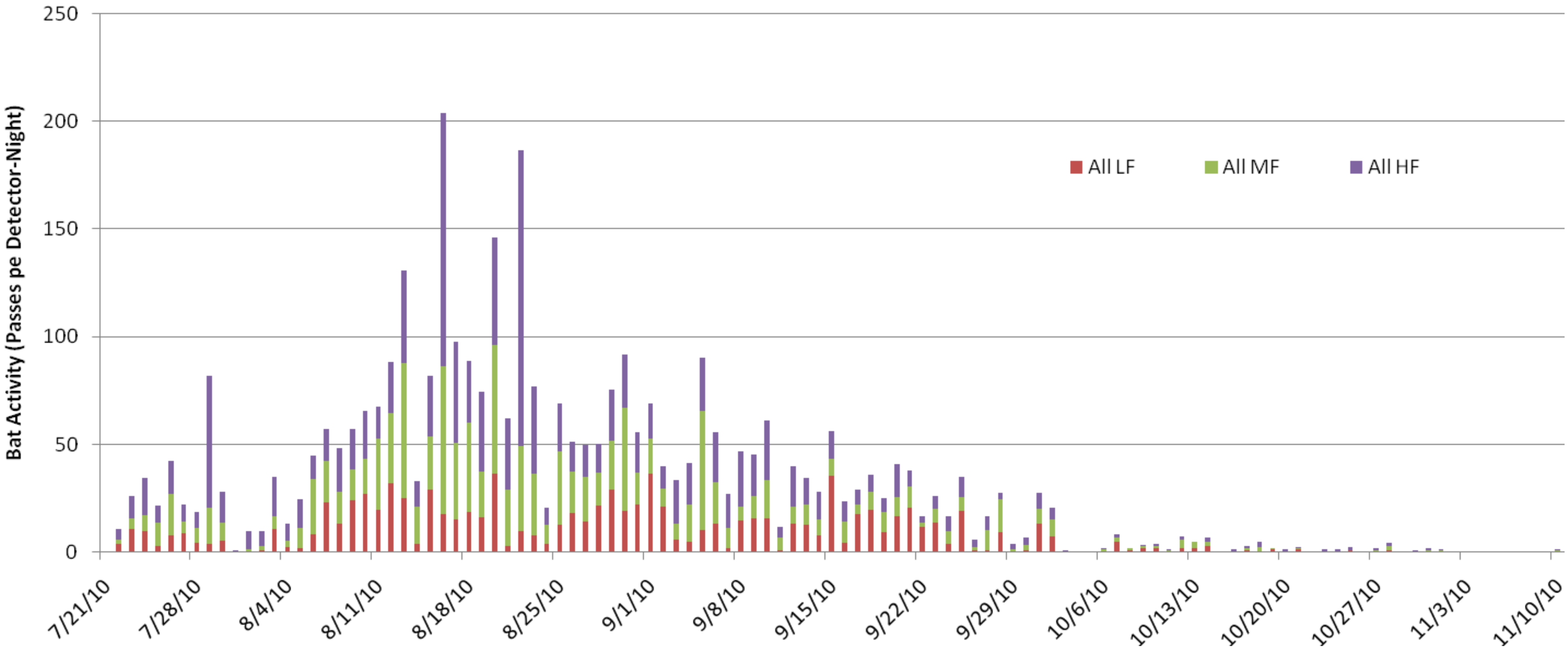
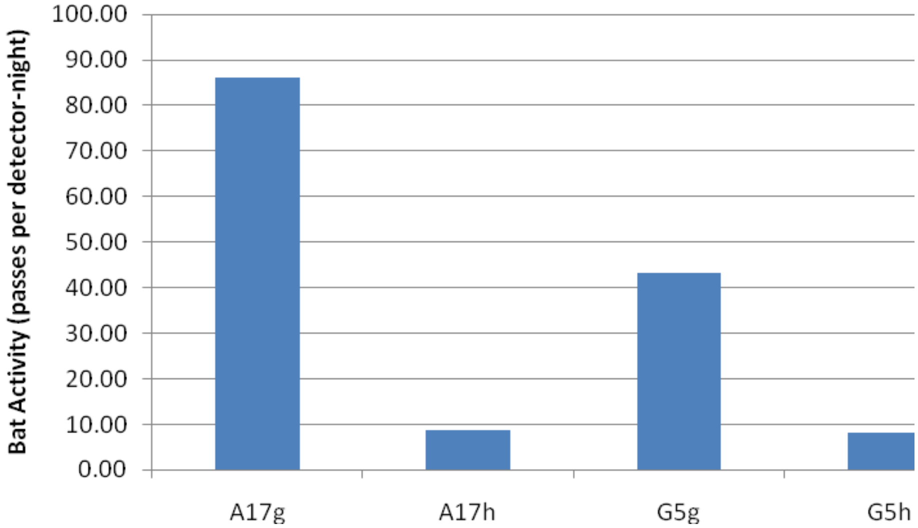
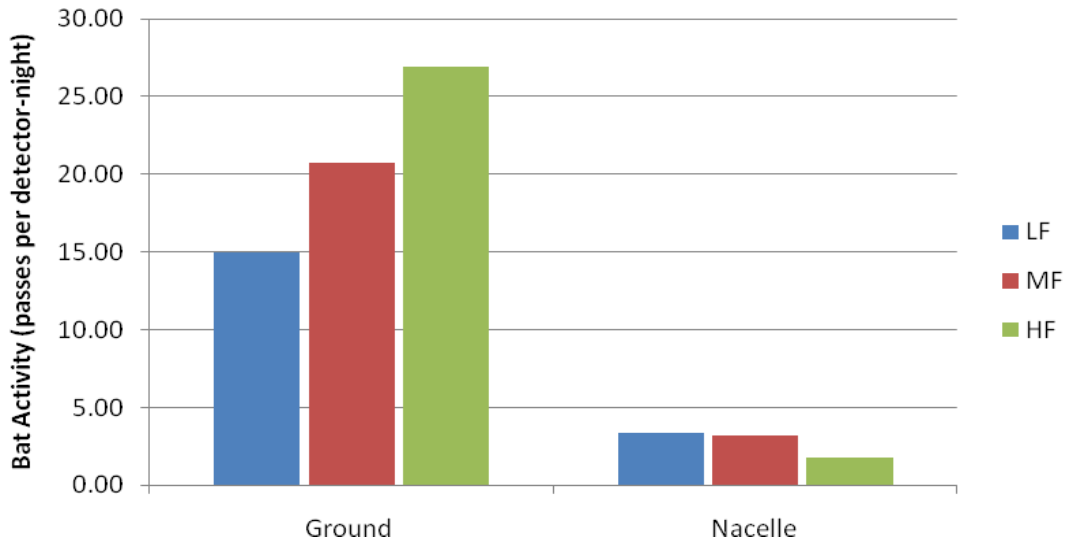


Figure 4. Bat activity at ground versus nacelle AnaBat detectors (A17 and G5 are turbine numbers, g = ground, h = nacelle



Station			
A17g	A17h	G5g	G5h
86.24	8.60	43.24	8.16

Figure 5. Bat activity by echolocation type at ground versus nacelle AnaBat detectors.



Two additional AnaBat detectors were used to investigate bat activity near mist-net sites. The number of sites netted per night during the summer period ranged from 1-4 and during the fall period ranged from 2-3. During the summer netting period, there was a distinctive pattern in bat activity with increasing activity through approximately 11:00 PM followed by a decrease in activity to the end of the netting period which usually occurred around 1:00 or 2:00 AM (Figure 6). The majority of bat passes recorded during the summer netting period were high frequency calls (Table 8), which is consistent with the results from the ground level detectors at turbines. During the fall netting period, bat activity was highest during the first two hours of netting and dropped off after approximately 9:00 PM. The majority of bat passes recorded during the fall netting period were high-frequency calls; however, the relative percentage of high frequency calls was lower during the fall netting period compared with summer (Table 8).

Figure 6. Bat passes per detector-hour recorded near net sites during the summer netting period.

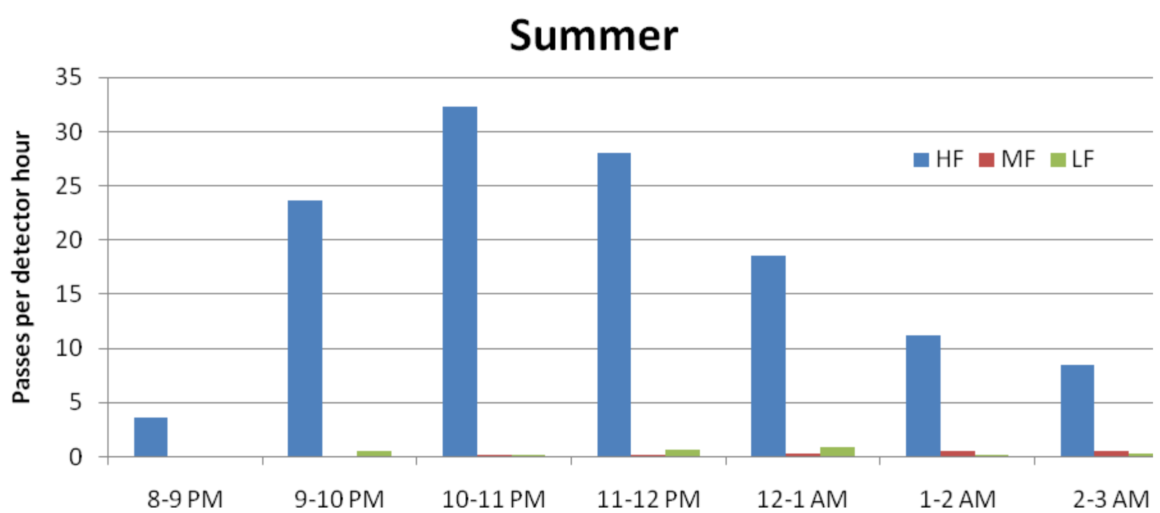
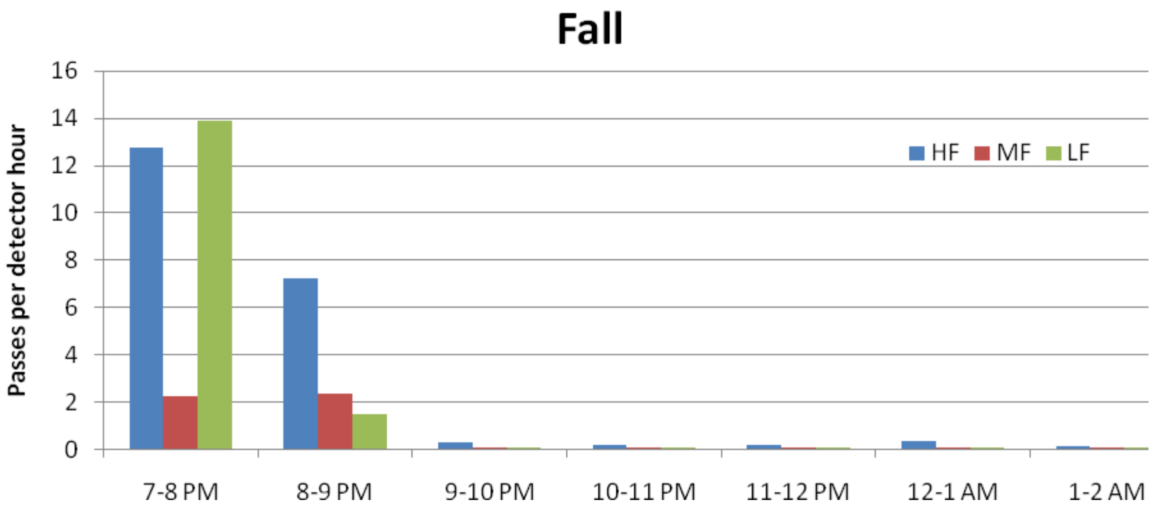


Table 8. Summary of bat passes recorded by survey night during the summer and fall mist-net surveys

Survey Night	HF	MF	LF	Total
7/28/10	57	0	3	60
7/29/10	900	4	0	904
7/30/10	203	12	16	231
8/1/10	37	0	0	37
8/2/10	25	0	5	30
8/3/10	64	1	6	71
8/7/10	210	1	0	211
8/8/10	45	0	0	45
8/9/10	44	1	3	48
Total	1585	19	33	1637
Percent of Total	97%	2%	1%	
9/13/10	59	10	6	75
9/14/10	93	0	0	93
9/15/10	582	91	69	742
9/18/10	32	1	4	37
9/19/10	33	5	1	39
9/20/10	31	0	4	35
9/21/10	141	50	42	233
9/22/10	9	0	4	13
9/23/10	16	9	33	58
9/24/10	6	0	1	7
Total	1002	166	164	1332
Percent of Total	75%	12.5%	12.5%	
Grand Total	2587	185	197	2969

Figure 7. Bat passes per detector-hour recorded near net sites during the fall netting period.



3.2.1 Quantitative Analysis of Echolocation Data

12,431 call sequences recorded at the turbines and during mist-netting AnaBat surveys were examined for potential Indiana bat calls. Of the 12,431 files, eight (0.006%) were identified as potential Indiana bat calls by the Britzke Filter. Of the 12,431 files, 1,481 call sequences were of sufficient quality to be used in the DFA (see Section 2.2.1), of which 111 (7.5%) were considered by the model to fit best as Indiana bat calls. Of these totals, three files were considered by both quantitative screens as potential Indiana bat calls (Table 9).

Table 9. Summary of echolocation files identified by 2 or more screening tools**.**

			Screening Tool		
Station	**File**	**Survey Night**	**Britzke Filter**	**DFA**	**Dr. Kevin Murray**
3559	K7282137.28#	7/28/2010		x	x
3559	K7290021.10#	7/28/2010	x		x
3559	K7292225.33#	7/29/2010	x	x	
3559	K7302217.27#	7/30/2010	x	x	x
4141	K7292145.36#	7/29/2010	x	x	
A17g	K7282143.23#	7/28/2010	x		x
A17g	K8052321.16#	8/5/2010	x		x

Based on results of the DFA, potential calls from big brown and eastern red bats were most frequently detected during the survey period, followed by tri-colored bats and the *Myotis* species (Table 10). Calls from nearly all the species were more frequently detected at ground-based detectors. Potential calls for silver-haired bat were identified at one nacelle station only.

Table 10. Percentage of survey nights by location that possible calls of each species were detected at least once, determined by the DFA.

Location	Big brown bat	Red bat	Silver-haired bat	Northern long-eared bat	Little brown bat	Eastern small-footed bat	Tri-colored bat
3559	7.1%	21.4%	0.0%	35.7%	28.6%	35.7%	28.6%
4141	7.1%	0.0%	0.0%	28.6%	7.1%	35.7%	0.0%
A17g	16.1%	19.5%	0.0%	13.6%	15.3%	9.3%	17.8%
A17h	8.5%	5.1%	0.8%	8.5%	0.0%	9.3%	2.5%
G5g	18.6%	14.4%	0.0%	4.2%	13.6%	2.5%	18.6%
G5h	5.1%	7.6%	0.0%	7.6%	0.0%	0.8%	2.5%
Totals	50.0%	49.2%	0.8%	41.5%	33.1%	30.5%	44.9%

3.2.2 Qualitative Analysis of Echolocation Data

Of the 12,431 call files, Dr. Murray identified a total of eight call files as potential Indiana bats: five files from mist-net site 3559 (k7282137.28#, k7282218.02#, k7290021.10#, k7300055.39#, and k7302217.27#); two files from turbine site A17g (k7282143.23# and k8052321.16#); one file from mist-net site 4141 (k7310009.18#); and 0 files from turbine sites A17h, G5g, and G5h.

Dr. Murray further re-examined the 111 call files identified by the DF model as *Myotis sodalis* and concurred with the call identifications of three of the 111 call files (i.e., he identified as potential *M. sodalis* three of the call files identified by the DF as *M. sodalis*). The rest of the calls were identified by him as other species (either *M. lucifugus* or *L. borealis*) or were not classified to species in cases where call structure did not show characteristics clearly consistent with a particular species. The three call files were k7282137.28# and k7302217.27# from mist-net site 3559 and k8052321.16# from turbine site A17g. Dr. Murray identified 3 of the 8 calls that the Britzke Filter identified as potential Indiana bat calls. The three call files were k7290021.10# and 7302217.27# from mist-net site 3559 and k7282143.23# from turbine site A17g (Table 9).

4.0 Discussion

4.1 Mist-Net Survey

The primary objectives of the study were to provide additional information about bat species composition and occurrence at the Project site during the summer and fall seasons (WEST 2010). The purpose of netting during the summer and fall was to provide data on presence/probable absence of Indiana bats throughout the Project during the summer maternity season and fall migration and swarming period (Carter 2010).

During the 2005-2006 pre-construction development period, BRE conducted mist-netting surveys of the project site and transmission line (see BHE 2005, 2006). Results of the 2010 mist-netting survey were similar to the 2005-2006 surveys in terms of species composition, with the exception that eastern small-footed myotis and silver-haired bats were captured in 2010. No Indiana bats or Virginia big-eared bats have been captured during either study period at the Project.

More bats were captured during the 2010 surveys than in 2005-2006; however, the level of netting effort was similar for both periods: 15 sites in 2005 resulting in 80 bats captured, 12 sites in 2006 resulting in 42 bats captured, and 14 sites in 2010 resulting in 209 summer captures and 116 fall captures. The number of bats captured over the different study periods could be influenced by a number of factors including nightly weather conditions, time of year, population status, mist-net site conditions, bat behavior, and experience of the field biologists. For example, the surveys in 2005-2006 were conducted slightly earlier in the summer, June 12-22 and July 22-26, when there may have been fewer volant juvenile bats. During the 2010 surveys 28% and 58% of the bats captured were juveniles over the summer and fall netting periods, respectively. In contrast during the 2005-2006 surveys, 16% of the bats captured in July were juveniles (BHE 2005) and 35% of the bats captured in June were juveniles (BHE 2006).

It is also possible that the number of bats in the project area has increased since 2005; however, due to the numerous factors influencing mist-netting surveys it is difficult to use mist-netting data to assess population sizes. The 2010 surveys do, however, corroborate the 2005-2006 results (BHE 2005, 2006) that suggested that no Indiana bats or Virginia big-eared bats occur on the site during the summer maternity period. Based on these results it is considered a low likelihood of an Indiana bat or Virginia big-eared bat maternity area being on or within 2.5 miles of the areas surveyed (L. Hill, USFWS, pers. comm.).

No Indiana bats were captured out of 116 total bat captures during the fall survey. Based on available data from cave counts (USFWS 2007) the number of Indiana bats moving through area is likely low. For example the nearest known Indiana bat hibernacula, Snedegar Cave and Martha Cave, have extant wintering populations with estimates of between 110 and 304 and 145 to 285 (since 1993), respectively. Snedegar Cave is approximately 9.2 mi (14.7 km) and Martha Cave is approximately 12.6 mi (20.2 km) from the eastern edge of the Project area (BHE 2006a). The lack of Indiana bat captures during the fall likely indicates a low level of movement through the project area and little roosting on the site during the fall season.

The lack of Virginia big-eared bat captures during summer and fall surveys supports the general knowledge that this species is generally sedentary and supports other data on the known distribution of the species and lack of known occurrences in the proximity of the project area. In West Virginia, the greatest movement recorded between summer and winter roosts was 19.8 mi (31.9 km; C. Stihler unpublished data in Piaggio et al. 2009). The Project is more than 30 miles (x km) from the nearest known Virginia big-eared bat cave.

4.2 AnaBat Acoustic Survey

The primary objective of the acoustic sampling was to investigate temporal patterns of bat activity within the Project to help support the HCP. In general, bat activity increased from late July to mid- to late-August and then began to taper off. This is likely an indication that bats are moving through the Project during August and September and corresponds with the period of time when most impacts to bats from wind turbines occur (see Johnson 2005, Arnett et al. 2008).

A secondary objective of the AnaBat survey, as requested by USFWS, was to screen the bat calls for species identification to the extent possible. The initial analysis for species identification was identifying echolocation call sequences that had characteristics consistent with echolocation produced by Indiana bat. A secondary analysis was to screen the acoustic data for all species potentially occurring in the project area.

Unequivocal identification of bat call sequences to species is confounded by intrinsic plasticity of bat echolocation (Barclay 1999) that results from individual and behavioral variability (Faure and Barclay 1994), as well as variability introduced by habitat differences (Broders et al. 2004) and the presence of conspecifics (i.e., other individuals of the same species) (Obrist 1995). The effects of this variability on accurate species identification are exacerbated for species whose echolocation structure is inherently similar, as with many species in the genus *Myotis*. Therefore, a multi-level strategy was used to identify potential Indiana bat echolocation calls. The approach consisted of two quantitative screens and one qualitative screen. Quantitative screens included a call analysis filter and a multivariate statistical model developed from a set of known calls, as described above. In addition, calls were examined qualitatively by WEST's Indiana bat biologist, Dr. Kevin Murray. In an effort to maintain a conservative approach in the analysis, echolocation sequences that were identified by two or more of the screens were considered to have likely come from an Indiana bat.

In an effort to increase prediction accuracy for the DFA analysis, a filter was used to remove low quality and incomplete calls that could introduce variability. The filter eliminated calls with fewer than five pulses and resulted in approximately 88% of the calls being dropped from suitability for analysis using the DFA. This process likely introduced a bias against short duration calls in favor of longer duration calls. For example, hoary bat is known to occur in the region and was captured during the mist-net survey, yet no calls were identified by the DFA as potential hoary bat calls. However, a qualitative analysis of the acoustic data suggests that hoary bats were present on up to 58% of the nights, yet were recorded primarily by short duration calls. This also reflects that, as with any model, the DFA is not 100% accurate and results should be viewed as potential calls for any given species.

Results of the 2010 acoustic data analysis suggest that Indiana bats were potentially recorded onsite in very low numbers from late July to early August which coincides with the beginning of the fall migration period for Indiana Bats. Of the 12,431 files examined for characteristics of Indiana bat calls, six were identified by two screening tools, and one was identified by all three screening tools (Table 9) as potentially coming from Indiana bats. Three of the files were recorded on the same night (7/28/10), and of those, two were from the same mist-net site (3559). The only file to have been considered by all three screening tools to be consistent with Indiana bat echolocation was also recorded at mist-net site 3559 on the night of July 29, 2010.

USFWS & KDFWR (2007) suggest that at least two potential Indiana bat call files per night are needed to conclude that the species is present. During the study period, this occurred only on the night of July 28 at station 3559.

Given the very low number of recorded calls that were potentially Indiana bat relative to the overall number of recorded calls (6 out of 12,431 or 0.04%), and the fact that acoustic analyses do not provide 100% positive identifications, it is possible that no Indiana bats were in fact recorded during the acoustic survey (i.e., detections were false positives). Furthermore, none of the potential Indiana bat calls (selected by two or more screens) were recorded at the two detectors mounted on turbine nacelles; all were recorded at ground level where fatalities with operating rotors would not occur.

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Appendix A. Nightly Mean Bat Passes by Echolocation Type.

Night	All LF	All MF	All HF	All Bats
7/21/10	0.00	0.00	0.00	0.00
7/22/10	4.00	1.75	5.00	10.75
7/23/10	10.75	5.00	10.50	26.25
7/24/10	9.50	7.75	17.25	34.50
7/25/10	2.75	10.75	8.25	21.75
7/26/10	7.75	19.50	15.25	42.50
7/27/10	8.75	5.50	8.00	22.25
7/28/10	4.25	6.75	7.50	18.50
7/29/10	3.75	16.75	61.50	82.00
7/30/10	5.50	8.00	14.75	28.25
7/31/10	0.25	0.00	0.25	0.50
8/1/10	0.50	1.00	8.00	9.50
8/2/10	1.00	1.75	7.00	9.75
8/3/10	10.75	5.75	18.25	34.75
8/4/10	2.25	3.00	8.00	13.25
8/5/10	2.00	9.00	13.75	24.75
8/6/10	8.50	25.25	11.00	44.75
8/7/10	23.25	19.00	15.00	57.25
8/8/10	13.25	14.75	20.25	48.25
8/9/10	24.00	14.50	18.50	57.00
8/10/10	27.00	16.25	22.25	65.50
8/11/10	19.50	33.25	14.75	67.50
8/12/10	31.75	32.75	23.75	88.25
8/13/10	25.25	62.50	43.00	130.75
8/14/10	4.00	17.25	11.50	32.75
8/15/10	29.00	24.50	28.25	81.75
8/16/10	17.75	68.50	117.50	203.75
8/17/10	15.00	35.50	47.00	97.50
8/18/10	18.75	41.50	28.50	88.75
8/19/10	16.25	21.25	37.00	74.50
8/20/10	36.25	59.75	50.25	146.25
8/21/10	2.75	26.25	33.00	62.00
8/22/10	9.75	39.50	137.25	186.50
8/23/10	8.00	28.25	40.75	77.00
8/24/10	4.00	8.75	8.00	20.75
8/25/10	12.75	34.25	21.75	68.75

Night	All LF	All MF	All HF	All Bats
8/26/10	18.25	19.25	13.75	51.25
8/27/10	14.00	21.00	14.50	49.50
8/28/10	21.75	15.25	13.00	50.00
8/29/10	28.75	22.75	24.00	75.50
8/30/10	19.00	48.25	24.25	91.50
8/31/10	22.00	15.00	18.50	55.50
9/1/10	36.25	16.25	16.25	68.75
9/2/10	21.00	8.50	10.50	40.00
9/3/10	6.00	7.25	20.00	33.25
9/4/10	4.75	17.25	19.25	41.25
9/5/10	10.25	55.50	24.25	90.00
9/6/10	13.25	19.00	23.25	55.50
9/7/10	2.00	9.25	15.75	27.00
9/8/10	14.50	6.75	25.50	46.75
9/9/10	15.50	10.50	19.50	45.50
9/10/10	15.50	18.00	27.50	61.00
9/11/10	1.00	6.00	4.75	11.75
9/12/10	13.25	8.00	18.75	40.00
9/13/10	12.50	9.50	12.50	34.50
9/14/10	7.75	7.50	12.75	28.00
9/15/10	35.50	8.00	12.75	56.25
9/16/10	4.25	9.75	9.75	23.75
9/17/10	17.50	4.75	6.50	28.75
9/18/10	19.50	8.50	7.75	35.75
9/19/10	9.00	9.75	6.50	25.25
9/20/10	16.50	9.00	15.25	40.75
9/21/10	20.75	9.50	7.50	37.75
9/22/10	11.50	2.00	3.25	16.75
9/23/10	13.75	6.25	6.25	26.25
9/24/10	3.75	6.00	6.75	16.50
9/25/10	19.00	6.75	9.00	34.75
9/26/10	1.00	1.25	3.50	5.75
9/27/10	0.75	9.50	6.50	16.75
9/28/10	9.25	15.25	3.00	27.50
9/29/10	0.00	1.25	2.50	3.75
9/30/10	1.00	2.50	3.25	6.75
10/1/10	13.25	7.00	7.25	27.50
10/2/10	7.25	7.75	5.50	20.50
10/3/10	0.25	0.00	0.25	0.50

Night	All LF	All MF	All HF	All Bats
10/4/10	0.00	0.00	0.00	0.00
10/5/10	0.00	0.00	0.00	0.00
10/6/10	0.33	1.00	0.67	2.00
10/7/10	5.00	1.67	1.67	8.33
10/8/10	0.67	1.00	0.00	1.67
10/9/10	2.00	1.00	0.33	3.33
10/10/10	2.00	1.00	0.67	3.67
10/11/10	0.33	0.33	0.33	1.00
10/12/10	1.67	4.33	1.33	7.33
10/13/10	1.67	3.00	0.00	4.67
10/14/10	3.00	2.00	2.00	7.00
10/15/10	0.00	0.00	0.00	0.00
10/16/10	0.00	0.33	1.00	1.33
10/17/10	0.67	1.33	1.00	3.00
10/18/10	0.33	2.00	2.67	5.00
10/19/10	1.33	0.67	0.00	2.00
10/20/10	0.00	0.33	1.00	1.33
10/21/10	1.33	0.33	0.67	2.33
10/22/10	0.00	0.00	0.00	0.00
10/23/10	0.00	0.33	1.00	1.33
10/24/10	0.00	0.00	1.33	1.33
10/25/10	1.00	0.00	1.33	2.33
10/26/10	0.00	0.33	0.00	0.33
10/27/10	0.33	0.33	1.33	2.00
10/28/10	0.67	2.00	1.67	4.33
10/29/10	0.00	0.00	0.00	0.00
10/30/10	0.00	0.00	1.00	1.00
10/31/10	0.00	1.00	0.67	1.67
11/1/10	0.33	0.33	0.33	1.00
11/2/10	0.00	0.00	0.00	0.00
11/3/10	0.00	0.00	0.00	0.00
11/4/10	0.00	0.00	0.00	0.00
11/5/10	0.00	0.00	0.00	0.00
11/6/10	0.00	0.00	0.00	0.00
11/7/10	0.00	0.00	0.00	0.00
11/8/10	0.00	0.33	0.00	0.33
11/9/10	0.00	0.00	0.33	0.33
11/10/10	0.00	0.67	0.67	1.33
11/11/10	0.00	0.00	0.00	0.00

Night	All LF	All MF	All HF	All Bats
11/12/10	0.00	0.00	0.00	0.00
11/13/10	0.00	0.33	0.33	0.67
11/14/10	0.00	0.00	0.00	0.00
11/15/10	0.00	0.00	0.00	0.00
Totals	**8.67**	**11.18**	**13.22**	**33.08**

2012 Post-construction Carcass Monitoring Study for the Beech Ridge Wind Farm Greenbrier County, West Virginia

Final Report
April 1 – October 28, 2012

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January 18, 2013

NATURAL RESOURCES ◆ SCIENTIFIC SOLUTIONS

EXECUTIVE SUMMARY

Beech Ridge Energy LLC (BRE) contracted Western EcoSystems Technology, Inc. to conduct a post-construction carcass monitoring study during spring, summer and fall 2012 of the 67 1.5 megawatt capacity turbines comprising the Beech Ridge Wind Farm, located in Greenbrier County, West Virginia. The study was implemented to satisfy the Modification of Stipulation as ordered by the U.S. District Court for the District of Maryland, Greenbelt Division (Civil Action No. 09-vc-01519 (RWT). The primary purpose of the study was to document carcass discoveries of the federally endangered Indiana bat and Virginia big eared bat, should they occur, during the 2012 bat-active period during which operational protocols for avoiding take of Indiana bats were implemented. These operational protocols included operating all 67 turbines 24 hours per day April 1 – November 15, 2012; however, from one-half hour before sunset to one-quarter hour after sunrise (nighttime hours) turbines were operated only when wind speeds exceeded 6.9 meters/second (15.2 mph).

The 2012 study was originally scheduled to occur April 1 - November 15, but was terminated on October 28 due to persistent deep snow resulting from Hurricane Sandy, which deposited over three feet of snow in portions of the Project on October 28 – 30, and a subsequent snowstorm which occurred on November 3. As a result, conditions for completing carcass searches were unsuitable over approximately the last two weeks of the anticipated study period. BRE consulted with the U.S. Fish and Wildlife Service (USFWS) prior to terminating the study and agreed that BRE's operations and maintenance staff would conduct one additional survey, during winter 2012/13, when the ground is clear. Operations personnel searched all turbines on November 19 – 20, and found one wild turkey carcass at Turbine H-01 that had been shot.

Three methods were used to document carcasses of bats and birds at the Project during the study period, including: 1) standardized carcass searches conducted by qualified and trained biologists employed by WEST; 2) incidental detection of bat and bird carcasses by WEST biologists during the course of daily activities within the Project, and; 3) incidental detection of bat and bird carcasses by O&M staff, reported to WEST and recorded using standard protocols. Secondary aims of the study included calculating annualized estimates of bat and bird fatality rates at the site using assumptions described below. As such, all bat and bird carcasses noted during standardized carcass searches and incidentally were recorded, and bias trials designed to estimate carcass removal and searcher efficiency rates were conducted throughout the study period. Post-construction monitoring surveys were conducted from April 1 through October 28, 2012.

Carcass Searches

The objective of carcass searches was to document any bat carcasses, particularly Indiana bat and Virginia big eared bat carcasses, and bird carcasses at all turbines within the Project. All 67 Project wind turbines were included in the study, with carcass searches occurring on a two-day search interval. Carcass searches were conducted within a study plot of a maximum 131-ft (40-m) radius centered on wind turbines, with some variation in search plot due to constraints

related to vegetation/ground cover and terrain. Search plots were periodically mowed during the study period to maintain a target average vegetation height of 5-8 inches to increase the probability of detecting carcasses during standardized carcass searches. Mowing occurred on specific search plots immediately following those plots being searched.

A total of 6,345 carcass searches were conducted during the study period. No Indiana bat or Virginia big-eared bat carcasses were recorded during carcass searches or incidentally.

Forty-nine bat carcasses, representing four species, were found within search plots, including one silver-haired bat that was found incidentally on a search plot. Four additional bats, representing three species, were found outside of search plots and were not included in any further data analysis. The eastern red bat was the most common bat species found within search plots (59.2%) and overall (56.6%). Other species found included hoary, silver-haired bat, and tricolored bat. Bat carcasses were found at 28 (42%) of the turbines. All bats were found within two weeks of the time of death and the majority (74.5%) was estimated to have been killed or injured the previous night. All bat carcasses were discovered within the Project between April 14 and October 18, 2012. Just over half of the bat carcasses were recorded between August 14 and October 18.

Eighty-one bird carcasses, representing 31 species and four unidentifiable species, were found throughout the study period including: red-eyed vireo (20 individuals), wild turkey (6), yellow-rumped warbler (6), black-billed cuckoo (4), blue-headed vireo (4), unidentified passerine (4), blackpoll warbler (2), golden-crowned kinglet (2), ruffed grouse (2), Tennessee warbler (2), and wood thrush (2). Additional bird carcasses were found during standardized carcass searches included one individual each from 20 additional species. A third ruffed grouse carcass was found incidentally at turbine F7 on March 30, before the onset of the survey period on April 1. One brown creeper, one eastern towhee, one hermit thrush, and one unidentified small bird were also found incidentally outside of search plots. Bird carcasses were found at 41 (61%) of the turbines. Eighty-nine percent of carcasses were estimated to have been found within two weeks of death; approximately half (47.9%) of birds were estimated to have died the previous night.

Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of carcasses found by searchers. Searcher efficiency estimates were calculated for bats, small birds, and large birds. Estimates of searcher efficiency were used to adjust the total number of carcasses found by correcting for detection bias. Searcher efficiency trials were conducted throughout the study period using a total of 384 carcasses; including 169 bats, 109 small birds, and 106 large birds. The percent of trial carcasses that were available and found by searchers was 51.7%, 69.5%, and 93.3%, respectively.

Carcass Removal Trials

The objectives of carcass removal trials were to estimate the length of time a carcass remained in the Project and was available for detection, and to calculate the expected rate of carcass removal at the Project. Carcass removal estimates were used to adjust the total number of carcasses found by correcting for removal bias. Carcass removal trials were conducted March 15 – October 28, 2012 using a total of 360 carcasses; including 45 mice, 75 bats, 120 small birds, and 120 large birds. Overall for the study period, after the first day, approximately 60% of bat or mouse carcasses, 70% of small bird carcasses, and 90% of large bird carcasses remained. The average removal time was much shorter for bats or small birds (5.5 and 6.3 days, respectively) than for large birds (17.5 days). Despite inter-month variability in removal rates, the carcass removal times observed at the Project suggest that carcass searchers had multiple chances to find most bat carcasses, given the two-day carcass search interval used at the Project.

Mice were used as surrogates for bats when necessary to achieve sample size targets for the study, however, mice exhibited significantly faster removal rates than bats. A statistical analysis of mice versus bat carcass removal rates was conducted for this report. Across the entire study period the average carcass removal time for bats was 8.58 days which is significantly slower than for mice (1.69 days, P-value = <0.001). However, mice were used only when needed and only during monthly periods when bats were not available. Mice only were used for carcass removal trials in summer, and both mice and bats were used in fall. As a result only a small sample size was available for a paired side by side fall comparison, which did not indicate a statistically significant difference in removal rates (P-value = 0.2024).

Annual Fatality Estimates

Annual fatality estimates and 90% confidence intervals (CI) for bats, all birds, small birds, large birds and raptors were calculated using the Shoenfeld (2004) statistical estimator. The Shoenfeld estimator was used to provide consistency with nearby studies including those conducted at the Mountaineer, Myersdale, Mount Storm, and Casselman wind projects. The adjusted annual fatality estimate for bats during the 2012 study was 3.04 (90% CI = 1.89, 7.44) fatalities/turbine/year. The adjusted annual fatality estimate for all birds was 1.79 (90% CI = 1.46, 2.24) fatalities/turbine/year. For small and large birds, annual fatality estimates were 1.53 (90% CI = 1.24, 1.97) and 0.26 (90% CI = 0.14, 0.36) fatalities/turbine/year, respectively, while the diurnal raptor fatality estimate was 0.02 (0, 0.05) fatalities/turbine/year. Adjusting the per turbine fatality estimates by nameplate turbine megawatt capacity resulted in annual fatality estimates of 2.03 bats and 1.19 birds/megawatt/year. Bat fatality estimates were higher in the summer (1.97 fatalities/turbine/season) than for either fall or spring (0.91 and 0.16 fatalities/turbine/season, respectively). Small bird fatality estimates were highest in fall (0.68 fatalities/turbine/season), followed by spring and summer (0.48 and 0.37, respectively). Fatality estimates for large birds was highest in spring (0.14 fatalities/turbine/season), followed by summer and fall (0.09 and 0.02, respectively).

No Indiana bat or Virginia big-eared bat carcasses, two bat species federally listed as endangered species, were recorded during the 2012 fatality monitoring study. In addition it resulted in low overall bat fatality rates compared with publically available bat fatality rates observed during similar monitoring studies.

REPORT REFERENCE

Tidhar, D., M. Sonnenberg, and D. Young. 2013. DRAFT 2012 Post-construction Fatality Monitoring Study for the Beech Ridge Wind Farm, Greenbrier County, West Virginia. Final Report: April 1 – October 28, 2012. Prepared for Beech Ridge Wind Farm, Beech Ridge Energy, LLC, Chicago, Illinois. Prepared by Western EcoSystems Technology, Inc., NE/Mid-Atlantic Branch, Waterbury, Vermont.

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1.0 INTRODUCTION

Beech Ridge Energy LLC (BRE) contracted Western EcoSystems Technology, Inc. (WEST) to conduct a post-construction fatality monitoring study during spring, summer, and fall 2012, of the Beech Ridge Wind Farm (Project), located in Greenbrier County, West Virginia. The study was implemented to satisfy the Modification of Stipulation as ordered by the U.S. District Court for the District of Maryland, Greenbelt Division (Civil Action No. 09-vc-01519 (RWT). The primary purpose of the study was to document carcasses of the federally endangered Indiana bat (*Myotis sodalis*) and Virginia big-eared bat (*Corynorhinus townsendii virginianus*), should they occur, during the 2012 bat-active season in which operational protocols for avoiding take of Indiana bats were implemented. These operational protocols included operating all 67 turbines 24 hours per day April 1 – November 15, 2012; however, from one-half hour before sunset to one-quarter hour after sunrise (nighttime hours) turbines were operated only when wind speeds exceed 6.9 meters/second (15.2 mph). These operational protocols were designed in consultation with the US Fish and Wildlife Service (USFWS).

Post-construction monitoring surveys were conducted from April 1 through October 28, 2012. The 2012 study was originally scheduled to occur April 1 - November 15, but was terminated on October 28 due to persistent deep snow resulting from Hurricane Sandy, which deposited over three feet of snow in portions of the Project on October 28 - 30, and a subsequent storm which occurred on November 3. As a result, conditions for completing carcass searches were unsuitable over approximately the last two weeks of the anticipated study period. BRE consulted with the U.S. Fish and Wildlife Service (USFWS) prior to terminating the study and agreed that BRE's operations and maintenance staff would conduct one additional survey, during winter 2012/13, when the ground is clear (November 5, 2012 email from Laura Hill, USFWS to BRE). That survey was not a part of this study. Operations personnel searched all turbines on November 19 – 20, and found one wild turkey (*Meleagris gallopavo*) carcass at Turbine H-01 that had been shot.

To document carcasses of Indiana bats and Virginia big-eared bats, standardized carcass searches were conducted at all 67 Project wind turbines at a two-day search interval. In addition, biologists completing field surveys and operations and maintenance (O&M) personnel recorded bat and bird carcasses found incidentally. Secondary aims of the study included calculating annualized estimates of bat and bird fatality rates resulting from Project operations. As such, all bat and bird carcasses noted during carcass searches and incidentally were recorded, and bias trials designed to estimate searcher efficiency and carcass removal rates were conducted. Interim results of the study were reported in monthly memoranda. This annual report includes the methods and final results for the 2012 study.

2.0 PROJECT AREA

BRE, a wholly owned subsidiary of Invenergy LLC, owns and operates the Project, which consists of several primary components, including 67 1.5-megawatt (MW) General Electric wind turbines, access roads, transmission and communication equipment, storage areas, and control facilities (Figure 2.1). The Project is located in Greenbrier and Nicholas counties, West Virginia, approximately 8 kilometers (km; 5 miles [mi]) northwest of the town of Trout, approximately 11 km (7 mi) north-northwest of Williamsburg, and approximately 14 km (9 mi) northeast of downtown Rupert, West Virginia. The Project is located primarily along Beech Ridge and is bounded on the west by Clear Creek Mountain, on the south by Old Field Mountain, on the east by Cold Knob, and on the north along County Road 10/1, just past Big Bull Hill. The Project is located on a 63,000-acre tract of forestlands owned and managed for commercial timber harvesting by MeadWestvaco.

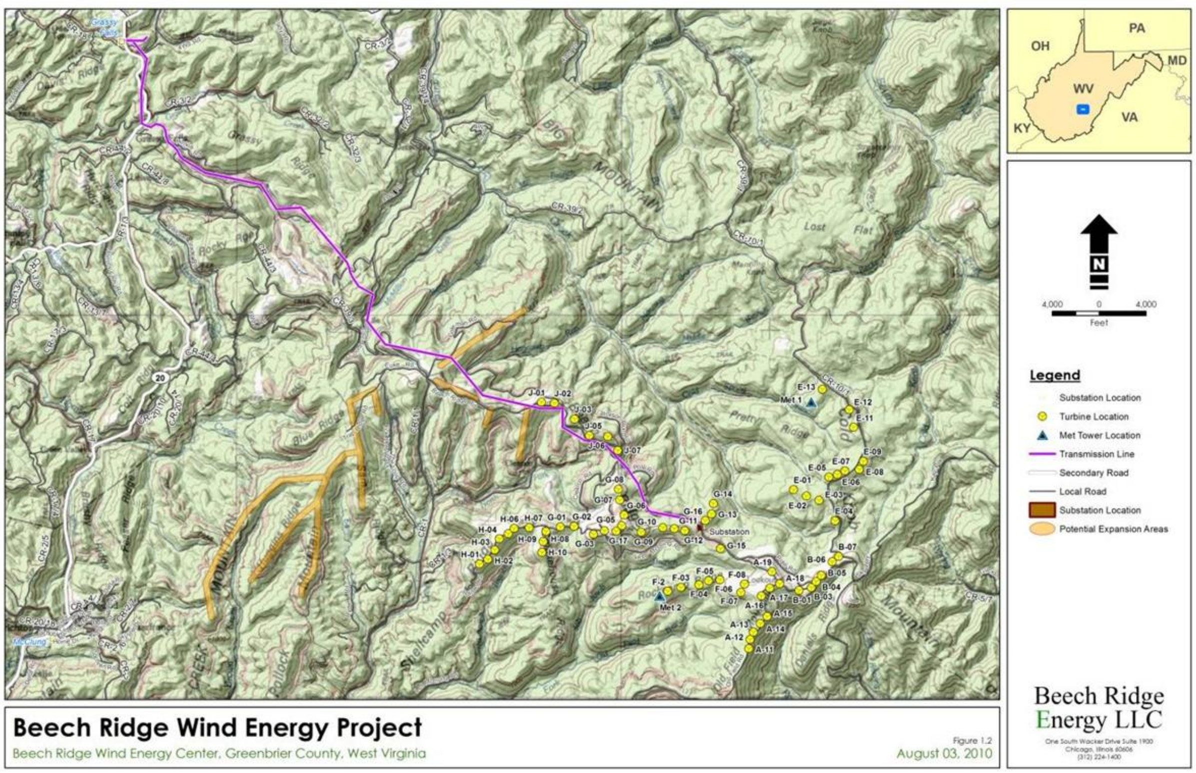

Figure 2.1. Location of the Beech Ridge Wind Farm and project wind turbines.

The Project lies within the Central Appalachian Broadleaf Forest Ecological Subregion (Bailey 1997; McNab and Avers 1994). Within this subregion, the Project is located in southern portion of the Allegheny Mountains ecological section. The Allegheny Mountains section composes part of the Appalachian Plateau physiographic province and is characterized by a dissected plateau of high ridges, low mountains, and narrow valleys. Bedrock is covered by residuum on the ridges and mountain tops, colluvium on the slopes, and alluvial materials in the valleys. Devonian shale and siltstone, Mississippian carbonates and sandstones, and Pennsylvanian shale, sandstone, and coal form the bedrock. Sandstone and sturdy carbonates support upland areas, and weaker carbonates and shale underlie valleys (McNab and Avers 1994).

The Project is largely forested, interspersed with areas cleared for roads, timber harvest activities, and historic mining activities. The landscape is a mosaic of deciduous forest in various stages of growth; of the 48,000 acres within 0.8 km (0.5 mi) of the site, approximately 79% is characterized as timber greater than 26 years old, 19% is characterized as timber less than 26 years old, and 2% is non-forested (e.g., roads, surface mines; BHE 2006). Dominant tree species include oaks (*Quercus* sp), sugar maple (*Acer saccharum*), black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), and mountain maple (*Acer spicatum*) (BHE 2006). Historical land use included timber harvesting and surface coal mining. Local relief varies from approximately 15 m (50 feet [ft]) to 60 m (200 ft), and crestal elevations generally increase towards the east and range from about 366 m (1,200 ft) to 1,402 m (4,600 ft).

Construction of the Project resulted in approximately 373 acres of habitat conversion from predominantly forest to grassland/scrub shrub habitat and approximately 50 acres of life of project impacts that could be reclaimed to grass/shrub vegetation during project decommissioning if so requested by the landowner. The life of project disturbance is associated with nine acres at turbines, 16 acres for new roads, 11 acres for transmission line access, eight acres for collection line trenching, three acres for permanent meteorological towers, two acres for the operations and management (O&M) facility, and one acre for the substation. Further information on Project characteristics may be found in the HCP (BRE 2012).

3.0 METHODS

3.1 Post-construction Fatality Monitoring

The post-construction fatality monitoring study at the Project had three principal objectives:

1. To document carcasses of Indiana bat and Virginia big-eared bat, should they occur, from the Project operating under modified turbine operational protocols during the period April 1 – November 15, 2012;
2. To estimate 2012 bat and bird fatality rates for the site; carcass discoveries occurring at the site;
3. To provide a general understanding of the factors associated with the timing, extent, species composition, distribution, and location of the carcasses found.

Three methods were used to document bat and bird carcasses at the Project during the study period, including: 1) standardized carcass searches conducted by qualified and trained biologists employed by WEST; 2) incidental detection of bat and bird carcasses by WEST biologists during the course of daily activities within the Project, and; 3) incidental detection of bat and bird carcasses by O&M staff, reported to WEST and recorded using standard protocols.

3.1.1 Standardized Carcass Searches

The objective of carcass searches was to document any bat carcasses, particularly Indiana bat and Virginia big-eared bat carcasses, and bird carcasses at all turbines within the Project. Standardized carcass searches were conducted from April 1 to October 28, 2012. Carcass searches were conducted at all 67 Project turbines on a two-day search interval, unless searches could not be conducted due to inclement weather or safety. Carcass searches were conducted within a study plot of a maximum 40-m (131-ft) radius centered on turbines, with some variation in search plot size due to constraints related to vegetation/ground cover and terrain. Carcass search plots did not include forest, dense shrub-scrubland or potentially unsafe search areas (i.e., steep sloped areas of dense boulders/large rocks).

Methodology for carcass searches followed standard practices (e.g., Young et al 2009a, Tidhar et al 2011, Strickland et al 2011) and were conducted by qualified field technicians employed by WEST who were trained in proper technique. Transects within search plots were set approximately 5 m (16 ft) apart in the area to be searched. Searchers walked at a rate of approximately 45-60 m/min (150-200 ft/min) along each transect, searching both sides out to approximately 2-3 m (7-10 ft). Search area and speed were adjusted if vegetation variation or terrain within the search area warranted adjustment and/or after evaluation of the searcher efficiency trials. Searches for any given day began at randomly-selected turbines shortly after sunrise, when there was enough ambient light for locating and identifying carcasses, and continued until all turbines had been searched, if weather conditions were conducive to searching.

All bird and bat carcasses located within the search areas, regardless of species, were recorded. Due to the difficulty associated with obtaining accurate estimates of natural or reference mortality (Johnson et al. 2000), the assumption was made that all carcasses found were attributable to wind turbines. This assumption may not be true, and likely leads to an over-estimation for bat and bird fatalities attributable to the facility (e.g., road collisions are treated as turbine-caused fatalities). The age of each carcass was estimated to the extent possible, and the condition of each carcass found was recorded using the following categories:

- *Intact* - a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.
- *Scavenged* - an entire carcass, which shows signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, portion of a carcass, etc.), or a carcass that has been heavily infested by insects.
- *Feather Spot* - ten or more feathers or two or more primaries at one location indicating a bird fatality had been there.

All carcasses were labeled with a unique number, bagged, and frozen for future reference and possible further analysis (e.g., genetic determination of species, if needed). A copy of the data sheet for each carcass was maintained, bagged, and frozen with the carcass at all times. For all carcasses discovered, data recorded included species, sex and age when possible, date and time collected, global positioning system (GPS) location, condition (above), and any comments that indicated possible cause of death. All carcasses were photographed as found and plotted on a map of the study area showing the location of the wind. In addition to carcasses, any injured bat or bird observed in the search plots was recorded and treated as a casualty. Dominant vegetation cover within a 1-m (3-ft) radius of the carcass location was recorded.

Carcasses discovered in non-search areas, or observed within search areas but outside of the study period for carcass searches (April 1 – October 28, 2012), were coded as incidental discoveries and were documented in a similar fashion as those found during standard searches. Carcasses discovered by O&M personnel and others not conducting the formal searches were similarly documented and included in the overall dataset[1].

3.1.2 Vegetation Management of Search Plots

Search plots were periodically mowed during the study period to maintain a target average vegetation height of approximately 12-21 centimeters (cm; 5-8 inches [i]) to increase the probability of detecting carcasses during standardized carcass searches. Mowing occurred on specific search plots immediately following those plots being searched.

3.1.3 Searcher Efficiency Trials

The objective of the searcher efficiency trials was to estimate the percentage of carcasses found by searchers. Searcher efficiency estimates were made for bats, small birds, and large birds. Estimates of searcher efficiency were used to adjust the total number of carcasses found, thus correcting for detection bias.

Searcher efficiency trials were conducted within search plots throughout the study period (April 1 – October 28, 2012) on a monthly basis. Monthly targets for trials included 15 carcasses each of bats, small birds and large birds. Trials were conducted such that searchers did not know when trials were being conducted or locations of trial carcasses. Carcasses used included those of native birds and bats recovered during carcass searches or provided by the West Virginia Department of Natural Resources and the USFWS, non-native/non-protected or commercially-available bird species (e.g., house sparrows [*Passer domesticus*] for small birds and rock pigeons [*Columba livia*] for large birds), and non-threatened and non-endangered birds recovered during fatality searches. Each carcass was discreetly marked so that it could be identified as a trial carcass when found. Trial carcasses were placed at random locations within search plots prior to that day's scheduled carcass searches. Carcasses were dropped from waist height and allowed to land in a natural manner to simulate a fall from collision with a turbine.

The number and location of the searcher efficiency carcasses found during the standardized carcass searches were recorded. The number of carcasses available for detection during each trial was determined immediately after the trial by the person responsible for distributing the carcasses. Carcasses may become unavailable due to removal by scavengers or by other means. A carcass missed by the searcher but retrieved by the person conducting the trial was determined to be available for detection but undetected. A carcass missed by the searcher and not subsequently found by the person conducting the trial was determined to be unavailable for detection.

[1] During the 2012 study, no carcasses were found by O&M personnel or others not conducting the formal searches.

3.1.3 Carcass Removal Trials

The objective of carcass removal trials was to estimate the length of time a carcass remained in the study area and was available for detection. Carcass removal estimates were used to adjust the total number of carcasses found by correcting for removal bias. Carcass removal trails began on March 15, 2 weeks prior to the commencement of carcass searches, to verify the adequacy of the two-day search interval for detecting any turbine-related fatality within the Project. Carcass removal estimates were calculated monthly and for the period March 15 – October 28, 2012. Monthly targets for trials included 15 carcasses each of bats, small birds and large birds.

Trials were conducted throughout the study period to include varying weather and scavenger densities. The species used in carcass removal trials were similar to those used in searcher efficiency trials; however, non-*Myotis* bats recovered during carcass searches, and mice used as surrogates for bats when necessary to achieve monthly sample size targets for carcass removal trials, were also used. Trial carcasses were randomly placed within 40 m (131 ft) of turbines by dropping the carcasses from waist height and allowing them to land in a natural manner to simulate a fall from collision with a turbine. Trial carcasses were discreetly marked, for recognition by searchers and other personnel, and left in place until the end of each 14-day trial or until it was removed by scavengers. Carcasses were monitored up to 14 days and checked on days 1-5, 7, 10 and 14. The schedule varied slightly depending on weather and coordination with the other survey work. At the end of each trial any remains of the carcasses were removed.

3.1.4 Statistical Analysis

<u>3.1.4.1 Quality Assurance and Quality Control</u>

Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and during report writing. Following field surveys, observers were responsible for inspecting data forms for completeness, accuracy, and legibility. Regular QA/QC visits to the site were made by the project manager and field coordinator to ensure field surveys were conducted to protocols by field technicians. The project statistician compared samples of records from an electronic database to raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

3.1.4.2 Data Compilation and Storage

A Microsoft® ACCESS database was developed to store, organize, and retrieve data. Data were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks, and electronic data files were retained for reference. Data was compiled for the eight-month study period as well as seasonal periods defined as: winter: March 15 – March 31; spring: April 1 – June 14; summer: June 15 – August 15, and; fall: August 16 – November 15.

3.1.4.3 Statistical Methods for Fatality Estimates

The Shoenfeld (2004) estimator was used to calculate bat and bird fatality estimates for the Project. The Shoenfeld estimator was used to provide consistency with nearby studies including those conducted at the Mountaineer, Myersdale, Mount Storm, and Casselman wind projects (Arnett et al. 2005; Young et al. 2009a; Arnett et al. 2010). Fatality estimates and 90% confidence intervals (CI) were calculated on a per turbine and a per MW basis for five categories: 1) bats, 2) small birds, 3) large birds, 4) diurnal raptors, and 5) all birds.

Estimates of facility-related fatalities were based on:

1. Number of bird and bat carcasses found during standardized carcasses searches during the study period;
2. Searcher efficiency expressed as the proportion of trial carcasses found by searchers during searcher efficiency trials; and
3. Non-removal rates expressed as the average probability a carcass is expected to remain in the study area and be available for detection by the searchers during carcass removal trials.

3.1.4.3.1 Definition of Variables

The following variables are used in the equations below:

- c_i the number of carcasses detected at plot *i* for the study period of interest (e.g., one monitoring year), for which the cause of death is either unknown or is attributed to the facility
- k the number of turbines searched
- A proportion of the search area of a turbine actually searched
- $\bar{c}$ the average number of carcasses observed per turbine per monitoring period
- s the number of carcasses used in removal trials
- s_c the number of carcasses in removal trials that remain in the study area after 14 days
- t_i the time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
- $\bar{t}$ the average time (in days) a carcass remains in the study area before it is removed, as determined by the removal trials
- p the estimated proportion of detectable carcasses found by searchers, as determined by the searcher efficiency trials
- $\hat{\pi}$ the estimated probability that a carcass is both available to be found during a search and is found, as determined by searcher efficiency and carcass removal trials
- m the estimated annual average number of fatalities per turbine per year, adjusted for searcher efficiency and carcass removal bias
- N the total number of turbines at the facility

M the estimated annual average number of fatalities at the facility per year, adjusted for searcher efficiency and carcass removal bias

3.1.4.3.2 Observed Number of Carcasses

The estimated average number of carcasses ($\bar{c}$) observed per turbine per year is:

$$\bar{c} = \frac{\sum_{i=1}^{k} c_i}{k} \qquad (1)$$

3.1.4.3.3 Estimation of Searcher Efficiency

Searcher efficiency is expressed as p, the estimated proportion of trial carcasses found by searchers. Carcass detection rates were estimated by carcass size class and season.

3.1.4.3.4 Estimation of Carcass Removal

Estimates of carcass non-removal rates are used to adjust carcass counts for removal bias. Mean carcass removal time ($\bar{t}$) is the average length of time a carcass remains in the study area before it is removed:

$$\bar{t} = \frac{\sum_{i=1}^{s} t_i}{s - s_c} \qquad (2)$$

Mean carcass removal time was calculated for each carcass size class and season.

3.1.4.3.5 Estimation of the Total Number of Facility-Related Fatalities

Assuming an equal sampling effort among turbines, equal observer detection and scavenging rates, the total number of facility-related fatalities (*M*) is calculated by dividing the observed fatality rate divided by $\hat{\pi}$, an estimate of the probability a carcass is not removed by a scavenger (or other means) and is detected, and multiplying by A, a search area adjustment:

$$M = \frac{N * c * A}{\pi} \qquad (3)$$

The quantity *A* is the ratio of the estimated number of carcasses that would have been found within search plots (including area not searched) to the number of carcasses found within search plots. Tables 3.1, 3.2 and 3.3 include search area adjustment calculations for bats, small birds and large birds, respectively, based on the results of the 2012 study.

Table 3.1. Estimated number of bat carcasses within search plots based on percent of area searched and distribution of carcasses at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

Distance Band (m)	% Area Searched	Number of Carcasses Found	Estimated Number of Carcasses
0 to10	100.0	5	5
11 to 20	99.3	10	10.1
21 to 30	93.1	11	11.8
31 to 40	68.6	19	27.7
Total		**45**	**54.6**
Search Area Adjustment		**1.21**	

Table 3.2. Estimated number of small bird carcasses within search plots based on percent of area searched and distribution of carcasses at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

Distance Band (m)	% Area Searched	Number of Carcasses Found	Estimated Number of Carcasses
0 to10	100.0	21	21
11 to 20	99.3	8	8.1
21 to 30	93.1	19	20.4
31 to 40	68.6	14	20.4
Total		**62**	**69.9**
Search Area Adjustment		**1.13**	

Table 3.3. Estimated number of large bird carcasses within search plots based on percent of area searched and distribution of carcasses at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

Distance Band (m)	% Area Searched	Number of Carcasses Found	Estimated Number of Carcasses
0 to10	100.0	4	4
11 to 20	99.3	2	2.0
21 to 30	93.1	6	6.4
31 to 40	68.6	2	2.9
Total		**14**	**15.4**
Search Area Adjustment		**1.10**	

Annual fatality estimates were calculated for bats, small birds, large birds, diurnal raptors, and all birds combined. The final standard errors and 90% confidence intervals were calculated using bootstrapping (Manly 1997). Bootstrapping is a computer simulation technique that is useful for calculating variances and confidence intervals for complicated test statistics. For each iteration of the bootstrap, the turbines and associated mortality data, searcher efficiency trial carcasses and associated data, and the scavenging removal trial carcasses and associated data are sampled with replacement. Estimates of $\bar{c}$, $\bar{t}$, p, and *m* are calculated for each of the 1,000 bootstrap samples. The bootstrap percentile confidence intervals are calculated from the 1,000 bootstrap estimates. The standard deviation of the bootstrap estimates is the estimated standard error. The lower 5th and upper 95th percentiles of the 1,000 bootstrap estimates are estimates of the lower limit and upper limit of 90% confidence intervals. Annual fatality estimates were presented per turbine and per MW to provide comparable results to other regional or national monitoring studies.

4.0 RESULTS

4.1 Standardized Carcass Surveys

A total of 6,345 carcass searches was conducted within the Project from April 1 through October 28, 2012. No Indiana bat or Virginia big-eared bat carcasses were recorded during standardized searches or incidentally.

Poor weather limited the number of carcass searches completed during all months of the study period (Appendix A). During April, searches were not completed at all plots on April 3, April 11, April 23, and April 24. During May, searches were discontinued due to lightning on 10 different dates (May 1, 7, 8, 17, 22, 23, 26, 27, 28 and 29). During June, searches were not completed at any turbines on June 30 due to a severe storm which resulted in widespread power outages, downed trees, and closure of the site. Weather, primarily lightning, limited the number of searches on an additional eight dates in June: June 5, 12, 18, 20, 22, 25, 26 and 27. The June 30th storm carried over into the beginning of July. Surveys were not conducted at the site July 1, 2, or 3, but resumed on July 4. Due to limitations in access due to downed trees, several turbines were not searched on July 7. During July, the number of searches was limited due to lightning on 10 days: July 5, 9, 14, 15, 18, 23, 24, 27, 30, and 31. An additional search was missed on July 10 at turbine E13 due to turbine maintenance. During the month of August, searchers were unable to complete all scheduled searches due to lightning on eight different dates (August 1, 2, 3, 6, 9, 10, 19, and 20). Lightning limited searches on September 5, 25 and 28. On October 5, the scheduled search at G16 was unintentionally omitted. Snow cover prevented searches at E1 and E5 on October 8. Searches were missed due to turbine maintenance activities on October 9 at H10 and on October 19 at E12. On the last day of surveys, October 28, turbines in the A and F strings (A13, A15, A17, A19, F3, F5, and F7) were not available due to access issues (Appendix A).

4.1.1 Bat Carcasses

Forty-nine bat carcasses, representing four species, were found within search plots, including one silver-haired bat (*Lasionycteris noctivagans*) that was found incidentally on a search plot (Table 4.1; Appendix B). In addition, four bats, representing three species, were found outside of search plots and were not included in any further data analysis. The eastern red bat (*Lasiurus borealis*) was the most common bat species found within search plots (n=29, 59.2%) and overall (n=30, 56.6%). Other species found included hoary bat (*Lasiurus cinereus*; search plots: n=11, 22.4%; overall: n=12, 22.6%), silver-haired bat (search plots: n=7, 14.3%; overall: n=9, 17.0%), and tricolored bat (*Perimyotis subflavus*; search plots: n=2, 4.1%; overall: n=2, 3.8%).

Table 4.1. Total number and percent composition of bat carcasses found at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

	Within search plots		Outside of search plots		Total	
Species	**Number**	**%**	**Number**	**%**	**Number**	**%**
eastern red bat	29	59.2	1	25.0	30	56.6
hoary bat	11	22.4	1	25.0	12	22.6
silver-haired bat	7[a]	14.3	2	50.0	9	17.0
tricolored bat	2	4.1	0	0	2	3.8
Total	**49**	**100**	**4**	**100**	**53**	**100**

[a]One individual found within search plot outside of scheduled searches.

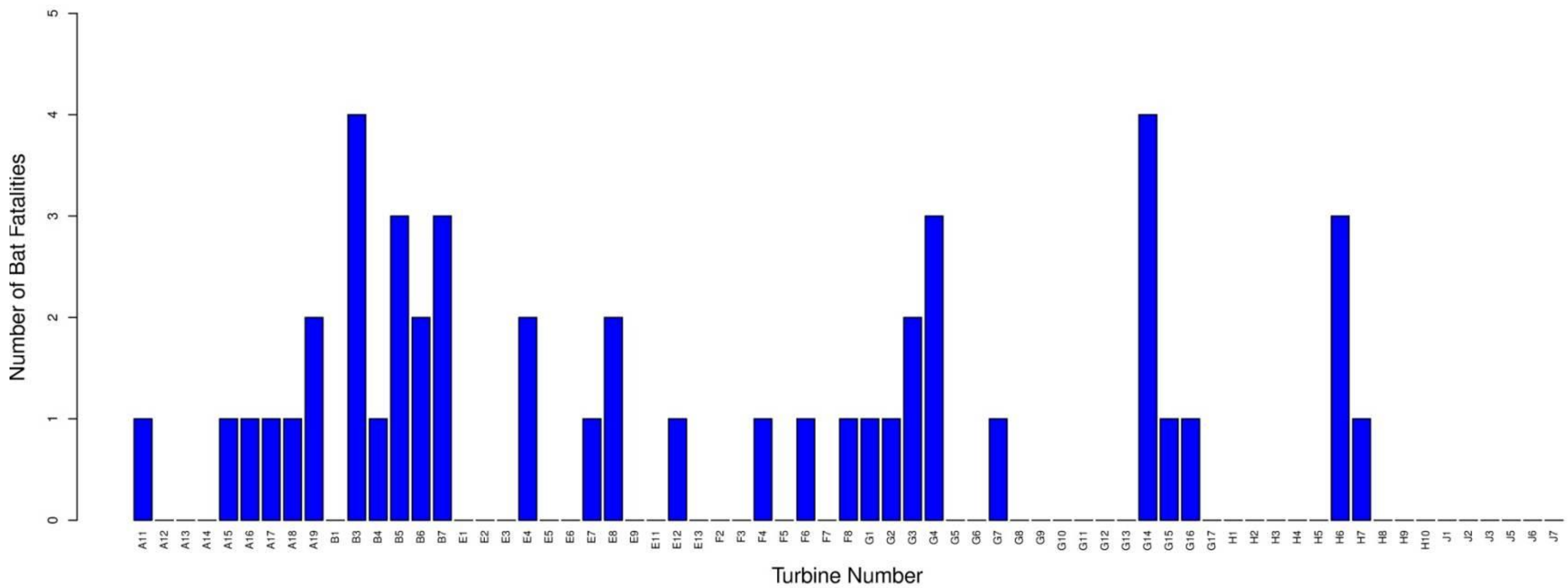

Figure 4.1. The number of bat carcasses found at turbines during carcass monitoring at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

Bat carcasses were found at 28 (42%) of the turbines (Figure 4.1; Appendix C). The number of bat carcasses by turbine ranged from zero to four. Four bat carcasses were found at turbines B3 and G14, while three were found at turbines B5, B7, G4 and H6. Two bat carcasses were found at five turbines (A19, B6, E4, E8, and G3), and one or zero bats were found at the remaining turbines (Figure 4.1; Appendix C).

Nearly three-fourths (74.5%) of bat carcasses were estimated to have been killed or injured the night before the search, and about 13% were estimated to have been found within two to three days of time of death (Figure 4.2). The remaining 13% of bats found were estimated to have been found four to 14 days since time of death.

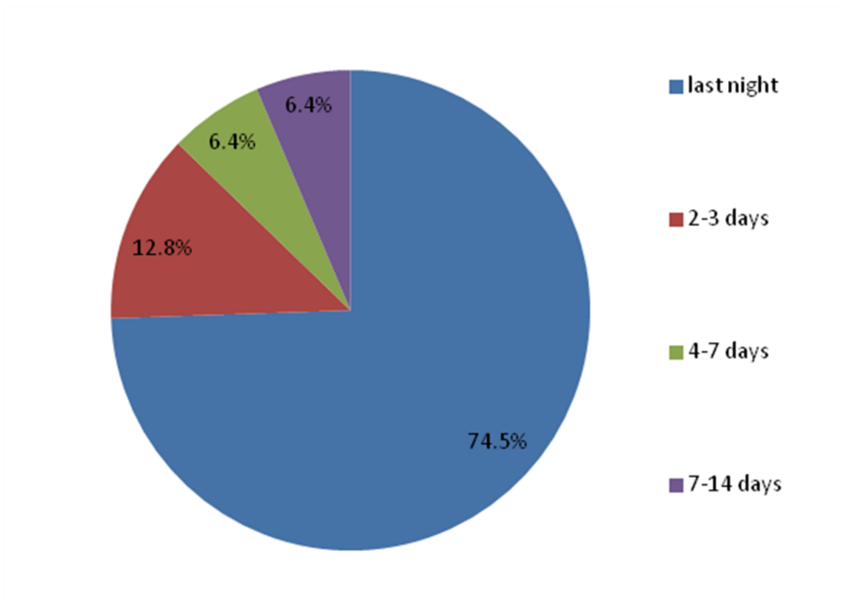

Figure 4.2. Estimated time since death categories of bats found during carcass monitoring at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

Bat carcasses (41.7%) were most often found between 30 and 40 m (98 and 131 ft) from the wind turbine, 22.9% were found within 20 to 30 m (66 to 98 ft), and 20.8% were found within 10 to 20 m (33 to 66 ft; Table 4.2). All bat carcasses were found within 50 m (164 ft) of a turbine.

The temporal distribution of bat discoveries found was plotted and adjusted on a per turbine basis (Figure 4.3). All bat carcasses were found within the Project between April 14 and October 18, 2012. Based on the seasonal distribution of bat carcasses, the greatest proportion were found in fall (48.9%), followed by summer (38.3%), and spring (12.8%; Figure 4.3).

Table 4.2. Distance to turbine (10-m [33-ft] distance intervals) of bat carcasses found during standardized carcass searches and incidentally at turbine search plots during carcass monitoring of the Beech Ridge Wind Farm; April 1 to October 28, 2012.

	Within Search Plot	
Distance band	**Number**	**%**
0 to 10	5	10.4
10 to 20	10	20.8
20 to 30	11	22.9
30 to 40	20	41.7
40 to 50	2	4.2
Total	**48**	**100**

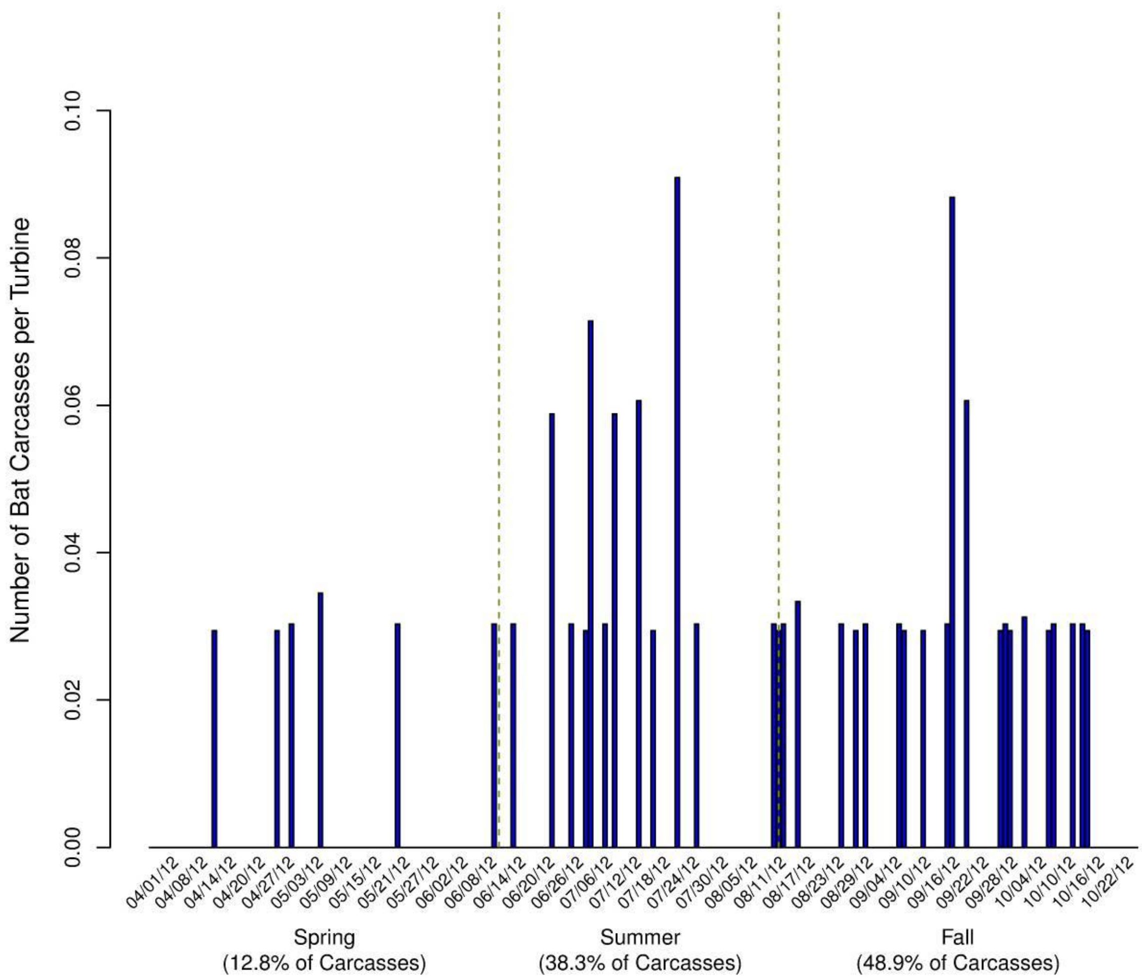

Figure 4.3. Temporal distribution of bat carcasses per turbine searched at the Beech Ridge Wind Farm; April 1 to October 28, 2012. Dashed lines denote seasonal periods.

4.1.2 Bird Carcasses

Overall, including those found within and outside of search plots, 81 bird carcasses, representing 31 known and four unidentifiable species, were recorded during the study (Table 4.3; Appendix B), including: red-eyed vireo (*Vireo olivaceus*; 20 individuals), wild turkey (*Meleagris gallopavo*; 6), yellow-rumped warbler (*Setophaga coronata*; 6), black-billed cuckoo (*Coccyzus erythropthalmus*; 4), blue-headed vireo (*Vireo solitaries*; 4), blackpoll warbler (*Setophaga striata*; 2), golden-crowned kinglet (*Regulus satrapa*; 2), ruffed grouse (*Bonasa umbellus*; 2), Tennessee warbler (*Oreothlypis peregrine*; 2), and wood thrush (*Hylocichla mustelina*; 2). Additional bird carcasses found during standardized carcass searches included one individual each from 20 additional identified species and four unidentified passerines. A third ruffed grouse carcass was found incidentally at turbine F7 on March 30, before the onset of the survey period on April 1. A single sharp-shinned hawk (*Accipiter striatus*) was the only raptor found during the study. It was found on a scheduled carcass search of turbine F4 on July 13. One of the wild turkeys detected during standardized carcass searches (041712-WITU-E1-1) was in poor condition and comprised of only bones. This carcass may have been unearthed by scavengers prior to detection and may not have been killed during the survey period. Nonetheless, this carcass was included in calculations of estimated bird fatality rates. One brown creeper (*Certhia americana*), one eastern towhee (*Pipilo erythrophthalmus*), one hermit thrush (*Catharus guttatus*), and one unidentified small bird were also found incidentally outside of the search plots. Bird carcasses were found at 41 (61%) of the turbines (Figure 4.4; Appendix C). The number of bird carcasses found at each turbine ranged from zero to five (turbine B1; Figure 4.4; Appendix C).

Table 4.3. Total number and percent composition of bird carcasses found at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

	Within search plots		Outside of search plots		Total	
Species	**Number**	**%**	**Number**	**%**	**Number**	**%**
red-eyed vireo	20	25.6	0	0	20	24.7
wild turkey	6	7.7	0	0	6	7.4
yellow-rumped warbler	6	7.7	0	0	6	7.4
black-billed cuckoo	4	5.1	0	0	4	4.9
blue-headed vireo	4	5.1	0	0	4	4.9
unidentified passerine	4	5.1	0	0	4	4.9
ruffed grouse	2	2.6	1	33.3	3	3.7
blackpoll warbler	2	2.6	0	0	2	2.5
golden-crowned kinglet	2	2.6	0	0	2	2.5
Tennessee warbler	2	2.6	0	0	2	2.5
wood thrush	2	2.6	0	0	2	2.5
eastern towhee	1	1.3	1	33.3	2	2.5
hermit thrush	1	1.3	1	33.3	2	2.5
black-and-white warbler	1	1.3	0	0	1	1.2
black-throated blue warbler	1	1.3	0	0	1	1.2
brown-headed cowbird	1	1.3	0	0	1	1.2
brown creeper	1	1.3	0	0	1	1.2
field sparrow	1	1.3	0	0	1	1.2
gray-cheeked thrush	1	1.3	0	0	1	1.2
indigo bunting	1	1.3	0	0	1	1.2
northern flicker	1	1.3	0	0	1	1.2

Table 4.3. Total number and percent composition of bird carcasses found at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

	Within search plots		Outside of search plots		Total	
Species	**Number**	**%**	**Number**	**%**	**Number**	**%**
northern parula	1	1.3	0	0	1	1.2
pine warbler	1	1.3	0	0	1	1.2
prairie warbler	1	1.3	0	0	1	1.2
rose-breasted grosbeak	1	1.3	0	0	1	1.2
savannah sparrow	1	1.3	0	0	1	1.2
scarlet tanager	1	1.3	0	0	1	1.2
sharp-shinned hawk	1	1.3	0	0	1	1.2
tree swallow	1	1.3	0	0	1	1.2
unidentified small bird	1	1.3	0	0	1	1.2
unidentified thrush	1	1.3	0	0	1	1.2
unidentified warbler	1	1.3	0	0	1	1.2
white-eyed vireo	1	1.3	0	0	1	1.2
winter wren	1	1.3	0	0	1	1.2
yellow-bellied sapsucker	1	1.3	0	0	1	1.2
Total	**78**	**100**	**3**	**100**	**81**	**100**

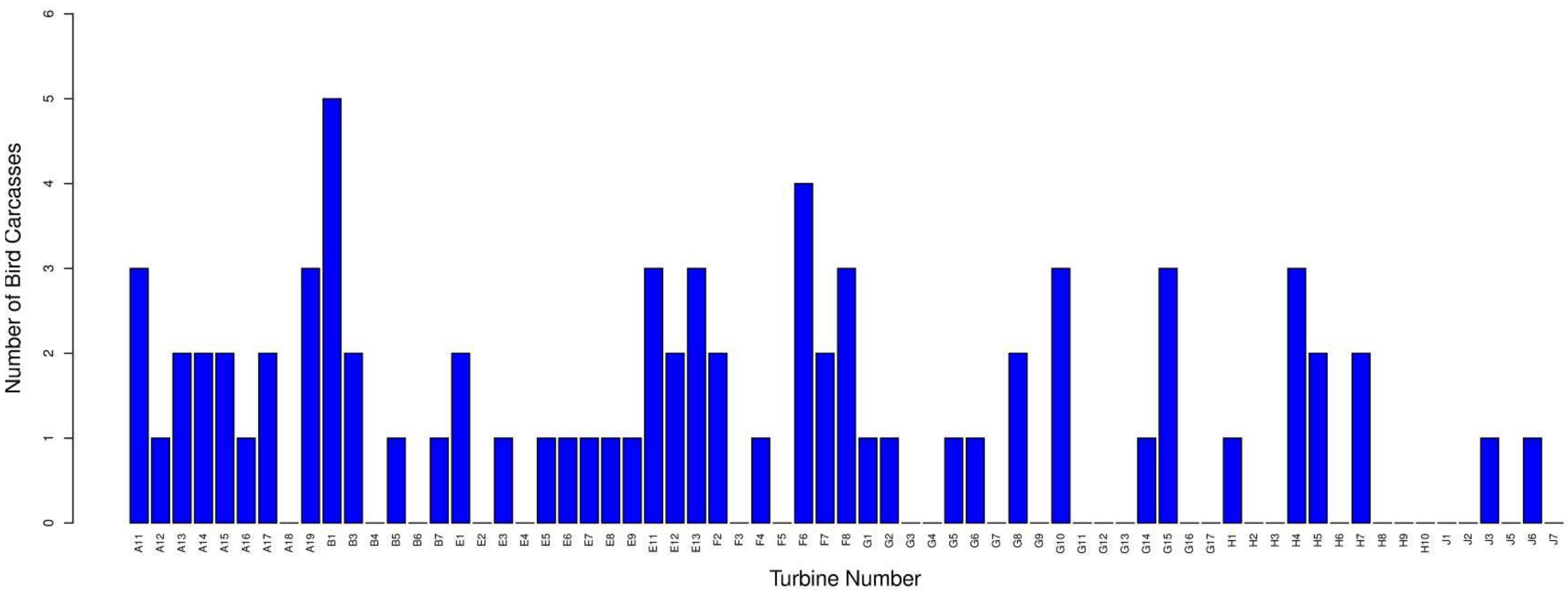

Figure 4.4. The number of bird carcasses found at turbines during carcass monitoring at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

Based on carcass condition, the estimated time of death for 47.9% of bird carcasses was the previous night (Figure 4.5). Nearly 33% of birds were estimated to have been found within two to three days of time of death. Just over 8% of birds were estimated to be found between four and 14 days since time of death, and the time of death for 11% of bird carcasses was unknown .

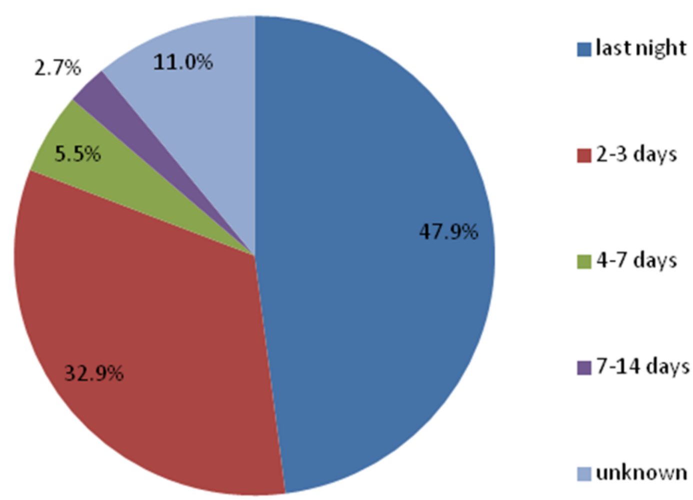

Figure 4.5. Estimated time since death categories of birds found during carcasses monitoring at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

All bird carcasses found on turbine search plots were found within 40 m (131 ft) from a wind turbine (Table 4.4). About 32.5% of all bird carcasses were found between the 0 to 10 m (0 to 33 ft); 13.0% were found between 10 and 20 m (33 to 66 ft); and 33.8% were found within 20 to 30 m (66 to 99 ft).

The temporal distribution of bird discoveries found was plotted and adjusted on a per turbine basis (Figure 4.6). Bird carcasses were found throughout the study period. Based on the seasonal distribution of bird carcasses, the greatest proportion were found in spring (42.1%), followed by fall (35.5%) and summer (22.4%; Figure 4.6).

Table 4.4. Distance to turbine (10-m [33-ft] distance intervals) of bird carcasses found during standardized carcass searches and incidentally at turbine search plots during carcass monitoring of the Beech Ridge Wind Farm; April 1 to October 28, 2012.

	Within Project	
Distance band (m)	**Number**	**%**
0 to 10	25	32.5
10 to 20	10	13.0
20 to 30	26	33.8
30 to 40	16	20.8
40 to 50	0	0
Total	**77**	**100**

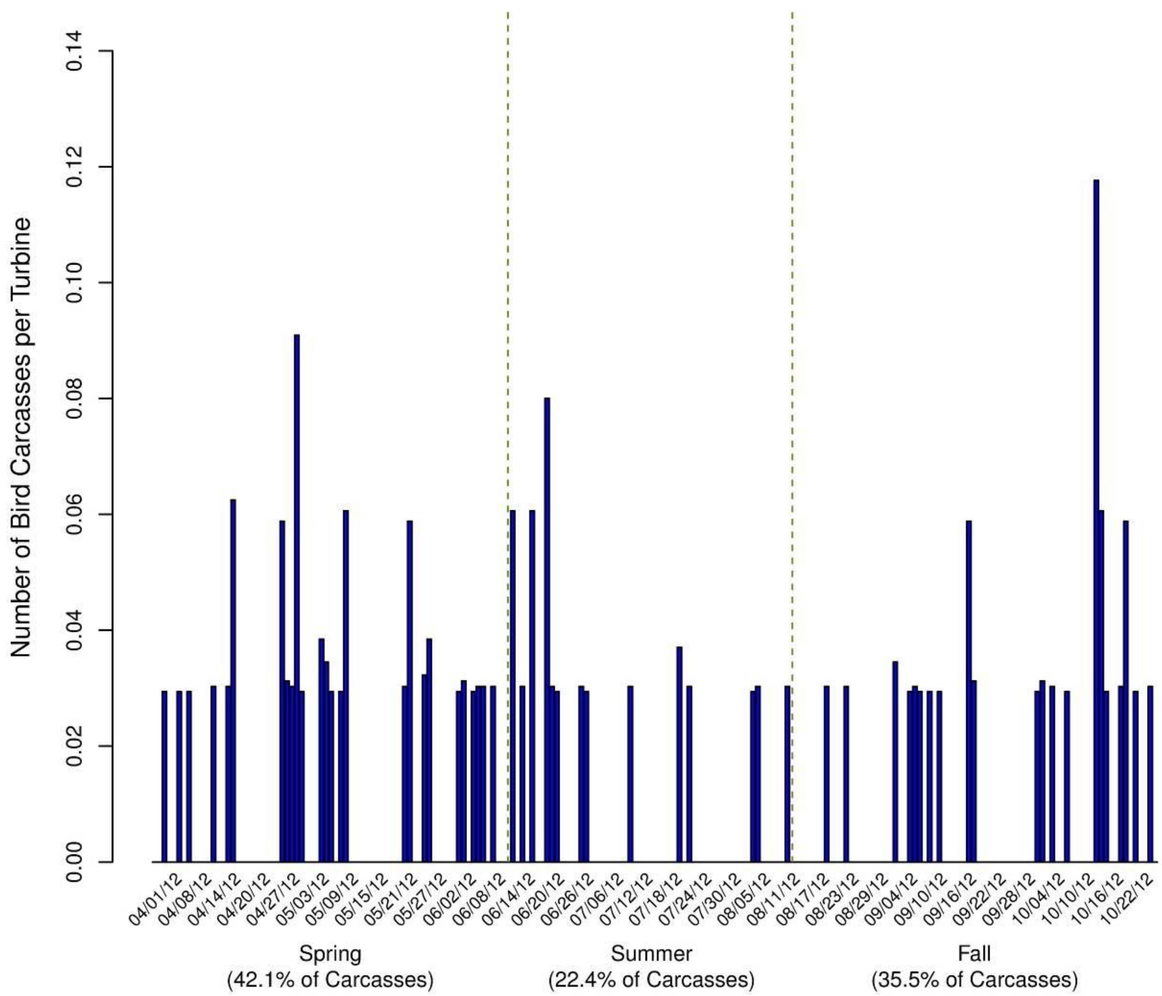

Figure 4.6. Temporal distribution of bird discoveries per turbine searched at the Beech Ridge Wind Farm; April 1 to October 28, 2012. Dashed lines represent seasonal periods.

4.2 Searcher Efficiency Trials

Searcher efficiency trials were conducted on 34 days throughout the study period April 1 – October 28, during which 384 carcasses were deployed (169 bats, 109 small birds, and 106 large birds; Table 4.5). Eighty-nine percent (n=151) of bats were available for detection and 51.7% (n=78) were found. Eighty-seven percent (n=95) of small birds were available for detection and 69.5% (n=66) were found. One-hundred-five large birds were available for detection and 93.3% (n=98) were found (Table 4.5).

Searcher efficiency for bats was highest during August (74.5%), while searcher efficiency for small and large birds was highest in September (85.7% and 100%, respectively; Table 4.5). Searcher efficiency for bats was much lower in April and July (28.6% and 16.7%, respectively) compared to the other months, which ranged from 44.1% to 74.5%. These relatively low rates of detection were attributed to vegetation height and weather. During April, rapid vegetation growth exceeded the rate at which mowing operations could be completed. During July, high rates of rain coupled with site access limitations due to safety (lightning) resulted in decreased mowing frequency at a period of rapid vegetation growth. Small and large bird detection rates were fairly consistent between months, with the lowest detection rates for both small and large birds occurring in October (42.9% and 86.7%, respectively).

Table 4.5 Searcher efficiency results at the Beech Ridge Wind Farm as a function of month and carcass type; April 1 to October 28, 2012.

Carcass Type	Month	Number Placed	Number Available	Number Found	Percent Found
Bats	Apr	15	14	4	28.6
	May	27	26	14	53.8
	Jun	15	12	7	58.3
	Jul	16	12	2	16.7
	Aug	34	31	23	74.2
	Sep	26	22	13	59.1
	Oct	36	34	15	44.1
	Overall	**169**	**151**	**78**	**51.7**
Small Birds	Apr	15	14	10	71.4
	May	19	16	13	81.3
	Jun	15	13	9	69.2
	Jul	14	9	6	66.7
	Aug	16	15	10	66.7
	Sep	15	14	12	85.7
	Oct	15	14	6	42.9
	Overall	**109**	**95**	**66**	**69.5**
Large Birds	Apr	14	14	13	92.9
	May	17	17	16	94.1
	Jun	15	15	14	93.3
	Jul	16	15	14	93.3
	Aug	14	14	13	92.9
	Sep	15	15	15	100
	Oct	15	15	13	86.7
	Overall	**106**	**105**	**98**	**93.3**

The percent of bats found varied across seasons, with the highest searcher efficiency in fall (60%), followed by spring (46.9%), and summer (23.5%; Table 4.6). For small birds, searcher efficiency was slightly higher in spring (71.8%) than in summer and fall (68.4% and 67.6%, respectively). Large bird searcher efficiency was similar across seasons, ranging from 92.0% found in summer to 94.6% found in fall (Table 4.6).

Table 4.6 Searcher efficiency results at the Beech Ridge Wind Farm as a function of season and carcass type; April 1 to October 28, 2012.

Carcass Type	Season	Number Placed	Number Available	Number Found	Percent Found
Bats	Spring	52	49	23	46.9
	Summer	23	17	4	23.5
	Fall	94	85	51	60.0
Small Birds	Spring	45	39	28	71.8
	Summer	24	19	13	68.4
	Fall	40	37	25	67.6
Large Birds	Spring	43	43	40	93.0
	Summer	26	25	23	92.0
	Fall	37	37	35	94.6

4.3 Carcass Removal Trials

A total of 360 carcass removal trial carcasses was deployed on 15 dates throughout the study period (beginning in March): 45 mice, 75 bats, 120 small birds, and 120 large birds. Overall for the study period, after the first day of each trial approximately 60% of bat or mouse carcasses, 70% of small bird carcasses, and 90% of large bird carcasses remained (Figure 4.7). After two weeks, about 20% of small bird and bat/mice carcasses and approximately 60% of large bird carcasses remained. The average removal time was much shorter for bats or small birds (5.5 and 6.3 days, respectively) than for large birds (17.5 days; Table 4.7).

Table 4.7. Average carcass removal times by month and overall for the 2012 Beech Ridge Wind Energy Project post-construction monitoring studies.

	Average Removal Time (days)		
Time Period	Bats	Small Birds	Large Birds
March	20.8	8.0	7.5
April	9.8	14.1	23.5
May	11.7	10.4	13.6
June	4.6	7.0	42.3
July	2.9*	3.8	18.9
August	1.0*	2.7	26.1
September	1.2*	3.9	13.4
October	3.1	3.7	19.1
Overall	**5.5**	**6.3**	**17.5**

*****Small brown mice used as surrogates for bats.

The average bat carcass removal time was relatively long in winter (20.8 days) compared to spring and fall (8.3 and 3.1 days, respectively; Table 4.8). For mice carcasses, the average removal time was similar in both summer and fall (1.9 and 1.2 days, respectively). Small bird average removal time was longer in spring and winter (10.4 and 8.0 days) than in summer and fall (3.2 and 3.8), while large bird carcass removal time was longer in spring and summer (31.6 and 22.0 days) than in fall and winter (16.6 and 7.5 days; Table 4.8).

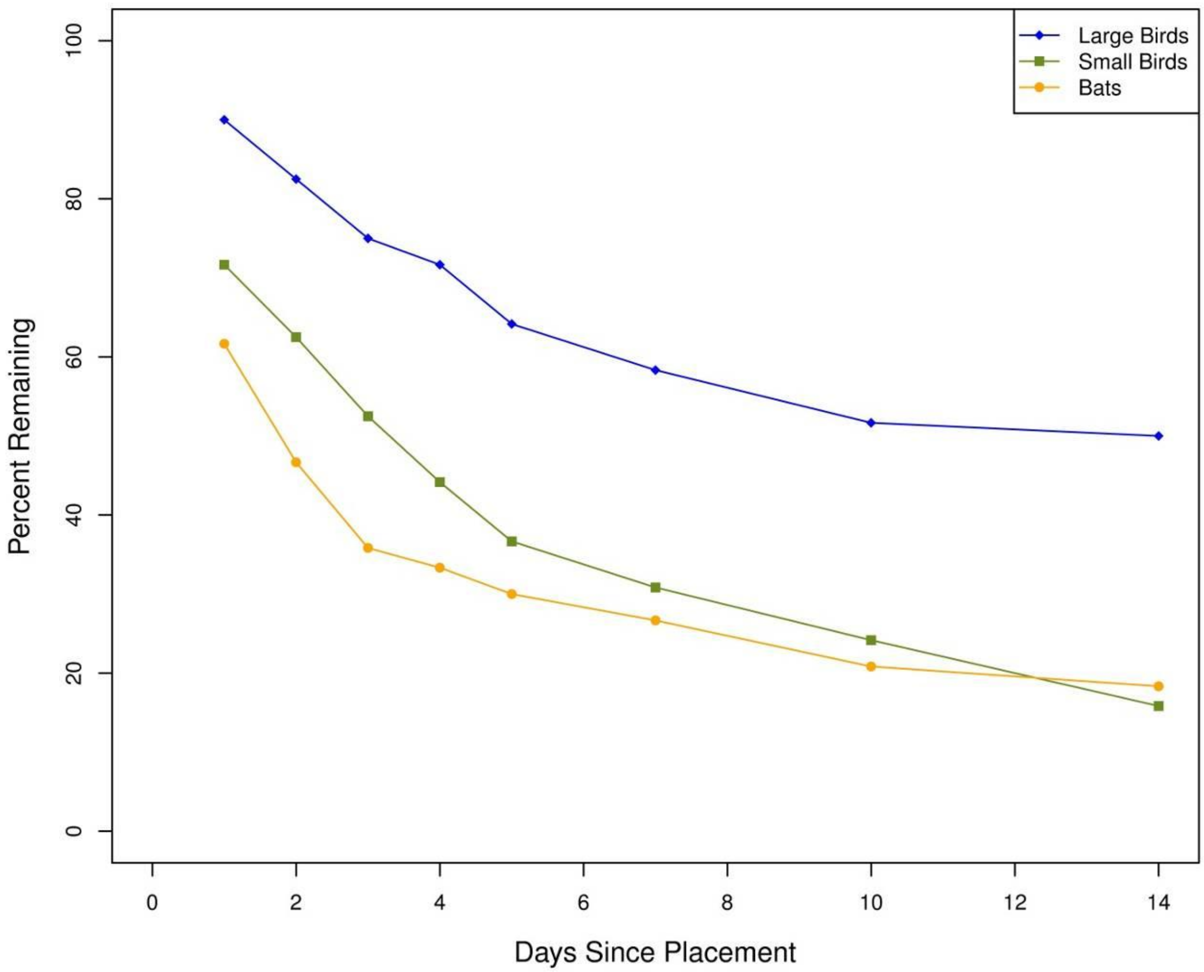

Figure 4.7. Rate of removal of small bird, large bird, and bat/mice carcasses during carcass removal trials at the Beech Ridge Wind Farm; March 15 to October 28, 2012.

Table 4.8. Average carcass removal times by season for the 2012 Beech Ridge Wind Energy Project post-construction monitoring studies.

Season[A]	Average Removal Time (days) Bats	Mice	Small Birds	Large Birds
Winter	20.8	--	8.0	7.5
Spring	8.3	--	10.4	21.6
Summer	--	1.9	3.2	22.0
Fall	3.1	1.2	3.8	16.0

[A] Winter: March 15 – March 31; Spring: April 1 – June 14; Summer: June 15 – August 15; Fall: August 16 – November 15.

To test for potential differences between removal rates of bats and mice, which were used as surrogates for bats in carcass removal trials, the average carcass removal rate was compared for bats and mice across the entire study period and during the fall, when both bats and mice were used concurrently. Across the entire study period the average carcass removal time for bats was 8.58 days and for mice was 1.69 days (Table 4.9). Based on Monte Carlo methods, the overall average removal time for bats and mice was statistically significantly different at the <0.0001 level when data across the entire study period are used. There were mice used in summer and fall, but no bats in summer. Therefore, the only period in which both mice and bats were used at the same time was fall, representing the best available side-by-side test. When only fall data were used, the average removal times for bats and mice were not statistically significantly different (P-value = 0.2024). When sample sizes are randomized in 5,000 repetitions, a difference in carcass removal time between bats and mice was not observed to the extent observed for the entire study period. It is important to note that the side by side test for fall was for a relatively small sample size, and that mice were used only when needed to result in a monthly carcass removal trial sample size of a minimum of 15 bats/bat surrogates. The scavenger removal correction factor used to estimate carcass removal rates (Section 4.4) included average monthly removal rates determined during trials and therefore included both bat and mouse removal rates.

Table 4.9. Comparison of average carcass removal times for bats and mice during the 2012 Beech Ridge Wind Energy Project post-construction monitoring studies.

Carcass Type	Number Censored	Summary of Time in Field (days)	Number of Carcasses	Average Carcass Removal Time (days)
Entire Study Period				
Bat	21	463.5	54	8.58
Mice	1	74.5	44	1.69
Fall Only Trials				
Bat	1	43.5	14	3.11
Mice	0	18.5	15	1.23

4.4 Fatality Estimates

Fatality estimates and 90% confidence intervals (CI) were calculated for bats, small birds, large birds, raptors, and all birds, by season and overall for the study period April 1 – October 28, 2012 (Table 4.10). The adjusted annual fatality estimate for bats during the 2012 study was 3.04 (90% CI = 1.89, 7.44) fatalities/turbine/year. For small and large birds, annual fatality estimates were 1.53 (90% CI = 1.24, 1.97) and 0.26 (90% CI = 0.14, 0.36) fatalities/turbine/year, respectively, while the diurnal raptor fatality estimate was 0.02 (0, 0.05) fatalities/turbine/year. The adjusted annual fatality estimate for all birds was 1.79 (90% CI = 1.46, 2.24) fatalities/turbine/year. Adjusting the per turbine fatality estimates by nameplate WTG megawatt capacity (1.5) resulted in annual fatality estimates of 2.03 bat and 1.19 all bird fatalities/MW/year.

Bat fatality estimates were higher in the summer (1.97 fatalities/turbine/season) than either fall or spring (0.91 and 0.16 fatalities/turbine/season, respectively; Table 4.10). Small bird fatality estimates were highest in fall (0.68 fatalities/turbine/season), followed by 0.48 in spring and 0.37 in summer. Fatality estimates for large birds was highest in spring (0.14 fatalities/turbine/season), followed by 0.09 in summer and 0.02 in fall. Raptors were only recorded in the summer (0.02 fatalities/turbine/season). Fatality estimates for all birds were highest in fall (0.70 fatalities/turbine/season), followed by 0.62 in spring and 0.46 in summer.

Table 4.10. Summary of fatality estimates for bats, small birds, large birds, raptors, and all birds at the Beech Ridge Wind Farm; April 1 to October 28, 2012.

	Spring			Summer			Fall		
		90 % CI[A]			90% CI[A]			90% CI[A]	
	mean	ll	Ul	Mean	ll	ul	mean	ll	Ul
Search Area Adjustment									
Bats	1.21	--	--	1.21	--	--	1.21	--	--
Small Birds	1.13	--	--	1.13	--	--	1.13	--	--
Large Birds	1.10	--	--	1.10	--	--	1.10	--	--
Raptors	1.10	--	--	1.10	--	--	1.10	--	--
Searcher Efficiency									
Bats	0.47	0.35	0.59	0.24	0.06	0.41	0.60	0.52	0.69
Small Birds	0.72	0.59	0.82	0.68	0.53	0.84	0.68	0.57	0.78
Large Birds	0.93	0.86	0.98	0.92	0.80	1.00	0.95	0.89	1.00
Raptors	0.93	0.86	0.98	0.92	0.80	1.00	0.95	0.89	1.00
Average Removal Time									
Bats	8.32	5.70	11.96	1.93	1.18	3.04	2.14	1.12	3.43
Small Birds	10.39	7.61	14.33	3.23	2.13	4.96	3.80	2.30	5.73
Large Birds	21.63	14.90	32.37	21.96	14.86	34.60	16.03	9.71	28.60
Raptors	21.63	14.90	32.37	21.96	14.86	34.60	16.03	9.71	28.60
Observed Fatality Rates (fatalities/turbine/season)									
Bats	0.09	0.03	0.15	0.27	0.16	0.37	0.34	0.21	0.51
Small Birds	0.36	0.22	0.49	0.18	0.10	0.27	0.39	0.28	0.51
Large Birds	0.12	0.04	0.19	0.07	0.03	0.13	0.01	0	0.04
Raptors	0	--	--	0.01	0	0.04	0	--	--
All Birds	0.48	0.33	0.64	0.25	0.16	0.36	0.40	0.28	0.54
Average Probability of Carcass Available and Detected									
Bats	0.69	0.58	0.79	0.16	0.05	0.30	0.46	0.28	0.59
Small Birds	0.84	0.77	0.88	0.55	0.41	0.69	0.65	0.50	0.75
Large Birds	0.94	0.92	0.96	0.94	0.90	0.96	0.93	0.89	0.96
Raptors	0.94	0.92	0.96	0.94	0.90	0.96	0.93	0.89	0.96
Adjusted Fatality Estimates (fatalities/turbine/search type/season)									
Bats	0.16	0.05	0.26	1.97	0.90	6.23	0.91	0.50	1.72
Small Birds	0.48	0.31	0.68	0.37	0.21	0.59	0.68	0.48	1.00
Large Birds	0.14	0.05	0.23	0.09	0.03	0.16	0.02	0	0.05
Raptors	0	--	--	0.02	0	0.05	0	--	--
All Birds	0.62	0.43	0.85	0.46	0.28	0.69	0.70	0.49	1.02

Overall Adjusted Fatality Estimates (fatalities/turbine/year)			
		90% Confidence Interval	
	Mean	Lower Limit	Upper Limit
Bats	3.04	1.89	7.44
Small Birds	1.53	1.24	1.97
Large Birds	0.26	0.14	0.36
Raptors	0.02	0	0.05
All Birds	1.79	1.46	2.24

[A] ll = lower limit; ul = upper limit

5.0 DISCUSSION

5.1 Listed Species

No federally-listed endangered Indiana bat or Virginia big-eared bat or other listed species carcasses were recorded during the 2012 fatality monitoring study.

5.2 Carcass Removal of Bats

Carcass removal rates were calculated monthly throughout the study period to inform BRE on the suitability of the carcass search interval to meet the objective of documenting Indiana bat or Virginia big-eared bat discoveries. Trials began in mid-March, approximately two-weeks prior to the start of carcass searches. Carcass removal rates varied monthly and averaged 5.5 days for the study period. Despite inter-month variability in removal rates, the carcass removal times observed at the Project suggest that on average searchers had multiple chances to find bat carcasses, given the two-day carcass search interval used in the study. According to current suggested guidelines for estimating all bird and bat fatality rates, the search interval should not be longer than twice the average removal time (Strickland et al, 2011).

Carcass removal rates for bats became shorter as the study period extended from the spring into summer and fall. A similar pattern was also observed for small birds, but interestingly, not for large birds. *Corvids* were observed by biologists deploying and monitoring carcass removal trials and it is likely that some *Corvids* queued into trial carcasses as easy sources of carrion. Measures were taken to reduce this behavior by deploying carcass removal trials in the dark during September and October; however, substantially elongated carcass removal rates did not result from these measures. It was possible that *Corvids* were able to detect trial carcasses by queuing in on biologists visited trial locations during daylight hours to document scavenger rate and carcass condition (e.g. on days 2, 3, 4, 5, etc. of a trial).

Mice were used as surrogates for bats for carcass removal trials (ie. non-myotis bats) in July, August, and September because the low bat casualty rate observed at the Project meant there were few bats available for use in the trials[2]. Although agencies were contacted to request additional specimens for use in the trials, few suitable carcasses were available[3]. A statistical analysis of mice versus bat carcass removal rates was conducted for this report. This analysis showed an overall significant ($p < 0.001$) increase in removal times for mice (1.69 days) compared with bats (8.59 days). However, mice were used only when needed and only during monthly periods when bats were not available. As a result only a small sample size was available for a paired side by side seasonal comparison, which did not indicate a statistically significant difference in removal rates. To our knowledge there has been no experimental test of scavenging rates using a robust paired simultaneous study design to validate the suitability of

[2] In addition, some bat carcasses recovered during the study were no longer considered suitable for use in bias trials following extended power outages associated with a tropical storm at the end of June and early July. Carcasses which fully defrosted and began to decay within freezers were considered not suitable for use in a study designed to estimate natural patterns of scavenger removal of freshly killed bats.

[3] Some bat carcasses provided to WEST were either old or heavily decayed, and were therefore considered not suitable for use in a study designed to estimate natural patterns of scavenger removal of freshly killed bats.

using mice as bat surrogates for future carcass removal trials and the results reported here suggest such an experiment is needed. We hypothesize that differences in ecological factors (e.g. prey availability, attractiveness to predators, etc) or differences in palatability/energetic value may affect rates of scavenging for bats and mice. The scavenger removal correction factor used in this study included both bat and mouse removal rates. Because removal rates of mice were higher (faster) than for bats, the overall removal rate used to correct estimates of bat carcasses was higher than if only bats had been used for carcass removal trials.

5.3 Fatality Estimates and Turbine Operational Protocols Involving High Cut-in Speeds and Blade-feathering below Cut-in

The turbine operational protocols implemented during the 2012 monitoring period resulted in bat mortality far below the regional average bat mortality recorded at other wind generation facilities. BRE modified turbine operational protocols so that turbine blades were fully feathered below wind speeds of 6.9 m/s (15.2 mph) from ½ hour before sunset to ¼ hour after sunrise. Raising turbine cut-in speeds and feathering blades have been found to be effective at significantly reducing bat fatalities at other operating wind facilities in the region of the Project (Arnett et al 2010, Young et al 2011) and within in other regions of the U.S. and Canada (Good et al 2011, Baerwald et al. 2009). Previous curtailment studies have evaluated cut-in wind speeds ranging from 4.0 m/s (8.8 mph) up to 6.5 m/s 14.3 mph). At the BRE Project, feathering turbine blades up to a cut- in speed of 6.9 m/s (15.2 mph) was used, and, unlike at other facilities we are aware of, was conducted at all turbines within the Project. As a result, evaluating the effectiveness of the turbine operation changes are best made through a comparison of observed bat mortality rates from other regional studies.

WEST has compiled data from monitoring studies[4] across regional areas for meta-analyses which are illustrated in Figure 5.1. Three spatial scales for meta-analysis were used for comparison: a) the Eastern North American analysis which included the Northeast, Southeast, Southern Plains and Midwest regions (Figures 5.1 and 5.2); b) the Northeast regional analysis (Figures 5.1 and 5.3), and; c) the West Virginia projects analysis. At all spatial scales used for comparison the bat fatality rate observed at the Project was below the median and mean of the range of bat fatality rates observed during other studies (Figures 5.1 and 5.2). At the Eastern North America scale, the 2012 observed bat fatality estimate at the Project (2.03 fatalities/MW/year) was approximately 73% less than the average for other annualized estimates which was approximately 7.40 bat fatalities/MW/year (Table 5.1, Figure 5.2). The observed bat fatality estimate at the Project was also approximately 73% less than the average for other annualized projects just within the Northeastern region (Projects from areas including: Maine, New Hampshire, West Virginia, New York, Pennsylvania, and Ontario, Canada; Table 5.1, Figure 5.3). Only two facilities in West Virginia have published comparable, publicly-available fatality studies: Mount Storm and Mountaineer (Table 5.1; Figures 5.2 and 5.3). Bat fatality rates at Mount Storm ranged from 6.62 to 24.32 bat fatalities/MW/year, while rates at Mountaineer were 25.17 and 31.69 fatalities/MW/year (Table 5.1). The bat fatality rate at the

[4] WEST uses minimum standards for inclusion of fatality monitoring studies for such meta-analysis. Standards include: inclusion of standardized carcass searches and bias trials, use of accepted statistical estimators (see Strickland et al 2011), study period duration, search plot size, and field methods.

Project was approximately 89% less than the average for other annualized West Virginia projects.

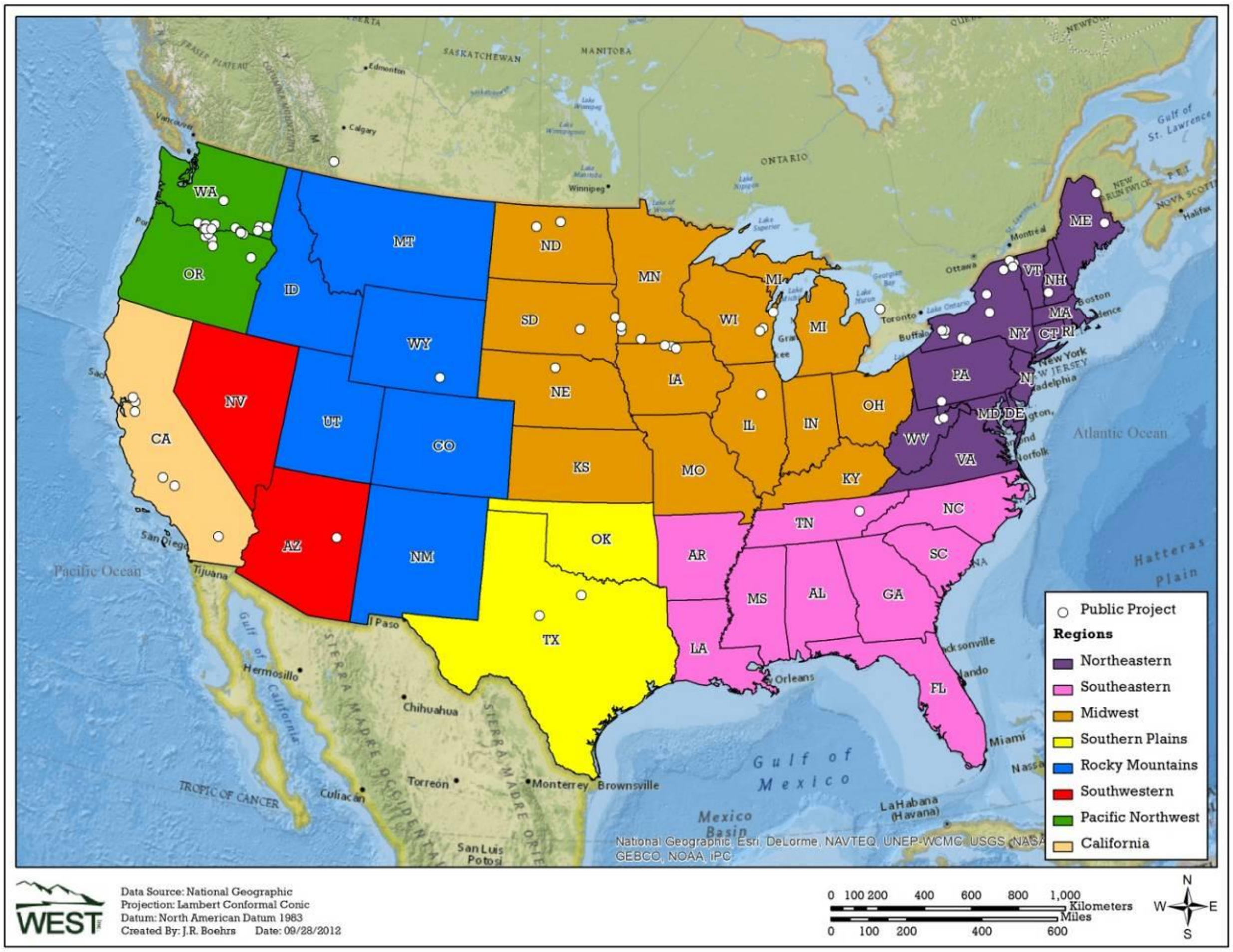

Figure 5.1. Regional areas defined by WEST and locations of wind projects where publically-available post-construction monitoring studies were completed, which meet minimum criteria for inclusion in meta-analysis. The Eastern meta-analysis included Northeastern, Southeastern, Southern Plains and Midwest regions.

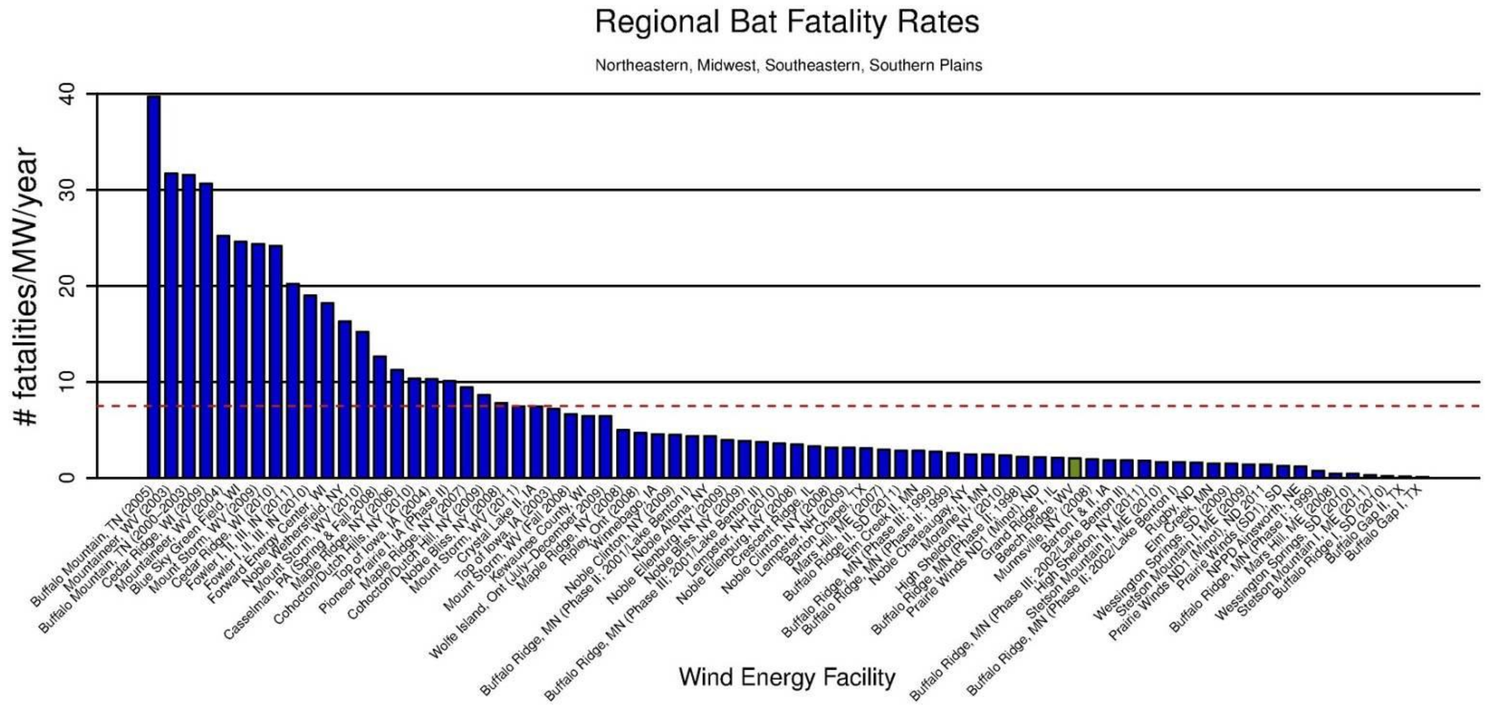

Figure 5.2. Estimated fatality rates for bats (number of bat fatalities per MW per year) from publicly-available wind energy facilities in Eastern North America. The dashed line indicates the mean number of bat fatalities per MW per year in eastern North America.

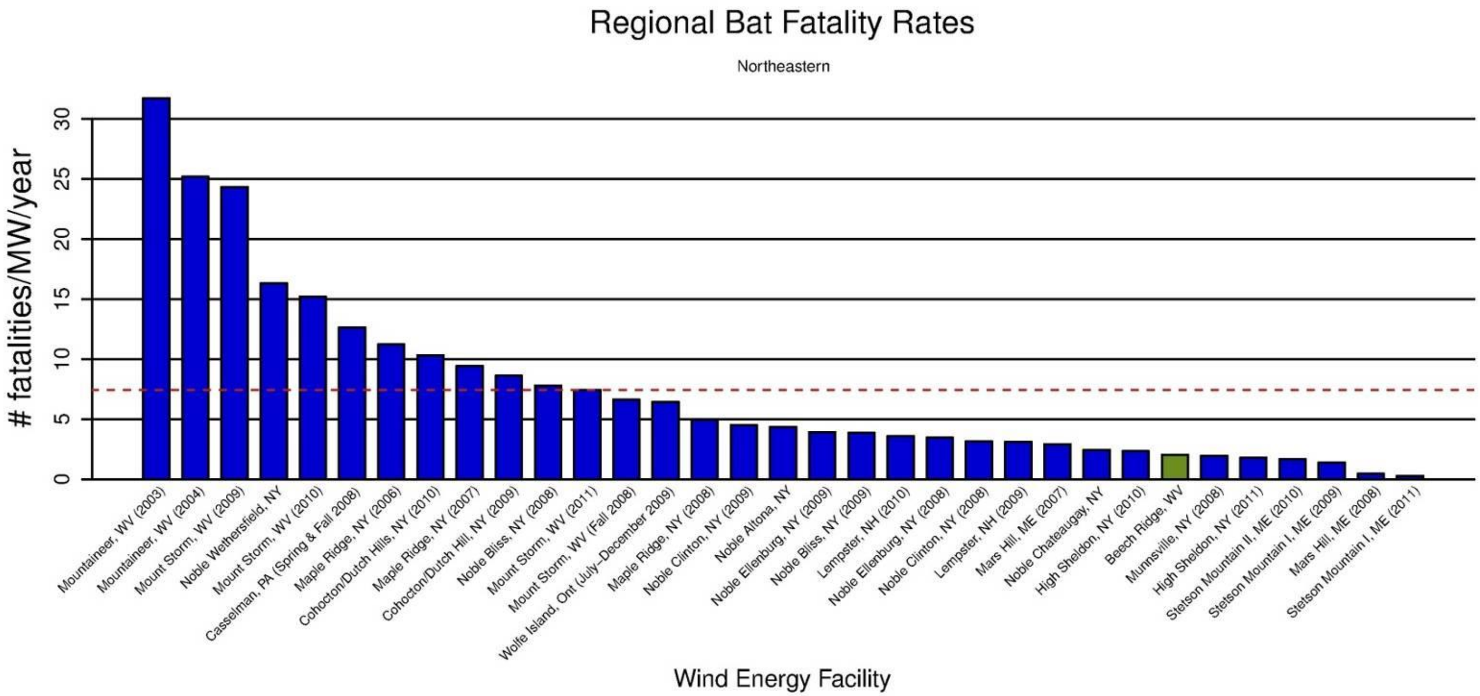

Figure 5.3. Estimated fatality rates for bats (number of bat fatalities per MW per year) from publicly-available wind energy facilities in northeastern North America. The dashed line indicates the mean number of bat fatalities per MW per year in northeastern North America.

Table 5.1 Summary of publically-available estimated fatality data from wind energy projects in Eastern North America included in the meta-analysis.

Project Name/Location	Estimated Bat fatality/MW/ study period	Estimated Bird fatality/MW/ study period	Estimated Raptor fatality/MW/ study period	Habitat	Reference
Beech Ridge, WV	**2.03**	**1.19**	**0.01**		**This Study**
Barton Chapel, TX	3.06	1.15	0.25	agriculture/forest	WEST 2011
Barton I & II, IA	1.85	5.5	0	agriculture	Derby et al. 2011a
Blue Sky Green Field, WI	24.57	7.17	0	agriculture	Gruver et al. 2009
Buffalo Gap I, TX	0.1	1.32	0.1	grassland	Tierney 2007
Buffalo Gap II, TX	0.14	0.15	0	Forest	Tierney 2009
Buffalo Mountain, TN (2000-2003)	31.54	11.02	0	Forest	Nicholson et al. 2005
Buffalo Mountain, TN (2005)	39.7	1.1	0	Forest	Fiedler et al. 2007
Buffalo Ridge I, SD (2010)	0.16	5.06	0.2	agriculture/grassland	Derby et al. 2010b
Buffalo Ridge II, SD (2011)	2.81	1.99	0	agriculture/grassland	Derby et al. 2012a
Buffalo Ridge, MN (Phase I; 1996)	NA	4.14	0.47	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1997)	NA	2.51	0	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1998)	NA	3.14	0	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase I; 1999)	0.74	1.43	0	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1998)	2.16	2.47	0	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 1999)	2.59	3.57	0	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase II; 2001/Lake Benton I)	4.35	NA	NA	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase II; 2002/Lake Benton I)	1.64	NA	NA	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 1999)	2.72	5.93	0	agriculture	Johnson et al. 2000
Buffalo Ridge, MN (Phase III; 2001/Lake Benton II)	3.71	NA	NA	agriculture	Johnson et al. 2004
Buffalo Ridge, MN (Phase III; 2002/Lake Benton II)	1.81	NA	NA	agriculture	Johnson et al. 2004
Casselman, PA (Spring & Fall 2008)	12.61	3.13	0	Forest	Arnett et al. 2009
Cedar Ridge, WI (2009)	30.61	6.55	NA	agriculture	BHE Environmental 2010
Cedar Ridge, WI (2010)	24.12	3.72	NA	agriculture	BHE Environmental 2011
Cohocton/Dutch Hill, NY (2009)	8.62	1.39	NA	agriculture/forest	Stantec 2010
Cohocton/Dutch Hills, NY (2010)	10.32	1.32	NA	agriculture/forest	Stantec 2011
Crescent Ridge, IL	3.27	NA	NA	agriculture	Kerlinger et al. 2007
Crystal Lake II, IA	7.42	NA	NA	agriculture	Derby et al. 2010a

Elm Creek II, MN	2.81	3.64	NA	agriculture/grassland	Derby et al. 2012b
Elm Creek, MN	1.49	1.55	0	agriculture	Derby et al. 2010c
Forward Energy Center, WI	18.17	NA	NA	agriculture	Grodsky and Drake 2011
Fowler I, II, III, IN (2010)	18.96	NA	NA	agriculture	Good et al. 2011
Fowler I, II, III, IN (2011)	20.19	NA	NA	agriculture	Good et al. 2012
Grand Ridge I, IL	2.1	0.48	0	agriculture	Derby et al. 2010g
High Sheldon, NY (2010)	2.33	1.76	0.06	agriculture	Tidhar et al. 2012a
High Sheldon, NY (2011)	1.78	1.57	0	agriculture	Tidhar et al. 2012b
Kewaunee County, WI	6.45	1.95	0	agriculture	Howe et al. 2002
Lempster, NH (2009)	3.11	3.38	0	grasslands & rocky embankments	Tidhar et al. 2010
Lempster, NH (2010)	3.57	2.64	0	grasslands & rocky embankments	Tidhar et al. 2011
Maple Ridge, NY (2006)	11.21	NA	NA	agriculture/forested	Jain et al. 2007
Maple Ridge, NY (2007)	9.42	3.44	0.25	agriculture/forested	Jain et al. 2009a
Maple Ridge, NY (2008)	4.96	2.07	0.03	agriculture/forested	Jain et. al 2009d
Mars Hill, ME (2007)	2.91	1.67	0	Forest	Stantec 2008
Mars Hill, ME (2008)	0.45	1.76	0	Forest	Stantec 2009a
Moraine II, MN	2.42	5.59	0.37	agriculture/grassland	Derby et al. 2010d
Mount Storm, WV (Fall 2008)	6.62	NA	NA	Forest	Young et. al 2009b
Mount Storm, WV (2009)	24.32	5.73	0	Forest	Young et. al 2009a, 2010b
Mount Storm, WV (2010)	15.18	2.6	0.1	Forest	Young et al. 2010a, 2011
Mount Storm, WV (2011)	7.43	4.24	0.03	Forest	Young et al. 2011; Young et al. 2012
Mountaineer, WV (2003)	31.69	2.69	NA	Forest	Kerns and Kerlinger 2004
Mountaineer, WV (2004)	25.17	NA	NA	Forest	Arnett et al. 2005
Munnsville, NY (2008)	1.93	1.48	0.59	agriculture/forest	Stantec 2009b
Noble Altona, NY	4.34	1.84	0	Forest	Jain et al. 2011b
Noble Bliss, NY (2008)	7.8	1.3	0.1	agriculture/forest	Jain et al. 2009e
Noble Bliss, NY (2009)	3.85	2.28	0.12	agriculture/forest	Jain et al. 2010a
Noble Chateaugay, NY	2.44	1.66	NA	agriculture	Jain et al. 2011c
Noble Clinton, NY (2008)	3.14	1.59	0.1	agriculture/forest	Jain et al. 2009c
Noble Clinton, NY (2009)	4.5	1.11	0.16	agriculture/forest	Jain et al. 2010b
Noble Ellenburg, NY (2008)	3.46	0.83	0.11	agriculture/forest	Jain et al. 2009b

Noble Ellenburg, NY (2009)	3.91	2.66	0.25	agriculture/forest	Jain et al. 2010c
Noble Wethersfield, NY	16.3	1.7	NA	agriculture	Jain et al. 2011a
NPPD Ainsworth, NE	1.16	1.63	0.06	agriculture/grassland	Derby et al. 2007
Pioneer Prairie I, IA (Phase II)	10.06	0.27	0	agriculture/grassland	Chodachek et al. 2012
Prairie Winds (SD1), SD	1.23	1.41	0	grassland	Derby et al. 2012d
Prairie Winds ND1 (Minot), ND	2.13	1.48	0.05	agriculture	Derby et al. 2011c
Prairie Winds ND1 (Minot), ND 2011	1.39	1.56	0.05	agriculture/grassland	Derby et al. 2012c
Ripley, Ont (2008)	4.67	3.09	NA	agriculture	Jacques Whitford 2009
Rugby, ND	1.6	3.82	0.06	agriculture	Derby et al. 2011
Stetson Mountain I, ME (2009)	1.4	2.68	0	Forest	Stantec 2009c
Stetson Mountain I, ME (2011)	0.28	1.18	0	Forested	Normandeau Associates 2011
Stetson Mountain II, ME (2010)	1.65	1.42	0	Forested	Normandeau Associates 2010
Top of Iowa, IA (2003)	7.16	0.42	NA	agriculture	Jain 2005
Top of Iowa, IA (2004)	10.27	0.81	NA	agriculture	Jain 2005
Wessington Springs, SD (2009)	1.48	8.25	0.06	grassland	Derby et al. 2010f
Wessington Springs, SD (2010)	0.41	0.89	0.07	grassland	Derby et al. 2011d
Winnebago, IA	4.54	3.88	0.27	agriculture/grassland	Derby et al. 2010e
Wolfe Island, Ont (July-December 2009)	6.42	NA	NA	grassland	Stantec Ltd. 2010

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Appendix A: Carcass Search Periods at Beech Ridge Wind Farm

Appendix A. Carcass search periods at the Beech Ridge Wind Farm for the period April 1 to October 28, 2012.

Search Period	Search Period Dates	Number of Turbines Searched	Interval between Searches
1	April 1 – April 2, 2012	67	2 days
2	April 3 – April 4, 2012	34	2 days
3	April 5 – April 6, 2012	66	2 days
4	April 7 – April 8, 2012	67	2 days
5	April 9 – April 10, 2012	67	2 days
6	April 11 – April 12, 2012	38	2 days
7	April 13 – April 14, 2012	67	2 days
8	April 15 – April 16, 2012	67	2 days
9	April 17 – April 18, 2012	65	2 days
10	April 19 – April 20, 2012	67	2 days
11	April 21 – April 22, 2012	67	2 days
12	April 23 – April 24, 2012	8	2 days
13	April 25 – April 26, 2012	48	2 days
14	April 27 – April 28, 2012	67	2 days
15	April 29 – April 30, 2012	66	2 days
16	May 1 – May 2, 2012	66	2 days
17	May 3 – May 4, 2012	67	2 days
18	May 5 – May 6, 2012	67	2 days
19	May 7 – May 8, 2012	55	2 days
20	May 9 – May 10, 2012	67	2 days
21	May 11 – May 12, 2012	67	2 days
22	May 13 – May 14, 2012	67	2 days
23	May 15 – May 16, 2012	57	2 days
24	May 17 – May 18, 2012	62	2 days
25	May 19 – May 20, 2012	67	2 days
26	May 21 – May 22, 2012	52	2 days
27	May 23 – May 24, 2012	52	2 days
28	May 25 – May 26, 2012	60	2 days
29	May 27 – May 28, 2012	59	2 days
30	May 29 – May 30, 2012	58	2 days
31	May 31, 2012	33	2 days
32	June 1 – June 2, 2012	67	2 days
33	June 3 – June 4, 2012	67	2 days
34	June 5 – June 6, 2012	66	2 days
35	June 7 – June 8, 2012	67	2 days
36	June 9 – June 10, 2012	67	2 days
37	June 11 – June 12, 2012	63	2 days
38	June 13 – June 14, 2012	67	2 days
39	June 15 – June 16, 2012	67	2 days
40	June 17 – June 18, 2012	57	2 days
41	June 19 – June 20, 2012	66	2 days
42	June 21 – June 22, 2012	58	2 days
43	June 23 – June 24, 2012	67	2 days
44	June 25 – June 26, 2012	50	2 days
45	June 27 – June 28, 2012	66	2 days
46	June 29 – June 30, 2012	33	2 days
47	July 4 – July 5, 2012	44	2 days
48	July 6 – July 7, 2012	62	2 days
49	July 8 – July 9, 2012	49	2 days
50	July 10 – July 11, 2012	66	2 days
51	July 12 – July 13, 2012	67	2 days

Appendix A. Carcass search periods at the Beech Ridge Wind Farm for the period April 1 to October 28, 2012.

Search Period	Search Period Dates	Number of Turbines Searched	Interval between Searches
52	July 14 – July 15, 2012	39	2 days
53	July 16 – July 17, 2012	67	2 days
54	July 18 – July 19, 2012	45	2 days
55	July 20 – July 21, 2012	67	2 days
56	July 22 – July 23, 2012	61	2 days
57	July 24 – July 25, 2012	37	2 days
58	July 26 – July 27, 2012	51	2 days
59	July 28 – July 29, 2012	67	2 days
60	July 30 – July 31, 2012	36	2 days
61	August 1 – August 2, 2012	50	2 days
62	August 3 – August 4, 2012	56	2 days
63	August 5 – August 6, 2012	54	2 days
64	August 7 – August 8, 2012	67	2 days
65	August 9 – August 10, 2012	27	2 days
66	August 11 – August 12, 2012	67	2 days
67	August 13 – August 14, 2012	67	2 days
68	August 15 – August 16, 2012	67	2 days
69	August 17 – August 18, 2012	67	2 days
70	August 19 – August 20, 2012	53	2 days
71	August 21 – August 22, 2012	67	2 days
72	August 23 – August 24, 2012	67	2 days
73	August 25 – August 26, 2012	67	2 days
74	August 27 – August 28, 2012	67	2 days
75	August 29 – August 30, 2012	67	2 days
76	August 31, 2012	34	2 days
77	September 1 – September 2, 2012	66	2 days
78	September 3 – September 4, 2012	66	2 days
79	September 5 – September 6, 2012	63	2 days
80	September 7 – September 8, 2012	67	2 days
81	September 9 – September 10, 2012	67	2 days
82	September 11 – September 12, 2012	67	2 days
83	September 13 – September 14, 2012	67	2 days
84	September 15 – September 16, 2012	67	2 days
85	September 17 – September 18, 2012	67	2 days
86	September 19 – September 20, 2012	67	2 days
87	September 21 – September 22, 2012	66	2 days
88	September 23 – September 24, 2012	67	2 days
89	September 25 – September 26, 2012	65	2 days
90	September 27 – September 28, 2012	45	2 days
91	September 29 – September 30, 2012	67	2 days
92	October 1 – October 2, 2012	67	2 days
93	October 3 – October 4, 2012	67	2 days
94	October 5 – October 6, 2012	66	2 days
95	October 7 – October 8, 2012	65	2 days
96	October 9 – October 10, 2012	66	2 days
97	October 11 – October 12, 2012	67	2 days
98	October 13 – October 14, 2012	67	2 days
99	October 15 – October 16, 2012	67	2 days
100	October 17 – October 18, 2012	67	2 days
101	October 19 – October 20, 2012	66	2 days
102	October 21 – October 22, 2012	67	2 days

Appendix A. Carcass search periods at the Beech Ridge Wind Farm for the period April 1 to October 28, 2012.

Search Period	Search Period Dates	Number of Turbines Searched	Interval between Searches
103	October 23 – October 24, 2012	67	2 days
104	October 25 – October 26, 2012	67	2 days
105	October 27 – October 28, 2012	60	2 days
Total	**April 1 – October 28, 2012**	**6,345**	

Appendix B: Complete Casualty Listing

Appendix B. Summary of bat and bird carcasses found within search plots at the Beech Ridge Wind Farm during the 2012 study.

Sample ID	Date	Turbine	Distance From Turbine	Type of Find[1]	Condition	Common Name	Gender[2]	Age[3]
033012-HOBA-A12-1	3 /30/2012	A12	31	incidental find	Intact	hoary bat	F	A
033012-RUGR-F7-1	3 /30/2012	F7	26	incidental find	Feather Spot	ruffed grouse	U	U
040312-WITU-A19-1	4 /3 /2012	A19	20	carcass search	Feather Spot	wild turkey	U	U
040712-BHCO-G15-1	4 /7 /2012	G15	26	carcass search	Feather Spot	brown-headed cowbird	U	U
040912-NOFL-B3-1	4 /9 /2012	B3	26	carcass search	Feather Spot	northern flicker	U	U
041412-WITU-H4-1	4 /14/2012	H4	28	carcass search	Feather Spot	wild turkey	U	U
041512-SHBA-B7-1	4 /15/2012	B7	6	carcass search	Intact	silver-haired bat	U	A
041712-WITU-E1-1	4 /17/2012	E1	26	carcass search	Dismembered	wild turkey	U	U
041812-YBSA-F6-1	4 /18/2012	F6	18	carcass search	Intact	yellow-bellied sapsucker	F	A
041812-UNPA-B1-1	4 /18/2012	B1	28	carcass search	Dismembered	unidentified passerine	U	U
042712-ERBA-E7-1	4 /27/2012	E7	55	carcass search	Intact	eastern red bat	F	A
042912-ERBA-A19-1	4 /29/2012	A19	25	carcass search	Scavenged	eastern red bat	U	A
042912-SAVS-E7-1	4 /29/2012	E7	17	carcass search	Intact	savannah sparrow	U	A
042912-WITU-F7-1	4 /29/2012	F7	24	carcass search	Feather Spot	wild turkey	U	U
043012-HETH-G2-1	4 /30/2012	G2	36	carcass search	Intact	hermit thrush	U	A
050112-WITU-G1-1	5 /1 /2012	G1	27	carcass search	Feather Spot	wild turkey	U	U
050212-BAWW-F6-1	5 /2 /2012	F6	25	carcass search	Dismembered	black-and-white warbler	U	A
050212-WOTH-A11-1	5 /2 /2012	A11	25	carcass search	Dismembered	wood thrush	U	A
050212-WOTH-A14-1	5 /2 /2012	A14	23	carcass search	Intact	wood thrush	U	A
050212-SHBA-E12-1	5 /2 /2012	E12	37	carcass search	Scavenged	silver-haired bat		
050312-REVI-E9-1	5 /3 /2012	E9	32	carcass search	Intact	red-eyed vireo	U	U
050712-EATO-B7-1	5 /7 /2012	B7	0	carcass search	Intact	eastern towhee	M	A
050812-HOBA-F4-1	5 /8 /2012	F4	12	carcass search	Injured	hoary bat	M	A
050812-SCTA-F6-1	5 /8 /2012	F6	38	carcass search	Intact	scarlet tanager	F	A
050912-REVI-A13-1	5 /9 /2012	A13	10	carcass search	Intact	red-eyed vireo	U	A
051112-NOPA-A13-1	5 /11/2012	A13	39	carcass search	Intact	northern parula	M	A
051212-REVI-F2-1	5 /12/2012	F2	18	carcass search	Intact	red-eyed vireo	U	A
051212-REVI-A11-1	5 /12/2012	A11	36	carcass search	Intact	red-eyed vireo	U	A
052412-RUGR-H4-1	5 /24/2012	H4	40	carcass search	Feather Spot	ruffed grouse	U	U
052412-SHBA-E8-1	5 /24/2012	E8	35	carcass search	Intact	silver-haired bat	M	A
052512-REVI-E11-1	5 /25/2012	E11	2	carcass search	Intact	red-eyed vireo	U	A
052512-BLPW-B5-1	5 /25/2012	B5	19	carcass search	Intact	blackpoll warbler	M	A

Appendix B. Summary of bat and bird carcasses found within search plots at the Beech Ridge Wind Farm during the 2012 study.

Sample ID	Date	Turbine	Distance From Turbine	Type of Find[1]	Condition	Common Name	Gender[2]	Age[3]
052812-REVI-A11-1	5 /28/2012	A11	25	carcass search	Intact	red-eyed vireo	U	A
052912-REVI-H7-1	5 /29/2012	H7	1	carcass search	Scavenged	red-eyed vireo	U	A
060412-FISP-A15-1	6 /4 /2012	A15	29	carcass search	Injured	field sparrow	U	U
060512-BBCU-F8-1	6 /5 /2012	F8	1	carcass search	Intact	black-billed cuckoo		A
060712-UNWA-F7-1	6 /7 /2012	F7	40	carcass search	Scavenged	unidentified warbler	U	A
060812-REVI-H5-1	6 /8 /2012	H5	2	carcass search	Intact	red-eyed vireo	U	A
060912-RBGR-G10-1	6 /9 /2012	G10	1	carcass search		rose-breasted grosbeak	M	A
061112-UNPA-B1-1	6 /11/2012	B1	29	carcass search	Feather Spot	unidentified passerine	U	U
061312-HOBA-G4-1	6 /13/2012	G4	18	carcass search	Scavenged	hoary bat	U	U
061512-REVI-G10-1	6 /15/2012	G10	1	carcass search	Scavenged	red-eyed vireo	U	A
061512-ERBA-G6-1	6 /15/2012	G6	44	incidental find	Intact	eastern red bat	M	A
061512-REVI-H4-1	6 /15/2012	H4	1	carcass search	Intact	red-eyed vireo	U	A
061712-ERBA-E4-1	6 /17/2012	E4	17	carcass search	Intact	eastern red bat	M	U
061712-BHVI-E12-1	6 /17/2012	E12	3	carcass search	Intact	blue-headed vireo	U	A
061912-BBCU-J6-1	6 /19/2012	J6	0	carcass search	Intact	black-billed cuckoo	U	A
061912-BBCU-E12-1	6 /19/2012	E12	0	carcass search	Scavenged	black-billed cuckoo	U	U
062212-REVI-E13-1	6 /22/2012	E13	31	carcass search	Scavenged	red-eyed vireo	U	A
062212-REVI-A19-1	6 /22/2012	A19	1	carcass search	Intact	red-eyed vireo	U	A
062312-BHVI-B1-1	6 /23/2012	B1	0	carcass search	Intact	blue-headed vireo	U	A
062412-INBU-E13-1	6 /24/2012	E13	0	carcass search	Intact	indigo bunting	M	J
062512-ERBA-H6-1	6 /25/2012	H6	14	carcass search	Intact	eastern red bat	M	A
062912-RUGR-B1-1	6 /29/2012	B1	28	carcass search	Feather Spot	ruffed grouse	U	A
062912-ERBA-H6-1	6 /29/2012	H6	36	carcass search	Intact	eastern red bat	U	A
070412-REVI-H7-1	7 /4 /2012	H7	9	carcass search	Scavenged	red-eyed vireo	U	U
070612-HOBA-B5-1	7 /6 /2012	B5	22	carcass search	Dismembered	hoary bat	U	A
070712-HOBA-A11-1	7 /7 /2012	A11	17	carcass search	Intact	hoary bat	U	A
070712-HOBA-E8-1	7 /7 /2012	E8	39	carcass search	Scavenged	hoary bat	M	A
071012-TRBA-A19-1	7 /10/2012	A19	17	carcass search	Intact	tricolored bat	M	A
071212-HOBA-E7-1	7 /12/2012	E7	31	carcass search	Intact	hoary bat	F	A
071212-ERBA-G7-1	7 /12/2012	G7	13	carcass search	Intact	eastern red bat	M	A
071312-SSHA-F4-1	7 /13/2012	F4	19	carcass search	Intact	sharp-shinned hawk	F	A
071712-ERBA-B6-1	7 /17/2012	B6	35	carcass search	Intact	eastern red bat	F	A

Appendix B. Summary of bat and bird carcasses found within search plots at the Beech Ridge Wind Farm during the 2012 study.

Sample ID	Date	Turbine	Distance From Turbine	Type of Find[1]	Condition	Common Name	Gender[2]	Age[3]
071712-HOBA-A16-1	7 /17/2012	A16	0	carcass search	Dismembered	hoary bat	U	U
072012-ERBA-G15-1	7 /20/2012	G15	23	carcass search	Intact	eastern red bat	M	A
072312-REVI-A16-1	7 /23/2012	A16	1	carcass search	Intact	red-eyed vireo	U	A
072512-ERBA-E4-1	7 /25/2012	E4	1	carcass search	Intact	eastern red bat	U	A
072512-HOBA-G4-1	7 /25/2012	G4	40	carcass search	Intact	hoary bat	F	A
072512-HOBA-B6-1	7 /25/2012	B6	22	carcass search	Intact	hoary bat	M	A
072512-REVI-F2-1	7 /25/2012	F2	2	carcass search	Intact	red-eyed vireo	U	A
072912-ERBA-B4-1	7 /29/2012	B4	5	carcass search	Intact	eastern red bat	F	A
080712-BBCU-H5-1	8 /7 /2012	H5	6	carcass search	Feather Spot	black-billed cuckoo	U	U
080812-REVI-F8-1	8 /8 /2012	F8	1	carcass search	Intact	red-eyed vireo	U	A
081412-UNPA-A12-1	8 /14/2012	A12	5	carcass search	Scavenged	unidentified passerine	U	U
081412-ERBA-G14-1	8 /14/2012	G14	21	carcass search	Intact	eastern red bat	U	A
081512-ERBA-G3-1	8 /15/2012	G3	33	carcass search	Scavenged	eastern red bat	U	U
081612-ERBA-A18-1	8 /16/2012	A18	25	carcass search	Intact	eastern red bat	M	A
081912-ERBA-A15-1	8 /19/2012	A15	9	carcass search	Scavenged	eastern red bat	U	U
082112-UNID-E11-1	8 /21/2012	E11	41	carcass search	Feather Spot	unidentified bird (small)	U	U
082212-WITU-G8-1	8 /22/2012	G8	32	carcass search	Feather Spot	wild turkey	U	U
082612-BHVI-G8-1	8 /26/2012	G8	3	carcass search	Intact	blue-headed vireo	F	A
082812-ERBA-H6-1	8 /28/2012	H6	35	carcass search	Intact	eastern red bat	M	A
083112-ERBA-H7-1	8 /31/2012	H7	14	carcass search	Intact	eastern red bat	M	A
090212-HOBA-B7-1	9 /2 /2012	B7	27	carcass search	Intact	hoary bat	M	A
090512-BHVI-F8-1	9 /5 /2012	F8	3	carcass search	Intact	blue-headed vireo	U	A
090812-REVI-A19-1	9 /8 /2012	A19	17	carcass search	Intact	red-eyed vireo	U	A
090912-REVI-A14-1	9 /9 /2012	A14	3	carcass search	Scavenged	red-eyed vireo	U	A
090912-ERBA-G14-1	9 /9 /2012	G14	32	carcass search	Intact	eastern red bat	M	A
091012-TEWA-E13-1	9 /10/2012	E13	18	carcass search	Intact	Tennessee warbler	U	A
091012-ERBA-B5-1	9 /10/2012	B5	26	carcass search	Injured	eastern red bat	M	A
091012-ERBA-G11-1	9 /10/2012	G11	44	carcass search	Scavenged	eastern red bat	M	A
091212-BTBW-E3-1	9 /12/2012	E3	22	carcass search	Scavenged	black-throated blue warbler	F	A
091412-ERBA-B3-1	9 /14/2012	B3	41	carcass search	Scavenged	eastern red bat	M	A
091412-REVI-G5-1	9 /14/2012	G5	30	carcass search	Intact	red-eyed vireo	U	A
091912-SHBA-G1-1	9 /19/2012	G1	26	incidental find	Intact	silver-haired bat	F	A

Appendix B. Summary of bat and bird carcasses found within search plots at the Beech Ridge Wind Farm during the 2012 study.

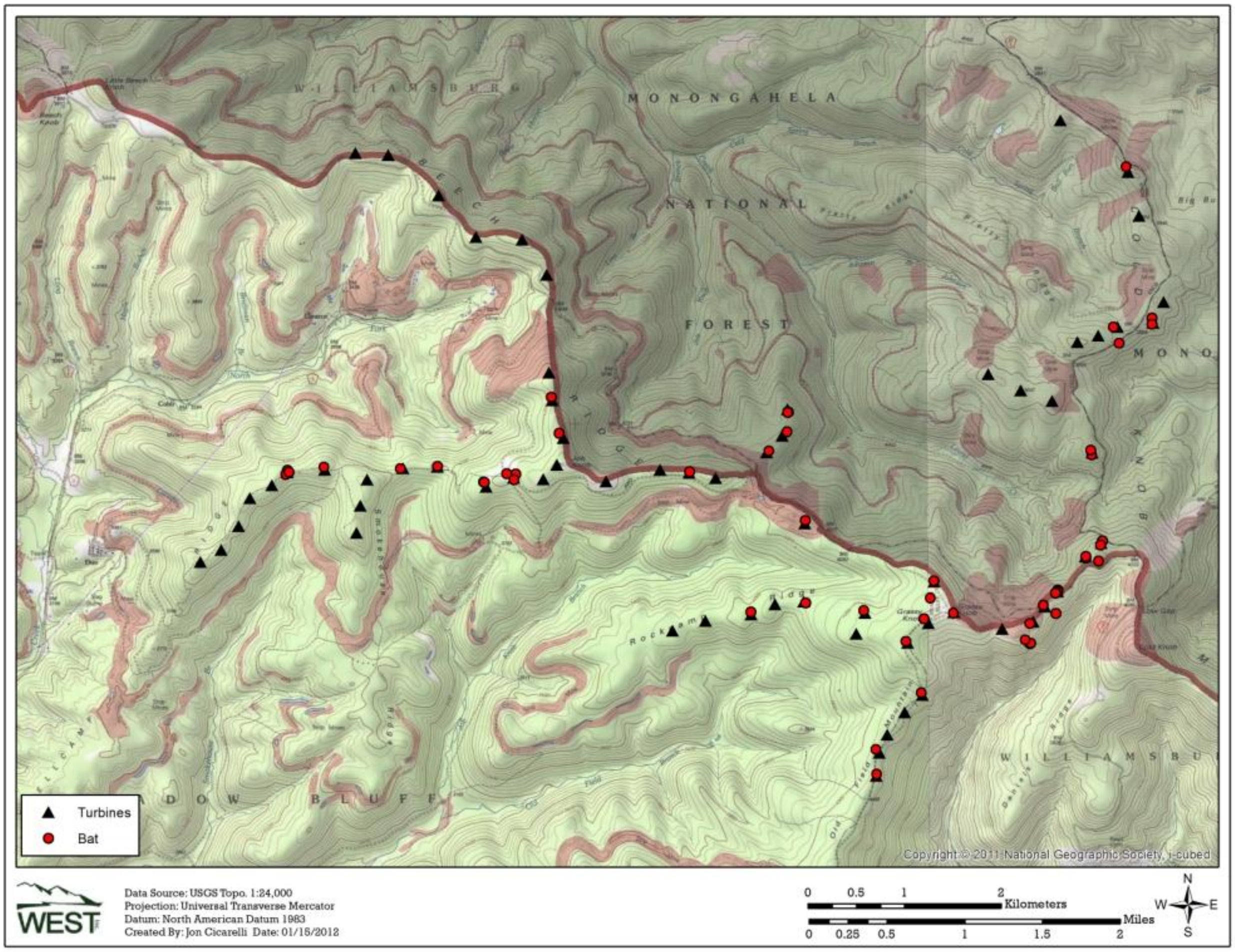
Sample ID	Date	Turbine	Distance From Turbine	Type of Find[1]	Condition	Common Name	Gender[2]	Age[3]
092012-ERBA-B3-1	9 /20/2012	B3	41	carcass search	Dismembered	eastern red bat	U	A
092012-SHBA-G4-1	9 /20/2012	G4	62	incidental find	Intact	silver-haired bat	M	A
092012-SHBA-A17-2	9 /20/2012	A17	36	carcass search	Intact	silver-haired bat	M	A
092012-PRAW-A17-1	9 /20/2012	A17	24	carcass search	Scavenged	prairie warbler	U	U
092012-SHBA-B5-1	9 /20/2012	B5	44	incidental find	Intact	silver-haired bat	M	A
092012-ERBA-B3-2	9 /20/2012	B3	40	carcass search	Intact	eastern red bat	F	A
092012-UNTH-G15-1	9 /20/2012	G15	33	carcass search	Intact	unidentified thrush	U	A
092112-BLPW-G10-1	9 /21/2012	G10	23	carcass search	Scavenged	blackpoll warbler	U	U
092312-ERBA-G14-1	9 /23/2012	G14	32	carcass search	Intact	eastern red bat	M	A
092312-ERBA-G16-1	9 /23/2012	G16	36	carcass search	Intact	eastern red bat	M	A
093012-ERBA-B7-1	9 /30/2012	B7	36	carcass search	Intact	eastern red bat	M	A
100112-TRBA-G4-1	10/1 /2012	G4	40	carcass search	Intact	tricolored bat	M	A
100212-SHBA-B5-1	10/2 /2012	B5	37	carcass search	Intact	silver-haired bat	M	A
100412-TRES-B3-1	10/4 /2012	B3	27	carcass search	Intact	tree swallow	M	A
100512-ERBA-G14-2	10/5 /2012	G14	27	carcass search	Intact	eastern red bat	M	A
100512-UNPA-G14-1	10/5 /2012	G14	27	carcass search	Scavenged	unidentified passerine	U	A
100712-WEVI-B1-1	10/7 /2012	B1	19	carcass search	Intact	white-eyed vireo	U	A
101012-SHBA-G3-1	10/10/2012	G3	28	carcass search	Scavenged	silver-haired bat	M	A
101012-GCKI-J3-1	10/10/2012	J3	28	carcass search	Intact	golden-crowned kinglet	M	A
101112-ERBA-G2-1	10/11/2012	G2	20	carcass search	Intact	eastern red bat	M	A
101512-ERBA-F8-1	10/15/2012	F8	12	carcass search	Scavenged	eastern red bat	U	U
101612-YRWA-E11-2	10/16/2012	E11	35	carcass search	Intact	yellow-rumped warbler	M	A
101612-YRWA-G15-1	10/16/2012	G15	23	carcass search	Intact	yellow-rumped warbler	F	A
101612-GCTH-E11-1	10/16/2012	E11	0	carcass search	Intact	gray-cheeked thrush	U	A
101612-EATO-NA-1	10/16/2012	INC		incidental find	Intact	eastern towhee	F	A
101612-HETH-NA-1	10/16/2012	INC		incidental find	Intact	hermit thrush	U	A
101612-REVI-A15-1	10/16/2012	A15	22	carcass search	Intact	red-eyed vireo	M	A
101712-ERBA-F6-1	10/17/2012	F6	40	carcass search	Intact	eastern red bat	U	A
101712-TEWA-F6-1	10/17/2012	F6	35	carcass search	Intact	Tennessee warbler	U	A
101712-PIWA-E6-1	10/17/2012	E6	32	carcass search	Intact	pine warbler	U	A
101812-WIWR-H1-1	10/18/2012	H1	18	carcass search		winter wren	U	A
101812-HOBA-B3-1	10/18/2012	B3	38	carcass search	Intact	hoary bat	U	A

Appendix B. Summary of bat and bird carcasses found within search plots at the Beech Ridge Wind Farm during the 2012 study.

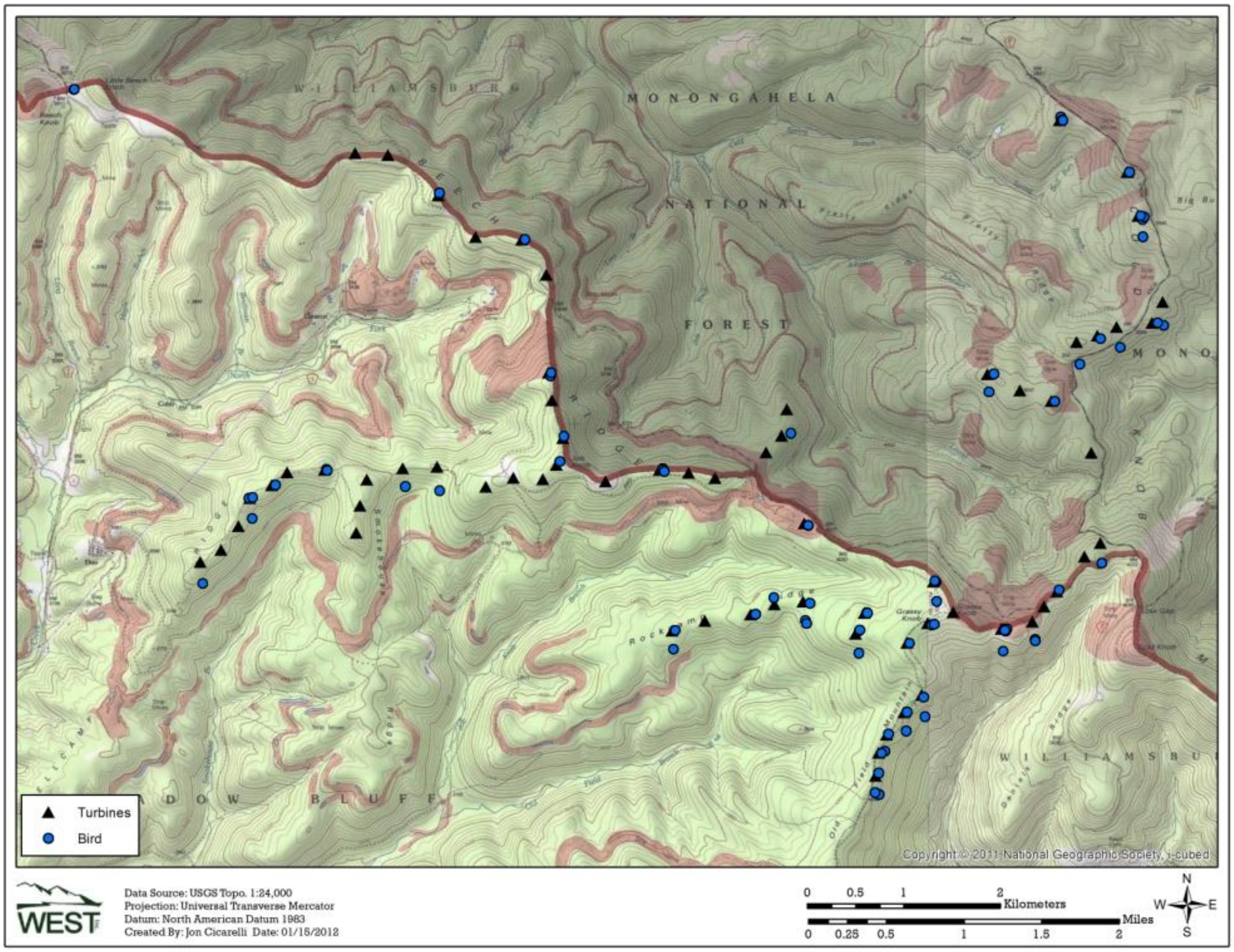
Sample ID	Date	Turbine	Distance From Turbine	Type of Find[1]	Condition	Common Name	Gender[2]	Age[3]
102112-YRWA-E8-1	10/21/2012	E8	26	carcass search	Intact	yellow-rumped warbler	U	U
102212-YRWA-E1-1	10/22/2012	E1	39	carcass search	Intact	yellow-rumped warbler	M	A
102212-BRCR-E11-1	10/22/2012	E11	40	carcass search	Intact	brown creeper	U	A
102212-YRWA-E5-1	10/22/2012	E5	32	carcass search	Intact	yellow-rumped warbler	M	A
102412-GCKI-A17-1	10/24/2012	A17	33	carcass search	Intact	golden-crowned kinglet	U	U
102712-YRWA-G6-1	10/27/2012	G6	23	carcass search	Intact	yellow-rumped warbler	M	A

[1] ~~Casualties~~Discoveries found incidentally off plot were found outside the search area and not included when calculating fatality estimates.
[2] Gender was classified as M = male, F = female, and U = unknown.
[3] Age was classified as A = adult, J = juvenile, and U = unknown.

Appendix C: Location of Bat and Bird Casualties at the Beech Ridge Wind Farm



Appendix C1. Location of bat casualties found at the Beech Ridge Wind Farm. Some locations are overlapping.



Appendix C2. Location of bird casualties found at the Beech Ridge Wind Farm. Some locations are overlapping.

Memorandum to File

Subject: Revision of Take Estimate for Beech Ridge Energy Permit

Prepared by: Laura Hill. USFWS, West Virginia Field Office, Elkins, West Virginia

Date: May 22, 2013

We received public comments relating to the Indiana bat take estimate in the Beech Ridge draft Habitat Conservation Plan (dHCP). These comments spanned a range of diverse opinions, including: (1) comments against use of Little brown bats (LBB) as a surrogate for Indiana bats, (2) a cautionary note that the current rapid changes in bat populations from White Nose Syndrome (WNS) alter the critical assumptions underlying Beech Ridge Energy's (BRE) analysis in the dHCP, (3) comments that the take estimate was too low; and (4) concern that the Fish and Wildlife Service would authorize too high a level of estimated take (i.e., a level that would jeopardize the Indiana bat in the face of populations already declining due to WNS).

<u>Take Model</u>:

The model used to estimate take of Indiana bats in the Beech Ridge dHCP is:

(Estimate of total annual bat mortality for the project) x (Percent of fatalities that are little brown bats at other projects) x (Percent of Indiana bats to little brown bats in the population) x 100 turbines x (# of years)

<u>Updated Take Estimate</u>:

In partial response to public comments about the take estimate, and in partial response to new information about bat population numbers, the FWS has independently analyzed the take estimate in the dHCP. The model used to estimate take is sensitive to total annual bat mortality rates and to the ratios of the Indiana bat to the surrogate species. Because bat species compositions are changing rapidly as a result of WNS, and because the take estimate in the dHCP was based on pre-WNS data, the take estimate in the dHCP is not current and overestimates the anticipated take. We therefore re-ran the take models using the best available post-WNS data.

As bat populations decline due to WNS, we expect reduced total numbers of bats killed because fewer bats are flying in the air-space and potentially interacting with turbine blades. For bats that enter the turbine risk zone, the risk of fatality remains for those individuals using the turbine air space; however, as the total number of bats in a population declines, the total number killed should decline if fatality of bats is density dependent. The total number of bats killed by turbine interactions would eventually reach zero if bat populations reach zero.

Myotis bat fatality appears to be density dependent. The number of Myotis killed at wind turbines has been declining in the past few years in the AMRU as populations of Myotis have declined due to WNS. At wind project sites in Pennsylvania using standard monitoring protocol, the percent of total bat carcasses found that were Myotis bats declined from a high of 17% in 2009 (6 sites) to 4% in 2011 (5 sites) (Traucher et al. 2012). At the Mount Storm Wind Power project in West Virginia, 9% of all carcasses found in 2009 were Myotis, compared to 3% in 2010, and zero in 2011 (Young et al. 2009a, 2009b, 2010a, 2010b, 2011a, 2011b, 2012a). At the Laurel Mountain Wind Power project in West Virginia, 2.7% of all bat carcasses found were Myotis during the fall 2011 and spring/summer 2012 combined periods (Stantec 2013). At the Criterion Wind Power project in Maryland, 4.5% of all bat carcasses found were Myotis in 2011 and 0% in 2012 (Young et al. 2012b, 2013). Likewise, no Myotis carcasses were found during monitoring at the Pinnacle Wind Power project in West Virginia during 2012 (Hein et al. 2013). We therefore would expect Myotis fatality at wind power projects in the Appalachian Mountain Recovery Unit to currently be 4.5% or less, and trending toward zero as Myotis populations further decline due to WNS. Likewise, the post-WNS proportion of Little brown bats to all bat fatalities at these wind power projects is currently in the range of 0 to 4.4 percent (see revised table 4.5), compared to 3.0 to 12.9 percent pre-WNS as reported in the dHCP.

We have updated the numbers in several tables from the dHCP below to reflect post-WNS data (see revised tables 4.5 through 4.8). WNS was first detected in the AMRU in 2008/2009. It takes 3 to 7 years for the effects of the disease to manifest. We began seeing large declines in some hibernacula in the AMRU in 2011, and severe declines in 2013. To account for uncertainty and err on the side of slightly overestimating Indiana bat take, we decided to use 4.4 percent[1] in the take model as the proportion of all bat fatalities that are little brown bats. We would expect this percentage to be zero in some years as Little brown bat populations decline, but to increase slightly over time as little brown bats populations slowly recover from WNS over a long period of time.

Other values in the take model also have changed post-WNS. The ratio of Indiana bats to Little brown bats in West Virginia mist net data was 2.38 percent in 2012 and now averages 2.38 percent for the post-WNS period from 2009 to 2012, versus an average of 0.81 percent for the pre-WNS period from 2003 to 2008 (see revised table 4.6). We therefore used 2.38 percent as the ratio of Indiana to Little brown bats in the Indiana bat take formula.

Of all the variables in the Indiana bat take formula, the overall bat fatality rate varies the most. Post-WNS bat fatality rates at 4 projects within 200 miles of the Beech Ridge Wind Energy Project vary from 15 to 96 bats per turbine per year and average 43 bats per turbine (see revised table 4.5). These current post-WNS rates are higher than pre-WNS data averaging 32 bats/turbine/year and ranging from 24 to 48 bats/turbine for other projects within 200 miles of Beech Ridge. We decided to use the average rate of

[1] The 4.4 percent figure comes from the Criterion Wind Power study in 2011, which had the highest little brown bat ratio of all studies in revised table 4.5 of the dHCP. The figure of 4.4 percent is based upon all bats found by researchers during regularly scheduled turbines searches, as well as bats found by Operation and Maintenance (O&M) workers incidental to their other duties. Including incidental carcasses could bias the results if O&M workers have a tendency to find larger carcasses and overlook smaller carcasses such as Myotis bats. On the other hand, including incidental carcasses enlarges the sample size and could be more reflective of the overall bat community at some studies, especially where researchers only search a small subset of turbines, the same set of turbines are always searched, and carcass persistence times are shorter than the search interval. If one were to exclude the incidental finds from the Criterion 2011 study, the proportion of all bat fatalities that are little brown bats would be 4.5 percent. In this case, there is little difference between 4.4 or 4.5 percent.

43 bats/turbine/year in the take estimate formula as we do not believe it reasonable to assume the extreme values (the low end or high end estimates) would occur consistently every year at Beech Ridge. Overall bat fatality estimates can vary considerably across projects and across years at the same project. The rate of 96 bats/turbine/year at the Pinnacle project is extremely high (the highest rate we are aware of in the northeast). It is unclear why the rate is so high or if this rate will remain high in future years. Even so, no Myotis were killed at the Pinnacle project. Using the high end of 96 bats/turbine/year at Beech Ridge would greatly inflate the Indiana bat take estimate. We assume overall bat fatality at the Beech Ridge wind project without curtailment will vary from year to year but over the life of the permit will not exceed an average of 43 bats/turbine/year. Annual take thresholds and adaptive management will help to ensure that take stays within limits.

Using this updated information, we predict the total project take for the 25-year life of the 100-turbine Beech Ridge Wind Energy Project to be 53 Indiana bats (Table 1). We therefore propose to authorize cumulative take of 53 bats. The amount of take initially authorized is the amount that is "not to be exceeded" and could be modified over time in response to new information. Our take estimates are predictions based on best available information. The baseline bat fatality rate (without curtailment) will be determined during years 1 through 3 of the permit. It may be higher or lower than predicted. The 60% fatality reduction commitment is then applied to the average baseline fatality for years 1 through 3. If baseline fatality levels are low, the estimated future take will be lower than currently predicted. If necessary, and consistent with the HCP No Surprises policy, the Service could amend the permitted take consistent with 50 C.F. R. 13.23(b). If baseline fatality levels are high, the estimated future take will be higher than currently predicted, which could trigger the need for a permit amendment.

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Table 1. Total estimated Indiana bat take for life of project: average value and possible (but unlikely) low and high ends.

# bats/ turbine/ year	Proportion of bat fatalities that are Little brown bats	Proportion of Indiana bats to Little brown bats in natural communities (mist-net data)	# turbines	# years	Estimated total Indiana bat take in 25 years (no curtailment)	Annual take (w/o curtailment)	Annual take (with curtailment; 60% reduction)	Take during first 3 years (assumes no reduction)	Take during years 4-25 (assumes 60% reduction)	Total Estimated Project Take
15 (low end)	0.044	0.0238	100	25	39	1.6	0.6	4.8	13.2	18
43 (avg.)	0.044*	0.0238	100	25	112	4.5	1.8	13.5	39.6	53
96 (high end)	*0.044*	*0.0238*	*100*	*25*	*251*	*10.0*	*4.0*	*30.0*	*88.0*	*118*

* The 4.4 percent figure is based upon all bats found by researchers during regularly scheduled turbines searches, as well as bats found by Operation and Maintenance workers incidental to their other duties at the Criterion Wind Power study in 2011. If one were to exclude the incidental finds at Criterion, the proportion of all bat fatalities that are Little brown bats would be 4.5 percent. Using 4.5 percent Little brown bats results in an estimated take of 53.4 Indiana bats for the life of the Beech Ridge project, which is not meaningfully different than the 53.1 Indiana bats calculated using 4.4 percent Little brown bats. Both take estimates round down to 53 Indiana bats.

Update of table 4.5 in dHCP. Annual number of bat carcasses found by species and bat fatality rates at wind project monitoring studies in 2011 and 2012 located within 200 miles of the Beech Ridge Wind Energy Project (for control turbines that were not curtailed).

Species	Mount Storm, WV (spring - fall 2011)	Laurel Mountain, WV (spring/ summer 2012 and fall 2011)	Criterion, MD (spring – fall 2011)	Pinnacle, WV (spring-fall 2012)	Total
# bat carcasses found during scheduled searches and incidental to searches					
Non Myotis species:					
Hoary bat	90 (49.2%)	68 (37.4%)	236 (33.4%)	79 (34.8%)	473(36.4%)
E. red bat	54 (29.5%)	62 (34.1%)	244 (34.6%)	86 (37.9%)	446 (34.4%)
Tri-colored bat	12 (6.6%)	18 (9.9%)	47 (6.6%)	21 (9.2%)	98 (7.6%)
Silver-haired bat	23 (12.5%)	17 (9.3%)	103 (14.6%)	23 (10.1%)	166 (12.8%)
Big brown bat	2 (1.1%)	12 (6.6%)	38 (5.4%)	16 (7.0%)	68 (5.2%)
Seminole bat			1 (0.1%)		1 (0.08%)
Unknown bat species	2 (1.1%)		5 (0.7%)	2 (0.9%)	9 (0.7%)
Sub-total Non Myotis	183 (100%)	177 (97.3%)	674 (95.5%)	227 (100%)	1261 (97.1%)
Myotis species:					
Little brown bat	0	4 (2.2%)	31 (4.4%)	0	35(2.7 %)
N. long-eared bat					
Indiana bat		1 (0.5%)			1 (0.08%)
Unknown Myotis sp.			1 (0.1%)		1(0.08%)
Sub-total Myotis	0	5 (2.7%)	32 (4.5%)	0	37 (2.9%)
Total bats:	**183**	**182**	**706**	**227**	**1298**
Overall bat fatality rates					
Estimated bat fatalities/turbine/ year at control turbines (based on Shoenfeld estimator)	14.87 (CI: 11.93-18.31)	23.4 (CI: 17.6 - 30.2)	39.03 (CI: 34.58 – 46.51)	96.47* (CI: 68.62-146.39)	Avg: 43.44 (range of 15 to 96)

Update of Table 4.6 in dHCP. Number of little brown bats and Indiana bats captured in mist-net surveys in West Virginia where Indiana bats had not been known prior to the first survey. Data for regularly scheduled long-term bat monitoring on the Monongahela National Forest (MNF) were included only for those sites where Indiana bat presence was not known at the time of the first survey. MNF sites selected because of known Indiana bat presence were excluded (e.g. netting at known sites to capture and radio-track bats).

Year	No. Little Brown Bats	No. Indiana bats	Percentage(%) of Indiana bats to Little Brown bats
Pre-WNS:			
2003	373	3	0.80
2004	266	13	4.88
2005	446	5	1.12
2006	559	0	--
2007	827	3	0.36
2008	996	4	0.40
Total:	3467	28	0.81
Post-WNS:			
2009	356	7	1.96
2010	196	7	3.57
2011	79	1	1.26
2012	420	10	2.38
Total:	631	15	2.38

Update of Table 4.7 in dHCP. Results of model estimating take of Indiana bats for the Beech Ridge Energy Project (100 turbines).

Data Sources	Estimate of total annual bat mortality*	Percent of fatalities that are LBB**	Estimate of annual LBB mortality	Percent Indiana bats***	Estimate of annual Indiana bat mortality without curtailment
WV mist-netting data 2009 to 2012	1500 (low end)	4.4%	66	2.38	1.6
	4300 (avg.)	4.4%	189	2.38	4.5
	9600 (high end)	4.4%	422	2.38	10.0

*Local average of 43 bats/turbine/year in WV and MD at uncurtailed turbines post-WNS (range of 15 to 96 bats/turbine annually).

**The post-WNS proportion of LBB carcasses to all bat carcasses is now in the range of 0 to 4.4 percent ; used 4.4 percent (high end) to err on the side of slightly overestimating take.

***The ratio of Indiana bats to little brown bats in mist net data post-WNS was 2.38 percent in 2012 and averaged 2.38 percent from 2009 to 2012, with a range of values across years from a low of 1.26 to a high of 3.57 percent.

HCP section 4.1.4, Alternative Models Considered but Not Used

The Beech Ridge dHCP also discussed alternative models for estimating take that were consider but not used. One alternative relied upon hibernacula data. We updated the hibernacula data below to account for post-WNS data; however, as further explained below, available cave data overinflate the estimate of take. For reasons similar to those explained in the dHCP, we decided not to use the hibernacula data in estimating take.

Update of table 4.8, cave count data.

Data Source	Estimate of total annual bat mortality	Percent of fatalities that are LBB	Estimate of annual LBB Mortality	Indiana bat to LBB ratio	Estimate of annual Indiana bat mortality
WV cave counts 2008/2009 (Hellhole not surveyed)	1500 (low end)	4.4%	66	0.196	13
	4600 (middle)	4.4%	189	0.196	37
	9600 (high end)	4.4%	422	0.196	83
WV cave counts 2009/2010 (Hellhole surveyed but fewer overall caves surveyed than normal)	1500	4.4%	66	0.453	30
	4600	4.4%	189	0.453	86
	9600	4.4%	422	0.453	191
WV cave counts 2010/2011 (Hellhole not surveyed)	1500	4.4%	66	0.304	20
	4600	4.4%	189	0.304	57
	9600	4.4%	422	0.304	128
Hellhole 2012/ 2013 (data for other caves not yet available)	1500	4.4%	66	1.03	68
	4600	4.4%	189	1.03	195
	9600	4.4%	422	1.03	435

Cave data inflate the ratio of Indiana bats to Little brown bats because the focus is on caves with known Indiana bat populations. Hundreds of caves without listed bats are not surveyed; thus the composition of bat species in all caves across the landscape is unknown. Surveys of caves with small bat populations have been inconsistent across time due to staff shortages. Cave surveys also sometimes do not count all bats, but focus instead on complete counts of Indiana bats. Beginning in 2009/2010, fewer caves than normal were surveyed due to concerns about WNS. In years when Hellhole is not surveyed, many bats are missed. A complete cave count was done in 2013; however, data are only available for Hellhole at this time.