Indiana Bat and Northern Long-Eared Bat Habitat Conservation Plan Blue Creek Wind Farm Van Wert and Paulding Counties, Ohio

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Overview and Background

The Blue Creek Wind Farm (Project) includes 152 operating 2.0-megawatt (MW) Gamesa G90 wind turbines with a total generating capacity of approximately 304 MW. The Project is located in Van Wert and Paulding counties in northwestern Ohio (Figure 1.1) and is owned by Blue Creek Wind Farm, LLC (Applicant). The Applicant is a wholly-owned subsidiary of Avangrid Renewables, LLC. The Applicant has prepared this Habitat Conservation Plan (HCP) in order to apply for an Incidental Take Permit (ITP) under Section 10(a)(1)(B) of the Endangered Species Act of 1973 (ESA), 16 United States Code [USC] Section 1539(a)(1)(B).

The purpose for the ITP is to authorize incidental take of Indiana bats *(Myotis sodalis*) and northern long-eared bats *(M. septentrionalis)* that may result from the operation of the Project. ESA Section 10(a)(1)(B) requires that an applicant for an ITP develop and submit to the US Fish and Wildlife Service (USFWS or Service) an HCP along with its application for the ITP.

The Project provides power generation from a non-polluting, renewable source. Increased generation from wind energy facilities has the potential to offset demand for other energy generation technologies that produce carbon emissions that have been shown to contribute to global climate change (USDOE 2008), identified as a threat to Indiana bats (USFWS 2007) and northern long-eared bats (USFWS 2015b). Climate influences food availability, timing of hibernation, frequency and duration of torpor, rate of energy expenditure, reproduction, and development rates of juveniles for insectivorous bats (Sherwin et al. 2012). The overall impact of climate change will likely be negative for Midwestern bats, due to a reduction in the suitability of existing hibernacula (Humphries et al. 2002) and maternity roosts (Greenberg 2014) and disruption of the distribution and availability of insect prey necessary to provide energy for maintenance, growth, and reproduction (Neuweiler 2000, Meretsky et al. 2006, Rodenhouse et al. 2009). The Project, under normal operations, is capable of producing enough energy to offset approximately 726 million kilograms (about 1.6 billion pounds) of carbon dioxide emissions each year, the equivalent of planting an estimated 558,467 hectares ([ha]; 138,000 acres [ac]) of trees, taking 114,000 cars off the road, or not consuming over 2.1 million barrels of oil (NREL 2015).

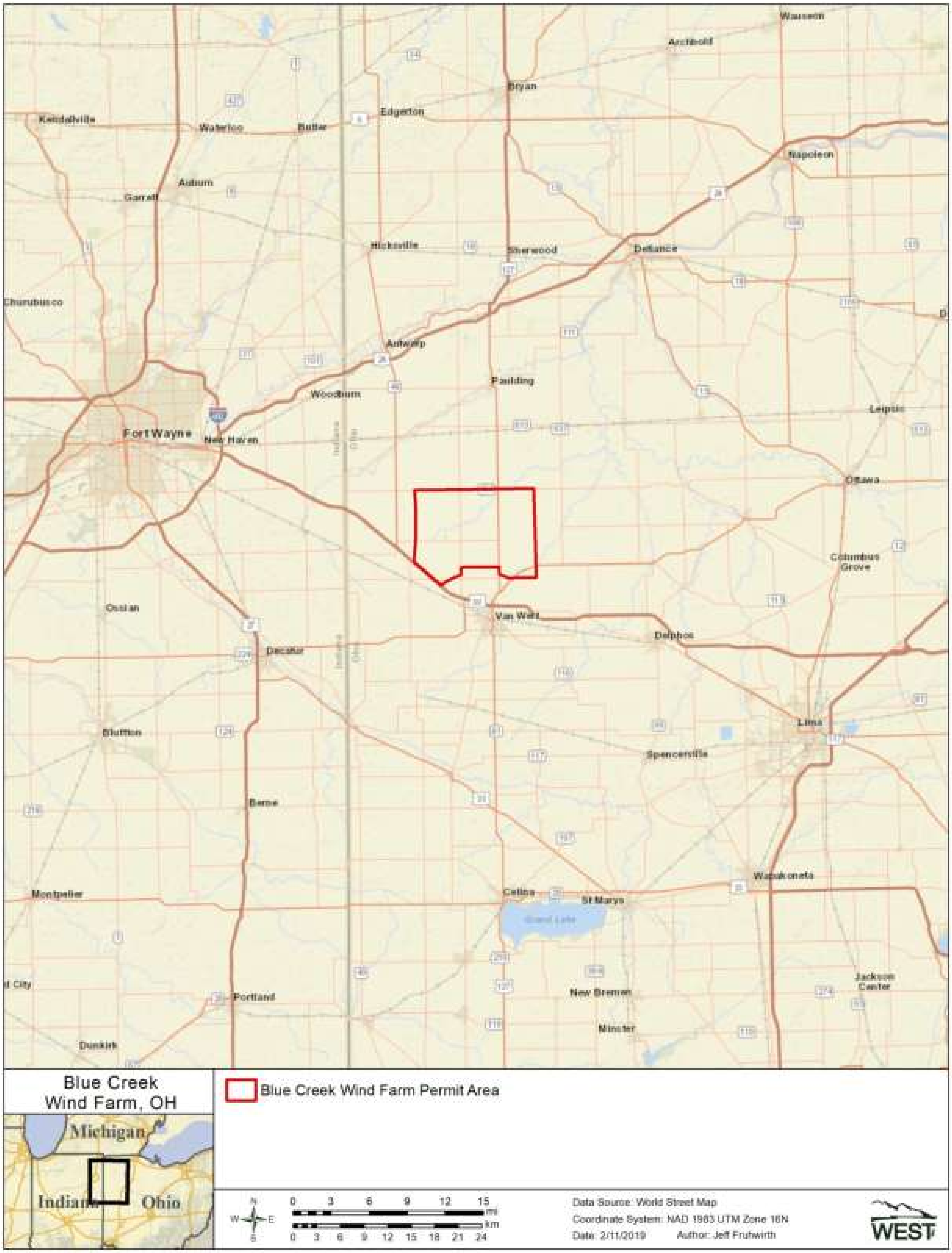

Figure 1.1 Blue Creek Wind Farm location.

176

1.2 Regulatory Framework

1.2.1 Endangered Species Act

The purpose of the ESA is “to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved…” (ESA § 2(b), 16 USC 1531(b)). The ESA § 9(a)(1)(B) prohibits the take of any species of fish or wildlife listed under the ESA as an endangered species (16 USC 1538(a)(1)(B)). The USFWS extended by regulation the “take” prohibition for endangered species to fish and wildlife species listed under the ESA as threatened species, unless the USFWS promulgates a special species-specific rule for a threatened species that applies the “take” prohibition in full or in part to that species (50 CFR 17.31(a)). Under the ESA, the term "take" means “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” (ESA § 3(19), 16 USC 1532(19)). FWS further defines “harm” (50 CFR § 17.3) as “...an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering.”

The ESA § 10(a)(1)(B) provides that the Secretary of the Interior (Secretary) and the Secretary of Commerce may authorize, under certain terms and conditions, any taking otherwise prohibited by the ESA § 9(a)(1)(B) if such taking is “incidental to, and not the purpose of, the carrying out of an otherwise lawful activity” (16 USC 1539(a)(1)(B)). To obtain this incidental take authorization, a non-federal landowner, land manager, or Project proponent must apply to the USFWS or National Marine Fisheries Service (NMFS) for an ITP, and develop, fund, and implement a USFWS- or NMFS-approved HCP to minimize and mitigate to the maximum extent practicable the impact of the proposed taking[1].

As outlined in the ESA § 10(a)(2)(A) (16 USC § 1539(a)(2)(A)) and its implementing regulations at 50 CFR §§ 17.22(b)(1) and 17.32(b)(1), to obtain an ITP the applicant must submit:

1) A complete description of the activity sought to be authorized;
2) The common and scientific names of the species sought to be covered by the permit, as well as the number, age, and sex of such species, if known;
3) A conservation plan that specifies:
    a. The impact that will likely result from such taking;
    b. What steps the applicant will take to monitor, minimize, and mitigate such impact, the funding that will be available to implement such steps, and the procedures to be used to deal with unforeseen circumstances;

[1] As the species covered by this HCP are within the jurisdiction of the Secretary of the Interior and the USFWS, hereafter all references to “Secretary” refer to the Secretary of the Interior and no references will be made to the NMFS.

c. What alternative actions to such taking the applicant considered and the reasons why such alternatives are not proposed to be utilized; and

d. Such other measures that the Secretary may require as being necessary or appropriate for purposes of the plan.

An ITP will be issued if, after a specified public comment period, the USFWS finds that the ITP application and the related HCP meet the following *issuance criteria* outlined in the ESA § 10(a)(2)(B) and 50 CFR §§ 17.22 (b)(2) and 17.32 (b)(2):

1) The taking will be incidental;
2) The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such taking;
3) The applicant will ensure that adequate funding for the HCP and procedures to deal with unforeseen circumstances will be provided;
4) The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild;
5) Any other measures that the USFWS may require as being necessary or appropriate will be met; and
6) USFWS has received such other assurances as the USFWS may require that the plan will be implemented.

In addition to these necessary HCP elements, the HCP Handbook (USFWS and NMFS 2016) describes five clarifying components that should be included in an HCP:

1) Biological goals and objectives,
2) Adaptive management,
3) Monitoring,
4) ITP duration, and
5) Public participation.

The USFWS considers the issuance of an ITP to be a federal agency action that must also comply with § 7 of the ESA (16 USC 1536). ESA § 7(a)(2) requires federal agencies to consult with the USFWS to ensure that actions that the federal agencies authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in destruction or adverse modification of designated critical habitat of such species. Under the authority of ESA § 7 and implementing regulations, where, as here, the federal agency action is the USFWS's issuance of an ITP under ESA § 10(a)(1)(b), the USFWS must conduct an internal formal consultation process for issuance of the ITP. Formal consultation terminates with preparation of a Biological Opinion (BO), which provides the Service's determination as to whether the proposed action of ITP issuance is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. This intra-Service consultation ensures that issuance of the ITP meets the ESA § 7(a)(2) standards.

1.2.2 National Environmental Policy Act

The National Environmental Policy Act of 1970 ([NEPA]; 42 USC §§ 4321, et. seq.), requires federal agencies to examine environmental impacts of their actions and provide for public participation. USFWS considers its issuance of an ITP a federal action subject to compliance with the NEPA. The Council on Environmental Quality's NEPA implementing regulations require federal agencies to analyze alternatives to the proposed action, the effects of their proposed action on the human environment, and to include other agencies and the public in the process (40 CFR §§ 1500, et seq.). The NEPA does not require that a federal agency select a particular alternative or course of action.

1.3 Permit Duration

The requested ITP term is 35 years. Because the Project became commercially operational in 2012, this 35-year ITP term provides for an approximately 42-year functional operational life for the wind project. If, prior to the end of the 35-year ITP term the Applicant decides to continue to operate the facility, and if the total take limit has not been reached, the Applicant may consider applying for a renewal of the ITP in accordance with Section 9.4 of this HCP.

1.4 Covered Lands

The lands covered by this HCP include a Permit Area and a Plan Area. The Permit Area is a subset of the Plan Area and includes all areas where take of Covered Species may occur and be authorized by the ITP. The Permit Area for this HCP is a 16,360-ha (40,426-ac) area in Van Wert and Paulding counties, Ohio, and contains all Project turbines. The northern boundary runs along State Highway 114 on either side of US 127. Its southeast corner crosses US Route 224 and its southwest border runs along US Route 30 (Figure 1.2). The Plan Area includes the Permit Area plus those area(s) in Ohio to be preserved as mitigation. Mitigation areas have not been selected yet; however, criteria for selection of mitigation areas is described in Section 5.2.3. Generally, mitigation areas must be within the documented home range of an Indiana bat or northern long-eared bat maternity colony, or within a specified buffer around a documented hibernation site in Ohio.

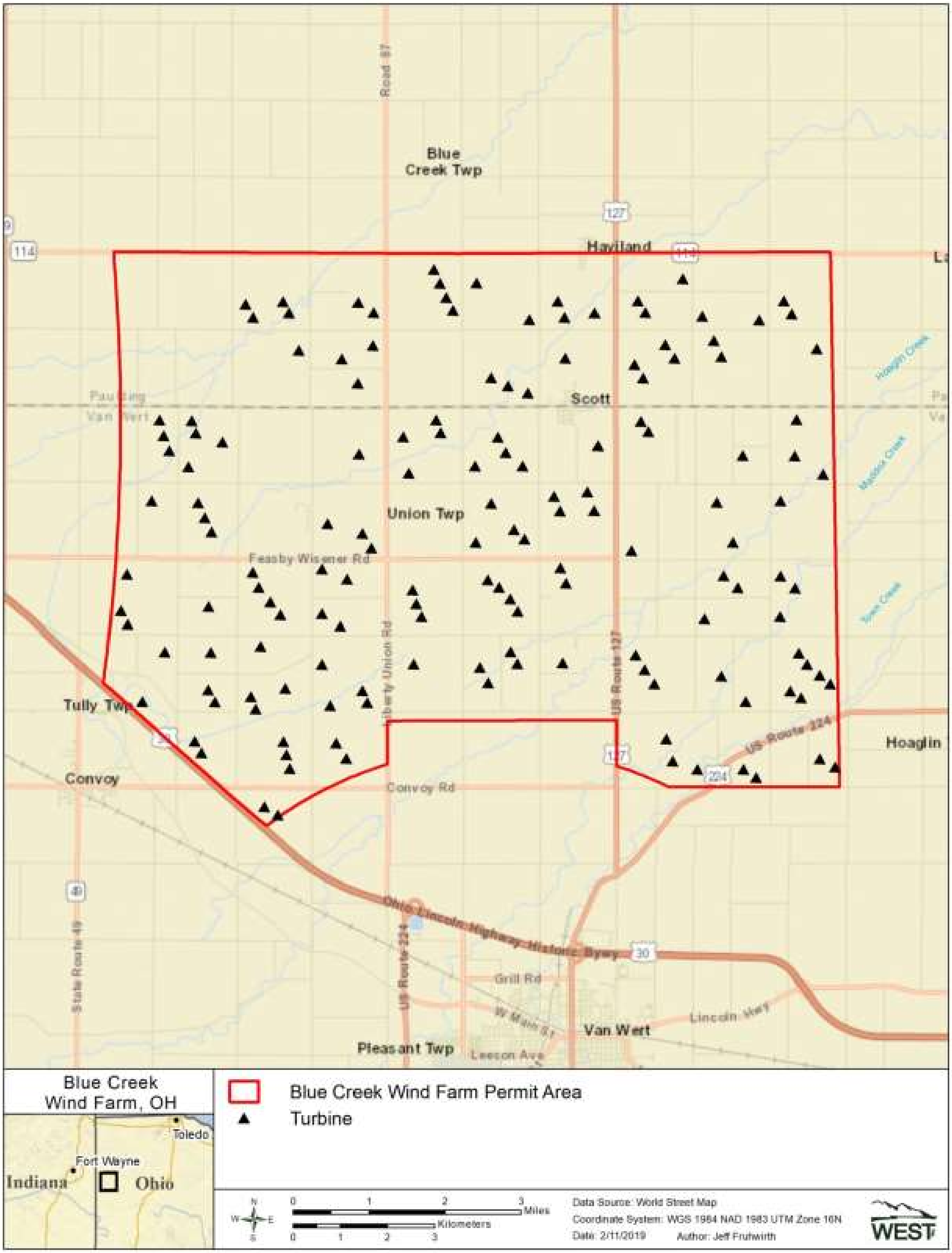

Figure 1.2 Turbines locations and boundary of the Permit Area for the Blue Creek Wind Farm Habitat Conservation Plan.

284

1.5 Covered Species

Species covered by this HCP and for which Applicant has requested incidental take authorization are the Indiana bat and the northern long-eared bat (collectively, the Covered Species). The Indiana bat is listed as endangered under ESA. The northern long-eared bat is currently listed as threatened under the ESA (USFWS 2015b; 80 FR 17974 [April 2, 2015]). The USFWS issued a final 4(d) rule for the northern long-eared bat, published January 14, 2016 (USFWS 2016b; 81 FR 1900 [January 14, 2016]), that exempts the incidental take of northern long-eared bats resulting from most otherwise lawful activities from ESA Section 9 take prohibitions, including incidental take of northern long-eared bats due to the operation of wind turbines that fall within certain circumstances[2]. While the Covered Activities (Section 2.2) fall within the exemption provided by the 4(d) rule, the Applicant chooses to include the northern long-eared bat as a Covered Species so that incidental take will be authorized should its listing status be changed to endangered or the 4(d) rule be revised or revoked.

Currently no other listed or candidate species under ESA are known to occur within the Permit Area and no critical habitat designated under the ESA is located within the Permit Area.

2.0 PROJECT DESCRIPTION AND COVERED ACTIVITIES

2.1 Project History and Description

Siting considerations are described in greater detail in Section 5.2.1. Project construction began in September 2010. The project achieved commercial operation in June 2012.

The Project turbines are 2.0-MW Gamesa G90 turbines. The turbine towers are 100 meters (m; 328 feet [ft]) in height and the rotor blade length is 45 m (148 ft). Therefore, the maximum height of the turbines from tower base to highest blade tip is 145 m (476 ft) above the ground. Gamesa G90 turbines are designed to begin generating electricity when the wind speed reaches 3.0 m per second (m/s; 9.8 ft/s), known as the “manufacturer’s cut-in speed.” The turbines reach their maximum generation at approximately 12 m/s (39 ft/s) at a rotational speed of approximately 18.6 revolutions per minute, at which point the blades pitch to catch less wind and remain revolving at this speed. At about 25 m/s (82 ft/s) the turbine shuts down to prevent an overspeed scenario of the generator, known as the “cut-out speed.” Each turbine includes a supervisory control and data acquisition operations and communications system that allows automated independent and remote operation of the turbine.

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[2] The USFWS published the final 4(d) rule for the northern long-eared bat on January 14, 2016 (81 FR 1900). The rule exempts all incidental take of northern long-eared bats within the WNS zone from otherwise lawful activities from take prohibitions under Section 9 of the ESA, except: take of northern long-eared bats in their hibernacula; take resulting from tree removal within 0.04 kilometers (0.25 miles) of a known, occupied northern long-eared bat hibernaculum; and take resulting from removal of a known, occupied northern long-eared bat maternity roost tree or tree removal within a 45-m (150-ft) radius of a known northern long-eared bat maternity roost tree during the pup season (June 1 – July 31). Take resulting from hazard tree removal for protection of human life and property is exempt from take prohibitions regardless of where and when it occurs.

Gravel pads under each turbine extend approximately 1.8 m (6.0 ft) from the base of the turbine and the access roads are 4.3 m (14.0 ft) wide. These are atypically narrow for a Midwestern wind project. For example, the gravel turbine pads are not large enough to allow a vehicle to drive around the turbine.

Two permanent un-guyed 100-m (328-ft) meteorological towers are located within the Permit Area. Roads associated with the Project include upgraded existing roads and new roads. Electrical power generated by the wind turbines is transformed and collected through a network of underground and overhead collection circuits. The Project includes two substations and an Operations and Maintenance (O&M) Facility consisting of an approximately 465-m^2 (5,000-ft^2) building.

Regular maintenance activities will be conducted during daylight hours when Covered Species are not active. Any tree removal (other than emergency tree removal; Section 5.2.1) necessary for regular maintenance will be conducted between October 16 – March 31 to avoid potential impacts to roosting bats (see Sections 3.2.2, 3.3.2, and 5.2.1 for information used to define these dates).

After the useful life of the turbines is complete, the Applicant will assess the viability of either repowering the Project by installing new or refurbished turbines, or completely decommissioning the Project. In the event that the Project will be decommissioned, the decommissioning process will be similar in scope and duration to the construction process and will be conducted according to the *Blue Creek Wind Farm Decommissioning Report* (Westwood Professional Services 2016). Most components and materials will be removed, recycled, or disposed of in an approved and appropriate waste management facility. Repowering and decommissioning activities should result in little to no impact to Covered Species, and will not result in take of the Covered Species.

2.2 Covered Activities: Project Operation

Covered Activities are "activities that a permittee will conduct for which take is authorized in an ESA Section 10 permit" (USFWS and NMFS 2016). To be eligible for incidental take authorization, covered activities must be "(1) otherwise lawful, (2) non-Federal, and (3) under direct control of the permittee." The potential for take arises from the operation of turbines at times when Covered Species may be present in the Permit Area and are at risk for collision with the spinning turbine blades (this risk is described further in Sections 3.4, 4.1, and 4.2). Operation of Project turbines is therefore the "Covered Activity" for which take authorization is being sought. Based on the best available site specific data, take of Covered Species may potentially occur from operation of turbines during spring and fall migration periods, thus take estimation, minimization, and monitoring focus primarily on these periods of time. However, in the event that a summer take of a Covered Species is discovered, it would be covered under this HCP and Changed Circumstances would be triggered (Section 9.1).

3.0 ENVIRONMENTAL BASELINE, AFFECTED SPECIES

3.1 Environmental Setting

The Project is located in northwest Ohio and falls within the Huron/Erie Lake Plains Ecoregion, which encompasses a large portion of northern Ohio and part of southeastern and east-central Michigan (Woods et al. 1998). The Huron/Erie Lake Plains Ecoregion is a broad, fertile plain punctuated by relict sand dunes, beach ridges, and end moraines. The region is characterized by nearly flat topography; the Permit Area is relatively flat with no hills, ridges, or other areas of elevated topography. Although carbonate rock is present beneath the ground surface at depths of six to 21 m (20 to 70 ft), there are no records or observed evidence of karst topography (e.g., sinkholes, solution cavities) to suggest the potential presence of caves in vicinity of the Permit Area (BHE Environmental 2010).

The Project is located within an area formerly dominated by extensive elm (*Ulmus* spp.) -ash (*Fraxinus* spp.) swamps and American beech (*Fagus grandifolia*) forests, with oak (*Quercus* spp.) savanna typically restricted to sandy, well drained dunes and beach ridges. Today, most of the forests have been cleared and artificially drained for highly productive farms producing corn (*Zea mays*), soybeans (*Glycine max*), livestock, and vegetables.

According to the 2011 National Land Cover Database (NLCD; US Geological Survey [USGS] NLCD 2011, Homer et al. 2015) the two main land cover types in the Permit Area are cultivated crops (92.5%) and developed lands (6.3%). Deciduous forest, herbaceous cover, open water, barren land, and wetlands each account for less than 1% of the total land cover in the Permit Area (Figure 3.1). Cultivated cropland is ubiquitous throughout the Permit Area and Project vicinity, while deciduous forest is generally restricted to small, isolated tracts of forest and windbreaks, fence lines and hedgerows bordering fields, and residences, farms, and roads scattered throughout the Project vicinity. Wetlands and open water are rare within the Project vicinity and are limited primarily to farm ponds and areas along small creeks and irrigation ditches. Developed areas are scattered along roads throughout the Project vicinity.

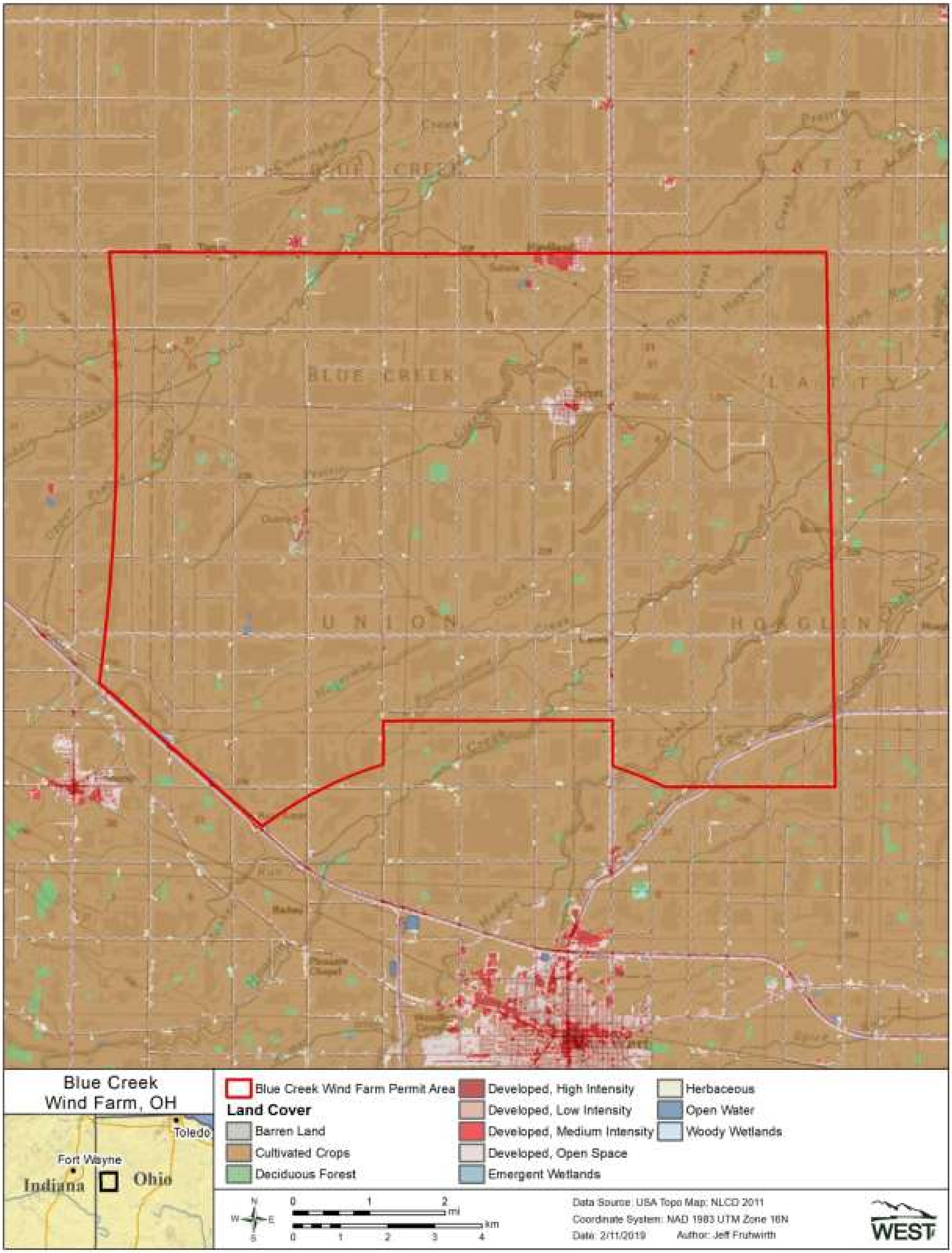

Figure 3.1 Blue Creek Wind Farm land cover.

3.2 Covered Species – Indiana Bat

The Indiana bat is a small (7 – 10 gram [g; 0.2 – 0.4 ounce (oz)]), insectivorous bat in the genus *Myotis* that was not described as a separate species until 1928 (Miller and Allen 1928). The Indiana bat was included on the list of endangered species in 1967 under the Endangered Species Preservation Act of 1966 (USFWS 1967), prior to the enactment of the ESA of 1973. At the time of listing, primary threats to the species were believed to include loss of habitat and human disturbance, especially at winter hibernacula, and a general lack of knowledge about the species' biology and distribution (USFWS 1999). The *Indiana Bat (Myotis sodalis*) *Draft Recovery Plan* (2007 Draft Recovery Plan; USFWS 2007) organized the species' range into four Recovery Units (RU) based on several factors such as traditional taxonomic studies, banding returns, and genetic variation: the Eastern, Appalachian Mountain, Midwest, and Ozark Central RUs (Figure 3.2). As described in Section 3.6, white-nose syndrome (WNS) is currently the most severe threat facing Indiana bat populations range-wide (USFWS 2009).

3.2.1 Overview of Life History Characteristics

Indiana bats exhibit life history traits similar to other small, temperate bat species. Despite the Indiana bat's small size, it is relatively long-lived (Barclay and Harder 2005). Similar to most temperate *Myotis* species, female Indiana bats give birth to one offspring per year (Humphrey et al. 1977, Kurta and Rice 2002). Mating occurs in the vicinity of the hibernacula in late summer and early fall during what is termed the swarming period, and fertilization is delayed until the spring (Guthrie 1933). Timings of parturition and lactation are likely dependent in part on latitude and weather conditions (Fujita 1986, Frick et al. 2010, Bishop-Boros 2014).

It is likely that once the young are born, females leave their pups in the diurnal roost while they forage, returning during the night periodically to feed the pups (Barclay and Kurta 2007). Within five weeks of birth, young Indiana bats begin to fly and maternity colonies begin to break up and spend less time in primary maternity roosts (USFWS 2007). Indiana bat maternity colonies will use several roosts, known as alternate roosts. In Missouri, each maternity colony used between 10 and 20 separate roost trees (Miller 2002). In Kentucky, Gumbert et al. (2002) recorded 463 roost switches over 921 radio-tracking days of tagged Indiana bats, an average of one switch every 2.21 days. There are a number of suggested reasons for roost switching, including thermoregulation, reproductive condition, predator avoidance, evaluation of new trees for future use, ectoparasite load, and reduced suitability of roost trees (Gumbert et al. 2002, Kurta et al. 2002, Ritzi et al. 2002, Kurta 2005, Barclay and Kurta 2007). Roost trees are an ephemeral resource and can become unusable if they are toppled by wind, lose large pieces of bark, or are otherwise destroyed (Kurta and Rice 2002, Barclay and Kurta 2007).

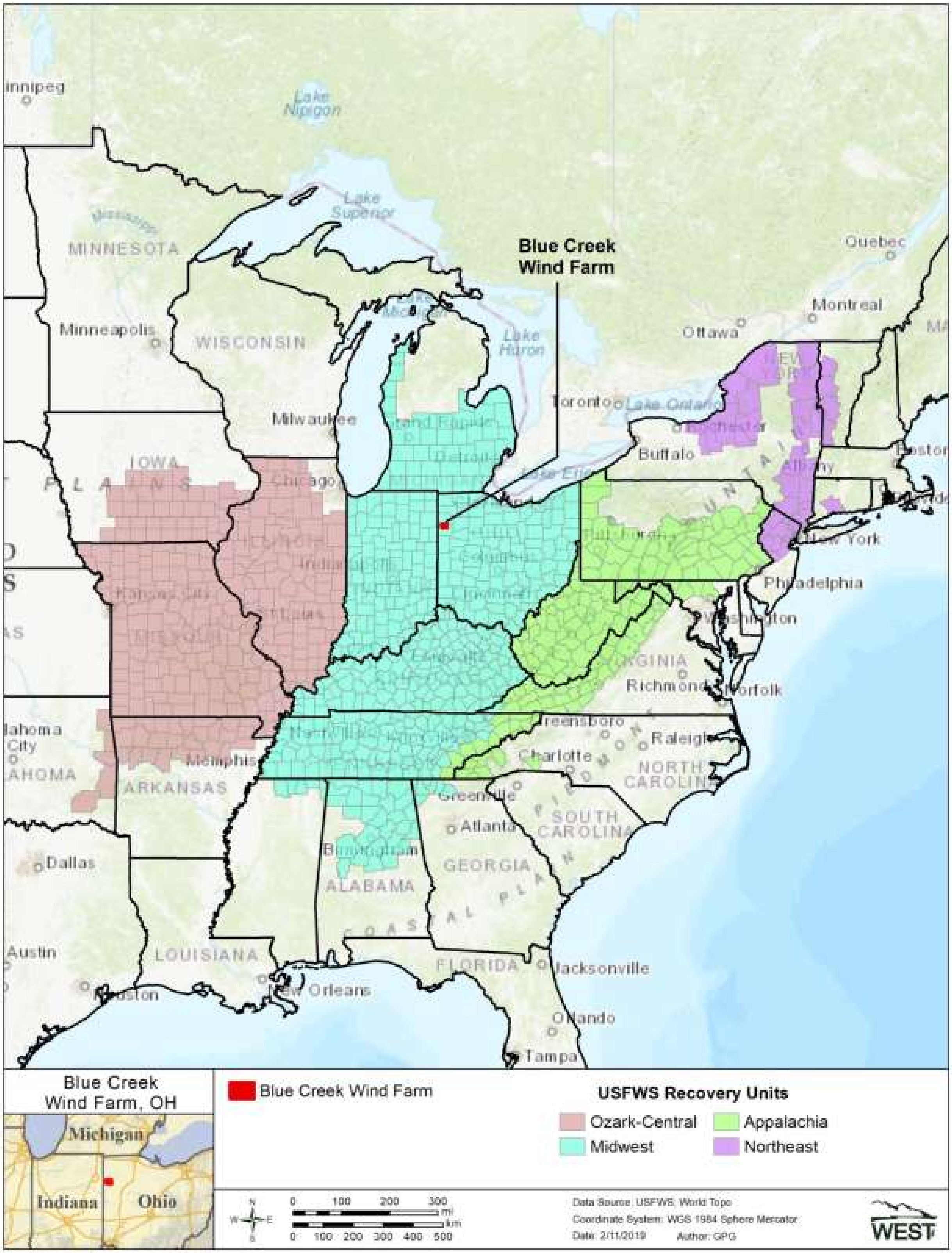

Figure 3.2 US Fish and Wildlife Service Indiana bat Recovery Units.

423

Female and juvenile Indiana bats remain in the colony area until they migrate to hibernacula, typically departing maternity colonies beginning in the first two weeks in August though some individuals may be present at the maternity colony through late September or early October (USFWS 2007); this fall migration primarily occurs between August 1 and October 15. Indiana bats return to the vicinity of the hibernaculum in late summer and early fall, where they exhibit a behavior known as swarming. This involves large numbers of bats flying in and out of the cave entrances from dusk to dawn, though relatively few of the bats roost in the cave during the day (Cope and Humphrey 1977). The fall swarm is a critical period in the Indiana bats' annual life cycle when they must build up their fat reserves to sustain them through the winter (Cope and Humphrey 1977). Therefore, forests around caves provide important habitat for swarming bats.

The 2007 Draft Recovery Plan states that during the swarming period most Indiana bats roost within approximately 2.4 kilometers (km; 1.5 miles [mi]) of the cave. The USFWS provided guidance in 2011 (USFWS 2011a) suggesting that areas within 16 km (10 mi) of Priority 3 (P3; 50 to 999 Indiana bats) and Priority 4 (P4; one to 49 Indiana bats) hibernacula should be considered potentially occupied by swarming Indiana bats, whereas areas within 32 km (20 mi) of P1 (10,000 or more Indiana bats) and Priority 2 (P2; 1,000 to 9,999 Indiana bats) hibernacula should be considered potentially occupied. The density of bats is believed to increase in areas closest to the cave, also known as a "funnel effect." The funnel effect is thought to be most pronounced for hibernacula with relatively large populations of wintering bats, due to increased competition for resources around the cave (USFWS 2011a). Mating occurs during the swarming period. While females enter the hibernaculum soon after arrival at the site, males remain active for a longer period and may also travel between hibernacula, which may increase mating opportunities (USFWS 2007).

Spring emergence from the hibernacula generally occurs as early as late March, but more typically in early to mid-April to the end of May and varies across the range, depending on latitude and weather conditions (USFWS 2007). Females typically emerge before males, traveling sometimes hundreds of miles to their summer habitat (Winhold and Kurta 2006).

3.2.2 Habitat Requirements

<u>Winter Habitat</u>

Indiana bats typically hibernate from October to April (USFWS 2007). The majority of hibernacula are located in karst areas of the east-central US. Indiana bats are also known to hibernate in other cave-like structures, such as mines, dams and tunnels (Kurta and Teramino 1994, Sanders and Chenger 2000, Butchkoski and Turner 2008). In 2005, approximately 30% of the population hibernated in man-made structures (predominantly mines), with the rest using natural caves (USFWS 2007).

Indiana bats typically require low, stable temperatures (3 degrees [°] Celsius [C] to 8 °C [37 °Fahrenheit (F) to 46 °F]) for successful hibernation (Tuttle and Kennedy 2002, Brack 2004). Cave configuration determines internal microclimate, with larger, more complex cave systems with multiple entrances more likely to provide suitable habitat for Indiana bats (Tuttle and Stevenson 1978, LaVal and LaVal 1980, Richter et al. 1993). Cave volume and complexity help buffer the cave environment against rapid and extreme shifts in outside temperature, and vertical relief provides a range of temperatures of roost sites (USFWS 2007). Because bats are able to decrease exposure to fluctuating air temperatures by increasing surface contact with other individuals, Indiana bats tend to hibernate in large, dense clusters, ranging from 3,333 to 5,555 bats per m^2 (300 to 500 bats per ft^2; USFWS 2007, Boyles et al. 2008).

Spring Emergence and Dispersal

In the spring, female Indiana bats emerge from hibernacula in late March to early April, with a peak emergence time of mid-April (USFWS 2007), and disperse to their summer habitat where they form maternity colonies (Winhold and Kurta 2006). While female Indiana bats may depart for maternity habitat immediately or remain near their hibernacula for several days, once migration begins the bats migrate quickly to their summer habitat (USFWS 2007). Britzke et al. (2006) found Indiana bats in Indiana arrived at summer maternity roosts within a couple of weeks to one month of their mid-April departure from hibernacula. In Indiana, female Indiana bats arrived at maternity colonies between March 17 and April 15 (average April 3), from 2002 – 2014, and primary maternity roosts (30 or more bats) formed between April 8 and May 14 (average April 27; Petit and O'Keefe 2017). Bats arriving early to maternity colonies in a similar area of Indiana were tracked on April 10 and found to be summer residents at their maternity colonies, rather than transients still in the process of migration (Judy et al. 2010). In Illinois, Indiana bats may arrive at summer maternity colonies by May 1 (Gardner et al. 1991).

Radio-telemetry studies and band return data have shown that dispersal or migration distances vary across the species' range. Indiana bats in the Midwest appear to migrate the longest distances between hibernacula and their summer habitat. Twelve female Indiana bats from maternity colonies in Michigan migrated an average of 477 km (296 mi) to their hibernacula in Indiana and Kentucky, with a maximum migration of 575 km (357 mi; Winhold and Kurta 2006), which is the maximum migration distance recorded for the species. Indiana bats have also been known to make small spring migratory movements if suitable maternity habitat is closer. Britzke et al. (2006) tracked Indiana bats just 14.6 – 40.0 km ([9.1 – 24.9 mi]; mean 26.9 km [16.8 mi]) and Petit and O'Keefe (2017) recorded Indiana bat movement data of 62 – 158 km (38.8 – 98.8 mi) between hibernacula and summer range. Eleven female Indiana bats tracked from Tennessee (and one from Indiana) in the spring, primarily moved west, although a few migrated north or south to maternity colonies, moving an average of 187.6 km (116.6 mi), with a range of 6.2 – 368.1 km (3.9 – 228.7 mi; Roby and Gumbert 2016a). Some non-reproductive female and male Indiana bats do not migrate as far as reproductive females, and instead remain in the vicinity of their hibernacula throughout the summer (Gardner and Cook 2002, Whitaker and Brack 2002).

Little is known about the behavior of Indiana bats during migration. Bats may try to minimize the time spent in transit, as migration is energetically expensive and dangerous (Fleming and Eby 2003). This may be especially true for reproductive females during the spring when they are pregnant and energetically constrained from spending the winter in hibernation. Initial studies have indicated that Indiana bat migration from winter to summer habitat is fairly linear and short-term, while in the fall, it is more dispersed and varied (Butchkoski and Turner 2005, 2006; Hicks et al. 2005; Britzke et al. 2006), but recent studies have found the converse to be true. Roby and

Gumbert (2016a) found that Indiana bats flew in a generally straight line when migrating in the spring, although fall migrating bats flew both in a straighter line and faster than did spring migrating bats (see *Fall Migration and Swarming*, below). Eleven Indiana bats tracked during spring migratory movements flew an average of 9.4 km per hour (kph; 5.8 miles per hour [mph]) with a range of 0.7 – 19.0 kph (0.4 mph – 11.8 mph) depending on the weather (Roby and Gumbert 2016b). Evidence from radio-tracking studies in New York and Pennsylvania documented Indiana bats migrating 48 – 64 km (30 – 40 mi) in one night (Sanders et al. 2001, Hicks 2004, Butchkoski and Turner 2006), and Roby and Gumbert (2016a) reported a female Indiana bat migrated 268.9 km (167.1 mi) in a single night during spring migration.

There is some evidence that bats in the Appalachian Mountain region and Northeast follow landscape features while migrating (McShea and Lessig 2005, Turner 2006, J. Chenger, Bat Conservation Management, pers. comm.) However, in the Midwest where there can be relatively limited forest cover between hibernacula and summer habitat, Indiana bats must fly across open areas during migration, as evidenced by extrapolations from band return data indicating no contiguous habitat between hibernacula and summer habitat, as well as the occurrence of Indiana bat fatalities at wind energy facilities in agricultural areas in the spring and fall migration seasons (USFWS 2011a). Roby and Gumbert (2016a) observed female Indiana bats migrating at tree-level heights or lower, using forested areas but crossing open fields quickly when necessary in Indiana.

Summer Habitat

Suitable summer habitat for the Indiana bat includes roosting, foraging, and commuting areas. Suitable summer roosting habitat is characterized by trees (dead, dying, or alive) or snags with exfoliating or defoliating bark, or containing cracks or crevices that can be used as a roost. Foraging habitat includes forested patches, wooded riparian corridors, and natural vegetation adjacent to these habitats. Commuting habitat includes open corridors in wooded tracts, tree lines, wooded hedgerows, and other pathways that are connected to roosting or foraging areas (USFWS 2007).

In the summer, female Indiana bats predominantly roost under slabs of exfoliating bark, preferring not to use tree cavities, but occasionally using narrow cracks in trees (Kurta 2004). Because of their cryptic nature, the first Indiana bat maternity colony was not discovered until 1971 (Cope et al. 1974, Gardner and Cook 2002). Maternity colonies vary greatly in size in terms of the number of individuals and the number of roost trees used, with members of the same colony utilizing over 20 trees during one season (Kurta 2004). Roosts are usually located in dead trees, though partly dead or live trees (e.g., if the species has naturally peeling bark) may also be used for roosting (USFWS 2007). A meta-analysis of 393 roost trees in 11 states found 33 tree species that were used, with ash, elm, hickory (*Carya* spp.), maple (*Acer* spp.), poplar (*Populus* spp.), and oak (*Quercus* spp.) accounting for approximately 87% of trees documented (Kurta 2004). Roost trees also vary in size. Typically, roost trees are greater than 22 centimeters (cm; 8.6 inch [in]) diameter-at-breast-height (dbh; Kurta 2004). The mean size roost tree in the aforementioned meta-analysis was 45 ± 2.0 cm (18 ± 0.8 in) dbh, with a range of 28 to 62 cm (11 to 24 in) dbh (Kurta 2004, Britzke et al. 2006). The smallest maternity roost tree recorded was 11 cm (4.3 in) dbh (Britzke 2003). Primary roosts can be much larger (Kurta et al. 2002, USFWS 2007).

Maternity colonies use primary roosts and alternate roosts, switching between roosts every two or three days (Kurta et al. 2002, Kurta 2005). Primary roosts were defined by Callahan (1993) in terms of number of bats (i.e., roosts used by more than 30 bats), but may also be defined by the number of days the roosts are used by bats over one maternity season (Kurta et al. 1996, Callahan et al. 1997, USFWS 2007). Bats from the same maternity colony may use between 10 and 20 trees throughout the summer, but usually only one to three of these are considered primary roosts (Callahan 1993, Callahan et al. 1997). Primary roosts are used throughout the summer, while alternate roosts may be important during changing weather conditions and are used less frequently, typically for only one or two days in a row (Callahan et al. 1997, Kurta et al. 2002, Kurta 2005).

An important characteristic for the location of maternity roost sites is a mosaic of woodland and open areas, with the majority of maternity colonies having been found in agricultural areas with fragmented forests (USFWS 2007). Further, absolute height of the roost tree appears to be less important than the height of the tree relative to surrounding trees (Kurta 2004). Primary roosts usually receive direct solar radiation for more than half the day and are almost always located in either open canopy sites along forest edges or within gaps in forest stands, or above the canopy of adjacent trees (Kurta et al. 1996, 2002; Callahan et al. 1997, USFWS 2007). This characteristic is thought reduce thermoregulatory costs for reproductive females and their young (Vonhof and Barclay 1996).

While the primary and alternate roosts of a maternity colony may change over the years, it is thought that foraging areas and commuting paths are relatively stable (Winhold et al. 2005, Barclay and Kurta 2007). In general, the distance from the roost to foraging areas varies from 0.5 to 8.5 km (0.3 to 5.3 mi; USFWS 2007); this distance may be constrained by the need to periodically return to the roost to nurse once young are born (Henry et al. 2002). Lactating females have been shown to return to the roost two to four times during a night (Butchkoski and Hassinger 2002, Murray and Kurta 2004).

Although individuals from a maternity colony appear to show fidelity to a general home range within and between years (Sparks et al. 2004), due to differences in study methodology it is difficult to determine a common home range size (Lacki et al. 2007). In Indiana, mean home range area was 145 ± 18 ha (358 ± 44 ac; Sparks et al. 2005); while on the Vermont-New York state line it was 83 ± 83 ha (205 ± 203 ac; Watrous et al. 2006), and a single female in Pennsylvania exhibited a home range estimated at 21 ha (52 ac; Butchkoski and Turner 2006).

Fall Migration and Swarming

Indiana bats start leaving their summer habitat as early as late-July and begin arriving at hibernacula in August (USFWS 2007). From 2002 – 2014 in Indiana, primary Indiana bat maternity colonies broke up between August 7 – October 4 (average September 6), and departure for fall swarming sites occurred between August 20 and October 31 (average October 6; Petit and

O'Keefe 2017). Range-wide, Indiana bat fall migration occurs primarily between August 1 and October 15 (USFWS 2007). Little is known about Indiana bat behavior during fall migration, because most of what is known about fall migration comes from band returns (i.e., individuals that are banded during the summer and subsequently documented during winter hibernacula counts), which provide information about migration distances and beginning and ending destinations, but not information about timing or migration routes. While it was previously thought that fall migration takes longer and is less direct than the relatively direct and short-term spring migration (USFWS 2011a), as noted above, recent studies have found the converse to be true; Roby and Gumbert (2016a) found that Indiana bats flew in a nearly straight line when migrating in the fall. Furthermore, Roby and Gumbert (2016a) found that the two Indiana bats radio-tracked during their study did not stop during migration, completing their entire migration in one night.

When Indiana bats arrive at hibernacula, they perform a behavior known as swarming, in which they fly around the entrances in an attempt to find mates (Cope and Humphrey 1977). Once arriving at hibernacula, females may only remain active for a few days, whereas males remain active, seeking mates into late October and early November (timing varies with latitude and annual weather conditions). During the swarming period, most male Indiana bats roost in trees in the area surrounding hibernacula during the day roost and fly to their hibernaculum at night (USFWS 2007). Clusters of active bats have also been observed roosting in caves during swarming events (Gumbert et al. 2002).

The maximum distance between identified roost trees and associated hibernacula varies among telemetry studies conducted during the fall roosting and swarming season. Most telemetry studies conducted during fall swarming have occurred outside of hibernacula with relatively small populations of Indiana bats. At two small P3 hibernacula in Kentucky, Indiana bats roosted primarily within 2.4 and 4.1 km (1.5 and 2.5 mi) of the cave entrances (Kiser and Elliot 1996, Gumbert 2001). In Virginia, all roost trees identified from eight male and three female Indiana bats were within 1.4 km (0.9 mi) of a P3 hibernaculum (Brack 2006). In Michigan, Kurta (2000) tracked two male Indiana bats to roost trees located 2.2 and 3.4 km (1.4 and 2.1 mi) from a P4 hibernaculum.

Bats have been documented roosting relatively further from hibernacula in areas with larger populations of hibernating bats (Rommé et al. 2002, USFWS 2007). The longer distances traveled by bats at larger hibernacula seems to suggest that the density of bats influenced how bats used the area surrounding hibernacula (Hawkins et al. 2005). As the density of bats swarming outside of the hibernaculum increases, bats may need to move farther from the site to find available roost and prey resources.

Indiana bats tend to roost more often as individuals in fall than in summer (USFWS 2007). Roost switching occurs every two to three days and trees used by the same individual tend to be clustered. Similar to summer roosts, fall roost trees most often are in sunny forest openings created by natural or human disturbance (USFWS 2007). Indiana bats show strong site fidelity (especially females) and typically return to the same hibernacula year after year (Hall 1962, LaVal and LaVal 1980, Gumbert et al. 2002).

3.2.3 Demographics

Female Indiana bats give birth to one young per year, similar to most bats of temperate regions (Mumford and Calvert 1960, Humphrey et al. 1977, Thomson 1982), and the birth rate of males to females appears to be essentially even (Hall 1962, Myers 1964, LaVal and LaVal 1980). Guthrie (1933) reported that female Indiana bats are sexually mature by the end of their first summer, although there may be considerable intraspecific variation in the age of sexual maturity (Racey 1982).

The proportion of females in a population that produce young each year is thought to be fairly high (USFWS 2007). In one study, volant young were produced during two consecutive years of study by about 93% and 82% of female Indiana bats, respectively (Humphrey et al. 1977), and in another study it was estimated that approximately 89% of adult females were in reproductive condition (pregnant, lactating, or post-lactating; Kurta and Rice 2002).

Age structure and survival rates among different life stages of Indiana bats are poorly understood, due in part to the lack of accurate techniques for aging individuals (Anthony 1988, Batulevicius et al. 2001 [as cited by USFWS 2007]). It is expected, however, that, similar to many other species, survival of Indiana bats is lowest during the first year of life, and that threats and sources of mortality vary during the annual cycle (USFWS 2007). More research is needed to define annual survival rates of Indiana bats accurately; however, data from Humphrey and Cope (1977) suggest that annual mortality of adult females is likely to be between 24% and 34% up to the age of 10 years.

3.2.4 Range and Distribution

The range of the Indiana bat extends throughout much of the eastern US and includes 22 states (Gardner and Cook 2002, USFWS 2007; Figure 3.2). Historically, the Indiana bat winter range was restricted to areas of cavernous limestone in the karst regions of the east-central US (USFWS 2007; Figure 3.3), apparently concentrated in a relatively small number of large and complex cave systems, with over 90% of the population hibernating just 10 caves in the five states of Indiana, Missouri, Kentucky, Illinois, and New York. More recently, the use of man-made structures for hibernation has extended the winter range of Indiana bats into some caveless parts of the country (Kurta and Teramino 1994).

Relatively little is known about the historic summer range of Indiana bats. It is believed that the historical summer distribution of this species was similar to that of today (Cope et al. 1974). As of October 2007, the USFWS (USFWS 2007) had records of 269 maternity colonies in 16 states (Figure 3.4), with the majority of summer habitat in the Midwest rather than the more eastern portion of the species' range (Woodward and Hoffman 1991, Brack et al. 2002). This likely represents only about 6-9% of the 2,859 to 4,574 colonies thought to exist based on the estimated total wintering population (Whitaker and Brack 2002, USFWS 2007).

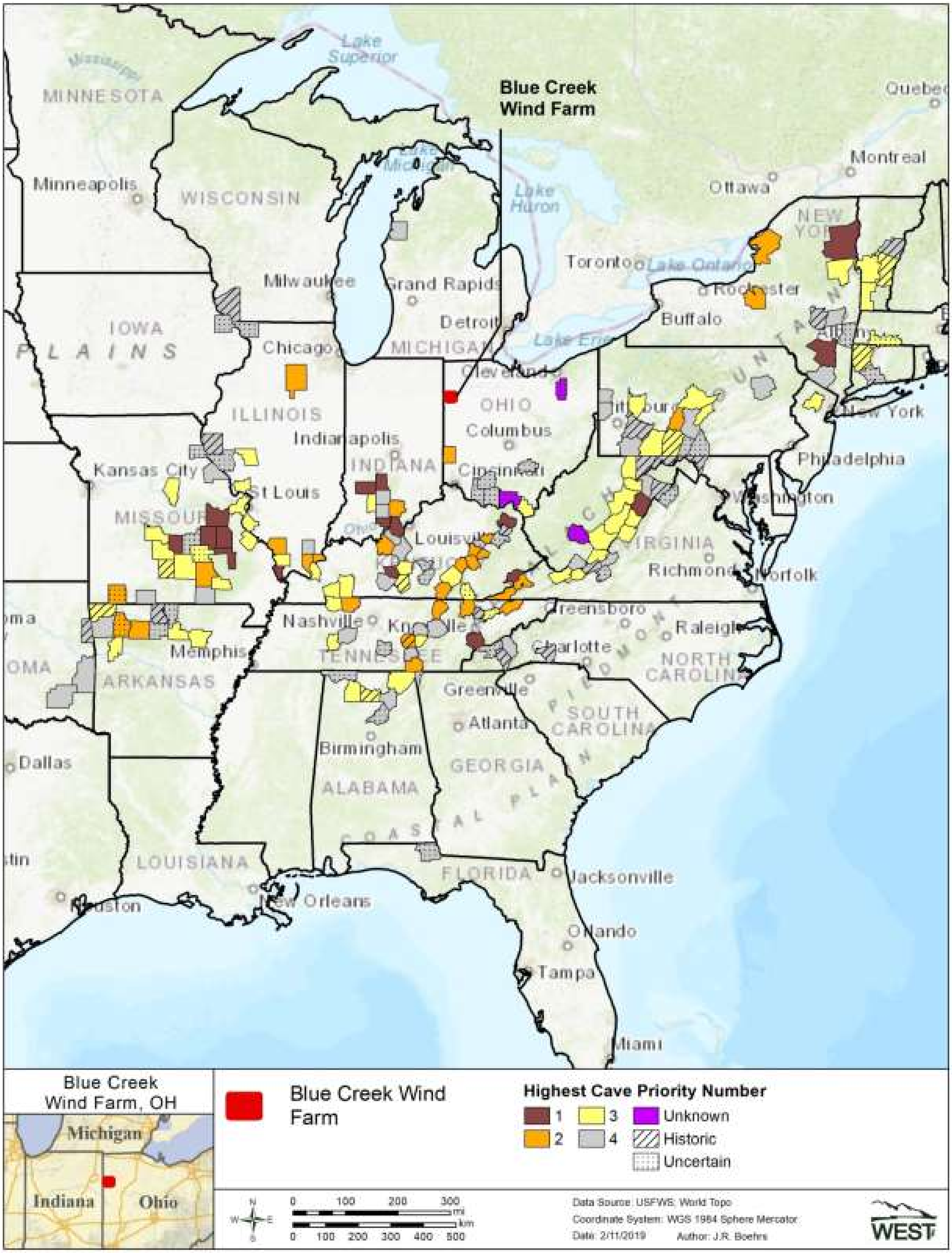

Figure 3.3 Counties with historic or extant Indiana bat hibernacula.

682

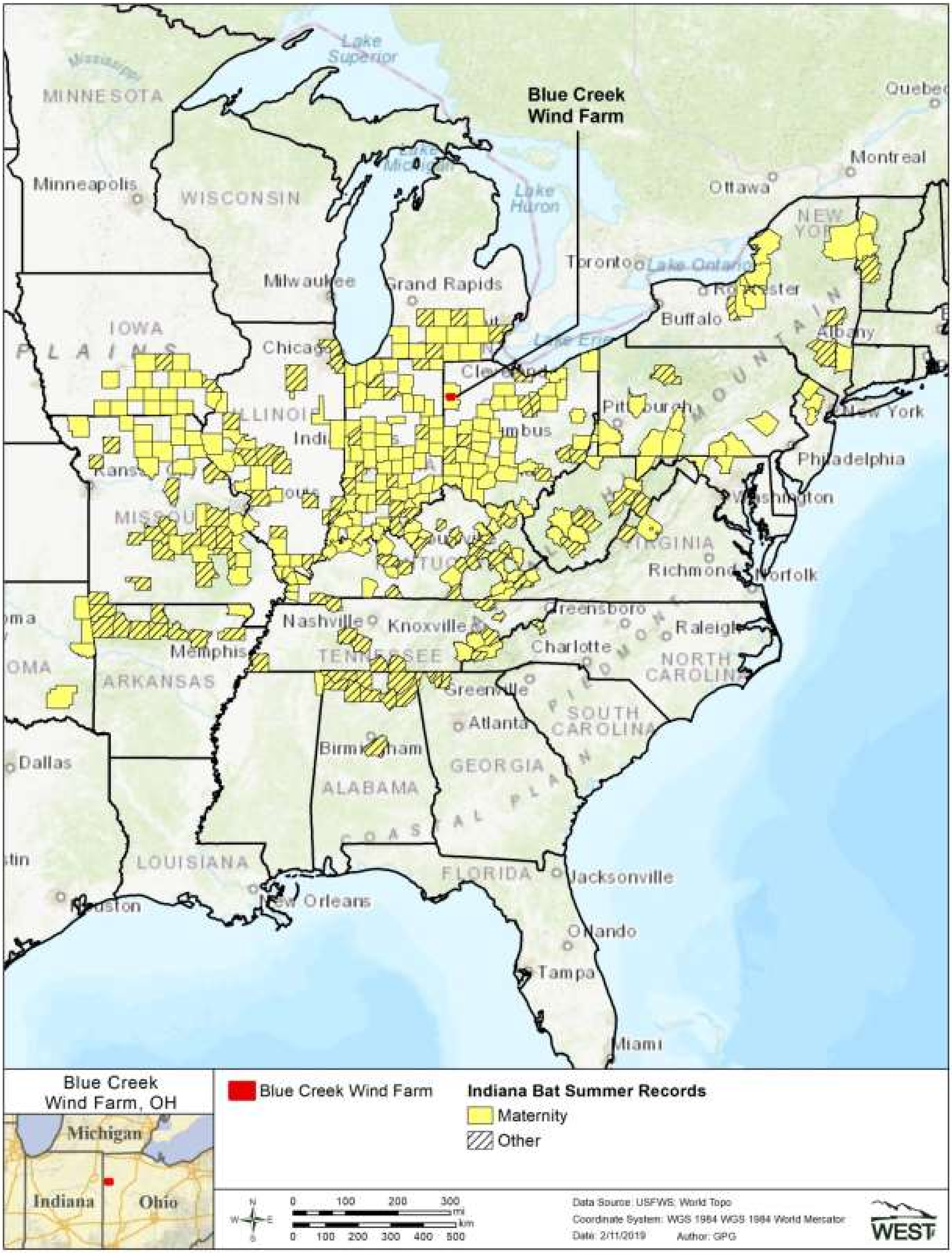

Figure 3.4 Counties with summer Indiana bat records.

683

3.2.5 Species Status and Occurrence

Rangewide

Population estimates for the Indiana bat are derived from surveys of hibernating bats. In 1967, the range-wide population size was estimated to be 880,000 bats (Clawson 2002), which decreased to approximately 550,000 bats by 1983 (USFWS 1983). In 2012, a previously unknown P1 bat hibernaculum was discovered in Missouri, containing approximately 123,000 Indiana bats (USFWS 2013a). The USFWS added the 2012 population estimate from the new hibernaculum to previous population estimates (USFWS 1983, 2013a, 2017). The Indiana bat population declined between 1983 and 2001, with 526,026 individuals reported in 2001 (USFWS 2015a). After 2001, there was a gradual population increase to 664,632 Indiana bats in 2007; however, the estimated population has decreased with each subsequent survey, with 537,297 bats estimated in 2019 (USFWS 2019). A high proportion of that decline (more than 50%) was probably due to the effects of WNS. An evaluation of long-term (1999-2011), regional population trajectories of bats in the eastern US found a cumulative decline of approximately 30% (+/- 26%) in Indiana bat regional relative abundance from peak levels (Ingersoll et al. 2013).

Midwest Recovery Unit

The Project falls within the Midwest RU (MRU) which includes the states of Indiana, Kentucky, Ohio, Tennessee, Alabama, southwestern Virginia, Michigan and Georgia (USFWS 2007). According to the *2019 Indiana Bat (Myotis sodalis) Population Status Update* (USFWS 2019), the overall population within the MRU was 243,388 Indiana bats in 2017 and 245,474 in 2019 (a two-year net increase of 0.9%; Table 3.1). The MRU represents 45.7% of the 2019 range-wide population of Indiana bats (USFWS 2019). According to the 2007 Draft Recovery Plan, there are 190 known Indiana bat hibernacula within the MRU, with 116 being classified as extant (at least one record since 2000). There are 12 P1 hibernacula in the MRU: seven in Indiana and five in Kentucky.

Table 3.1 Indiana bat population estimates for the Midwest Recovery Unit by state (US Fish and Wildlife Service 2019).

State	2009	2011	2013	2015	2017	2019
Indiana	213,244	225,477	226,572	185,720	180,611	184,848
Kentucky	57,319	70,626	62,018	64,599	58,057	55,946
Ohio	9,261	9,870	9,259	4,809	2,890	2,890
Tennessee	1,657	1,791	2,369	2,401	1,587	1,561
Alabama	253	261	247	90	85	90
southwest Virginia	217	307	214	137	70	119
Michigan	20	20	20	20	20	20
Georgia	0	0	0	0	1	0
Total	**281,971**	**308,352**	**300,699**	**257,776**	**243,321**	**245,474**

Ohio

In the last decade, the estimated population size of Indiana bats in Ohio peaked in 2011 at 9,870 bats (Table 3.1; USFWS 2013a, 2019). Approximately 3% of the estimated range-wide population of Indiana bats hibernated in Ohio in both 2011 and 2013 (USFWS 2013a), decreasing to less than 1% since 2015 (USFWS 2019). There are few known major hibernacula in the state for Indiana bats or other bats, though a comprehensive survey of all possible hibernacula in Ohio has not been conducted. The extant population of hibernating Indiana bats in Ohio is known from two underground mines: the Lewisburg Limestone Mine in Preble County (P2, the largest known Indiana bat hibernaculum in Ohio) and the Ironton Mine (P3) in Lawrence County (Figure 3.3). Four other hibernacula in three counties (Hocking, Brown, and Highland) have been designated as P4 (i.e., current or observed historic populations of fewer than 50 Indiana bats), but currently have no known hibernating Indiana bats (USFWS 2007).

The closest known Indiana bat hibernaculum to the Permit Area is the Lewisburg Limestone Mine, located approximately 121 km (75 mi) to the south. The Lewisburg Limestone Mine is categorized as a P2 hibernaculum by the USFWS, and a 2012 census of the Lewisburg Limestone Mine documented a winter Indiana bat population of 9,243 (A. King, USFWS, pers. comm.). WNS (see Section 3.6.1) appears to have resulted in a significant population reduction; 2,890 Indiana bats were counted in the winter of 2016 census, representing a 69% reduction from the 2012 census (ESI 2016).

Data collected every two years since the Ironton Mine was discovered showed annually fluctuating Indiana bat populations prior to 2013 (e.g., winter counts were 277, 276, 254, 224, 333, 208, and 150 Indiana bats recorded in 2012, 2011, 2009, 2007, 2005, 2003, and 1999, respectively; A. King, USFWS, pers. comm.). Subsequently, however, the population was greatly reduced as a result of WNS, with a population count of only 17 bats in 2013, representing a 94% decline from the 2012 population, and no Indiana bats found in either the 2014 or 2016 counts (K. Schultes, Wayne National Forest, pers. comm.).

Band return records indicate that Indiana bats that migrate through or summer in Ohio overwinter in hibernacula in southern states. Indiana bats migrating from Kentucky and Indiana to southern Michigan may pass through Ohio on their northward migration, based on band recovery data summarized in Gardner and Cook (2002), Kurta and Murray (2002), and Winhold and Kurta (2006), as well as three unpublished band returns documented by A. Kurta (Eastern Michigan University, pers. comm.). These include records of 19 Indiana bats passing through Ohio. There are multiple records showing Indiana bats traveling between summer habitat in Ohio and hibernacula caves in Kentucky. Specifically, Barbour and Davis (1969) reported several Indiana bats banded at Bat Cave and Mammoth Cave in Kentucky were recovered in west-central Ohio. Four Indiana bats captured during separate summer mist-netting activities in Logan and Champaign counties, Ohio, were recovered during hibernacula surveys in Kentucky (J. Kiser, Stantec Consulting Inc. [Stantec], and K. Lott, USFWS, pers. comm.).

The summer range of Indiana bats covers all of Ohio. As from the 2007 Draft Recovery Plan and updated information from the USFWS (M. Seymour, USFWS, pers. comm.), 49 counties in Ohio (out of 88 total counties) had records of summer maternity colonies (Figure 3.4). An additional four counties had summer records that did not include maternity colonies.

Permit Area/Local Population

There are no known hibernacula in Van Wert County or in Paulding County, where the Project is located. One active maternity colony was documented in Paulding County in 1976 (USFWS 2007); because there has been no subsequent survey effort, this colony is still considered active (K. Lott, USFWS, pers. comm.). There is also a documented male Indiana bat mist-net capture in southwestern Van Wert County the summer of 2012 (M. Seymour, USFWS, pers. comm.)

Based upon the environmental setting, the Permit Area does not provide suitable maternity or high-quality roosting habitat for Indiana bats due to the predominance of cultivated cropland and developed lands (approximately 99% of the area). Bat mist-net surveys were completed at five sites at the Blue Creek Wind Farm between July 18 – 25, 2016, following the *2016 Range-Wide Indiana Bat Summer Survey Guidelines* (USFWS 2016) and ODNR wind project-specific bat survey protocols (ODNR 2009) (Appendix A). Neither Indiana nor northern long-eared bats were detected during these surveys, indicating probable absence of summer maternity colonies of these species within the Permit Area.

The Permit Area does not contain sensitive areas, such as natural areas, nature preserves, state parks, wilderness areas, wildlife refuges, or wildlife management areas that may provide high-quality bat habitat; the closest public land managed for natural resource conservation is about 14 km (nine mi) away.

Based on bat mortality monitoring data from the Project and other nearby wind facilities, Indiana bats are known to migrate through Ohio's agricultural landscape in both spring and fall (Pruitt and Reed 2018). Although no Indiana bats were identified in pre- or post-construction acoustic monitoring surveys at the Project (BHE Environmental 2010, Ritzert et al. 2013, Good et al. 2014), an Indiana bat fatality at the Project occurred during fall migration in 2012 (Section 3.5.3).

3.2.6 Conclusions

Based on the data presented in Section 3.2.2, Indiana bats are most likely to occur within the Permit Area during the spring (April 1 to May 15) and fall (August 1 to October 15) migratory periods. Because of the documented presence of Indiana bats in the Permit Area during the fall and the higher levels of Indiana bat fatality recorded in the Midwest in the fall (see Section 5.2.2, Appendix B), the risk of Indiana bat take within the Permit Area is expected to be highest during the fall migration period (August 1 – October 15), and lower during the spring migration period (April 1 – May 15). Indiana bats are not expected to occur in the Permit Area during the summer maternity season (May 16 – July 31), based upon the lack of suitable maternity habitat within the Permit Area and the negative results of all pre- and post-construction acoustic studies and mist net surveys at the Project, during which no Indiana bats have been recorded. Similarly, due to the lack of suitable winter habitat, Indiana bats are not anticipated to occur during the winter hibernation season.

3.3 Covered Species – Northern Long-Eared Bat

The northern long-eared bat has traditionally been a common bat species in the mid- to northeastern US, with continental range extending into southeastern and western Canada. The USFWS was petitioned to list northern long-eared bat as threatened or endangered in January 2010 (see Center for Biological Diversity [CBD] 2010). In October 2013, the USFWS released a 12-month finding on the petition in which it determined that listing the northern long-eared bat was warranted and proposed to list the species as an endangered species under ESA (USFWS 2013b; 78 FR 61046 [October 2, 2013]). Information regarding the species' biology, range, and population trends was requested by the USFWS in the proposed rule. A final decision listing the northern long-eared bat as federally threatened was issued (USFWS 2015b; 80 FR 17974 [April 2, 2015]). The listing decision was followed by issuance of a final 4(d) rule for the species on January 14, 2016 (USFWS 2016b; 81 FR 1900). The final 4(d) rule exempts incidental take of northern long-eared bats resulting from most otherwise lawful activities from ESA Section 9 take prohibitions, including the incidental take of northern long-eared bats due to the operation of wind turbines (see footnote in Section 1.5).

The northern long-eared bat was formerly considered a subspecies of Keen's bat (*Myotis keenii*), though they are now considered to be two genetically distinct species (Caceres and Pybus 1997). Most literature prior to the 1980s under the name Keen's bat pertains to the northern long-eared bat.

3.3.1 Overview of Life History Characteristics

The northern long-eared bat is a small bat weighing approximately 5 to 10 g (0.17 to 0.35 oz) with yellow to brown coloration and large ears relative to other similar species (Whitaker and Mumford 2009).

In spring, females leave hibernacula and form maternity colonies ranging from seven to 100 individuals, but most commonly 30-60 individuals (USFWS 2014). Parturition dates and subsequent weaning are likely dependent on regional conditions (Foster and Kurta 1999). Studies completed by Broders et al. (2006) over a 3-year period in New Brunswick, Canada found parturition to occur in mid- to late-July. Other studies suggest that southeastern population parturition dates occur between mid-May and mid-June (Cope and Humphrey 1972, Caire et al. 1979). Ohio populations, which exist in the middle of these geographic regions, likely have most common parturition dates throughout July.

Generally, female northern long-eared bats roost communally, while males select solitary roosts (Caceres and Barclay 2000). Northern long-eared bats have shown site fidelity related to summer roost habitat, but use a number of roost trees in an area, switching between trees every one to three days (Foster and Kurta 1999, Arnold 2007, Timpone et al. 2010). Movement to hibernacula occurs as early as late July and extends as late as October. Copulation occurs outside of hibernacula during swarming behavior; however, fertilization does not occur until spring (Caceres and Barclay 2000).

Northern long-eared bats are likely opportunistic insectivores that primarily glean prey from substrates (Faure et al. 1993). They typically forage within intact forests, but are known to forage along the forest edge, or along paths, roads, small streams and ponds within forested areas (Caire et al. 1979, Henderson and Broders 2008).

3.3.2 Habitat Requirements

Winter Habitat

Mine and cave sites have been most often reported as hibernacula for northern long-eared bats (Griffin 1940, Whitaker and Winter 1977, Stones 1981). This species reportedly hibernates in caves or abandoned mines with Indiana bats, little brown bats (*Myotis lucifugus*), big brown bats (*Eptesicus fuscus*), and tricolored bats (*Perimyotis subflavus*; Mills 1971, Caire et al. 1979, Boyles et al. 2009). Northern long-eared bats generally compose a small proportion of the total known hibernating population (1% or less to 15%; NatureServe 2017).

Within hibernacula, northern long-eared bats do not form large aggregations or clusters typical of some eastern species. Instead, individuals or small groups seem to favor deep crevices for hibernation (Caceres and Barclay 2000), and relatively few hibernating individuals can be found even in caves known to serve as hibernacula (Whitaker et al. 2002). Rarely are there more than 100 individuals documented per hibernation colony (Barbour and Davis 1969, Caire et al. 1979), though mist-netting surveys conducted at cave and mine entrances suggest that northern long-eared bats are much more numerous than the numbers documented by counts of hibernating individuals (Whitaker et al. 2002). Northern long-eared bats generally exhibit strong philopatry to hibernacula, but have also been reported to occasionally move between hibernacula during the winter (Whitaker and Rissler 1992, USFWS 2014).

Spring Emergence and Dispersal

There is little information available regarding spring emergence and dispersal of northern long-eared bats from hibernacula. However, the length of hibernation period can change with different regions and climates (Caceres and Barclay 2000). Depending on the specific climate patterns and which region the bats are hibernating in, spring emergence may occur from March to May (Fenton 1969, Caire et al. 1979, Whitaker and Rissler 1992, Nagorsen and Brigham 1993). Like other *Myotis* species in the eastern US, northern long-eared bats mate in the fall, with ovulation and fertilization occurring shortly after females awaken in the spring (Caceres and Barclay 2000).

Shortly after emergence, northern long-eared bats migrate to their summer habitat (USFWS 2014). Spring migration direction of northern long-eared bats may be similar to little brown bats, which have been shown to radiate outward from hibernacula during migration, with the bats migrating directly to the natal sites, rather than moving primarily north or south (Davis and Hitchcock 1965, Fenton 1970, Griffin 1970, Humphrey and Cope 1976). Little is known about male northern long-eared bat migrations, but male little brown bats and Indiana bats have been captured outside of known hibernacula in midsummer, suggesting that some males may migrate short distances from their hibernacula (Davis and Hitchcock 1965, Gardner and Cook 2002, Whitaker and Brack 2002). If male northern long-eared bats behave similar to other *Myotis* species, then it can be expected that they form small bachelor colonies or stay close to known hibernacula (Davis and Hitchcock 1965).

Summer Habitat

Northern long-eared bats most frequently select mature-growth forests with decaying trees and/or live trees with cavities or exfoliating bark during the summer maternity season (Foster and Kurta 1999, Lacki and Schwierjohann 2001, Ford et al. 2006). Day and night roosts are utilized by northern long-eared bats during spring, summer, and fall (Foster and Kurta 1999, Owen et al. 2003, Broders and Forbes 2004). Variation in roost selection criteria has been reported between northern long-eared bat sexes, with females forming maternity colonies in snags and solitary males roosting in live tree cavities (Caceres and Barclay 2000, Lacki and Schwierjohann 2001, Broders and Forbes 2004).

Broders and Forbes (2004) further reported that maternity colonies were more often in shade-tolerant deciduous stands and in tree species that are susceptible to cavity formation. This is supported by Lacki and Schwierjohann's (2001) findings that colony roosts were more likely to occur in stands with higher density of snags. Though some may roost alone, females often roost colonially. Maternity colonies are generally small, consisting of 30 (Whitaker and Mumford 2009 as cited in USFWS 2013b; 78 FR 61046 [October 2, 2013]) to 60 (Caceres and Barclay 2000 as cited in USFWS 2013b; 78 FR 61046 [October 2, 2013]) individuals, though maternity colonies of up to 100 individuals have been observed (Layne 1978, Dickinson et al. 2009, Whitaker and Mumford 2009 as cited in USFWS 2013b; 78 FR 61046 [October 2, 2013]).

Northern long-eared bats do not typically forage in intensively harvested stands or open agricultural areas, instead constraining their movement to intact forest when it is available (Patriquin and Barclay 2003, Henderson and Broders 2008). They are known to forage under the forest canopy at small ponds or streams, along paths and roads, or at the forest edge (Caire et al. 1979). However, in agricultural areas such as the Project, northern long-eared bats may be forced to move across open habitat to reach nearby forest. Northern long-eared bats have low wing loading, a low aspect ratio, and are highly maneuverable in forested habitat and therefore well-adapted to foraging in dense vegetation (Patriquin and Barclay 2003, Carter and Feldhamer 2005). This species is also frequently observed to forage in close proximity to ephemeral upland pools (Owen et al. 2003, Brooks and Ford 2005). In managed forests of West Virginia, northern long-eared bats utilized on average a 65-ha (161-ac) home range and patches smaller than this were considered unsuitable habitat (Owen et al. 2003). However, in Van Wert County, Ohio, northern long-eared bats were captured and tracked to roost trees in forest patches ranging from 1.89 to 45.50 ha (4.67 to 112.4 ac; K. Lott, USFWS, pers. comm.). Females have been reported to move up to approximately 2,000 m (6,562 ft) and males up to approximately 1,000 m (3,281 ft) between roost sites (Broders et al. 2006).

Fall Migration and Swarming

Little is known about migration for northern long-eared bats, but there is evidence that portions of the population may move seasonally. Late summer swarming behavior and relatively high concentrations at some caves indicate that there is some degree of local or regional movement prior to reproduction. Short migratory movements between 56 km (35 mi) and 89 km (55 mi) from hibernacula to summer habitat are most common (Griffin 1945, Nagorsen and Brigham 1993 as cited in USFWS 2013b [78 FR 61046 (October 2, 2013)]), suggesting northern long-eared bats are regional migrants. The longest recorded migration distance for the species is 97 km (60 mi), reported in Griffin (1945).

Northern long-eared bats begin arriving at hibernacula in August, and by mid-September large numbers of individuals can be seen flying about the entrances to certain caves and mines (Boyles et al. 2009). The majority of breeding occurs during this fall swarming period.

3.3.3 Demographics

Similar to other *Myotis* bat species, northern long-eared bat has a low reproductive rate, with females birthing one offspring per year (USFWS 2014). The northern long-eared bat is a fairly long-lived species (Thompson 2006), with one individual reported living up to 19 years (Hall et al. 1957). The sex ratio in northern long-eared bat populations appears to be approximately even; Perry et al. (2010) found a sex ratio of approximately 1:1 over eight years of mist-netting northern long-eared bats in an Arkansas forest. Although the sex ratio in the Ohio statewide summer mist-netting dataset is skewed towards female northern long-eared bats (60% female, 40% male captures) over a 9-year period (K. Lott, USFWS, pers. comm.), male northern long-eared bats are believed to remain closer to hibernacula during the summer and may be underrepresented in summer surveys that are conducted away from hibernacula locations (M. Seymour, USFWS, pers. comm.). Multiple studies report higher percentages of male northern long-eared bats compared to females during hibernation (Griffin 1940, Hitchcock 1949, Pearson 1962, Stones 1981). The skewed ratio is believed to be due to greater mortality among female northern long-eared bats (Griffin 1940, Hitchcock et al. 1984). Therefore, because studies show a range from an even distribution to ones skewed either male or female, the sex ratio in the Permit Area is assumed to be approximately 1:1.

3.3.4 Range and Distribution

Northern long-eared bats are known to occur from eastern US and southeastern Canada, west to Montana and British Columbia, and south to northern Florida (Figure 3.5; Caceres and Barclay 2000, Schmidt 2001, Crnkovic 2003). Common hibernacula locations include Quebec, Ontario, and the New England states (Caceres and Barclay 2000). Barbour and Davis (1969) reported that the winter and summer geographic ranges of the northern long-eared bat appear to be identical.

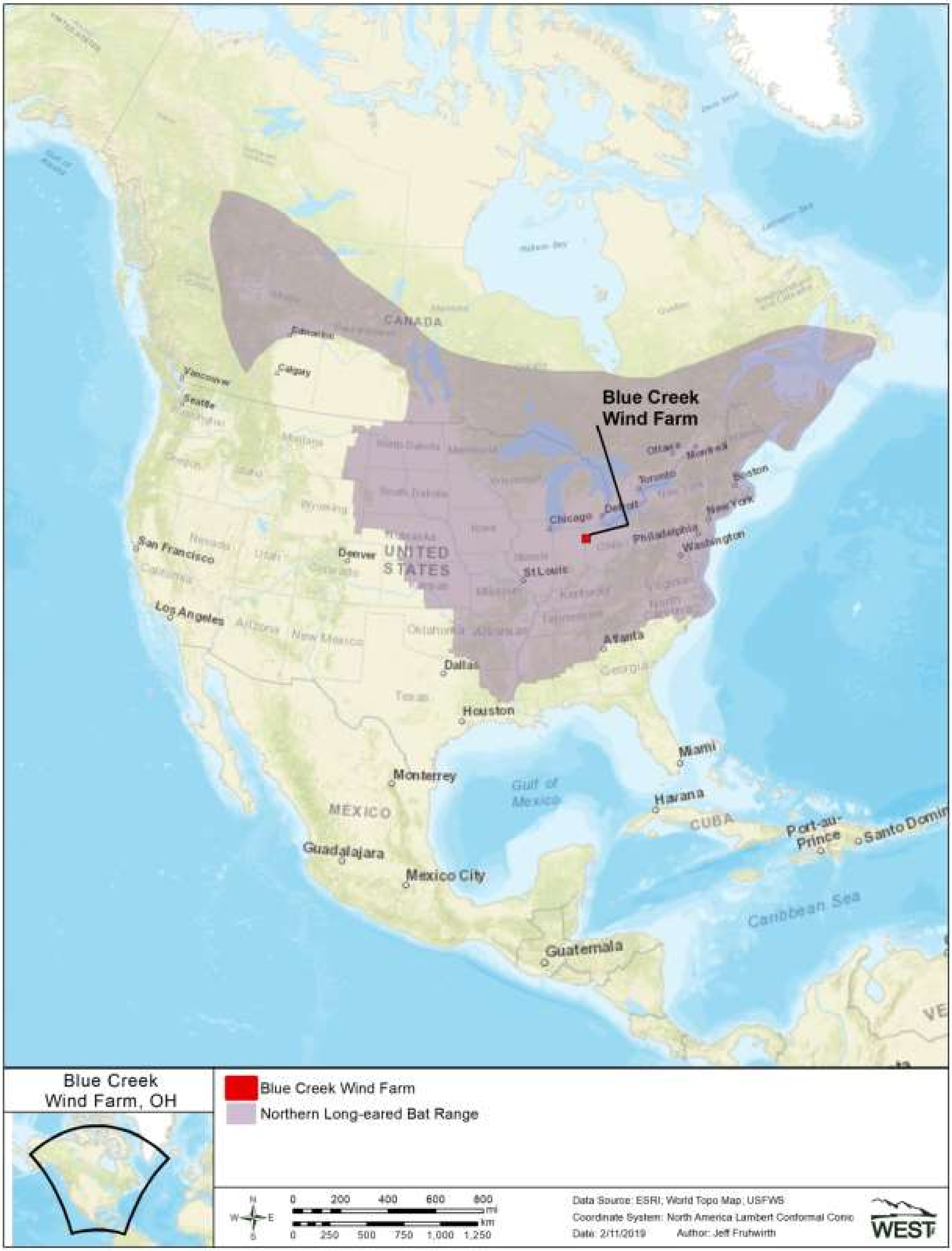

Figure 3.5 Geographic range of the northern long-eared bat in the United States and Canada.

959

3.3.5 Species Status and Occurrence

Rangewide

The range-wide northern long-eared bat population estimate calculated in the 2016 4(d) rule biological opinion using pre-WNS data was 3,273,359 adult females, 6,546,718 total adults, and 3,273,359 total pups (USFWS 2016b; 81 FR 1900 [January 14, 2016]). The Midwest (i.e., Illinois, Indiana, Iowa, Ohio, Michigan, and Missouri) northern long-eared bat population was estimated at four million total bats (USFWS 2015b; 80 FR 17974 [April 2, 2015]). Since these estimates were calculated, data indicate that WNS has caused significant population declines in Ohio and elsewhere (Section 3.6.1).

This species occurs in a widespread but irregular, patchy distribution, rarely in large numbers (Barbour and Davis 1969). Northern long-eared bats have historically been most common in the Northeast and Midwest, with lower densities known in the southern and western portions of the range (USFWS 2013b; 78 FR 61046 [October 2, 2013]).

Ohio

In Ohio, northern long-eared bats were captured in approximately 40% of all summer mist-netting surveys and comprised approximately 14% of all bats captured in summer mist-netting surveys prior to WNS impacts (Section 3.6.1; K. Lott, USFWS, pers. comm.). There are summer records for northern long-eared bats in 71 of Ohio's 88 counties; the counties without records are located in the western part of the state where summer habitat for northern long-eared bats is more limited and fewer surveys have been conducted. The nearest summer records for northern long-eared bat are found in Van Wert County, approximately 3.5 miles from the project boundary. (M. Seymour, USFWS. pers. comm.)

Northern long-eared bats have been recorded at both of the extant Indiana bat hibernacula in Ohio, the Lewisburg Limestone Mine and the Ironton Mine. The 2014 census documented 17 northern long-eared bats (among a total of 5,443 hibernating bats) at the Lewisburg Mine and no northern long-eared bats (among a total of nine hibernating bats) in the Ironton Mine (ESI 2016). In 2016, the Lewisburg Mine had 13 northern long-eared bats, a 96.3% decline from the 2009 population peak (ESI 2016). In addition to these two hibernacula, northern long-eared bats have been documented at 32 other hibernacula in Ohio, but abundance data are lacking for these locations (M. Seymour, USFWS, pers. comm.). The closest known northern long-eared bat hibernaculum to the Permit Area is the Sanborn's Cave, located approximately 115 km (71 mi) southeast in Logan County. Although a winter survey of the cave is not possible because the cave is not accessible, a total of 653 northern long-eared bats (380 males and 250 females) were captured during five swarming surveys conducted from September 15 – October 27, 2008, representing 74% of all bats captured (Stantec 2013). There is also a known northern long-eared bat hibernaculum located approximately 240 km (149 mi) east of the Project in Summit County. The hibernaculum is managed by Metro Parks Serving Summit County (Metro Parks) and has been monitored regularly. Prior to WNS, northern long-eared bat populations in the hibernaculum numbered in the thousands. Post-WNS data were collected in fall 2015 and indicate extensive declines in the northern long-eared bat population (M. Johnson, Metro Parks, pers. comm.).

A thorough search of Ohio karst features that could provide winter habitat for northern long-eared bats has not been conducted. Given this, and the species ubiquitous occurrence in Ohio during the summer (northern long-eared bat summer records have been documented in 71 out of 88 Ohio counties [M. Seymour, USFWS, pers. comm.]), there are most likely undocumented hibernacula within the state.

Permit Area/Local Population

As indicated above, the locations of northern long-eared bat maternity colonies and hibernacula are not well known in Ohio. However, based on the lack of karst features in the Permit Area, northern long-eared bats are not believed to be present in the Permit Area prior to spring migration, after fall migration, or during winter hibernation periods. Although northern long-eared bats could potentially occupy fragments of forested habitat during the summer, the negative results of all pre- and post-construction data, including a summer mist-netting survey (see Section 3.5.3; Good et al. 2016b) completed with an effort exceeding the presence/absence survey protocol standards of the USFWS (2016a) and Ohio Department of Natural Resources (ODNR, 2009), indicate that northern long-eared bats are likely not present in the Permit Area during the summer maternity season.

Northern long-eared bats were not found as fatalities during post-construction monitoring of the Project during 2011, 2012, and 2013 (see Section 3.5.3; Ritzert et al. 2013, and Good et al. 2014). In addition, no northern long-eared bats were identified in acoustic monitoring surveys at the Project (see BHE Environmental 2010, Ritzert et al. 2013, Good et al. 2014).

However, while not positively documented in the Permit Area, northern long-eared bats are reasonably likely to occur in the Permit Area during migration. Because data on northern long-eared bat migration is limited (USFWS 2014), northern long-eared bats may make occasional local and regional migrations through the Permit Area. While range-wide fatalities have been observed during the summer and fall migratory season, no publicly known northern long-eared bat fatalities have occurred in the spring (among 48 known fatalities across the species range, the earliest recorded fatality was May 25 in Ontario [James 2008]).

3.3.6 Conclusions

Based on the data presented above, the Applicant assumes that northern long-eared bats could occur within the Permit Area as early as April 1 in the spring and as late as October 15 in the fall during migration. Because none of the documented northern long-eared bat fatalities have occurred during the spring and because of the higher levels of northern long-eared bat fatality recorded in the Midwest in the fall (Section 5.2.2, Appendix B), the risk of northern long-eared bat take within the Permit Area is expected to be highest during the fall migration period (August 1 – October 15), and lower during the spring migration period (April 1 – May 15). Northern long-eared bats are not expected to occur in the Permit Area during the summer maternity season (May 16 – July 31), based upon the lack of substantial forested suitable maternity habitat within the Permit Area and the negative results of all pre- and post-construction studies at the Project, during which no northern long-eared bats have been found or recorded. Similarly, due to the lack of suitable winter habitat, northern long-eared bats are not anticipated to occur during the winter hibernation season.

3.4 Bat Activity Patterns Related to Weather Conditions

3.4.1 Wind Speed

The effect of wind speed on Covered Species' flight behavior (and therefore, risk of collision) has been demonstrated through the available published research on Covered Species, the broader biology of all bats, robust data collected at the Project itself, and dozens of specific studies on wind turbine-bat fatality curtailment studies, including one conducted at the Project itself.

Specific to the Covered Species, Petit and O'Keefe (2017) found that Indiana bat migration was correlated with wind speed, with bat migration activity most highly associated with periods of average wind speeds of 2.82 m/s (9.25 ft/s) in the fall and 3.86 m/s (12.66 ft/s) in the spring. While there are no publicly available studies that describe the flight behavior of northern long-eared bats relative to wind speed, it is likely that this species exhibits a similar relationship between wind speed and flight activity as that observed for Indiana bats, based on similarities in species biology (Sections 3.2 and 3.3).

One Indiana bat fatality was found at a turbine in Illinois that was feathered up to a manufacturer's rated cut-in speed of 3.0 m/s (9.8 ft/s) in September 2016 (M. Seymour, USFWS, pers. comm.). One Indiana bat fatality was found at Fowler Ridge Wind Farm in 2010, when the cut-in speed was raised to 5.0 m/s (16.4 ft/s), but the turbines were not feathered and were therefore still rotating normally at speeds below the raised cut-in speed (Good et al. 2011).

More generally, bat flight activity has been shown to decrease with increasing wind speed (Fiedler 2004, Jain 2005, Kerns et al. 2005, Arnett 2006, Redell et al. 2006, Arnett et al. 2008, Gruver et al. 2009, Rydell et al. 2010, Baerwald and Barclay 2011, Schuster et al. 2015). Recent studies have found bats are most active at wind speeds less than 3.0 m/s (9.8 ft/s; Bachen et al. 2017) or less than 5.0 m/s (16.4 ft/s; Peterson 2016).

Over two dozen studies have shown that operating turbines under a feathering scenario demonstrably minimizes bat fatalities (Table 5.2). Feathering means that turbine blades will be pitched into the wind such that they spin at less than one rotation per minute. When turbines are feathered up to the manufacturer turbine cut-in speeds, reductions in all-bat fatalities of 36% to 58% have been documented (Table 5.2; Baerwald et al. 2009, Young et al. 2011, Good et al. 2012). In studies that increased the cut-in speed to 5.0 m/s (16.4 ft/s), all-bat mortality was reduced on average 68%, and ranged from 47% to 84% reduction (Table 5.2). This includes a Project-specific study that demonstrated a 40% reduction in all-bat mortality, described in further detail below.

In 2013, the Applicant conducted a study to measure the effectiveness of raising the cut-in speeds of turbines on reducing bat fatality rates at the Project (Appendix A). The primary objective of the Project's curtailment study was to measure the actual, Project-specific reductions in bat fatality rates. The curtailment study occurred during the fall migratory period for Indiana bats (August 1 – October 15). Most (137 of the 152) turbines were included in the study. To be consistent with other cut-in speed studies that looked at wind speeds 1.5 m/s (4.9 ft/s) higher than the manufacturer's setting, a cut-in speed increase to 4.5 m/s (14.8 ft/s) was tested on half of the turbines. Turbines were curtailed during the study period beginning one hour after sunset and ending one hour before sunrise as 99% of bat activity recorded during the 2012 post-construction surveys occurred during these times.

Results of the 2013 curtailment study at the Project showed a significant decrease in fatality rates at turbines where the cut-in speed had been raised to 4.5 m/s (14.5 ft/s) as compared to normally-operating turbines. Bat mortality at turbines that were feathered below 4.5 m/s (14.8 ft/s; 4.17 bats/MW/study period, 3.07 – 5.27 90% confidence interval [CI]) was 40% lower than bat mortality at the normally operating turbines (7.01 bats/MW/study period, 5.53 – 8.80 90% CI). Additionally, no Covered Species or other *Myotis* were found during the study.

3.4.2 Temperature

Bat flight activity is correlated with temperature as well as season, with bats being more active at higher temperatures, and becoming inactive when the ambient temperature is low. As described below, this correlation is supported by published data on Covered Species and other closely-related species in the Project region, site-specific Project data on all bats, and the 2012 Indiana bat fatality at the Project.

Support for an effective temperature threshold is found in published data specifically on Indiana bats. *Myotis* bats will cease flight activity in cold temperatures (Roby and Gumbert 2016a, Brooks et al. 2017). Roby and Gumbert (2016a, 2016b; Roby, Copperhead Environmental Consulting, pers. comm.) found that tagged and tracked Indiana bats did not forage or migrate when the ambient air temperature was below 10 °C (50 °F) in the spring (number of tracked bats = 13) or fall (number of bats = 2). Therefore, under 10 °C (50 °F), collision risk is assumed to be negligible because bats are not flying, and take would be avoided. Roby and Gumbert (2016b) further reported that the mean migration temperature for four Indiana bats ranged from 13 °C – 22 °C (56 °F – 72 °F).

Between 2002 and 2014 in Indiana, Petit and O'Keefe (2017) found that temperature was the second most important modeled parameter associated with Indiana bat spring arrival, colony formation, colony breakup, and fall migration (date of year, likely influenced by photoperiod, was the most important parameter). Temperature was correlated with migration in both the spring and fall, when bats arrived at maternity colonies as temperatures increased and left maternity colonies when temperatures decreased. Fall migration was initiated when temperatures the week before departure averaged 22 °C (72 °F), and every 1.0 °C (1.8 °F) decrease in average temperature the prior week increased the odds of fall departure by 20% (Petit and O'Keefe 2017). While there are no publicly available studies that describe the migration behavior of northern long-eared bats relative to temperature, it is likely that migration activity by this species decreases as temperatures decrease, based on similarities in species biology described in Sections 3.2 and 3.3.

Regional and Project-specific data on the Covered Species also supports the application of a temperature threshold. The two Indiana bat carcasses found at the Fowler Ridge Wind Farm in Indiana occurred when the average temperatures on the preceding nights were above 20 °C (68 °F; Good et al. 2011). On the night before the one Indiana bat carcass was found at the Project in 2012, the average temperature was 18 °C (64 °F), and ranged from approximately 16 °C – 19 °C (61 °F – 66 °F).

More broadly as it relates to all bats, Project-specific data from the 2012 and 2013 post-construction mortality and acoustic monitoring found that bat activity and bat fatalities at the Project were more likely to occur above 10 °C (50 °F; Ritzert et al. 2013, Good et al. 2014). In 2012, 99% of the fresh[3] bat fatalities per turbines searched occurred when average nightly temperatures were above 10 °C (50 °F). In 2013, 88% of the fresh bat fatalities per turbines searched occurred when average nightly temperatures were above this same threshold (Figure 3.6). During the study period, the average nightly temperature was above 10 °C (50 °F) on 84% of nights in 2012 and 78% of nights in 2013; therefore, a disproportionately greater number of fatalities occurred when average temperatures were above, rather than below, 10 °C (50 °F). Additionally, post-construction monitoring from the Fowler Ridge Wind Farm in Indiana showed that only 0.3%, 1.0%, and 1.8% of all fresh bat fatalities occurred during nights when the average nightly temperature was below 10 °C (50 °F) in 2010, 2011, and 2012, respectively (Good et al. 2013).

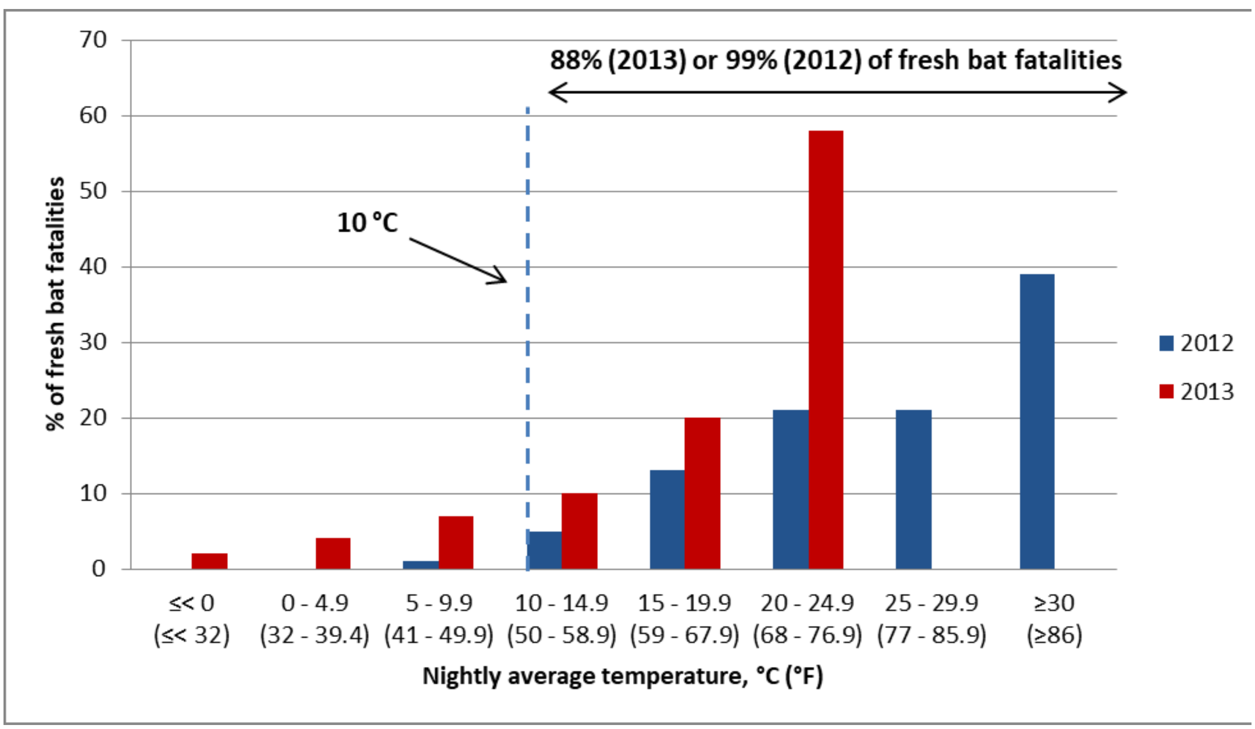

Figure 3.6 Bat fatality percentages at normally operating turbines within each temperature class at the Blue Creek Wind Farm from April 1 – November 15, 2012 and 2013.

[3] I.e., those fatalities identified as occurring the previous night, and consequently the subset of fatalities most reliably connected to weather conditions.

3.5 Project-Specific Surveys of Covered Species

3.5.1 Pre-Construction Studies

Pre-construction studies included an acoustic study of bat activity and analysis of Indiana bat habitat suitability.

Pre-Construction Acoustic Study

Between March 5 and November 15, 2009, a total of 541 bat calls, including 11 *Myotis* calls, were identified using two ultrasound detectors placed on one met tower (one detector was near ground level and the other was raised to within the approximate rotor-swept area) associated with the Project. Of the 11 *Myotis* calls, six occurred during August through October, corresponding to the approximate fall migration period. Calls were not identified to species in 2009, as the technology at the time did not allow definitive species identification. However, bat calls recorded during the 2009 study were re-analyzed in 2015, and no Covered Species calls were identified (Appendix A).

Pre-Construction Indiana Bat Habitat Assessment

A 2009 assessment of habitat suitability within the Project determined that while two woodlots provided potential foraging and roosting areas for Indiana bats, they were of limited size (approximately 10 ha [24 ac] total) and isolated in a landscape dominated by tilled agriculture. This overall lack of forest cover and highly fragmented forested areas on the landscape corresponds to limited potential use by Indiana bats (Section 3.2.2).

3.5.2 Agency Communication

The Applicant has coordinated with the USFWS Ohio Field Office and the ODNR since 2009. The USFWS Ohio Field Office initially concluded that because of the general lack of suitable Indiana bat habitat within the Project, adverse effects on Indiana bats were not anticipated. The Ohio Power Siting Board (OPSB) Opinion, Order, and Certificate conclude that the Project is not expected to impact Indiana bats (OPSB 2010). In 2011, after Project construction had commenced, the USFWS identified potential risk of take of Indiana bats during the migratory season as part of review for a proposed second phase of the Project (Knapp 2011).

3.5.3 Post-Construction Fatality Monitoring Studies

To evaluate fatalities associated with turbine collision at the Project, the Applicant conducted post-construction fatality monitoring during turbine testing in 2011 and during operations in 2012, 2013, and 2015. Each of these monitoring efforts in 2012, 2013, and 2015 were conducted in accordance with ODNR's *On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio*, Option B protocol (ODNR 2011a). The Applicant conducted post-construction fatality monitoring during operations in 2016, using methods designed to achieve a site-wide probability of detection (g) of 0.1 to detect a bat carcass per USFWS recommendations. A summary of these studies is included in Appendix A.

2011

In the fall of 2011 (October 24 – November 14), fatality monitoring during turbine testing included searches at the first 10 turbines that became operational, and then one additional turbine was searched after each five additional turbines became operational. One bat carcass, a hoary bat (*Lasiurus cinereus*), was found during the 2011 monitoring.

2012

Between April 1 – November 15, 2012, post-construction fatality monitoring included searches at all 152 turbines following ODNR's "Option B" protocol. This protocol included daily searches at 15 turbines with 90-m (295-ft) radius cleared plots, 3-day searches at 23 turbines with 60-m (197-ft) radius cleared plots, and weekly searches of turbine pads and access roads out to 100-m (328-ft) at the remaining 114 turbines. Searcher efficiency and carcass persistence trials were completed as well. One Indiana bat and no northern long-eared bats were found in a total of 850 recorded bat fatalities representing eight species. More than 99% of bat carcasses per turbine searched occurred when average nightly temperatures were above 10 °C (50 °F; Appendix A). The estimated annual bat fatality rate was 15.51 bats/MW/study period calculated using the Huso estimator (Huso et al. 2015), which was comparable to bat fatality rates reported in publicly available post-construction monitoring studies conducted at other wind energy facilities in the region (Ritzert et al. 2013). Turbines operated normally (i.e., per the manufacturer's rated cut-in speed of 3.0 m/s [9.8 ft/s] with no feathering under cut-in) until October 3, 2012, when an Indiana bat was found during post-construction monitoring. Between October 4 and November 15, 2012, the Project implemented cut-in speed curtailment to avoid impacts to Indiana bats. To account for the effect of the change in turbine operation and to avoid biasing the estimates low, the fall fatality rates were calculated by extrapolating the August 1 – October 3 rates through the end of the study period on November 15.

2013

Between April 1 – November 15, 2013, post-construction fatality monitoring included searches at all 152 turbines using the same search protocol as in 2012. No Covered Species were found in a total of 728 bats representing six species. More than 95% of bat carcasses per turbine searched occurred when average nightly temperatures were above 10 °C (50 °F). During the fall migration period (August 1 – October 15), the Applicant also conducted a curtailment effectiveness study where 68 of the Project turbines were feathered at wind speeds below 4.5 m/s (14.8 ft/s). Bat mortality at turbines that were feathered at 4.5 m/s (14.8 ft/s; 4.17 bats/MW/study period [August 2 – October 15]) was 40% lower than bat mortality at the normally operating turbines (7.01 bats/MW/study period [August 2 – October 15]). At normally operating turbines, the estimated annual bat fatality rate was 11.76 bats/MW/study period (April 1 – November 15), calculated using the Huso estimator, which again was comparable to bat fatality rates reported in publicly available post-construction monitoring studies conducted at other wind energy facilities in the region (Good et al. 2014).

2015

Between April 1 – November 15, 2015, post-construction fatality monitoring again included searches at all 152 turbines using the same protocol as in 2012 and 2013. All turbines were feathered at wind speeds below 6.9 m/s (22.6 ft/s) one half-hour before sunset to one half-hour after sunrise from March 15 – May 15 and from August 1 – October 31 to avoid impacts to Covered Species. No Covered Species were found in a total of 363 bats representing five species. The estimated bat fatality rate for the Project in 2015 when turbines were curtailed in spring and in fall was 7.83 bats/MW/study period, calculated using the Huso estimator.

2016

Between March 15 – May 15, 2016 and August 1 – October 31, 2016, post-construction monitoring occurred at 37 of the 152 turbines on 60-m (197-ft) cleared plots, weekly in spring and twice weekly during fall. All turbines were feathered at wind speeds below 6.9 m/s (22.6 ft/s) one half-hour before sunset to one half-hour after sunrise from March 15 – May 15 and from August 1 – October 31 to avoid impacts to Covered Species. No Covered Species were found in a total of 99 bats representing six species. The estimated bat fatality rate for the Project in 2016 when turbines were curtailed in spring and in fall was 1.62 bats/MW/spring and fall, calculated using the Huso estimator.

3.5.4 Post-Construction Acoustic Study and Correlation Analyses

Bat activity was acoustically monitored during fatality monitoring in 2012, 2013, and 2015. In all years, acoustic bat activity was surveyed using four ultrasound detectors at two permanent met towers from April 1 – November 15. The detectors were deployed at 45 m (148 ft) and five m (16 ft) above the ground on each met tower. The number of bat passes was 7,724, 3,146, and 3,960 in 2012, 2013, and 2015, respectively. Using automated call identification software, a total of 14,830 calls, recorded over a total of 2,648 detector nights in three years, were analyzed. The software tentatively identified 17 Indiana bat calls. However, subsequent examination by a qualified bat biologist did not confirm any calls of the Covered Species following USFWS protocols (Appendix A).

Correlation analyses between acoustic bat activity rates (passes/station/detector-night) and daily bat carcass counts from April 1 – October 5, 2012, were conducted to examine potential relationships between the timing of bat activity and fatality rates. The correlation between weather variables including wind speed, wind direction, temperature, barometric pressure, and relative humidity were also evaluated. Temperature and all bat passes per detector-night at raised detectors were statistically the best predictors of the level of bat fatality. In general, both bat activity and bat fatalities were positively correlated with temperature, and all measures of activity and fatality had a negative correlation with wind speed. Bat passes occurring at frequencies greater than 30 kilohertz (kHz) were defined as HF, and bat passes below 30 kHz were defined as low-frequency (LF). Both the activity and fatality of high-frequency bat species, a group which includes both Covered Species, increased with increasing average temperatures (Appendix A).

3.5.5 Post-Construction Mist-Netting Study

Bat mist-net surveys were completed at five sites in the Project between July 18 and 25, 2016. The study was designed to determine the presence or probable absence of Covered Species during the summer maternity season, following the *2016 Rangewide Indiana Bat Summer Survey Guidelines* (USFWS 2016a) and ODNR wind project-specific bat survey protocols (ODNR 2009). Although Indiana bats are not expected to occur during the summer due to lack of suitable maternity habitat for the species, this mist-netting was conducted to confirm probable absence. Eleven bats were captured at three of the five sites. No Covered Species were captured during the surveys, which confirmed their probable absence from the Permit Area in the summer (Iskali et al. 2017).

3.5.6 Conclusions

Based on Covered Species fatalities recorded at wind energy facilities in the Midwest to date (Pruitt and Reed 2018; Appendix B) and the results of the post-construction monitoring studies, take of Covered Species is expected to occur within the Permit Area during the spring (April 1 – May 15) and fall (August 1 – October 15) migration seasons, with the fall migration season (August 1 – October 15) being the period of highest documented risk. Covered Species are not expected to occur in the Permit Area during the summer maternity season (May 16 – July 31) based upon the lack of suitable habitat for maternity colonies, the absence of documented fatalities at the Project during this time period, and the negative results of the post-construction summer mist-netting survey completed in the Permit Area in 2016 and acoustic studies in 2009, 2012, 2013, and 2015.

3.6 White-Nose Syndrome and Other Threats to Covered Species Populations

3.6.1 White-Nose Syndrome

WNS is the most severe threat facing Covered Species populations range-wide (USFWS 2009, 2014b). WNS was first discovered during the winter of 2006/2007 in four caves in New York (USFWS 2011b, 2016g), and has since spread steadily in all directions (Heffernan 2016). As of 2012, the USFWS estimated that the disease was responsible for 5.7 to 6.7 million bat fatalities, primarily in the northeastern US (USFWS 2012b). Since then the disease has continued spread west and south, and as of 2018 the disease has been confirmed in 32 states and five Canadian provinces and the causative fungus has been identified in Mississippi and Texas (White-Nose Syndrome.org 2018). Currently, WNS is spreading into areas in the Midwest that contain a number of large and important hibernacula, and population declines similar to those originally observed in the Northeast are beginning to be observed in the Midwest (USFWS 2019).

If current trends for spread and mortality continue at affected sites, WNS threatens to drastically reduce the abundance of Covered Species throughout their ranges. Large population declines have been observed over a 5- to 6-year period from the onset of the disease (USGS National Wildlife Health Center 2016). Within a 5-state area affected by WNS for multiple years (New York, Pennsylvania, Vermont, Virginia, West Virginia), population monitoring at 42 hibernacula documented a 98% decline in northern long-eared bats and a 72% decline in Indiana bats (Turner et al. 2011). The USFWS conducted a similar analysis for an additional 12 hibernacula in

Connecticut, Massachusetts, New Hampshire, and Vermont, and estimated that the combined overall rate of decline for northern long-eared bats across the eight states was 99% (USFWS 2013b; 78 FR 61046 [October 2, 2013]).

WNS is named after the white mycelia growth of the fungus *Pseudogymnoascus destructans* (Pd), frequently found on the muzzles, ears, feet, or patagium of infected bats (Blehert et al. 2009). Blehert et al. (2009) suggested that irritation from the fungal growth causes infected bats to arouse frequently and for an extended duration to groom. There is strong support that WNS causes the premature expenditure of energy stores (Reeder et al. 2012, Warnecke et al. 2012, Verant et al. 2014) prior to spring emergence of insects (Turner and Reeder 2009).

WNS was first detected in Ohio in the winter of 2010 – 2011 (ODNR 2011b). Consistent with the idea that population impacts due to WNS may lag behind initial detection of the disease, a marked drop in Indiana bat winter population estimates was first documented in the winter of 2015 – 2016 (USFWS 2019); it is reasonable to assume that other cave hibernating bat species in Ohio first experienced impacts of WNS around 2015 – 2016. Two hibernacula in Ohio contained approximately 90% of the state's winter bat population prior to WNS detection (USFWS 2015b; 80 FR 17974 [April 2, 2015]). Declines of northern long-eared bat populations from pre-WNS numbers of 96.3% occurred in one hibernaculum and 100% in the other by 2016 (ESI 2016). The Indiana bat population at these two hibernacula declined by approximately 69% and 100% by 2016 compared to pre-WNS average population estimates (ESI 2016). The ODNR conducted statewide summer acoustic surveys along driving transects across the state from 2011 – 2014. Although they have not yet analyzed calls for individual species, initial results from the ODNR indicate a 56% decline in recorded *Myotis* bat species' calls over the 3-year period (ODNR 2014, unpublished data). Mist-net capture rates of northern long-eared bats declined from 42% in surveys conducted during the pre-WNS period in Ohio (2007 – 2011) to 0.2% in 2017 surveys (M. Seymour, USFWS, pers. comm.).

Researchers have noted a progressive lessening of mortality rates at some hibernacula, but no clear evidence of resistant hibernating populations or decreased susceptibility of survivors to infection has been found (Langwig et al. 2010). However, by comparing populations of bats in Asia, where *Pd* is endemic, to populations in North America where the fungus appears to be novel, Hoyt et al. (2016) concluded that host resistance, rather than competing mechanisms, were likely responsible for lower transmission intensity and pathogen growth in Asia. Based on proportions of individuals of WNS-affected North American species with relatively high fungal loads but lower infection intensities, Hoyt et al. (2016) predicted that Indiana bats and big brown bats were unlikely to experience WNS-related extinction. In addition, Lilley et al. (2016) found that surviving little brown bats exhibited less frequent arousals than had been documented for bats dying due to WNS, suggesting that survivors may respond to the disease differently. However, northern long-eared bat populations may not have the same ability to stabilize or recover from WNS (Frick et al. 2015). Differences in disease response, rather than or in addition to disease resistance, may explain the maintenance of some populations in infected hibernacula. It is important to note that although recent research suggests these species may ultimately persist in the long-term, local extirpations may nonetheless occur in the short-term.

Erickson et al. (2016) evaluated the potential interaction between WNS and wind turbine mortality on Indiana bat populations. The authors found that across all modeled scenarios, WNS determined the trajectory of Indiana bat populations across the species' range and any level of mortality from wind turbines was compensatory (i.e., bats taken by turbines would have otherwise died from WNS) at the range-wide scale.

3.6.2 Climate Change

Climate change may negatively impact bat populations by constraining their local and regional geographic distribution and by affecting food and water availability, success of reproduction and offspring developmental rate, timing of hibernation, and suitability of existing hibernacula and maternity colonies (Sherwin et al. 2012). While studies have not focused specifically on the effects of climate change on Covered Species, the following summary applies to insectivorous bats, a category which includes the Covered Species. Insectivorous bats are particularly susceptible to the influences of weather because aerial insect availability is dependent upon both ambient temperature and precipitation (Racey and Speakman 1987). The frequency of heavy rainfall events in the US has nearly doubled in recent years and extreme weather events are expected to increase as a result of climate change (USEPA 2014), potentially affecting bat foraging behavior (van der Wiel et al. 2017). Because bats and their insect prey tend to fly less in heavy rain (Anthony et al. 1981), rainfall increase could reduce prey intake (Racey and Speakman 1987).

Heavy precipitation or low ambient temperatures which may result from climate change may cause females to enter daily torpor as a physiological response that conserves energy or water (Rodenhouse et al. 2009). While torpor decreases energy expenditure (Kurta 1986, 1991), it simultaneously halts or delays fetal development, resulting in an aborted pregnancy, or in extended gestation and later parturition (Pearson et al. 1952, Racey 1973, Racey and Swift 1981). Bats have evolved such that the birth of pups coincides with peak insect activity (Racey 1973, Syme et al. 2001, Willis et al. 2006). In Midwestern bats, delayed fertilization synchronizes parturition with the season of peak insect activity (Neuweiler 2000); later dates of birth may decrease both mother and pup survival rates as they have less time to accumulate stored fat prior to fall migration and hibernation. Entering torpor also results in decreased milk production for nursing young, increasing their risk of dehydration (Racey 1973; Audet and Fenton 1988; Grindal et al. 1992; Wilde et al. 1995, 1999; Hoying and Kunz 1998; Pretzlaff et al. 2010). As noted above, bats are particularly vulnerable to declines in reproduction because of their inherently low reproductive rate (Barclay et al. 2004).

Temperature is also a key constraint for hibernacula suitability, and because surface temperature influences cave temperature, climate change will likely affect suitability of currently established bat hibernacula. Bats may respond by shifting both maternity and hibernation habitat. By modeling climate change effects on hibernacula, Humphries et al. (2002) predicted the range of the little brown bat, a species that is closely related to and co-occurs with both Covered Species, would expand north as temperature increases, although the ability for populations to expand may be constrained by the availability of suitable caves at higher latitudes. As the temperature of caves in more northern latitudes become more suitable, southern caves may become too warm to serve as hibernacula, ultimately constraining the availability of suitable hibernacula throughout the range of cave-roosting bats.

3.6.3 Other Threats

One recognized threat to Covered Species is human disturbance and vandalism. Indiana bats are known to hibernate in large clusters, but this leaves them more vulnerable to disturbances during this sensitive time. Hibernating bats are susceptible to arousals from disturbance, which can deplete fat reserves and possibly lead to starvation (Thomas et al. 1990). Vandalism was one of the first problems to be addressed during the initial assessment of the species' decline; however, when populations continued to decline it became apparent that loss of summer habitat was also a significant threat (USFWS 2004). The conversion of forest to agricultural, urban or developed land is causing the greatest loss of habitat for the Indiana bat (USFWS 2009). The loss and modification of the Indiana bat's winter habitat (cave and mine hibernacula) and summer habitat (forests) have been identified as long-standing and ongoing threats. A more extensive list of both historical and current threats to Indiana bats can be found in the original *Recovery Plan for the Indiana Bat* (USFWS 1983), the 2007 Draft Recovery Plan, and the *Indiana Bat (Myotis sodalis) 5-Year Review* (USFWS 2009).

The northern long-eared bat is facing similar threats as the Indiana bat, due to similarity in winter and summer habits. Disturbance during hibernation and loss of forest habitat also may pose threats to the species (USFWS 2014). Some studies have found that northern long-eared bats are associated with mature, interior forest stands for roosting and foraging during the summer maternity season (Cryan et al. 2001, Yates and Muzika 2006). The permanent or temporary removal of forested habitat may adversely affect the northern long-eared bat due to reduced roosting, foraging, and traveling habitat (USFWS 2014). However, other studies have suggested that silvicultural practices, such as prescribed burning, are beneficial for northern long-eared bat roosting habitat (Lacki et al. 2009) and that intensively managed forests are suitable, perhaps owing to the species' general flexibility in roosting requirements (Owen et al. 2002, 2003; Silvis et al. 2012).

4.0 IMPACT ASSESSMENT

To predict the potential for Covered Species to be taken as a result of the Covered Activities and the impacts of that estimated take, the Applicant followed a three-step process that considered regional and site-specific fatality data, factors known to minimize risk of Covered Species mortality, and the Covered Species' reproductive biology. The steps were as follows:

1. Calculate the Covered Species take that might occur without minimization measures and quantify the variance around the take prediction,
2. Adjust the pre-minimized take prediction based on the proposed minimization measures, and
3. Determine how the requested take might impact the affected population over time.

4.1 Indiana Bats

4.1.1 Predicted Indiana Bat Mortality without Minimization Measures (Pre-minimized Take)

The Species Composition method was used to calculate the predicted pre-minimized take. The Species Composition method involves first determining the predicted annual number of all-bat fatalities that may occur at a facility and then determining the proportion of the all-bat fatality that may consist of Indiana bats to predict the annual rate of Indiana bat take that may occur (e.g., Fowler Ridge Wind Farm LLC 2013, Pioneer Trail Wind Farm LLC 2015, USFWS 2016d).

This strategy was selected in consideration of the Project-specific datasets available to inform the take prediction. Post-construction monitoring data collected at the Project were available to provide a reliable prediction of the future all-bat mortality rate at the Project, and data were also available to inform the proportion of future Indiana bat mortality at the Project. To develop the pre-minimized Indiana bat take prediction for the Covered Activities using the Species Composition method, it was assumed that the proportion of Indiana bat mortality relative to all-bat mortality documented during intensive fatality monitoring in the Permit Area in 2012 and 2013 at turbines operating normally is representative of, and can therefore be used to predict, the proportional Indiana bat mortality that may occur as a result of the Covered Activities.

Though Indiana bat fatalities have been rare at wind energy facilities and data on collision risk factors for migrating Indiana bats (and *Myotis* species in general) are limited, the Project has undergone robust post-construction bat mortality monitoring. The Project's monitoring data represent the best available data to inform a site-specific take assessment, and therefore provide the most accurate estimate of future Project take.

Indiana bats may occur within the Permit Area during the spring and fall (Section 3.2.5). Therefore, to first determine an all-bat fatality rate for the Project, spring (April 1 – May 15) and fall (August 1 – October 15) bat mortality estimates were calculated from the Project's 2012 and 2013 monitoring results[4]. The combined annual spring and fall bat fatality rate was estimated at 12.55 bats/MW/spring and fall (90% confidence interval [CI]: 10.47 – 17.96), for a total of 3,815 bats facility-wide in spring and fall.

To then calculate the proportion of the all-bat mortality that may consist of Indiana bats, bat carcass numbers recorded during the same time period were again used. Of the 969 total bat carcasses recorded at the Project in spring and fall of 2012 and 2013, one was an Indiana bat (0.103%). Using the data that Indiana bats are expected to compose, on average, 0.103% of the total bat fatalities in the spring and fall migration seasons each year, and that an estimated 3,815 total bat fatalities are expected to occur during this period annually (based on an average rate of 12.55 bats/MW/spring and fall), produces a predicted average of 3.94 Indiana bats per year. This take prediction was based on pre-WNS data (3.6.1).

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[4] These estimates are only for normally operating turbines (turbines operating under manufacturer's rated cut-in speed with no feathering under the cut-in speed). Additionally, these estimates were calculated to be consistent with the Huso mortality estimator, area correction, and variance estimation methodologies in the 2015 report.

The predicted fatality rate for Indiana bats provided above is presented as a mean value, or the expected number of Indiana bats taken on average each year. A mean value inherently contains both statistical uncertainty (i.e., the data may not be sufficient to produce an exact prediction) and ecological uncertainty (i.e., the number of fatalities each year varies due to ecological conditions and chance). Year-to-year variation in the number of fatalities could arise from any number of sources, including but not limited to annual variation in bat densities, long-term population trends, and differences in weather. Therefore, in order to ensure the Project is in compliance with the ITP, a value higher than the mean was used to accommodate year-to-year variation in actual take. One standard measure of statistical uncertainty is variance, which can in turn be used to calculate a confidence bound. Using a confidence bound provides a buffer against inherent uncertainty in the take predictions. An upper bound of 70% was used to provide a pre-minimized Indiana bat take prediction that is reasonably certain to avoid underestimation of the take that may occur from the Covered Activities. The pre-minimized take prediction is 6.27 Indiana bats per year, or 219 Indiana bats over the 35-year permit term (Appendix C).

4.1.2 Predicted Indiana Bat Mortality with Minimization Measures (Minimized Take)

Following determination of the pre-minimized take of Indiana bats, the effects of impact minimization on predicted take of Indiana bats were determined. Based on the best available science on bat and wind turbine interactions described in Sections 3.4 and 5.2.2, minimization measures will include restricting turbine operations. Specifically, turbines will be feathered below the manufacturer's cut-in speed in the spring and below an increased cut-in speed of 5.0 m/s (16.4 ft/s) in the fall under conditions when Indiana bats are most likely to be at risk of take from the Covered Activities. Existing studies show that feathering below cut-in alone would be expected to have a meaningful reduction in all-bat fatalities and studies of cut-in speeds raised to 5.0 m/s (16.4 ft/s) show a 47% to 84% reduction (Section 5.2.2). However, to ensure that the conservation program fully offsets the impacts of the take, the Applicant has only assumed a 30% minimization from the pre-minimized Indiana bat take (Section 5.2.2). Applying a 30% reduction results in a minimized take prediction of 4.39 Indiana bat fatalities per year, on average. Over the 35-year permit term, the total amount of take is predicted to be 154 Indiana bats.

4.1.3 Proposed Indiana Bat Take Authorization Request

The Applicant requests a take limit of 154 Indiana bats over the 35-year ITP term, based on an average annual take of 4.39 Indiana bats per year.

4.1.4 Impacts of the Taking of Indiana Bats

The ESA Section 10(a)(1)(B) requires that an Applicant provide an analysis of the impacts of the take. This section describes the impact of the requested Indiana bat take prior to mitigation; however, as described in Section 5.2.3, the take will be fully offset by mitigation.

To understand the biological impact of the Project take on Indiana bat populations, it is necessary to estimate what proportion of the Indiana bats taken are likely to be reproductive females. The geographic location of the Project indicates that the sex ratio of Indiana bats migrating through the Permit Area could be female-biased based on dispersal patterns. Female Indiana bats disperse from hibernacula to join summer maternity colonies, while male Indiana bats typically remain closer to hibernacula throughout the summer (Gardner and Cook 2002, Whitaker et al. 2002). There are no known Indiana bat hibernacula in Van Wert County or in Paulding County (USFWS 2007), so Indiana bats occurring in these counties would need to disperse farther distances from hibernacula, a behavior that is more typical of female Indiana bats than males.

Based on the best available science it is expected that there will be more female adults than males migrating through the Permit Area in the spring and fall. Therefore, a 3:1 ratio of female to male Indiana bats at the Project is a reasonable assumption, which means that approximately 75% of the Indiana bats that will be taken by the Project as assumed to be reproductive females. This 3:1 ratio is consistent with recommendations from the USFWS.

The Applicant predicts that an average of 4.39 Indiana bats may be taken each year during the 35-year ITP term (Section 4.1.3). Loss of a female would have a greater impact to the overall population than loss of a male, as it results in greater lost reproductive potential. The USFWS has developed a model to calculate the reproductive loss of Indiana bats, the *Region 3 Indiana Bat Resource Equivalency Analysis Model for Wind Energy Projects, Public Version 1* (Indiana Bat REA Model; USFWS 2016e). This model may also be used to calculate the mitigation needed to offset the impact of take (see Section 5.2.3). Inputs to calculate the impact of take in the model include the average annual female take, the number of years of take, and the population trend. The REA model accepts only female-bat inputs to determine reproductive loss and mitigation requirements. Approximately 75% of the Indiana bats that may be taken by the Covered Activities are expected to be reproductive females. Therefore, predicted female take is 3.29 females/year (115 female Indiana bats over the 35-year ITP term). Using an average annual female take of 3.29 Indiana bats/year over a 35-year ITP term and a declining population trend, the total predicted lost reproductive capacity resulting from the Covered Activities is 183 female pups, resulting in a total predicted impact of take of 299 female Indiana bats (115 female Indiana bats + 183 female Indiana bat pups = 299 total female Indiana bats) over the ITP term.

The loss of bats and reproductive capacity from maternity colonies may reduce the productivity of the colony as a reproductive unit and, if losses are great enough, could potentially threaten the persistence of the colony on the landscape. There is an old record of an Indiana bat maternity colony in one of the Project counties (Section 3.2.5). Similarly, the loss of bats from hibernacula populations may diminish the abundance of the population and, if losses are great enough, could potentially affect the population trend of the hibernaculum. There are no known hibernacula in the counties where the Project is located (Section 3.2.5). Therefore, there are no particular hibernacula or colonies in the immediate vicinity of the Project that are expected to experience a large proportion of the take and be unduly impacted by the Project. Take from the Project is thus assumed to consist of individual bats migrating from various hibernacula and various maternity colonies; it is not likely to have a concentrated or frequent impact on any single maternity colony or hibernaculum. Because losses are not likely to be concentrated, impacts great enough to threaten the persistence of a colony or hibernaculum population are not likely to occur.

The USFWS established Indiana bat RUs based upon data from genetic, banding, and telemetry studies (USFWS 2007). In part, RUs describe distinct breeding populations such that impacts to Indiana bats belonging to an RU are likely to be somewhat isolated from other RU populations. It is highly likely that Indiana bats migrating through the Permit Area belong to the MRU. Thus, the impacts of the taking are evaluated as they pertain to the MRU population, as well as the range-wide population (i.e., over the total range of the species). Collectively, female take from the Covered Activities and lost reproductive capacity of females represents an annual impact of take of approximately 8.54 female Indiana bats/year over the 35-year ITP term (299 total female Indiana bats / 35 years = 8.54 female Indiana bats/year). This annual loss equates to a 0.003% reduction of the 2019 population of 245,474 Indiana bats in the MRU (USFWS 2019), the Indiana bat population most likely to be impacted. The loss to the range-wide population would be 0.002%, based on the 2019 estimated population size of 537,297 Indiana bats (USFWS 2019). The impact of Indiana bat take from the Project has been assessed against current, WNS-reduced population levels because the 2019 population estimates reflect WNS-impacted populations at both the MRU and range-wide scales.

This predicted impact of take likely represents the upper limit of what is expected to occur during the ITP term, given the effects of WNS. *Myotis* bat populations in the Midwest, including Indiana bat populations, began to decline due to WNS in 2013, and have continued to decline since wind project bat mortality data were first collected (USFWS 2019). As fewer Indiana bats occur on the landscape, the likelihood of take from turbine collision is, in turn, likely to be reduced and remain low until the population has recovered. *Myotis* populations are likely to require several generations to return to pre-WNS levels given their relatively slow rates of reproduction (Erickson et al. 2016); recovery to pre-WNS levels is likely to take longer than the requested ITP term. Therefore, past mortality data likely over-predicts take of Indiana bats at current and future population levels. However, this approach was taken to avoid potentially under-predicting and under-mitigating take of Indiana bats over the ITP term as the populations begin to recover. Furthermore, the impact of this conservative level of take has been analyzed and compared to current, WNS-reduced population levels.

Because the rate of take is likely to decline as populations decline from WNS, the impact of take is unlikely to increase over the permit term. A local population would be subject to less threat of take as the population declines. As a result, the take is assumed to reduce proportionally with any local population reduction. In addition, if the take is distributed across several maternity colony or hibernaculum populations, the impact of take to any particular population is likely to be very small.

Consequently, regardless of the effect of WNS on population levels during the ITP term, these losses from the Covered Activities (even prior to application of the Conservation Measures described in Section 5.2) are anticipated to have a minimal impact on overall population levels. In addition, the minimization and mitigation measures described in Section 5.2 are expected to fully offset the impacts of any take that may occur; therefore, the Applicant does not expect the Covered Activities to have an adverse impact on the population of the species at current or future population levels.

4.1.5 Summary

To predict the take of Indiana bats from Covered Activities, the Applicant used the best available science to account for the effect of minimization measures and to determine the impacts of the take. The pre-minimized take, accounting for a 70% confidence level based on the variance, is approximately 6.27 Indiana bats per year, or 219 Indiana bats over the permit term (Section 4.1.1). This value is reasonably certain to avoid underestimation of the take that may result from the Covered Activities. Based on the proposed minimization measures to reduce the potential level of take for Indiana bats (see detailed discussion in Section 5.2.2), Indiana bat take is expected to be minimized by approximately 30%, to yield a minimized take prediction of 4.39 Indiana bats per year or 154 Indiana bats over the ITP term (Section 4.1.2). The requested take limit of 154 Indiana bats (Section 4.1.3; Table 4.1) is anticipated to have a minimal impact on population levels (0.003% in the MRU or 0.002% range wide; Section 4.1.4), even prior to mitigation, which is designed to fully offset the impact of the taking (Section 5.2.3).

Table 4.1 Summary of Indiana bat take prediction and requested Indiana bat take for the Blue Creek Wind Farm.

Estimated Value	Indiana Bats/Year	Total Indiana Bats Over 35-Year ITP Term	Description
Pre-minimized Indiana bat take prediction	6.27	219	Calculated from species composition data and adjusted for estimated variance (70% confidence level)
Minimized Indiana bat take prediction	4.39	154	Minimization protocol estimated to provide at least 30% reduction in point estimate of take prediction (Section 5.2.2)
Requested Indiana bat permitted take	4.39	154	Proposed Indiana bat take authorization

4.2 Northern Long-Eared Bats

4.2.1 Predicted Northern Long-Eared Bat Mortality without Minimization Measures (Pre-Minimized Take)

As with Indiana bats, the Species Composition method was used to calculate the predicted northern long-eared bat pre-minimized take. Project-specific data were used to determine the predicted total all-bat mortality. However, because northern long-eared bats were not found during post-construction monitoring conducted in the Permit Area in 2012 and 2013, it was not possible to use only Project-specific data to determine what proportion of the all-bat mortality may consist of northern long-eared bats. Therefore, a Region 3 dataset provided by the USFWS (Appendix D), which included the Project-specific data, was used to determine the proportion of all-bat mortality that may consist of northern long-eared bats and predict the annual rate of northern long-eared bat take that may occur. This approach was based on the assumption that the proportion of northern long-eared bat mortality relative to all-bat mortality in the Region 3 dataset is representative of, and therefore can be used to predict the proportional northern long-eared bat mortality that may occur as a result of the Covered Activities.

Northern long-eared bats are not expected to occur within the Permit Area outside of the spring and fall (*see* Sections 3.3.5 and 3.4). Therefore, to first determine an all-bat fatality rate for the Project, spring (April 1 – May 15) and fall (August 1 – October 15) bat mortality estimates were calculated from the Project's 2012 and 2013 monitoring results.[5] The combined annual spring and fall bat fatality rate was estimated at 12.55 bats/MW/spring and fall (90% confidence interval [CI]: 10.47 – 17.96), for a total of 3,815 bats facility-wide in spring and fall.

To then calculate the proportion of the all-bat mortality that may consist of northern long-eared bats, the USFWS Region 3 dataset (Appendix D) was used. Of the 9,044 bat carcasses in the Region 3 dataset[6], eight were northern long-eared bats (0.088%). Using the data that northern long-eared bats are expected to comprise, on average, 0.088% of the total bat fatalities in the spring and fall migration seasons each year, and that an estimated 3,815 total bat fatalities are expected to occur during this period annually (based on an average rate of 12.55 bats/MW/spring and fall) produces a point estimate of 3.36 northern long-eared bats per year, on average.

As described in Section 4.1.1 for Indiana bats, the Applicant also quantified the variance around the northern long-eared bat take prediction to better understand how the take estimates from monitoring data may be expected to fluctuate during the ITP term. A 70% confidence level (4.23 northern long-eared bats per year, or 148 northern long-eared bats over the permit term) was utilized to provide a pre-minimized northern long-eared bat take prediction that is reasonably certain to avoid underestimation of the take that may occur from the Covered Activities.

4.2.2 Predicted Northern Long-Eared Bat Mortality with Minimization Measures (Minimized Take)

Following determination of the pre-minimized take of northern long-eared bats, the effects of impact minimization on predicted take of northern long-eared bats were determined. Based on the best available science on bat and wind turbine interactions described in Sections 3.4 and 5.2.2, minimization measures will include restricting turbine operations: specifically, feathering below cut in speed in the spring and increasing cut in speed of 5.0 m/s (16.4 ft/s) in the fall under conditions when northern long-eared bats are most likely to be at risk of take from the Covered Activities. Existing studies show that feathering below cut-in alone would be expected to have a meaningful reduction in all-bat fatalities and studies of cut-in speeds raised to 5.0 m/s (16.4 ft/s) show a 47% to 84% reduction (see Section 5.2.2). However, to ensure that the conservation program fully offsets the impacts of the take, the Applicant has only assumed a 30% minimization from the pre-minimized northern long-eared bat take (Section 5.2.2). Applying a 30% reduction results in a minimized take prediction of 2.96 northern long-eared bat fatalities per year, on average. Over the 35-year permit term, the total amount of take is predicted to be 103 northern long-eared bats.

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[5] These estimates are only for normally operating turbines (turbines operating under manufacturer's rated cut-in speed with no feathering under the cut-in speed). Additionally, these estimates were calculated to be consistent with the Huso mortality estimator, area correction, and variance estimation methodologies used in the 2015 report.

[6] The dataset provided by the USFWS included all bat carcasses found during scheduled searches and incidental finds, regardless of turbine operational protocol, to maximize the amount of data in the dataset.

4.2.3 Proposed Northern Long-Eared Bat Take Authorization Request

The Applicant requests a take limit of 103 northern long-eared bats over the 35-year ITP term, based on an average annual take of 2.96 northern long-eared bats per year.

4.2.4 Impacts of the Taking of Northern Long-Eared Bats

This section describes the impact of the requested northern long-eared bat take prior to mitigation; however, as described in Section 5.2.3, the take will be fully offset by mitigation.

Information on the sex of carcasses of northern long-eared bats has not typically been reported during post-construction mortality monitoring at wind projects. Therefore, data on patterns related to sex of northern long-eared bat carcasses are not available. Unlike Indiana bat hibernacula, the locations of most northern long-eared bat hibernacula remain undocumented, in part due to the species' use of smaller hibernacula that are more dispersed on the landscape (Barbour and Davis 1969), and because northern long-eared bats hibernate in small spaces within caves where detection is difficult (Schmidt 2001, Whitaker et al. 2002). While the Project is not located near any known northern long-eared bat hibernacula, their use of smaller hibernacula that are more distributed on the landscape (Barbour and Davis 1969) indicates that male and female northern long-eared bats may be equally likely to transit the Permit Area. Therefore, the Applicant assumes that risk to male and female northern long-eared bats will be similar, as there are no known concentrations of either sex, such that 50% of the take at the Project may be attributed to reproductive females.

The Applicant predicts that an average of 2.96 northern long-eared bats may be taken each year during the 35-year ITP term. Approximately 50% of the northern long-eared bats that may be taken by the Covered Activities are expected to be reproductive females. Therefore, estimated take is 1.48 female northern long-eared bats/year (52 female northern long-eared bats over the 35-year ITP term). As was done for Indiana bats, the USFWS developed a model to calculate the reproductive loss and total impact of take on northern long-eared bats, the USFWS' *Region 3 Northern Long-Eared Bat Resource Equivalency Analysis Model for Wind Energy Projects, Public Version 1* (Northern Long-Eared Bat REA Model; USFWS 2016f). This model may also be used to calculate the impact of take that a mitigation project will offset (see Section 5.2.3). Inputs to calculate the impact of take in the model include the average annual female take, the number of years of take, and the species' population trend. Using an average annual female take of 1.48 northern long-eared bats/year over a 35-year ITP term and a declining population trend, the total predicted lost reproductive capacity resulting from the Covered Activities is 82 female pups, resulting in a total predicted impact of take of 134 female northern long-eared bats (52 female northern long-eared bats + 82 female northern long-eared bat pups = 134 total female northern long-eared bats) over the ITP term.

Collectively, female take from the Covered Activities and lost reproductive capacity of females represents an annual impact of take of approximately 3.83 female northern long-eared bats/year over the 35-year ITP term (134 total female northern long-eared bats / 35 years = 3.83 female northern long-eared bats/year). Based upon a pre-WNS population size of northern long-eared bats of four million for the 6-state region of the Midwest (i.e., Illinois, Indiana, Iowa, Ohio, Michigan, and Missouri) as described in Section 3.3.5, the annual loss of northern long-eared bats estimated to be caused by the Covered Activities equates to an approximate 0.0001% reduction in the species' population. The substantial reductions in the Indiana bat MRU population due to WNS indicate that the northern long-eared bat population in the Midwest is also likely to have declined substantially due to WNS, although a reliable estimate of this reduction is not available. Assuming this population could be reduced by as much as 98% as a result of WNS (the population loss reported in the northeast by Turner et al. 2011), the loss of 3.83 northern long-eared bats per year represents 0.005% of the WNS-reduced population of 80,000 northern long-eared bats in the Midwest.

The loss of bats and reproductive capacity from maternity colonies may reduce the productivity of the colony as a reproductive unit and, if losses are great enough, could potentially threaten the persistence of the colony on the landscape. The nearest record of a northern long-eared bat colony is approximately 5.6 km (3.5 mi) south of the Project boundary, but summer mist net surveys did not document colonies with the permit area (Section 3.3.5). Similarly, the loss of bats from hibernacula populations may diminish the abundance of the population and, if losses are great enough, could potentially affect the population trend of the hibernaculum. There are no known hibernacula in the counties where the Project is located (Section 3.2.5). Therefore, there are no particular hibernacula or summer colonies in the immediate vicinity of the project that are expected to experience a large proportion of the take and be unduly impacted by the Project. Take from the Project is thus assumed to consist of individual bats migrating from various hibernacula and various maternity colonies; it is not likely to have a concentrated or frequent impact on any single maternity colony or hibernaculum. Because losses are not likely to be concentrated, impacts great enough to threaten the persistence of a colony or hibernaculum population are not likely to occur.

This predicted impact of take likely represents the upper limit of what is expected to occur during the ITP term due to the effect of WNS. As described for Indiana bats, *Myotis* bat populations in the Midwest, including northern long-eared bat populations, began to decline due to WNS concurrent with the collection of the data that inform the take prediction, and have continued to decline since these data were first collected. With fewer bats on the landscape, the likelihood of take of northern long-eared bats is likely lower than predicted and is expected to remain low until the population has recovered. Northern long-eared bat populations, like those of other *Myotis* bats, are likely to require several generations to return to pre-WNS levels given their relatively slow rates of reproduction; recovery to pre-WNS levels is likely to take longer than the requested ITP term. Therefore, past mortality data likely over-predicts take of northern long-eared bats at current population levels, but this approach was taken to avoid potentially under-predicting and under-mitigating take of northern long-eared bats over the ITP term as the populations begin to recover. Furthermore, the impact of this level of take has been analyzed against current, WNS-reduced population levels.

Because the rate of take is likely to decline as populations decline from WNS, the impact of take is unlikely to increase over the permit term. A local population would be subject to less threat of take as the population declines. As a result, the take is assumed to reduce proportionally with any local population reduction. In addition, if the take is distributed across several maternity colony or hibernaculum populations, the impact of take to any particular population is likely to be very small.

Consequently, regardless of the effect of WNS on population levels during the permit term, these losses from the Covered Activities (even prior to application of the conservation measures described in Section 5.2) are anticipated to have a minimal impact on overall population levels. In addition, the minimization and mitigation actions described in Section 5.2 are expected to fully offset the impacts of any take that may occur; therefore, the Applicant does not expect the Covered Activities to have an adverse impact on the population of the species at current or future population levels.

4.2.5 Summary

As described for Indiana bats, the Applicant used the best available science to account for the effect of minimization measures and to determine the impacts of the take to predict the take of northern long-eared bats from Covered Activities. The pre-minimized take, accounting for a 70% confidence level based on the variance, is approximately 4.23 northern long-eared bats per year or 148 northern long-eared bats over the permit term (Section 4.2.1). This value is reasonably certain to avoid underestimation of the take that may result from the Covered Activities. Based on the proposed minimization measures to reduce the potential level of take for northern long-eared bats (Section 5.2.2), northern long-eared bat take is expected to be minimized by approximately 30%, to a minimized take prediction of 2.96 northern long-eared bats per year or 103 northern long-eared bats over the ITP term. The requested take limit of 103 northern long-eared bats (Section 4.2.3; Table 4.2) is anticipated to have a minimal impact on the overall population (0.005% in the Midwest; Section 4.2.4), even prior to mitigation, which is designed to fully offset the impact of the taking (Section 5.2.3).

Table 4.2 Summary of northern long-eared bat take prediction and requested northern long-eared bat take for the Blue Creek Wind Farm.

Estimated Value	Northern Long-Eared Bats/Year	Total Northern Long-Eared Bats Over 35-Year ITP Term	Description
Pre-minimized northern long-eared bat take prediction	4.23	148	Calculated from species composition data and adjusted for estimated variance (70% confidence level)
Minimized northern long-eared bat take prediction	2.96	103	Minimization protocol estimated to provide at least 30% reduction in point estimate of take prediction (Section 5.2.2)
Requested northern long-eared bat permitted take	2.96	103	Proposed northern long-eared bat take authorization

5.0 CONSERVATION PLAN

In accordance with ESA Section 10(a)(1)(B)(2)(A), this chapter provides the approach the Applicant will use to minimize and mitigate the impacts of the taking to the maximum extent practicable. This chapter also describes avoidance measures the Applicant has voluntarily included in the HCP, although avoidance measures are not required by ESA Section 10. Monitoring will be implemented as part of this HCP to provide information necessary to assess ITP compliance, to evaluate take from Covered Activities, and to determine the effectiveness of conservation measures. Adaptive management will be implemented as needed to respond to monitoring results.

5.1 Biological Goals and Objectives

An HCP's biological goals "broadly describe the desired future conditions of an HCP in succinct statements" and each biological goal "steps down to one or more objectives that define how to achieve these conditions in measureable terms" (USFWS and NMFS 2016). The biological goals and objectives "lay the foundation from which all conservation activities arise" (USFWS and NMFS 2016). While conservation or recovery of a listed species is not required under ESA Section 10, the biological goals and objectives of this HCP are consistent with actions to promote the recovery of the Indiana bat, as identified in the 2007 Draft Recovery Plan. The biological goals and objectives of this HCP also focus on conservation of the northern long-eared bat, although a recovery plan has not yet been developed for this species.

Biological Goal 1: Maintain the integrity of the Covered Species populations that migrate through the Plan Area by minimizing incidental take of Covered Species within the Permit Area.

Biological Objective to achieve Goal 1: Implement an Operational Minimization Plan that is anticipated to minimize mortality of Covered Species by 30% for the Permit Term (Section 5.2.2) to reduce the impact on the Covered Species.

Biological Goal 2: Support Covered Species populations within Ohio by protecting or restoring habitat that supports one or more life stages of documented populations.

Biological Objective to achieve Goal 2: Implement mitigation within the Plan Area during the ITP term to protect Covered Species and/or their habitats from disturbance or other threats during important life history stages, such as fall swarming, winter hibernation, or summer reproduction (Section 5.2.3). Mitigation will be quantified and designed pursuant to the REA and swarming models (USFWS 2016c, e, and f).

Biological Goal 3: Optimize electrical output of the Project to realize the environmental benefit of wind energy. Specifically, increased generation from wind energy facilities has the potential to offset demand for other energy generation technologies that produce carbon emissions that have been shown to contribute to global climate change (USDOE 2008), identified as a threat to Indiana bats (USFWS 2007) and northern long-eared bats (Section 3.6.2).

> ***Biological Objective to achieve Goal 3***: Implement a turbine operation strategy at the Project in each permit year that maximizes output of non-carbon-emitting, renewable energy (Section 1.1) and also meets Biological Goal 1, minimization of the impacts of incidental take of the Covered Species.

Measures that will be used to meet these goals and objectives are described in the following sections.

5.2 Measures to Avoid, Minimize, and Mitigate the Impacts of the Taking

To obtain an ITP, ESA Section 10(a)(1)(B) requires that the Applicant, "to the maximum extent practicable, minimize and mitigate the impacts of the taking." The USFWS will evaluate the minimization and mitigation components of the HCP together to determine whether the applicant has met this statutory requirement (USFWS and NMFS 2016). Minimization measures the Applicant will implement are described in Table 5.1 and Section 5.2.2. The best available science and Project-specific data were used to inform these measures. Mitigation measures are described in Section 5.2.3.

5.2.1 Voluntary Avoidance through Project Design and Planning

From the Project's inception, the Applicant has coordinated with federal and state agencies to evaluate the Project's risk to bat species, including Covered Species. To assess potential impacts of the Project during the development process, the Applicant followed industry Best Management Practices (BMPs), including pre-construction surveys as required by the ODNR *On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio* (ODNR 2009, 2011a) and following the tiered approach identified in the *Land Based Wind Energy Guidelines* (USFWS 2012a).

The Applicant sited the Project in a previously disturbed, predominately agricultural landscape, which avoided impacts to native forest habitats, based on the understanding of bat interactions with wind energy facilities, and USFWS and ODNR consultation at the time of development. The Applicant used pre-construction studies to evaluate the risk of adverse impacts prior to Project construction.

The USFWS's pre-construction review of the Project concluded that there was a lack of suitable habitat for Indiana bats within the Permit area and that adverse effects to, or take of Indiana bats, were not anticipated. The Applicant sited the Project to exclude a 500-m (1,640-ft) buffer from Flat Rock Creek, identified by the USFWS to have the highest quality, potential Indiana bat habitat in the vicinity of the Project. The Applicant also implemented the USFWS's suggested tree cutting date restrictions (no tree cutting between April 1 – September 30) to further minimize the likelihood of impacts to Indiana bats.

The OPSB Opinion, Order, and Certificate issued on August 23, 2010, determined that there was no expected impact to Indiana bats from the Project and noted that the USFWS had concluded the Applicant's efforts to locate the Project footprint so as to avoid environmentally-sensitive areas (such as wooded areas, streams, and wetlands) should minimize impacts to all bat species (OPSB 2010). The Applicant has, and continues to implement, the following BMPs:

- During the spring (April 1 – May 15) and fall (August 1 – October 15) migration periods, regular maintenance activities on turbines will be conducted primarily during daylight hours, when Covered Species are not active.
- Tree removal is considered unlikely due to the scarcity of trees near Project facilities, and the likelihood of Covered Species roosting in any given tree in the Project during migration very low; therefore, take of Covered Species is considered unlikely and tree clearing is not a Covered Activity in this HCP. If tree removal is necessary the Applicant will either 1) clear trees between October 1-March 31, when Covered Species are not likely to be active in the Project area; or 2) if tree removal in the summer is necessary due to emergency or hazardous conditions, the Applicant will follow the currently-defined USFWS-approved emergence survey protocol if the trees to be cut have peeling bark, cracks, crevices, or cavities. If any bats are observed emerging from the tree, the Applicant will coordinate with the Service.
- To limit potential impacts to prey resource abundance and distribution within the Project boundary, the use of herbicides will be limited, and local policies for noxious weed control will be followed.
- Exhibits will be provided to Project employees and on-site contractors that identify Covered Species' resources and associated conservation measures for avoiding and reducing risk of impacts to Covered Species.
- Federal and state measures for handling hazardous substances will be followed to minimize contamination of water and other resources potentially used by Covered Species.
- To limit the risk of wildfire that might lead to the loss of bat habitat resources, fire hazards from vehicles and human activities will be managed by providing instructions for site personnel to use spark arrestors on power equipment, ensuring that no metal parts are dragging from vehicles, and the use of caution with respect to open flame (e.g., cigarettes).

5.2.2 Measures to Minimize the Impact of the Taking

The Applicant will minimize potential impacts of the proposed taking primarily by implementing seasonal turbine operational adjustments following an Operational Minimization Plan (Table 5.1). The minimization plan focuses on the season, wind speed, time of day, and temperatures which are the highest periods of risk to Covered Species (Biological Goal 1) while optimizing renewable energy production (Biological Goal 3; see Section 5.1) when risk to Covered Species is lowest. Given the temperature-bat mortality relationship documented by existing studies, the proposed temperature threshold and cut-in speed combination is expected to focus on the conditions of greatest risk when bats are most active.

Table 5.1 Operational Minimization Plan for the Blue Creek Wind Farm.

Season	Time of Day	Turbine Operations	Temperature
Spring (April 1 – May 15)	one half-hour prior to sunset[1] to one half-hour after sunrise	All turbines feathered until wind speed of 3.0 m/s (9.8 ft/s)	Implemented at all temperatures
Summer[2] (May 16 – July 31)	one half-hour prior to sunset to one half-hour after sunrise	All turbines feathered until wind speed of 3.0 m/s (9.8 ft/s)	Implemented at all temperatures
Fall (August 1 – October 15)	one half-hour prior to sunset to one half-hour after sunrise	All turbines feathered until wind speed of 5.0 m/s (16.4 ft/s)	When temperature is greater than 10 °C (50 °F)
Winter (October 16 – March 31)	Normal turbine operation		

[1] Civil sunset and sunrise.

[2] Although no take of Covered Species is expected during summer, the Applicant will implement this measure to minimize impacts to all bats in general.

<u>Wind Speed Threshold</u>

Because *Myotis* activity decreases as wind speed increases (Section 3.4), raising turbine cut-in speed and feathering the turbines until cut-in speed is reached is expected to minimize mortality of the Covered Species. This has been demonstrated by reductions in all-bat mortality both at the Project and in other studies of bat mortality (Table 5.2). No Indiana bat fatalities or northern long-eared bat fatalities have been found at any of the publicly available studies with turbines feathered up to the raised cut-in speeds (see sources identified in Table 5.2), further supporting the effectiveness of raised cut-in speeds in minimizing impacts to Covered Species. The weight of evidence from curtailment studies conducted to date, including the curtailment study conducted at the Project, indicates that this combination of raising the turbine cut-in speed and feathering until the cut-in speed will be an effective minimization measure for the Covered Species. While a cut-in speed of 4.5 m/s has been shown to substantially reduce the number of fatalities at the Project (Section 3.4), the Applicant will implement a higher cut-in speed in the fall to further minimize impacts to the Covered Species. The Applicant has chosen to feather Project turbines to 5.0 m/s (16.4 ft/s) when bats are most at risk (see Table 5.1), and feather up to manufacturer's cut-in speed (3.0 m/s [9.8 ft/s]) during periods of lesser risk.

Turbine feathering will begin when the average wind speed is less than or equal to the specified cut-in speed. Turbine feathering will cease and normal operation will resume when the average wind speed is equal to or greater than the specified cut-in speed. The time period for which these averages are calculated can be set to values between 5 and 20 minutes, depending on level of refinement chosen by the Applicant. The Applicant will demonstrate the minimization program was implemented as part of monitoring report (see Section 6.1.6).

Table 5.2 Results from publicly available curtailment effectiveness studies.

Study Name	Normal Cut-In Speed (m/s)	Treatment Cut-In Speed (m/s)	Percent Reduction in All-Bat Mortality	Mean Percent Reduction in All-Bat Mortality	Source
Fowler Ridge, IN 2011[1]	3.5	3.5	36	36	Good et al. 2012
Summerview, Alberta [1]	4.0	4.0	58	46	Baerwald et al. 2009
Mount Storm, WV 2010[1]	4.0	4.0	35		Young et al. 2011
Mount Storm, WV 2011[1]	4.0	4.0	not reported[2]		Young et al. 2012
Blue Creek 2013[8]	3.0	4.5	40	48	Good et al. 2016b; Appendix A
Fowler Ridge, IN 2011	3.5	4.5	57		Good et al. 2012
Anonymous Project (AN01), USFWS Region 3	3.5	4.5	47		Arnett et al. 2013
Wolfe Island, Lake Ontario	4.0	4.5	48		Stantec Consulting Ltd. 2011
Casselman, PA 2008	3.5	5.0	82	68	Arnett et al. 2010
Casselman, PA 2009	3.5	5.0	72		Arnett et al. 2010
Fowler Ridge, IN 2010[7]	3.5	5.0	50		Good et al. 2011
Fowler Ridge, IN 2012[5,6]	3.5	5.0	84		Good et al. 2015
Fowler Ridge, IN 2013[5,6]	3.5	5.0	82		Good et al. 2015
Fowler Ridge, IN 2014[6]	3.5	5.0	78		Good et al. 2015
Fowler Ridge, IN 2015[6]	3.5	5.0	72		Good et al. 2016a
Criterion, MD 2012	4.0	5.0	62		Young et al. 2013
Pinnacle, WV 2012[3]	3.0	5.0	47		Hein et al. 2013
Pinnacle, WV 2013	3.0	5.0	54		Hein et al. 2014
Summerview, Alberta	3.5	5.5	60	66	Baerwald et al. 2009
Fowler Ridge, IN 2011	3.5	5.5	73		Good et al. 2012
Anonymous Project (AN01), USFWS Region 3	3.5	5.5	72		Arnett et al. 2013
Wolfe Island, Lake Ontario	4.0	5.5	60		Stantec Consulting Ltd. 2011
Sheffield, VT[4]	4.0	6.0	60	60	Arnett et al. 2013

Table 5.2 Results from publicly available curtailment effectiveness studies.

Study Name	Normal Cut-In Speed (m/s)	Treatment Cut-In Speed (m/s)	Percent Reduction in All-Bat Mortality	Mean Percent Reduction in All-Bat Mortality	Source
Casselman, PA 2008	3.5	6.5	82	77	Arnett et al. 2010
Casselman, PA 2009	3.5	6.5	72		Arnett et al. 2010
Fowler Ridge, IN 2010[2]	3.5	6.5	78		Good et al. 2011
Pinnacle, WV 2013	3.0	6.5	76		Hein et al. 2014

Note: Unless otherwise stated, all studies curtailed from at least one half hour before sunset to at least one half hour after sunrise.

[1] Turbines were feathered under normal cut-in wind speed.

[2] Results were considered inconclusive; the number of casualties in the treatment and control groups were not significantly different, but this may be attributable to differences in the total number of casualties found in the treatment year.

[3] Study did not include turbine feathering. Had turbines been feathered below cut-in, the percent reduction would likely have been greater.

[4] This effect was only found when an outlier was removed from the dataset.

[5] Raised cut-in speeds were applied only when temperatures were above 9.5 ºC (49.1 ºF).

[6] Approximated from the text and Figures 7 and 8 of Good et al. 2016a.

[7] Percent reduction is based on comparison to a previous year's results from mortality monitoring, since there were no control turbines during the year the study was implemented; this is the standard against which the Fowler Ridge HCP's minimization effectiveness is measured.

[8] Turbines were curtailed from one half hour after sunset to one half hour before sunrise.

Seasons of Implementation

The risk of take for Covered Species varies seasonally due to their life history cycles. Accordingly, implementation of operational curtailment will vary by season. Covered Species may be at risk of take within the Permit Area during the spring (April 1 – May 15) and fall (August 1 – October 15) migration seasons as they move across the landscape between hibernacula and summer habitat. Risk of take is expected to be higher in fall than in spring as the highest *Myotis* mortality and all-bat mortality at wind energy facilities in the Midwest has consistently been documented during the fall migration period (Kunz et al. 2007, Arnett et al. 2008, Arnett and Baerwald 2013, USFWS 2016d). Additionally, seven of the eleven Indiana bat fatalities recorded at wind energy facilities in the Midwest have occurred in the fall (of the remaining four, two occurred in spring and two occurred in summer; see Appendix B). Six of the eight northern long-eared bat fatalities recorded at wind energy facilities in the Midwest have also occurred in the fall. Of the remaining two northern long-eared bat fatalities, one occurred in spring and one occurred in summer (Appendix B).

Risk of take of the Covered Species is expected to be very low during the late fall/winter hibernation season (October 16 – March 31), due to the Project's distance from hibernacula used by Covered Species during this season and the species' inactivity during winter (see Sections 3.2.2 and 3.3.2). Additionally, none of the publicly available Indiana bat or northern long-eared bat fatalities recorded to date at wind energy facilities have occurred during the late fall/winter hibernation season (see Appendix B).

Take is also not expected for either Covered Species during the summer maternity season (May 16 – July 31), based on the limited amount (0.7%) of forested habitat (see Section 3.1), the lack of Indiana bat and northern long-eared bat captures during the presence/absence mist-netting studies conducted during summer 2016 (see Section 3.5.5), and the lack of Indiana bat or northern long-eared bat calls during acoustic surveys within the Permit Area (see Sections 3.5.1 and 3.5.3).

Based on Project-specific presence/absence data, habitat suitability surveys, and mortality data, as well as other sources of regional mortality data, the fall migration period (August 1 – October 15) represents the documented season of highest risk to bats, including the Covered Species. This timeframe is also supported by a number of guidance documents defining seasonal activity periods of the Covered Species, including the 2007 Draft Recovery Plan and the USFWS *Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects* (USFWS 2011a).

In light of these findings and agency guidance demonstrating that the greatest risk to Covered Species is in the fall, the minimization measures will focus on this season and will result in all Project turbines being feathered to a raised cut-in speed of 5.0 m/s (16.4 ft/s) in fall (Table 5.1). To provide additional minimization measures during seasons of lower documented risk, the

Project will be operated to reduce risk accordingly during the spring and summer by being feathered up to a cut-in speed of 3.0 m/s (9.8 ft/s), in spring and summer.[7]

Temperature Threshold

Collectively, the data supports the conclusion that the majority of Covered Species flight (and therefore, risk) occurs above 10 °C (50 °F; Section 3.4). Therefore, the HCP fall impact minimization measures will be triggered above this temperature threshold.

Time of Night

Both Covered Species are nocturnal, meaning they are active at night. Risk of take for bats varies temporally within a night due to patterns in foraging behavior; most bat activity occurs within two hours of sunset (Kunz 1973, Barclay 1982) and coincides with peak insect activity. Lee and McCracken (2004) found that captures of Indiana bats peaked in the 2-hour interval before midnight, and overall, bat activity is highest towards the beginning of the night. Post-construction acoustic monitoring at the Project in 2012 and 2013 showed that the rate of bat activity during the fall migration period was consistently highest during the initial hours after sunset and declined with time over the night (Good et al. 2014). Bat activity rates tapered off throughout the remainder of the night.

To cover the full temporal range of nightly activities, the curtailment scenario will be implemented throughout the bat active season from a half hour before sunset to a half hour after sunrise (Table 5.1).

Summary of Minimization Measures

As described above, risk has been shown to vary by wind speed, season, temperature, and time of day. The best available science, including robust Project-specific data and the relevant broader published biological data, has been analyzed to identify the conditions of greatest risk to Covered Species and effective measures to minimize these risks. The Applicant used this information to design a minimization plan which involves feathering turbines up to the manufacturer's cut-in speed (3.0 m/s [9.8 ft/s]) from one half-hour prior to sunset to one half-hour after sunrise in spring (April 1 – May 15) and summer (May 16 – July 31) and feathering turbines up to 5.0 m/s (16.4 ft/s) from one half-hour prior to sunset to one half-hour after sunrise when temperatures are greater than 10 °C (50 °F) in fall (August 1 – October 15). This approach targets the identified periods and conditions when risks to Covered Species are highest (Biological Goal 1), and also allows for optimum output of the Project to realize the environmental benefit of wind energy (Biological Goal 3; see Section 5.1).

Anticipated Take Reduction from Minimization Measures

Collectively, the data above on wind speed, seasons, and temperature demonstrate that minimization measures are focused on conditions when the Covered Species are most at risk for

[7] Although no take of Covered Species is expected during summer, the Applicant will implement this measure to reduce impacts to all bats in general.

take. For purposes of calculating predicted take of Covered Species (Sections 4.1.2 and 4.2.2), a quantitative assumption on effectiveness of these minimizations was made. The results of multiple cut-in speed evaluations that measured the percent reduction in all-bat fatalities at different wind speeds (see Table 5.2). These studies show that feathering below manufacturer's cut-in speed reduced bat mortality by 30% to 35%, and feathering below cut-in speeds raised to 5.0 m/s (16.4 ft/s) reduced bat mortality by an average of 68%, with specific reductions shown between 47% to 84%.

While the minimizations measures described here can be expected to reduce actual take of Covered Species by at least 50%, in order to avoid underestimating the level of take, the Applicant has conservatively assumed that the effectiveness would be less at the Project. Accordingly, the Applicant used the anticipated benefits from feathering below cut-in speed alone and assumed a 30% reduction in bat fatalities. This 30% reduction is likely to be well below the actual bat fatality reduction achieved when cut-in speeds are raised to 5.0 m/s (16.4 ft/s).

These minimization measures, combined with the mitigation described in Section 5.2.3, ensure that the conservation program fully offsets the impacts of the take.

5.2.3 Measures to Mitigate the Impact of the Taking

The Applicant will secure and provide funding for mitigation designed to increase the populations of Indiana bats and northern long-eared bats by at least 299 and 134 females, respectively, using the Indiana Bat REA Model (USFWS 2016e) and Northern Long-Eared Bat REA Model (USFWS 2016f) (see Sections 4.1.4 and 4.2.4, respectively).

This section sets forth the mitigation component of the conservation program. Consistent with the Habitat Conservation Planning and Incidental Take Permit Processing Handbook (HCP Handbook; USFWS and NMFS 2016), the Applicant has designed the minimization and mitigation program that fully offsets the impacts of the taking.

<u>Relation of Mitigation to Impacts of Potential Take</u>

The Indiana Bat REA Model (USFWS 2016e), the Northern Long-Eared Bat REA Model (USFWS 2016f), and the *USFWS Guidelines for Non-REA Staging/Swarming Mitigation Option* (USFWS 2016c)[8] (collectively, the "Models") will be used to evaluate the amount of take a mitigation project will offset for Covered Species, unless a conservation bank or other mitigation method becomes available as a viable mitigation option for the Covered Species (see Section 9.1.4). Based on guidance from the USFWS, mitigation projects that provide conservation value for both of the Covered Species will be adjusted by a 10% stacking ratio when more than one species is present.

<u>Mitigation Phasing</u>

Mitigation will be implemented in up to two phases to enable the amount of mitigation to be adjusted, if appropriate, based on the results of the Intensive Monitoring (see Section 6.1.2). This

[8] The Applicant may, at its discretion, opt to use a more current version of any of the Models, should one be published or provided by the Service.

approach ensures both that mitigation occurs prior to take of Covered Species beyond year two, and that the amount of mitigation implemented aligns with the impact of take estimated to be occurring at the Project. Implementation of the mitigation will stay ahead of the take with the exception of up to the first two years after ITP issuance (see Mitigation Timeline and Responsible Parties). Some types of mitigation take longer for benefits to the species to accrue, for example mitigation benefit from a restoration site takes longer to accrue than mitigation for a preservation site because in a restoration site, the restored habitat takes a few years to become suitable for covered species. The REA model incorporates these timing considerations when calculating mitigation benefits.

The first mitigation phase (Phase I) will offset the impact of at least the first 20 years of the predicted impacts of take. At the Applicant's discretion, the Applicant may also choose to implement a mitigation project that offsets more than the first 20 years of impact of take. If Phase I addressed all of the anticipated take for the entire permit term, then there is no need for Phase II so long as the permittee does not exceed the level of take authorized. By providing, at a minimum, mitigation for the first 20-years of ITP term as soon as possible (see *Mitigation Timeline and Responsible Parties,* below*)*, Phase I will provide a large upfront conservation benefit to Covered Species. Using an average annual female take of 3.29 Indiana bats/year (as set forth in Section 4.1.4) and applying the Indiana Bat REA Model, the impact resulting from the first 20 years of predicted take is 171 female Indiana bats. Using an average annual female take of 1.48 northern long-eared bats/year (as set forth in Section 4.2.4) and applying the Northern Long-Eared Bat REA Model, the impact resulting from the first 20 years of predicted take is 77 female northern long-eared bats. A REA-based mitigation project that offsets this impact of take for both of the Covered Species will be adjusted by a 10% stacking ratio, following the USFWS recommendation.

The second mitigation phase (Phase II), if needed, will begin in Year 19 of the ITP term to keep mitigation ahead of the take and will offset the impact of take for the remainder of the 35-year ITP term. The amount of mitigation required for Phase II will be the amount required to offset the impact of the last 15 years of predicted take; this amount will be determined using the REA model(s). If the Intensive Monitoring data (see Section 6.1.2) indicate that the average annual take of either or both Covered Species is below the predicted annual take, any extra mitigation credit due to estimated take will be carried forward and applied to Phase II. The amount of mitigation required for Phase II will then be adjusted for either or both Covered Species to the amount required to offset the impact of the average annual predicted take over a 15-year period. If the Phase II mitigation project is only required for one of the Covered Species, no stacking adjustment will be made.

If the monitoring data indicate that the take limit of either or both Covered Species may be exceeded, an adaptive management response (see Section 6.3) will be implemented to keep the take of both Covered Species within the ITP take limit. In such a scenario, the total mitigation amount for Covered Species will remain the amount necessary to offset the impact of the ITP take limit (i.e., the full amount required to offset the impact of the last 15 years of predicted take).

Identification of Mitigation Projects

The REA provides for outputs for different types of mitigation projects including a preservation project and a restoration project at documented maternity colonies, while the Non-REA Staging/Swarming Mitigation Guidelines provides options for mitigation near hibernacula. The Applicant has not yet finalized the exact mitigation projects it will implement as a part of the conservation program, but the following provides an example of the three types of mitigation that the Applicant anticipates implementing, using hypothetical REA and Staging/Swarming model calculations. Following the three examples, this subsection includes implementation details that mitigation projects must include to be eligible as a mitigation project under this HCP.

Summer habitat preservation project: This scenario would involve finding existing suitable forested habitat for the Covered Species, preserving the habitat in perpetuity, and managing that habitat according to a management plan. Consistent with discussions with USFWS, the following REA inputs were used for a summer habitat preservation project: 1) populations of the Covered Species were declining, 2) the forest served as both roosting and foraging habitat, and 3) that the habitat under consideration was not currently managed for bats. Eligible projects would be located in Ohio and would be located within a documented maternity colony homerange[9] with one or both species present within 10 years of the time of encumbrance. Using the estimated take numbers for the first 20 years of the permit term, the following two examples contemplate preservation mitigation projects (1) for each species alone and (2) where both Covered Species are present:

- If mitigation parcels only have one Covered Species present, mitigation for the impacts of taking 171 female Indiana bats alone would be 210 acres and mitigation for the impacts of taking 77 northern long-eared bats alone would be 93 acres.
- If a mitigation parcel has both Covered Species present, 117 acres mitigation are required for Indiana bats alone and would not be subject to stacking (210 Indiana bat acres – 93 northern long-eared bat acres =117 Indiana bat-only acres). The remaining 93 acres would be used to mitigate for both species and have a 10% stacking ratio added (93 acres + (93 acres * 0.1)) = 102 acres. Therefore, in this example where both Indiana bats and northern long-eared bats are found on the same mitigation parcels, the total mitigation required in order to offset the 171 female Indiana bats and 77 female northern long-eared bats anticipated during the first 20 years of the permit term is 219 acres (117 acres + 102 acres).

The mitigation acreage total for the second phase would be calculated in a similar method to offset anticipated take during the final 15 years of the permit term.

[9] Indiana bat homerange is defined in the *Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects* (USFWS 2011), generally 5.0 miles from a summer capture of a reproductively active female or juvenile bat, or 2.5 miles from the centerpoint of documented maternity roost tree(s), unless radiotelemetry data shows that foraging distances are further than 2.5 miles, in which case the further distance would be applied. Northern long-eared bats are treated similarly, but the distances, based on species-specific data are 1.5 miles from roost tree(s) and 3.0 miles from capture points.

Summer habitat restoration project: In this scenario, the Applicant would create suitable foraging and roosting habitat for one or both of the Covered Species within a documented maternity colony homerange with one or both species present within 10 years of the time of encumbrance, and protect and manage that habitat. Consistent with discussions with USFWS, the following REA inputs were used for a summer habitat restoration project: 1) populations of the Covered Species were declining, 2) roosting and foraging habitat function, and 3) 20% or less existing forest cover for Indiana bat; 30% or less for northern long-eared bat. Eligible projects would be located in Ohio and would be planted and managed to become suitable foraging and roosting habitat in accordance with a USFWS-approved management plan (see below). Using the estimated take numbers for the first 20 years of the permit term, the following two examples contemplate restoration mitigation projects (1) for each species alone and (2) where both Covered Species are present.

- If mitigation parcels only have one species present, mitigation for the impacts of taking 171 female Indiana bats alone would be 139 acres and mitigation for the impacts of taking 77 female northern long-eared bats alone would be 82 acres.
- If a mitigation parcel is intended to be restored for both Covered Species, 57 acres mitigation are required for Indiana bats alone and would not be subject to stacking (139 Indiana bat acres - 82 northern long-eared bat acres = 57 Indiana bat-only acres). The remaining 82 acres would be used to mitigate for both Covered Species and has a 10% stacking ratio added (82 acres + (82 acres * 0.1)) = 90.2 acres. Therefore, in this example where both Indiana bats and northern long-eared bats are expected to occupy the same mitigation parcels, the total mitigation required in order to offset the 171 female Indiana bats and 77 female northern long-eared bats anticipated during the first 20 years of the permit term is 147.2 acres (57 acres + 90.2 acres).

Swarming habitat protection project: The *USFWS Guidelines for Non-REA Staging/Swarming Mitigation Option* (USFWS 2016c) provides a method to cacluate mitigation credit for protecting and restoring habitat within up to 16 km (10 mi) of a documented Covered Species hibernaculum, with a greater value assigned to sites closer to hibernacula and for sites where habitat availability is limited. Mitigation credit is based on the number of females of covered species that have been documented to use the hibernaculum. Using this guidance and the estimated take numbers for the first 20 years of the permit term, the following three examples contemplate staging/swarming mitigation projects, at the Lewisburg Limestone Mine, Ohio's only Priority 2 Indiana bat hibernaculum. This hibernaculum had a population of 2,890 Indiana bats and 13 northern long-eared bats during the most recent survey (ESI 2016), with an assumed 50:50 sex ratio. Because so few northern long-eared bats were documented here, the below mitigation scenario would likely provide credit only for Indiana bats.

- Mitigation for 171 female Indiana bats could be achieved by protecting or restoring 96 ha (237 ac) of habitat within 1.6 km (1 mi) of the hibernaculum opening.
- Mitigation for 171 female Indiana bats could be achieved by protecting or restoring 2,423 ha (5,987 ac) of habitat between 6-8 km (4-5 mi) of the hibernaculum opening.

- Mitigation for 171 female Indiana bats could be achieved by protecting or restoring 3,462 ha (8,556 ac) of habitat between 8-16 km (5-10 mi) of the hibernaculum opening.
- Although the examples above are based on the protection of swarming habitat for the Lewisburg Limestone Mine, swarming habitat protection could also be implemented within 16 km (10 mi) of a different Priority 1 or 2 hibernaculum if a new hibernaculum is discovered in Ohio.
- If a swarming habitat project also meets the above criteria for a summer habitat protection or restoration project, the credit from this habitat function would be calculated using the REA model and added to the swarming credit provided by the project. Additionally, the Applicant would discuss the potential for a swarming habitat project to qualify for up to 5 percent mitigation credit instead of the 1 percent mitigation credit used in the examples above, per the criteria for this credit described in the USFWS Guidelines for Non-REA Staging/Swarming Mitigation Option (USFWS 2016c).

<u>Performance Criteria for Mitigation Projects</u>: Mitigation implemented for this HCP (summer habitat protection, summer habitat restoration, or swarming habitat protection) will be generally in accordance with the USFWS Ohio Field Office's *Selection Criteria for Indiana Bat Conservation Area (BCA)* (USFWS 2017). Whether a mitigation site provides summer or swarming habitat for Covered Species, the ultimate goal of the mitigation site is to provide roosting and foraging habitat comprised of forest communities native to Ohio. Key provisions of the BCA and "Performance Criteria" for mitigation projects include the following:

- Mitigation parcels must be at least 8 ha (20 ac) in size. No open space (fields, pastures, etc.) will be wider than 500 feet at any given point to allow connectivity for bat movements. Property being preserved must be under threat of development (i.e., not otherwise protected with a legal protection instrument or owned by a conservation organization. Any area preserved must be suitable forested habitat, defined as any tree covered area that is 0.2 ha (0.5 ac) or larger, containing any potential roosts (i.e., live trees and/or snags ≥ 7.6 cm [3 in] diameter-at-breast-height [dbh] that have exfoliating bark, cracks, crevices, and/or cavities) greater than 4 m (13 ft) tall and at least 7.6 cm (3 in) dbh, or any patch of trees with these characteristics that is less than 0.2 ha (0.5) ac in size but is within 152 m (500 ft) of or connected by a travel corridor to a potential maternity roost tree, a 0.2-ha (0.5-ac) or larger stand of suitable forested habitat, or any patch of wooded riparian buffer.
- For preservation mitigation projects, the goal would be to ensure a mature forest canopy and limit invasive species, such as by maintaining tree density, canopy cover, non-native woody plants, and similar characteristics that make the mitigation project support occupancy by the Covered Species. Specific goals would be described in the Service-approved management plan.
- For restoration projects, a minimum of eight Ohio native hardwood tree species will be planted to restore and/or enhance Indiana bat habitat. Planting plans will consider the species composition of nearby mature forest stands with similar soil composition and landscape position. Species selection will be determined based on site-specific

characteristics (soil moisture, sun exposure, etc.) and seedling availability. Trees should be planted at a minimum of 3 m by 3 m (10 ft by 10 ft) spacing (i.e., 1,077 trees per ha [436 trees per ac]). In order to maximize bat habitat benefits, the performance goal of not less than 741 native, live, and healthy trees per ha (300 trees per ac) will be achieved at the end of the fifth growing season after planting. At least 30% of planting should consist of native oak species (*Quercus* spp.). At least 10% of planting should include one or a combination of loose bark species (shagbark [*Carya ovata*] or shellbark [*C. laciniosa*] hickory, bur oak [*Q. macrocarpa*], eastern cottonwood [*Populus deltoides*], swamp white oak [*Q. bicolor*], silver maple [*Acer saccharinum*]). The remainder of the planting will be other native, adapted hardwood species. Tree species should be distributed randomly throughout the site to avoid large groups of like species.

- Control of non-native woody species (e.g., bush honeysuckle [*Lonicera* spp.], tree of heaven [*Ailanthus altissima*]), is important to ensure long-term persistence and regeneration of native forest communities. Therefore, a goal of less than 10% cover of non-native woody plants at mitigation sites is also a part of the success criteria. Minor adjustments to this non-native woody species criteria may be made upon Service approval.

Steps that will be taken to establish an eligible mitigation project include:

1) The Applicant or a mitigation provider will propose a mitigation project to the USFWS in writing, and the USFWS will confirm that the site is located within a documented maternity colony homerange or staging/swarming buffer of one or both species, and that it is appropriate as a mitigation location.
2) The land will be protected through a permanent conservation easement, fee simple acquisition with deed restrictions, or another site protection instrument that provides an equivalent level of protection, and the party responsible for the long-term enforcement of the site protection instrument will be a state wildlife agency, land trust, or non-governmental conservation organization. USFWS will approve the form of site protection instrument.
3) A USFWS-approved management plan that includes a monitoring program will be developed for the mitigation land. The management plan would set forth site-specific "Performance Criteria" for suitable bat habitat (e.g., stem density, snag density, percent canopy cover, thresholds for invasive species cover), address activities needed to maintain existing habitat (such as managing activities on the property, fire management, etc.) and provide for periodic monitoring and reporting to ensure the mitigation land achieves the performance criteria set forth in the management plan. The plan will also describe: background information on the habitat, a threats analysis, the action and implementation strategy for the project, the reporting process, the entity responsible for periodic evaluation of the mitigation project, the frequency of the periodic evaluation, and corrective actions to be taken if the periodic evaluation indicates that the habitat quality of the project has been compromised by vandalism or natural disaster.

4) Financial assurances will be provided to implement the mitigation project as set forth in Section 7.3;

5) If the Applicant relies on a third-party entity to implement the mitigation project, the Applicant will transfer responsibility for the management of the mitigation project to that mitigation provider in a form agreed to by the Applicant and the USFWS. Any responsibilities not explicitly described in such an agreement will be retained by the Applicant.

6) The mitigation will not occur within designated critical habitat for any ESA listed species, nor will it adversely affect a historic property as defined by the National Historic Preservation Act.

<u>Mitigation Timeline and Responsible Parties</u>

In coordination with the USFWS, the Applicant will implement the mitigation project(s) for Phase I as soon as possible after ITP issuance. Within 90 days of issuance of the ITP, the Applicant will either enter into a contract with a mitigation provider or establish a corporate guarantee for the anticipated costs of the Phase I mitigation (Chapter 7). Within 2 years of ITP issuance, the mitigation project will be secured and management plan for bat conservation will be developed and implemented. Phase II of mitigation will be implemented by Year 19 of the ITP term (Table 5.3). Once the Applicant has selected a mitigation project and confirmed with the USFWS that the project is suitable consistent with the above examples, the Applicant will work to secure the project.

Table 5.3 Timeline for completion of mitigation tasks for the Blue Creek Wind Farm Habitat Conservation Plan.

Task	Timing	Responsible Parties
Applicant to enter into contract with mitigation provider or establish a parent guarantee for mitigation funds	Within 90 days of ITP issuance	Applicant, Mitigation provider
Phase I project is secured, and management for bat conservation is implemented	Within 2 years of ITP issuance	Applicant, Mitigation provider
Phase II project is selected	ITP Year 16 through Year 19	Applicant, Mitigation provider
Phase II project is secured and management for bat conservation is implemented	ITP Year 19	Applicant, Mitigation provider

The process of identifying and selecting a mitigation project for Phase II may begin early to ensure the Applicant has sufficient time to implement Phase II according to the schedule in Table 5.3. If a conservation bank for the Covered Species approved by the USFWS becomes available, the Applicant may choose to purchase credits through the conservation bank instead of implementing an independent mitigation project.

This mitigation timeline ensures that mitigation will largely stay ahead of the take, and the REA Model ensures that the amount of mitigation will account for the impact of the take to the Covered Species that occurs between permit issuance and when the benefit accrues from Phase I mitigation. In the event of early Project decommissioning (i.e., prior to Year 20), the impact of the cumulative estimated take would have been fully mitigated at the time of decommissioning. If the

Project is decommissioned, the Applicant will evaluate the estimated take to that point to ensure that mitigation has offset any remaining impacts of estimated take. However, because of the conservation plan and adaptive management strategy, the Applicant anticipates that no additional mitigation will need to be implemented after Project decommissioning.

6.0 MONITORING AND ADAPTIVE MANAGEMENT

As described in the HCP Handbook, an HCP monitoring program should provide sufficient information "to determine whether or not:

- a permittee is in compliance with their ITP and HCP,
- progress is being made toward meeting an HCPs [sic] biological goals and objectives,
- the HCP's conservation program is effective at minimizing and/or mitigating impacts, and
- there is a need for adjusting measures to improve the HCP's conservation strategy."

This HCP's Compliance Monitoring (Section 6.1), Mitigation Effectiveness Monitoring (Section 6.2), and Adaptive Management (Section 6.3) are designed to meet the information needs of the first, third, and fourth bullets, respectively, and thereby to collectively inform assessment of the second bullet.

6.1 Compliance Monitoring

6.1.1 Monitoring Objectives

The primary objective of Compliance Monitoring is to evaluate whether the level of take of Covered Species at the Project is within the level of take authorized by the ITP. Following the directive in the HCP Handbook, the Applicant has designed the Project's Compliance Monitoring to be commensurate with the scope, duration, and certainty of the Project's impact of take. The Compliance Monitoring plan incorporates current advanced statistical models for monitoring rare events like take of Covered Species, covers the duration of the ITP term, and will provide a robust evaluation of take of Covered Species. Results of Compliance Monitoring will also provide the basis for mitigation and adaptive management decisions. Compliance Monitoring will consist of two parts: Intensive Monitoring and Operations Wildlife Monitoring.

The Project has been intensively monitored for bat fatalities, including Covered Species, since it began commercial operation in 2012. This includes two years of intensive fatality monitoring at normal Project operations (which provided the baseline data for the take predictions, see Section 3.5.3), and two years of intensive fatality monitoring while the Project turbines were operated under various operational scenarios (see Section 3.5.3). Therefore, the Applicant has leveraged the site-specific information to develop the Compliance Monitoring protocol in order to meet the requirements in the HCP Handbook.

6.1.2 Intensive Monitoring

The Applicant will implement Intensive Monitoring to provide an estimate of the fatalities of Covered Species over the ITP term and to signal when adaptive management actions should be initiated or an amendment may be necessary. The Intensive Monitoring program has two primary components – fatality surveys and bias trials – that are used to estimate the number of fatalities that occurred during the monitoring period. Results from the fatality surveys and bias trials allow for a statistical estimation of the number of fatalities that occurred.

Fatality Surveys: During fatality surveys, searchers will systematically search for bat carcasses within plots at selected turbines. Exact methods will be determined prior to initial surveys based on an evaluation of the Evidence of Absence (see below) which accounts for differences in the number of turbines surveyed, the size of the study plots, the interval between searches, and other variables. Based on initial evaluations, the estimate of the proportion of turbines surveyed could be up to 100%, although actual numbers could vary. Fatality surveys involve walking transects (usually ~3-5 m apart) looking for fatalities on either side of transects and/or focusing on areas of high visibility such as the roads and pads around the turbines. The distance that the transects extend past the turbine will be one of the factors evaluated during study design, as most bats fall closer to turbines than other larger species. Based on previous monitoring conducted at the Project, a combination of plots (approximately 60 m) cleared of surrounding vegetation and plots consisting of the graveled turbine pads and roads out to 100 m will need to be utilized to achieve the target detection probability (*g*) value of 0.15. Similarly, the interval between searches will be evaluated prior to the initial survey, but is anticipated to range between 3 and 14 days depending on season. If evidence of a bat carcass is detected, the searcher collects the relevant data, such as location and condition of the carcass, and species and sex, if known. Photos are taken of the carcass for documentation. All bat carcasses, including Covered Species carcasses, will be collected, placed in plastic bags and frozen for use in future analysis, or in the case of non-covered species, for bias trials. Covered Species will be turned over to the USFWS upon request. Collected bat carcasses will be disposed of per ODNR collection permit requirements. Absent ODNR requirements, carcasses of either category will be stored for no longer than one (1) year.

Bias Trials: Because not all carcasses are detected during fatality surveys, bias trials for searcher efficiency and carcass persistence time will be conducted to measure potential biases to provide a more accurate estimate of bat fatalities. During searcher efficiency trials, test carcasses are placed prior to a fatality survey unbeknownst to the searcher conducting the survey. After the survey is completed, the number of trial carcasses detected is recorded to calculate the probability that a searcher detected a carcass. During carcass persistence trials, test carcasses are placed on the landscape in the vicinity of turbines and checked every few days initially with longer intervals between checks out to approximately 30 days to determine how long a carcass persists on the landscape.

Evidence of Absence: Because the objective of Intensive Monitoring is to evaluate a rare event (take of Covered Species), the Applicant has designed the monitoring protocol around use of a robust statistical tool for rare event estimation: the Evidence of Absence (EoA) model (Huso et al. 2015). EoA uses a Bayesian statistical model based upon information about carcass counts, searcher efficiency rates, carcass persistence rates, and the proportion of carcasses expected to occur in searched areas to estimate occurrence of rare events (Huso et al. 2015). The *g* value calculated from these model inputs provides an estimate of the probability that the take of a Covered Species is detected during the monitoring, and can be used as a metric of certainty in the resulting take estimates, with a higher *g* value equating to higher certainty in the results.

To determine the appropriate level of effort for the years in which monitoring is conducted, the Applicant considered the *g* value in the EoA model that could be achieved through various monitoring plan designs, since the degree of certainty in the take estimates depends on the probability of detection. Probability of detection in the EoA model is influenced by searcher efficiency rates, carcass persistence probability, and the proportion of carcasses expected to occur in searched areas (Huso et al. 2015). Higher searcher efficiency rates, higher carcass persistence probabilities, and larger search areas will lead to a higher probability of detection and less uncertainty in the monitoring results. The Applicant designed the HCP monitoring plan reflecting not only these factors, but also the specific site conditions at the Project. These site conditions were informed by the data collected onsite, which provide a level of prior knowledge about the site that substantially reduces the uncertainty in the effectiveness of the conservation program and the monitoring design parameters.

The Applicant developed a broad range of potential monitoring designs that consider the site conditions (i.e. narrow access roads and small turbine pads) and practical considerations (i.e. active agricultural practices) informed by the four years of Intensive Monitoring that has already been conducted at the Project. The Applicant then evaluated this range of potential monitoring designs in the EoA Scenario Explorer module software package (Huso et al. 2015) to determine their capacity to achieve the HCP's Intensive Monitoring objective, based on the number of bat fatalities simulated by the Scenario Explorer (actual take) and the take estimate calculated by the Scenario Explorer using the simulated number of bat fatalities and the *g* value (estimated take). The actual take represents the number of bats that are simulated to be impacted by take from the Project, while the estimated take represents the resulting take estimates that would be calculated from the monitoring data which would be used to evaluate compliance with the ITP.

The EoA Scenario Explorer analysis found that above a certain threshold (*g* value of 0.15), additional monitoring effort did not substantively change the estimated take or the risk of changes to the Operational Minimization Plan strategy in response to adaptive management triggers (Appendix E). Estimated impacts to Covered Species remained within the amount contemplated, and offset by, the HCP. These results indicated that monitoring with *g* value of 0.15 at the Project is sufficient to detect, and trigger correction of, take levels that may threaten compliance with the ITP, and therefore meets the HCP's monitoring objective of evaluating compliance with the ITP. Consequently, methods for Intensive Monitoring will be designed using the EoA model to achieve a *g* value of 0.15 (see Table 6.1). In addition to carcass searches, searcher efficiency and carcass persistence trials will be conducted and density-weighted carcass distribution will be modeled in each monitoring year to enable evaluation of these bias factors.

EoA is designed to allow numerous monitoring protocol designs to achieve a target *g* value of 0.15. Therefore, the monitoring protocol for each upcoming year of the ITP monitoring will be designed using the information gathered during the previous monitoring year regarding key input values, such as the searcher efficiency rate, carcass persistence probability, and the proportion of carcasses expected to occur in searched areas. Different combinations of the number of turbines searched, the plot radius, plot type, and search interval may be used to achieve a desired *g* value. This iterative approach will enable the Applicant to modify the monitoring protocol as necessary to achieve the target *g* value, while also selecting the most efficient protocol that ensures compliance with the take authorization in the ITP. The monitoring protocol for each upcoming year of monitoring will be provided to the USFWS; this protocol will include detailed search methods and bias trial parameters.

<u>Area Correction:</u> Within EoA, sampling coverage (a) is the fraction of the total carcasses expected to arrive in the searched area (USGS 2014). This value, along with searcher efficiency, the interval between searches, the total time spanned by the searches, carcass persistence, and carcass arrival rates, all influence the probability of detection, or g value. The Applicant has collected data on carcass spatial distribution relative to the turbine in 2012, 2013, 2015 and 2016, at various wind cut-in speeds and within various search areas (i.e., 60 m cleared plot, 90 m cleared plots, pads and roads out to 100 m, see Appendix A). The data collected onsite and at other wind projects generally demonstrate that the number of carcasses falling at a given distance from a turbine tends to decrease with distance (Good et al. 2016b, Huso and Dalthorp 2014). Site-specific data indicate that bat carcasses were detected as far as 90 m from the turbine, and that "the higher densities of carcasses occurred closer to the turbines to normally operating turbines… compared to periods of curtailment" (Good et al. 2016b). For bat carcasses found during Intensive Monitoring, the Applicant will record the distance and azimuth to the turbine. This dataset will inform the estimation of how bat carcasses are distributed around the turbines, assuming a maximum distance of 100 m, when operating at the proposed cut-in speeds of 3.0 m/s in spring and summer and 5.0 m/s in fall. The estimation of carcass density distribution will be modeled using the most appropriate method at the time of analysis and incorporated into EoA for the monitored years, and may be used to model carcass density distribution in future years.

<u>All-Bat Fatality Estimate:</u> Although all-bat fatality at the Project does not inform take compliance evaluation for the Covered Species, at the request of USFWS the all-bat fatality rate will be estimated as part of the Intensive Monitoring data analysis. Once the monitoring data are collected from an Intensive Monitoring year, the all-bat fatality estimate for each monitoring year will be calculated by adjusting for search frequency, carcass persistence, searcher efficiency, and proportion of carcass distribution searched. Estimates of searcher efficiency will be used to adjust the total number of carcasses found for those missed by searchers, correcting for detection bias. Estimates of carcass persistence will be used to adjust the total number of carcasses found for those removed from search plots. The area correction factor will be used to account for unsearched areas of the potential carcass distribution. These adjustments will be made using the updated Huso estimator, or, for the area correction, will be made based on the more contemporary methods in the 2015 monitoring report (Good et al. 2016b). The Applicant may, at its discretion,

opt to use a more current area correction factor or estimator, should one become available, per the New Technology and Information Changed Circumstance (Section 9.1.3).

6.1.3 Operations Wildlife Monitoring

Operations Wildlife Monitoring will be conducted by operations personnel for the purpose of documenting incidental finds of Covered Species within the Project to meet the objective of documenting permit compliance. This monitoring consists of year-round reporting of incidental observations by all on-site personnel. All plant personnel will have wildlife awareness training which includes the documentation of any potential Covered Species injuries or fatalities including photographs. Any suspected Covered Species will be reviewed by a qualified third-party biologist and protected from scavenging until identification is confirmed. Operations Wildlife Monitoring will contribute information on any Cover Species fatalities over the ITP term and will inform take compliance. While it is not intended to provide the statistical rigor of the Intensive Monitoring, Covered Species have previously been detected at wind facilities using this methodology. In 2009, an Indiana bat fatality at Fowler Ridge Wind Farm was found incidentally by plant personnel (Good et al. 2011).

6.1.4 Monitoring Schedule

Compliance Monitoring has been designed to sample periodically, but with the same, robust intensity at each sampling interval. Intensive Monitoring will be conducted with a probability of detection (*g*) of 0.15 in the first and second years of the ITP and in every fifth year thereafter (Table 6.1), with Operations Wildlife Monitoring conducted in the years when Intensive Monitoring is not conducted.

The 5-year interval for Intensive Monitoring is suited to the timescale over which potential increases in take of Covered Species may occur based on population dynamics of Covered Species (see Sections 3.2.3 and 3.3.3). Changes on a more frequent interval are not expected given the low fecundity rates and long lifespan of the Covered Species. Because the Covered Species' populations are currently severely reduced due to WNS, there are fewer bats on the landscape and the likelihood of take is anticipated to be lower than predicted in this HCP (see Section 3.6.1). *Myotis* populations, such as both Covered Species, are likely to require several generations for any substantial population growth, given their relatively slow rates of reproduction (Erickson et al. 2016). Recovery to pre-WNS levels is likely to take longer than the requested ITP term and sudden population increases in the interim are not expected to occur (Erickson et al. 2016). However, it is possible that bat populations could shift their distribution or migration paths unexpectedly during the permit term. Therefore, a 5-year Intensive Monitoring interval was selected to capture potential changes in take rates over time.

In addition to the Intensive Monitoring, the Applicant will continue to implement its Operations Wildlife Monitoring program (Section 6.1.3) during the off years.

Table 6.1 Compliance monitoring schedule for the Blue Creek Wind Farm Habitat Conservation Plan.

ITP Year	Monitoring Effort
ITP Year 1	Intensive Monitoring
ITP Year 2	Intensive Monitoring
ITP Years 3 - 6	Operations Wildlife Monitoring
ITP Year 7	Intensive Monitoring
ITP Years 8 - 11	Operations Wildlife Monitoring
ITP Year 12	Intensive Monitoring
ITP Years 13 - 16	Operations Wildlife Monitoring
ITP Year 17	Intensive Monitoring
ITP Years 18 - 21	Operations Wildlife Monitoring
ITP Year 22	Intensive Monitoring
ITP Years 23 - 26	Operations Wildlife Monitoring
ITP Year 27	Intensive Monitoring
ITP Years 28 - 31	Operations Wildlife Monitoring
ITP Year 32	Intensive Monitoring
ITP Years 33 - 35	Operations Wildlife Monitoring

6.1.5 Take Estimation

The EoA model will be used to assess take rates and cumulative take of both Covered Species each year. The rolling average take rate (λ in the EoA model) will be updated to assess whether the short-term adaptive management threshold (Section 6.3.1) has been exceeded at the 95% credibility level and adaptive management responses are needed. The average take rate will be assessed in every monitoring year based on all available ITP years within a 6-year interval. Under the Intensive Monitoring schedule, the take rate will be assessed for ITP Year 1, ITP Years 1-2, ITP Years 2-7, and thereafter on a 6-year rolling interval to ensure that at least one year of Intensive Monitoring data informs the estimate. The cumulative (ITP term to date) take estimate will be updated to assess whether the projected cumulative take amount (M*) has exceeded the permitted take amount at the 50% credibility level.

In years with Operations Wildlife Monitoring, a *g* of 0.001 (effectively, a *g* of zero) will be used to represent the absence of standardized monitoring effort. Covered bat carcasses found, if any, during these periods are informative with respect to the total mortality occurring at the site. Consequently, if covered bat carcasses are detected at the site during Operations Monitoring, the default prior in EoA will be replaced with a truncated prior equal to the number of covered bat carcasses found that prevents the take estimate from being less than the total number of carcasses detected (D. Dalthorp, USGS, pers. comm.). This approach has the advantages of explicitly including information from the incidentals in the take analysis without degrading the accuracy of the EoA model.

6.1.6 Monitoring Reporting

Monitoring reports will be submitted to the USFWS by April 1 the calendar year following each round of Intensive Monitoring. These reports will include information necessary to estimate take of Covered Species, such as: date, time, location, species, and sex, of all bat carcasses documented; bias trial data; calculated g value; estimated average annual take rates and cumulative take estimates of the Covered Species; adaptive management triggers activated (if any) and planned response; EoA inputs for the monitoring year; all-bat fatality rate; and a record of ambient temperatures and wind speeds and the application of cut-in speeds during a representative sample of the minimization period. Operational data will be retained by the Applicant, which can be accessed in the event of a Covered Species fatality or unusual event. During Intensive Monitoring, raw data forms will be stored at the offices of the monitoring contractor. Raw data forms will be made available to the USFWS upon request. The USFWS may choose to make these monitoring reports publicly available.

Information on bats found incidentally during Operations Wildlife Monitoring will also be made available to the USFWS annually.

Although take would be authorized by the ITP, in the event that a Covered Species fatality is documented during Compliance Monitoring, the USFWS and ODNR will be notified by phone within 24 hours of positive species identification.

6.2 Mitigation Effectiveness Monitoring

The primary objectives of Mitigation Effectiveness Monitoring are to ensure that the mitigation project(s) is (are) meeting the Performance Criteria (Section 5.2.3) and that the conditions in the legal protection instrument are being met. Monitoring will also document that the quantity of mitigation implemented to date is sufficient to compensate for, and stay ahead of, the impact of take that has been estimated to have occurred to date, and is projected to occur over the next 5-year period.

Compliance with the legal protection instrument can be determined by completion of an in-person walk through of the site to document that none of the use restrictions have occurred and that reserved rights are being implemented as authorized. Monitoring of compliance with the legal protection instrument will be conducted annually for the life of the ITP.

Documentation of the percent forest cover at the mitigation site can be achieved using current (within 1 year) aerial or satellite imagery, drone photography, or similar methods. Percent forest cover will be monitored every-other year for the life of the ITP.

Documentation of percent non-native woody species cover can be achieved through an initial site visit that maps portions of the mitigation site with non-native woody cover in either the understory or canopy, and summing the acreage of these non-native woody areas across the entire site. Cover of non-native woody species will be monitored annually in the first three years, and once every fifth year afterwards.

For mitigation projects that involve forest restoration, monitoring will occur to ensure at least 300 native, live and healthy trees per acre are established at the end of the fifth growing season after planting.

If adaptive management is implemented or a changed circumstance is triggered, additional monitoring may be necessary (see Sections 6.3.3 and 9.1.4).

A detailed effectiveness monitoring and reporting plan will be a component of the management plan that will be developed for each mitigation project and approved by the USFWS. The monitoring will include an assessment of compliance with the site protection instrument, an assessment of characteristics set forth in the USFWS-approved management plan, the need for any maintenance measures, and an assessment of threats.

If a USFWS-approved mitigation bank is used to implement mitigation, or the Applicant contracts with a third party to implement the mitigation (see option in Section 5.2.3), responsibility for mitigation effectiveness monitoring and reporting will transfer to that mitigation bank or third party in a form agreed upon by the Applicant and the USFWS.

6.3 Adaptive Management

Adaptive management is a tool to address uncertainty in the conservation of a species covered by an HCP by allowing management changes to be implemented based on results of the HCP's monitoring program (USFWS and NMFS 2016). One area of uncertainty is the number of Covered Species that will be taken under the plan. Adaptive management will be used to ensure the take of Covered Species at the Project does not exceed the permitted level of take. Adaptive management decisions will be informed by the data collected through Compliance Monitoring (Section 6.1) and Mitigation Effectiveness Monitoring (Section 6.2). The need for adaptive management will be evaluated following each year of Intensive Monitoring, if a Covered Species is found incidentally during Operations Monitoring years, and each year of Mitigation Monitoring.

6.3.1 Adaptive Management for Minimization Measures

The EoA model will provide an estimate of the take rate (λ) and the cumulative take (M*) based on data collected during the monitoring. Dalthorp and Huso (2015) provide a framework for two types of adaptive management tests in EoA: 1) a short-term test of whether the average take rate is on pace to exceed the expected average rate, and 2) a long-term test of whether the total cumulative take has exceeded the permitted level of take. The short-term test is designed to trigger an adaptive management response in time to prevent the cumulative take estimate from exceeding the permitted take. The long-term test is designed to ensure compliance with the permitted take limit and will trigger an avoidance response if the take limit is met. The EoA fatality estimation model has the capacity to account for the application or reversion of adaptive management actions, or other actions that are expected to affect the take rate at the facility (such as non-operating turbines in any given year) by specifying a relative weight (rho) for each year of data (Dalthorp et al. 2014). Rho represents the relative fatality rate in each year of operation; if no adaptive management responses have been implemented, the fatality rate will be assumed to be constant across years (rho would equal 1 for all years). For any years following an adaptive management response, the assumed effectiveness of the response in reducing take of the Covered Species will be determined based on the best available data or literature (as the Intensive Monitoring is not designed to quantify the effectiveness of adaptive management measures) and used to determine rho for these years. For example, if the adaptive management action was increasing curtailment from 5.0 m/s to 5.5 m/s, rho would be reduced from 1.0 to 0.62 based on the mean bat reductions in Table 5.2 (i.e., 5.0 m/s curtailment has an average reduction of 48% from the non-curtailed rate whereas 5.5 m/s curtailment has an average reduction of 68% from the non-curtailed rate; therefore, a 38% reduction in bat fatalities from the rate at 5.0 m/s would be expected to occur if curtailment was increased to 5.5 m/s).

For this HCP, a 6-year rolling window will be utilized to ensure that sufficient data are available to inform the estimated take rate (λ) in any given window. If, within any rolling window, the estimated take rate exceeds the expected take rate with 95% confidence (per Dalthorp and Huso 2015, page 7), the short-term test will be triggered such that action will be taken. Regardless of the 6-year rolling window for adaptive management evaluation, the Applicant may choose to implement additional monitoring or minimization at any time.

In response to a short-term adaptive management trigger, the Applicant will evaluate the magnitude of additional bat mortality reduction necessary to bring the estimated take back to a rate that is consistent with remaining below the authorized total in the ITP. For example, the expected northern long-eared bat take rate is 2.96 bats/year for the 35-year ITP term (103 total northern long-eared bats); if a short-term trigger is fired after Intensive Monitoring in year 7 of the permit and λ is estimated to be, hypothetically, 4.96 bats/year, the Applicant could determine that the take rate should be reduced by 49% to remain within the authorized total in the ITP (4.96 bats/year for the 6-year evaluation window = 29.76 estimated bats plus the estimated take prior to the evaluation window [hypothetically, 2 bats from year 1], 103 total bats – 31.76 estimated bats = 71.24 bats remaining for the 28 years left on the ITP, 71.24 bats / 28 years = 2.54 bats/year adjusted take rate to maintain compliance, (1 – (2.54 bats/year / 4.96 bats/year)) * 100 = 49% required reduction in the take rate). Next, the Applicant will determine the appropriate type and scale of corrective action based on the best available scientific information regarding the effectiveness of available bat mortality reduction measures. This information may include data sources and studies from outside the Permit Area, and analysis methods developed for other similar projects.

Responses to adaptive management triggers may include the following:

- If a short-term trigger is met based on a dataset that includes zero carcasses of the Covered Species (i.e.,. no Covered Species carcasses are found and the trigger is met using EoA described in Section 6.1.5), the Applicant may, at their discretion, wait to implement a corrective action until conducting additional monitoring. This scenario would indicate the trigger was based solely on the confidence in the monitoring results. This monitoring would occur during the next calendar year. The monitoring may be implemented prior to taking other corrective actions
- If a short-term trigger is hit and no refining information is available to understand the circumstances of the trigger, the Applicant will raise the wind speed under which turbine blades are feathered by 0.5 m/s during the fall migratory season. Such a response is the default adaptive management response. Furthermore, this response may be increased higher than 0.5 m/s during the fall migratory season (and/or also increased by at least 0.5

m/s during the spring migratory season)by the Applicant to respond if a higher level of take reduction is needed, as determined by the take estimate calculations.

- If, a short-term trigger is hit and further refining information is available to evaluate the circumstances resulting in the trigger (i.e. a Covered Species is found at Project or another Ohio wind project where temporal or meteorological conditions can be assessed), a more effective/tailored action may be implemented with approval by USFWS and the Applicant. Corrective actions may include, but are not limited to: raising cut-in speeds by 0.5 m/s during the spring migratory season, extending the seasonal period within which the turbine operational adjustments are applied, lowering the temperature above which turbines are feathered, adding curtailment at specific turbines if evidence shows that some turbines result in higher bat mortality. Any such response shall be implemented with approval from the USFWS and the Applicant.
- Under either scenario above (with or without refining information), the Applicant may also chose to implement a technological solution (see Section 9.1.3 regarding incorporation of new technology). The expected magnitude of bat mortality reduction associated with any correction action selected will be, at a minimum, comparable to the expected reduction that could be achieved by increasing the cut-in speed by 0.5 m/s (1.6 ft/s). Corrective action achieving a minimum of a comparable level of additional bat mortality reduction will be implemented by the Applicant. The efficacy of a corrective action (other than a 0.5 m/s curtailment increase) must have been demonstrated in published, peer reviewed literature and/or in a technical report produced by a third party (such as the American Wind Wildlife Institute, the National Renewable Energy Laboratory, or the Department of Energy). If no such literature or report is available for a corrective action proposed by the Applicant, the Applicant will coordinate with USFWS to seek approval of the proposed action before implementation.

The Applicant will determine the appropriate corrective actions or additional monitoring response and will describe the corrective action or additional monitoring response to the USFWS at least 30 days prior to the start of the spring season (April 1) of the following year. Corrective actions will be intended to maintain the estimated annual take at a rate below the predicted annual take (ensuring compliance with the ITP limit over the ITP term). USFWS will review the proposed corrective action and must agree that it is likely to result in the desired reduction in fatality of Covered Species and approve it in writing prior to implementation. If the action will result in impacts that were not previously analyzed in the NEPA document or Biological Opinion, an amendment may be necessary.

The Applicant may implement a reversion trigger (Dalthorp and Huso 2015), designed to allow reversal of an adaptive management response, if take estimates of both Covered Species indicate ITP compliance can be maintained over the ITP term in so doing. If the monitoring data collected to date indicate the estimated take rates of both Covered Species are equal to or less than 60% of the predicted take rates with 95% confidence, the reversion trigger indicates that corrective actions implemented in a previous adaptive management response may be reversed while ensuring compliance with the take limit. As with the rest of the adaptive management framework, this trigger is structured per the USGS guidance (Dalthorp and Huso 2015) without modification. For example, if adaptive management was triggered based on a year with an unusually high all-bat mortality estimate, the corrective action may be unnecessarily restrictive. The reversion trigger must be triggered by the take estimates of both of the Covered Species.

In response to a reversion trigger, the Applicant may choose to reverse all or part of the corrective action(s) implemented in the most recent adaptive management response. The Applicant will present the revised minimization measures to the USFWS prior to the start of the bat active season (April 1) of the following year. Reversion of corrective actions will be intended to optimize output of renewable energy from the Project, while ensuring compliance with the take limit over the ITP term.

In addition to the short-term triggers, the EoA estimation framework has a long-term trigger, which indicates that the permitted level of take has been met or exceeded (based on the cumulative estimated take using the 50^{th} credible bound of M*). In response to a long-term trigger, the Applicant will implement the current USFWS recommendation to feather turbines at wind speeds below 6.9 m/s [22.6 ft/s] from half hour before sunset to half hour after sunrise in spring and fall to avoid take of the Covered Species. A technology-based solution that the Applicant and the USFWS agree in writing is an avoidance strategy may be implemented. The Applicant will consult with the USFWS to determine whether the Project will operate under the avoidance strategy or pursue a permit amendment.

6.3.2 Adaptive Management for Monitoring

If a corrective action is implemented in response to an adaptive management trigger, the next Intensive Monitoring event (at a *g* of 0.15) will be rescheduled to occur in the year of the adaptive management response. One year of Intensive Monitoring will be conducted following implementation of a corrective action for which effectiveness has already been demonstrated in published, peer reviewed literature and/or in a technical report produced by a third party. If a corrective action is implemented (with USFWS concurrence), for which no such literature or report is available, the Applicant would conduct up to two (2) years of Intensive Monitoring to demonstrate the effectiveness of the action. The monitoring schedule will resume such that Intensive Monitoring is conducted every fifth year after the rescheduled monitoring event(s).

If a reversion is implemented, the next Intensive Monitoring event (at a *g* of 0.15) will be rescheduled to occur in the year of the reversion. The monitoring schedule will resume such that Intensive Monitoring is conducted every fifth year after the rescheduled monitoring event.

If a carcass of a given Covered Species is found incidentally during Operations Wildlife Monitoring, then Intensive Monitoring will be implemented in the next year and rescheduled to be conducted every fifth year after the rescheduled monitoring event.

If the Project is decommissioned prior to the end of the 35-year ITP term, take of Covered Species will stop at the time turbines are no longer operating. Because no take will occur, the Applicant will also stop monitoring at the time turbines are decommissioned.

6.3.3 Adaptive Management for Mitigation

Adaptive management for mitigation will be conducted in accordance with a Project-specific mitigation management plan developed by the Applicant, mitigation provider, and the Service once a mitigation parcel(s) has been identified. The purpose of adaptive management for mitigation is to respond to changes in the mitigation lands and ensure they continue to offset impacts to the Covered Species.

On all mitigation projects, baseline conditions (such as a percent canopy coverage, stems per acre, and/or non-native woody species) will be evaluated at the time of encumbrance. If monitoring results indicate a decline in forest canopy cover or an increase in non-native woody species cover such that it exceeds 10% of the site, adaptive management will be triggered and action will be taken by the mitigation provider to restore characteristics of the mitigation site. Specific Performance Criteria would be described in the Service-approved management plan. Within one year of the trigger being met, adaptive management actions will be implemented. In the case of management action taken to address non-compliance with any of the above components, monitoring will occur for at least one year after the corrective action is taken.

Additionally, on a Restoration mitigation project, if monitoring reveals that planted portions of the mitigation site are not surviving to a density of 300 stems per acre at any point during the permit term, adaptive management will be triggered. Within one year of the trigger being met, adaptive management actions will be implemented. These will entail planting additional trees at a density of 430 stems per acre in those areas that are not meeting performance goals. Planted areas will be monitored annually for an additional five years, and if planted sites are meeting performance criteria after 5 years, monitoring will revert to every fifth year thereafter.

Ultimately, the detailed adaptive management provisions will be developed by the Applicant, mitigation provider, and the USFWS, as part of the management plan approved by the USFWS.

Should any monitoring report document that mitigation implementation is not staying ahead of the estimated impacts of the take, action will be taken to address this. Further, if a monitoring report reveals that over the next 5-year period, future projected take at a similar rate as has been observed to date may cause more take than has already been mitigated for, action will be taken to address this. Within one year of the monitoring report, additional mitigation will be implemented to address any deficiencies to date plus mitigation for one additional year of predicted take. Within two years of the monitoring report, the Applicant will coordinate with USFWS to implement a revised Phase II mitigation implementation schedule that will ensure all remaining mitigation stays ahead of the take and fully offsets the impacts of the take.

7.0 FUNDING ASSURANCES

Sections 10(a)(2)(A)(ii) and 10(a)(2)(B)(iii) of the ESA provide that the USFWS shall issue an ITP if, among other things, it finds that "the applicant will ensure that adequate funding for the plan will be provided."

The Applicant's parent company's history of self-funding wind power project development and operation (over 50 wind farms), including the type of post-construction studies identified in this HCP, demonstrates its capability and commitment to continue such funding. Avangrid Renewables, LLC has more than $10 billion of operating assets totaling more than 6,000 MW of owned and controlled wind and solar generation in more than 20 states. The Avangrid Renewables, LLC's parent company, Avangrid, Inc, is a publicly-traded company and maintains a BBB+ credit rating from Fitch and S&P[10]. Funding for each element of the HCP is described in the following sections.

7.1 Project Operations

The Applicant will implement the Operational Minimization Plan (Table 5.1) that is intended to minimize potential impacts to Covered Species by limiting turbine rotation during periods when Covered Species are considered at risk, as identified Section 5.2.2. The cost associated with these operational adjustments and analysis of operational data to determine compliance with those operational adjustments will be accounted for through lost revenues and annual project budgets and as such do not require financial assurances. The analysis of operational data will be done by the Applicant's permanent employees and will be funded through annual salary allocations. No separate or additional funding is required to implement the tasks described here.

7.2 Compliance Monitoring

The Applicant will conduct Compliance Monitoring within the Permit Area during the ITP term (Section 6.1). Costs for Intensive Monitoring are detailed in Section 7.5, which were estimated based on 2018 third-party wildlife contractor and crop damage costs for achieving a *g* of 0.15 ($277,500, see Table 7.1), and are assumed to increase by 3.0% annually to account for estimated inflation. Costs of Compliance Monitoring will be applicant-funded through the annual O&M budget during Intensive Monitoring Years. In the year prior to each monitoring year, the Applicant will obtain a proposal from an independent consultant for the Intensive Monitoring for the next monitoring year, and will include that amount in the annual O&M budget for that monitoring year. As of February 1 of the monitoring year, annual costs of compliance monitoring will either be assured (1) through certification from a corporate representative such that the costs are identified and included in the annual O&M budget for the monitoring year or (2) through a contractual commitment for the upcoming fatality monitoring with a contractor. Although the cost of implementing compliance monitoring will be accounted for in the O&M budget, the Applicant will provide funding assurances for one additional year of Intensive Monitoring ($277,500; see details of assurances in Section 7.4). Providing Compliance Monitoring as set forth in Section 6.1 is a requirement of this HCP, and failure to provide adequate assurance for compliance monitoring on time could result in suspension or revocation of the permit.

Operations Wildlife Monitoring (Section 6.1.3) will entail annual training of maintenance staff, data compilation, and reporting. This will be done by the Applicant's permanent employees and will be

[10] As of 2019 First Quarter results.

funded through annual salary allocations. No separate or additional funding is required to implement Operations Wildlife Monitoring.

7.3 Mitigation

The Applicant will provide funding for mitigation projects, including funding for the acquisition, management, monitoring, long-term stewardship, and reports associated with these projects (see Section 5.2.3). Estimated costs for mitigation for the impact of the requested permitted level of take for both of the Covered Species, calculated using the REA models, are detailed in Section 7.5. The Applicant estimated costs based on discussions with companies experienced in development of mitigation for bats and represent "all-in costs" that include the land acquisition, long-term stewardship, implementation of management activities, and effectiveness monitoring and reporting.

The REA allows for different types of mitigation projects, as described in Section 5.2.3. The Applicant is in preliminary discussions with a third party mitigation provider regarding a preservation project for the initial mitigation project. Therefore costs discussed below reflect those of a project developed based on the Preservation REA. Based on the Preservation REA the mitigation provider has provided an estimate using existing land prices in Ohio and estimated costs to manage the mitigation based on mitigation plans that have been approved for similar preservation projects. The average estimated costs provided by mitigation entity for 219 acres of preservation associated with Phase I mitigation was $2,365,210. For Phase II mitigation, future costs were estimated to be $2,761,421 in Year 20, based on current estimated costs as Phase I, and with 3% annual inflation added.

Within 90 days after ITP issuance, the Applicant will either provide to USFWS (1) a fully paid and executed implementation contract with the mitigation provider, (2) a corporate guarantee, (3) a performance bond, or (4) an irrevocable letter of credit for the anticipated costs of the Phase I mitigation. If actual costs differ from the amount of the $2,365,210 estimated here, the Applicant will pay the full amount needed to implement the mitigation, notwithstanding the No Surprises Assurances. Take authorization will begin when the fully paid and executed implementation contract with the mitigation provider or the alternative funding assurances identified above is/are received by the Service. The lag between the impacts of the take and the benefit to the Covered Species from Phase I mitigation is taken into account by the REA Models. If Phase II mitigation is necessary (Section 5.2.3), the Applicant will provide proof of funding of the respective mitigation project including costs associated with Section 5.2.3 by ITP Year 19. If actual costs differ from the amount of estimated ($2,761,421), the Applicant will pay the full amount needed to implement the mitigation, notwithstanding the No Surprises Assurances. The mitigation payment will be made from the O&M budget and implemented prior to the end of Year 20. Because the impact of take being mitigated by Phase II will not occur before Year 20, and the Applicant will know after Year 17 monitoring results whether Phase II mitigation will be needed, the Applicant will have adequate time to identify, coordinate with USFWS consistent with Section 5.2.3, and secure mitigation prior to ITP Year 19 such that the mitigation benefit to the Covered Species will accrue before the impact of the take. The mitigation implementation for years 2-35 will therefore "stay ahead" of the expected take (as described in the HCP Handbook) and all mitigation will have full funding assurances before any potential take occurs. (USFWS and NMFS 2016).

7.4 Changed Circumstances, Adaptive Management, and Contingency Fund

The purpose of the Changed Circumstances, Adaptive Management, and Contingency fund is to provide funds in the event that Changed Circumstances are triggered (Section 9.1), if adaptive management responses are required (Section 6.3), and if monitoring costs are underestimated. It is anticipated that should Changed Circumstances or Adaptive Management responses be triggered, these costs will be paid from the O&M budget and as set forth in the provisions of those HCP sections. It is also anticipated that monitoring costs will either be paid out of the O&M budget (Section 7.2) or already paid for as part of the contract with the mitigation provider (Sections 6.2 and 7.3)

However, the fund described in this section will ensure a reasonable contingency exists in the unlikely event that the O&M budget, or in the case of effectiveness monitoring, the mitigation provider, does not cover these costs. Not all Change Circumstances or Adaptive Management responses require additional funding. For example, changes to curtailment speeds triggered in Section 6.3.1 do not have associated out-of-pocket costs, except for where Changed Circumstance 9.1.3 (New Technology and Information) is triggered. For mitigation, the primary adaptive management response to mitigation will be replanting, the specifics of which will be provided in the mitigation project management plan and Changed Circumstance 9.1.4 (Change in Mitigation Project Viability). Other additional costs triggered by adaptive management or Changed Circumstances include but are not limited to the cost of an additional year of Intensive Monitoring, or the cost of a summer bat survey (Section 9.1.7, summer bat survey cost estimated by WEST, Inc. to be $30,000).

It is impossible to predict precisely the extent or magnitude that Changed Circumstances or adaptive management responses may be triggered over the course of the ITP term. Further, the conservation program has been designed so that triggering adaptive management responses is unlikely. However, to account for the potential that one or more Changed Circumstances or adaptive management responses may be required over the course of the ITP term, the Applicant is establishing a Contingency Fund in an amount that is estimated would be needed to respond to a hypothetical changed circumstance at a mitigation site and to pay for a full year of Intensive Monitoring. The Applicant presumes that habitat restoration or preservation will be the mitigation method selected and that a Changed Circumstance may occur that would require re-planting of 50% of the Phase I mitigation acreage. The Applicant will provide funding assurances for the cost of replanting 50% of the Phase I acreage, which has been estimated by potential mitigation providers as $38,325 ($350 per acre for 50% of the anticipated 219 acres of Phase I mitigation). If another form of mitigation is selected, the mitigation plan submitted to USFWS for approval may contain additional adaptive management measures, changed circumstances, monitoring and funding assurances that are tailored to that mitigation. As such, this section is not intended to limit the expenditure of mitigation-specific funding assurances to the cost estimates included in Section 7.5.

The Applicant will also provide funding assurances for the cost of one-year of Intensive Monitoring ($277,500), for a total of $315,825 in funding assurances. The cost of a summer bat survey is approximately $30,000 based on estimates provided by WEST, Inc. In the event that this Changed Circumstance response is triggered, the $315,825 funding assurances and the four times replenishing nature (described below) of the Contingency Fund would address this cost.

The Applicant will provide additional security in an amount equal to $315,825 in the form of (1) a corporate guarantee, (2) a performance bond, or (3) an irrevocable letter of credit, the form of which will be approved by the USFWS prior to ITP issuance. The security amount will total $315,825 exclusive of fees or interest associated with the security. This funding assurance will be secured and provided to FWS within 90 days of ITP issuance. Notwithstanding the No Surprises Assurances, while the Applicant intends that these costs will be borne by the O&M budget, should the Applicant's O&M budget be unavailable to pay these costs and the security be drawn down, the Applicant commits to replenishing the security up to but not to exceed four additional times. This estimated number is based on the number of times the monitoring adaptive management response could be triggered before moving to 6.9 m/s and avoiding take. Replenishment will occur when the security totals less than $50,000. In that event, the Applicant will ensure the security is restored to its full amount ($315,825) within 90-days of the balance reaching that threshold. This should reasonably allow funding for response actions should a Changed Circumstance or adaptive management response be triggered and allow for a reasonable contingency should costs exceed initial estimates.

During the ITP term, the Applicant may elect to change its form of security while maintaining the same level of funding for the Changed Circumstance, Adaptive Management, and Contingency Fund, subject to FWS approval as to form. In this instance, the Applicant will notify the USFWS and provide the requisite information. In all instances, any changed form of security will be approved by FWS in advance and provided to FWS before the security it is replacing expires such that there will be no lag time during which funding assurances are secured. Changes in funding are contemplated in the HCP Handbook and will follow the guidance provided therein. (USFWS and NMFS 2016).

7.5 Funding Assurance Cost Estimates

Table 7.1 Funding assurance cost estimates, by task, for the Blue Creek Wind Farm Habitat Conservation Plan.

HCP Task	First Year Cost	ITP Years in which Cost Incurred	Total Estimated Cost	Funding Assurance	Timing of Funding
Compliance Monitoring					
Intensive Monitoring	$ 277,500	ITP years 1, 2, 7, 12, 17, 22, 27, 32	$ 3,638,540[1]	Annual costs will be assured through (1) certification from a corporate representative that the costs are included in the annual O&M budget for the monitoring year or (2) a provision of a contract with a third party for the upcoming Intensive Monitoring	February 1 during each monitoring year
Operations Wildlife Monitoring	--	ITP years 3-6, 8-11, 13-16, 18-21, 23-26, 28-31, 33-35	--	Costs incorporated as part of corporate policies and included as part of Project's annual O&M budget	N/A
Compliance Monitoring Subtotal					$ 3,638,540
Mitigation					
Mitigation (Phase I) (land acquisition, mitigation monitoring and reporting, long-term stewardship fund, management plan and work implementation)	$ 2,365,210	ITP Year 1 or 2	$ 2,365,210	Executed contract with mitigation provider or security (irrevocable letter of credit, corporate guarantee, performance bond).	Within 90 days of ITP issuance
Mitigation (Phase II)	--	ITP Year 19	$ 2,761,421[1]	"Stay-ahead" funding as described in Section 7.3.	By ITP Year 19
Mitigation Subtotal					$ 5,126,631
Additional Assurances					
Changed Circumstances, Adaptive Management, and Contingency fund	N/A	ITP Year 1	$ 315,825	Corporate guarantee, performance bond, or irrevocable letter of credit replenished up to 4 times as described in Section 7.4.	Within 90 days of ITP issuance
Additional Assurances Subtotal					$ 315,825
Total Funding Assurances					**$ 9,080,996**

[1] Average annual inflation of 3.0% was used to project these cost estimates for future years

8.0 ALTERNATIVES CONSIDERED

ESA implementing regulations 50 CFR § 17.22 (b)(1)(iii)(C) and 17.32 (b)(1)(iii)(C) state that an HCP submitted in support of an ITP application must describe "what alternative actions to such taking the applicant considered, and the reasons why such alternatives are not proposed to be utilized." The HCP Handbook (USFWS 2016) indicates that the applicant "should focus on significant differences in project design that would avoid or reduce the take." In evaluating potential alternatives, ESA Section 10(a)(2)(B)(ii) provides that the USFWS shall issue an ITP if the Applicant's proposed alternative "will, to the maximum extent practicable, minimize and mitigate the impacts of such [incidental] taking." Because the Project is already constructed and operating, the alternatives available to avoid take of Covered Species at the Project would be turbine operational adjustments for avoiding or minimizing take of these species.

8.1 Proposed Alternative

Under the proposed alternative, the Applicant would follow the conservation program as identified in this HCP. The proposed conservation program provides the optimal balance of reducing take of the Covered Species and maximizing renewable energy production in a way that allows for economic viability throughout the life of the Project.

8.2 Avoidance Alternative

Under the avoidance alternative, Project turbines would be fully feathered at wind speeds below 6.9 m/s (22.6 ft/s) from one half-hour before sunset to one half-hour after sunrise during the fall migratory period (August 1 – October 31) and during the spring migratory period (March 15 – May 15) at all turbines. With the Project implementing these turbine operational adjustments during the extended spring and fall seasons, the USFWS indicated in their Technical Assistance Letter (TAL) to the Project (dated March 3, 2015) that take of the Covered Species will be avoided or is unlikely. Because take of Covered Species would be unlikely, an HCP would not be developed and an ITP would not be issued.

Under the Avoidance Alternative, the short-term interim operational adjustments being employed by the TAL would be employed for the duration of the Project. Operating under the TAL for the life of the Project is not viable for the Project, which is why the Project is seeking this ITP. The Avoidance Alternative fails to meet Project's purpose and need because power production loss is estimated to be greater than 10 times the Proposed Alternative. The long-term projections for operational and financial benefits of the Project could not be realized and renewable energy production would be either greatly diminished or stopped entirely.

In summary, the Avoidance Alternative does not meet the Project's purpose and need because the environmental benefits of renewable energy would not be realized should the Project become economically unfeasible (Section 5.1, Biological Goal 3). Therefore the Avoidance Alternative was considered, but rejected in favor of the proposed alternative.

8.3 Higher Curtailment Alternative

Under the Higher Curtailment Alternative, Applicant would raise its cut-in speeds for all turbines to 6.5 m/s (21.3 ft/s ft) from one half-hour before sunset to one half-hour after sunrise during the spring migratory period (April 1 – May 15) and during the fall migratory period (August 1 – October 15). Based on publicly available data from other wind energy facilities, increasing cut-in speed to 6.5 m/s (21.3 ft/s) could reduce the potential for all-bat mortality, including Covered Species take, by 72-82% (average 77%) when compared to the manufacturer-recommended cut-in speed (see Table 5.2).

As noted in Section 8.2, the USFWS has indicated that take of Covered Species would be unlikely at cut-in speeds of 6.9 m/s (21.3 ft/s) or greater. Under the Higher Curtailment Alternative, take of Covered Species may occur, albeit at reduced levels. For the same reasons as the Avoidance Alternative, the Higher Curtailment Alternative fails to meet Project's purpose and need because power production loss is estimated to be approximately 8 times the Proposed Alternative. Furthermore, a Higher Curtailment Alternative would have a lower take limit, which poses challenges to conduct Compliance Monitoring using the USFWS-recommended EoA approach required to ensure the project would be in compliance with its ITP. If reduced by 77%, Covered Species take at the Project would be predicted to be 1.43 Indiana bats/year and 0.97 northern long-eared bat/year. Demonstrating ITP compliance using EoA becomes problematic when take is near or below one bat per year. Thus these lower take limits would require a doubling of monitoring effort and costs to maximize the probability of detection; even with this significantly increased effort, monitoring may not be able to reliably demonstrate compliance with the ITP. Therefore the Higher Curtailment Alternative was considered, but rejected in favor of the proposed alternative. Other curtailment alternatives implemented over the life of the project would similarly cause the Project to become economically unfeasible due to reduction of power production, and the renewable energy production of the Project would be foregone. Therefore, other alternatives were not further considered.

9.0 CHANGED AND UNFORESEEN CIRCUMSTANCES

9.1 Changed Circumstances

Under the USFWS's regulations, Changed Circumstances are those "changes in circumstances affecting a species or geographic area covered by a conservation plan or agreement that can reasonably be anticipated by plan or agreement developers and the Service and that can be planned for" (50 CFR 17.3; 1975). As discussed in the HCP Handbook with respect to foreseeable Changed Circumstances, the HCP should discuss measures developed by the Applicant to address such changes over time.

The Applicant believes the following are foreseeable Changed Circumstances warranting planning considerations:

- Climate change: change in migration dates;
- Delisting of a Covered Species;
- New technology or information that improves monitoring mortality, estimating mortality, and/or minimizing or avoiding mortality;
- Changes in mitigation project viability;
- Early decommissioning or other substantive change in Project operation;
- White-Nose Syndrome Impacts are Greater than Anticipated; and
- Discovery of New or Previously Unidentified Maternity Colony

Pursuant to the "No Surprises" Rule and regulations (USFWS 1998; 63 FR 8859 [February 23, 1998]), if the USFWS determines that additional conservation and mitigation measures are necessary and such measures were addressed in this HCP, implementation is required (50 CFR 17.22(b)(5)(i); 1985). If the USFWS determines that additional conservation and mitigation measures are necessary, but they were not provided for in the plan, such conservation and mitigation measures will not be required of the Applicant without its consent (50 CFR 17.22(b)(5)(ii); 1985).

9.1.1 Climate Change: Change in Migration Dates

Climate change is ongoing and the effects on species are considered reasonably foreseeable. Climate change may influence the phenology of migratory species, resulting in changes in the timing of spring and fall migration. For example, warmer temperatures may allow Covered Species to leave hibernacula earlier and remain in summer habitat longer (Meretsky et al. 2006, Rodenhouse et al. 2009), pushing the dates of spring migration earlier in the year and the dates of fall migration later in the year.

In the event that the timing of Covered Species spring or fall migration changes, the timing of Covered Species mortality at the Project could change, warranting a response by the Applicant.

<u>Trigger</u>

The USFWS releases a final publication in the Federal Register (e.g., of a revised recovery plan, 5-year status review) noting a shift in the timing of Covered Species spring or fall migration, a peer-reviewed publication documents such a shift, or the carcass of a Covered Species is discovered incidentally at the Project or at another wind energy facility in Ohio during the early spring or late fall seasons (i.e., before April 1 or after October 15).

Response

If triggered, the Project will shift avoidance and minimization measures being implemented at the time of the notice (i.e., wind speed, temperature thresholds, etc.) to match the new migration dates. This change will entail shifting the start and end dates while maintaining the duration of the avoidance and minimization period. The change will be implemented during the next season after publication or notification by the USFWS. The cost associated with these operational adjustments will be accounted for through lost revenues and will not require financial assurances.

If a Covered Species fatality is discovered in early spring or late fall outside of the existing survey season, the Applicant will notify the USFWS within 24 hours of positive identification and implement the spring and fall minimization strategies described in Section 5.2.2.

9.1.2 Delisting of a Covered Species

Over the ITP term, one or both of the Covered Species could be delisted under the ESA. Therefore, delisting of a Covered Species is considered a foreseeable Changed Circumstance.

Trigger

Over the term of the ITP, one or more of the listed Covered Species could become delisted under the ESA through the promulgation of a final rule delisting the species. In the event that USFWS delists a listed Covered Species, the provisions of this changed circumstance will be triggered.

Response

If a listed Covered Species becomes delisted over the term of the ITP, the Applicant will coordinate with the USFWS in review of the final delisting rule to evaluate and identify the applicable elements of the ITP that are not necessary to preclude a potential relisting of the species. With concurrence of the USFWS, any elements of the ITP that are not deemed to be necessary to maintain the species delisting will no longer be required to be implemented. Elements that are deemed necessary by the USFWS in its final delisting rule to maintain the delisting status will continue to be implemented. All mitigation for take incurred up until the time of the delisting must be implemented in accordance with the terms of the ITP. All mitigation that has been implemented prior to delisting will be required to be maintained as provided for in the HCP and terms of the permit. Mitigation, monitoring, changed circumstance, and adaptive management funding assurances that are specific to the delisted species and are provided by the Applicant in advance of any taking of the Covered Species following its delisting will be de-obligated.

9.1.3 New Technology and Information

Over the ITP term, new information on Covered Species and bat/wind energy interactions is likely to become available, such as new methods for monitoring or estimating mortality, new or alternative methods for evaluating mitigation credit, new technology to treat WNS, or new technology to minimize or avoid bat mortality from wind turbines. The Applicant may wish to incorporate new information, methods, or technology into the operations and monitoring plans or conservation program outlined in the HCP. These types of technological advances and new information may be used to improve the ability to estimate take, maximize the effectiveness of the minimization, mitigate the impacts of the take, or improve monitoring associated with the Project and this HCP.

Trigger

At its sole discretion, the Applicant will notify the USFWS of its desire to utilize the new technology or information. These methods will be based on the best available science, be as effective as or more effective than the methods described in this HCP, be logistically feasible, be cost-effective, and will not require an increase in the take authorization for the Project, and will be subject to approval by USFWS.

Response

Prior to implementing any new measures, the Applicant will meet and confer with the USFWS to discuss the new method(s) and how they will be implemented. The Applicant will then incorporate the new measures into the HCP. The Applicant will work with the USFWS to ensure that any new methods or technologies that are used are compatible with the Biological Goal and Objectives of this HCP. Any new technology implemented will be paid for out of the O&M budget. The inclusion of new technology will be memorialized through a note to the file maintained by USFWS. If the new method or technology was not sufficiently analyzed under ESA and NEPA, the Applicant will pursue a formal permit amendment (HCP Handbook; USFWS and NMFS 2016). The monitoring study plan will be determined in coordination with the USFWS.

9.1.4 Change in Mitigation Project Viability

This Changed Circumstance addresses the unlikely potential for deforestation (such as a result of fire, flooding, drought, invasive species, contaminant spills, or other disasters that many impact the success of the mitigation project) of a portion of the mitigation project.

Trigger

Results of mitigation effectiveness monitoring indicate that a mitigation site no longer meets general or site-specific Performance Criteria (Section 5.2.3).

Response

The Applicant will coordinate with the USFWS to calculate the remaining amount of take (i.e., the impact of any take projected to occur over the remainder of the ITP term that was not already offset by the mitigation project); this calculation will be based on monitoring data results and the REA model. The Applicant will then work with the USFWS to evaluate potential options for offsetting the remaining amount of authorized take. These options may include: 1) restoration of the mitigation project in accordance with the management plan (as described in Section 5.2.3); 2) purchase of credits (in the amount of the remaining take) from a USFWS approved bat conservation/mitigation bank in Ohio; 3) securement of an additional mitigation project that complies with all mitigation components in Section 5.2.3 and is approved by USFWS to offset the remaining amount of take; 4) contribution to WNS remediation effort(s); or 5) contribution to bat conservation fund(s); Options 1 and 3 will follow the relevant conditions of the management plan or requirement set forth in Section 5.2.3. Options 2, 4 and 5 are not yet available within USFWS Region 3. Should Options 2, 4 or 5 become available and the Applicant and USFWS agree they are appropriate responses here, the Applicant will work with USFWS to amend the HCP to incorporate these options. Should the Applicant and the USFWS not agree on the appropriate response within one (1) year, the Applicant will implement Option 1 or 3.

Once the appropriate response has been determined and either USFWS agrees with the response or the one (1) year window for agreement has lapsed, the Applicant will implement the response as soon as practical but no longer than within one (1) year from determining the appropriate response. The Applicant intends that the cost of the selected option would be paid for out of the O&M budget, or, in the unlikely event that O&M budget does not cover these costs, the selected option would be paid for through Changed Circumstances, Adaptive Management, and Contingency funding (Section 7.4 and 7.5).

9.1.5 Early Decommissioning or Similar Substantive Changes in Plant Operation

If the Project is decommissioned or if turbines are otherwise not operational prior to the end of the 35-year permit term, take, which is a direct result of turbine operation, will also stop.

<u>Trigger</u>

The Project is decommissioned prior to the end of the 35-year permit term pursuant and all turbines cease operating. In the event that the Project operations decrease substantially but do not quite trigger formal decommissioning (such as a long-term temporary pause in Project operation), this Changed Circumstance is also triggered.

<u>Response</u>

In the event that the Project is decommissioned prior to the end of the 35- year permit term, Compliance Monitoring, reporting, and other expectations related to measuring the level of take described in this HCP will cease because no take will be occurring. Given the timing of mitigation commitments described in Section 5.2.3, in which mitigation is funded and implemented prior to the anticipated take, no additional mitigation will be required. Because mitigation funding will be funded prior to take occurring (Section 7.3), no additional costs are associated with implementing a full decommissioning changed circumstance.

9.1.6 White-Nose Syndrome Impacts are Greater than Anticipated

It is difficult to predict at this time what the long-term effects of WNS will be on the Covered Species. Should WNS reductions prove to be more severe over the long term than assessed in this HCP (Sections 4.1.4 and 4.2.4), the impact of the permitted level of take on the populations of either or both Covered Species may be greater than expected, then the Applicant will evaluate this changed circumstance with respect to the impact of the permitted level of take. Under this changed circumstance, take from the Project may be less likely, due to lower than expected population levels, but it will nevertheless be important for the Applicant to re-evaluate the impact of the permitted level of take. Therefore, the Applicant has planned for the event that WNS-caused reductions in Indiana bat and/or northern long-eared bat populations are greater than assessed in this HCP.

<u>Trigger</u>

USFWS notification that cave counts or hibernaculum emergence surveys or other relevant population estimates arrived at using USFWS methods for northern long-eared bats (e.g., (USFWS 2015b) in the MRU (Indiana bats) or Region 3 (northern long-eared bat) document a trend of WNS impacts that are more severe than contemplated in this HCP's analyses (i.e., greater than a 72% Indiana bat decline from the 2019 population estimates provided in the impact of take analysis in Sections 4.1.4 or greater than a 98% northern long-eared bat decline as considered in the impact of take analysis in Section 4.2.4) at any time during the permit term. Notification must include the relevant survey results that led the USFWS to conclude this trigger has been met.

<u>Response</u>

The Applicant will work with the USFWS to determine, using the Erickson et al. (2014) or the USFWS-endorsed model at the time, what level of reduced take would cease to result in significant population impacts under scenarios modeled with the observed WNS impacts. The Applicant will evaluate the likelihood that the take level has already been reduced because there are fewer individuals of the Covered Species on the landscape that may be taken by Covered Activities. If the number of bats in the Permit Area is reduced due to WNS, this may mean that take is less likely and no change to the HCP is warranted because take is occurring at a level sufficiently below the ITP authorized amount. If the result of analysis showed that changing the take authorized by the ITP would have a meaningful effect on the trajectory of the MRU (Indiana bat) or Region 3 (northern long-eared bat) populations, the ITP would be adjusted to this level of reduced take for the duration of the ITP term, unless surveys show, at some point in the future, that WNS impacts have relaxed to the levels under which the impact of take was originally evaluated for the Project. In that case, the Applicant would again work with the USFWS to determine, using the Erickson et al. (2014) or the USFWS-endorsed model at the time, if the take level can be restored to the original permitted level without resulting in significant population impacts under scenarios modeled with the newly observed WNS impacts.

If the results of the analysis show that changes to the Project's minimization measures may have a meaningful effect on the trajectory of populations because of the effect of the authorized take within the MRU, the Applicant and USFWS will evaluate what types of additional measures may be available to reduce the impact of the Project's take, taking into account economic and technical feasibility. Examples of adjustments to the HCP minimization measures that will be considered include changes in the turbine cut-in wind speed or temperature, changes in timing of the seasonal turbine operational adjustment period, and deployment of bat deterrent technology, if suitable technology is available.

9.1.7 Discovery of New or Previously Unidentified Maternity Colony

Though risk to Covered Species is not anticipated during the summer maternity season (Sections 3.2.5 and 3.3.5), there is the possibility that new summer maternity colonies may form over the life of the permit, or that a previously unidentified colony may be found. If this is the case, the

Applicant may need to manage risk during the summer maternity period (May 16 to July 31) at some point during the life of the permit.

Trigger

This may be triggered in the following ways:

1) The carcass of a pregnant or lactating female or a juvenile (first-year) individual of the Covered Species is found and the time of mortality is estimated to have occurred between May 16 and July 31.
2) A female or juvenile Indiana bat is captured during summer surveys May 16-July 31 and a 8-km (5-mi) buffer of the capture point of an Indiana bat or a 4.1-km (2.5-mi) buffer of the roost tree of an Indiana bat overlaps with the Permit Area.
3) A female or juvenile northern long-eared bat is captured during summer surveys May 16-July 31 and a 5-km (3-mi) buffer of the capture point of a northern long-eared bat or a 2.4-km (1.5-mi) buffer of the roost tree of a northern long-eared bat overlaps with the Permit Area

The Service will notify the Applicant if a female or juvenile Indiana bat or northern long-eared bat is detected in the summer and a buffer overlaps with the Permit Area, per trigger 2 or 3. Summer presence/absence surveys shall be conducted in accordance with the USFWS mist-netting standards at the time the study is conducted, and all positive identifications shall be made by a USFWS-permitted Indiana bat biologist. Notification to the Applicant must include the relevant survey results that led the USFWS to conclude this trigger has been met.

Response

The Applicant will notify USFWS within 24 hours of identifying the carcass of an Indiana bat or northern long-eared bat during incidental monitoring in the summer. The turbine where the carcass was found will begin operating within 48 hours of positive identification according to the minimization measures for fall migration described in Section 5.2.2 (that is a cut-in speed of 5.0 m/s [16.4 ft/s] between a half hour before sunset to a half hour after sunrise when temperatures are greater than 10 °C [50 °F]). The Applicant will also conduct presence/absence surveys within the Permit area, in accordance with the current USFWS guidelines at the time, in order to search for a new or previously unidentified maternity colony. Should new captures or colonies be found as a result of the Project-level surveys, the Project's turbines that fall within those buffers will also begin operating according to the minimization measures for fall migration described in Section 5.2.2. The application of increased minimization measures for turbines with newly-discovered summer risk will continue for the remainder of the permit term unless supplemental information is collected that summer risk no longer exists.

If USFWS notifies the Applicant that summer surveys have identified captures or colonies that meet the buffer distances described above, the Project's turbines that fall within those buffers will also begin to operate according to the minimization measures for fall migration described in Section 5.2.2 within 48 hours of notification by the FWS.

With any of the above triggers, the Applicant will confer with the USFWS to determine whether the Project's original take estimate is still accurate, if monitoring during summer should be implemented to quantify summer take, and if the mitigation plan will continue to fully offset the impact of the take. If the take estimate is not more than already permitted and the impact of the take is still fully-offset by the mitigation described in this HCP, then no further response is required. If the updated annual take prediction for the Covered Species, projected for the remaining years on the ITP, indicates that take will exceed the amount of take authorization remaining on the ITP, the Applicant will take action expected to keep the project within the authorized take, or will pursue an ITP amendment within one year of the trigger being met. If permitted take will not be exceeded (i.e. Phase II mitigation has not been implemented), but additional mitigation is necessary to fully offset the impact of the take, mitigation will be funded within one year.

9.2 Unforeseen Circumstances

Unforeseen circumstances are defined as changes in circumstances affecting a species or geographic area covered by an HCP that could not reasonably have been anticipated by the Applicant and the USFWS at the time of the development of the HCP, and that result in a substantial and adverse change in the status of a Covered Species (50 CFR 17.3; 1975). If unforeseen circumstances arise, the USFWS will not require the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources otherwise available for development or use under the original terms of the conservation plan and beyond the level otherwise agreed upon for the species covered by the HCP without the consent of the Applicant (50 CFR 17.22(b)(5)(iii)(A)-(B) [1985]). "If additional conservation and mitigation measures are deemed necessary to respond to unforeseen circumstances," and the Applicant is properly implementing the HCP, the USFWS is limited in what it may ask of Applicant. Response measures are limited to "modifications within conserved habitat areas, if any, or to the conservation plan's operating conservation program for the affected species," and any measures must maintain the original terms of the conservation plan "to the maximum extent possible" (50 CFR 17.22(b)(5)(iii)(B) [1985]). Notwithstanding these assurances, nothing in the "No Surprises" Rule "will be construed to limit or constrain the [Service], any federal agency, or a private entity, from taking additional actions, at its own expense, to protect or conserve a species included in a conservation plan" (50 CFR 17.22(b)(6) [1985]).

As described in Section 7.4, the Applicant has provided a Changed Circumstance, Adaptive Management, and Contingency Fund of $315,825 and has committed to replenish this fund up to four (4) additional times. The Applicant considers any single Changed Circumstance requiring a response that exceeds this $315,825 to be an Unforeseen Circumstance,

9.3 Permit Amendment

Any amendments to the ITP and HCP will be made in accordance with 50 CFR 13.23 (1989) and the HCP Handbook (USFWS and NMFS 2016). The Applicant and the USFWS will coordinate and evaluate any amendments to the HCP or ITP to determine the appropriate approach to documenting the amendment and whether prior public notice may be required. Amendments can range from ministerial, clarifying changes to more expansive changes. Where an amendment does not increase the levels of incidental take authorization or expand in ways not analyzed in the original NEPA or ESA Section 7 documents, then public notice will likely not be required. USFWS will determine the level of public participation and analysis or review required to meet statutory and regulatory requirements. Changes not requiring notice in the Federal Register may be made through an exchange of written correspondence between the Applicant and the USFWS. For example, the Applicant may submit a letter to the USFWS explaining a proposed change, and the USFWS may respond with a letter approving of the change. Such a letter will specify the old text, the proposed new text, the reason for the change, the intended effects, and the justification for the modification. USFWS-approved changes will be documented in a note to the Project file.

Amendments that may require HCP or ITP amendment and publication in the FR include:

- Addition of new species, either listed or unlisted,
- Increased level or different form of take for Covered Species,
- Changes to funding that affect the ability of the Applicant to implement the HCP,
- Changes to Covered Activities not previously addressed,
- Changes to Permit Area or Plan Area, and
- Significant changes to the conservation program that have not already been contemplated by this HCP through adaptive management or Changed Circumstances.

9.4 Permit Renewal

As set forth in 50 CFR 13.22 (1989), an ITP term may be renewed at the request of the Applicant if the amount of take authorized in the ITP has not been expended. If the Applicant desires to renew the ITP term, the Applicant will notify the USFWS in writing at least 30 days before the then-current term is scheduled to expire. Monitoring and adaptive management will continue as described in the HCP. Permit renewals are published in the Federal Register and an amendment will likely be needed.

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10.2 Laws, Acts, and Regulations

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Appendix A. Summary of Monitoring Studies

Introduction

Several years of rigorous pre- and post-construction monitoring were conducted at the Blue Creek Wind Farm (BCWF) and provide a robust and site-specific data set to inform the Habitat Conservation Plan (HCP). These studies were originally performed to adhere to the US Fish and Wildlife (USFWS) *Wind Energy Guidelines* (WEG; USFWS 2012), comply with Ohio Department of Natural Resources (ODNR) requirements (ODNR 2011), and adhere with the condition of BCWF's Ohio Power Siting Board (OPSB) certificate.

The purpose of this document is to summarize the key aspects of the monitoring reports to provide further detail on the decision process behind the BCWF's HCP. For each monitoring report, the methods are described and key results presented. Further, temporal and weather patterns were examined to determine if they affected fatality or activity rates so that the operational minimization measures described in the BCWF HCP are tailored to periods and conditions of greatest risk to the Covered Species (Indiana bat [*Myotis sodalis*] and northern long-eared bat [*Myotis septentrionalis*]).

This appendix summarizes the monitoring studies conducted at BCWF that were used to inform and support the conservation plan described in the HCP, including:

- Post-Construction Monitoring (2012, 2013 [including a curtailment study], 2015, and 2016);
- Pre- and Post-Construction Acoustic Studies;
- Post-Construction Fatality and Acoustic Weather Correlation Analyses (2012, 2013, and 2015); and
- Post-Construction Mist Netting Study (2016).

Post-Construction Fatality Monitoring

To meet guidelines described in the WEG (USFWS 2012) and conditions of the BCWF's OPSB Certificate, post-construction monitoring was conducted in 2012, 2013, 2015, and 2016 after the BCWF became fully operational and followed the ODNR Option B post-construction monitoring protocol (ODNR 2011). The objective of monitoring was to document bird and bat fatalities and provide a fatality estimate for the BCWF. Monitoring methods were similar between years, but turbine operations and survey effort differed among years (Table A1).

Table A1. Post-construction fatality monitoring study attributes at the Blue Creek Wind Farm in 2012, 2013, 2015, and 2016.

Study Attribute	2012	2013	2015	2016
Total turbines searched (percent of total)	152 (100%)	152 (100%)	152 (100%)	37 (24%)
Number of turbines per plot size	90 m = 15 turbines 60 m = 23 turbines road-and-pad = 114 turbines	90 m = 15 turbines 60 m = 23 turbines road-and-pad = 114 turbines	90 m = 15 turbines 60 m = 23 turbines road-and-pad = 114 turbines	60 m = 37 turbines
Search interval	Daily = 90 m from turbine 3rd day = 60 m from turbine weekly = road-and-pad	Daily = 90 m from turbine 3rd day = 60 m from turbine, road-and-pad in fall weekly = road-and-pad in spring, summer, and late fall	Daily = 90 m from turbine 3rd day = 60 m from turbine, road-and-pad in fall weekly = road-and-pad in spring, and fall	weekly = 60 m from turbine in spring, twice weekly = 60 m from turbine in fall
Study period	April 1 – November 15	April 1 – November 15	April 1 – November 15	March 15 – May 11, August 1 – October 27[1]
Turbine operational adjustments	Normal operation/ manufacturer cut-in speed until Oct 3, October 4 – November 15 = raised cut-in speed in response to Indiana bat fatality	April 1 – July 31 = normal operation/manufacturer cut-in speed, August 1 – October 15 = curtailment study (see below), October 16 – November 15 = normal operation/manufacturer cut-in speed	March 15 – May 15 = feather below 6.9 m/s, May 16 – July 31 = normal operation/manufacturer cut-in speed, August 1 – October 31 = feather below 6.9 m/s, November 1 – March 14 = normal operation/manufacturer cut-in speed	March 15 – May 15 = feather below 6.9 m/s, May 16 – July 31 = normal operation/manufacturer cut-in speed, August 1 – October 31 = feather below 6.9 m/s, November 1 – March 14 = normal operation/manufacturer cut-in speed
Curtailment study	n/a	In addition to normal ODNR Option B Protocol, a raised cut-in speed of 4.5 m/s (10.1 mph) was tested at 68 of BCWF's turbines during the fall (August 1 – October 15). See Section 2.3.	n/a	n/a
Bias trials	Searcher efficiency and carcass persistence	Searcher efficiency and carcass persistence	Searcher efficiency and carcass persistence	Searcher efficiency and carcass persistence

[1] In 2016, search interval was weekly during the spring and twice weekly during the fall. A full week was not available at the end of each season, therefore ending prior to May 15 in spring and October 31 in fall.

2012 Post-Construction Fatality Monitoring Summary

In 2012, a total of 850 bat carcasses representing eight species were found during scheduled searches and incidentally (observed outside of scheduled search efforts). The most commonly found species of bat was eastern red bat (*Lasiurus borealis*; 468 carcasses; 55.1% of all bat carcasses), followed by hoary bat (*Lasiurus cinereus*; 149; 17.5%), silver-haired bat (*Lasionycteris noctivagans*; 120; 14.1%), big brown bat (*Eptesicus fuscus*; 105; 12.4%), evening bat (*Nycticeius humeralis*; three; 0.4%), Seminole bat (*Lasiurus seminolus*; two; 0.2%), Indiana bat (one; 0.1%), tricolored bat (*Perimyotis subflavus*; one; 0.1%), and one unidentified Lasiurid bat (0.1%).

The estimated all-bat spring, summer, and fall fatality rate for the BCWF in 2012 was 15.51 per megawatt (MW) per study period, calculated using the Huso (2015) estimator. The all-bat spring and fall only fatality rate (the seasons of anticipated potential risk to Indiana bats and northern long-eared bats at the BCWF) was 15.01 per MW per study period, again calculated using the Huso (2015) estimator. Because turbine operation changed after an Indiana bat was found during post-construction monitoring on October 3, the fatality rates were calculated by extrapolating the fall rate from August 1 to October 3 through November 15, to avoid biasing the estimates low due to the change in turbine operation.

The Indiana bat found on October 3, 2012 during a daily scheduled carcass search was located 57 meters (m; 187 feet [ft]) from Turbine 68. The bat was an adult female and did not have signs of decomposition or injury. The bat was estimated to have died the previous night (October 2) or that morning (October 3). The average temperature for the night of October 2 was 17.6 degrees Celsius (°C; 63.7 degrees Fahrenheit [°F]), and ranged from approximately 16 °C – 19 °C (60.8 °F – 66.2 °F). Wind speeds fell from approximately 6.0 m per second (m/s; 13.4 miles per hour [mph]) when the sun set at 1918 hours (H) to below 5.0 m/s (11.1 mph) by approximately 2030 H on October 2. Wind speeds remained below 5.0 m/s (11.1 mph) for over five hours, until approximately 0210 H on October 3, after which point wind speeds picked up for the rest of the night (average wind speed for the whole night was 5.3 m/s [11.7 mph]). Species identification of the bat was made by Dr. K. Murray and T. Sichmeller of Western EcoSystems Technology, Inc. (WEST) on October 3 via photographs and was verified in-hand by Dr. T. Carter with Ball State University on October 4. On October 4, the USFWS and ODNR were notified by BCWF of the Indiana bat and the bat was delivered to K. Lott of the USFWS on October 4 by M. Ritzert of WEST.

2013 Post Construction Monitoring Summary

In 2013, a total of 728 bat carcasses representing six species were found during scheduled searches and incidentally at all turbines, including turbines that were feathered[11] at wind speeds below 4.5 m/s (10.1 mph; see below), and turbines that operated at manufacturer cut-in speed. The most commonly found bat species was hoary bat (270 carcasses; 37.1% of all bat carcasses),

[11] Feathering means that turbine blades are pitched into the wind such that they spin at less than one rotation per minute.

followed by eastern red bat (234; 32.1%), silver-haired bat (152; 20.9%), big brown bat (63; 8.7%), evening bat (four; 0.5%), unidentified bat (three; 0.4%), and Seminole bat (two; 0.3%). No Covered Species or other *Myotis* bats were found.

The estimated all-bat spring, summer, and fall fatality rate for normally operating turbines for BCWF in 2013 was 11.76 per MW per study period, calculated using the Huso (2015) estimator. The all-bat spring and fall only (the seasons of anticipated potential risk to Indiana bats and northern long-eared bats at the BCWF) fatality rate for normally operating turbines was 10.08 per MW per study period, again calculated using the Huso (2015) estimator.

2015 Post Construction Monitoring Summary

In 2015, a total of 375 bat carcasses representing five species were found during scheduled searches and incidentally at all turbines, which were feathered below 6.9 m/s (15.4 mph) during the spring and fall, and operated normally during the summer. The most commonly found bat species was the eastern red bat (156 carcasses; 41.6% of all bat carcasses), followed by the hoary bat (106; 28.3%), silver-haired bat (90; 24.0%), big brown bat (22; 5.9%), and Seminole bat (one; 0.3%). No Covered Species or other *Myotis* bats were found.

The estimated all-bat spring, summer, and fall fatality rate for turbines operating above 6.9 m/s (15.4 mph) during migration and normally during the summer was 7.83 bats/MW/study period, calculated using the Huso (2015) estimator. The all-bat spring and fall only (the seasons of anticipated potential risk to Indiana bats and northern long-eared bats at the BCWF) fatality rate was 5.58 per MW per study period, again calculated using the Huso (2015) estimator.

2016 Post Construction Monitoring Summary

In 2016, a total of 98 bat carcasses representing six species were found during scheduled searches and incidentally at all turbines, which were feathered below 6.9 m/s (15.4 mph) during the spring and fall. The most commonly found bat species was the eastern red bat (36 carcasses; 40.5% of all bat carcasses), followed by the silver-haired bat (29; 32.1%), hoary bat (23; 17.9%), big brown bat (7; 6.0%), evening bat (1; 1.2%), Seminole bat (1; 1.2%), and an unidentified bat (1; 1.2%). No Covered Species or other *Myotis* bats were found.

The estimated all-bat spring and fall (the seasons of anticipated potential risk to Indiana bats and northern long-eared bats at the BCWF) fatality rate was 1.62 bats/MW/study period, calculated using the Huso (2015) estimator.

Temporal and Temperature Correlates of Fatality Patterns Analysis

<u>Temporal Patterns in Fatalities</u>

To tailor the operational minimization measures described in the BCWF HCP to the periods of highest risk, the timing of bat fatalities was examined to identify seasonal patterns. For this analysis, only bats estimated to have perished the previous night that were found on daily search plots were used to evaluate the seasonal timing of bat fatalities. In 2012, approximately 19% were found in April through June. The number of carcasses found during daily searches increased in

July (approximately 31% of bat carcasses) and was highest in August through October 15 (approximately 49% of the bat carcasses) before decreasing between October 16 and November 15 (approximately 2% of the bat carcasses). In 2013, approximately 20% of the bat carcasses found during daily searches were found in April through June. The number of carcasses found during daily searches decreased in July (approximately 6% of bat carcasses) and was highest in August through October 15 (approximately 77% of the bat carcasses) before decreasing between October 16 and November 15 (0% of the bat carcasses).

Based on the seasonal analysis, most bat fatalities occurred August 1 – October 15. Combined with the data from other curtailment studies described in Section 5.2.2 of the HCP, raising cut-in speeds during the fall migration period as a conservation measure in the BCWF HCP would provide the greatest potential reduction in impacts to Covered Species.

Fatality Patterns Related to Temperature

To tailor the operational minimization measures described in the BCWF HCP to the conditions of highest risk, the relationship between the average nightly temperature and bat fatalities was examined. For this analysis, data was limited to carcasses estimated to have perished the previous night and the mean temperatures during the assumed night the fatality occurred (Good and Adachi 2015). The number of fatalities per turbine search was calculated for each temperature class and summed (see Table A2). The number of fatalities per turbine search per temperature class was divided by the total to calculate the proportion of fatalities per turbine search per temperature class.

Table A2. The proportion of nights and bat fatalities per turbines searched (at turbines with a 3.0 meters per second [6.7 miles per hour] cut in speed during the entire monitoring period) that fell within each temperature class at Blue Creek Wind Farm from April 1, 2012 – November 15, 2012. Temperature is presented as the nightly average.

	Nights				Fresh Fatalities per Turbines Searched	
Temperature °C (°F)	**# of Nights**	**Proportion**	**# of Fatalities**	**# of Turbine Searches**	**Fatalities per Turbine Searches**	**Proportion**
≤< 0 (≤< 32)	0	0	0	0	0.000	0.00
0 to 4.9 (32 to 39.4)	10	0.04	0	150	0.000	0.00
5 to 9.9 (41 to 49.9)	28	0.12	3	420	0.007	0.01
10 to 14.9 (50 to 58.9)	34	0.15	13	508	0.026	0.05
15 to 19.9 (59 to 67.9)	51	0.22	48	731	0.066	0.13
20 to 24.9 (68 to 76.9)	61	0.27	92	846	0.109	0.21
25 to 29.9 (77 to 85.9)	41	0.18	66	579	0.114	0.21
≥30 (≥86)	4	0.02	12	59	0.203	0.39
Total	**229**	**1.00**	**234**	**3293**	**0.525**	**1.00**

In 2012, the percentage of bat carcasses per turbine searched that occurred when average temperature was greater than 10 °C (50 °F) was 99%, whereas 84% of nights had an average temperature above 10 °C (50 °F; Figure A1, Table A2). In 2013, percentage of bat carcasses per turbine searched that occurred when average temperature was greater than 10 °C (50 °F) was

88%, whereas 60% of nights had an average temperature above 10 °C (50 °F; Figure A1, Table A3).

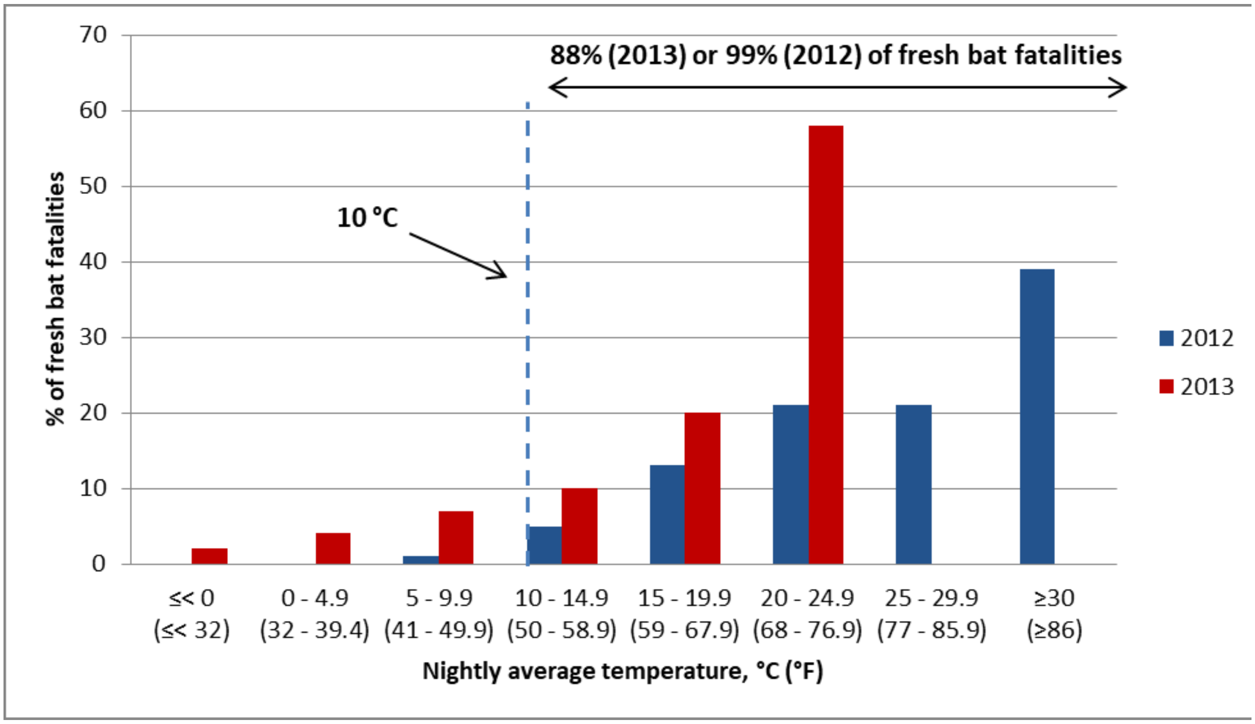

Figure A1. Bat fatality percentages at normally operating turbines within each temperature class at Blue Creek Wind Farm from April 1 – November 15, 2012 and April 1 – November 15, 2013. Temperature is presented as the nightly average.

Table A3. The proportion of nights and bat fatalities per turbines searched (at turbines with a 3.0 meters per second [6.7 miles per hour] cut in speed during the entire monitoring period) that fell within each temperature class at Blue Creek Wind Farm from April 1 – November 15, 2013. Temperature is presented as the nightly average.

	Nights				Fresh Fatalities per Turbines Searched	
Temperature °C (°F)	# of Nights	Proportion	# of Fatalities	# of Turbine Searches	Fatalities per Turbine Searches	Proportion
≤ 0 (≤ 32)	24	0.11	4	647	0.006	0.02
0 to 4.9 (32 to 39.4)	25	0.11	8	644	0.012	0.04
5 to 9.9 (41 to 49.9)	40	0.18	27	1247	0.022	0.07
10 to 14.9 (50 to 58.9)	57	0.25	55	1679	0.033	0.10
15 to 19.9 (59 to 67.9)	66	0.29	127	1934	0.066	0.20
20 to 24.9 (68 to 76.9)	13	0.06	73	388	0.188	0.58
25 to 29.9 (77 to 85.9)	0	0.00	0	0	0.000	0.00

Based on the above analysis of temperature and fatalities, there were more fatalities found per turbine search when temperatures were above 10 °C (50 °F). Specifically, percentage of fatalities found when temperatures were above 10 °C (50 °F) was 99% and 88% in 2012 and 2013, respectively. Thus, selecting a 10 °C (50 °F) temperature threshold as a conservation measure in the BCWF HCP would provide significant reduction in risk to Covered Species at temperatures where bats have been demonstrated to be the most at risk for collision. Based on the 2012 and 2013 data, curtailing turbines when temperatures are below 10 °C (50 °F) would provide little conservation benefit to the Covered Species.

2013 Curtailment Study Results

The curtailment study occurred during the fall migratory period for Indiana bats (August 1 to October 15), concurrent with the 2013 post-construction monitoring. One hundred thirty-seven (137) of the 152 turbines were included in the study and turbines were searched at three-day intervals. Twenty-three of the turbines were searched within 60 m (197 ft) of turbines and the gravel roads and pads of 114 turbines were searched within 100 m (328 ft) of turbines.

Consistent with other studies that used an increase of 1.5 m/s (3.4 mph) higher than the manufacturer setting, cut-in speed was increased to 4.5 m/s (10.1 mph) at half of the study turbines (68 of the 137 turbines). Turbines were feathered during the study period beginning one hour after sunset and ending one hour before sunrise because 99% of bat activity recorded during the 2012 post-construction surveys occurred from one hour after sunset to one hour before sunrise. The remaining 67 turbines in the study group were operated normally, without feathering and at a cut-in speed of 3.0 m/s (6.7 mph).

A total of 252 bat fatalities were found at the 137 turbines included in the curtailment study. More bat fatalities were found at the control turbines where cut-in speed was unchanged (154 fatalities) than the treatment turbines (98 fatalities). Species composition was similar between the control and treatment turbines with hoary bats being the most commonly found species (40.3% and 42.9% of fatalities, respectively), followed by eastern red bats (34.4% and 34.7% of fatalities, respectively). No *Myotis* were found during the study.

Results of the curtailment study showed a significant decrease in fatality rates at turbines where the cut-in speed had been increased to 4.5 m/s (10.1 mph) as compared to normally-operating turbines. Bat mortality at turbines that were feathered at 4.5 m/s (4.17 bats/MW/study period [August 2 – October 15]; 3.07 – 5.27 90% confidence interval [CI]; Shoenfeld estimator) was 40% lower than bat mortality at the normally operating turbines (7.01 bats/MW/study period [August 2 – October 15]; 5.53 – 8.8 90% CI; Shoenfeld estimator).

Summary of Post-Construction Fatality Data

One Indiana bat fatality was found at the BCWF in 2012 and no Indiana bat or *Myotis* fatalities were found at the BCWF in 2013. Based on temperature and wind speeds measured on the night the Indiana bat died in 2013, it is unlikely turbines would have been operational during the period of highest risk under the proposed HCP minimization plan. The highest percentage of bat fatalities in 2012 (49%) and 2013 (77%) occurred August 1 – October 15, which supports that the fall migration period is the season of highest risk to Covered Species. Most fatalities occurred when temperatures were above 10 °C (50 °F) in 2012 (99%) and 2013 (88%); therefore, a 10 °C (50 °F) temperature threshold was proposed as a conservation measure in the BCWF HCP to provide significant reduction in risk to Covered Species at temperatures where bats have been demonstrated to be the most at risk for collision. Finally, although raising cut-in speeds to 4.5 m/s (10.1 mph) resulted in a 40% reduction in bat fatalities at the BCWF, BCWF selected 5.0 m/s (16.4 mph) as a conservative operational measure in the HCP to further minimize impacts to the Covered Species.

Bat Acoustic Studies

To characterize bat activity at the BCWF, acoustic monitoring data of bat vocalizations were recorded during four years; one year during pre-construction in 2009 (BHE Environmental 2010), and three years during post-construction in 2012 (Ritzert et al. 2013), 2013 (Good et al. 2014a), and 2015 (Good et al. 2016b). Acoustic data were evaluated to determine (1) species composition, specifically the presence of Indiana bats and northern long-eared bats; (2) seasonal characteristics of bat activity; (3) daily characteristics of bat activity; and (4) the correlation between bat activity and temperature. The methodology for data collection and analysis followed protocol described in the ODNR On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio, and an Addendum to the Ohio Department of Natural Resource’s Voluntary Cooperative Agreement (ODNR Protocol; ODNR 2009) for pre- and post-construction wind project monitoring.

During pre-construction acoustic monitoring at the BCWF, bat acoustic monitors were attached to the single meteorological (met) tower within the proposed BCWF. Acoustic monitoring was conducted March 15 – November 15, 2009. Two AnaBat units with built-in microphones (model AnaBat II) were used to record bat vocalizations at the met tower, with one unit elevated to 2.5 m (8 ft) above ground level (AGL), and a second unit elevated to 45 m (148 ft) AGL. Microphones were enclosed in weather-resistant housing and connected via cables to Anabat units on the ground. Sound reflector plates were positioned beneath the microphone at 15 degrees below horizontal so that the detector cone of receptivity was oriented at 45 degrees.

Post-construction acoustic monitoring in 2012, 2013, and 2015 was conducted from two met towers (at this time a second met tower had been added to the existing 2009 met tower) within the BCWF during wind turbine operation. Two AnaBat units (model SD1) were used to record bat activity at each met tower April 1 – November 15, with one microphone elevated to 5 m (16 ft) above ground level (AGL), and a second microphone elevated to 50 m (164 ft) AGL. Similar to the methods used in 2009, each microphone was encased in a weather-resistant 45-degree angle polyvinyl chloride (PVC) tube with drain holes drilled in the PVC. The sensitivity on the AnaBat detectors was set to six to reduce background noise and increase discrimination of bat calls in order to maximize the number of high quality bat calls recorded.

For all monitoring years, bat detectors operated nightly from 30 minutes before sunset to 30 minutes after sunrise. This methodology followed the ODNR Protocol for acoustic monitoring (ODNR 2009). Bat call passes, recorded using the detectors, were defined as a sequence of at least two echolocation pulses produced with no pause between pulses of more than one second (Fenton 1980), were analyzed to characterize species and to determine correlations with temporal and temperature variation.

Bat calls were divided into frequency types which correspond to taxonomic groups, thereby providing information regarding the species of bats that were observed. Bat passes occurring at frequencies greater than 30 kilohertz (kHz) were defined as high-frequency (HF), and bat passes below 30 kHz were defined as low-frequency (LF). Because *Myotis* species that may occur within the geographic range of the BCWF each emit high-frequency calls, this classification is commonly used to roughly distinguish species groups. Species of bats whose range overlaps with the BCWF and their frequency categorization are provided in Table A4.

Table A4. Bat species which have ranges that potentially overlap with the Blue Creek Wind Farm (Harvey et al. 1999, Bat Conservation International 2011), defined by call frequency (measured in kilohertz).

High-Frequency (> 30 kHz)	Low-Frequency (< 30 kHz)
eastern small-footed bat	big brown bat
little brown bat	silver-haired bat
northern long-eared bat	hoary bat
Indiana bat	
tri-colored bat	
eastern red bat	
evening bat	

Bat Species Identification

Acoustic data were analyzed to determine if Covered Species (Indiana bats and/or northern long-eared bats) were detected at the BCWF. WEST analyzed all acoustic bat call data from the BCWF using both quantitative (i.e. using USFWS-approved automated call identification software) and qualitative analyses (requiring visual examination and characterization of call spectral energy distribution by experienced personnel) following methods described in the current USFWS Indiana bat summer survey guidelines (USFWS 2017). It is common for quantitative software analysis to misidentify species, especially when poor quality calls are classified. Qualitative analysis is the best available method to identify calls accurately (USFWS 2017), and is considered a more accurate method for call identification than is automated acoustic bat identification. Species identified by acoustic monitoring by year are provided below for HF species observed.

2009 Pre-Construction Acoustic Monitoring

No bat calls of *Myotis* species (i.e. for the BCWF, Indiana bats, northern long-eared bats, little brown bats [*Myotis lucifugus*], or eastern small-footed bats [*Myotis leibii*]) were identified by either Bat Call Identification software (BCID) or qualitative analysis in 2009 (Table A5).

Table A5. BCID and qualitative analysis species identifications for high frequency bat calls (minimum frequency > 30 kilohertz) recorded at each acoustic survey station for the Blue Creek Wind Farm prior to construction in 2009.[1]

Acoustic Station	Identification Method	LABO	MYLU	MYSE	MYSO	NYHU	PESU	UNK	Total
BC1-2.5m	BCID	9	0	**0**	**0**	6	4	0	19
	Qualitative	42	0	**0**	**0**	0	3	5	50
BC1-45m	BCID	8	0	**0**	**0**	2	5	0	15
	Qualitative	30	0	**0**	**0**	0	1	4	35
Total	BCID	17	0	**0**	**0**	8	9	0	34
	Qualitative	72	0	**0**	**0**	0	4	9	85

[1] LABO = eastern red bat, MYLU = little brown bat, MYSE = northern long-eared bat, MYSO = Indiana bat, NYHU = evening bat, PESU = tri-colored bat, UNK = bat call of unknown species

2012 Post-Construction Acoustic Monitoring

BCID classified 11 Indiana bat calls, but none of these calls were verified by qualitative analysis (Table A6), and therefore are not considered to be Indiana bat calls. Seven of these calls were reclassified as eastern red bats by qualitative analysis, two were reclassified as little brown bats, one was reclassified as an unknown *Myotis* species, and one was reclassified belonging to the big brown/silver-haired bat group. No northern long-eared bats were identified. As for other Myotis in the sample, BCID classified a total of six little brown bats in 2012; two of these calls were verified by qualitative analysis. Three of the calls were reclassified as eastern red bat and one was reclassified as belonging to either little brown or eastern red bats. One call identified as Myotis species by qualitative analysis was recorded during late spring (May 11) and could not be identified to species because it consisted of fragmented calls and approach-phase calls.

Table A6. Summary of BCID and qualitative analysis species identifications for high frequency bat calls (minimum frequency > 30 kilohertz) recorded at each acoustic survey station for the Blue Creek Wind Farm in 2012.[1]

Acoustic Station	Identification Method	LABO	MYLU	MYSE	MYSO	UNMY	NYHU	PESU	UNK	Total
BC1-5m	BCID	153	2	**0**	**3**	0	23	91	14	286
	Qualitative	664	1	**0**	**0**	0	0	0	14	679
BC1-45m	BCID	63	0	**0**	**0**	0	8	33	6	110
	Qualitative	559	0	**0**	**0**	0	0	0	7	566
BC2-5m	BCID	121	4	**0**	**5**	0	21	97	17	265
	Qualitative	600	3	**0**	**0**	1	0	7	12	623
BC2-45m	BCID	108	0	**0**	**3**	0	11	55	11	188
	Qualitative	638	0	**0**	**0**	0	0	1	8	647
Total	BCID	445	6	**0**	**11**	0	63	276	48	849
	Qualitative	2462	4	**0**	**0**	1	0	8	42	2,515

[1] LABO = eastern red bat, MYLU = little brown bat, MYSE = northern long-eared bat, MYSO = Indiana bat, NYHU = evening bat, PESU = tri-colored bat, UNK = bat call of unknown species

2013 Post-Construction Acoustic Monitoring

BCID classified two calls as Indiana bats, but both of these calls were reclassified as eastern red bat calls by qualitative analysis (Table A7). No calls of northern long-eared bats were identified. Of other *Myotis*, BCID assigned a total of seven little brown bat calls in 2013. Of these seven, one call was verified as a little brown bat call using qualitative analysis. Of the remaining six calls, four were reclassified as eastern red bats, one as a big brown or silver-haired bat and one as a HF unknown. The HF unknown call had traits common to both eastern red bats and little browns bats and therefore was not identified to species.

Table A7. Summary of BCID and qualitative analysis species identifications for high frequency bat calls (minimum frequency > 30 kilohertz) recorded at each acoustic survey station for the Blue Creek Wind Farm in 2013.[1]

Acoustic Station	ID Method	LABO	MYLU	MYSE	MYSO	NYHU	PESU	UNK	Total
BC1-5m	BCID	32	3	0	1	4	30	6	77
	Qualitative	166	2	0	0	0	4	35	207
BC1-45m	BCID	9	0	0	0	5	7	0	21
	Qualitative	87	0	0	0	0	0	2	89
BC2-5m	BCID	31	3	0	1	5	22	3	65
	Qualitative	155	0	0	0	0	4	18	177
BC2-45m	BCID	14	1	0	0	3	7	2	27
	Qualitative	77	0	0	0	0	0	0	77
Total	BCID	86	7	0	2	17	66	11	189
	Qualitative	485	2	0	0	0	8	55	550

[1] LABO = eastern red bat, MYLU = little brown bat, MYSE = northern long-eared bat, MYSO = Indiana bat, NYHU = evening bat, PESU = tri-colored bat, UNK = bat call of unknown species

2015 Post-Construction Acoustic Monitoring

Between April 1 – November 15, 2015, all turbines were feathered at wind speeds below 6.9 m/s (15.4 mph) to avoid impacts to Indiana bats. Bat calls from 2009, 2012 and 2013 were identified using Bat Call Identification Software (BCID; version 2.7c). Bat calls from 2015 were identified using Kaleidoscope Pro (version 3.0.0; Wildlife Acoustics, Inc.). Both BCID and Kaleidoscope are USFWS-approved automated acoustic bat identification (ID) software programs. Kaleidoscope call identification software classified four calls as Indiana bats, one call as northern long-eared bat and seven calls as little brown bats (Table A8). Two of the Indiana bat calls were reclassified by qualitative analysis as HF unknown species because they were composed entirely of sounds of poor quality, call fragments, or approach-phase calls; one call was reclassified as an eastern red bat; and one call was reclassified as a big brown bat. The potential northern long-eared bat call was reclassified as an eastern red bat call. The little brown bat calls were reclassified as eastern red bat calls (five) and HF unknowns (two). No echolocation calls were identified as *Myotis* species by qualitative analysis in 2015 (Table A8).

Table A8. Summary of Kaleidoscope and qualitative analysis species identifications for high frequency bat calls (minimum frequency > 30 kilohertz) recorded at each acoustic survey station for the Blue Creek Wind Farm in 2015.[1]

Acoustic Station	ID Method	LABO	MYLU	MYSE	MYSO	NYHU	PESU	UNK	Total
BC1-5m	Kaleidoscope	98	3	1	0	27	4	43	176
	Qualitative	166	0	0	0	0	2	35	203
BC1-45m	Kaleidoscope	164	0	0	1	61	4	46	276
	Qualitative	286	0	0	0	0	2	3	291
BC2-5m	Kaleidoscope	171	4	0	3	54	8	55	295
	Qualitative	273	0	0	0	0	2	28	303
BC2-45m	Kaleidoscope	137	0	0	0	32	2	43	214
	Qualitative	218	0	0	0	0	0	4	222
Total	Kaleidoscope	570	7	1	4	174	18	187	961
	Qualitative	943	0	0	0	0	6	70	1,019

[1] LABO = eastern red bat, MYLU = little brown bat, MYSE = northern long-eared bat, MYSO = Indiana bat, NYHU = evening bat, PESU = tri-colored bat, UNK = bat call of unknown species

Seasonal Variation in Bat Activity Based on Acoustic Studies

The temporal variation in bat activity during the spring (April 1 – May 14), summer (May 15 – July 31), and fall (August 1 – November 15) was summarized over 2012, 2013, 2015 to evaluate bat activity, and by association the potential for turbine collision by bats, at the BCWF. For each year studied, bat activity, as measured by the number of all species of bat acoustic call passes, were highest in the fall, followed by summer, then spring (Table A9).

In 2012, 7,724 bat passes were recorded over a total of 899 detector nights (one detector night equals one acoustic detector operating for one night). Fifty-eight percent of the bat passes were recorded in fall, followed by 36% in summer, and 6% in spring (Table A9).

In 2013, 3,146 bat passes were recorded over a total of 849 detector nights. Seventy-four percent of the bat passes were recorded in fall, followed by 23% in summer, and 3% in spring (Table A9).

In 2015, 3,960 bat passes were recorded over a total of 920 detector nights. Seventy percent of the bat passes were recorded in fall, followed by 24% in summer, and 6% in spring (Table A9).

Table A9. Number of bat acoustic call passes by season recorded at the Blue Creek Wind Farm in 2012, 2013, and 2015.

Monitoring Year	No. Bat Passes/Detector Night and Standard Error	Percent of Calls		
		Spring	Summer	Fall
2012	8.6 +/- 0.85	6	36	58
2013	3.7 +/- 0.37	3	23	74
2015	4.3 +/- 0.43	6	24	70

Bat Activity, Bat Fatality, and Weather Correlation

Bat activity was evaluated during pre- and post-construction monitoring in 2012, and 2013 to evaluate how bat mortality risk may vary with weather at the BCWF (Ritzert et al. 2013; Good et al. 2014a, b; 2016b).

In 2012, the relationships between bat activity, bat fatality, and weather variables including wind speed, wind direction, temperature, barometric pressure, and relative humidity were evaluated using Pearsons correlations and linear regression. Bat activity (R^2 = 0.35) and bat fatality (R^2 = 0.45), were positively correlated with temperature and negatively correlated with wind speed (R^2 = -0.22). Correlations of bat activity and bat fatality to wind direction, barometric pressure, and relative humidity were weak and inconsistent. Model comparison with AICc[12] found that temperature and all-bat passes per detector-night at raised detectors were the best predictors of the level of bat fatality, with lower bat fatality occurring when temperatures and bat pass rates were lower.

Data from 2012 and 2013 were used to hone in on a temperature threshold for cut-in that would be protective of the Covered Species. Based on these data, 99% of the bat activity occurred when temperatures were above 10 °C (50 °F; Tables A10 and A11); therefore, selecting a 10 °C (50 °F) temperature threshold as a conservation measure in the BCWF HCP would provide significant reduction in risk to Covered Species by focusing on temperatures where they have been demonstrated to be the most active and therefore at risk for collision.

Table A10. Bat passes recorded per hour by temperature category as recorded during 2012 post-construction monitoring at the Blue Creek Wind Farm.

Temperature °C (°F)	Hours of Survey	Number of Passes	Percent Composition of All Passes	Bat Passes per Hour	Relative Abundance
≤ 0 (≤ 32)	0.0	0	0.000	0.000	0.000
0 to 4.9 (32 to 39.4)	723.8	4	0.001	0.004	0.001
5 to 9.9 (41 to 49.9)	1,406.4	90	0.012	0.055	0.013
10 to 14.9 (50 to 58.9)	1,519.2	399	0.052	0.225	0.052
15 to 19.9 (59 to 67.9)	2,232.2	1,276	0.166	0.450	0.104
20 to 24.9 (68 to 76.9)	2,669.1	2,755	0.358	0.988	0.229
25 to 29.9 (77 to 85.9)	1,647.9	2,763	0.359	1.365	0.316
≥30 (≥86)	238.5	412	0.054	1.227	0.284

[12] Corrected Akaike Information Criterion (AICc) is a statistical method used to identify models that are the best predictors of response variables.

Table A11. Bat passes recorded per hour by temperature category as recorded during 2013 post-construction monitoring at the Blue Creek Wind Farm.

Temperature °C (°F)	Hours of Survey	Number of Passes	Percent Composition of Passes	Bat Passes per Hour	Relative Abundance
≤ 0 (≤ 32)	164.8	0	0.000	0.000	0.000
0 to 4.9 (32 to 39.4)	717.1	0	0.000	0.000	0.000
5 to 9.9 (41 to 49.9)	1,060.8	20	0.007	0.010	0.006
10 to 14.9 (50 to 58.9)	1,760.9	176	0.058	0.081	0.047
15 to 19.9 (59 to 67.9)	2,489.4	671	0.223	0.240	0.140
20 to 24.9 (68 to 76.9)	2,773.0	1,230	0.409	0.310	0.182
25 to 29.9 (77 to 85.9)	862.4	874	0.290	0.610	0.357
≥30 (≥86)	50.3	39	0.013	0.457	0.267

Given that bat activity was consistent between years in 2012 and 2013 (99% of bat activity occurring when temperatures were above 10 °C [50 °F] in both years), temperature was not evaluated in 2015.

Summary of Acoustic Data

Several patterns emerged from the review of the acoustic monitoring data. First, no calls of the Covered Species were qualitatively identified in any year (2009, 2012, 2013, or 2015) of monitoring. Second, bat activity was consistently higher in fall (58% in 2012, 74% in 2013, 70% in 2015) compared to spring (6% in 2012, 3% in 2013, 6% in 2015) and summer (36% in 2012, 23% in 2013, 24% in 2015). Third, nearly all (99% in 2012 and in 2013) bat activity occurred at temperatures above 10 °C (50 °F). Thus, the multiple years of acoustic data collected at the BCWF supports that implementing the minimization measures described in the BCWF HCP would focus curtailment on the season and temperature that represents the majority of bat activity when the Covered Species are at highest risk.

Post-Construction Mist Netting Study

Bat mist-net surveys were completed at five sites at the BCWF between July 18 – 25, 2016, following a study plan that was reviewed and approved by USFWS (M. Seymour, USFWS, pers. comm.) and ODNR (J. Norris, ODNR, pers. comm.) prior to initiating the surveys (Figure A2). The study plan was designed to determine the presence or probable absence of Indiana bats and northern long-eared bats during the summer maternity season, following the *2016 Range-Wide Indiana Bat Summer Survey Guidelines* (USFWS 2016) and ODNR wind project-specific bat survey protocols (ODNR 2009). Although Indiana bats are not expected to occur during the summer due to lack of suitable maternity habitat for the species, this mist-netting was conducted to confirm probable absence. Eleven bats were captured at three sites, including eight big brown bats, two eastern red bats, and one hoary bat. No Covered Species were captured during the surveys, which confirmed their probable absence from the BCWF in the summer (Iskali et al. 2017).

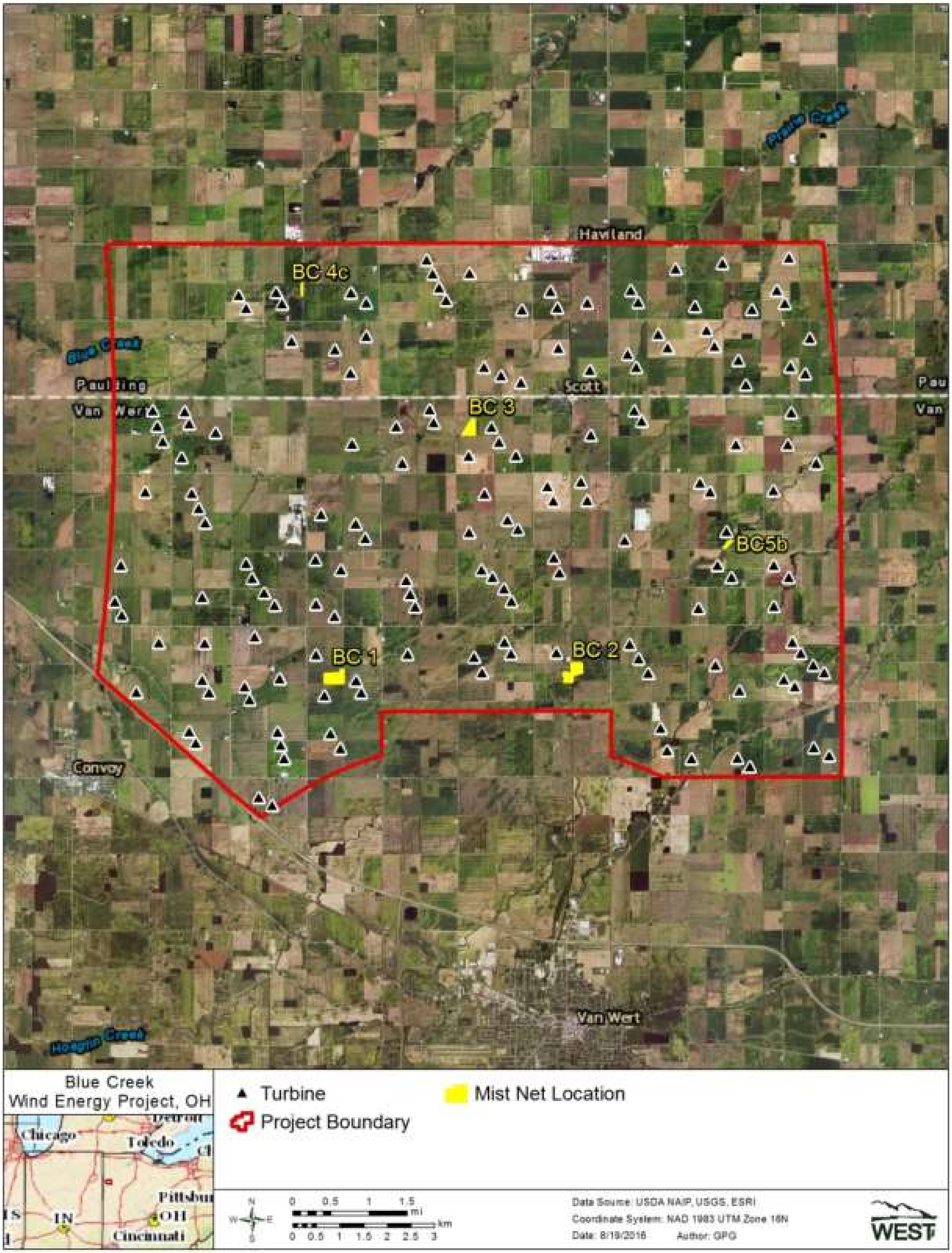

Figure A2. Locations of sites surveyed for bats with mist-nets during the summer of 2016 at the Blue Creek Wind Farm, Van Wert, Ohio.

Conclusions

The BCWF has been extensively studied since 2009, including multiple years of intensive post-construction monitoring, a study of the effectiveness of cut-in speed adjustment on bat mortality, multiple years of bat acoustic activity surveys, and a mist-net survey designed to determine if Covered bat species occur at BCWF during the summer maternity period (Table A12). These studies show that while the Indiana bat is an infrequent migrant through the BCWF, it is likely absent during the summer, the level of Indiana bat mortality is low relative to other bat species, and it is likely at higher risk during the fall than the spring. Northern long-eared bats were not detected at BCWF, showing that risk to northern long-eared bat is low as well.

Table A12. Primary results from studies conducted or analysis performed to evaluate risk to bats at the Blue Creek Wind Farm, 2012 – 2015.

Study or Analysis	Primary Results
Timing of fatalities	All bat fatalities highest in fall
Temperature and fatalities	Higher proportion of all bat fatalities per turbine search when average night temperatures are above 10 °C (50 °F)
Curtailment	Significant reduction in bat fatalities when cut-in speed raised to 4.5 m/s (10.1 mph)
Acoustic monitoring	No Covered Species qualitatively identified
Seasonal variation in bat activity (acoustic)	All bat activity highest in fall
Bat activity and weather (acoustic)	Nearly all bat activity when temperatures above 10 °C (50 °F)
Mist netting	No Covered Species detected

Based on the site-specific studies presented above, the proposed minimization measures in the BCWF HCP can be expected to minimize impacts when risk to Covered Species is highest, while allowing turbine operation during conditions when risk to Covered Species is lowest, enabling the HCP to achieve its Biological Goals.

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Appendix B. Publicly Available Indiana Bat and Northern Long-Eared Bat Fatalities Documented at Wind Energy Facilities in the US and Canada

Table B1. Publicly available Indiana bat and northern long-eared bat fatalities documented at wind energy facilities in the US and Canada.[1]

Project Name	State/Province	County	Date Found	WNS Status[2]	Reference	# of Fatalities
			Indiana Bat Fatalities			
Fowler Ridge	Indiana	Benton	9/11/2009	Pre	Good et al. 2011	1
Fowler Ridge	Indiana	Benton	9/18/2010	Pre	Good et al. 2011	1
Anonymous	Indiana	Anonymous	8/23/2015	Post	Pruitt and Reed 2018	1
Anonymous	Indiana	Anonymous	7/1/2017	Post	Pruitt and Reed 2018	1
Anonymous	Indiana	Anonymous	5/1/2018	Post	Pruitt and Reed 2018	1
Anonymous	Indiana	Anonymous	9/17/2018	Post	Pruitt and Reed 2018	1
North Allegheny	Pennsylvania	Blair, Cambria	9/26/2011	Transition	US Fish and Wildlife Service (USFWS) 2011	1
Laurel Mountain	West Virginia	Barbour, Randolph	7/8/2012	Post	USFWS 2012b	1
Blue Creek	Ohio	Van Wert	10/3/2012	Post	USFWS 2012a, Pruitt and Reed 2018	1
Anonymous	Ohio	Anonymous	10/9/2013	Post	Pruitt and Reed 2018	1
Anonymous	Ohio	Paulding	4/14/2014	Post	Knapp 2014, Pruitt and Reed 2018	1
Anonymous	Illinois	Anonymous	9/23/2016	Unknown	M. Seymour, USFWS, pers. comm.	1
Anonymous	Iowa	Anonymous	7/13/2016	Unknown	Pruitt and Reed 2018	1
			Northern Long-Eared Bat Fatalities			
Mountaineer	West Virginia	Tucker	8/18/2003	Pre	Kerns and Kerlinger 2004	1
Mountaineer	West Virginia	Tucker	8 or 9/2003[5]	Pre	Kerns and Kerlinger 2004	1
Mountaineer	West Virginia	Tucker	8 or 9/2003[5]	Pre	Kerns and Kerlinger 2004	1
Mountaineer	West Virginia	Tucker	8 or 9/2003[5]	Pre	Kerns and Kerlinger 2004	1
Mountaineer	West Virginia	Tucker	8 or 9/2003[5]	Pre	Kerns and Kerlinger 2004	1
Mountaineer	West Virginia	Tucker	9/8/2003	Pre	Kerns and Kerlinger 2004	1
Meyersdale	Pennsylvania	Somerset	9/13/2004	Pre	Arnett et al. 2005	1
Meyersdale	Pennsylvania	Somerset	9/11/2004	Pre	Arnett et al. 2005	1
Kingsbridge I	Ontario	Huron	10/5/2006	Pre	Stantec Consulting, Ltd. 2007	1
Erie Shores	Ontario	Norfolk	5/25/2007	Pre	James 2008	1
Erie Shores	Ontario	Norfolk	6/11/2007	Pre	James 2008	1
Erie Shores	Ontario	Norfolk	6/12/2007	Pre	James 2008	1
Steel Winds	New York	Erie	7/13/2007[3]	Pre	Grehan 2008	1
Steel Winds	New York	Erie	8/3/2007[3]	Pre	Grehan 2008	1
Steel Winds	New York	Erie	8/24/2007[3]	Pre	Grehan 2008	1
Steel Winds	New York	Erie	8/24/2007[3]	Pre	Grehan 2008	1
Erie Shores	Ontario	Norfolk	8/28/2007	Pre	James 2008	1

Table B1. Publicly available Indiana bat and northern long-eared bat fatalities documented at wind energy facilities in the US and Canada.[1]

Project Name	State/Province	County	Date Found	WNS Status[2]	Reference	# of Fatalities
Erie Shores	Ontario	Norfolk	8/28/2007	Pre	James 2008	1
Erie Shores	Ontario	Norfolk	8/30/2007	Pre	James 2008	1
Steel Winds	New York	Erie	9/4/2007[3]	Pre	Grehan 2008	1
Steel Winds	New York	Erie	9/24/2007[3]	Pre	Grehan 2008	1
Noble Ellenburg	New York	Clinton	8/2008	Pre	Jain et al. 2009	1
Ripley	Ontario	Bruce	8/4/2008	Pre	Jacques Whitford 2009	1
Mount Storm	West Virginia	Grant	8/26/2008	Pre	Young et al. 2009	1
Ripley	Ontario	Bruce	9/5/2008	Pre	Jacques Whitford 2009	1
Fowler Ridge	Indiana	Benton	8/25/2009	Pre	Good et al. 2011	1
Anonymous	Missouri	Anonymous	9/2009[6]	Pre	M. Turner, USFWS, pers. comm.	1
Pennsylvania Game Commission (PGC) Site 2-14[4]	Pennsylvania	n/a	9/2009	Pre	J. Taucher, PGC, pers. comm.	1
Noble Wethersfield	New York	Wyoming	6/11/2010	Post	Jain et al. 2011	1
Cohocton/Dutch Hills	New York	Stueben	6/22/2010	Post	Stantec Consulting, Inc. 2011	1
Bear Mountain	British Columbia	-	8/2010	Pre	Hemmera 2011	1
Bear Mountain	British Columbia	-	8/2010	Pre	Hemmera 2011	1
Bear Mountain	British Columbia	-	8 or 9/2010	Pre	Hemmera 2011	1
Bear Mountain	British Columbia	-	9/1/2010	Pre	Hemmera 2011	1
Bear Mountain	British Columbia	-	9/1/2010	Pre	Hemmera 2011	1
Noble Wethersfield	New York	Wyoming	7/17/2011	Post	Kerlinger et al. 2011	1
Criterion	Maryland	Garrett	7/22/2011	Pre	Young et al. 2013	1
Noble Wethersfield	New York	Wyoming	8/6/2011	Post	Kerlinger et al. 2011	1
Noble Wethersfield	New York	Wyoming	8/18/2011	Post	Kerlinger et al. 2011	1
Noble Wethersfield	New York	Wyoming	9/2/2011	Post	Kerlinger et al. 2011	1
Noble Wethersfield	New York	Wyoming	9/3/2011	Post	Kerlinger et al. 2011	1
PGC unknown site[4]	Pennsylvania	n/a	7/2012	Post	J. Taucher, PGC, pers. comm.	1
Anonymous	Illinois	Anonymous	8/10/2013	Transition	M. Turner, USFWS, pers. comm.	1
Anonymous	Illinois	Anonymous	8/22/2013	Transition	M. Turner, USFWS, pers. comm.	1
Anonymous	Illinois	Anonymous	9/25/2013	Transition	M. Turner, USFWS, pers. comm.	1
Anonymous	Michigan	Anonymous	7/10/2014	Transition	M. Turner, USFWS, pers. comm.	1
Anonymous	Illinois	Anonymous	5/2014	Transition	M. Seymour, USFWS, pers. comm.	1
Anonymous	Illinois	Anonymous	9/2/2014	Transition	M. Seymour, USFWS, pers. comm.	1

[1] Through April 2019.

[2] WNS status signifies the extent of WNS contamination in the region's hibernacula. The WNS status for northeastern projects was provided by R. Niver, USFWS, pers. comm.; the WNS status for all other was projects sourced from the WNS map (Heffernan 2016).

Table B1. Publicly available Indiana bat and northern long-eared bat fatalities documented at wind energy facilities in the US and Canada.[1]

Project Name	State/Province	County	Date Found	WNS Status[2]	Reference	# of Fatalities

[3] New York State Department of Environmental Conservation identified the bat species for this survey and provided the information via pers. comm. with Western EcoSystems Technology, Inc.; species were not included in the original study report.

[4] Sites participating in the PGC Wind Energy Voluntary Cooperation Agreement are not identified by name.

[5] Study reported that these northern long-eared bat fatalities were first recorded on August 18, 2003, and last recorded on September 8, 2003, but did not provide dates for every fatality event of the species.

[6] Northern long-eared bat fatality occurred between May 16 – November 15, 2009.

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Appendix C. Take Prediction Variance Calculation Methods

In developing a Habitat Conservation Plan (HCP), an applicant must calculate take that may result from Covered Activities. For the Blue Creek Wind Farm (Project) HCP, the species composition method was used to obtain estimates, predictions, and associated variances of bat fatalities. The species composition method is commonly used for calculating take for rare species and is used in many HCPs. The method combines an estimate of overall bat fatalities at the facility with an estimate of the proportion of those fatalities that may be the Covered Species. Combining these two components yields an estimate of the total number of fatalities of the Covered Species.

This appendix discusses the estimation methodology and the results for predicting take of the Covered Species at Blue Creek. Recognizing that the take predictions have inherent uncertainty (Chapter 4 of the HCP), approximate confidence levels were calculated for Indiana bat and northern long-eared bat (the Covered Species; Section 1.5 of the HCP) take calculations. Take of each Covered Species was derived from the predicted total number of bat fatalities and the proportion of each Covered Species among the total. Formally, this was expressed as a product:

$$\hat{F}_{CS} = \hat{F}_T \times \hat{p} \quad (1)$$

where $\hat{F}_{CS}$ was the number of fatalities of the Covered Species, $\hat{F}_T$ was the total number of fatalities, and $\hat{p}$ was the proportion of each Covered Species. The 'hat' symbol (^) indicates that each of these quantities is an estimate and, as such, it has associated uncertainty.

Uncertainty is represented formally by the estimated variance. Calculating the variance of the number of Covered Species fatalities required estimates of the variance for each of the terms in the product. Variance was estimated for the total number of bat fatalities and the species composition proportion, and then these variances were combined by relying on statistical theory to estimate the variance of a product.

First, the variance for the total number of bat fatalities ($\hat{F}_T$) will be denoted by $\hat{\sigma}^2_{F_T}$; it depends on the sampling design for post-construction fatalities and typically it accounts for the fact that not all turbines were searched, searched turbines were not visited daily, scavengers may have removed some carcasses, and carcasses that remained may not have been detected by searchers. The Huso mortality estimator (see Huso 2011, Huso et al. 2012, Huso et al. 2015) and a bootstrapping procedure were used to calculate $\hat{\sigma}^2_{F_T}$.

As in many cases, the proportion of the Covered Species ($\hat{p}$) was available only as a point estimate: estimates of the variance of the count of one Indiana bat carcass in the site's monitoring data and the variance of the count of eight northern long-eared bats in the Region 3 dataset were not available due to sampling design. As such, the variance was estimated based on the properties of the binomial distribution. The binomial distribution describes the behavior of a count variable if the following conditions apply:

1. The number of observations or trials is fixed (i.e., the dataset includes a known, static number of bat carcasses);
2. Each observation represents one of two mutually exclusive outcomes (i.e., the carcass is or is not that of a Covered Species);
3. The probability that a bat carcass belongs to a Covered Species is the same for each outcome; and
4. Each observation is independent, such that a success in one trial does not affect the probability of success in any other trial.

The binomial distribution was appropriate because interest centered on the number of "successes" (fatalities of the Covered Species) among all outcomes (fatalities of all species). Because the true proportion was very small (Covered Species fatalities were rare), the proportion and the associated variance were estimated using methods that Agresti and Coull (1998) and Brown et al. (2001) have recommended for improved estimation of small proportions. Brown et al. (2001) gives the following equations: $\kappa = z_{\alpha/2}$(p. 103), $\tilde{X} = X + \kappa^2/2$, $\tilde{n} = n + \kappa^2$, and $\tilde{p} = \tilde{X}/\tilde{n}$ (p. 108). Using the general equivalence, notation used here ≡ notation in Brown et al., we have $z \equiv \kappa$, $x \equiv X$, $n \equiv n$, and $\hat{p} \equiv \tilde{p}$. Let x be the count of the Covered Species carcasses, n be the total count of all bat carcasses, and z be the normal quantile for a (1-α) 100% one-sided confidence interval. Then the estimate of the proportion of bat carcasses attributable to the Covered Species was:

$$\hat{p} = \frac{x + z^2/2}{n + z^2}. \quad (2)$$

In Brown et al. (2001), $\tilde{q} = 1 - \tilde{p}$ and the Agresti-Coull confidence interval for the true proportion was $CI_{AC} = \tilde{p} \pm \kappa(\tilde{p}\tilde{q})^{1/2}\tilde{n}^{-1/2}$ (Eq. 5, p. 108, from Brown et al.). Here, we interpret the quantity $(\tilde{p}\tilde{q})^{1/2}\tilde{n}^{-1/2}$ to represent the standard error. Therefore, in our notation, the estimate of the variance of the proportion was:

$$\hat{\sigma}_p^2 = \frac{\hat{p}(1-\hat{p})}{n + z^2}. \quad (3)$$

Finally, calculation of the variance of the product (number of fatalities of the Covered Species, $\hat{F}_{CS}$, Equation 1) accounted for the fact that both components of the product (the total number of bat fatalities, $\hat{F}_T$ and the proportion, $\hat{p}$) were random variables. Using the first-order Taylor series approximation (Casella and Berger 1990), the variance of the product is given by:

$$\hat{\sigma}_{F_{CS}}^2 = \sigma_{\hat{p}^2, \hat{F}_T^2} + \left(\hat{\sigma}_p^2 + \hat{p}^2\right)\left(\hat{\sigma}_{F_T}^2 + \hat{F}_T^2\right) - \left(\sigma_{\hat{p}, \hat{F}_T} + \hat{p}\hat{F}_T\right)^2 \quad (4)$$

Under the assumptions that the two components were independent of each other and the correlation terms, $\sigma_{\hat{p}^2,\hat{F}_T^2}$ and $\sigma_{\hat{p},\hat{F}_T}$, equaled 0, Equation 4 simplified such that the variance of the number of fatalities of the Covered Species was:

$$\hat{\sigma}^2_{F_{CS}} = \hat{\sigma}^2_p \hat{\sigma}^2_{F_T} + \hat{p}^2 \hat{\sigma}^2_{F_T} + \hat{\sigma}^2_p \hat{F}_T^2 . \quad (5)$$

For a one-sided confidence interval (CI) based on this variance and assuming normality, the upper bound was (Zar 1984):

$$CI_{\hat{F}_{CS}} = \hat{F}_{CS} + \left(z\sqrt{\hat{\sigma}^2_{F_{CS}}} \right) . \quad (6)$$

To determine the appropriate take limit, the Applicant explored the relationship between the statistical confidence in the take prediction (i.e., 50%, 60%, …, 90% confidence) and potential monitoring and adaptive management outcomes. A one-sided CI, derived from the above variance calculations, was used for this exercise because the amount of variation below the predicted take number would not affect ITP compliance; the Applicant was concerned only with variation above the predicted take number. Based on the results of this exercise, the Applicant determined that use of the 70% confidence level is reasonably certain to avoid underestimation of the take that may occur and provides an acceptable certainty that take compliance will be achieved with minimal adaptive management. The requested take levels in the HCP reflect the 70% confidence levels for both Covered Species (Table D1).

Table D1. Summary of take predictions and 70% confidence bounds (CB) for the Blue Creek Wind Farm.

Covered Species	Estimated Value	Bats/Year (Spring and Fall)	Total Bats over 35-year ITP Term	Description
Indiana bat	Pre-minimized take prediction	3.94 (70% CB: 6.27)	138 (70% CB: 219)	Calculated from species composition data
	Minimized take prediction	2.76 (70% CB: 4.39)	96 (70% CB: 154)	Minimization protocol with cut-in speed of 5.0 m/s conservatively assumed to provide 30% reduction in take
Northern long-eared bat	Pre-minimized take prediction	3.42 (70% CB: 4.23)	120 (70% CB: 148)	Calculated from species composition data
	Minimized take prediction	2.39 (70% CB: 2.96)	84 (70% CB: 103)	Minimization protocol with cut-in speed of 5.0 m/s conservatively assumed to provide 30% reduction in take

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Appendix D. Northern Long-Eared Bat Carcasses in the US Fish and Wildlife Service Region 3 Dataset

Northern Long-Eared Bat Post-Construction Monitoring Data

Provided by USFWS Columbus, Ohio, Ecological Services Field Office

September 28, 2015

The U.S. Fish and Wildlife Service's Columbus, Ohio Ecological Services Field Office maintains a database of post-construction monitoring studies from wind energy facilities. Some of these studies are publicly available, while others contain privileged information and are FOIA-exempt as determined by our Solicitors. The data has been summarized in order to maintain privilege but still be able to use the information in a meaningful way.

Range-Wide Northern Long-Eared Bat Wind Project Mortality Data

- 69 unique wind project locations (all "phases" of project count as same project)
- Project locations in 17 states/provinces (IA, IL, IN, MD, ME, MI, MN, MO, NE, NY, OH, PA, TN, VT, WI, WV, Ontario)
- Study dates range: 1998-2014
- 16,489 all-bat mortalities
- 43 Northern long-eared bat mortalities (0.261% of all-bat mortalities)
- States where Northern long-eared bats were documented as mortalities: IA, IL, IN, MD, MI, MO, NY, PA, WV, and Ontario
- Of the 69 unique projects, 19 (27.5%) had one or more Northern long-eared bat mortality

Region 3 Northern Long-Eared Bat Wind Project Mortality Data

- 38 unique wind project locations (all "phases" of project count as same project)
- Project locations in 8 states (IA, IL, IN, MI, MO, MN, OH, WI)
- Study dates range: 1998-2014
- 9,044 all-bat mortalities
- 8 northern long-eared bat mortalities (0.088% of all-bat fatalities)
- States where Northern long-eared bats were documented as mortalities: IA, IL, IN, MI, MO
- Of the 38 unique projects, 6 (15.8%) had one or more Northern long-eared bat mortality

Appendix E. Decision Process Behind Blue Creek Wind Farm's Proposal to Use a Detection Probability (g) of 0.15 for Habitat Conservation Plan Compliance Monitoring

Introduction

The primary objective of Blue Creek Wind Farm, LLC's (Blue Creek) proposed Habitat Conservation Plan (HCP) compliance monitoring is to evaluate whether the level of take of the Covered Species at the Blue Creek Wind Project (Project) is within the level of take authorized by the Incidental Take Permit (ITP). Following the directive in the HCP Handbook (USFWS and NMFS 2016), Blue Creek has designed the Project's compliance monitoring to be commensurate with the scope, duration, and certainty of the Project's impact of take. The compliance monitoring plan incorporates current advanced statistical models for monitoring rare events like take of Covered Species, covers the duration of the ITP term, and will provide the basis for mitigation and adaptive management decisions.

The Endangered Species Act allows for HCPs to reflect the characteristics of each facility (USFWS and NMFS 2016). Currently, each of the 11 wind energy bat HCPs in the US for which an ITP has been issued is unique across many of the components of the HCP, including compliance monitoring design. Thus, this HCP specifically reflects the characteristics of this facility and leverages Project-specific data collected since 2012 in order to meet the requirements in the HCP Handbook.

The USFWS has recommended that Blue Creek use the Evidence of Absence (EoA) model for evaluating ITP compliance (Huso et al. 2015). One parameter that is estimated in EoA is the overall probability of detecting a carcass that arrives at a project during the monitoring season. Detection probability is key to estimating the total number of fatalities at the Project. Detection probability is estimated because, for a variety of reasons, it is often the case that some bats that are turbine fatalities are missed by observers. As detection probability increases, so does the cost of monitoring along with diminishing returns on the certainty of fatality estimates. This appendix is an exploration of the tradeoff between monitoring effort and the precision of fatality estimates.

Blue Creek considered a range of detection probabilities in the EoA model that could be achieved through various monitoring plan designs. Detection probability in the EoA model is influenced by bias parameters including searcher efficiency rates, carcass persistence probability, and the proportion of carcasses expected to occur in searched areas (Huso et al. 2015). Higher searcher efficiency rates, more frequent searches (which lead to higher carcass persistence probabilities), and larger search areas will lead to a higher detection probability. However, there are practical constraints on searcher efficiency, search area, and search intervals.

Blue Creek developed a compliance monitoring plan after (1) considering several practical aspects of monitoring at the Project and (2) evaluating the ability of a monitoring plan to achieve the HCP's compliance objectives.

Monitoring Plan

Compliance monitoring will be conducted to a g of 0.15 in the first two years of the ITP and in every fifth year thereafter. Monitoring at five-year intervals will allow Blue Creek to evaluate if the Project is in compliance with the ITP. Frequent or significant increases in annual take due to population growth are not expected given the low fecundity rates and long lifespans of the Covered Species (Sections 3.2.3 and 3.3.3 of the HCP). Given the anticipated slow rate of population growth (Erickson et al. 2016), if any, over the course of the ITP term, a five-year monitoring interval will be capable of detecting whether the permitted level of take has been exceeded. The process of estimating take over this interval monitoring schedule will follow US Geological Survey recommendations (D. Dalthorp, M. Huso, USGS, pers. comm. 12/2017) for accommodating non-monitoring years in the EoA model.

Practical Considerations

The monitoring design initially recommended by the USFWS was based on the conditions found at a typical wind facility. However, Blue Creek is different from other facilities because of its small roads and pads, lease requirements, and large-scale agriculture, as detailed in the sections below.

Small Roads and Pads

The access roads and turbine pads of a wind energy facility are conducive to mortality monitoring because it is easier for human searchers to detect bat carcasses on the gravel substrate of roads and pads than on other surfaces such as mowed grass or crops, resulting in higher searcher efficiency on roads and pads. The larger the road and pad dimensions of a wind energy facility, the higher the proportion of bat carcasses that are likely to fall on roads or pads where they will be more easily detected by searchers. Thus, larger roads and pads enable more effective mortality monitoring of a wind energy facility, which results in an increased overall detection probability. Compared to other contemporary wind energy facilities in the Midwest, including the four operational Midwest wind energy facilities with ITPs[13], the Project has very narrow access roads and turbine pads. The pads extend approximately 6 feet from the base of the turbine and are not large enough to allow a vehicle to drive around the turbine. Turbine pads at other wind projects in the Midwest vary, but are typically much larger than the pads at the Project, ranging from "ring-road" pads around the turbine that extend approximately 14 feet or more from the base of the turbine, to rectangular crane pads up to approximately 165 feet by 50 feet in size. The access roads are 14-feet wide compared to a standard road width of at least 16-feet wide; because of the linear nature of the roads, a 2-foot difference in width results in a large difference in road surface area. These site design factors substantially reduce the area of high searcher efficiency available to be searched, which increases the monitoring effort required to provide a given detection probability.

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[13] Fowler Ridge Wind Farm (Indiana), Hoopeston Wind Project (Illinois), Pioneer Trail Wind Farm (Illinois), and Wildcat Wind Farm (Indiana): roads are a minimum of 16 feet wide and pads vary in size from approximately 14 feet from the base of the turbine to more than 30 feet from the base of the turbine.

Based on the road and pad dimensions at the Project, a road and pad search effort of a weekly search interval at all 152 turbines is capable of achieving a maximum detection probability of 0.03. In fact, the highest detection probability achievable with road and pad monitoring at the Project is 0.04, which requires a daily search interval at all 152 turbines, a significant amount of effort for a low detection probability.

Therefore, to achieve a higher detection probability, the Project would need to clear vegetation within plots so that areas outside of the road and pad are searchable. Clearing large plots of productive agricultural lands is not compatible with co-locating wind turbines within disturbed, active agricultural fields. The costs to do so annually are significant and not commensurate with the impact of the take.

Landowner Concerns

Implementing long-term monitoring at the Project is also challenging due to the need for landowner approval to access and clear search plots. As the desired detection probability increases, more search plots must be cleared and each search plot must be larger. Both factors require increased land access and permission to clear plots.

Blue Creek does not own the land on which the turbines or roads are located. The land where facilities (i.e., turbines, turbine pads, and access roads) sit is leased from private landowners – the leases do not grant Blue Creek control over lands surrounding the turbine. The Project's land control is governed by 212 separate contracts, which are not designed to cover the access, crop clearing damages, and disruption of normal farming practices necessary for post-construction monitoring for the life of the Project.

Because of how the contracts are structured, Blue Creek cannot require landowners to participate in crop clearing and access for monitoring; rather, Blue Creek must depend on their voluntary cooperation. Although landowners are compensated for crop loss due to clearing, cleared areas at the site create logistic farming challenges due to the design of the landowners' large-scale commercial farming equipment, which cannot be adapted to relatively small-scale changes in field shape and size.

These practical concerns led Blue Creek to explore monitoring plans better suited to the characteristics of the Project that both incorporated the EoA framework and met the HCP's compliance monitoring objectives. In particular, because of the practical limitations, annual road and pad monitoring would provide very little information about take compliance with the ITP. Instead, Blue Creek designed an interval monitoring plan allowing monitoring to be conducted periodically with a level of effort sufficient to result in a detection probability of 0.15 (Section 6.1.2 of the HCP). The periodic approach to monitoring alleviates some landowner concerns, while the higher level of monitoring effort accommodates the Project's small roads and pads.

Achieving Compliance Monitoring Objectives with a Detection Probability of 0.15

Blue Creek evaluated a detection probability of 0.15 to ensure it has the ability to achieve the compliance monitoring objectives. Based on the practical considerations described above, Blue Creek evaluated a range of potential monitoring designs using the EoA Scenario Explorer framework to determine their capacity to achieve the HCP's compliance monitoring objective. Monitoring was modeled to occur in the first two years of the ITP term followed by every fifth year thereafter, consistent for all of the detection probabilities. The evaluation was based on the take estimate calculated by the Scenario Explorer (estimated take) under monitoring detection probabilities (*g*) ranging from 0.10 to 0.30. The terms used in this evaluation and the following description of the evaluation results are provided in Table F1. The results of the evaluation are show in Tables F2 and F3, which yielded the two following conclusions:

Table F1. Definition of terms.

Term	Definition
Detection probability (*g*)	The overall probability of detecting a carcass of a Covered Species at the entire facility during an entire year
Estimated take	Take estimate calculated from the simulated monitoring data that would be "collected" under a given g value in the EoA Scenario Explorer
Short-term adaptive management trigger	Test of whether the average take rate is on pace to exceed the expected average take rate under the ITP
Long-term adaptive management trigger	Test of whether the cumulative take estimate has exceeded the permitted level of take under the ITP

Table F2. Simulated Indiana bat compliance results for a range of detection probabilities at the Blue Creek Wind Farm.

Detection probability (*g*)	Long-term trigger (year triggered at 90 and 95th confidence interval)	Short-term trigger (% of simulations in which triggered once or twice)	ITP take limit	Total estimated take (50th quantile[1])	Relative monitoring cost
0.10	90th Year 29 95th Year 25	one trigger 16% two triggers 1%	154	131	X
0.15	90th Year 33 95th --[2]	one trigger 26% two triggers 3%	154	120	1.5 X
0.25	90th --[2] 95th --[2]	one trigger 18% two triggers 1%	154	120	2.5 X
0.30	90th --[2] 95th --[2]	one trigger 26% two triggers 3%	154	119	2.9 X

[1] Total estimated take is presented as the 50th quantile of the simulated distribution because that is the metric used to test permit compliance.

[2] Long-term trigger was not met during the ITP term at this confidence interval

Table F3. Simulated northern long-eared bat compliance results for a range of detection probabilities at the Blue Creek Wind Farm.

Detection probability (*g*)	Long-term trigger (year triggered at 90 and 95th confidence interval)	Short-term trigger (% of simulations in which triggered once or twice)	ITP take limit	Total estimated take (50th quantile[1])	Relative monitoring cost
0.10	90th Year 18 95th Year 16	one trigger 15% two triggers 0%	103	96	X
0.15	90th Year 24 95th Year 21	one trigger 25% two triggers 4%	103	90	1.5 X
0.25	90th Year 33 95th Year 28	one trigger 40% two triggers 14%	103	88	2.5 X
0.30	90th Year 29 95th Year 27	one trigger 20% two triggers 1%	103	89	2.9 X

[1] Total estimated take is presented as the 50th quantile of the simulated distribution because that is the metric used to test permit compliance.

<u>Result #1: Any detection probability between 0.15 and 0.30 is equally effective at demonstrating compliance with the ITP</u>

Above a detection probability of 0.15, additional monitoring effort at Blue Creek does not substantively change the estimated take. Tables F2 and F3 show that the total take estimates with monitoring between a detection probability of 0.15 and 0.30 were all below the ITP take limit: Indiana bat take estimates ranged from 119 bats per permit term (*g* = 0.30) to 120 bats per permit term (*g* = 0.15 and 0.25), all of which are below the ITP take limit of 154 total Indiana bats. Similarly, northern long-eared bat take estimates ranged from 88 bats per permit term (*g* = 0.25) to 89 bats per permit term (*g* = 0.30) to 90 bats per permit term (*g* = 0.15), all of which are below the ITP take limit of 103 total northern long-eared bats. Therefore, any of these monitoring strategies would successfully demonstrate compliance with the requested take permit.

<u>Result #2: Any detection probability between 0.15 and 0.30 has a similar probability of meeting adaptive management triggers</u>

Short-term adaptive management triggers are designed to keep the total estimated take in compliance with the ITP limit and a long-term trigger is designed to indicate when the project is out of compliance with the ITP limit (Section 6.3.1 of the HCP). A range of detection probabilities was evaluated based on the percentage of the Scenario Explorer simulations in which the short-term trigger was met once or twice during the ITP term, and based on the permit year at which there was an estimated 90 or 95% probability that the long term trigger would have been met. As shown in Tables F2 and F3, the number of simulations in which one and two short-term adaptive management triggers were met (a test of whether the average take rate is on pace to exceed the expected average rate) increased above a detection probability of 0.10 for northern long-eared bats but were variable across all detection probabilities for Indiana bats. The long-term adaptive management triggers (a test of whether the total cumulative take has exceeded the permitted level of take) followed the opposite pattern. Long-term triggers were met sooner in the permit term with a detection probability of 0.10 and at a later point in the permit term (or not at all) with probabilities of detection of 0.15 to 0.30, because the higher likelihood of short-term triggers at higher detection probabilities results in adaptive management before the permitted level of take is exceeded.

The risk of meeting these triggers does not represent an increased risk to the Covered Species but rather is the risk to Blue Creek of having to implement adaptive management. Regardless of when and whether adaptive management triggers occur, Blue Creek will fully offset the impact of the ITP take limit. For example, the percent of simulations in which one short-term trigger was met for Indiana bats ranged from 26% at a detection probability of 0.15, to 18% at a detection probability of 0.25, to 26% at a detection probability of 0.30. This indicates that above a detection probability of 0.15, the likelihood of a short-term trigger varies across these probabilities of detection, rather than continually increasing with increasing probabilities of detection. Therefore, at detection probabilities above 0.15, search costs increase significantly without a corresponding benefit in sensitivity to Covered Species take estimation or operational certainty.

Conclusion

Blue Creek's proposed approach of monitoring with a detection probability of 0.15 in the first two ITP years and every fifth year thereafter has been chosen based on multiple years of site-specific data, while accommodating the practical realities related to long-term monitoring at the Project. Statistical analysis using EoA shows that detection probability values of 0.15 or higher result in similar take estimates and similar chances of meeting adaptive management triggers. Monitoring at a higher detection probability provides a marginal increase in the ability to evaluate compliance with the ITP and creates a scenario where the cost of monitoring is several times more expensive than the proposed monitoring approach. The HCP's proposed program of monitoring with a detection probability of 0.15 in the first two ITP years and every fifth year thereafter achieves the compliance monitoring objectives while remaining commensurate with the impacts of the take.

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