Indiana Bat and Northern Long-Eared Bat Habitat Conservation Plan Timber Road II, III, and IV Wind Farms, Paulding County, Ohio

Prepared by:

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1.0 INTRODUCTION

1.1 Overview and Background

This Habitat Conservation Plan (HCP) has been prepared by Paulding Wind Farm II LLC, Paulding Wind Farm III LLC, and Paulding Wind Farm IV LLC (collectively, the Applicant), all Delaware limited liability corporations and subsidiaries of EDP Renewables North America LLC (EDPR), also a Delaware limited liability corporation. The Applicant has prepared this HCP to support an application to the US Fish and Wildlife Service (USFWS) for an Incidental Take Permit (ITP) under Section (§) 10(a)(1)(B) of the Endangered Species Act (ESA), 16 United States Code (USC) 1531-1599 (1973), 1539(a)(1)(B) (1973) that would cover the three phases of the Timber Road Wind Farm (Project; Table 1.1), namely, the Timber Road II Wind Farm (TR-II), Timber Road III Wind Farm (TR-III), and Timber Road IV Wind Farm (TR-IV). The Project includes 134 wind turbines that generate approximately 325.8 megawatts (MW) of electricity at peak output. The Project's phases achieved commercial operation in different years. TR-II and TR-III are already in operation – with the first full year of commercial operation in 2012 and 2017, respectively – and TR-IV is expected to have its first full year of commercial operation in 2020 (Table 1.1). The Project is located in Paulding County in northwestern Ohio (Figure 1.1).

Table 1.1. Project overview.

Project phase	Owner	# turbines	Total generating capacity (MW)	First full year of commercial operation
Timber Road II Wind Farm	Paulding Wind Farm II LLC	55	99.0	2012
Timber Road III Wind Farm	Paulding Wind Farm III LLC	48	100.8	2017
Timber Road IV Wind Farm	Paulding Wind Farm IV LLC	31	126.0	2020
		134	**325.8**	

1.1.1 Purpose and Need

The purpose and need for this HCP is to provide a comprehensive plan for the conservation of Indiana bats (*Myotis sodalis*) and northern long-eared bats (*Myotis septentrionalis*) (collectively, the Covered Species) at the Project and in so doing support an ITP application for the Covered Species to enable the operation of a financially viable Project.

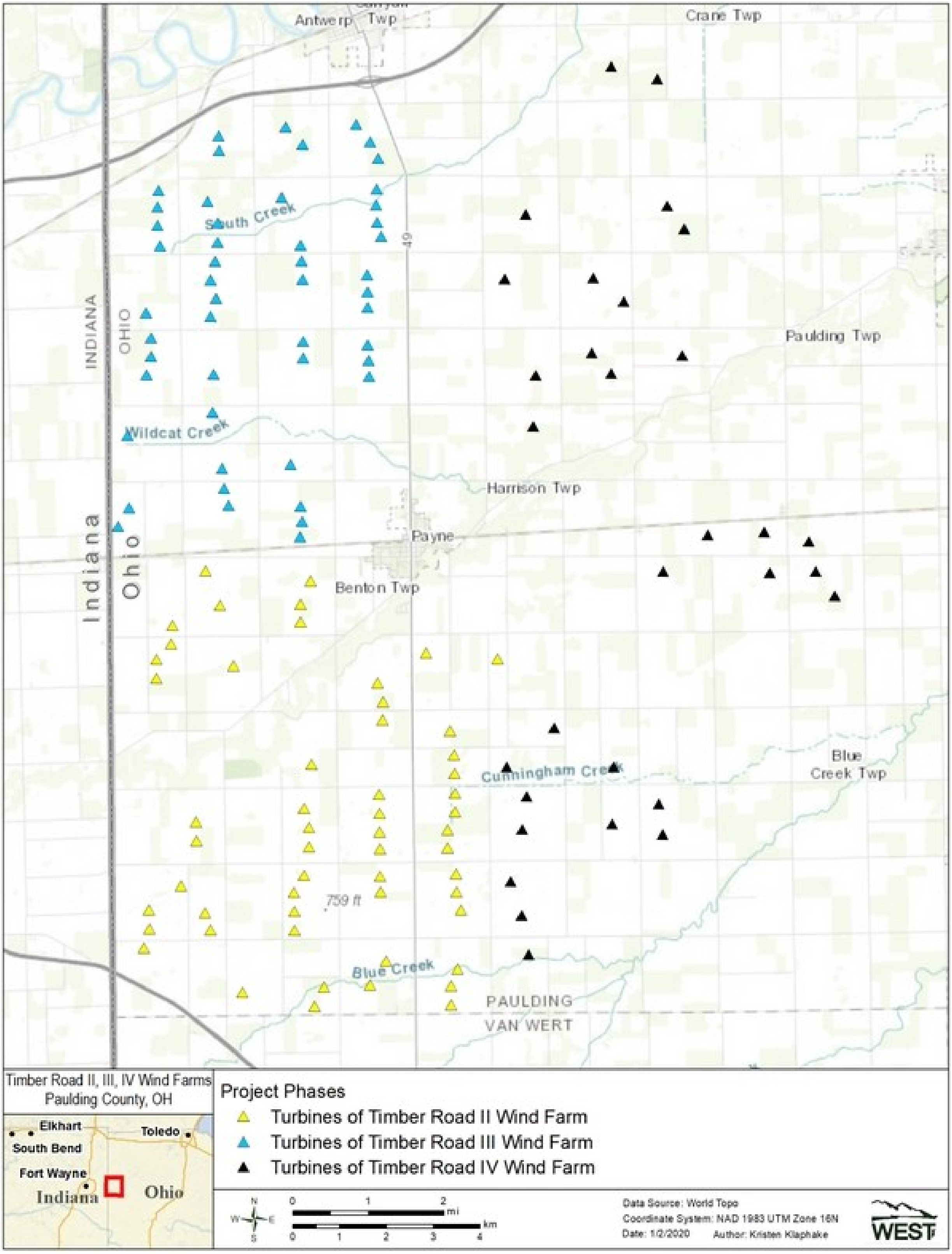

Figure 1.1. Project location in Paulding County, Ohio.

The implementing regulations for the ESA § 10(a)(1)(B) (50 Code of Federal Regulations [CFR] 17.22 [1985]) identify the criteria that must be met for issuance of a permit authorizing the incidental take of species listed as endangered or threatened under the ESA (listed species). Those criteria include the requirement that the applicant minimize and mitigate the impacts of the authorized take to the maximum extent practicable, and that the incidental take proposed will not appreciably reduce the likelihood of the survival and recovery of the Indiana bat and northern long-eared bat in the wild.

The ITP application process requires the development and submission of an HCP. An HCP must describe the impact that will likely result from the proposed take; the measures that will be taken to monitor, minimize, and mitigate such impacts; the funding mechanism that will be used to implement those measures and respond to changed circumstances; and the alternatives to the taking that were considered and the reasons why those alternatives were not adopted. This HCP includes these and all other elements necessary to meet the criteria for ITP issuance (see Section 1.2.1 for a list of all required issuance criteria).

1.1.2 Organization

This HCP is divided into nine chapters following the USFWS and National Marine Fisheries Service (NMFS) *Habitat Conservation Planning and Incidental Take Processing Handbook* (HCP Handbook; USFWS and NMFS 2016). This chapter describes the overview of the HCP, the regulatory framework, the duration of the requested ITP, and the Covered Lands and Covered Species. Chapter 2 describes the Project and the activities for which incidental take coverage is sought. Chapter 3 details the biology of the Covered Species. Chapter 4 explains how take resulting from Covered Activities was predicted and characterizes the impact of that taking on the species. Chapter 5 describes the measures the Applicant will implement to minimize and mitigate the impacts of the take to the maximum extent practicable. Chapter 6 outlines the funding assurances that the Applicant will provide to ensure implementation of the HCP. Chapter 7 addresses the alternatives to the taking that the Applicant considered, but did not elect to implement. Chapter 8 considers specifics of HCP implementation, including changed and unforeseen circumstances that could arise over the ITP term and procedures the Applicant will utilize to address changed circumstances. Chapter 9 provides references for the sources of data and information used in the development of the HCP. In addition to the chapters as described, the HCP includes a number of appendices with supporting information.

1.2 Statutory and 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 United States Code [USC] 1531(b) [1973]). The ESA § 9(a)(1)(B) prohibits the "take" of any species of fish or wildlife listed under the ESA as endangered (16 USC 1538(a)(1)(B) [1973]). The USFWS extended by regulation the “take” prohibition 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 removes the "take" prohibition in full or in part to that species (50 CFR 17.31(a) [1978]). 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) [1973]).

The ESA § 10(a)(1)(B)) provides that the Secretary of the Interior (Secretary) 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 for an ITP, and develop, fund, and implement a USFWS-approved HCP to minimize and mitigate to the maximum extent practicable the impact of the proposed taking (16 USC 1539(a)(2) and 50 CFR 17.22(b) [1985]).

As outlined in the ESA § 10(a)(2)(A) (16 USC 1539(a)(2)(A) [1973]) and its implementing regulations at 50 CFR 17.22(b)(1) (1985) and 17.32(b)(1) (1985), to obtain an ITP an 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 the 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;
    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 HCP.

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) (1985) and 17.32(b)(2) (1985):

1) The taking will be incidental;
2) The applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such takings;
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 measures that the USFWS may require as being necessary or appropriate will be met;
6) USFWS has received such other assurances as it may require that the HCP 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 issuance of the ITP is a federal agency action that must also comply with ESA § 7 (16 USC 1536 [1973]). The ESA § 7 requires federal agencies to consult with the USFWS to ensure that actions that the federal agencies implement, authorize, or fund are not likely to jeopardize the continued existence of any endangered or threatened 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, the USFWS must conduct an internal formal consultation process for issuance of the ITP. Formal consultation culminates with issuance by the USFWS of a biological opinion, which provides the USFWS' 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 standards.

1.2.2 National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA; 42 USC 4321, *et. seq.* [1970]), requires federal agencies to examine environmental impacts of their actions through environmental assessments or impact statements and provide for public participation on those documents. Issuance of an ITP is a federal action subject to compliance with NEPA. To comply with NEPA, the USFWS must conduct and publish an environmental impact statement or environmental assessment which includes detailed analysis of all direct, indirect, and cumulative impacts of issuing the ITP on the human environment, not just on the Covered Species or resources.

1.3 Permit Duration

The proposed term of the requested ITP is 30 years, which is expected to cover the minimum 30-year functional operational life of the TR-IV turbines and the remaining functional operational life of the TR-II and TR-III turbines (Table 1.2). If the Applicant decides to continue to operate (i.e., re-power) the Project after the 30-year ITP term, then the Applicant will apply for a new ITP or for an ITP renewal. Operation beyond the permit duration is addressed in Chapter 8, as is early decommissioning of the Project.

Table 1.2 Proposed Incidental Take Permit term and operational years for the Timber Road Wind Farms.

Calendar Year	Incidental Take Permit (ITP) Year	Timber Road II Operational Year	Timber Road III Operational Year	Timber Road IV Operational Year
2011	Pre-ITP	Construction		
2012	Pre-ITP	Year 1		
2013	Pre-ITP	Year 2		
2014	Pre-ITP	Year 3		
2015	Pre-ITP	Year 4		
2016	Pre-ITP	Year 5	Construction	
2017	Pre-ITP	Year 6	Year 1	
2018	Pre-ITP	Year 7	Year 2	
2019	Pre-ITP	Year 8	Year 3	Construction
2020	1	Year 9	Year 4	Year 1
2021	2	Year 10	Year 5	Year 2
2022	3	Year 11	Year 6	Year 3
2023	4	Year 12	Year 7	Year 4
2024	5	Year 13	Year 8	Year 5
2025	6	Year 14	Year 9	Year 6
2026	7	Year 15	Year 10	Year 7
2027	8	Year 16	Year 11	Year 8
2028	9	Year 17	Year 12	Year 9
2029	10	Year 18	Year 13	Year 10
2030	11	Year 19	Year 14	Year 11
2031	12	Year 20	Year 15	Year 12
2032	13	Year 21	Year 16	Year 13
2033	14	Year 22	Year 17	Year 14
2034	15	Year 23	Year 18	Year 15
2035	16	Year 24	Year 19	Year 16
2036	17	Year 25	Year 20	Year 17
2037	18	Year 26	Year 21	Year 18
2038	19	Year 27	Year 22	Year 19
2039	20	Year 28	Year 23	Year 20
2040	21	Year 29	Year 24	Year 21
2041	22	Year 30	Year 25	Year 22
2042	23	Decommissioned	Year 26	Year 23
2043	24	Decommissioned	Year 27	Year 24
2044	25	Decommissioned	Year 28	Year 25
2045	26	Decommissioned	Year 29	Year 26
2046	27	Decommissioned	Year 30	Year 27
2047	28	Decommissioned	Decommissioned	Year 28
2048	29	Decommissioned	Decommissioned	Year 29
2049	30	Decommissioned	Decommissioned	Year 30

1.4 Plan Area and Permit Area

The lands covered by this HCP include the Plan Area and the Permit Area. The Plan Area is the geographic area that is analyzed in the NEPA analysis and the ESA § 7 intra-USFWS consultation. It includes any and all areas that may be within the HCP's sphere of influence, whether or not take of the Covered Species is likely to occur. The Applicant has determined that the Plan Area for the HCP includes the Permit Area (Figure 1.2), as well as all areas influenced by the HCP's biological goals and objectives, such as the minimization, monitoring, mitigation, and adaptive management activities associated with this HCP (see Chapter 5). As such, the Plan Area includes the Permit Area and all lands involved in the off-site mitigation project(s) associated with this HCP (see Section 5.3).

The Permit Area is a subset of the Plan Area and consists of all areas under the Applicant's control where take of the Covered Species is expected to occur and be authorized by the requested ITP. Operation of Project's wind turbines is the only activity that is likely to cause take of the Covered Species. Therefore, the Permit Area includes the locations of all 134 Project turbines (Figure 1.2) and the conservative distance from the turbines within which bat carcasses are expected to occur (Table 1.3). This includes all areas within 100 meters (m, 328 feet [ft]) of turbines, truncated by the lands leased for the Project because any areas outside of the leased lands are not under the Applicant's control. This conservative distance is based on bat species search data collected at TR-II and TR-III in 2017 and 2018, at the Hog Creek Wind Farm, another EDPR project in Ohio, in 2018, and at the Fowler Ridge Wind Farm (FRWF) in Benton County, Indiana, which is monitored under an ITP, along with ancillary data from another facility for search areas beyond 80 m (262 ft) as provided in the *Midwest Wind Energy Multi-Species Habitat Conservation Plan Public Review Draft* (USFWS 2016c). Note that, in Table 1.3 and henceforth, curtailment means a reduction in the electricity output of a turbine, in this case by intentionally increasing cut-in speed, i.e., the air speed at which a turbine begins to generate electricity. Feathering means increasing the angle of pitch of a turbine's blades so that the blades are parallel to airflow, thereby stopping or considerably slowing the rotation of the rotor.

Table 1.3. Assumed percentage of total covered bat species carcasses available to be found by search radius from turbines.

Search Radius from the Wind Turbines in Meters (Feet)	Assumed Carcasses Available to be Found within the Search Radius[a]	TR-II and TR-III Feathered and Curtailed[b,c]	TR-II and TR-III Feathered[c]	Hog Creek Feathered and Curtailed[b,d]	Hog Creek Feathered[d]
40 (131)	70%	35.8%	44.5%	40.5%	73.4%
50 (164)	80%	53.5%	58.3%	56.3%	84.4%
60 (197)	90%	70.4%	71.4%	72.1%	91.4%
70 (230)	95%	83.7%	82.7%	85.6%	95.5%
80 (262)	98%	92.3%	91.1%	94.5%	97.8%
90 (295)	99%	96.9%	96.3%	98.7%	98.9%
100 (328)	100%	99.0%	98.9%	99.8%	99.5%

[a] *Midwest Wind Energy Multi-Species Habitat Conservation Plan Public Review Draft* (USFWS 2016c).

[b] The term ‘curtailed’ indicates curtailment at 6.9 m/s cut-in speed in all cases.

[c] Iskali and Riser 2018a, 2018b, 2018c, Iskali et al. 2019a.

[d] Iskali et al. 2019b.

1.5 Covered Species

The Applicant is applying for an ITP for the Indiana bat and the northern long-eared bat for the Covered Activities as described below. The Indiana bat is listed as an endangered species under the ESA (see USFWS 1967) and the northern long-eared bat is listed as a threatened species under the ESA (80 Federal Register [FR] 17974 [April 2, 2015]). No land within the Permit Area is designated as critical habitat for the Covered Species under the ESA.

Currently no other endangered, threatened, or candidate species under the ESA are known to occur, and no critical habitat for any species designated under the ESA is located within the Permit Area. The potential future listing of additional species under the ESA that could be adversely affected by the Project is considered a changed circumstance and is addressed in Chapter 8.

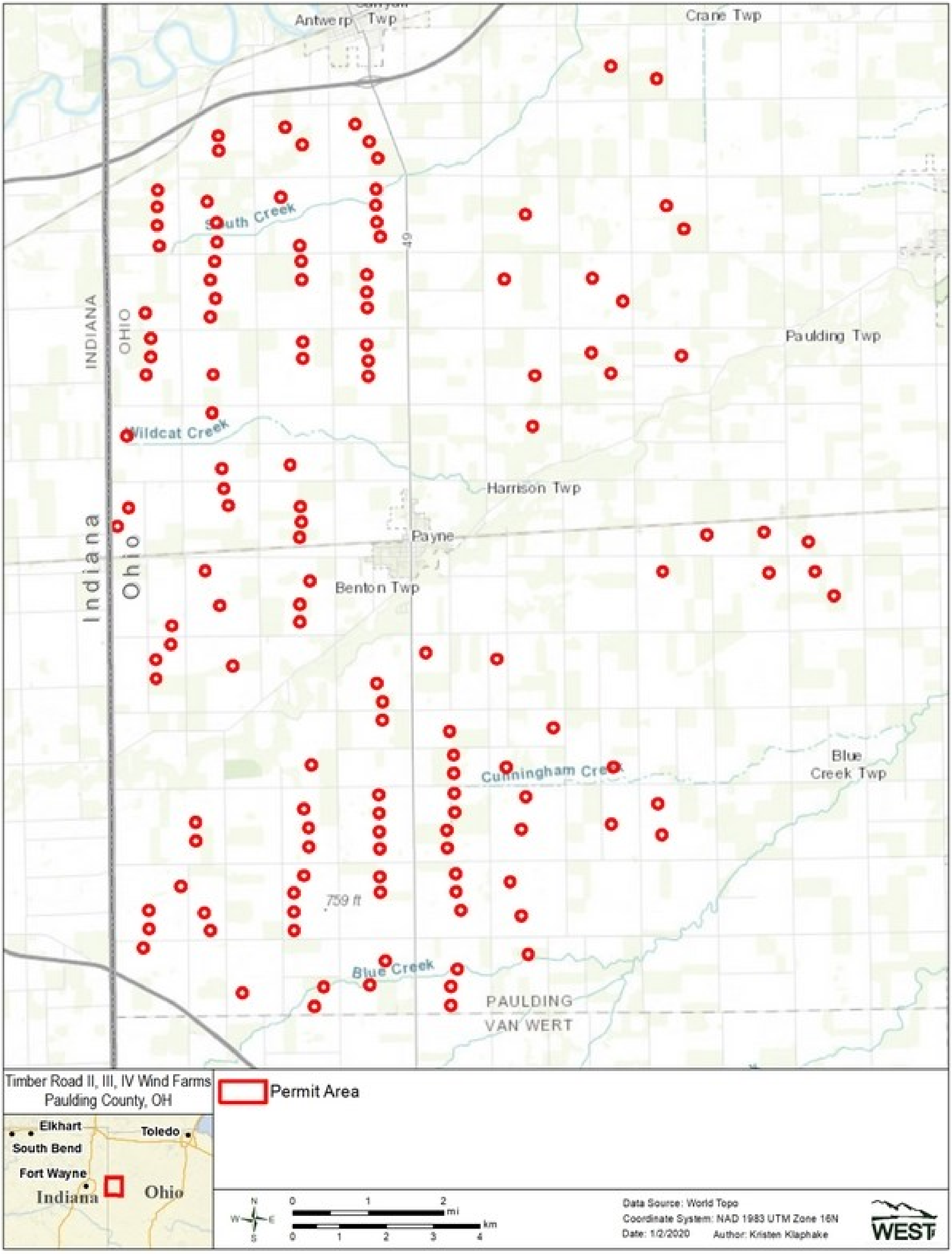

Figure 1.2. Permit Area of the Timber Road II, III, and IV Wind Farms.

2.0 PROJECT DESCRIPTION AND COVERED ACTIVITIES

2.1 Project Description

As noted (Table 1.1), TR-II and TR-III are already in operation, and TR-IV is expected to have its first full year of commercial operation in 2020. The collective 134 turbines will have a total generation output of 325.8 MW. Facilities associated with the Project include access roads, underground and overhead electrical lines, substations and switchyards, and other infrastructure typically associated with the operation and maintenance of a utility-scale wind energy facility.

2.1.1 Project Components

Project components include:

- Wind turbines
- Meteorological (met) towers
- Roads and pads
- Generator lead line
- Underground collection and communications cables
- Substation and switchyard
- Operation and maintenance (O&M) facilities

2.1.1.1 Wind Turbines

The wind turbine models, number deployed, generating capacities, manufacturer's cut-in speeds, hub heights, rotor diameters, and maximum heights are summarized in Table 2.1.

Table 2.1. Turbine specifications

Specification	Timber Road II Wind Farm	Timber Road III Wind Farm	Timber Road IV Wind Farm	Timber Road IV Wind Farm	Total
Turbine model	Vestas V100	Gamesa G114	Vestas V150	Vestas V136	
Turbine number	55	48	24	7	134
Per turbine generating capacity (MW)	1.8	2.1	4.2	3.6	
Total generating capacity (MW)	99.0	100.8	100.8	25.2	325.8
Manufacturer's cut-in speed (m/s)	3.0	3.0	3.0	3.0	
Tower height (m)	95	93	105	105	
Rotor diameter (m)	100	114	150	136	
Maximum turbine height (m)	145	150	180	173	

2.1.1.2 Meteorological Towers

Four permanent un-guyed 100-m (328-ft) meteorological (met) tower are located within the Plan Area (one in TR-II, one in TR-III, and two in TR-IV). The permanent met tower and associated electrical components are situated on a gravel pad that is approximately 12.2 m by 12.2 m (40 ft by 40 ft) enclosed by a standard chain link fence. Project personnel access the met towers on roads that are 5 m (16 ft) wide.

2.1.1.3 Roads and Pads

Roads associated with the Project include upgraded existing roads and new roads, both of which are constructed in accordance with wind industry standards and local building codes. The roads are designed to accommodate all-weather access by heavy equipment during construction and long-term use during the O&M phase.

All new roads have been constructed for the specific purpose of Project construction, operation, and maintenance. The permanent width of access roads is approximately 5 m (16 ft) and the Project includes a total of 68.9 kilometers (km; 42.8 miles [mi]) of permanent access roads. All roads include road base, surface materials, appropriate drainage, and culverts where necessary.

Crane pads at each turbine site consist of an approximately 18 × 25 m (59 × 120 ft) permanent gravel crane pad extending from the roadway to the turbine foundation.

2.1.1.4 Underground Electrical and Communications Cables

Electrical power generated by the wind turbines is collected through a network of underground cables that measures about 209.2 km (130.0 mi). These cables, along with a separate network of communication cables, are buried in trenches 1.2 to 1.5 m (4 to 5 ft) deep.

2.1.1.5 Substation

The substation consists of transformation and switching equipment to collect the energy from the Project to make suitable for delivery into the bulk power system. The TR-II switchyard and substation are located immediately adjacent to the switchyard for TR-III. The TR-III substation is located in the middle of TR-III, north of the switchyard, and is connected to the switchyard by the overhead generator lead line. The TR-IV substation is located in the southwest portion of TR-IV.

2.1.1.6 Generator Lead Line

There is no overhead transmission line associated with TR-II. TR-III owns an existing 13.8 km (8.6 mi) 138 kilovolt (kV) overhead generator lead line, while TR-IV owns an existing approximately 4.7 km (2.9 mi) 138 kV overhead generator lead line. Both have a right-of-way (ROW) that is 46 m (150 ft) in width.

2.1.1.7 Operations and Maintenance Facility

The same O&M building will serve the three Project phases. Measuring 348 m^2 (3,750 ft^2), it contains control equipment, offices, storage, bathrooms, and a kitchenette. A free-standing shop will be constructed behind the O&M building and measure 251 m^2 (2,700 ft^2).

2.1.2 Operations and Maintenance

The Project is operated both locally from the control room in the O&M building and remotely from Houston, Texas, through a remote operations control center. A permanent staff of approximately 13 to 15 on-site personnel provides O&M support activities to the Project. Each turbine includes a supervisory control and data acquisition (SCADA) operations and communications system that allows automated independent and remote operation of the turbine. The SCADA data provide detailed operating and performance information for each turbine, allowing real-time control and continuous monitoring to ensure optimal operation, as well as timely identification of potential problems. A local wind technician is either on site or available on call to respond in the event of an emergency.

The Project has a preventative maintenance and inspection schedule. Typical O&M activities include regularly scheduled wind turbine inspections and maintenance. Some repair activities may require the use of heavy equipment, such as cranes, to assist in the repair of large or heavy equipment, such as the rotor, turbine blades, and nacelle components.

Maintenance activities may include periodic mowing to increase searcher efficiency during mortality monitoring (see Section 5.4) and to maintain cleared areas associated with Project infrastructure, such as the ROWs of roads and the generator lead lines. Mowing maintains cleared areas in an herbaceous or shrub-scrub condition. The need for mowing is periodically evaluated during the growing season by site operations staff, and the mowing occurs as needed. Maintenance also consists of building inspection and repairs, as needed; periodic grading of roads to restore the road surface or repair of culverts, as needed; and annual inspection and removal of hazards (e.g., downed trees or encroaching branches) on the generator lead lines.

Required Federal Aviation Administration (FAA) lighting (see Advisory Circular 70/7460-1L; FAA 2015) consisting of flashing red, light-emitting diode lights on nacelles will be installed on selected turbines. The O&M facility and substation are designed to have outside safety lights that may be operated manually or via motion detectors.

2.1.3 Decommissioning

The minimum operating life of the Project turbines is 30 years. 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 is decommissioned after 30 years, the decommissioning process will be similar in scope and duration to the construction process. Most components and materials will be removed, recycled, or disposed of in an approved and appropriate waste management facility. Decommissioning activities will occur during daylight hours and will not create hazards for Covered Species. Turbines will be locked to prevent spinning during decommissioning, which will avoid the potential for collisions of the Covered Species with spinning rotors. Decommissioning of the Project is not expected to result in take of the Covered Species and is therefore not a Covered Activity under the requested ITP.

2.1.3.1 Decommissioning Process

The decommissioning process is scheduled to be completed within 18 months of initiation. It will include removal of above-ground structures and concrete foundations to a depth of at least 1.2 m (4 ft) below ground surface. It will also include replacement of topsoil and revegetation where necessary.

Above-ground structures include turbines, the met tower, the substation, the generator lead line, and the O&M facility. Below-ground structures include turbine foundations, collection and communication cables, drainage structures, and access road foundations. Components and materials will be evaluated for reuse, salvage, recycling, or disposal. They may be stored on site until ready for transport.

Access roads may be widened as necessary to accommodate movement of cranes or other machinery required for the disassembly and removal of the turbines. The access road widening will require the removal of no more than 2.0 hectares (ha; 5.0 acres [ac]) of forest and any tree removal necessary will be conducted during the winter months (October 1 – March 31) to avoid any potential take of the Covered Species. If additional clearing is required outside the winter months the Applicant will complete the required presence/probable absence surveys prior to the tree clearing.

Turbine components, control cabinets, electronic systems, and internal cables will be de-energized before removal. The blades, hub, and nacelle will be lowered to the ground for disassembly. Tower sections will be disconnected and lowered to the ground where they will be further disassembled, as needed, into transportable sections.

Any foundations will be excavated to remove anchor bolts, rebar, conduits, cable, and concrete to a depth of 1.2 m (4 ft) below grade. The excavations will be filled and compacted with clean sub-grade material of a quality and density comparable to the surrounding terrain. All unexcavated areas compacted by equipment used in decommissioning will be de-compacted to adequately restore the topsoil and sub-grade material to the proper quality and density comparable to the surrounding area.

All underground electrical collection lines are buried at least 1.2 m (4 ft) below finished grade and will be abandoned in place. Decommissioning of the substation will include removal of fencing, conductors, switches, transformers, foundations, and other substation components. Substation material and equipment disposal, reconditioning, or reuse will be dependent on condition and market value. Foundations and underground components will be removed to a depth of 1.2 m (4 ft) and the excavation filled, contoured, and re-vegetated. The O&M building, as a functional and relatively new building, may be repurposed upon Project decommissioning.

2.1.3.2 Site Restoration

Areas requiring restoration or reclamation will be leveled or re-contoured to match the surrounding terrain, covered with topsoil, and re-seeded in accordance with landowner preferences, if needed.

Other steps will be taken as necessary to prevent soil erosion, ensure establishment of vegetation cover, and control for noxious weeds and pests.

2.2 Covered Activities

According to the HCP Handbook (USFWS and NMFS 2016), covered activities are "activities that a permittee will conduct for which take is authorized in an ESA § 10 permit." 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 HCP Handbook explains that "in addition to having legal authority to carry out the proposed project, the applicant must also have direct control over any other parties who will implement any portion of the proposed activity and the HCP" (see 50 CFR 13.25 [1999]; 50 CFR 222.305(b) [1999]). "Direct control" under this regulation extends to:

1) "those who are employed by a permittee (e.g., contractors),
2) anyone under the regulatory jurisdiction of a permittee (e.g., the permittee is a county that issues building permits to individuals with conditions to implement the terms of the HCP), or
3) entities that have an interagency agreement establishing the permittee's legal control […]."

The Applicant has determined which Project-related activities could potentially result in incidental take of the Covered Species, are reasonably certain to occur, and over which the Applicant has control. Essentially, the Applicant has identified turbine operation over a proposed 30-year ITP term as the principal Covered Activity under the HCP. The Applicant will implement measures to minimize and mitigate potential take of Covered Species that may occur as a result of Project operations. No incidental take of the Covered Species is anticipated from the proposed mitigation project(s); however, the authority typically granted in the ITP includes implementation of mitigation measures in occupied habitat for the Covered Species, and therefore the Applicant proposes inclusion of these activities as a Covered Activity in the requested ITP.

2.2.1 Operation of the Project

Two phases of the Project are already in operation: TR-II since 2012 and TR-III since 2017 (Table 1.1). TR-IV is expected to begin commercial operation in late 2019. The Applicant anticipates that the TR-IV turbines will operate for a minimum of 30 years, hence the proposed 30-year ITP term. Spinning rotor blades are known to cause injury and mortality of bats, including the Covered Species, through collision[1] (Horn et al. 2008). Due to potential mortality of Covered Species from operation of the Project, operation of the 134-turbine Project is a Covered Activity in this HCP.

[1] Bat deaths and injuries were once thought also to result from decompression sickness, or barotrauma, which was hypothesized to occur in bats flying in close proximity to rotating turbine blades. It was thought they experienced rapid or excessive pressure change, resulting in pulmonary trauma, or lung damage, due to expansion of air in the lungs that was not accommodated by exhalation (Baerwald et al. 2008). However, one study found that the pressure changes around operating wind turbine blades were not large enough to cause fatal barotrauma in bats (National Renewable Energy Laboratory 2012).

2.2.2 Mitigation Measures

Implementation of this HCP will include measures to mitigate the impacts of the take of the Covered Species. These measures, described in detail in Chapter 5, are included as a Covered Activity in this HCP. The mitigation measures are intended to provide conservation benefits to the Covered Species, and thus are not likely to lead to take.

3.0 AFFECTED SPECIES, ENVIRONMENTAL SETTING, AND BASELINE

3.1 Environmental Setting

The Project is located in northwestern Ohio and falls entirely within the Huron/Erie Lake Plains Level III U.S. Environmental Protection Agency ecoregion. This ecoregion is described as a broad, fertile, nearly flat plain interrupted by relict sand dunes, beach ridges, and moraines. Originally, this ecoregion was dominated by elm-ash swamp and beech forests. Oak savannas were found in the sandy, well-drained dunes and beach ridges. Today, most of the area has been cleared and artificially drained to allow for the agricultural production of soybeans, corn, livestock, and vegetables. Urban and industrial areas are also widespread within this ecoregion. Stream habitat has been degraded by channelization, ditching, and other agricultural activities (USGS 2018).

According to the 2011 National Land Cover Dataset (NLCD; MRLC 2019, Yang et al. 2018), the primary land cover type within the Permit Area is Cultivated Crops, which composes 99.9% of the Permit Area. The second most abundant land cover type in the Permit Area is Developed-Open Space, which comprises 0.1% of the Permit Area and generally consists of residences, farms, and roads scattered throughout the Permit Area (Table 3.1, Figure 3.1).

Table 3.1 National Land Cover Database land cover types and percent composition within the Permit Area of the Timber Road II, III, and IV Wind Farms.

Habitat	Hectares	Acres	% Composition
Cultivated Crops	425.5	1051.5	99.7
Developed, Open Space	0.6	1.5	0.1
Deciduous Forest	0.6	1.4	0.1
Total	**362.5**	**895.9**	**100**

Data from US Geological Survey National Land Cover Dataset 2011 (MRLC 2019, Yang et al. 2018).

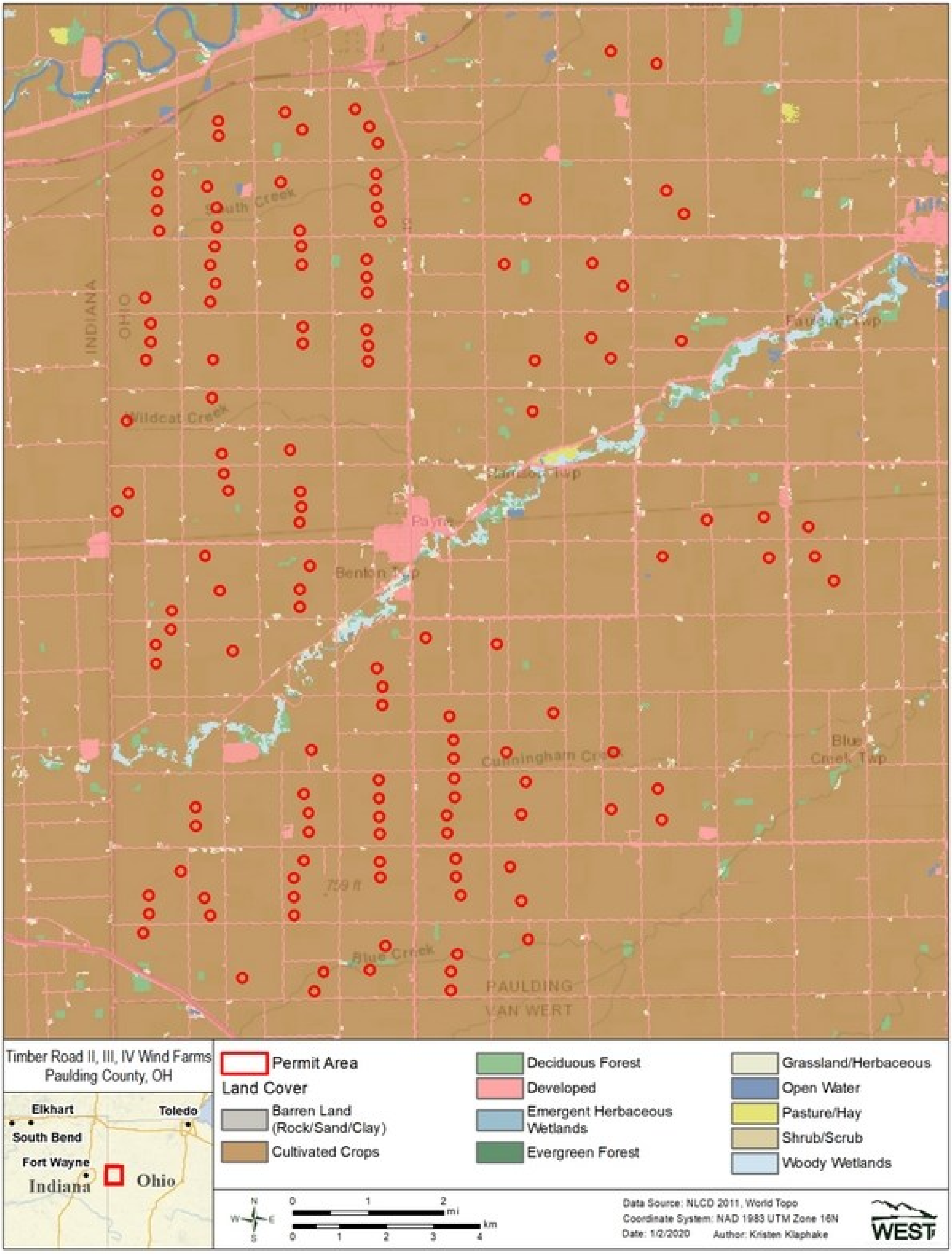

Figure 3.1. Land cover within the Permit Area of the Timber Road II, III, and IV Wind Farms.

Woody wetlands do not occur within the Permit Area and are relatively rare in the surrounding vicinity, where they are limited primarily to areas along small creeks and irrigation ditches, as well as areas along the Maumee River and Flat Rock Creek[2], which run northeast to southwest to the north and south respectively of the Project layout, but outside of the Permit Area (Figure 3.1). Other land cover types occurring in very small amounts in the lands adjacent to the Permit Area include developed, medium intensity; open water; emergent herbaceous wetlands; and developed, high intensity (Figure 3.1). Land use patterns were confirmed in a site visit conducted on July 7, 2016 (Tetra Tech 2017).

3.2 Covered Species – Indiana Bat

The Indiana bat is a small (7.0 – 10.0 gram [g; 0.2 – 0.4 ounce (oz)]) insectivorous bat first described as a separate species in 1928 (Miller and Allen 1928) based on re-examination of museum specimens collected in 1904 from Wyandotte Cave in Crawford County, Indiana. Before that time, specimens of the Indiana bat were confused with those of other *Myotis* species, especially the little brown bat (*Myotis lucifugus*). The Indiana bat can be distinguished from other *Myotis* species by its smaller foot (8.0 millimeters [mm; 0.31 inch (in)] instead of 9.0 – 10.0 mm [0.35 – 0.39 in] in the little brown bat); short, inconspicuous toe hairs; keeled calcar; more uniformly colored fur; and its pinkish colored pug-nose (Whitaker and Hamilton 1998).

The Indiana bat was determined to be an endangered species in 1967 under the Endangered Species Preservation Act of 1966, prior to the enactment of the ESA. 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 potentially ineffective management due to a general lack of knowledge about the species' biology and distribution (USFWS 1999). The 2007 *Indiana Bat (Myotis sodalis) Draft Recovery Plan* (Recovery Plan; USFWS 2007a) lists destruction/degradation of hibernation habitat; loss/degradation of summer, migration, and swarming habitat; disturbance of hibernating bats; disturbance of summering bats; disease and parasites; and natural factors and anthropogenic factors as threats to the species. White-nose Syndrome (WNS) is currently the most severe threat facing Indiana bat range-wide populations (see Section 3.5.1 for a detailed discussion of WNS and its effects on Indiana bats).

3.2.1 Life History Characteristics

Indiana bats exhibit life history traits similar to other temperate bat species. Despite the Indiana bat's small size, it is relatively long-lived compared to other mammal species of similar size (Barclay and Harder 2005). Similar to most temperate *Myotis* species, female Indiana bats generally give birth to one offspring per year (Humphrey and Cope 1977, Kurta and Rice 2002). Mating occurs in the vicinity of the hibernacula in late summer and early fall, and fertilization is delayed until the spring (Guthrie 1933).

[2] A setback of at least 0.8 km from the creek was imposed on all Project turbines based on Ohio Department of Natural Resources (ODNR Pers. Comm. 2008) recommendations for avoiding potential impacts to Indiana bats during the summer.

Timings of parturition and lactation are likely dependent in part on latitude and weather conditions. For example, in Iowa, female bats arrive at their maternity colonies at the end of April and parturition is completed by mid-July (Clark et al. 1987); in Michigan, young are born in late June or early July (Kurta and Rice 2002); and in southern Indiana, pregnant females have been documented from May 28 through June 30, while lactation has been recorded from June 10 - July 29 (Whitaker and Brack 2002). Young bats are able to fly within three to five weeks of birth, at which time the maternity colony begins to disperse (USFWS 2007a).

Females and juveniles may remain in the colony area until migration to hibernacula. It is likely that once the young are born, females leave their pups in the diurnal roost while they forage, returning periodically during the night to feed them (Barclay and Kurta 2007). Females will switch roost trees regularly and during these switches they must carry flightless young. Indiana bat maternity colonies will use several roosts. In Missouri, maternity colonies were found to use between 10 and 20 separate roost trees (Miller et al. 2002). In Kentucky, Gumbert et al. (2002) recorded 463 roost switches over 921 radio-tracking days of tagged Indiana bats (predominantly males) - an average of one switch every 2.21 days. Consecutive use of roost trees by individual bats ranged from one to 12 days. There are a number of suggested reasons for roost switching, including thermoregulation, predator avoidance, and reduced suitability of a roost tree - an ephemeral resource that may become unusable if it is toppled by wind, loses large pieces of bark, or is otherwise destroyed (Kurta et al. 2002, Barclay and Kurta 2007).

Indiana bats return to the vicinity of a hibernaculum in late summer and early fall, when the bats exhibit a behavior known as “swarming.” Swarming 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 hibernaculum during the day (Cope and Humphrey 1977). During the swarming period, most Indiana bats roost within approximately 2.4 km (1.5 mi) of the cave, suggesting that the forests around the caves provide important habitat prior to hibernation (USFWS 2007a). It is at this time that bats increase fat reserves that are vital for winter survival and for mating, which occurs during swarming.

Females enter the hibernaculum soon after arrival at the site, but males remain active for a longer period and may also travel between hibernacula - both of which may increase mating opportunities (USFWS 2007a). Spring emergence from the hibernacula generally occurs from mid-April to the end of May and varies across the range, depending on latitude and weather conditions. Females typically emerge before males, traveling sometimes hundreds of miles to summer habitats (Winhold and Kurta 2006).

3.2.2 Habitat Requirements

Indiana bats have two distinct habitat requirements: 1) a stable cave or cave-like environment in which to hibernate during the winter, and 2) woodland habitat in which to roost during the summer (USFWS 2007b). These and other less clearly-defined habitat associations during different periods of the Indiana bat life cycle will be described in the following sections.

3.2.2.1 Winter Habitat

Indiana bats generally hibernate from October to April, although this may be extended from September to May in northern parts of their range (USFWS 2007a). 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. For example, Indiana bats have been found hibernating in man-made tunnels in Pennsylvania (Sanders and Chenger 2000, Butchkoski and Turner 2008), and, in 1993, an Indiana bat was discovered hibernating in a hydroelectric dam in Manistee County, Michigan, 450 km (281 mi) from the closest recorded hibernaculum for Indiana bats, in LaSalle County, Illinois (Kurta and Teramino 1994). In 2005, approximately 30% of the population hibernated in man-made structures (predominantly mines), with the rest using natural caves (USFWS 2007a).

Indiana bats typically require low, stable temperatures (3 – 8 degrees Celsius [°C]; 37 – 46 degrees Fahrenheit [°F]) for successful hibernation (Brack 2004, Tuttle and Kennedy 2002). Cave configuration determines internal microclimate, with larger, more complex cave systems with multiple entrances more likely to provide suitable habitat for the Indiana bat (Richter et al. 1993, LaVal and LaVal 1980, Tuttle and Stevenson 1978). Most Indiana bats hibernate in caves or mines that tend to have large volumes, large rooms, and extensive vertical relief and passages, often below the lowest entrance. 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 and roost sites (USFWS 2007a). For example, the Sodalis Preserve, formerly known as Lime Kiln Mine, is the largest known Indiana bat hibernaculum, hosting approximately one-third of all hibernating Indiana bats; it has 34 entrances (USFWS 2016e). Bats are also able to decrease exposure to fluctuating air temperatures by increasing surface contact with the cave or other individuals. As such, Indiana bats tend to hibernate in large, dense clusters, ranging from 3,333 - 5,555 bats per m^2 (300 - 500 bats per ft^2; USFWS 2007a, Boyles et al. 2008). It is suggested that in hibernacula with small populations, Indiana bats cluster with other species (such as little brown bats) to gain this thermoregulatory advantage (USFWS 2007a).

3.2.2.2 Spring Emergence and Migration

In spring, Indiana bats emerge from hibernacula and disperse to their summer habitat where females form maternity colonies (Winhold and Kurta 2006). The spring migration season generally occurs from the end of March to late May, but the actual migration period may vary by latitude and weather, with spring emergence occurring earlier in more southern areas (USFWS 2007a). Relatively little is known about behavior of Indiana bats during migration, such as flight heights, echolocation frequency, or whether Indiana bats migrate singly or in groups.

Radio-telemetry studies and band return data have shown that dispersal or migration distances of Indiana bats from winter hibernacula to summer roost sites have varied geographically and between females and males, which categorizes Indiana bats as both a sedentary and regional migrant species based on categories defined by Fleming and Eby (2005). In Michigan, 12 female Indiana bats moved an average of 477 km (296 mi) between summer ranges and hibernacula in Indiana and Kentucky, with one individual migrating as far as 575 km (357 mi; Winhold and Kurta 2006), which is the maximum migration distance recorded for the species. Gardner and Cook

(2002) also reported long-distance migrations for Indiana bats traveling between summer ranges and hibernacula in the Midwest.

In the Northeast, however, radio-telemetry studies of 130 spring-emerging Indiana bats (primarily females) from six New York hibernacula found that all of the approximately 75% of bats that were later detected had migrated less than 68 km (42 mi) to their summer habitat (Butchkoski et al. 2008). Migration distances for Indiana bats in the Appalachian Mountain region appear to be longer than those in the Northeast (maximum distance reported for an adult female to date is 173 km [107 mi]; Butchkoski and Turner 2008), but not as long as those in the Midwest. Thus, Indiana bats in the northeastern US appear to travel the shortest distances (Hicks 2006, USFWS 2007a). In general, based on the results of studies to date, the summer range of Indiana bats could be any suitable habitat within approximately 575 km (357 mi) of a known winter hibernaculum.

Some non-reproductive female and male Indiana bats do not migrate as far as reproductive females. Instead, they typically remain in the vicinity of their hibernacula throughout the summer (Gardner and Cook 2002, Whitaker and Brack 2002). For example, mist-netting studies conducted during 1978 – 2002 mainly near maternity roosts in southern Michigan showed that only about 11% of the adults captured were males (Kurta and Rice 2002). However, some males make longer movements away from hibernacula. Males captured in southern Michigan likely migrated over 400 km (249 mi) from hibernacula in southern Indiana and Kentucky, based on several band return records for bats captured in this area (Kurta and Murray 2002).

Little is known about behavior of Indiana bats during migration. Indiana bats may try to minimize the time spent in transit, since 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. It appears that Indiana bat migration from winter to summer habitat is fairly linear and of short duration, while in the fall, migration is not as direct (USFWS 2007a, Hicks et al. 2012). Spring radio-telemetry studies have documented Indiana bats migrating relatively directly towards their summer ranges shortly after they emerge from hibernacula (Butchkoski and Turner 2006, Britzke et al. 2006).

Based on a combination of aerial and ground tracking, Indiana bats tracked from a hibernaculum in Pennsylvania flew almost straight lines to their roost trees 135 to 148 km (83 - 92 mi) away in Maryland (Butchkoski and Turner 2005). Similarly, a comparison between the range of initial bearings and the final bearings for 82 reproductive female Indiana bats radio-tracked to 65 maternity colonies in New York from 2000 to 2005 showed that the Indiana bats followed more or less direct routes from hibernacula to their summer ranges (Hicks et al. 2005). Evidence from radio-tracking studies in New York and Pennsylvania indicate that Indiana bats are capable of migrating at least 48 - 64 km (30 - 40 mi) in one night (Sanders et al. 2001, Hicks 2004, Butchkoski and Turner 2006), and up to 200 km (124 mi) in one night in Indiana and Kentucky (Roby and Gumbert 2016).

There is some evidence that Indiana bats in the Appalachian Mountain region and Northeast follow landscape features while migrating. Based on observations of 22 Indiana bats tracked during spring telemetry studies in Pennsylvania from 2000 to 2006, bats appeared to go out of their way to follow tree lines, including riparian buffers along streams through otherwise developed areas, and avoided open areas (Turner 2006). Several Indiana bats tracked during spring migration from the South Penn Tunnel in south-central Pennsylvania appeared to be moving along US Route 220, also known as the Appalachian Throughway, which follows a generally northeast-southwest direction in line with the Appalachian Mountains (J. Chenger, Bat Conservation Management, pers. comm.). Similarly, 12 Indiana bats tracked during spring migration in western Virginia generally followed ridges that ran northeast-southwest, with only one Indiana bat flying east (i.e., into the Shenandoah Valley) and none flying west (i.e., over the higher mountain ridges into West Virginia), suggesting that Indiana bats used ridgeline corridors as migration flyways (McShea and Lessig 2005). In Indiana and Kentucky, four radio-tracked female Indiana bats (two in each season) were observed flying in relatively straight paths during both spring and fall migration, mainly flying over decidious forest and cultivated crops (Roby and Gumbert 2016).

3.2.2.3 Summer Habitat

Suitable summer habitat for the Indiana bat includes roosting areas, foraging areas, and travel corridors. 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. Travel corridors (used for movement between roosts and between roosting and foraging habitat) consist of open corridors in wooded tracts, tree lines, wooded hedgerows, and other pathways that connect roosting and foraging areas (USFWS 2007a).

Female Indiana bats predominantly roost under slabs of exfoliating bark, preferring not to use tree cavities, but they have been found occasionally to use narrow cracks in trees (Kurta 2004). Maternity colonies use both primary and alternate roosts. Primary roosts were defined by Callahan (1993) in terms of number of bats (i.e., roosts used by more than 30 bats), but they may also be defined by the number of bat-days that the roosts are used over one maternity season (Kurta et al. 1996, Callahan et al. 1997, USFWS 2007a). Primary roosts are used throughout the summer, while alternate roosts are used less frequently and may be important during certain weather conditions related to temperature and precipitation, or when the primary roost becomes unusable (Callahan et al. 1997).

Due to their cryptic nature, Indiana bat maternity colonies had not been recorded until 1971 (Cope et al. 1974, Gardner and Cook 2002). Maternity colonies vary greatly in size in terms of number of individuals and 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 even live trees (if they have naturally peeling bark) may also be used (USFWS 2007a).

A meta-analysis of 393 roost trees in 11 states found 33 tree species that were used by female Indiana bats and their young, with ash, elm, hickory (*Carya*), maple (*Acer*), poplar (*Populus*), and oak (*Quercus*) accounting for approximately 87% of trees documented (Kurta 2004). Roost trees also vary in size. Typically, maternity colony roost trees are greater than 22 centimeters (cm; 8.6 in) diameter at breast height (dbh; Kurta 2004). The mean dbh of roost trees for a maternity colony (including primary and alternate roosts) in the aforementioned meta-analysis was 45 ± 2.0 cm, range 28 to 62 cm (18 ± 0.8 in, range 11 - 24 in; 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. For example, the average of five primary roosts used between 1997 and 2001 during long-term studies of the Indiana bat at the Indianapolis International Airport was 65.8 cm dbh (25.9 in; D.W. Sparks, USFWS, unpublished data).

An important characteristic for the location of Indiana bat 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 2007a). Mean values of canopy cover were highly variable among studies (20 - 88%; USFWS 2007a). Reports of roost trees in closed-canopy forests may appear to conflict with statements that primary roosts are generally located in areas with high solar exposure. For instance, Gardner et al. (1991) reported that 32 of 48 roost trees examined in Illinois occurred within forests with 80% to 100% canopy closure. There are several points to consider in evaluating this apparent discrepancy.

First, some variation undoubtedly was related to differences in methodology, because virtually every study measured canopy cover in a different way. Second, roosts found in closed-canopy forests, particularly primary roosts, were often associated with natural or man-made gaps (e.g., openings created by tree falls, riparian edges, and trail or forest road edges). Although the forest may be accurately described as closed canopy, the canopy in the immediate vicinity of the roost tree may have had an opening that allowed for solar radiation to reach the roost. Indiana bat roosts have been created by the death of a single large-canopy tree (A. King, USFWS, pers. comm.). Further, the absolute height of the roost tree appears to be less important than the height of the roost tree relative to the height of surrounding trees, with roost trees often extending above the surrounding canopy (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 or above the canopy of adjacent trees (Kurta et al. 1996, 2002; Callahan et al. 1997). Primary roosts are usually not located in densely forested areas, but rather occur along forest edges or within gaps in forest stands where they receive greater solar radiation (USFWS 2007a), a factor that may be important in reducing thermoregulatory costs for reproductive females and their young (Vonhof and Barclay 1996). Female Indiana bats are able to use torpor to conserve energy during cold temperatures; however, torpor slows gestation (Racey 1973), milk production (Wilde et al. 1999), and juvenile growth, and it is costly when the reproductive season is short (Hoying and Kunz 1998, Barclay and Kurta 2007).

As noted, Indiana bats from the same maternity colony may use up to 20 trees throughout the summer, but usually only one to three of these qualify as primary roosts, where the majority of bats roost for part or all of the summer (Callahan 1993, Callahan et al. 1997). Alternate roost trees are typically used by individual Indiana bats or small groups of Indiana bats for only one day or a few days. On average, Indiana bats switch roosts every two to three days, although reproductive condition of the female, roost type, and time of year affect switching (Kurta et al. 2002, Kurta 2005).

While the primary and alternate roosts of an Indiana bat maternity colony may change over the years, it is thought that foraging areas and travel corridors are relatively stable (Barclay and Kurta 2007). Members of a maternity colony in Michigan used a wooded fence line as a travel corridor for nine years (Winhold et al. 2005). In general, the distance from the roost tree to foraging areas was found to vary from 0.5 to 8.4 km (0.3 - 5.3 mi; USFWS 2007a); this distance may be constrained by the need to return to the roost periodically to nurse once the 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). In Pennsylvania, the mean distance from the roost to the nearest edge of an activity center was 2.7 km (1.7 mi) and ranged from 1.3 to 5.3 km (0.8 - 3.3 mi; Butchkoski and Turner 2005). In Indiana, 11 females used foraging areas that were on average 3.0 km from roosts, range 0.8 to 8.4 km (1.9 mi, range 0.5 - 5.3 mi; Sparks et al. 2005); and, in Michigan, the distance between roosts and foraging areas was 2.4 km, range 0.5 to 4.2 km (1.5 mi, range 0.3 - 2.6 mi; Murray and Kurta 2004). In areas of low-density forested habitat (approximately 2% forested area) in Ohio, the maximum foraging distances for lactating females from the primary roost tree were 9.4 to 10.8 km (5.9 - 6.7 mi) (K. Lott, USFWS, pers. comm.).

Although individual Indiana bats from a maternity colony appear to show fidelity to a general home range within and between years (Sparks et al. 2004), due to the differences in methodology, it is difficult to determine a typical home range size (Lacki et al. 2007). In Indiana, mean home range was 145 ± 18 ha (358 ± 44 ac; Sparks et al. 2005); while on the Vermont-New York state line it was 83 ± 82 ha (205 ± 203 ac; Watrous et al. 2006). Both of these estimates are higher than for a single female in Pennsylvania, whose home range was estimated at 21 ha (52 ac; Butchkoski and Turner 2006). The range of home ranges estimated likely reflects differences in habitat quality between sites, as well as differences in methodology.

3.2.2.4 Fall Migration and Swarming

Indiana bats start leaving their summer habitat as early as late July and begin arriving at hibernacula in August, with arrivals extending to mid-October (USFWS 2007a). Migration periods may vary by latitude and weather, with fall migration occurring earlier in more northern areas (USFWS 2007a).

Limited telemetry studies during spring and fall migration suggest that Indiana bats may migrate simultaneously, though perhaps independently (S. Darling, Vermont Department of Fish and Wildlife, pers. comm., 2010; J. Chenger, Bat Conservation Management, pers. comm., 2011; R. Reynolds, Virginia Department of Game and Inland Fisheries, pers. comm. 2010, as cited in

USFWS 2011b; Hicks et al. 2012). Environmental cues may pulse migration, and it is reasonable to assume that at least some individuals leave summer colonies together or at least during the same period (L. Pruitt, USFWS, pers. comm., 2011; R. Reynolds, Virginia Department of Game and Inland Fisheries, pers. comm., 2010; as cited in USFWS 2011b). However, given that females from the same maternity colony do not all hibernate in the same hibernaculum (though some do; Kurta and Murray 2002, Winhold and Kurta 2006), at least some females likely migrate independently.

Little is known about Indiana bat behavior during fall migration compared to spring migration. This is due, at least in part, to the ease of capturing and tagging bats roosting in hibernacula prior to spring dispersal compared to capturing bats dispersed throughout their summer habitat prior to fall migration. Consequently, most of what is known about fall migration comes from band returns (i.e., individual Indiana bats 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 do not provide information about timing or migration routes. In general, it is thought that fall migration takes longer and is less direct than the relatively direct and short-term spring migration (USFWS 2011b). However, both of the female Indiana bats radio-tracked by Roby and Gumbert (2016) completed their fall migration in one night, flying for 8.5 to 10.8 hours in relatively straight paths and travelling distances of 197 to 200 km (122 - 124 mi), apparently without stopping to forage.

Data regarding the height at which Indiana bats fly during migration are lacking. However, it is clear that some *Myotis* bats fly well above the tree canopy at rotor-swept height during fall migration, given that their fatalities are primarily recorded at wind energy facilities during late summer and fall, including eight of the 13 Indiana bat fatalities documented to date (Pruitt and Reed 2019). Nonetheless, data indicate that the cave-dwelling bat species, including Indiana bats, are probably not flying within the rotor-swept zone as frequently as long-distance migrating tree bats, given that of all bat fatalities detected at wind energy facilities within the range of the Indiana bat, less than 10% are *Myotis* and tri-colored bats (*Perimyotis subflavus*) (USFWS unpublished data, as cited in USFWS 2011b).

This assumption is supported by anecdotal and empirical data that suggest that Indiana bats primarily migrate at tree canopy level (Turner 2006; L. Robbins, Missouri State University, pers. comm., 2010; C. Butchkoski, Pennsylvania Game Commission [PGC], pers. comm., 2010; C. Herzog, New York State Department of Environmental Conservation, pers. comm., 2011; as cited in USFWS 2011b). Data from Indiana bats radio-tracked in spring in the Northeast showed that bats closely followed topographic features, such as meandering stream corridors and utility ROWs for miles, and over multiple years (J. Chenger, Bat Conservation Management, and G. Turner, PGC, pers. comm., 2011, as cited in USFWS 2011b). Similar findings have been documented in Tennessee and Illinois, indicating that Indiana bats may be flying near canopy height during migration (Gumbert et al. 2011, Hicks et al. 2012). However, it is uncertain if flight heights suggested in these studies would be similar to other portions of the species' range. Further, it is unknown whether flight heights during spring and fall migration are similar.

Females may remain active for only a few days after arriving at hibernacula, whereas males remain active, seeking mates, into late October and early November (timing varies with latitude and annual weather conditions). When swarming, most male Indiana bats roost in trees in the area surrounding hibernacula during the day and fly to their hibernaculum at night (USFWS 2007a). Clusters of active bats have also been observed roosting in caves during swarming events (Gumbert et al. 2002).

During fall roosting and swarming, the maximum distance between roost trees and associated hibernacula varied by hibernacula size. At two small hibernacula in Kentucky, Indiana bats roosted primarily within 2.4 and 4.1 km (1.5 and 2.5 mi) of cave entrances (Kiser and Elliot 1996, Gumbert 2001). In Virginia, all roost trees used by eight male and three female Indiana bats were within 1.4 km (0.9 mi) of a small hibernaculum[3] (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 small hibernaculum.

Indiana bats were documented to roost farther from hibernacula with more bats. Outside of the Canoe Creek Mine (with a hibernating population of 774 Indiana bats in 2007) in Pennsylvania, a male Indiana bat twice traveled 14 km (8.7 mi) from the hibernaculum where it was captured (USFWS 2007a). In Missouri, radio-tagged individuals traveled maximum distances of 6.4 km (4.0 mi) away from nearby hibernacula that had a collective hibernating population of 2,495 individuals (Rommé et al. 2002). During telemetry studies outside Wyandotte Cave in Indiana, two females were recorded 30.7 km (19.1 mi) away from the cave (Hawkins et al. 2005, USFWS 2007a). The longer distances traveled by Indiana bats at larger hibernacula seem to suggest that the density of Indiana bats influenced how they used the area surrounding hibernacula (Hawkins et al. 2005). As the density of Indiana bats swarming outside of hibernacula increases, they may need to move farther from the site to find available roost and prey resources (USFWS 2011b).

Indiana bats tend to roost more often as individuals in fall than in summer (USFWS 2007a). 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 2007a). 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). However, an Indiana bat captured during swarming at the Canoe Creek Mine in fall 2007 was captured in a cave in Tucker County, West Virginia, in winter 2009 - 2010, a distance of approximately 214 km (133 mi; C. Butchkoski, PGC, and C. Stihler, West Virginia Department of Natural Resources [WVDNR], pers. comm.). Similarly, a female Indiana bat that was captured emerging from the South Penn Tunnel in Bedford County, Pennsylvania, in the spring of 2007 was recaptured in winter 2009 - 2010 at Hellhole Cave in Pendleton County, West Virginia, a distance of approximately 138 km (86 mi; C. Butchkoski, PGC, and C. Stihler, WVDNR, pers. comm.). Hall (1962) also reported Indiana bats apparently switching between hibernacula.

[3] The author noted that bats traveling outside of the study area (defined as the north side of a 3.2-km [2.0-mi] circle, centered on the hibernaculum) were not able to be located.

3.2.2.5 Effects of Temperature on Bat Migration

Temperature affects bat migration both seasonally (O'Farrell and Bradley 1970, Avery 1985, Rydell 1991) and nightly (Lacki 1984, Hayes 1997, Vaughan et al. 1997, Gaisler et al. 1998, Shiel and Fairley 1998). Bat experts consulted by the USFWS (2011b) noted that weather conditions that impair flight, impair the ability to thermoregulate, or reduce insect activity, such as heavy rain, high wind, heavy fog, and cold (some specifically cited temperatures below 10 to 13°C [50 – 55°F]), are likely to reduce activity in all bat species. Data obtained from fatality monitoring at wind energy facilities also suggest correlations between weather conditions (i.e., temperature, wind speeds, and storm fronts) and bat activity.

Post-construction monitoring conducted during the fall (i.e., August 1 – October 15, 2010) at the Fowler Ridge Wind Farm in Indiana show that 0.3%, 1.0%, and 1.8% of all fresh bat casualties occurred during nights when the average nightly temperature was below 10°C in 2010, 2011, and 2012, respectively (Good et al. 2011, 2012, 2013). During the FRWF studies, average nightly temperatures below 10°C occurred about 4.1%, 2.7% and 9.5% of the time in 2010, 2011 and 2012, respectively. No *Myotis* species carcasses were found when average nightly temperatures were below 10°C at the FRWF. The average nighttime temperature during the evening when an Indiana bat carcass was found at the FRWF in fall 2010 was 21°C (69.8°F Good et al. 2011), which was slightly above the average nighttime temperature for the period of study.

Two Indiana bat fatalities have been documented at TR-II (Simon et al. 2014, Good et al. 2015). Neither of those casualties occurred when the average nightly temperature was below 10°C. Mortality monitoring was performed at TR-II in the fall of 2011 (July 31 – November 15) and in the spring, summer and fall of 2013 (March 31 – November 15). In 2011, average nightly temperatures below 10°C occurred on 20.4% of those nights, accounting for only 2.1% of bat casualties observed during the period, none of which were *Myotis* species. In 2013, average nightly temperatures below 10°C occurred on 20.6% of nights during the monitoring period, accounting for only 2.6% of bat casualties, also with no *Myotis* species. More information regarding these post-construction monitoring studies is included in Section 3.4.2.

Temperatures associated with the nights when the two Indiana bat fatalities occurred at TR-II were well above 10°C. One Indiana bat carcass was found on October 10, 2013; the carcass was decomposed and the bat was estimated to have been killed four to seven days prior to the date of collection. This placed the estimated time of death during the nights of October 3, 4, 5 or 6. Average nighttime temperatures during these dates ranged from 20.3 – 21.7°C (68.5 – 71.1°F), which was warmer than most other nights in October and November. The second Indiana bat carcass at TR-II was found on April 14, 2014; the carcass was fresh and estimated to have been killed the previous night. The average temperature on the evening of April 13 was 19.6°C (67.3°F) and ranged from 17.4°C – 22.5°C (63.3 – 72.5°F). The average temperature during the spring migration period (i.e., April 1 – May 15) was 11.1°C (52.0°F). The night of April 13 was the fifth warmest night of the 46 days in the spring migration season.

No site-specific temperature data are available for wind energy facilities where other fresh Indiana bat fatalities have been documented, but historic weather data for as close to the wind energy facilities as possible are as follows:

- Valparaiso, Indiana, September 8 - 9, 2009 – minimum temperature: 16 - 17°C (60 - 62°F)
- Valparaiso, Indiana, September 17, 2010 – minimum temperature: 16°C (60°F)
- Cresson, Pennsylvania, September 25, 2011 – minimum temperature: 14°C (57°F)
- Elkins, West Virginia, July 7, 2012 – minimum temperature: 18°C (65°F)
- Lima, Ohio, October 2 - 3, 2012 – minimum temperature: 12 - 14°C (53 - 57°F)

Although 10°C may not be a “hard cut-off” for Indiana bat activity, this temperature represents a threshold below which minimal activity is expected to occur (USFWS 2011b). Post-construction monitoring data from TR-II and the FRWF in Indiana have shown that only a small percentage of bat mortality occurs when temperatures are below the 10°C threshold.

3.2.3 Demographics

Little is known about annual survival rates for Indiana bats, either for adults or juveniles (USFWS 2007a). It is expected, however, that similar to many other species, survival of Indiana bats is lowest during the first year of life, and threats and sources of mortality vary during the annual cycle. During summer months, sources of mortality may include loss of occupied forested habitat, predation, and human-related disturbance (Kurta et al. 2002, USFWS 2007a). Sources of winter mortality may include predation, natural disasters that impact hibernacula, disturbance or modifications at the hibernacula and surrounding areas that physically disturb the bats or change the microclimate within the hibernacula, and direct human disturbance during hibernation that leads to disruption of normal hibernation patterns (USFWS 2007a).

Currently, WNS is the most severe threat facing Indiana bat populations range-wide. WNS was first discovered during the winter of 2006 in four caves in New York and has since spread steadily in all directions (White-Nose Syndrome Response Team 2016). The disease infects hibernating bats and is caused by a fungal pathogen (*Pseudogymnoascus destructans* [*Pd*]; Blehert et al. 2009; 2011, Minnis and Lindner 2013). To date, the disease is responsible for more than 5.7 million bat fatalities in eastern North America (USFWS 2016g). See Section 3.5.1 for a detailed discussion of WNS and its effects on the Covered Species.

In a study in Indiana, survival rates among male and female Indiana bats ranged from 66% - 76% for six to 10 years after marking, with female living approximately 12 – 15 years and males about 14 years (Humphrey and Cope 1977). The oldest known Indiana bat was captured 20 years after its first capture (LaVal and LaVal 1980). Research from banding studies during the 1970s suggests that adult Indiana bat survival during the first six years varies from approximately 70 - 76% annually (i.e., an average of 70 - 76% of the group studied survived each year; Humphrey and Cope 1977, O'Shea et al. 2004, USFWS 2007a). After this period, annual survival varied from 36 - 66%, and after 10 years, it dropped to approximately 4% (Humphrey and Cope 1977). There is less information available on neonatal survival, with one published study suggesting a neonatal survival rate of 92% based on observations at a maternity colony over a single season (Humphrey et al. 1977). More research is needed to accurately define annual survival rates of Indiana bats; however, available information suggests that annual survival rates are 76% for females and 70% for males during the first six years of life, decreasing to 66% survival for females and 36% for males from years seven to 10 (Humphrey and Cope 1977).

O'Shea et al. (2004) summarized survival rates for a number of bat species, including the little brown bat, which is considered a similar species to the Indiana bat in terms of life history. The range of annual survival rates cited varied considerably from approximately 13 - 86% (O'Shea et al. 2004). Other *Myotis* species also had variable annual survival rates, ranging from about 6 - 89%; however, in general, studies indicated that survival for first-year juveniles was generally lower than for adults. The sex ratio of the Indiana bat is generally reported as equal or nearly equal, based on early work by Hall (1962), Myers (1964), and LaVal and LaVal (1980). Humphrey et al. (1977) observed a nearly even sex ratio (nine females, eight males) in a sample of weaned young Indiana bats. However, differential survival in adults has been suggested (Humphrey and Cope 1977, LaVal and LaVal 1980).

As with mortality or survival rates for Indiana bats, relatively little is known about recruitment rates for the species; however, female Indiana bats typically give birth to one young per year (Mumford and Calvert 1960, Humphrey et al. 1977, Thomson 1982). The proportion of females in an Indiana bat population that produces young in a year is thought to be fairly high (USFWS 2007a). In one study, greater than 90% of female Indiana bats produced young each year (Humphrey et al. 1977), and in another study, it was estimated that 89% of adult female Indiana bats were reproductively active annually (Kurta and Rice 2002).

Location and environmental factors likely influence reproductive rates and there is concern that environmental threats such as WNS may lead to lower reproduction rates (USFWS 2011a). Non-reproductive female bats were captured with significantly higher frequency in post-WNS surveys of big brown bats (*Eptesicus fuscus*), eastern red bats (*Lasiurus borealis*), little brown bats, northern long-eared bats, and tri-colored bats in Indiana (O'Keefe et al. 2014). The Recovery Plan divides the species' range into four Recovery Units based on several factors, such as traditional taxonomic studies, banding returns, and genetic variation (USFWS 2007a). Recruitment in the total Indiana bat population in recent years has been variable by Recovery Unit (Figure 3.2), with the Ozark-Central Recovery Unit and the Midwest Recovery Unit (MRU; USFWS 2015b) being relatively stable since 2007. Populations in both the Northeast and Appalachian Recovery Units have decreased substantially in recent years due to WNS (USFWS 2015d). The Northeast Recovery Unit showed the largest percentage decline from 2007 to 2011 (70%; reduced by 37,639 bats); whereas the Appalachian Recovery Unit showed the largest decline from 2013 to 2015 (70%; reduced by 12,326 bats).

Figure 3.2. Range of the Indiana bat as shown by the US Fish and Wildlife Service Indiana bat Recovery Units (US Fish and Wildlife Service 2015b).

3.2.4 Range and Distribution

The range of the Indiana bat includes a large portion of the eastern US (Figure 3.2; Clark et al. 1987, Saugey et al. 1990, Evers 1992, Kurta and Teramino 1994, Kurta 1995, USFWS 2015b). Historically, general population trends of Indiana bats were decreasing in the south and increasing in the northern regions of its range (USFWS 2007a, 2017); however, after the onset of WNS, the species has disappeared from, or has greatly declined in, most of its former range in the Northeast (e.g., Trombulak et al. 2001). Historically, Indiana bat winter range was restricted to areas of cavernous limestone in the karst regions of the east-central US, apparently concentrated in a relatively small number of large, complex cave systems. These included Wyandotte Cave in Indiana; Bat, Coach, and Mammoth Caves in Kentucky; Great Scott Cave in Missouri; and Rocky Hollow Cave in Virginia (USFWS 2007a).

More recently, increasing numbers of Indiana bats have been found using man-made structures, such as mines, tunnels, and buildings for hibernation, extending their winter range into regions that lack caves (Kurta and Teramino 1994). For example, approximately 123,000 Indiana bats were discovered in Missouri in 2013 in what is now known as Sodalis Preserve (USFWS 2013b), where as many as 168,000 Indiana bats were estimated in 2016 (USFWS 2016e). Indiana bats also have been found hibernating in several man-made tunnels (Butchkoski and Hassinger 2002) and a hydroelectric dam (Kurta and Teramino 1994).

Pre-WNS, approximately 30% of the population hibernated in man-made structures (predominantly mines) with the rest using natural caves (USFWS 2007a). As of November 2006, there were 281 known extant Indiana bat hibernacula in 19 states (USFWS 2007a). At that time, over 91.8% of an estimated population of 457,374 hibernated in just five states: Indiana (45.2%), Missouri (14.2%), Kentucky (13.6%), Illinois (9.7%), and New York (9.1%) (USFWS 2007a). Since WNS, and with the discovery of the Sodalis Preserve population, the population estimate for 2019 was 537,297 Indiana bats, with 85.3% in three states: Missouri (36.3%), Indiana (34.4%), and Illinois (14.6%) (USFWS 2019a).

The distribution of Indiana bat summer habitat in the eastern US appears to be less extensive than in the Midwest (see range maps in USFWS 2007a), which may be due to the geographic distribution of important hibernacula or to differences in climate and elevation that may limit suitable summer colony sites in the east, as well as the effects of WNS more recently. Summer temperatures in portions of Indiana bat range in the east are slightly cooler than in the core part of the range in Indiana and Kentucky, which may influence the energetics of reproduction (Woodward and Hoffman 1991, Brack et al. 2002,).

3.2.5 Species Status and Occurrence

3.2.5.1 Range-Wide

A key component to the survival and recovery of the Indiana bat is maintenance of suitable hibernacula that ensure the over-winter survival of sufficient individuals to maintain population viability (USFWS 2007a). Hibernacula are categorized based on their priority to the species' population and distribution. Priority 1 (P1) hibernacula are essential to the recovery and long-term conservation of the species and have a current or historically observed winter population of 10,000 or more individuals. Priority 2 (P2) hibernacula contribute to the recovery and long-term conservation of the species and have a current or historical population of more than 1,000 but less than 10,000 individuals. Priority 3 (P3) sites have a current or historical population of 50 – 1,000 bats, and Priority 4 (P4) sites have a current or historical population of fewer than 50 bats.

Since the release of the *Recovery Plan for the Indiana Bat* (USFWS 1983), the USFWS implemented a biennial monitoring program at P1 and P2 hibernacula (USFWS 2007a). In 1965, the overall population was estimated to be 883,300 individuals, but there has been a long-term declining population trend, with 537,297 individuals reported range-wide in 2019 (USFWS 2019a).

3.2.5.2 Midwest Recovery Unit

The Project falls within the MRU which includes the states of Indiana, Kentucky, Ohio, Tennessee, Alabama, southwestern Virginia, southern Michigan, and northwest Georgia (Figure 3.2, USFWS 2016a).

According to the *2019 Indiana Bat (Myotis sodalis) Population Status Update* (USFWS 2019a), the overall population within the MRU was 245,474 in 2019, a 0.9% increase from 2017 (Table 3.2). The MRU represents 45.7% of the 2019 range-wide population of Indiana bats (USFWS 2019a). According to the Recovery Plan, there are 190 known Indiana bat hibernacula within the MRU, with 116 being classified as extant (i.e., having at least one recorded Indiana bat during census counts since 2000; USFWS 2007a). There are 12 P1 hibernacula in the MRU – seven in Indiana and five in Kentucky.

Table 3.2. Indiana bat population estimates for the Midwest Recovery Unit.

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**

Data from US Fish and Wildlife Service 2019.

3.2.5.3 Ohio

Approximately 0.5% of the estimated range-wide population of Indiana bats hibernated in Ohio in 2019 (USFWS 2019a). The estimated population size of Indiana bats in Ohio peaked in 2011 at 9,870 bats (Table 3.2; USFWS 2013a). There are few known major hibernacula in the state for Indiana bats or other bats. 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[4] (Figure 3.3). Four other hibernacula in three counties (Hocking, Brown, and Highland) have been designated as P4, but currently have no known hibernating Indiana bats (USFWS 2007a).

The Project is located in Paulding County, where there are no known Indiana bat hibernacula. The closest known Indiana bat hibernaculum to the Permit Area is the Lewisburg Limestone Mine, located approximately 145 km (90 mi) to the south. As noted, the Lewisburg Limestone Mine is categorized as a P2 hibernaculum by the USFWS. A 2012 census of the mine documented a winter Indiana bat population of 9,243 (A. King, USFWS, pers. comm.). WNS appears to have caused a significant population reduction, given that only 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 (1999 – 2012) showed annually fluctuating Indiana bat populations (150 – 333 individuals during winter counts; A. King, USFWS, pers. comm.). Subsequently, the population was greatly reduced as a result of WNS, with a population count of only 16 in 2013, representing a 94% decline from the 2012 population. No Indiana bats were found during the 2014 and 2016 winter counts (K. Lott, USFWS, pers. comm.)

Band-return records suggest that Indiana bats that migrate through fall and/or summer in Ohio over winter 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 by Gardner and Cook (2002), Kurta and Murray (2002), and Winhold and Kurta (2006), as well as in three unpublished band returns documented by A. Kurta (Eastern Michigan University, pers. comm.). These include records of 19 Indiana bats passing through Ohio. Barbour and Davis (1969) reported that several Indiana bats banded at Bat Cave and Mammoth Cave in Kentucky were recovered in west-central Ohio. Additional contemporary data from mist netting efforts in Ohio and hibernacula surveys in southern states suggests similar migratory patterns (Table 3.3).

[4] A comprehensive survey of all possible hibernacula in Ohio has not been conducted; therefore, other Indiana bat hibernacula may exist.

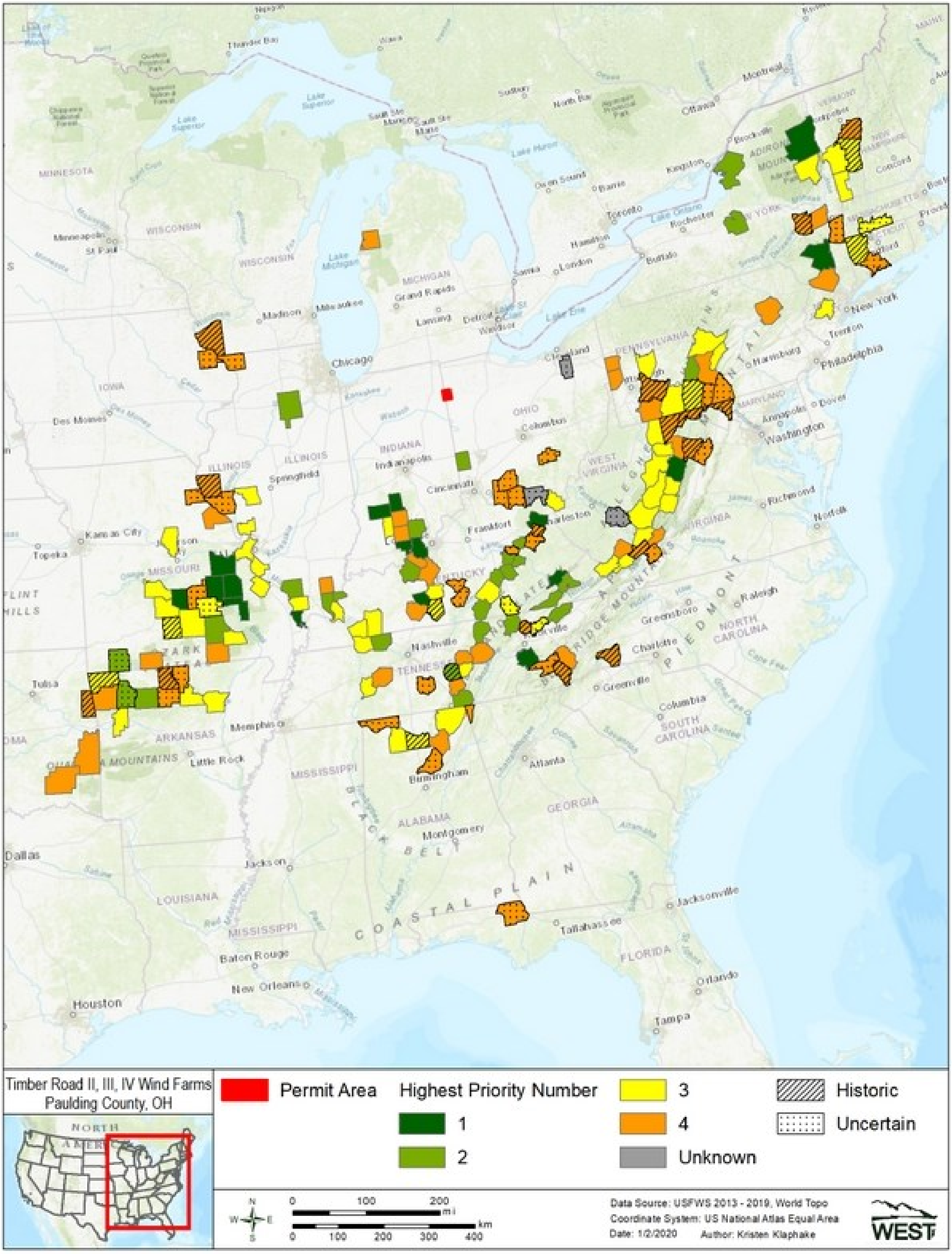

Figure 3.3 Counties with historic or extant Indiana bat hibernacula.

Table 3.3. Indiana bat migration distances between mist netting capture locations and hibernation recapture locations.

Capture Location	Recapture Relocation	Migration Distance km (mi)	Year	Age/Sex	Citation
Logan County, OH	Bat Cave, Carter County, KY	218 (136)	2008	Adult/Female	J. Kiser, Stantec, and K. Lott, Ohio Department of Natural Resources [ODNR], pers. comm.
Greene County, OH	Wolf River Cave, Fentress County, TN	376 (234)	2008	Unknown	K. Lott, US Fish and Wildlife Service (USFWS), pers. comm.
Champaign County,OH	Goochland Cave, Daniel Boone National Forest, KY	308 (191)	2009/2010	Adult/Female	J. Kiser, Stantec, and K. Lott, Ohio Department of Natural Resources (ODNR), pers. comm.
Indiana	Lewisburg Limestone Mine, OH	80 (50)	2015	Unknown	K. Lott, USFWS, pers. comm.
Shelby County, OH	Bat Cave, Carter County, KY	246 (153)	2013	Unknown	K. Lott, USFWS, pers. comm.
Greene County, OH	Bat Cave, Carter County, KY	179 (112)	2013	Unknown	K. Lott, USFWS, pers. comm.
Pickaway County, OH	Saltpetre Cave,Lee County, KY	239 (149)	2011	Unknown	K. Lott, USFWS, pers. comm.
Pickaway County, OH	Bat Cave, Carter County, KY	144 (90)	2011	Unknown	K. Lott, USFWS, pers. comm.

km = kilometer; mi = mile

The summer range of Indiana bats in Ohio is throughout the state. As of the 2007 Recovery Plan and updated information from the USFWS (USFWS 2007a; K. Lott, USFWS, pers. comm.), 40 counties in Ohio (out of 88 total counties) had records of Indiana bat summer maternity colonies or other records of non-reproductive female Indiana bats or male Indiana bats (Figure 3.4).

Section 3.4.3 covers the likely occurrence of Indiana bats in the Permit Area.

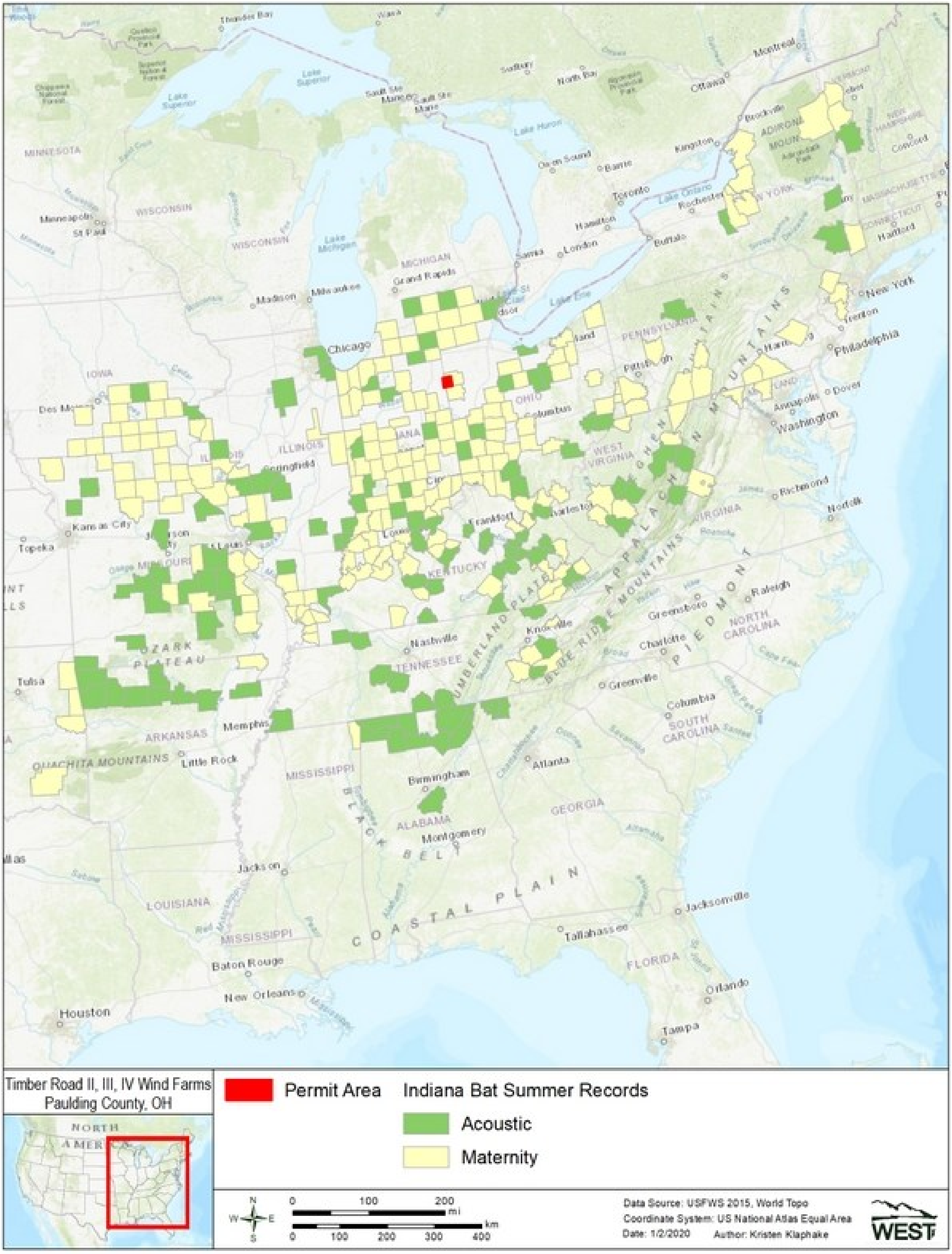

Figure 3.4 Counties with summer Indiana bat records.

3.3 Covered Species – Northern Long-Eared Bat

The northern long-eared bat is a small (5.0 – 8.0 g [0.2 – 0.3 oz]) insectivorous bat. Compared to other *Myotis* species, these bats have long ears with a relatively long tragus; when folded forward, the ears extend well past the nose. They also have a longer tail and larger wing area than most comparably sized *Myotis* bats, giving them increased maneuverability during slow flight (Caceres and Barclay 2000). Their fur color can be medium to dark brown on the back and tawny to pale-brown on the underside. 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 actually pertains to the northern long-eared bat.

The life history of the northern long-eared bat makes this species particularly vulnerable to a variety of threats. Because of the species' low reproductive rate, populations of northern long-eared bats are likely slow to recover from loss of individuals, increasing the possibility that mortality caused by WNS (see Section 3.5.1), development, or other factors will extirpate the species from portions of its range (e.g., USGS 2009). Although population trends have not historically been recorded for the species, it is understood that WNS is currently causing severe population declines in the eastern part of the species' range. Other sources of mortality may further diminish the species' ability to persist in areas where populations are significantly reduced due to WNS.

Due to the immediate and severe threat to the species from WNS, the USFWS was petitioned by the Center for Biological Diversity to list northern long-eared bat under the ESA. On October 2, 2013, the USFWS issued a 12-month finding on the petition to list the northern long-eared bat, which proposed the northern long-eared bat for listing under the ESA as an endangered species (78 FR 61046). Based on the best available scientific information and following an extended public comment period, the USFWS listed the northern long-eared bat as a threatened species under the ESA (80 FR 17974 [April 2, 2015]). The final 4(d) rule for the species published January 14, 2016 (81 FR 1900) exempts from the ESA § 9 take prohibition the incidental take of northern long-eared bats resulting from most otherwise lawful activities[5], including the operation of wind turbines. The USFWS further concluded that the designation of critical habitat was not determinable at the time of listing.

3.3.1 Life History Characteristics

Northern long-eared bats exhibit life history traits similar to Indiana bats and other temperate bat species. Like most bats, northern long-eared bats are relatively long-lived. Similar to most

[5] The final 4(d) rule published January 14, 2016 (81 FR 1900), exempts all incidental take of northern long-eared bats caused by otherwise lawful activities from the take prohibition under § 9 of the ESA, except: take of northern long-eared bats in their hibernacula in areas affected by WNS; take resulting from tree removal within 0.4 km (0.25 mi) of a known northern long-eared bat hibernaculum; and take resulting from removal of a known 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). Incidental take resulting from hazard tree removal for protection of human life and property is exempt from the take prohibition regardless of where and when it occurs.

temperate *Myotis* species, female northern long-eared bats generally give birth to one offspring per year (Barbour and Davis 1969). Mating occurs in the vicinity of hibernacula from late July in northern regions to early October in southern regions and commences when males and females swarm at hibernacula (Whitaker and Hamilton 1998, Whitaker and Mumford 2009, Caceres and Barclay 2000, Amelon and Burhans 2006). Mating also occasionally occurs again in the spring (Racey 1982). Hibernating females store sperm until spring, employing a delayed fertilization strategy (Racey 1979, Caceres and Pybus 1997).

In spring, female northern long-eared bats leave hibernacula and form maternity colonies ranging from seven to 100 individuals, but most commonly 30 - 60 individuals (USFWS 2014a). Birthing within the colony tends to be synchronous, with the majority of births occurring around the same time (Krochmal and Sparks 2007). Parturition dates and subsequent weaning are likely dependent on regional conditions (Foster and Kurta 1999). Parturition likely occurs in late May or early June (Caire et al. 1979, Easterla 1968, Whitaker and Mumford 2009), but may occur as late as July (Whitaker and Mumford 2009). Studies completed by Broders et al. (2006) over a three-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 (Caire et al. 1979, Cope and Humphrey 1972).

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 back to hibernacula for fall swarming and hibernation occurs at the end of the summer maternity season, as early as late July and extending as late as October (Whitaker and Hamilton 1998, Whitaker and Mumford 2009, Caceres and Barclay 2000, Amelon and Burhans 2006).

Northern long-eared bats are likely opportunistic insectivores that primarily glean prey from substrates (Faure et al. 1993). 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).

3.3.2 Habitat Requirements

3.3.2.1 Winter Habitat

Mine and cave sites have been most often reported as hibernacula for northern long-eared bats (Whitaker and Winter 1977, Stones 1981, Griffin 1940). This species reportedly hibernates in caves or abandoned mines with Indiana bats, little brown bats, big brown bats, and tri-colored bats (Caire et al. 1979, Mills 1971, Boyles et al. 2009). Northern long-eared bats are generally a small proportion of the total known hibernating population in a hibernaculum (less than 1% - 15%; Griffin 1940, Hitchcock 1949, Pearson 1962, Caire et al. 1979, Stones 1981). Northern long-eared bats have more recently been suspected to hibernate in cracks of cliffs, which also may help explain why numbers of bats hibernating in caves are low, but this hypothesis has yet to be validated.

Hibernating 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 very 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 2014a).

3.3.2.2 Spring Emergence and Migration

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). There is little information available regarding spring emergence and dispersal of northern long-eared bats from hibernacula. According to the *Northern Long-eared Bat Interim Conference and Planning Guidance* (Northern Long-Eared Bat Guidance; USFWS 2014a), the primary spring migration season is from the beginning of April to mid-May. As with Indiana bats, the actual migration periods may vary by latitude and weather, with spring emergence occurring earlier in more southern areas (USFWS 2014a).

Shortly after emergence, northern long-eared bats migrate to their summer habitat. Although species-specific data are lacking, the spring migration direction of northern long-eared bats may be similar to the migration direction documented for little brown bats, meaning that northern long-eared bats may radiate outward from hibernacula during migration and migrate directly to the natal sites, rather than moving primarily north or south (Davis and Hitchcock 1965, Fenton 1970, Griffin 1970, Humphrey and Cope 1976). Short migratory movements between 56 to 89 km (35 - 55 mi) from hibernacula to summer habitat are most common (Griffin 1945, Nagorsen and Brigham 1993), suggesting the species is a regional migrant. The longest recorded migration distance for the species is 97 km (60 mi), reported by Griffin (1945).

Little is known about male northern long-eared bat migrations, but male little brown and Indiana bats have been captured outside of known hibernacula in midsummer, suggesting that some males may migrate only short distances from their hibernacula (Davis and Hitchcock 1965, Gardner and Cook 2002, Whitaker and Brack 2002). If male northern long-eared bats behave similarly 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). However, records of non-reproductive male northern long-eared bats have been documented in 64 counties in northeastern, northwestern, and southern Ohio, locations distant from any known nearby hibernacula (K. Lott, USFWS, pers. comm.).

3.3.2.3 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, with old-growth forest communities selected most frequently (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 northern long-eared bat 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 northern long-eared bats may roost alone, female northern long-eared bats often roost colonially.

Northern long-eared bats do not typically forage in intensively harvested stands or open agricultural areas, but instead concentrate their movement in and near intact forest (Patriquin and Barclay 2003, Henderson and Broders 2008). However, in areas where forest has a patchy distribution, northern long-eared bats are forced to move across open agricultural areas to reach nearby forest. In northwestern Ohio, the smallest forested patch where a northern long-eared bat was captured was 0.7 ha (1.8 ac); in Van Wert County, the smallest patch of forest where northern long-eared bats were captured was 1.9 ha (4.7 ac; K. Lott, USFWS, pers. comm.).

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 (Brooks and Ford 2005, Owen et al. 2003). In managed forests of West Virginia, northern long-eared bats utilized on average a 65-ha (160.6-ac) home range and patches smaller than this likely represent unsuitable habitat (Owen et al. 2003). Females have been reported to move up to approximately 2,000 m (6,500 ft) and males up to approximately 1,000 m (3,300 ft) between roost sites (Broders et al 2006).

A radio telemetry study of seven northern long-eared bats (two males and five females) and five Indiana bats (all males) at Wayne National Forest in Ohio found significant differences in roost selection between the two species (Schultes and Elliott 2002). Northern long-eared bats exhibited a wider roosting niche than Indiana bats, using both bark and cavity roost in live and dead trees. Northern long-eared bat roost trees had significantly higher basal area (23 m^2/ha versus [vs] 15 m^2/ha) and percent shrub cover within five m of the tree (44% vs 23%) than Indiana bat roost trees and were located in slightly younger forest stands (76 years vs 86 years), although it was noted that average stand age is not representative of the possible range in tree age within a stand. Northern long-eared bat roosts were located farther from water (117 m vs 27 m [383.9 ft vs 88.6 ft]) but closer to mist-net sites (300 m vs 1,600 m km [984.3 ft vs 5,249.3 ft]) than Indiana bat roosts, suggesting that northern long-eared bats had shorter nightly travel distances at Wayne

National Forest. Northern long-eared bat roosts were associated with upper slopes and ridgetops, although the authors noted that this association may have been the result of a limited sample size. Both northern long-eared bats and Indiana bats selected for roost trees located closer (80 – 100 m [262.5 – 328.1 ft]) to roads and trails, possibly making use of these areas as flyways between roost trees and foraging areas. Both species changed roosts regularly and at similar rates during the study, including in response to the loss of two roost trees, identified by the study as an ephemeral resource.

3.3.2.4 Fall Migration and Swarming

According to the Northern Long-eared Bat Guidance (USFWS 2014a), the primary fall migration period is from mid-August to mid-October. Relative to Indiana bats, even less is known about behavior of northern long-eared bats during migration than during the summer maternity season. Knowledge gaps include flight heights, echolocation frequency, influence of weather, or whether they migrate singly or in groups.

Data regarding the height at which northern long-eared bats fly during migration are lacking, as no radio-telemetry studies have been conducted to date to study their migration behavior. Nonetheless, as described for Indiana bats, it is clear that at least a portion of *Myotis* bats are flying well above the tree canopy at rotor-swept height during migration, based on the 50 northern long-eared bat fatalities that have been publicly documented to date at wind energy facilities, occurring primarily during late summer and fall.[6] However, as explained in Section 3.2.2.4, data indicate that the cave-dwelling bat species are probably not flying within the rotor-swept zone as frequently as long-distance migrating tree bats, as *Myotis* species fatalities make up about 10% of the total bat fatalities at wind turbines (USFWS unpublished data, as cited in USFWS 2011b).

Northern long-eared bats begin arriving at hibernacula in August. By mid-September large numbers can be seen flying about the entrances to certain caves and mines (Boyles et al .2009). As noted, mating occurs during this fall swarming period around hibernacula (USFWS 2014a).

3.3.2.5 Effects of Temperature on Bat Migration

As explained in Section 3.2.2.5, positive correlations of bat activity and temperature are numerous in bat literature, both seasonally (O'Farrell and Bradley 1970, Avery 1985, Rydell 1991) and nightly (Lacki 1984, Hayes 1997, Vaughan et al. 1997, Gaisler et al. 1998, Shiel and Fairley 1998). Temperatures below 10 – 13°C [50 – 55°F]) are likely to result in reduced bat activity among all bat species (USFWS 2011b). Although 10°C may not be a "hard cut-off" for northern long-eared bat activity, this temperature is expected to represent a threshold below which minimal activity is expected to occur (USFWS 2011b). This is supported by post-construction monitoring data from the TR-II and Fowler Ridge wind farms in Ohio and Indiana respectively, where only a small

[6] Kerns and Kerlinger 2004; Arnett et al. 2005; Stantec Consulting Ltd. 2007; Grehan 2008; James 2008; Jain et al. 2009, 2011; Jacques Whitford 2009; Young et al. 2009, 2013; Good et al. 2011; Kerlinger et al. 2011; Stantec Consulting 2011; J. Taucher, PGC, pers. comm. ,

percentage of bat mortality, and no observed *Myotis* mortality, occurred when temperatures were below the 10°C threshold (see Section 3.2.2.5).

3.3.3 Demographics

Similar to other *Myotis* bat species, northern long-eared bats have a low reproductive rate, with females generally birthing one offspring per year. The sex ratio in northern long-eared bat populations appears to be dominated by males, with multiple studies reporting higher percentages of males compared to females (Griffin 1940, Pearson 1962, Hitchcock 1949, Stones 1981). The skewed ratio is believed to be due to greater mortality among females. 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).

There is little information regarding survival trends for northern long-eared bats. Few have ever been banded, and the prospects for banding more are reduced as populations are decreasing (USFWS 2015a). There is no available information on recruitment rates or the proportion of females in a population that produce young in a year.

3.3.4 Range and Distribution

The northern long-eared bat has been found in 39 states in the Eastern and Midwestern US, as well as across the northern Great Plains and across eastern and central Canada (USFWS 2014a, 2015c; Figure 3.5). While the range is large, the species' distribution is irregular and patchy, with large numbers rarely occurring (Barbour and Davis 1969). Harvey (1992) found large numbers to be more common in the northern part of its range. Barbour and Davis (1969) found the overall winter and summer ranges of the species to be identical.

3.3.5 Species Status and Occurrence

3.3.5.1 Range-Wide

Little is known about overall population size or trends of the northern long-eared bat within its broad range. The species has historically been most common in the Northeast and Midwest (USFWS Regions 5 and 3), with lower densities known in the southern and western portions of the range (USFWS 2013b). As with the Indiana bat, WNS is the most severe threat facing northern long-eared bat populations range-wide and is the primary reason the species was listed as threatened under the ESA (80 FR 17974 [April 2, 2015]) (see Section 3.5.1).

Across the species' range, northern long-eared bat population trends have not been historically monitored. Moreover, given the tendency of northern long-eared bats to hibernate individually or in small groups, it is difficult to obtain accurate counts of hibernating northern long-eared bats. However, mist-netting surveys suggest that northern long-eared bats are more numerous than hibernacula counts detect (Whitaker et al. 2002). Prior to WNS, adequate data to assess broad-scale population trends were not available, although some studies reported stable populations within portions of the species' range (e.g., Trombulak et al. 2001). Before the advent of WNS in 2006, this species was common in bat surveys in the Northeast; after the arrival of WNS, survey numbers for northern long-eared bats declined to zero in many hibernacula (Hicks et al. 2008).

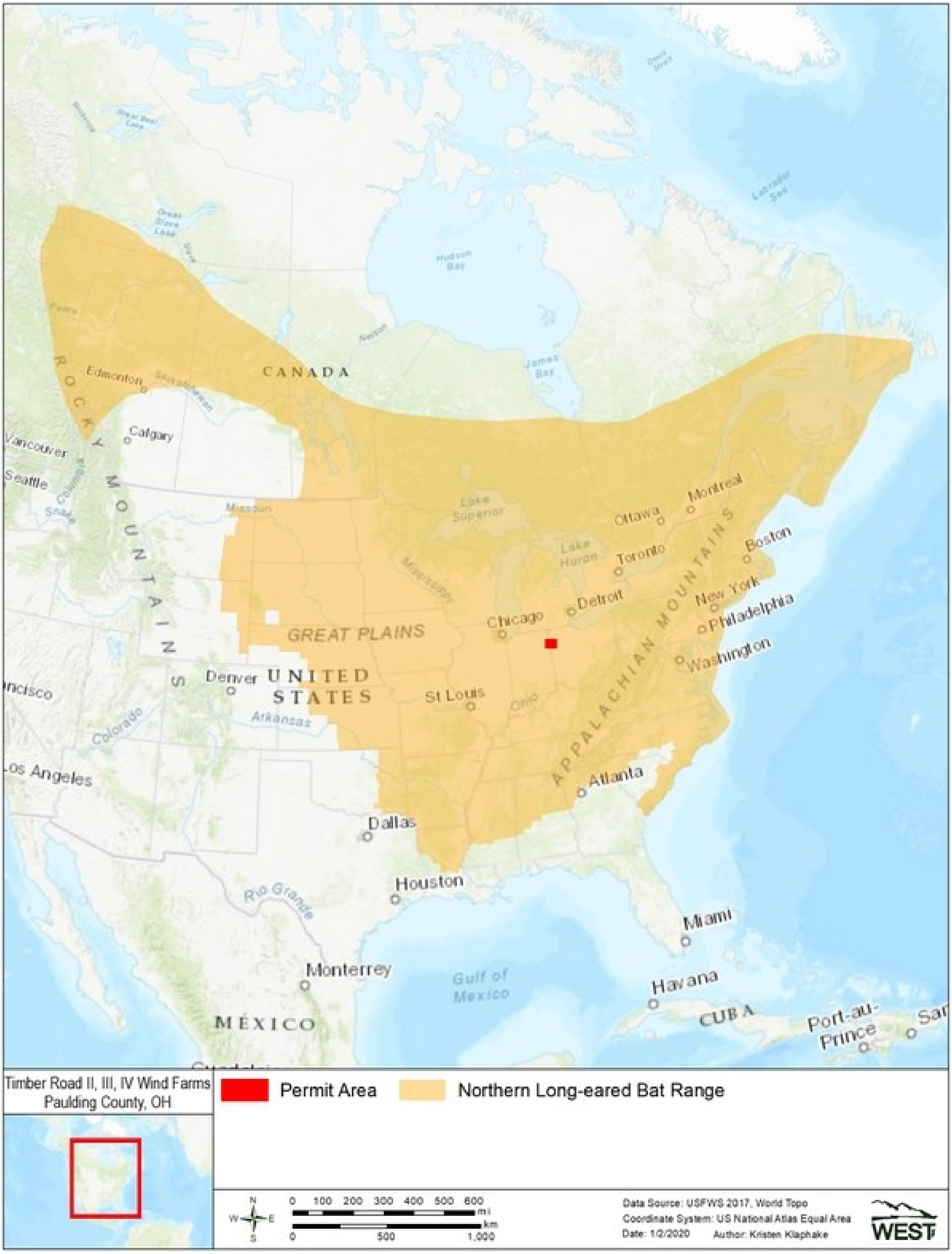

Figure 3.5 Geographic range of northern long-eared bat in the US and Canada (US Fish and Wildlife Service 2015c).

The most recent range-wide population estimate for northern long-eared bat – 6,546,718 adults – was published in the *Programmatic Biological Opinion on 4(d) Rule for the Northern Long-eared Bat and Activities Exempted from Take Prohibition* (Table 2.4 in USFWS 2016d). This population estimate assigns 240,240 adults to Ohio.

3.3.5.2 Ohio

Northern long-eared bats have been recorded at both extant Indiana bat hibernacula in Ohio. Censuses conducted in 2014 found 17 northern long-eared bats among a total of 5,443 hibernating bats in the Lewisburg Limestone Mine, and zero northern long-eared bats among a total of nine hibernating bats in the Ironton Mine. In 2016, 13 northern long-eared bats were found at the Lewisburg Limestone Mine and none at the Ironton Mine (K. Lott, USFWS, pers. comm.). In addition to these two hibernacula, northern long-eared bats have been documented at 30 other hibernacula in Ohio (USFWS 2016d). The closest known northern long-eared bat hibernaculum to the Permit Area is Sanborn's Cave, located approximately 130 km (80 mi) southeast, on the border of Logan and Champaign Counties. Although a winter survey of the cave is not possible because the cave is not accessible, a total of 653 northern long-eared bats (including 380 males and 250 females) were captured during five swarming surveys conducted from September 15 to October 27, 2008, representing 74% of all bats captured (Stantec 2013).

In Ohio prior to WNS, northern long-eared bats were captured at approximately 40% of all summer mist-netting surveys, but in 2018, they were only captures at 3.3% of mist-netting sites (K. Lott, USFWS, pers. comm.). There are summer records for northern long-eared bats in 73 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 (M. Seymour, USFWS. pers. comm.).

A thorough search of Ohio karst features that could document more winter habitat for northern long-eared bats has not been conducted. Given this, and the wide-ranging occurrence of northern long-eared bats in Ohio during the summer, it is likely that hibernacula remain to be discovered within the state.

The occurrence of northern long-eared bats in the Permit Area.is covered in Section 3.4.3.

3.4 Occurrence of the Covered Species in the Permit Area/Local Population

The following sections summarize pre- and post-construction monitoring studies that were conducted in the Permit Area. These studies help inform the magnitude and seasonality of risk to the Covered Species.

3.4.1 Pre-Construction Studies at the Project

3.4.1.1 Pre-Construction Acoustic Surveys

Good et al. (2010) conducted surveys at the Project from March 19 to November 16, 2009, using two paired AnaBat™ (Titley Scientific, Australia) SD1 ultrasonic detectors placed at each of five meteorological towers in a study area that encompassed the current turbine array as well as a larger area to the north and east (Figure 3.6). The detectors were paired to compare bat activity at different heights and monitor bat activity in the rotor-swept area. At each meteorological tower, one detector was raised to 5 m (16.4 ft) above ground level (agl) and the other detector was raised to approximately 50 m (164 ft) agl.

Together, the 10 AnaBat units recorded 5,985 all bat passes during 2,141 detector-nights. There was an average of 2.78 ± 0.18 bat passes per detector-night across all locations. The average pass rate for 5-m detectors was 3.59 ± 0.29 bat passes per detect-night, and for 50-m detectors, it was 1.97 ± 0.16 bat passes per detector-night. Activity levels for all bat passes peaked from late-July through mid-August.

For all stations combined, the majority (81.5%) of the recorded calls were less than 30 kilohertz (kHz) in frequency (low-frequency [LF]; e.g., big brown bat, hoary bat [*Lasiurus cinereus*], and silver-haired bat [*Lasionycteris noctivagans*]), while 7.3% were greater than 40 kHz in frequency (high-frequency [HF]; e.g., eastern red bat [*Lasiurus borealis*], tri-colored bat, and *Myotis* species). The remaining calls (11.2%) were at mid-frequency (MF; greater than 30 kHz but less than 40 kHz; e.g., eastern red bat).

Qualitative acoustic analysis conducted during the 2014 post-construction fatality monitoring study at TR-II recorded very few *Myotis* calls (Good et al. 2015)[7]. HF bat activity (the group that would include Indiana bats, if recorded) was highest during the fall migration period and HF bats were not recorded before April 16 or after November 11. The majority (67%) of HF bat calls were recorded at the 5-m stations.

A pre-construction acoustic survey (Iskali and Matteson 2018) was conducted at the TR-IV site from May 4, 2017 to July 15, 2018 (Figure 3.6). In 2017, the survey was conducted from May 4 through November 16 at the one met tower location in agricultural fields. Before the met tower was erected, one AnaBat™ SD2 detector was placed approximately 1 m (3 ft) above ground level from May 4 to July 15. Once the tower was up, three detectors were put into operation on July 15 with microphones stationed at 5 m, 45 m, and 80 m (263 ft). The detector at 80 m exceeded ODNR recommendations and was added to better estimate collision risk within the rotor-swept zone. All bat calls were classified by a qualified bat biologist to species group by comparing qualitative and quantitative call characteristics to a reference library of bat calls. In 2018, the survey continued at the 5-m, 45-m, and 80-m heights on the met tower from March 14 to July 15 to complete the monitoring requirements in the ODNR protocol.

[7] Note however that the ODNR acoustic monitoring protocol was not designed to provide species-specific information on timing of activity, including for *Myotis* species. Additionally, high-frequency calls itinerate quickly and therefore are detectable over shorter distances than low frequency calls, which may bias the species composition in recorded calls.

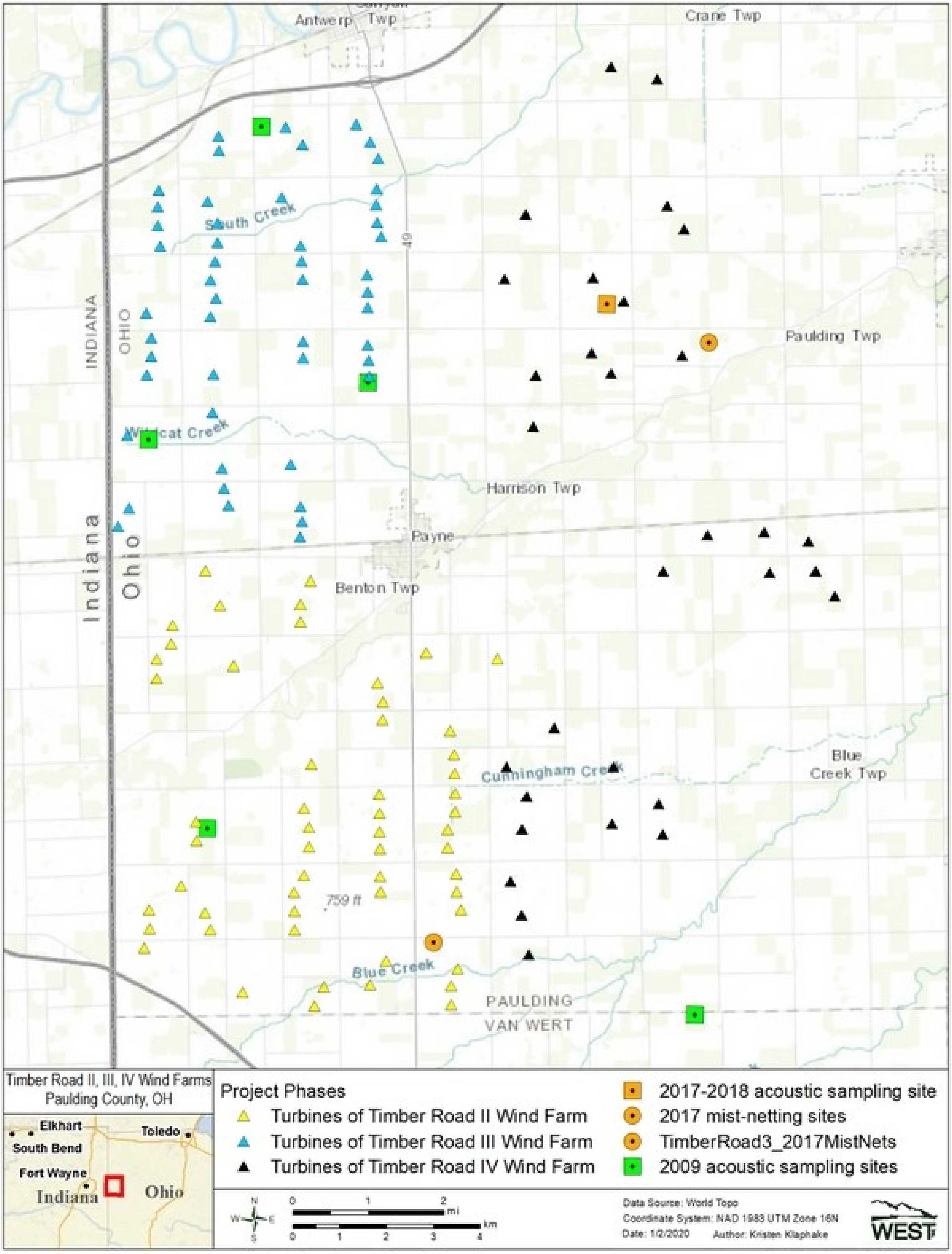

Figure 3.6. Location of bat acoustic monitoring and mist-netting sites at the Timber Road II, III, and IV Wind Farms.

A total of 1,626 total bat passes were recorded during 705 detector-nights from July 16, 2017, to July 15, 2018 when the three AnaBat detectors with microphones placed at 5-m, 45-m, and 80-m heights were operating. The percentage of bat passes recorded at each microphone were 63.2% at the 5-m microphone, 21.1% at the 45-m microphone, and 15.7% at the 80-m microphone. The majority of bat passes (61.9%; 1,007 bat passes) were classified as big brown bat (*Eptesicus fuscus*) and/or silver-haired bat (*Lasionycteris noctivagans*). The next most abundant species were eastern red bat (*Lasiurus borealis*; 16.2%; 264 bat passes) and hoary bats (*Lasiurus cinereus*; 11.4%; 185 bat passes). No bat passes of *Myotis* species were identified.

Bat activity at the met tower varied substantially between seasons, with lowest activity in the spring, intermediate activity in summer, and highest activity in the fall. Bat activity rates peaked in mid-August, largely driven by records of big brown bat/silver-haired bat group bat passes. Higher activity during the late summer and early fall may have been due to the presence of migrating bats and to the combined presence of post-lactating females and newly volant juveniles. This pattern is consistent with other wind projects in Ohio and the Midwest.

3.4.1.2 Pre-Construction Mist-Net Surveys

On July 17 – 19, 2017, a mist net survey (Iskali and Bishop-Boros 2017a) was conducted at the TR-IV site to determine presence or probable absence of the Covered Species (Figure 3.6). Nine net-nights over two non-consecutive nights were conducted within and along the edge of a woodlot in the vicinity of Flatrock Creek. This level of effort within the 66.4 acres (ac; 26.9 hectares [ha]) of forest habitat at the Project site exceeded the effort called for in USFWS guidelines (USFWS 2017b) and ODNR guidelines (ODNR 2009). A total of 26 bats of one species – big brown bat – were captured. The lack of captures of the Covered Species supported a conclusion that the Covered Species were probably absent during the maternity season.

On July 18 – 20, 2017, a mist-net survey (Iskali and Bishop-Boros 2017b) was also conducted at the southern end of the TR-II, where 64.7 ac (26.2 ha) of forest habitat was present (Figure 3.6). A total of nine net-nights over two non-consecutive nights at a woodlot crossed by a drainage ditch captured a total of 14 bats: 12 big brown bats and two eastern red bats. The lack of captures of the Covered Species supported a conclusion that the Covered Species were probably absent during the maternity season.

3.4.2 Post-Construction Fatality Monitoring Studies at TR-II and TR-III

Extensive post-construction monitoring has been conducted at TR-II and TR-III. This monitoring includes seven years of fatality monitoring at TR-II (2011 - 2018, excluding 2012 as explained below) and two years at TR-III (2017 – 2018). The results of these studies inform when fatalities of Covered Species may be expected to occur at the Project, including TR-IV.

In a combined seven years of fatality monitoring at TR-II and TR-III (Table 3.4), over 14,000 turbine searches have been conducted in cleared plots or on roads/pads at daily, three-day, and weekly search intervals. In total, 1,216 bat carcasses have been recorded, of which two were Indiana bats. One Indiana bat carcass was discovered on October 10, 2013 and another on April

14, 2014, dates that fall within migration periods. No northern long-eared bats have been recorded. It must be noted, however, that Indiana bat and northern long-eared bat fatalities were not expected after April 14, 2014 due to mandatory curtailment of turbines at wind speeds below 6.9 m/s (23 ft/s) during spring and fall migration, a measure that was triggered to avoid further fatalities. This is explained below.

The first year of fatality monitoring at TR-II was conducted in 2011, with searches performed from August 1 - November 15 in accordance with Option B of the June 2011 letter amendment to the *On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio* (Norris 2011). A second year of study began on April 1, 2012, but it was terminated on April 24 when a blade failure caused a shutdown of the facility, after which turbines were operated in a load reduced mode (LRM). Given that turbines were not operating normally, standardized monitoring was not conducted for the remainder of 2012.

In February 2013, five turbines were certified to operate normally, and the remaining 50 turbines continued to operate in LRM while being repaired. A post-construction monitoring study at the five fully functional turbines was conducted from April 1 - November 15, 2013, at the request of ODNR, with the objective of gaining an understanding of the species composition of bird and bat carcasses found at the operational turbines. All turbines were returned to full operation by spring 2014 and post-construction monitoring in accordance with Option B was conducted from April 1 - November 15.

The discovery of an Indiana bat carcass on April 14, 2014, triggered immediate curtailment of Timber Road turbines, and a Technical Assistance Letter (TAL) was issued by the USFWS on October 31, 2014 (USFWS 2014c). Beginning on April 15, blades were feathered below 6.9 m/s (23 ft/s) from one-half hour before sunset to one-half hour after sunrise for the remainder of the spring migration period (until May 15), then again during fall migration (August 1 – October 31) to avoid further fatalities. Additionally, DNA analysis of a bat carcass collected on October 13, 2013 determined the carcass to also be that of an Indiana bat.

From 2015 – 2018, turbine blades at TR-II were feathered under 6.9 m/s during March 15 – May 15 and August 1 – October 31. No Indiana bat or northern long-eared bat carcass was discovered during that period, demonstrating the effectiveness of the avoidance strategy. Estimated bat fatalities were lower than in years when turbines operated normally (Table 3.3). Note that 2018 monitoring at TR-II concluded on May 15, when the TAL requirement of three complete years of monitoring had been met.

TR-III began operation in late 2016. Fatality monitoring was conducted during April 1 – November 15, 2017, and March 15 – October 31, 2018, with curtailment below 6.9 m/s during March 15 – May 15 and August 1 – October 31. No Indiana bat or northern long-eared bat carcass was discovered during fatality monitoring.

Fatality patterns at TR-II and TR-III were similar to those found at other Midwestern wind farms (see studies referenced in Appendix B). Estimated bat fatality rates in years when there was no curtailment were in the range of other projects studied. Similar to other projects, fatalities peaked during the fall migration period, particularly during late July – September. Species most often recorded as fatalities were the migratory tree-roosting bats—eastern red bat (460 carcasses), silver-haired bat (404), and hoary bat (238)—as well as big brown bat (103). Other non-*Myotis* species recorded were evening bat (*Nycticeius humeralis*; four) and Seminole bat (*Lasiurus seminolus*; three). Other than the two Indiana bats recorded, there was one other *Myotis* species carcass for which results of genetic testing were inconclusive (Good et al. 2015).

To date, 13 Indiana bat fatalities have been documented nationwide, 11 of which occurred in USFWS Region 3, including the two carcasses found at TR-II (Table 3.5). The Applicant has obtained TALs for each phase of the Project advising that no take of listed species is expected to occur while turbine operations are curtailed during periods and conditions described in the TALs.

Table 3.4. Post-construction monitoring studies conducted at the Timber Road II and III Wind Farms

Year	Monitoring Period	Curtailment in Effect?	Turbines Searched	Turbine Searches[a]	Bat Carcasses Found	Estimated Bat Fatalities (bats/MW/year)[b]	Indiana Bat or Northern Long-Eared Bat Fatalities?	Citation
Timber Road II								
2011	August 1 to November 15	No	55	1,701	329	Shoenfeld 10.16, Huso 9.44[c]	No	Ritzert et al. 2012
2012	April 1 to April 24	No	55	[d]			No	Simon et al. 2014
2013	April 1 to November 15	No	5	380	77	[e]	Yes - IBAT discovered on 10/10/2013[f]	Simon et al. 2014
2014	April 1 to November 15	Yes - below 6.9 m/s during 4/15-5/15 and 8/1-10/31	55	3,565	222	Shoenfeld 8.98, Huso 10.14	Yes - IBAT discovered on 4/14/2014	Good et al. 2015
2015	April 1 to November 15	Yes - below 6.9 m/s during 3/15-5/15 and 8/1-10/31	55	2,875	103	Shoenfeld 4.48, Huso 6.49	No	Good et al. 2016
2016	March 16 - October 31	Yes - below 6.9 m/s during 3/15-5/15 and 8/1-10/31	55	1,294	24	Shoenfeld 2.51, Huso 2.88	No	Iskali et al. 2017
2017	March 16 - October 31	Yes - below 6.9 m/s during 3/15-5/15 and 8/1-10/31	55	1,365	46	Shoenfeld 3.90, Huso 3.69	No	Iskali and Riser-Espinoza 2018a
2018	March 15 - May 15	Yes - below 6.9 m/s during 3/15-5/15	55	540	4	Huso 0.5	No	Iskali and Riser-Espinoza 2018b
Timber Road III								
2017	April 1 to November 15	Yes - below 6.9 m/s during 3/15-5/15 and 8/1-10/31	48	3,109	415	Shoenfeld 10.6, Huso 13.7	No	Iskali and Riser-Espinoza 2018c

Table 3.4. Post-construction monitoring studies conducted at the Timber Road II and III Wind Farms

Year	Monitoring Period	Curtailment in Effect?	Turbines Searched	Turbine Searches[a]	Bat Carcasses Found	Estimated Bat Fatalities (bats/MW/year)[b]	Indiana Bat or Northern Long-Eared Bat Fatalities?	Citation
2018	March 15 - October 31	Yes - below 6.9 m/s during 3/15-5/15 and 8/1-10/31	48	1,702	70	Huso 6.0	No	Iskali et al. 2019

[a] Searches included full-plot searches and road/pad searches at daily, 3-day, and weekly intervals; for breakdown, see reports.
[b] The results of two fatality estimators, Shoenfeld and Huso, are reported in studies through 2017. In 2018, the more widely accepted Huso estimator is only reported.

[c] Results for fully cleared plots. For road/pad searches, the Shoenfeld estimate was 7.12 bats/MW/year, and the Huso estimate was 6.59 bats/MW/year.

[d] Study terminated when facility was shut down and placed on load reduced mode after blade failure on April 24, 2012.

[e] Bat fatalities not estimated because of small sample of searched turbines; other turbines in load reduced mode.

[f] The carcass in question was originally identified as a little brown bat, but subsequent deoxyribonucleic acid analysis analysis, conducted after the 2014 Indiana bat find, found it to be an Indiana bat.
Shoenfeld 2004; Huso et al. 2010

3.4.3 Dates of Likely Covered Species Occurrence in the Permit Area

Based on the studies summarized above and the biological information presented in Sections 3.2 and 3.3, the Covered Species may be expected to occur in the Permit Area as spring and fall migrants, but not as summer residents. Summer residency is not indicated given the lack of captures of the Covered Species in mist-net surveys conducted at the Project (Section 3.4.1.2), as well as the relative scarcity of forest habitat in the vicinity of the Project to provide roosts for maternity colonies (Section 3.1).

To determine the periods during the spring and fall migration when the Covered Species are likely to occur at the Project, the Applicant considered carcass records, USFWS guidance documents for the Covered Species, and the location of the Project relative to hibernacula and summer habitat for the Covered Species. Spring and fall records of carcass finds of the Covered Species at wind-energy facilities within their ranges (Table 3.5), including the two Indiana bat finds at TR-II, define the spring and fall migration periods as April 1 – May 15 and August 1 – October 15. The dates of these Indiana bat and northern long-eared bat carcass records are generally consistent with the seasons defined in the Recovery Plan and in the Northern Long-Eared Bat Guidance. These guidance documents (discussed below) provide information on the species' phenology on a range-wide and/or state-wide level, but they do not consider specific locations on the landscape. The TALs issued for TR-II, TR-III, and TRIV (USFWS 2014c, 2015e, 2019b) specify curtailment periods of March 15 – May 15 in spring and August 1 – October 31 in fall. Those curtailment periods are broader than the periods of risk indicated by the carcass records; however, the TAL dates are intentionally conservative to avoid take of the Covered Species, as explained further in Section 5.2.2.

The Recovery Plan defines spring migration for Indiana bats as the period from late March through late May and fall migration as the period from August through mid-October. However, the timing of spring migration depends upon the timing of the end of hibernation, and the Draft Recovery Plan notes that in Ohio Indiana bat hibernation typically lasts from October through April. Indiana bats may arrive at summer habitat as early as mid-April; by mid-May, most Indiana bats in the Midwest have reached their summer habitat (USFWS 2007a). The Northern Long-Eared Bat Guidance defines the spring migration for northern long-eared bats as mid-March to mid-May and fall migration as mid-August to mid-October, and states that the hibernation season in Ohio typically lasts from November to mid-March.

Spring staging and fall swarming periods overlap with the beginning of the spring migration period and the end of the fall migration period, respectively, for both of the Covered Species (USFWS 2007a, 2014a). These behaviors occur in the vicinity of hibernacula and can extend the seasonal period of risk for take of the Covered Species from wind energy facilities. However, the Project is not located within staging or swarming habitat for any known Indiana or northern long-eared bat hibernaculum. Therefore, the staging and swarming periods for the Covered Species are not a concern for the Project, and incidental take is most likely to occur during the core of the spring and fall migratory periods, as defined above.

Based on the site-specific, regional, and range-wide information presented above for Indiana bats and northern long-eared bats, the periods from April 1 – May 15 and August 1 – October 15 are expected to encompass nearly all of the Covered Species' migration activity through the Permit Area, and thus the periods of risk. Therefore, in the next two chapters of this HCP, these date ranges are used to predict take and design a conservation plan that practicably and effectively reduces the impact of Project operation on the Covered Species.

3.5 White-Nose Syndrome and Other Threats to the Covered Species

3.5.1 White-Nose Syndrome

White-nose syndrome (WNS) is the most severe threat facing Indiana and northern-long eared bat populations range-wide (USFWS 2009, 2014a). It was first discovered during the winter of 2006/2007 in four caves in Schoharie County, New York, and has since spread steadily in all directions (White-Nose Response Team 2018). By 2010, WNS had been documented in all known Indiana bat hibernacula in New York. Presently, it has been recorded in hibernacula from Nova Scotia to Mississippi and the Panhandle of Texas to across central North America and in Washington State (White-Nose Response Team 2018). The origin of WNS remains uncertain, although anthropogenic introduction of the disease from Europe has been hypothesized (Frick et al. 2010). The disease was found responsible for more than 5.5 million bat fatalities in the northeastern US and Canada (USFWS 2014b).

Recent research has shown that the fungal agent, *Pd*, is the causative agent of the bat deaths (Lorch et al. 2011). There is now strong evidence that WNS increases the frequency and duration of arousal bouts in hibernating bats and causes the wasting of energy stores needed to survive hibernation (Reeder et al. 2012, Verant et al. 2014). In addition to observed fatalities at hibernacula, WNS has also been linked to decreased bat abundance in summer habitat (Dzal et al. 2010, Brooks 2011). If current trends for spread and mortality continue at affected sites, WNS threatens to drastically reduce the abundance of Indiana bats and northern long-eared bats throughout their ranges and potentially cause local extirpation.

The effects of WNS appear to be realized over a prolonged period. Large population declines have been observed over a 5- to 6-year period from the onset of the disease. Within a 5-state area affected by WNS for multiple years (New York, Pennsylvania, Vermont, Virginia, and West Virginia), population monitoring at 42 hibernacula documented a 98% decline in northern long-eared bats (Turner et al. 2011).

Table 3.5. Publicly available Indiana bat and northern long-eared bat fatalities at wind energy facilities in the US and Canada.

Project Name	State/Province	County	Date	Reference
Indiana Bat Fatalities (one per row)				
Anonymous	Illinois*	Anonymous	9/23/2016	Pruitt and Reed 2019
Fowler Ridge	Indiana*	Benton	9/11/2009	Johnson et al. 2010a
Fowler Ridge	Indiana*	Benton	9/18/2010	Good et al. 2011
Anonymous	Indiana*	Anonymous	8/23/2015	Pruitt and Reed 2019
Anonymous	Indiana*	Anonymous	7/2017	Pruitt and Reed 2019
Anonymous	Indiana*	Anonymous	5/1/2018	Pruitt and Reed 2019
Anonymous	Indiana*	Anonymous	9/17/2018	Pruitt and Reed 2019
Macksburg	Iowa*	Madison	7/2016	MidAmerican Energy Company 2018
Blue Creek	Ohio*	Van Wert	10/3/2012	USFWS 2012a, Pruitt and Reed 2019
Timber Road II	**Ohio***	**Paulding**	**10/10/2013**	**Simon et al. 2014**
Timber Road II	**Ohio***	**Paulding**	**4/14/2014**	**Good et al. 2015**
North Allegheny	Pennsylvania	Blair, Cambria	9/26/2011	USFWS 2011c
Laurel Mountain	West Virginia	Barbour, Randolph	7/8/2012	USFWS 2012b
Northern Long-Eared Bat Fatalities (one per row)				
Bear Mountain	British Columbia	-	8/2010	Hemmera 2011
Bear Mountain	British Columbia	-	8/2010	Hemmera 2011
Bear Mountain	British Columbia	-	9/1/2010	Hemmera 2011
Bear Mountain	British Columbia	-	9/1/2010	Hemmera 2011
Bear Mountain	British Columbia	-	8 or 9/2010	Hemmera 2011
Anonymous	Iowa*	Anonymous	8/10/2013	M. Turner, pers. comm.
Anonymous	Iowa*	Anonymous	8/22/2013	M. Turner, pers. comm.
Anonymous	Illinois*	Anonymous	9/25/2013	M. Turner, pers. comm.
Anonymous	Illinois*	Anonymous	5/2014	M. Seymour, USFWS, pers. comm.
Anonymous	Illinois*	Anonymous	9/2/2014	M. Seymour, USFWS, pers. comm.
California Ridge	Illinois*	Vermilion, Champaign	unknown	K. Shank, IDNR, pers. comm.
California Ridge	Illinois*	Vermilion, Champaign	unknown	K. Shank, IDNR, pers. comm.
Fowler Ridge	Indiana*	Benton	8/25/2009	Johnson et al. 2010a
Criterion	Maryland	Garrett	7/22/2011	Young et al. 2013
Heritage Garden	Michigan	Delta	7/10/2014	Curry and Kerlinger, LLC 2014
Anonymous	Missouri*	Anonymous	2009[3]	M. Turner, pers. comm.
Cohocton/Dutch Hills	New York	Stueben	6/22/2010	Stantec Consulting 2011
Noble Ellenburg	New York	Clinton	8/2008	Jain et al. 2009
Noble Wethersfield	New York	Wyoming	6/11/2010	Jain et al. 2011
Noble Wethersfield	New York	Wyoming	7/17/2011	Kerlinger et al. 2011
Noble Wethersfield	New York	Wyoming	8/6/2011	Kerlinger et al. 2011

Table 3.5. Publicly available Indiana bat and northern long-eared bat fatalities at wind energy facilities in the US and Canada.

Project Name	State/Province	County	Date	Reference
Noble Wethersfield	New York	Wyoming	8/18/2011	Kerlinger et al. 2011
Noble Wethersfield	New York	Wyoming	9/2/2011	Kerlinger et al. 2011
Noble Wethersfield	New York	Wyoming	9/3/2011	Kerlinger et al. 2011
Steel Winds	New York	Erie	7/13/2007[1]	Grehan 2008
Steel Winds	New York	Erie	8/3/2007[1]	Grehan 2008
Steel Winds	New York	Erie	8/24/2007[1]	Grehan 2008
Steel Winds	New York	Erie	8/24/2007[1]	Grehan 2008
Steel Winds	New York	Erie	9/4/2007[1]	Grehan 2008
Steel Winds	New York	Erie	9/24/2007[1]	Grehan 2008
Erie Shores	Ontario	Norfolk	5/25/2007	James 2008
Erie Shores	Ontario	Norfolk	6/11/2007	James 2008
Erie Shores	Ontario	Norfolk	6/12/2007	James 2008
Erie Shores	Ontario	Norfolk	8/28/2007	James 2008
Erie Shores	Ontario	Norfolk	8/28/2007	James 2008
Erie Shores	Ontario	Norfolk	8/30/2007	James 2008
Kingsbridge I	Ontario	Huron	10/5/2006	Stantec Consulting Ltd. (Stantec Ltd.) 2007
Ripley	Ontario	Bruce	9/5/2008	Jacques Whitford 2009
Ripley	Ontario	Bruce	8/4/2008	Jacques Whitford 2009
Meyersdale	Pennsylvania	Somerset	9/11/2004	Arnett et al. 2005b
Meyersdale	Pennsylvania	Somerset	9/13/2004	Arnett et al. 2005b
PGC site 2-14	Pennsylvania	Anonymous	9/2009	J. Taucher pers. comm.
PGC anonymous site	Pennsylvania	Anonymous	7/2012	J. Taucher pers. comm.
Mount Storm	West Virginia	Grant	8/26/2008	Young et al. 2009
Mountaineer	West Virginia	Tucker	8/18/2003	Kerns and Kerlinger 2004
Mountaineer	West Virginia	Tucker	2003[2]	Kerns and Kerlinger 2004
Mountaineer	West Virginia	Tucker	2003[2]	Kerns and Kerlinger 2004
Mountaineer	West Virginia	Tucker	2003[2]	Kerns and Kerlinger 2004
Mountaineer	West Virginia	Tucker	2003[2]	Kerns and Kerlinger 2004
Mountaineer	West Virginia	Tucker	9/8/2003	Kerns and Kerlinger 2004

[1]New York State Department of Environmental Concern identified the bat species for this survey; species are not included in the study report

[2]Study reported that northern long-eared bat fatalities were first recorded on 8/18/2003 and last recorded on 9/8/2003 but did not provide dates for every fatality of the species

[3] Northern long-eared bat fatality occurred between 5/16/2009 and 11/15/2009

* Fatality recorded in USFWS Region 3

IDNR = Illinois Department of Natural Resources, PGC = Pennsylvania Game Commission, USFWS = US Fish and Wildlife Service

Thogmartin et al. (2012) estimated that, between 1983 and 2005, the range-wide Indiana bat population was generally stable, with some subpopulations increasing and others decreasing. However, since the onset of WNS in 2006, the range-wide Indiana bat population has experienced steady annual declines, leading the authors to conclude that WNS is having an appreciable influence on trends of Indiana bat populations, stalling or reversing population gains made in the previous 20 years. WNS is consequently expected to be the factor that has the greatest short-term and long-term impact upon the Indiana bat range-wide population (USFWS 2009).

The northern-long eared bat is one of the species most impacted by WNS (USFWS 2015a). As previously noted, Turner et al. (2011) found a 98% decline in the number of hibernating northern long-eared bats since initial WNS infection at 30 hibernacula in New York, Pennsylvania, Vermont, Virginia, and West Virginia. The USFWS conducted an analysis of additional survey data at 103 hibernacula in 11 eastern states (New York, Pennsylvania, Vermont, West Virginia, Virginia, New Hampshire, Maryland, Connecticut, Massachusetts, North Carolina, and New Jersey) and Quebec, and found the combined overall rate of decline for northern long-eared bat counts was approximately 96%. These areas were also historically the core of the northern long-eared bat range and the area where the species was most abundant. WNS has invaded the Midwest (USFWS Region 3) where there are a number of large and important hibernacula. There, population declines similar to those observed in the Northeast (USFWS Region 5) are expected (80 FR 63: 17974-18033 2015).

In Ohio, WNS was first detected during the winter of 2010–2011. Its effect on bat populations in the Lewisburg Limestone Mine and the Ironton Mine, where approximately 90% of the state's winter bat population hibernated, was substantial (Section 3.2.5.3). The pre-WNS count at the Lewisburg Limestone Mine in 2009 was 356 northern long-eared bats, while at the Ironton Mine a pre-WNS high count of 11 northern long-eared bats was recorded between 2003 and 2009. By 2016, a 96% decline was recorded at the Lewisburg Limestone Mine (13 bats) and extirpation at the Ironton Mine (K. Lott, USFWS, pers. comm.).

The ODNR conducted statewide summer acoustic surveys along driving transects across the state from 2011 to 2014. Although they have not yet analyzed calls for individual species, initial results show a 56% decline in recorded *Myotis* bat species' calls over the period (ODNR 2014, unpublished data).

Researchers have noted that mortality rates have decreased at some hibernacula, but there is no clear evidence of resistant hibernating populations or decreased susceptibility of survivors to infection (Langwig et al. 2010). Moreover, evidence is lacking of resistance to WNS among survivors, although some affected New York hibernacula continue to support relatively low numbers of bats several years after WNS exposure, and a few hibernacula have substantially lower mortality levels than most.

3.5.2 Other Threats

One of the first recognized threats to the Indiana bat was human disturbance and vandalism of hibernacula. Indiana bats are known to hibernate in large numbers, 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).

Human disturbance and vandalism were among 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 to the Indiana bat (USFWS 2009). The loss of and modification to the Indiana bat's winter habitat (i.e. cave and mine hibernacula) and summer habitat (i.e. 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 Recovery Plan, and *the Indiana Bat 5-Year Review* (USFWS 2009).

The northern long-eared bat is facing threats similar to the Indiana bat due to the similarity in their winter and summer habits. Disturbance during hibernation and loss of forest habitat may pose threats to the species also (USFWS 2014a). 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 forest may adversely affect the northern long-eared bat by reducing roosting, foraging, and traveling habitat (USFWS 2014a). However, other studies have suggested that silvicultural practices such as prescribed burning are beneficial for northern long-eared bat roost habitat (Lacki et al. 2009), and that intensively managed forests are suitable, perhaps owing to their general flexibility in roosting requirements (Owen et al. 2002, 2003; Silvis et al. 2012). Retaining large-diameter trees and snags (Sasse and Pekins 1996) and maintaining connectivity among forest patches (Owen et al. 2003) should help further minimize the effects of forest loss on northern long-eared bats.

More recently, global climate change has been identified as a threat to Indiana bats (USFWS 2007a) and northern long-eared bats (USFWS 2015a, 80 FR 17974 [April 2, 2015]). 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, including Indiana bats and northern long-eared 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 et al. 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).

4.0 IMPACT ASSESSMENT

This chapter describes the method the Applicant used to predict take of the Covered Species at the Project. It presents the initial take predictions, describes the expected effectiveness of the minimization measures in reducing take, and calculates the expected impact of the minimized level of take on the Covered Species. Finally, this chapter also describes potential effects of Project activities that are expected not to result in take to assist the USFWS in carrying out its internal consultation pursuant to ESA § 7.

4.1 Take Prediction Method

As noted in Section 2.2.1, operation of the wind turbines is the only Covered Activity that is expected to result in take of the Covered Species, as the Covered Species are known to collide with spinning turbine rotors. However, these collisions are believed to be relatively rare events.

Over the past decade, mortality monitoring has been conducted at thousands of turbines throughout the Midwest. To date, only 11 Indiana bat fatalities and 10 northern long-eared bat fatalities have been documented at wind energy facilities in USFWS Region 3 (Table 3.5).

In response to concerns on the part of the USFWS that the low number of estimated fatalities of the Covered Species was due in part to limitations in the available estimators, the USGS developed the Evidence of Absence (EoA) model (Huso et al. 2015) as a tool to estimate the occurrence of rare events such as collisions of *Myotis* bats with wind turbines. The Applicant has used the EoA model, as modified by USGS with a reference prior (Dalthorp and Huso 2015), to predict take of the Covered Species in this HCP and to quantify the uncertainty around those take predictions. The Applicant will also use the EoA model to estimate take of the Covered Species based on results of compliance monitoring over the 30-year ITP term and ensure compliance with the requested ITP (see Section 5.4.1).

4.2 Indiana Bats

4.2.1 Overview

The Applicant predicts that unconstrained operation of the Project turbines during the spring and fall periods may result in take of up to 552 Indiana bats over the 30-year ITP term (Table 4.1, Section 4.2.2). However, the Applicant will implement minimization measures to reduce the potential take of Indiana bats (Sections 4.2.3 and 5.2.2). Based on the best available scientific information, the Applicant conservatively[8] predicts that incidental take of Indiana bats from operation of the Project will be reduced by at least 50% with operational curtailment in place during the migration seasons (described in Section 4.2.3). Therefore, the predicted level of take and the requested amount of take to be authorized over the 30-year ITP term is 276 Indiana bats (Table 4.1). The actual level of take occurring will be estimated based on the results of compliance monitoring, and compliance with the authorized level of take will be assured through adaptive management.

The Applicant will implement mitigation to offset the impact of take, which includes the lost reproductive capacity of females that are taken by the Project, namely, the females that are directly taken plus the female pups that will not be born as a result of take. As explained below, available information suggests that up to 75% of Indiana bat take may be assigned to females. Using the USFWS' *Indiana Bat Resource Equivalency Analysis Model for Wind Energy Projects, Public Version 1* (Indiana Bat REA Model; USFWS 2016b), and assuming that the population is declining as a result of WNS, the predicted lost reproductive capacity resulting from the take of 276 Indiana bats is 207 adult females and 331 female pups, for a total impact of 538 Indiana bats over the 30-year ITP term (Table 4.1, Section 4.2.5).

[8] Conservative means that Indiana bat fatalities will likely be lower than these estimates. Curtailment studies at FRWF reported a 57% reduction in all bat fatality when turbines were feathered below 4.5 m/s (14.8 ft/s) and a 73% reduction when turbines were feathered below 5.5 m/s (18.0 ft/s; Good et al. 2012). Curtailment is expected to be at least as, if not more, effective for *Myotis* species (see Section 4.2.3)

Collectively, female take and lost reproductive capacity represent an average loss of approximately 17.9 Indiana bats per year over the 30-year ITP term. This average annual loss equates to an approximate 0.007% reduction in the MRU population (based on the size of the 2019 MRU population of 245,474; Table 4.1, Section 4.2.5), the Indiana bat population most likely to be impacted. Given that this loss represents a small percentage of the MRU population, and that mitigation implemented as part of this HCP is expected to fully offset the impacts of the taking, the Applicant does not expect the Project to have a significant impact on that population.

4.2.2 Predicted Indiana Bat Mortality without Minimization Measures

As described in Section 3.4.3, Indiana bats are assumed to occur within the Permit Area during the spring and fall migration periods (April 1 – May 15 and August 1 – October 15), but not during the summer maternity season. Thus, the spring and fall migration periods were designated as the periods of risk for Indiana bats at the Project. Note that the term "take rate" used throughout the rest of this section and the HCP refers to the amount of Indiana bat take either predicted to occur or estimated to have occurred during the spring and fall seasons in a given year.

The term "predicted" take refers to the amount of take that is projected to occur at the Project under implementation of the HCP. Take is predicted for the purposes of establishing a requested take level to be authorized under the ITP. The term "estimated" take refers to the amount of take that is estimated to have occurred during a given compliance monitoring period at the Project, based on monitoring data. Take is estimated for the purpose of evaluating compliance with the ITP. In other words, take prediction refers to quantification of projected future take, while take estimation refers to quantification of take that actually occurs.

Table 4.1. Overview of the predicted Indiana bat take from the operation of the Timber Road Wind Farms and the associated impact of the taking to be mitigated

HCP Section	HCP Topic	Detail	Per Turbine	Annual	Total	Assumption
4.2.2	Predicted take without minimization	134 turbines, Years 1- 22	0.1607	21.5	474	50th credible bound of predicted take rate
		79 turbines, Years 23 -27	0.1607	12.7	63	
		31 turbines, Years 28 - 30	0.1607	5.0	15	
		Total over 30-year ITP term			552	
4.2.3	Predicted take with minimization	134 turbines, Years 1- 22	0.0804	10.8	237	Minimization estimated at 50%
		79 turbines, Years 23 -27	0.0804	6.3	32	
		31 turbines, Years 28 - 30	0.0804	2.5	7	
		Total over 30-year ITP term			276	
4.2.5	Predicted female take with minimization	134 turbines, Years 1- 22	0.0603	8.1	178	3:1 ratio of females to males
		79 turbines, Years 23 -27	0.0603	4.8	24	
		31 turbines, Years 28 - 30	0.0603	1.9	6	
		Total over 30-year ITP term			207	
4.2.5	Lost reproductive capacity	134 turbines, Years 1- 22		12.9	284	*Indiana Bat REA Model Public v1* 2016 (USFWS 2016b)
		79 turbines, Years 23 -27		7.6	38	
		31 turbines, Years 28 - 30		3.0	9	
		Total over 30-year ITP term			331	
4.2.5	Loss of Indiana bats to be mitigated, i.e., females taken plus lost reproductive capacity	Years 1 - 30		17.9	538	*Indiana Bat REA Model Public v1* 2016 (USFWS 2016b)
4.2.5	Annual reduction in population, based on loss of 17.9 female Indiana bats per year	Range-wide population		0.003%		Population estimate = 537,297 Indiana bats (USFWS 2019a)
4.2.5	Annual reduction in population, based on loss of 17.9 female Indiana bats per year	MRU population		0.007%		Population estimate = 245,474 Indiana bats (USFWS 2019a)

Table 4.1. Overview of the predicted Indiana bat take from the operation of the Timber Road Wind Farms and the associated impact of the taking to be mitigated

HCP Section	HCP Topic	Detail	Per Turbine	Annual	Total	Assumption
4.2.5	Annual reduction in population, based on loss of 17.9 female Indiana bats per year	MRU population reduced 90% by WNS		0.07%		Population estimate = 24,547 Indiana bats
5.3.1	Target increase in Indiana bats during initial 3-year mitigation increment	Years 1 - 3 of ITP term		21.0	63	
5.3.1	Target increase in Indiana bats during 6-year mitigation increments, based on the impact of the taking when all turbines are in operation	Years 4-27 of the ITP term		21.0	126	
5.3.1	Target increase in Indiana bats during final 3-year mitigation increment	Years 28-30 of the ITP term		4.9	15	

HCP = Habitat Conservation Plan, ITP = Incidental Take Permit, MRU = Midwest Recovery Unit, REA = Resource Equivalency Analysis, USFWS = US Fish and Wildlife Service, WNS = White-nose Syndrome

As noted, Indiana bat fatalities at wind energy facilities are rare events, and their rarity affects the ability to predict take given the lack of data to inform a prediction. The EoA model (Dalthorp and Huso 2015, Huso et al. 2015) currently represents the best available method for predicting and estimating take of the Covered Species with quantification of the uncertainty in the take predictions produced. The EoA model used in this document is described in detail in Appendix A.

The EoA approach requires monitoring data to inform the model outputs. Because no monitoring of Project turbines operating at normal cut-in speeds has been conducted, other sources of relevant monitoring data had to be identified. The data from TR-II were the most representative data available for prediction of Covered Species take at the Project, given the proximity of the two facilities and the similarity of land use and bat habitat at the respective sites.

Monitoring data were available from TR-II from 2011 to 2018 and from TR-III from 2017-2018 (Section 3.4.2, Table 3.4). However, turbines at TR-II were feathered at wind speeds below 6.9 m/s to avoid take of Indiana bats beginning in 2014, and the same avoidance measure has been in effect at TR-III. Consequently, only data collected prior to April 14, 2014, were appropriate for use in the EoA model, given that the subsequent avoidance measures affected monitoring results.

TR-II carcass search data from 2011 (Ritzert et al. 2012), 2013 (Simon et al. 2014), and 2014 (Good et al. 2015) (when turbines were operating normally), and bias trial data from 2011 and 2014, were the basis for developing the take prediction. The probability of detection for 2011 was adjusted to account for the fact that there were no spring searches, and the 2014 data were weighted to reflect that no take of the Covered Species was expected after April 14 due to implementation of take avoidance measures. In 2013, only five of the 55 turbines were operational due to a blade issue and the monitoring data were weighted accordingly. Bias trials were not conducted in 2013, so the 2014 bias trial data were used in lieu of 2013 bias trial data.

Annual searcher efficiency data, carcass persistence data, and search schedule were supplied to the single-site-single-year module of the EoA model, which calculates (among other things) the probability that a carcass on the site will be available to searchers and detected (g), based on searcher efficiency, carcass persistence, density weighted proportion of area searched, and search interval. The estimated value of g was supplied to a modified version of the multiple year module[9] of EoA with the annual weights to predict the distribution of the annual take rate. The seasonal distribution of take within a year was informed by the pattern of seasonal proportions of bat fatalities in the Midwest (USFWS 2016c).

The EoA model outputs for annual take rates at various credible bounds were developed using the data from TR-II and adjusted to a per-turbine rate[10] for the purpose of scaling the take

[9] The function was modified to provide the predicted annual take rate with credible bounds; the function supplied by USGS calculates these credible bounds but does not supply them as output.

[10] It is not statistically appropriate to scale take estimates (estimated numbers of bats killed) generated by the EoA model, but the EoA model also produces an estimated take rate (lambda; bats per facility per year) which can be scaled to a per-turbine basis or a multiple-year basis (D. Dalthorp, Forest and Rangeland Ecosystem Science Center, USGS, pers. comm. 2016).

prediction to be appropriate for the Project. TR-II consists of 55 turbines. Therefore, the TR-II annual Indiana bat take rates were scaled by a factor of 0.018 (1/55) to obtain a per-turbine annual Indiana bat take rate for the Project.

Because take occurs as a stochastic process, the estimate of take will vary from year to year. Thus, it is important for an ITP to be based upon predicted take numbers that allow for this annual variation. To support ITP compliance, the variance in the take prediction was quantified and used to assess the likelihood that the best estimate of take (the point estimate or 50% confidence interval) would exceed the take authorization proposed for the ITP. There are two opportunities to choose credible bounds for a take prediction in EoA: first is for the per-turbine take rate, and second is for the predicted life-of-permit take. Schematically, the process is:

> Monitoring data → Estimated probability of detection (Section 3 of Appendix A)
> → Predicted annual per-turbine take rate distribution (Section 5 of Appendix A)
> → Scaled facility-wide life-of-permit take rate (Section 5 of Appendix A)
> → Predicted life-of-permit take distribution (Section 5 of Appendix A).

Credible bounds for the predicted annual per-turbine take rate (λ_q [lambda]) and the predicted life-of-permit take (M_q) were chosen using the explorer scenario in the EoA model, which simulates take and take estimation over the life of the permit to predict the probability of take being exceeded based on actual take rates, permitted take numbers, detection probabilities for monitoring, and adaptive management.

Although not reflected by the EoA model results, the confidence in the take prediction is additionally influenced by the extent of the monitoring data available for use in the model. The 2014 spring monitoring data from TR-II were limited to the April 1 – April 14 period, before the Indiana bat carcass was found. These 2014 data were included in the take rate prediction, but the statistical properties of rare events, and the way that the 2014 data were collected, probably introduced an upward bias in the take rate[11], meaning that the take predictions produced using these data are likely conservative.

[11] The bias results from the way that the sample was obtained. It is assumed (as in the EoA model) that fatalities during a season are distributed as a $\mathrm{Poisson}\ (\lambda)$ variable, where λ is the fatality rate. If the duration of a monitoring period is fixed in advance, the unbiased maximum likelihood estimate for λ is

$$\widehat{\lambda_{MLE}} = \frac{c}{d} \qquad (1)$$

where c is the count of fatalities during the monitoring period and d is the duration of the monitoring period. However, if the monitoring period only lasts until the first carcass is observed (as at Timber Road II in 2014) then the estimate is based on a waiting time until the first observation:

$$\widehat{\lambda_{waiting\ time}} = \frac{c}{t} = \frac{1}{t} \qquad (2)$$

where t is the waiting time until the first carcass and the count, c, is necessarily 1 (because its observation terminated the monitoring process). For $\lambda_{waiting\ time}$ to be unbiased, the following is needed:

$$t = \frac{1}{\lambda} \qquad (3)$$

Based on the EoA scenario explorer analysis of the likelihood of ITP compliance, the Applicant used the 50th credible bound of the distribution of the scaled take rate prediction as a conservative prediction of Indiana bat take that is likely to occur at the Project. The 50th credible bound of the predicted scaled take rate is λ_{50} = 0.1607 Indiana bat per turbine per year. The expected number of Indiana bats taken was obtained as the median of a Poisson distribution with a rate parameter of 552.1652 bats (= (0.1607 bat per turbine per year × 134 turbines × 22 years) + (0.1607 bat per turbine per year × 79 turbines × 5 years) + (0.1607 bat per turbine per year × 31 turbines × 3 years): M_{50} = 552; Table 4.1).

Although this value may overestimate the amount of Indiana bat take that could occur, the nature of a prediction is that there is no "correct" number, and the use of the 50th credible bound represents a conservative but reasonable approach that is not likely to trigger adaptive management actions at the Project when additional minimization measures are not actually warranted by changes in the underlying take rate. Based on this approach, the cumulative predicted take (M_{50}) over the 30-year ITP term is 552 Indiana bats in the absence of minimization measures. Additional details of the EoA take prediction methods are provided in Appendix A.

4.2.3 Predicted Indiana Bat Mortality with Minimization Measures

The analysis presented in Section 4.2.2 represents Indiana bat mortality that can be expected under normal operating conditions. However, operational adjustments will be made as a condition of this HCP and the requested ITP to minimize the impact of take of Indiana bats. Specifically, all turbine blades will be feathered below raised cut-in wind speeds of 3.5 m/s (11.5 ft/s; raised from the Project turbines' manufacturer's rated cut-in wind speed of 3.0 m/s [9.8 ft/s]) in the spring and 5.0 m/s (16.4 ft/s) in the fall (Table 4.2). These measures are expected to substantially reduce annual Indiana bat mortality in the Permit Area. Turbine blades will also be feathered below the manufacturer's rated cut-in speed in the summer, which is expected to further reduce all-bat mortality at the Project. Although there is uncertainty in the take prediction, the effectiveness of the proposed minimization measures at reducing take at 5.0 m/s in the fall, when the majority of bat fatalities is expected to occur, is supported by a substantial amount of research.

Table 4.2. Operational minimization plan for the Timber Road II, III, and IV Wind Farms.[a]

Season	Turbines	Time Period	Cut-in Speed (m/s)	Feathering Below Cut-in?[b]	Temperature Threshold[c]
Spring (April 1 – May 15)	All	0.5 hour before sunset to 0.5 hour after sunrise	3.5	Yes	10°C
Summer (May 16 – July 31)	All	0.5 hour before sunset to 0.5 hour after sunrise	3.0	Yes	None
Fall (August 1 – October 15)	All	0.5 hour before sunset to 0.5 hour after sunrise	5.0	Yes	10°C

but for a Poisson-distributed fatality process, the waiting time between carcasses, t, is known to be distributed as an $\text{exponential}\ (\lambda^{-1})$ variable. For an $\text{exponential}\ (\lambda^{-1})$ variable, the cumulative probability that the waiting time, t, will be less than λ^{-1} is 0.63. And because there is an inverse relationship between t and $\hat{\lambda}$, that means that there is a 63% chance to overestimate the fatality rate, λ, if the monitoring period is terminated after the first observed carcass.

Table 4.2. Operational minimization plan for the Timber Road II, III, and IV Wind Farms.[a]

Season	Turbines	Time Period	Cut-in Speed (m/s)	Feathering Below Cut-in?[b]	Temperature Threshold[c]
Winter (October 16 – March 31)	All	Normal turbine operation			

[a] See Section 5.2.2 for particulars about implementation of minimization through Project operations.

[b] Feathering means that turbine blades will be pitched into the wind such that the rotors spin at less than one rotation per minute.

[c] Turbines will be feathered below cut-in when temperatures are above the threshold.

Several operational adjustment experiments have documented significant reductions in bat fatalities that can be achieved by feathering turbines and increasing the wind speed at which they become operational (i.e., increasing the cut-in wind speed) during nighttime operations. Fatalities of bat species of the Eastern and Midwestern US have been shown to have an inverse relationship to wind speed (Arnett et al. 2005, 2013). Thus, raising cut-in speeds and feathering turbine blades below cut-in speeds during the night, during periods of low wind, and in the late summer and early fall can have a significant effect on rates of bat mortality, as evidenced in the studies included in Table 4.3[12].

In all of the included studies with the exception of Good et al. (2011), turbines were feathered below the cut-in wind speed. While different operational parameters of turbine types and models varied somewhat among studies, the results of these curtailment effectiveness studies can be used to estimate what can be expected from minimization measures that will be implemented as part of this HCP. These results confirm that raising cut-in wind speeds and feathering turbine blades at low wind speeds can substantially reduce bat mortality.

[12] Confidence intervals around the mean percent reductions in some studies overlapped, and in those cases, the reported reductions in bat mortality from curtailment were not significantly different from normally operating turbines or those curtailed at lower wind speeds. However, because fewer bat fatalities are generally found at turbines curtailed at higher wind speeds, there may have been insufficient power to detect a difference had there been one.

Table 4.3. Results from publicly available turbine curtailment studies.

Study	Manufacturer's Cut-in Speed (m/s)	Treatment Cut-in Speed (m/s)	Estimated Percent Reduction in Mortality	Mean Percent Reduction in Mortality	Source	Notes
Fowler Ridge, IN 2011	3.5	3.5	36	36	Good et al. 2012	Treatment = feathering below cut-in
Mount Storm, WV 2010	4.0	4.0	35	46	Young et al. 2011	Represents mean reduction from two halves of the night
Summerview, AB 2007	4.0	4.0	57	46	Baerwald et al. 2009	
Wolfe Island, ON 2010	4.0	4.5	48	48	Stantec Ltd. 2011	
Fowler Ridge, IN 2011	3.5	4.5	57	52	Good et al. 2012	
Anonymous Project (AN01), USFWS Region 3	3.5	4.5	47	52	Arnett et al. 2013	
Criterion, MD 2012	4.0	5.0	62	62	Young et al. 2013	Compared to 2011 monitoring results
Casselman, PA 2008	3.5	5.0	82	73	Arnett et al. 2010	All turbines received treatments in a randomized order
Casselman, PA 2009	3.5	5.0	72	73	Arnett et al. 2010	Half of turbines received randomized treatments
Fowler Ridge, IN 2010	3.5	5.0	50	73	Good et al. 2011	No feathering below cut-in
Fowler Ridge, IN 2012	3.5	5.0	84	73	Good et al. 2012	Reductions for all six years in reference to 2010 baseline.
Fowler Ridge, IN 2013	3.5	5.0	77	73	Good et al. 2014	Reductions for all six years in reference to 2010 baseline.
Fowler Ridge, IN 2014	3.5	5.0	78	73	Good et al. 2015	Reductions for all six years in reference to 2010 baseline.
Fowler Ridge, IN 2015	3.5	5.0	72	73	Good et al. 2016a	Reductions for all six years in reference to 2010 baseline.
Fowler Ridge, IN 2016	3.5	5.0	72	73	Good et al. 2017	Reductions for all six years in reference to 2010 baseline.
Fowler Ridge, IN 2017	3.5	5.0	66	73	Good et al. 2018	Reductions for all six years in reference to 2010 baseline.
Wildcat, IN 2017	3.5	5.0	74	73	Stantec Consulting 2018	Spring only. Treatment data from 2016, normal cut-in data from 2013-2015 and 2017.
Pinnacle, WV 2012	3.0	5.0	47	51	Hein et al. 2013	One outlier was removed from the dataset
Pinnacle, WV 2013	3.0	5.0	54	51	Hein et al. 2014	

Table 4.3. Results from publicly available turbine curtailment studies.

Study	Manufacturer's Cut-in Speed (m/s)	Treatment Cut-in Speed (m/s)	Estimated Percent Reduction in Mortality	Mean Percent Reduction in Mortality	Source	Notes
Fowler Ridge, IN 2011	4.0	5.5	73	67	Good et al. 2012	
Wolfe Island, ON 2010	4.0	5.5	60	67	Stantec Ltd. 2011	
Summerview, AB 2007	3.5	5.5	60	66	Baerwald et al. 2009	
Anonymous Project (AN01), USFWS Region 3	3.5	5.5	72	66	Arnett et al. 2013	
Sheffield, VT 2009	4.0	6.0	60	60	Arnett et al. 2013	Raised cut-in only when temperatures were above 9.5 °C (49.1 °F).
Pinnacle, WV 2013	3.0	6.5	76	76	Hein et al. 2014	
Casselman, PA 2008	3.5	6.5	82	77	Arnett et al. 2010	
Casselman, PA 2009	3.5	6.5	72	77	Arnett et al. 2010	
Fowler Ridge, IN 2010	3.5	6.5	78	77	Good et al. 2011	
Wildcat, IN 2017	5.0	6.9	51	51	Stantec Consulting 2018	Fall only. Treatment data from 2017, baseline data from 2013-2015.
Beech Ridge, WV 2012	3.5	6.9	89	93	Young et al. 2014	Compared to average mortality at two other West Virginia projects
Beech Ridge, WV 2013	3.5	6.9	97	93	Tidhar et al. 2013	Compared to average mortality at two other West Virginia projects

m/s = meters per second

Based on regional and landscape characteristics, the research conducted at the FRWF in 2010 and 2011 is considered the most meaningful study for understanding reductions in bat mortality that are likely to be achieved by feathering all turbine blades below cut-in speeds of 3.5 m/s in the spring and 5.0 m/s in the fall. All bat fatalities were reduced by a mean of 50% when cut-in speed was increased from 3.5 m/s to 5.0 m/s (90% CI = 38% – 60%), and by 78% when cut-in speeds were increased to 6.5 m/s (21.3 ft/s; 90% CI = 71% – 85%; Good et al. 2011). Although cut-in wind speed was raised in the 2010 study, turbines were allowed to spin below cut-in (i.e., turbines were not feathered). Thus, the 2010 results may underestimate the reduction in bat fatality that may be achieved by feathering turbines below cut-in wind speeds.

To test whether or not additional reductions could be achieved by feathering blades below the FRWF's cut-in wind speed of 3.5 m/s, turbines in the 2011 study were feathered below cut-in wind speeds of 3.5, 4.5, and 5.5 m/s (11.5, 14.8, and 18.0 ft/s), which resulted in reductions of 36% (90% confidence interval [CI] = 12% – 54%), 57% (90% CI = 39% – 70%), and 73% (90% CI = 60% – 83%) in bat mortality, respectively, compared with normally operating turbines (i.e., unfeathered below a cut-in wind speed of 3.5 m/s). Based on these results, between 57% and 73% reductions would have been achieved by feathering blades below a cut-in speed of 5.0 m/s in 2011 (Good et al. 2012). The average percent reduction for all studies that raised the cut-in speed to 5.0 m/s was 61%, which includes the results from FRWF 2010 which did not include feathering.

It is currently unclear if operational adjustments will be equally effective at reducing mortality among different species or species groups. Three species of long-distance migratory bats have been killed in the largest proportions at wind energy facilities in North America: the foliage-roosting hoary bat and eastern red bat, and the cavity-roosting silver-haired bat (Kunz et al. 2007, Arnett et al. 2008). Collectively, these species comprise the vast majority of all bat fatalities documented at wind energy facilities (e.g., 75% of all documented bat fatalities at 19 wind energy facilities reviewed by Arnett et al. [2008]); consequently, these three species have provided the bulk of the all bat fatality data analyzed in the curtailment studies to date.

No curtailment studies have specifically analyzed the effectiveness of raised cut-in speeds in reducing *Myotis,* or other small bat fatalities. However, it is plausible, based on morphology and flight behavior (see Norberg and Rayner 1987), that smaller species of Midwestern bats, such as the Covered Species, may be less active at higher wind speeds when compared with the larger species (e.g. hoary bats, silver-haired bats) that typically forage in more open habitats such as is found at the rotor-swept zone of turbines. If smaller bats are more active at lower wind speeds than are the species more commonly found as wind project fatalities, then feathering turbine blades at low wind speeds will have a relatively greater effect in reducing fatalities of these smaller species.

Given the variability in the estimated reductions in bat mortality among studies (Table 4.3) and potential year-to-year variation, the Applicant estimates that feathering turbine blades below 3.5 m/s during the spring migration season and 5.0 m/s during the fall migration season (Table 4.3) would reduce all bat mortality, including Indiana bat mortality, by at least 50% annually. This is a conservative estimate based on the expectation that feathering turbines below 3.5 m/s in the spring, when approximately 11%[13] of the take is expected to occur, will reduce bat mortality by approximately 36% (Good et al. 2012), and that feathering turbines below 5.0 m/s in the fall, when approximately 89% of the take is expected to occur, will reduce bat mortality by approximately 61% (Arnett et al. 2010; Good et al. 2011; Hein et al. 2013, 2014). Therefore, the 11% of the take that is expected to occur during the spring migration season times a 36% reduction in bat mortality, plus the 89% of the take that is expected to occur during the fall migration season times a 61% reduction in bat mortality, equals a 58% reduction in the take rate annually.

A 50% reduction of the 50th credible bound of predicted take yields a scaled take rate (λ_{50}) of 0.0804 bat per turbine per year and results in a minimized take prediction of 276 Indiana bats over the proposed 30-year ITP term (Table 4.1).

4.2.4 Proposed Indiana Bat Take Limit

The Applicant requests a take limit of 276 Indiana bats over the proposed 30-year ITP term.

The Applicant will conduct compliance monitoring and, if necessary, implement adaptive management to ensure that the cumulative take estimated from monitoring does not exceed the ITP take limit (Section 5.4).

4.2.5 Impact of the Taking of Indiana Bats

Determining the significance of predicted take on a species or population requires an understanding of demographics, in particular annual survival and mortality rates, the proportion of females taken, and the geographic bounds of the population being impacted.

The Indiana bat's demographics are summarized in Section 3.2.3. The USFWS used the population demographics of the Indiana bat to develop the Indiana Bat REA Model and the Applicant has employed that model in this HCP to calculate the impact of predicted take.

The Indiana Bat REA Model requires various inputs, such as predicted annual take of breeding females and project duration. Loss of females is particularly important because their loss has a greater impact on a population than loss of males, as loss of females reduces reproductive potential, specifically loss of female pups that would otherwise have been produced. To understand the biological impact of the proposed authorized take on the relevant Indiana bat population, it is necessary to estimate what proportion of the bats taken are likely to be reproductive females.

It is unclear based on available scientific information if there are sex-related factors that might influence collision risk during migration. Empirical data on the sex ratios of bats recorded in fatality monitoring studies are limited, partly because many carcasses cannot be identified to age or sex

[13] Seasonal distribution is based on *Myotis* fatalities from 41 studies conducted in the eastern and Midwestern U.S. that conducted monitoring during the entire Indiana bat active period (USFWS 2016b) and assuming that take of Indiana bats by the Project will be distributed only across the spring and fall seasons.

due to decomposition or scavenging. Western Ecosystems Technology, Inc. has assembled a database of the sex of bat carcasses reported in 151 publicly available fatality monitoring studies at wind energy facilities in the Northeastern and Midwestern US and Canada (Appendix B). Among 7,894 carcasses of all bat species for which sex was recorded, 23%, 40%, and 37% were identified as females, males, and unknown sex, respectively. For *Myotis* species specifically, among 490 carcasses for which sex was recorded, 19%, 39%, and 42% were identified as females, males, and unknown sex, respectively. Since such a large percentage of bats could not be identified to either sex (37% of all bats and 42% of *Myotis*), it was unclear whether or not males made up the majority of fatalities. If unidentified bats were divided equally among the two sexes, the ratio of females to males would have been skewed towards males (approximately two females to three males). This result is similar to that reported in Pennsylvania for 16 wind energy facilities monitored from 2007 to 2011, where 2,820 bat carcasses were collected, of which 23% were cave-dwelling species, including *Myotis* species (Taucher et al. 2012). For bats of all species (sex was not reported by species or species group), male bats were found more often than female bats (59% male; 29% female; 12% were of unknown sex). Similarly, Arnett et al. (2008) reviewed data from 21 fatality studies conducted from 1996 to 2006 at 19 wind facilities in five US regions and one Canadian province and found fatalities included more males for the four most commonly killed species (hoary bats, eastern red bats, silver-haired bats, and tri-colored bat). However, the authors did not report on sex ratios of *Myotis* bats specifically, or for cave-dwelling bats as a group.

The location of the Project, however, suggests that Indiana bats migrating through the Project area are mostly females. Female Indiana bats are known to disperse from hibernacula to reach distant summer maternity colonies, while males typically remain closer to hibernacula throughout the summer (Gardner and Cook 2002, Whitaker et al. 2002). As there are no hibernacula close to the Project (the closest known hibernaculum with Indiana bats is Lewisburg Mine in Preble County, Ohio, approximately 120 km [75 mi] to the south-southwest), it is likely that more female Indiana bats transit the Project in migration, resulting in greater collision risk for females. This is supported by fatality data: of the 13 Indiana bat fatalities documented at wind energy facilities, five have been females, two males, and six could not be identified to sex (Table 3.5; Pruitt and Reed 2019). Those records were from Indiana (six), Ohio (three), Illinois (one), Iowa (one), Pennsylvania (one), and West Virginia (one).

If there are more adult females than males in the spring and fall migratory populations, and if migrating juveniles occur at a 1:1 sex ratio, then a 3:1 ratio of females to males may be conservatively assumed. This ratio purposefully overestimates take of female Indiana bats, so that the impact of take is not underestimated.

If approximately 75% of the incidental take is expected to be attributable to females, then 207 female Indiana bats are predicted to be taken over the 30-year ITP term (Table 4.1). Using the USFWS' Indiana Bat REA Model and a declining population, the total predicted lost reproductive capacity during the ITP term is 331 female pups. This results in a total predicted impact of the taking of 538 Indiana bats (276 Indiana bats [total take] * 75% = 207 Indiana bats [total female take] + 331 Indiana bats [lost reproduction] = 538 Indiana bats [impact of the taking]) over the 30-

year ITP term (Table 4.1). Collectively, predicted female take and lost reproductive capacity of females represents the annual loss at the Project of approximately 17.9 Indiana bats per year over the 30-year ITP term. Mitigation actions, therefore, will have a target increase of 538 Indiana bats, or 17.9 bats per year to account for this lost reproductive capacity. Note, however, that when all 134 turbines are in operation during the first 22 years of the ITP term, the impact of the taking will be 21.0 Indiana bats annually (Table 4.1) and the mitigation implemented during this timeframe will be designed to offset the impact of take at this higher annual rate.

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 loss of bats from hibernacula populations may diminish the abundance of the population and, if losses are great enough, could potentially affect the growth rate (λ) of the hibernating population. However, because take from the Project is expected to consist of individual bats migrating from various hibernacula and various maternity colonies, take is not likely to have a concentrated or frequent impact on any single maternity colony or hibernaculum.

Based on data from genetic, banding, and telemetry studies, it is highly likely that Indiana bats migrating through the Permit Area are part of the MRU population (USFWS 2007a). Thus, the impacts of the taking are evaluated as they pertain to the MRU population. Impacts are additionally evaluated at the range-wide population level (i.e., over the total range of the species).

The MRU population was estimated at 245,474 Indiana bats in 2019 (USFWS 2019a). The average loss of 17.9 Indiana bats per year represents 0.007% of that population annually (Table 4.1). Even if the MRU population of Indiana bats were further reduced by 90% as a result of WNS, the loss of 17.9 Indiana bats per year would represent 0.07% of a WNS-reduced population of 24,547 Indiana bats. The range-wide population was estimated at 537,297 individuals in 2019 (USFWS 2019a). The average loss of 17.9 Indiana bats per year represents 0.003% of that population annually (Table 4.1).

In summary, the Applicant does not anticipate that the requested take authorization will have a significant impact on the Indiana bat population because: 1) the impact of the taking is not expected to be concentrated at particular maternity colonies or hibernacula, but will be spread among the MRU population; 2) the annual take represents a very small fraction of the MRU and range-wide populations; and 3) mitigation actions are expected to fully offset the impact of the taking. If the population of Indiana bats in the MRU becomes substantially reduced from present levels as a result of WNS or other factors, the Applicant will take corresponding action as described in Chapter 8.

4.3 Northern Long-Eared Bats

4.3.1 Overview

The Applicant predicts that turbine operation without minimization measures during the spring and fall periods may result in take of up to 127 northern long-eared bats over the 30-year ITP term (Table 4.4, Section 4.3.2). However, the Applicant will implement minimization measures to reduce the potential take of northern long-eared bats (Sections 4.3.3 and 5.2.2). Based on the best available scientific information, the Applicant conservatively[14] predicts that incidental take of northern long-eared bats from operation of the Project will be reduced by at least 50% with minimization measures in place. Therefore, the predicted level of take and the requested amount of take to be authorized over the 30-year ITP term is 64 northern long-eared bats (Table 4.4). The actual level of take occurring will be estimated based on the results of compliance monitoring, and compliance with the authorized level of take in the ITP will be assured through adaptive management.

The Applicant will implement mitigation to offset the impact of take, including lost reproductive capacity of females taken, namely, the females that are directly taken plus the female pups that will not be born as a result of the take. Available information suggests that 50% of the take may be assigned to females. Using 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 2016e), and assuming that the population is declining as a result of WNS, the predicted lost reproductive capacity resulting from the take of 64 northern long-eared bats is 32 adult females and 49 female pups, for a total impact of 81 northern long-eared bats over the 30-year ITP term (Table 4.4, Section 4.3.5).

Collectively, female take and lost reproductive capacity represent an average loss of approximately 2.7 northern long-eared bats per year over the 30-year ITP term. This average annual loss equates to a 0.00004% reduction in the last estimated range-wide population of 6,546,718 northern long-eared bats (USFWS 2016d), the population most likely to be impacted, since research to establish recovery units has not been conducted. Nonetheless, the range-wide population estimate is broken down by state, with an estimate of 240,240 northern long-eared bats in Ohio (USFWS 2016d), of which 2.7 individuals represents an annual reduction of 0.0011% (Table 4.4, Section 4.3.5). Given that these losses represent small percentages of the estimated northern long-eared bat population overall and in Ohio, and given that mitigation implemented as part of this HCP is expected to fully offset the impacts of the taking, the Applicant does not expect the Project to have a significant impact on northern long-eared bat populations.

[14] Conservative means that actual northern long-eared bat mortality is likely to be lower than these estimates; curtailment studies from the FRWF reported a 57% reduction in all bat fatality when turbines were feathered below 4.5 m/s and a 73% reduction in all bat fatality when turbines were feathered below 5.5 m/s (Good et al. 2012). Curtailment is expected to be at least as effective for *Myotis* species in particular (see Section 4.2.3).

Table 4.4. Overview of the predicted northern long-eared bat take from the operation of the Timber Road Wind Farms and the associated impact of the taking to be mitigated

HCP Section	HCP Topic	Detail	Per Turbine	Annual	Total	Assumption
4.3.2	Predicted take without minimization	134 turbines, Years 1- 22	0.0370	5.0	109	50th credible bound of predicted take rate
		79 turbines, Years 23 -27	0.0370	2.9	15	
		31 turbines, Years 28 - 30	0.0370	1.1	3	
		Total over 30-year ITP term			127	
4.3.3	Predicted take with minimization	134 turbines, Years 1- 22	0.0185	2.5	55	Minimization estimated at 50%
		79 turbines, Years 23 -27	0.0185	1.5	7	
		31 turbines, Years 28 - 30	0.0185	0.6	2	
		Total over 30-year ITP term			64	
4.3.5	Predicted female take with minimization	134 turbines, Years 1- 22	0.0093	1.2	27	1:1 ratio of females to males
		79 turbines, Years 23 -27	0.0093	0.7	4	
		31 turbines, Years 28 - 30	0.0093	0.3	1	
		Total over 30-year ITP term			32	
4.3.5	Lost reproductive capacity	134 turbines, Years 1- 22		1.9	42	*Northern Long-eared Bat REA Model Public v1* (USFWS 2016f)
		79 turbines, Years 23 -27		1.2	6	
		31 turbines, Years 28 - 30		0.3	1	
		Total over 30-year ITP term			49	
4.3.5	Loss of Indiana bats to be mitigated, i.e., females taken plus lost reproductive capacity	Years 1 - 30		2.7	81	*Northern Long-eared Bat REA Model Public v1* (USFWS 2016f)
4.3.5	Annual reduction in population, based on loss of 2.7 female northern long-eared bats per year	Range-wide population		0.00004%		Population estimate = 6,546,718 northern long-eared bats (USFWS 2016d)
4.3.5	Annual reduction in population, based on loss of 2.7 female northern long-eared bats per year	Ohio population		0.0011%		Population estimate = 240,240 northern long-eared bats (USFWS 2016d)

Table 4.4. Overview of the predicted northern long-eared bat take from the operation of the Timber Road Wind Farms and the associated impact of the taking to be mitigated

HCP Section	HCP Topic	Detail	Per Turbine	Annual	Total	Assumption
4.3.5	Annual reduction in population, based on loss of 2.7 female northern long-eared bats per year	Ohio population further reduced 98% by WNS		0.06%		Population estimate = 4,809 northern long-eared bats
5.3.1	Target increase in northern long-eared bats during initial 3-year mitigation increment	Years 1 - 3 of ITP term		3.1	9	
5.3.1	Target increase in northern long-eared bats during 6-year mitigation increments, based on the impact of the taking when all turbines are in operation	Years 4-27 of the ITP term		3.1	19	
5.3.1	Target increase in northern long-eared bats during final 3-year mitigation increment	Years 28-30 of the ITP term		0.6	2	

HCP = Habitat Conservation Plan, ITP = Incidental Take Permit, MRU = Midwest Recovery Unit, REA = Resource Equivalency Analysis, USFWS = US Fish and Wildlife Service, WNS = White-nose Syndrome

4.3.2 Predicted Northern Long-Eared Bat Mortality without Minimization Measures

As discussed in Section 3.4.5, northern long-eared bats are assumed to occur in the Permit Area during the spring and fall migration periods (April 1 – May 15 and August 1 – October 15), but not during the summer maternity season. Thus, the spring and fall migration periods were designated as the periods of risk for northern long-eared bats at the Project. The term "take rate" used throughout the rest of this section and the HCP refers to the amount of northern long-eared bat take either predicted to occur or estimated to have occurred during the spring and fall seasons in a given year. As explained for Indiana bats, take "prediction" refers to quantification of projected future take; take "estimation" refers to quantification of take that has actually occurred.

As with Indiana bat fatalities, northern long-eared bat fatalities at wind energy facilities are rare events. Thus, the method for predicting take was broadly similar to that used to predict take of Indiana bats (Section 4.2.2), namely, data from fall 2011, 2013, and spring 2014 monitoring at TR-II were used as input data for the EoA model. The annual take rate distribution was again scaled to a per-turbine rate.

As with the Indiana bat take prediction, the Applicant used the 50^{th} credible bound of the distribution of the scaled take rate prediction as a conservative prediction of northern long-eared bat take rate that may occur at the Project. The 50^{th} credible bound of the predicted scaled take rate is λ_{50} = 0.0370 northern long-eared bat per turbine per year. The expected number of northern long-eared bats taken was obtained as the median of a Poisson distribution with a rate parameter of 127.132 bats (= (0.0370 bat per turbine per year × 134 turbines × 22 years) + (0.0370 bat per turbine per year × 79 turbines × 5 years) + (0.0370 bat per turbine per year × 31 turbines × 3 years): M_{50} = 127; Table 4.4.4).

Although this value may overestimate the amount of northern long-eared bat take that could occur, the nature of a prediction is that there is no "correct" number, and the use of the 50th credible bound represents a conservative but reasonable approach that is not likely to trigger adaptive management actions at the Project when additional minimization measures are not actually warranted by changes in the underlying take rate. Thus, the cumulative predicted take (M_{50}) over the 30-year ITP term is 127 northern long-eared bats in the absence of minimization measures. As previously noted, Appendix A explains the EoA take prediction methods in detail.

4.3.3 Predicted Northern Long-Eared Bat Mortality with Minimization Measures

The analysis presented in Section 4.3.2 represents northern long-eared bat mortality that can be expected under normal operating conditions. However, specific operational adjustments will be made as a condition of this HCP and the requested ITP to minimize the impacts of take of northern long-eared bats. These measures are expected to substantially reduce annual northern long-eared bat mortality at the Project. As described for Indiana bat take minimization, although there is uncertainty in the take prediction, the effectiveness of the proposed minimization measures at reducing take is supported by a substantial amount of research.

Section 4.2.3 explains in detail the research and assumptions that justify proposed minimization measures, which are expected to reduce predicted take of northern long-eared bats by at least 50%. Specifically, these measures are feathering turbine blades below 3.5 m/s during the spring migration season (April 1 – May 15) and below 5.0 m/s during the fall migration season (August 1 – October 15; Table 4.3). Turbine blades will also be feathered below the manufacturer's rated cut-in speed in the summer, which is expected to further reduce all-bat mortality at the Project. A 50% reduction of the 50th credible bound of the predicted take rate yields a scaled take rate (λ_{50}) of 0.0185 bat per turbine per year, and the median of minimized life-of-permit take (M_{50}) would be 64 northern long-eared bats (Table 4.4).

4.3.4 Proposed Northern Long-Eared Bat Take Limit

The Applicant requests a take limit of 64 northern long-eared bats over the 30-year ITP term.

The Applicant will conduct compliance monitoring and, if necessary, implement adaptive management to ensure that the cumulative take estimated from monitoring does not exceed the ITP take limit (Section 5.4).

4.3.5 Impact of the Taking of Northern Long-Eared Bats

As explained for Indiana bats (Section 4.2.5), determining the impact of proposed take requires various demographic inputs, including annual survival and mortality rates, the ratio of females to males, and the population affected.

The northern long-eared bat's demographics are summarized in Section 3.3.3. The USFWS used the population demographics of the Indiana bat to develop the Northern Long-eared Bat REA Model and the Applicant has employed that model in this HCP to calculate the impact of predicted take.

The Northern Long-eared Bat REA Model requires various inputs, such as predicted annual take of breeding females and project duration. To understand the biological impact of the proposed authorized take on the relevant northern long-eared bat population, it is necessary to estimate what proportion of the bats taken is likely to be reproductive females. As discussed in Section 4.2.5, it is unclear if there are sex-related factors that influence bat collision risk during the spring and fall migration seasons; if the unsexed bat carcasses reported in 50 publicly available fatality monitoring studies at wind energy facilities (Appendix B) were divided equally among the two sexes and added to bat carcasses of known sex, the ratio of females to males would be skewed toward males (39% females and 61% males). Information on the sex of northern long-eared bat carcasses has not been collected in most cases.

Unlike Indiana bat hibernacula, the locations of most northern long-eared bat hibernacula remain undocumented, partly due to the species' common status prior to the impact of WNS, and partly due to the species' use of smaller hibernacula that are more dispersed on the landscape. Although the Project is not located near any known northern long-eared bat hibernacula, male and female northern long-eared bats are assumed equally likely to occur within the Permit Area, because data that would prove otherwise are lacking. Therefore, the Applicant assumes that 50% of the northern long-eared bat take at the Project may be attributable to reproductive females. This ratio may be an overestimate and thus conservative, given the evidence cited in Section 4.2.5 that male bats may be at higher risk of collision with wind turbines than female bats.

If approximately 50% of the incidental take is expected to be attributable to females, then 32 female northern long-eared bats are predicted to be taken over the 30-year ITP term (Table 4.4). Using the USFWS' Northern Long-eared Bat REA Model and a declining population, the total predicted lost reproductive capacity during the ITP term is 49 female pups. This results in a total predicted impact of take of 81 northern long-eared bats (64 northern long-eared bats [total take] * 50% = 32 northern long-eared bats [total female take] + 49 northern long-eared bats [lost reproduction] = 81 northern long-eared bats [impact of take]) over the 30-year ITP term (Table 4.4). Mitigation actions, therefore, will have a target increase of 81 northern long-eared bats bats, or 2.7 bats per year to account for this lost reproductive capacity. Note, however, that when all 134 turbines are in operation during the first 22 years of the ITP term, the impact of the taking will be 3.1 Indiana bats annually (Table 4.4) and the mitigation implemented during this timeframe will be designed to offset the impact of take at this higher annual rate.

Take of female northern long-eared bats at the Project during migration, including lost reproductive potential, is unlikely to affect the persistence of any one maternity colony or hibernaculum, because take from the Project is expected to consist of individual bats migrating from various hibernacula and various maternity colonies. Given that northern long-eared bat has only recently been listed, there has been little research to help the USFWS establish recovery units, as was done with Indiana bat. Thus, since recovery units have not been established, the range-wide population is considered to be the population that will be affected by take. Additionally, because the USFWS has also estimated the summer breeding population in Ohio (USFWS 2016d), that subpopulation is also considered. The Ohio subpopulation may have particular relevance because northern long-eared bat is considered a shorter distance migrant than Indiana bat.

The impact of take of 2.7 northern long-eared bats per year represents 0.00004% of the last range-wide population estimate of 6.5 million northern long-eared bats (USFWS 2016d). This population estimate was based on forest cover and factored in decreases from WNS, but the population may decrease further as a result of WNS.

With respect to the Ohio population, last estimated at 240,240 bats (USFWS 2016d), the impact of take represents 0.0011% of the population. In Ohio, mist-net capture rates have declined somewhat from pre-WNS to post-WNS, but summer colony occupancy rates have been relatively stable (USFWS 2016d). Nonetheless, the Ohio population may continue to decline as a result of WNS. In the Northeast, hibernacula data substantiated a decline of 98% (Turner et al. 2011). If such a decline were to occur within the estimated Ohio population, the impact of take would represent 0.06% of that reduced population (Table 4.4).

As with Indiana bat, the Applicant does not anticipate that the Project will have a significant impact on the northern long-eared bat population because: 1) the impact of take is not expected to be concentrated at particular maternity colonies or hibernacula, 2) the annual take represents a very small fraction of the range-wide and Ohio populations as they were last estimated, and 3) mitigation actions are expected to fully offset the impact of the taking. If population declines continue as a result of WNS or other factors, the Applicant will take corresponding action as described in Chapter 8.

4.4 Direct and Indirect Effects Not Expected to Result in Take

The purpose of this section is to describe the potential effects of the Project that are not expected to rise to the level of take. According to the ESA § 7 implementing regulations (50 CFR Part 402.02 [1986]), “effects” refer to the direct and indirect effects of an action on the Covered Species or any critical habitat, together with the effects of other activities that are interrelated or interdependent with the action and that add to the environmental baseline. To assist the USFWS in carrying out its internal ESA § 7 consultation obligations, this section describes separately the potential direct and indirect effects of the Project associated with Project operation, maintenance, and decommissioning activities, as well as with mitigation activities that will be implemented pursuant to this HCP to offset the impact of take.

Note that pre-construction studies conducted at the Project and post-construction studies conducted at TR-II and TR-III, discussed in Section 3.4, support a conclusion that the Covered Species occur at the Project only during migration, when they may transit the Project’s airspace or stopover briefly in forest patches. Forest cover does not appear to support summer maternity colonies, and presence/absence mist-net surveys of the Permit Area found probable absence of the Covered Species during the summer maternity season (Section 3.4.1).

4.4.1 Activities Resulting in Direct Effects

In the context of the ESA, direct effects are the direct and immediate effects of a project on the species or its habitat (USFWS and NMFS 2016). Such direct effects may constitute take even if they do not result in mortality, as the ESA’s definition of “take” includes “harm” and “harassment.” The concept of habitat impacts or other environmental damage as a take is captured by the term “harm,” which USFWS regulations define as “an act which actually kills or injures wildlife.” The definition explains that, “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” (50 CFR 17.3 [1975]). Take as a result of harm can be authorized under an ITP. By contrast, the term ”harass” in the definition of “take” is defined as “an intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns that include, but are not limited to, breeding, feeding, or sheltering” (50 CFR 17.3 [1973]). Because “harass” is limited to intentional or negligent actions, take as a result of harassment is not incidental and therefore cannot be permitted under ESA § 10(a)(1)(B) (USFWS 2018a).

4.4.1.1 Operation

As discussed at length in Sections 4.2 and 4.3, Project operation is reasonably certain to result in take of Covered Species through collisions with spinning rotors. Another direct effect that may result from turbine operation is displacement, whereby Covered Species would alter their migration route to avoid the Project and in doing so would use up so much of their fat reserves as to affect breeding, lactation, feeding, migration or hibernation.

Theoretically, these effects could be significant enough to constitute harm that rises to the level of take. However, displacement of bats has not been confirmed through empirical evidence. Indeed, the evidence available suggests that bats may be attracted to wind turbines. Observations of flight activity using thermal infrared cameras have documented bats flying and foraging in close proximity to wind turbines, even investigating revolving blades (Ahlén 2003, Horn et al. 2008). A thermal imaging study using videography (Cryan et al. 2014) has shown that bats in the vicinity of turbines (e.g., less than 50 m [164 ft]) alter course toward turbines.

The reasons for attraction are not fully understood, and the proportion of passing bats that approach turbines remains to be determined, but these findings suggest that some migratory bats (particularly the tree-roosting bats that make up the bulk of fatalities, not *Myotis*) may be more attracted to wind energy sites after turbines are erected. The records of fatalities at wind turbines, which to date include 13 Indiana bats and 50 northern long-eared bats (Table 3.5), provide evidence specific to the Covered Species that displacement does not occur on a meaningful scale.

<u>4.4.1.2</u> <u>Maintenance</u>

Maintenance of turbines involves periodic activities typically conducted inside turbines or within the O&M building. Occasionally, maintenance may require the use of a crane to access the rotors or nacelles. These activities, which take place during daylight hours, do not present hazards to the Covered Species because the activities do not generate excessive noise or activity that would disturb Indiana bats or northern long-eared bats potentially migrating through the Permit Area. Given the limited amount of forested habitat in the Permit Area, it is unlikely that bats of the Covered Species would stopover in the Permit Area during migration. However, if any bats using the Permit Area as stopover habitat during migration were disturbed, the disturbance would be minor (e.g., perhaps bats would move within the roost or switch roost trees at night if their stopovers lasted many days). It is highly doubtful that moving within a roost or switching roost trees during a brief migratory stopover would use up sufficient fat reserves to affect breeding, lactation, feeding, migration, or hibernation to a degree that would qualify as harm. Therefore, this disturbance, which is considered unlikely, is not reasonably certain to rise to the level of take.

Other outdoor maintenance activities include road grading, maintenance facility upkeep, and mowing. All of these activities would take place during daylight hours and also would not generate excessive noise and activity that would rise to the level of take. Any tree removal for regular maintenance would be conducted during October 1 – March 31, per guidance from the USFWS, to avoid potential impacts to roosting bats.

If any emergency tree removal[15] is necessary, the Applicant will conduct it as necessary and report it to USFWS as soon as possible. If non-emergency tree removal is necessary April 1 – September 30, the Applicant will implement a conservative protocol to avoid take of summer-roosting bats that are not Covered Species, as well as to avoid take of Covered Species that may roost during migratory stopover. Following the USFWS's recommendation, the Applicant will notify the USFWS in advance of any tree removal during this season and, if appropriate, have a qualified biologist conduct an emergence survey at the trees requiring removal. If no bats are observed during the emergence survey, the trees will be promptly removed. If bats are observed, then the Applicant will conduct further consultation with the USFWS. This will avoid removing an occupied roost tree. Therefore, maintenance activities are not expected to result in direct effects that could rise to the level of take.

4.4.1.3 Decommissioning

If the Project is decommissioned at the end of the ITP term, decommissioning activities will be conducted as described in Section 2.1.3. Decommissioning activities would occur during daylight hours, be similar to construction, and would not create hazards for active bats. Turbines would be locked to prevent rotors from spinning, which would avoid the potential for collision with spinning rotors. Any tree removal necessary for decommissioning would be primarily conducted during October 1 – March 31 as a conservative measure to avoid take of summer-roosting bats that are not Covered Species, as well as to avoid take of Covered Species that may roost during migratory stopover. If tree removal is necessary outside of that period, the avoidance protocol will be followed as described above. Decommissioning, therefore, is not expected to cause impacts to the Covered Species that would be reasonably certain to rise to the level of take.

4.4.1.4 Mitigation

Described in Section 5.3, mitigation will be conducted to offset the impact of taking under this HCP and benefit the Covered Species. Depending on the type of mitigation project, work may include installation of cave gates, restoration of habitat (e.g., tree planting and management of invasive plants), education of the public, and other activities intended to protect or enhance the habitat of Covered Species. Although implementation of these activities may have a temporary negative direct effect on the Covered Species if performed improperly, all mitigation activities will be conducted in a manner approved by the USFWS as not reasonably certain to result in take of the Covered Species.

4.4.2 Activities Resulting in Indirect Effects

Implementing regulations of the ESA (50 CFR 402.02 [1986]) define indirect effects as "those effects that are caused by or will result from the proposed action and are later in time, but still are reasonably certain to occur." As with direct effects, indirect effects may constitute take even if they do not result in mortality if they harass or harm the Covered Species. As explained below, however, the indirect effects of Project activities on the Covered Species are not reasonably certain to rise to the level of take.

[15] Emergency tree removal would be for trees that pose an imminent risk of human life or property damage.

4.4.2.1 Operation

Indirect effects from operation of a wind energy facility could include secondary development if operation of the facility increased employment opportunities, which in turn induced housing or urban development in previously undeveloped areas used by the Covered Species. The economic benefits from the Project are likely to enable farmers to maintain agricultural operations and existing land uses, so despite the positive economic impact of the Project on the local community, secondary development of this nature is not reasonably certain to occur. In the unlikely event that the Project resulted in increased housing or urban development, these are likely to be located in previously disturbed or agricultural habitat, primarily because Paulding County and surrounding counties are characterized by expansive, open fields of agriculture. Therefore, indirect effects of Project operation from secondary development or other factors are not expected and would not be reasonably certain to result in take.

4.4.2.2 Maintenance

As explained above, tree removal necessary for Project maintenance will be primarily conducted during the winter months (October 1 – March 31) as a conservative measure to avoid take of summer-roosting bats that are not Covered Species, as well as to avoid take of Covered Species that may roost during migratory stopover. If tree removal needs to occur outside of this period, the avoidance protocol described above will be employed. Tree removal for maintenance activities will be minor, limited to single trees or small clusters of trees.

Tree removal that may occur during Project maintenance is unlikely to cause indirect effects that rise to the level of take of the Covered Species because of the limited extent of the tree removal and the low likelihood that Covered Species roost within the Permit Area. Removal of dead and dying trees, or live shagbark hickories that typically provide higher quality roosting habitat, would presumably have greater impact to the Covered Species than removal of young saplings or healthy older trees without exfoliating bark. For example, Kurta (2005) suggested that the magnitude of impact to Indiana bats from roost tree removal will vary greatly depending on the scale of roost loss (i.e., how many roosts are lost and how much alternative habitat is left in the immediate vicinity of the traditional roost sites). However, presence/absence mist-net surveys of the Permit Area found probable absence of the Covered Species during the summer maternity season (Section 3.4.1), indicating that any tree removal conducted during Project maintenance would not affect summer roosting habitat for the Covered Species. Additionally, the limited amount of forested habitat in the Permit Area indicates that it is unlikely that bats of the Covered Species would stopover in the Permit Area during migration. Regardless, the limited tree removal that may be conducted for Project maintenance would not substantially alter the extent or quality of roosting habitat available to any bats of the Covered Species using the Permit Area as stopover habitat during migration. Therefore, any indirect effects resulting from maintenance are not reasonably certain to result in take.

4.4.2.3 Decommissioning

As explained above, tree removal necessary for Project decommissioning will be primarily conducted during the winter months (October 1 – March 31) as a conservative measure to avoid take of summer-roosting bats that are not Covered Species, as well as to avoid take of Covered Species that may roost during migratory stopover. If tree removal needs to occur outside of this period, the avoidance protocol described above will be employed. Tree removal for decommissioning will be minor, limited to single trees or small clusters of trees. Therefore, tree removal during decommissioning is unlikely to cause indirect effects that are reasonably certain to rise to the level of take of the Covered Species for the reasons given above for maintenance.

4.4.2.4 Mitigation

The mitigation project(s) that will be implemented to offset the impact of taking under this HCP are intended to benefit the Covered Species, as described in Section 5.3. Depending on the type of mitigation project(s) implemented, mitigation work may include installation of cave gate(s), habitat restoration (e.g., tree planting, management of invasive plants, etc.), installation of signage, or other activities intended to protect and/or enhance the habitat for the Covered Species. Although implementation of these activities may have a temporary negative indirect effect on the Covered Species if performed improperly, any mitigation activities conducted for this HCP will be conducted in a manner approved by the USFWS as not reasonably certain to result in take of the Covered Species.

5.0 MINIMIZATION, MITIGATION, AND MONITORING PLAN

As required by ESA § 10(a)(2)(B), the Applicant plans to “minimize and mitigate the impact of take” of the Covered Species from the Covered Activities “to the maximum extent practicable” (MEP). This chapter describes how the Applicant will meet this requirement. It begins by setting forth the biological goals and objectives of this HCP, which are followed by a description of the measures that the Applicant will take to avoid and minimize take. It then describes the measures that the Applicant will implement to mitigate the impact of the taking. It also details the monitoring program that will ensure both take limit compliance and the effectiveness of proposed mitigation. Finally, it covers the adaptive management methods that the Applicant will use to examine alternate strategies for meeting the biological goals and objectives and, if necessary, adjust future conservation management actions according to what is learned through the monitoring program (USFWS and NMFS 2016).

5.1 Biological Goals and Objectives

In an HCP, biological goals are broad guiding principles that describe a desired future condition. They should address the broad biological needs of the Covered Species (USFWS and NMFS 2016). From each goal follows one or more objectives that set forth the incremental steps needed to achieve the goal. The HCP Handbook suggests the acronym SMART to describe appropriate biological objectives, i.e., Specific, Measureable, Achievable, Result-oriented, and Time-fixed (USFWS and NMFS 2016). While ESA § 10 does not require HCPs to achieve conservation or recovery of an endangered or threatened species, this HCP’s biological goals and objectives are consistent with actions to promote the recovery of the Indiana bat, as identified in the Draft Recovery Plan (USFWS 2007). They also promote the conservation of the northern long-eared bat, for which a recovery plan has not yet been developed.

Goal 1: Contribute to maintaining the integrity of the populations of the Covered Species in Ohio by minimizing mortality of individuals migrating through the Permit Area.

> ***Objective to achieve Goal 1***: Implement an operational strategy in each permit year that decreases fatalities of the Covered Species by at least 50% when compared with fatalities predicted without minimization (Section 5.2).

Goal 2: Contribute to long-term persistence of the Covered Species by developing mitigation projects that will support the survival and recovery of the Covered Species in Ohio.

> ***Objective to achieve Goal 2***: Protect sufficient summer/swarming habitat acreage within the range of known Covered Species maternity colonies, and/or hibernacula used by sufficient numbers of the Covered Species, to fully offset the impact of the take on the Covered Species as indicated by the REA model and USFWS guidance (Section 5.3).

Goal 3: Increase understanding of Covered Species mortality at wind energy facilities.

> ***Objective to achieve Goal 3***: Conduct a mortality monitoring program with the primary goal of ensuring compliance with the requested ITP, and a secondary goal of increasing the amount of data available to understand take of the Covered Species under the HCP's minimization measures. Specifically, the monitoring program will be designed and implemented to document the likelihood of detecting Indiana bat and northern long-eared bat carcasses and to evaluate the actual level of Covered Species take that is occurring at the Project (Section 5.4).

Goal 4: Optimize the Project's electrical output to realize the environmental benefit of wind energy, namely, the offsetting of carbon and other emissions produced by other energy-generating technologies, which contribute to climate change, identified as a potential risk to Indiana bats (USFWS 2007a) and northern long-eared bats (80 FR 17974 [April 2, 2015]).

> ***Objective to achieve Goal 4***: Implement an operational strategy in each permit year that maximizes output of emission-free, renewable electricity while minimizing the impact of incidental take on the Covered Species (Section 5.2).

Measures that will be used to meet these goals and objectives, and the criteria that will be used to evaluate their success, are described in the following sections.

5.2 Measures to Avoid and Minimize the Impact of the Taking

5.2.1 Avoidance through Project Design and Planning

The Applicant followed a tiered evaluation process similar to the process outlined in the *USFWS Land-Based Wind Energy Guidelines* (USFWS 2012c) to assess potential impacts of the Project. Pre-construction surveys did not indicate summer risk to the Covered Species on-site, and the Project was situated in a primarily agricultural landscape to avoid impacts to forested bat habitat. Furthermore, the Project turbines were setback a minimum of 0.8 km (0.5 mi) from Flat Rock Creek to avoid potential summer habitat for Indiana bats.

Tree removal for Project construction was limited to November 1 – March 14 to avoid take of summer-roosting bats that are not Covered Species, as well as to avoid take of Covered Species that may roost during migratory stopover. Turbine commissioning during nighttime hours occurred outside of March 15 – May 15 and August 1 – October 31 to avoid collision fatalities of the Covered Species, following guidance in the TALs issued for TR-II, TR-III, and TR-IV.

When the Project reaches the end of its useful life, estimated at a minimum of 30 years, the Applicant will decide whether to decommission or recommission the Project. If the Project is decommissioned, take of Indiana bats or northern long-eared bats is not likely because the same seasonal and time-of-day restrictions for turbine operation during commissioning as detailed in the TALs (USFWS 2014c, 2015e, 2019b) will be applied. If the Project is recommissioned, the Applicant may renew the ITP if the incidental take limit has not been reached, apply for a new ITP, or operate in a manner that avoids take of ESA-listed species.

5.2.2 Minimization through Project Operations

The Applicant will minimize the impact of take of the Covered Species resulting from turbine operation by adjusting how turbines operate during seasons when take is expected. As discussed in Sections 4.2.3 and 4.3.3 and summarized in Table 4.2, over the 30-year ITP term, the Applicant will:

1) Raise the cut-in wind speed to 3.5 m/s during the spring migration season (April 1 – May 15) and raise the cut-in speed to 5.0 m/s during the fall migration season (August 1 – October 15), the periods of expected collision risk for the Covered Species in the Permit Area.

2) Adjust the turbine operational parameters so that the rotation of the turbine rotors below cut-in wind speed is minimized (i.e., feather the turbine blades). Feathering of turbine blades below cut-in wind speeds will be implemented on a nightly basis from 0.5 hour before sunset to 0.5 hour after sunrise, adjusted for sunset/sunrise times weekly, from April 1 to May 15 and August 1 to October 15 annually. The only exception to feathering turbine blades under these conditions would be when temperatures are below 10°C, as risk to the Covered Species is expected to be low when temperatures are below this threshold.

The TALs for TR-II, TR-III and TR-IV (USFWS 2014c, 2015e, 2019b) define the spring and fall migration curtailment periods as March 15 – May 15 and August 1 – October 31, respectively, those dates are intentionally conservative as the TAL identifies measures intended to ensure avoidance of take of the Covered Species. The intention of this HCP is not to avoid take of the Covered Species, but to minimize and mitigate the impact of the take to the maximum extent practicable. Thus, the curtailment periods included in this HCP adhere to actual observed and established periods of core migratory activity described in Section 3.4.3, which is consistent with the requirement to minimize and mitigate the impact of take to the maximum extent practicable.

During the seasonal curtailment windows, turbines will be monitored and controlled individually based on the wind speed that each records. In other words, operational adjustments will be made based on wind speed conditions specific to each turbine[16] and not to the Project as a whole. Based on the Project's turbine operation algorithms, turbines will begin operating normally (i.e., not feathered) when the 2-minute minimum wind speed is above the cut-in wind speed (3.5 m/s in spring and 5.0 m/s in fall). Turbines will be feathered again if the 5-minute maximum wind speed goes below the cut-in wind speed during the course of the night. Feathering turbine blades below 3.5 m/s in spring and 5.0 m/s in fall is expected to adequately minimize the impact of take, and reduce bat fatalities by at least 50%, based on the operational adjustment studies listed in Table 4.2.

Even within the seasonal curtailment windows, turbines will not be feathered when the temperature is less than 10°C. Below that threshold turbines will be allowed to operate at full capacity (refer to Section 3.2.2.5 for justification of temperature threshold). As with wind speed, feathering will be applied to individual turbines based upon the temperature reading at each turbine, not at the Project as a whole. Turbines will operate normally when the 5-minute rolling average of temperature drops below 10˚C; and feathering will be resumed when the 5-minute rolling average of temperature exceeds 10˚C during nighttime hours, if the wind speed is below the cut-in speed.

Temperatures at the Project are not expected to drop below 10˚C at night during the spring and fall migration periods very often; much less often than wind speeds are expected to be below the seasonal cut-in speeds. Thus, feathering turbine blades below 3.0 m/s in spring and 5.0 m/s in fall when temperature is above 10°C is expected to adequately minimize the impact of take, and reduce bat fatalities by at least 50%, based on the operational adjustment studies listed in Table 4.2.

5.3 Measures to Mitigate the Impact of the Taking

As described above, the Applicant will implement operational practices that are expected to reduce mortality of the Covered Species, thus minimizing the impact of take. However, some

[16] Each Project turbine is equipped with two well-calibrated wind sensors; if one sensor fails, the turbine will usually send out a warning signal. Additionally, the Project runs automated and manual power curve algorithms periodically, and any issues with the wind sensors would be reflected in a turbine's power curve. Lastly, technicians inspect Project turbines on a regular schedule, and if sensors are not functioning correctly they are replaced during the inspection.

incidental mortality is still expected to occur. Incidental take of the Covered Species with minimization is predicted to be 276 Indiana bats and 64 northern long-eared bats over the 30-year ITP term (Tables 4.1 and 4.4, Sections 4.2.3 and 4.3.3). Using the appropriate USFWS REA Models (USFWS 2016b, USFWS 2016f), the impact of this taking is calculated to be 538 female Indiana bats and 81 female northern long-eared bats (Tables 4.1 and 4.4, Sections 4.2.5 and 4.3.5). Thus, the Applicant will coordinate and provide funding for mitigation that offsets the loss of 538 female Indiana bats and 81 female northern long-eared bats.

Because the Applicant intends to implement mitigation that offsets the impact of take for both of the Covered Species, the total number of bats requiring mitigation (i.e., mitigation debit) will be calculated using a stacking discount of 10% per species, applied per USFWS guidance. The calculation entails the following steps:

1) Increase the northern long-eared bat impact of take by 10%
2) Use the Northern Long-Eared Bat REA model and/or the USFWS *Guidelines for Non-REA Staging/Swarming Mitigation Option* (Non-REA Guidelines; USFWS 2018b), based on the anticipated type of mitigation project, to determine the number of acres necessary to offset the adjusted northern long-eared bat impact of take
3) Use the Indiana Bat REA model and/or the Non-REA Guidelines, based on the anticipated type of mitigation project, to calculate the number of Indiana bat credits produced by that number of acres
4) Calculate 10% of the number of Indiana bats produced
5) Calculate the total Indiana bat debit by adding the 10% of the Indiana bats produced to the original Indiana bat impact of take
6) The total mitigation debit is the number of northern long-eared bats in #1 and the number of Indiana bats in #5; mitigation crediting calculations do not require additional stacking adjustments

Using this methodology, the mitigation debit that will be incurred based on the total impact of take authorized under this HCP (538 female Indiana bats and 81 female northern long-eared bats) is as follows:

1) 81 northern long-eared bats * 110% = 89 northern long-eared bats
2) Assuming protection of summer roosting and foraging habitat, the northern long-eared bat REA model indicates that 100 acres are necessary to offset 89 northern long-eared bats
3) Also assuming protection of summer roosting and foraging habitat, the Indiana bat REA model indicates that 100 acres produces 72 Indiana bats
4) 72 Indiana bats * 10% = 7 Indiana bats
5) The total Indiana bat debit = 538 Indiana bats + 7 Indiana bats = 545 Indiana bats
6) The total mitigation debit for this HCP = 89 northern long-eared bats and 545 Indiana bats; mitigation crediting calculations do not require additional stacking adjustments

This calculation will be repeated each time the mitigation credit balance is calculated, which will generally occur every six years as described in Section 5.3.1.

5.3.1 Mitigation Project Implementation Schedule

Section 9.4.9 of the HCP Handbook recommends that the timing of mitigation implementation should prevent any lag time between the occurrence of the impacts of the taking and the realization of mitigation benefits to offset the impacts. However, the Handbook acknowledges that this objective may not be possible in every instance, and it stipulates that where lag time occurs, the type and level of additional impacts occurring during the delay must be determined and offset as well. The USFWS REA models are designed to account for differences between the start of impact of take and the start of mitigation by adjusting the amount of mitigation required to offset the impact of take. The Applicant intends to implement its initial mitigation project as soon as practicable, but it may not be possible to avoid a lag between ITP issuance and mitigation project implementation due to the timing of ITP issuance (e.g., if the ITP is issued after the season for summer presence/absence surveys, which could delay implementation of a summer habitat protection project), as well as the potential for unforeseen logistical constraints associated with implementing a mitigation project.

To account for logistical constraints, the Applicant will have a period of one year from the issuance of the ITP to complete implementation of sufficient mitigation as determined by the REA models to offset approximately 50% of the impact of the total taking authorized to occur as a result of Project operations over the full term of the ITP. Thus, by the end of Year 1 of the ITP, the Applicant will have provided mitigation to offset the full impact of take expected from approximately the first 15 years of Project operations. This initial supply of mitigation credits (the “Mitigation Deposit”) will serve to set the Project’s mitigation account ahead of the take going forward, providing a conservation “cushion”, as suggested in section 9.4.10 of the HCP Handbook. It is possible that the Applicant may need an extension on the mitigation timeline in the event of unforeseen logistical constraints that prevent timely implementation of the mitigation projects. An example of a constraint that would qualify as requiring an extension of the mitigation timeline is the unwillingness of landowner(s) to sign the necessary conservation easement(s) for a summer habitat protection project. Any written request for an extension will: 1) include an assessment of the impact of the time lag in benefits being provided by the mitigation, 2) identify the increase in funding needed (if any) to assure additional mitigation required to compensate for the loss of benefit to the species due to the lag in mitigation implementation, and 3) describe how the applicant will provide the additional assurances (if any) within 30 days of an extension approval. In such an event, the Applicant would request a written extension from the USFWS.

In preparation for this commitment, the Applicant has contracted with a mitigation entity to implement the Mitigation Deposit. The mitigation entity is in the process of identifying specific mitigation parcels for that purpose.

To ensure that mitigation remains ahead of the take during the ITP term, the Applicant will evaluate ongoing mitigation needs in a series of increments, or tranches. The duration of these tranches will coincide with the intervals between years of standardized monitoring, as illustrated in Table 5.1 and described in Section 5.3.1.1 below. Years 1-3 of the ITP (in which standardized monitoring will be performed each year) will comprise the initial tranche. Subsequent tranches will initially be six years in duration, as standardized monitoring is scheduled to be performed every six years beginning in Year 9. However, the duration of subsequent tranches could change if adaptive management actions are implemented that change the schedule of standardized monitoring.

The Applicant will maintain a ledger of mitigation debits and credits that will be updated after each mitigation tranche, with the Mitigation Deposit serving as the initial entry. A separate ledger will be maintained for each of the Covered Species, because of different predicted take levels and differences in the credits that individual mitigation projects provide to each Covered Species. The following section explains the tranche method in more detail.

Table 5.1. Tranche schedule and method for assuring that mitigation remains ahead of the impact of the take.

Tranche	Years	Mitigation Credit at Beginning of Tranche	Projected Mitigation Debit	Actual Mitigation Debit	Trigger for Mitigation Implementations
Initial	1-3	By the end of Year 1, the Applicant aims to make a Mitigation Deposit of USFWS-approved mitigation credits that offset ~50% of the impact of the ITP-authorized take.	The projected debit is based on the impact of the predicted take for three years, i.e., 63 Indiana bats (Table 4.1) and 9 northern long-eared bats (Table 4.4).	The actual debit is determined at the end of the tranche based on the EoA estimate of the median cumulative take in Years 1-3, calculated from standardized monitoring in those years. REA models are applied to calculate the impact of the estimated take. A stacking discount of 10% is applied where the same acres offset the impact of the take for both Covered Species.	The Mitigation Deposit is triggered by the issuance of the ITP.
Second	4-9	The Mitigation Deposit minus the actual mitigation debit calculated for the initial tranche.	The projected debit is the median annual take rate estimated in EoA based on standardized monitoring in Years 1-3, multiplied by 6 years.	Same as the initial tranche except that the median cumulative take is estimated for Years 1-9.	If mitigation credits for either Covered Species are projected to run out before Year 9, then the Applicant will contract with a mitigation entity to secure sufficient mitigation credits to remain ahead of the impact of take.
Third	10-15	The Mitigation Deposit minus the actual mitigation debit calculated for the first two tranches.	The projected debit is the median annual take rate estimated in EoA based on standardized monitoring in Years 4-9, multiplied by 6 years	Same as the initial tranche except that the median cumulative take is estimated for Years 1-15.	If mitigation credits for either Covered Species are projected to run out before Year 15, then the Applicant will contract with a mitigation entity to secure mitigation credits to remain ahead of the impact of take.

Table 5.1. Tranche schedule and method for assuring that mitigation remains ahead of the impact of the take.

Tranche	Years	Mitigation Credit at Beginning of Tranche	Projected Mitigation Debit	Actual Mitigation Debit	Trigger for Mitigation Implementations
Fourth	16-21	The Mitigation Deposit plus any subsequent mitigation credits from additional mitigation project(s) minus the actual mitigation debit calculated for the first three tranches.	The projected debit is the median annual take rate estimated in EoA based on standardized monitoring in Years 10-15, multiplied by 6 years	Same as the initial tranche except that the median cumulative take is estimated for Years 1-21.	If mitigation credits for either Covered Species are projected to run out before Year 21, then the Applicant will contract with a mitigation entity to secure sufficient mitigation credits to remain ahead of the impact of take.
Fifth	22-27	The Mitigation Deposit plus any subsequent mitigation credits from additional mitigation project(s) minus the actual mitigation debit calculated for the first four tranches.	The projected debit is the median annual take rate estimated in EoA based on standardized monitoring in Years 16-21, multiplied by 6 years	Same as the initial tranche except that the median cumulative take is estimated for Years 1-27.	If mitigation credits for either Covered Species are projected to run out before Year 27, then the Applicant will contract with a mitigation entity to secure sufficient mitigation credits to remain ahead of the impact of take.
Final	28-30	The Mitigation Deposit plus any subsequent mitigation credits from additional mitigation project(s) minus the actual mitigation debit calculated for the first five tranches.	The projected debit is the median annual take rate estimated in EoA based on standardized monitoring in Years 22-27, multiplied by 3 years.	Same as the initial tranche except that the median cumulative take is estimated for Years 1-30.	If mitigation credits for either Covered Species are projected to run out before Year 30, then the Applicant will contract with a mitigation entity to secure sufficient mitigation credits to remain ahead of the impact of take.

EoA = Evidence of Absence, ITP = Incidental Take Permit

5.3.1.1 Mitigation Tranche Process

Note that there will be six tranches (Table 5.1): initial (Years 1-3), second (Years 4-9), third (Years 10-15), fourth (Years 16-21), fifth (Years 22-27), and final (Years 28-30), but as noted, the number and duration of tranches may change if adaptive management is triggered.

For the initial tranche under this HCP (Years 1-3 of the ITP), the following steps will be followed:

1. The mitigation requirement will be set based on the impact of the predicted take for the first three years of Project operation under the ITP.
    a. *Note: The impact of the predicted take during Years 1-3 is less than 12% of the impact of the total authorized take, namely, 63 Indiana bats (Table 4.1) and nine northern long-eared bats (Table 4.4). The Mitigation Deposit of approximately 50% of the impact of the total authorized take is more than sufficient to cover this.*
2. Once the initial tranche is complete, fatality monitoring data from the initial tranche will be evaluated using EoA to generate the median cumulative estimates for each Covered Species of the take that actually occurred in Years 1-3.
3. The take estimates from step 2 will be inputted into the appropriate REA models to determine the impact of the take for each Covered Species for Years 1-3.
4. The REA-derived impact of the take for each Covered Species will be adjusted by the 10% per-species stacking discount and deducted in the mitigation ledger to reflect the mitigation credits applied for the initial tranche.

For the second tranche under this HCP (Years 4-9 of the ITP), the steps are similar to the initial tranche except that the median annual take rate calculated in the previous tranche is the basis for the predicted take during the second tranche. Thus, the steps are:

1. At the onset of the second tranche, take will be predicted for the second tranche by projecting the median annual take rate in Years 1-3 over Years 4-9 (by multiplying that rate by six years). The impact of this predicted take will be calculated using the REA, and the output from the REA model will be compared against the credit remaining on the ledger to verify mitigation provides sufficient coverage.
    a. *Note: To ensure that mitigation remains ahead of take, if mitigation is not sufficient to cover the impact of the take predicted for the second tranche*[17]*, additional mitigation project(s) will be implemented prior to the date when the remaining balance in the mitigation ledger is projected to no longer be sufficient. If future mitigation projects are executed, they will be added to the credit side of the mitigation ledger.*

[17] This is not expected to occur in the second tranche given the amount of the Mitigation Deposit, but it may occur in later tranches.

2. After the second tranche is complete, fatality monitoring data from the second tranche will be evaluated using EoA to generate the median cumulative estimates for each Covered Species of the take that actually occurred in Years 1-9.
3. The take estimates from step 2 will be inputted into the appropriate REA models to determine the impact of the take for each Covered Species for Years 1-9. The REA outputs will be adjusted by the 10% per-species stacking discount.
4. The difference between the new stacked cumulative[18] impact of take since Year 1 and the prior stacked cumulative impact of take will be deducted in the mitigation ledger for each species, thus resulting in the mitigation credit applied for the second tranche.

For the third and all subsequent mitigation tranches during the permit term, the process described for the second tranche will be repeated.

5.3.2 Mitigation Project Selection, Evaluation, and Approval

5.3.2.1 Categories and Requirements for Mitigation Projects

The HCP Handbook states, "[m]itigation measures in the HCP must be based on the biological needs of covered species and should be designed to offset the impacts of the take from the covered activities to the maximum extent practicable" (USFWS and NMFS 2016). To identify the types of mitigation measures that would be appropriate for this HCP, the Applicant referred to the 1983 Indiana bay Recovery Plan and the 1999 draft Indiana bat Recovery Plan. These Recovery Plans identify as Priority 1 actions those actions that are most important and effective for recovery or reclassification of the Indiana bat. Specifically, Priority 1 actions for the Indiana bat include hibernacula- and summer habitat-related recovery actions as well as those actions "that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future" (USFWS 2007a, p. 172). Although the USFWS has not yet developed a recovery plan for northern long-eared bats, it has issued an Interim Conference and Planning Guidance for the species (USFWS 2014a). Based on the similarity in habitat requirements of, and threats to, northern long-eared bats as Indiana bats, the USFWS generally refers to the same recovery action priorities to determine appropriate types of mitigation projects for both species.

The USFWS developed the REA models and the Non-REA Guidelines to help applicants arrive at effective mitigation projects and identify minimum required elements for those projects. The REA models and the Non-REA Guidelines identify four general types of mitigation projects for which mitigation credits may be earned. To satisfy its mitigation obligation under this HCP, the Applicant has committed to implement mitigation projects that fit one or more of those four types. In addition, in consultation with the USFWS, the Applicant has identified certain minimum required elements for a mitigation project to be eligible for consideration under this HCP.

[18] Cumulative impact of take is calculated anew after each tranche for all ITP years to date

The following is a list of the four categories of acceptable mitigation under the REA models and the Non-REA Guidelines, including an explanation of how the Applicant will prioritize and evaluate potential projects and the minimum required elements for projects of each type:

Protection of an occupied hibernaculum – Mitigation credits would accrue from protecting a cave or mine occupied by Indiana bats and/or northern long-eared bats within two years before the mitigation is proposed. Protection strategies may include the installation of bat-friendly gates at all entrances, stabilization of the hibernaculum structure (e.g., an unstable mine shaft) and/or regulation of a hibernaculum's temperature. Hibernacula deemed priorities would be those that have a documented history of human disturbance, have large numbers of hibernating bats that are susceptible to disturbance or non-disturbance threats (such as unstable mine shafts), or demonstrate resilience to WNS. In general, hibernaculum projects are designed to protect, and improve the overwinter survival of, hibernating bats by protecting or enhancing hibernation habitat.

If the land surrounding the hibernaculum (out to 0.40 km [0.25 mi]) is not protected for conservation (by conservation easement or owned by a state or federal wildlife agency or by a conservation non-profit), the project must entail protection of that land, in perpetuity, through a conservation easement or similarly effective mechanism. If the hibernaculum is vulnerable to anthropogenic harm through multiple access points, all access points must be protected. Any gates installed on the hibernacula would be annually monitored over the life of the ITP to ensure they remain clear of debris, have not been vandalized, and remain functional.

Protection of occupied summer maternity colony habitat – Suitable summer habitat parcel(s) would qualify for mitigation credits if protected in perpetuity by conservation easement or similarly effective mechanism. To be eligible as mitigation, habitat parcels must be located within the home range (as defined in current USFWS guidance) of a maternity colony of Indiana bats or northern long-eared bats, with use by the relevant species documented within ten years before the parcel is proposed for use as mitigation. Parcels may include roosting and foraging habitat as well as travel corridor habitat (i.e., habitat that connects forest patches), provided that, to qualify for credits for these functions, such habitat must meet all of the requirements for each habitat function defined in the applicable USFWS REA model. While the mitigation may be a mix of several different categories (i.e., preservation, restoration, or hibernacula protection), should the mitigation be solely summer habitat preservation it would entail the preservation of a maximum of 754 acres of occupied roosting and foraging habitat to offset the total impact take for Indiana bats and northern long-eared bats based on the REA (USFWS 2016b, 2016g; see Appendix C for REA calculations). This assumes that the proposed mitigation site(s) is entirely within known Indiana and northern long-eared bat maternity home ranges. Enhancement of the habitat (e.g., tree girdling and installation of artificial roosting substrate) may also be part of a mitigation project of this type. Habitat enhancement will be identified during a due-diligence habitat survey that precedes land acquisition. To ensure a mature forest canopy, woody invasive species will be managed so that they will not exceed 10% of the understory vegetation throughout the term of the permit. During the Applicant's evaluation of potential mitigation parcels with the mitigation entity, in coordination with the USFWS, high-quality summer habitat at risk of development or vandalism, or habitat connected to other areas of suitable or protected habitat, will be prioritized for selection as mitigation projects. In general, summer habitat protection projects are designed to improve the survival and reproduction rates of maternity colonies by removing threats from occupied habitat. The habitat will be evaluated annually to ensure it remains suitable, has not been vandalized, and has not been compromised by a natural disaster.

Restoration of occupied summer maternity colony habitat – Habitat suitable to be restored as roosting, foraging, or travel corridor habitat within the home range of a maternity colony of either or both Covered Species qualifies for mitigation credits if use by that colony has been documented within ten years before the habitat parcel is proposed as mitigation. If not already protected, the habitat parcel will be protected in perpetuity under a conservation easement or similarly effective mechanism. While the mitigation may be a mix of several different categories (i.e., preservation, restoration, or hibernacula protection), should the mitigation be solely restoration of occupied summer maternity colony habitat, it would entail the restoration of a maximum of 3,032 acres[19] of roosting and foraging habitat (if existing % forest cover is between 51% and 75%) to offset the total impact of the take for Indiana bats and northern long-eared bats based on the REA models (USFWS 2016b, 2016g; see Appendix C for REA model calculations). This assumes that the proposed mitigation site(s) is entirely within known Indiana and northern long-eared bat maternity home ranges. Marginal or low-quality habitat (i.e., existing forest cover is less than 50%) that is suitable for restoration and located near, or connected to, other areas of suitable or protected habitat will be prioritized for selection as restoration mitigation projects. In general, summer habitat restoration projects are designed to improve the survival and reproduction rates of maternity colonies by increasing the amount of suitable habitat available. Trees would be planted at a minimum spacing of 3 m by 3 m (10 ft by 10 ft) to yield 436 trees per restored acre. The tree species selected would be native species matching the composition of nearby mature forests and site-specific characteristics (e.g., soil moisture, sun exposure, etc.). A minimum of eight of the tree species listed in Table 5.2 will be planted to restore and/or enhance Indiana bat and northern long-eared bat habitat. At least 30% of the planting will consist of native oak species, with at least 10% of plantings composed of one or a combination of loose bark species (e.g., shagbark or shellbark hickory, bur oak, eastern cottonwood, swamp white oak, silver maple). The remainder of the planting will be other native, adapted hardwood species selected from Table 5.2. Tree species will be distributed randomly throughout the restoration site to avoid clusters of like species. To ensure the development of a mature

[19] These acres offset the impact of the take based on the predicted take (see Chapter 4). The actual impact of the take, and the acres required to offset it, will be calculated from the cumulative take estimate derived from compliance monitoring.

forest canopy, woody invasive species will be managed so that they will not exceed 10% of the understory vegetation throughout the term of the permit.

Table 5.2. Tree species to be considered for planting in habitat restoration projects.

Birch, river (*Betula nigra*)	Oak, red (*Quercus rubra*)
Cherry, black (*Prunus serotina*)	Oak, scarlet (*Quercus coccinea*)
Coffeetree, Kentucky (*Gymnocladus dioicus*)	Oak, shingle (*Quercus imbricaria*)
Cottonwood, eastern (*Populus deltoides*)	Oak, Shumard (*Quercus shumardii*)
Hickory, shagbark (*Carya ovata*)	Oak, swamp chestnut (*Quercus michauxii*)
Hickory, shellbark (*Carya laciniosa*)	Oak, swamp white (*Quercus bicolor*)
Maple, red (*Acer rubrum*)	Oak, white (*Quercus alba*)
Maple, silver (*Acer saccharinum*)	Persimmon (*Diospyros virginiana*)
Oak, black (*Quercus velutina*)	Sweetgum (*Liquidambar styraciflua*)
Oak, bur (*Quercus macrocarpa*)	Sycamore (*Platanus occidentalis*)
Oak, chestnut (*Quercus prinus*)	Tuliptree (*Liriodendron tulipifera*)
Oak, chinquapin (*Quercus muehlenbergii*)	Walnut, black (*Juglans nigra*)
Oak, pin (*Quercus palustris*)	

Travel corridors linking roosting and foraging habitats are an important feature of bat habitat. Should the restoration project involve establishing travel corridors, a minimum travel corridor of three rows of trees will be planted to establish a suitable travel corridor at least 9.1 m (30.0 ft) wide. Priority will be given to restoring riparian habitat along existing stream corridors, particularly streams that have not been channeled, as these would provide both travel corridors and foraging habitats.

Additional restoration actions may include a combination of tree girdling, installation of artificial roosting substrate, pond construction, and wetland restoration. Deviations from this plan may be proposed but require USFWS approval.

Restored habitat will be monitored biennially to assess progress toward the establishment of suitable maternity colony habitat for either or both Covered Species. This includes achieving a 75% survival success of trees per acre in restoration plantings. Once suitable habitat conditions have been achieved, the mitigation site will be monitored annually to ensure it remains suitable, has not been vandalized and/or compromised by a natural disaster.

Protection of occupied swarming habitat – To be eligible as mitigation, swarming habitat must be located within the swarming distance (as defined in current USFWS guidance) of a hibernaculum occupied by either or both Covered Species in the two years prior to the habitat parcel being proposed as mitigation. Suitable swarming habitat would qualify for mitigation credits if protected in perpetuity by conservation easement or similarly effective mechanism. Swarming habitat may overlap suitable summer maternity colony habitat, in which case, the credit would be calculated using both the appropriate REA model(s) and the Non-REA Guidelines. Enhancement of the habitat (e.g., tree girdling, installation of artificial roosting substrate, management of invasive vegetation) may also be part of a mitigation project of this type. Priority mitigation projects will include high-quality roosting and foraging habitat at risk of development or vandalism, habitat connected to other areas of suitable or protected habitat, and habitat within the swarming distance of high-priority hibernacula. In general, swarming habitat protection projects are designed to improve overwinter survival by protecting habitat where the Covered Species forage to accumulate fat reserves that allow them to survive hibernation.

The habitat will be monitored annually according to the approved habitat management plan to ensure it remains suitable roosting and foraging habitat for either or both Covered Species, has not been vandalized, and has not been affected by a natural disaster.

In addition to the requirements for each type of mitigation project identified above, the Applicant must meet the following requirements for all mitigation projects for which credit is to be granted under this HCP:

1) Must be supported by a threats analysis of the hibernaculum, swarming habitat, or summer maternity habitat that indicates that human activity or other disturbances (e.g., likely land-use change) presents a threat of partial or total loss of the habitat or disturbance to bats using the habitat;
2) If roosting, foraging, and/or travel corridor habitat is to be used for mitigation, it must meet all of the requirements for each habitat function defined in the USFWS REA models specific to each Covered Species;
3) Must ensure that a landowner (public or private) of the hibernaculum, swarming habitat, or summer maternity habitat is willing to have the project implemented, and involve a third-party conservation entity that is capable of ensuring protection of the habitat in perpetuity;
4) Must grant the USFWS and state wildlife agency access to the mitigation site to monitor bat populations and habitat use, at such intervals and for such purposes as the agencies may deem necessary;
5) Must ensure funding for implementation and maintenance of the mitigation project;
6) Must implement all mitigation work (e.g., cave gating, habitat restoration) in a manner approved in advance by the USFWS as not likely to result in take of the Covered Species.
7) Must convey subsurface rights with the purchase or protection of the property.
8) Mitigation projects to be considered will be located in Ohio to the maximum extent practicable, but highly desirable projects located in the MRU but outside of Ohio may also be considered with approval of the USFWS and the ODNR.

Notwithstanding these requirements for acceptable mitigation projects, the Applicant retains the right to use USFWS-certified conservation mechanisms, such as banks or the Range-Wide Indiana Bat In-Lieu Fee (“ILF”) Program, as an alternative form of mitigation. If the Applicant elects to use the ILF Program or another available conservation bank to satisfy some or all of its mitigation obligation, the above criteria would not apply and the operator of the conservation bank would have discretion to direct the funding provided by the Applicant to any mitigation project meeting the approved conservation bank’s requirements. Any conservation bank that utilizes the

USFWS template conservation bank agreement would be required to obtain USFWS approval to issue credits for use under an ITP.

5.3.2.2 Procurement and Evaluation Process

The Applicant has executed a contract with a mitigation entity to provide enough bat credits to cover approximately 50% of the mitigation required under this HCP through one or more mitigation parcels located in Ohio. Once the mitigation parcel(s) are selected by the Applicant and its contracted mitigation entity, the parcel will be presented to USFWS for approval, as discussed in Section 5.3.2.3.

To meet subsequent mitigation requirements under this HCP, the Applicant will conduct one or more additional Request for Proposals (RFP) processes. Through these RFPs, the Applicant will select one or more qualified conservation entities (e.g., private conservation organizations, land trusts, or conservation banks) to execute one or more projects on a timeline that meets the requirements of section 5.3.1.1. Mitigation projects to be considered will be located in Ohio to the maximum extent practicable, but highly desirable projects located in the MRU but outside of Ohio may also be considered with approval of the USFWS and the ODNR. The RFPs will seek information from mitigation providers that allows the Applicant to evaluate each project and the organization's ability to execute it. Information requested will include:

- project location (including detailed maps),
- type of project,
- acreage amount,
- how the project meets the specifications and criteria set forth in this HCP,
- how mitigation lands will be legally and physically protected and managed in perpetuity,
- how the project will address threats that are reasonably certain to occur (e.g., human disturbance, encroachment, climate change, natural disasters),
- how the mitigation provider will maximize high-quality acreage within cost constraints,
- why the mitigation provider is qualified to execute the project, what track record the mitigation provider has in executing similar projects,
- how the mitigation provider will meet the schedule for project delivery,
- how the mitigation provider will report the effectiveness of the project in meeting mitigation objectives,
- how the project will provide additional conservation value, and other relevant information,
- how the mitigation provider will ensure management of the mitigation lands in perpetuity, and
- confirmation that any conservation easement or similarly effective instrument on the mitigation lands will include the restrictions and reserved rights recommended for Indiana bat and northern long-eared bat in the USFWS Region 3's example conservation easement template (USFWS 2016c).

Based on the responses received to the RFP, the Applicant may select one or more qualified mitigation entities to provide projects that meet the specified criteria. Finalists among the responding mitigation entities will be evaluated based on their responses to each of the questions outlined above and in the RFP. These measures will help to ensure that whatever conservation entities are chosen have the capacity to meet mitigation goals. Once a mitigation entity is selected by the Applicant, the Applicant and the mitigation entity will work to select the mitigation parcel(s) to be presented to USFWS for approval, as discussed in the section that follows.

5.3.2.3 Approval of Mitigation by the US Fish and Wildlife Service

After the Applicant has selected a specific mitigation parcel(s) through the RFP process and in accordance with the procurement and evaluation criteria set forth above, the Applicant will determine the mitigation credit value of the proposed parcel(s). As directed by the USFWS, the Applicant will use the applicable USFWS REA model to calculate credits for specific mitigation parcel(s) and a stacking discount of 10% per species will be applied, per USFWS guidance, to adjust the credit for any project providing mitigation credit for both Covered Species. These credits represent the expected gains in reproduction resulting from habitat protection and restoration. The credits offset the expected debits, which are the impacts of the taking, measured in female bats and lost reproductive capacity. Note that credits accumulate at different rates for the Covered Species because of differences in demographic parameters.[20] The only exceptions to using the REA models would be: (1) in circumstance where the unique quality of the project is more adequately represented by a supplemental approach to the REA (e.g., for a swarming habitat protection project, the Non-REA Guidelines would be used); or (2) in the event a USFWS-approved conservation bank or in-lieu fee program is available for the Covered Species (e.g., the Range-Wide Indiana Bat In-Lieu Fee Program), as a bank would already have a mitigation valuation system established.

The Applicant will submit the proposed mitigation parcel(s) and credit calculation to the USFWS. The USFWS will review the proposal to confirm that parcel(s) meets all applicable requirements and criteria set forth in this HCP and relevant USFWS guidance. The USFWS also will verify the Applicant's calculation of the credit value of the proposed parcel(s). The USFWS will promptly notify the Applicant of any deficiencies in the proposal or disagreement with the mitigation credit calculation, and the USFWS and the Applicant will work to resolve any such issues, in coordination with the mitigation services provider as needed. Upon confirmation that a proposal (as revised if necessary) meets the relevant criteria and the mitigation credit value has been properly established, the USFWS will approve the proposed mitigation parcel(s).

Following USFWS approval of the mitigation parcel(s), the Applicant will direct the mitigation service provider that presented the project to prepare a habitat management plan for the mitigation parcel(s) that meets all criteria set forth in this HCP and relevant USFWS guidance. Further detail regarding habitat management plan development is provided in section 5.4.2. The

[20] If both species benefit from a particular mitigation project, then a stacking discount of 10% will be applied per USFWS guidance to adjust the credits for the Covered Species, as described at the outset of this section 5.3 above. It is anticipated that mitigation projects also will provide conservation benefits to little brown bats and tri-colored bats, both of which are under status review by the USFWS.

habitat management plan will be submitted to the USFWS for review and approval prior to implementation of the mitigation project.

5.4 Monitoring and Adaptive Management

This HCP includes a monitoring program that ensures both take limit compliance and mitigation effectiveness. Results of monitoring may trigger adaptive management to adjust conservation management actions, if necessary, to meet this HCP's biological goals and objectives (Section 5.1) and ensure compliance with the authorized level of take in the ITP. The monitoring program also includes reporting requirements to keep the USFWS apprised of monitoring results and adaptive management decisions.

5.4.1 Compliance Monitoring

The primary objective of compliance monitoring is to estimate Covered Species take that has occurred as a result of collision with operating turbines in order to evaluate compliance with the ITP. Results of compliance monitoring will be the basis for adaptive management decisions. Carcasses of the Covered Species may never be found during the ITP term, because available fatality monitoring studies demonstrate that their fatalities are rare events. However, the proposed monitoring plan accounts for this by using statistical estimators to track cumulative take of Covered Species throughout the ITP term. If new information becomes available to suggest improved methods for estimating bat fatalities, the Applicant may coordinate with the USFWS to determine if it is appropriate to adopt a new take estimation method. Although this monitoring plan has been designed specifically to track cumulative take of Covered Species, all bat carcasses found during monitoring will be recorded and a summary of the bat carcasses found will be included in the monitoring reports. However, fatality rates will not be estimated for non-listed bats as part of the HCP monitoring plan because they do not inform the evaluation of ITP compliance.

The Applicant has designed compliance monitoring to occur in intervals so that robust data providing high confidence in the take estimates are collected throughout the ITP term. As noted in Section 3.5, populations of the Covered Species have declined significantly due to WNS. They may continue to decline, or they may stabilize and begin to recover. If populations of the Covered Species begin to recover, the recovery will be gradual, given *Myotis* life history parameters. The effect of population trends on estimated take from the Project, therefore, is likely to be small and incremental. Thus, robust monitoring will be required to detect trends, but is appropriately conducted in intervals because substantial variation in take is not expected from year to year. For example, fatality monitoring over eight years at the FRWF, both before and after issuance of an ITP, has shown a consistent bat fatality rate without pronounced swings in Indiana bat or northern long-eared bat fatalities (Johnson et al. 2010a, 2010b; Good et al. 2011, 2012, 2013, 2014, 2016a, 2017).

The monitoring framework described below is based on the objective of monitoring with a probability of detection sufficient to produce an estimate of zero take if no carcasses of the Covered Species are detected. This provides a fundamental level of confidence in the monitoring data. Data collected with the proposed probability of detection provide an accurate assessment of the actual take occurring at a site and are optimally useful for evaluating compliance with an ITP. Therefore, the Applicant's proposed monitoring framework achieves a level of monitoring sufficient to provide data that support an accurate evaluation of compliance with the ITP on an interval appropriate for detecting the potential trends in Covered Species take over the ITP term.

5.4.1.1 Monitoring Protocol and Schedule

The Applicant proposes to conduct compliance monitoring according to the framework set forth in Table 5.3. As noted, monitoring will be conducted in intervals throughout the 30-year ITP term according to a standard protocol for post-construction monitoring (see Table 5.4 for an example protocol). This protocol will be updated as necessary to ensure that a target probability of detection (or *g* value) of 0.25 (or 25% detection) is attained each year in the first three years, and then every sixth year thereafter. The probability of detection is sensitive to area searched, searcher efficiency, and carcass persistence. In all other years, the *g* value will be equal to 0.001 (or 0.1% detection), essentially zero, although O&M staff will report carcasses discovered on turbine pads and adjacent access roads when they visit turbines for regular maintenance, in accordance with the Applicant's Wildlife Incident Reporting System (WIRS).

Because there are numerous monitoring protocol designs that can achieve a target *g* value of 0.25, and because the designs that can achieve this *g* value will depend on prior monitoring data and the operational strategy (i.e., cut-in speed) of the Project at the time, the monitoring protocol for each monitoring year will be adjusted at the conclusion of the bias trials conducted in the year preceding the monitoring year. The monitoring protocol for each monitoring year will be submitted for USFWS approval prior to the beginning of the monitoring period. This will allow the Applicant to modify the monitoring protocol as necessary to achieve the target *g* value, while also selecting the most cost-effective or logistically feasible protocol.

The protocol in Table 5.4 serves as an example of the monitoring that may be implemented in Year 1 of the Project. The reason Year 1 monitoring is not fixed at this time is that the results of any monitoring taking place between the writing of this document and when the requested ITP is issued could inform a different monitoring protocol that could achieve a *g* value of 0.25; for example, monitoring conducted in 2019 at the Project may inform site-specific estimates of some of the parameters influencing *g*.

If new information becomes available to suggest improved methods for estimating bat mortality, the Applicant will seek USFWS approval to implement cost effective and logistically feasible changes to the protocol and implementation of applicable new methods, per the New Technology and Information changed circumstance (Section 8.2.4).

In addition to the standardized monitoring, the Applicant will implement routine O&M monitoring for the life of the Project. O&M monitoring will be conducted in accordance with the Applicant's WIRS. The purpose of the WIRS procedure is to standardize and describe the actions taken by site personnel in response to wildlife incidents found at the Project. The Applicant will maintain a record of all bats found incidentally at the Project over the entire life of the Project as part of the

O&M monitoring efforts. If carcasses of the Covered Species are found incidentally, they will be incorporated in the EoA Take estimate analysis with a truncated prior (see Appendix A).

Table 5.3. Compliance monitoring framework for the Timber Road II, III, and IV Wind Farms.

Tranche	Year(s) of ITP	Monitoring	Probability of Detection (*g*)	Purpose
Initial	1-3	Standardized	0.25	Establish baseline take estimates under ITP with *g* = 0.25 to yield an estimate of zero if zero carcasses found and confirm that mitigation remains ahead of estimated take
Second	4-7	O&M	0.001	Document and report Covered Species carcasses found incidentally
Second	8	O&M + carcass removal bias trials	0.001	Adjust study design to achieve a *g* of 0.25 in Year 9 assuming searcher efficiency is similar to Years 1 - 3
Second	9	Standardized	0.25	Update take estimates under ITP and confirm that mitigation remains ahead of estimated take
Third	10-13	O&M	0.001	Document and report Covered Species carcasses found incidentally
Third	14	O&M + carcass removal bias trials	0.001	Adjust study design to achieve a *g* of 0.25 in Year 15 assuming searcher efficiency is similar to Years 1 - 3 and 9
Third	15	Standardized	0.25	Update take estimates under ITP and confirm that mitigation remains ahead of estimated take
Fourth	16-19	O&M	0.001	Document and report Covered Species carcasses found incidentally

Table 5.3. Compliance monitoring framework for the Timber Road II, III, and IV Wind Farms.

Tranche	Year(s) of ITP	Monitoring	Probability of Detection (*g*)	Purpose
Fourth	20	O&M + carcass removal bias trials	0.001	Adjust study design to achieve a *g* of 0.25 in Year 21 assuming searcher efficiency is similar to Years 1 - 3, 9, and 15
Fourth	21	Standardized	0.25	Update take estimates under ITP and confirm that mitigation remains ahead of estimated take
Fifth	22-25	O&M	0.001	Document and report Covered Species carcasses found incidentally
Fifth	26	O&M + carcass removal bias trials	0.001	Adjust study design to achieve a *g* of 0.25 in Year 27 assuming searcher efficiency is similar to Years 1 - 3, 9, 15, and 21
Fifth	27	Standardized	0.25	Update take estimates under ITP and confirm that mitigation remains ahead of estimated take
Final	28-30	O&M	0.001	Document and report Covered Species carcasses found incidentally

ITP = Incidental Take Permit, O&M = operations and maintenance

Table 5.4 Example protocol for Compliance Monitoring that would provide a probability of detection of 0.25 at the Timber Road II, III, and IV Wind Farms.

Monitoring Season	Number of Turbines Searched	Plot Radius	Plot Type	Search Interval
Spring (April 1-May 15)	95	40 m (131 ft)	cleared	twice per week
Spring (April 1-May 15)	39	100 m (328 ft)	road and pad	weekly
Fall (August 1-October 15)	95	40 m (131 ft)	cleared	daily
Fall (August 1-October 15)	39	100 m (328 ft)	road and pad	weekly

5.4.1.2 Monitoring Methods

Two types of searches are proposed: cleared plot and road/pad. Cleared-plot searches will be cleared of crops out to a defined radius, planted with grass, and mowed regularly to maintain grass height at 10 cm (4 in) or less for the purpose of maximizing searcher efficiency in finding carcasses. Those plots, including the roads and pads that occur within them, will be searched by trained technicians (searchers) who walk transects spaced 5 m (16.4 ft) apart at rates of 45 – 60 m (148 – 197 ft) per minute, scanning the ground up to 2.5 m (8.2 ft) from the transect. Road/pad searches, on the other hand, will be conducted only on gravel roads and turbine pads out to a specified search radius.

Data Collection and Processing

All bat carcasses located within the search areas will be recorded. Injured bats will be recorded and treated as fatalities for the purposes of analysis. The following data will be recorded for each carcass: a unique identification code, sex and age when possible, date and time collected, observer, carcass condition (i.e., intact, scavenged, dismembered, or injured), injuries, scavenging, estimated time of death, Universal Transverse Mercator (UTM) location, distance and bearing from the turbine, habitat, and any relevant comments. All carcasses will be photographed as found and plotted on a map of the search area. Bat carcasses will be collected and species identification will be verified by bat biologists permitted by the USFWS and ODNR to survey for Indiana and northern long-eared bats. Skin and tissue samples from bat carcasses too decomposed to be identified by permitted bat biologists will be sent to a qualified lab for identification via DNA sampling. Carcasses found outside of the standardized search area, or within a search area on a day when a scheduled search is not taking place, will be recorded following the above protocol and labeled as incidental finds.

Bias Correction

Two biases affect fatality estimates: 1) searcher efficiency in finding carcasses (detection bias), and 2) carcass persistence in the face of scavenging pressure (removal bias).

Searcher efficiency is quantified using searcher efficiency trials, which estimate the proportion of available carcasses found by searchers. Searcher efficiency trials will be conducted seasonally both in cleared plots and roads/pads so that estimates may be differentiated by search plot type and season. The most appropriate searcher efficiency model will be used to adjust the number of bat carcasses found by those not found.

Searcher efficiency trials will be conducted in each month in which monitoring occurs. The person placing the carcasses will not inform searchers when a trial is being conducted or at which turbines carcasses are placed. A total of approximately 100 bat carcasses and/or bat surrogate carcasses (e.g., mice) will be placed in roughly even numbers across search area types (i.e., approximately four to five carcasses per search area type every other week). Carcasses of non-listed bat species found on-site, or available from other sources, will be used in trials. If an insufficient number of bat carcasses are available, brown or black mice may be used as surrogate bat carcasses.

A random design will be used to select search plot types, turbines, and locations within search areas to place carcasses. Carcasses will be placed prior to that day's scheduled carcass survey and will be discreetly marked (e.g., with zip ties) to identify them as trial carcasses when found.

The number and location of the searcher efficiency carcasses found will be recorded. The number of carcasses available for detection during a trial (i.e., that were not removed by scavengers before searchers could search for them) will be determined immediately after the trial by the person responsible for placing the carcasses.

The factor (*k*) by which searcher efficiency changes between searches, because carcasses deform with time, is difficult to estimate in the field. This is because estimating *k* requires a large number of carcasses to be tracked through multiple searches. Nonetheless, a recent analysis (Huso et al. 2017) suggests 0.67 as a reasonable value for *k* for bats. Unless a better estimate becomes available, *k* will be assumed to be 0.67.

Carcass persistence is also determined by trials. Carcass persistence trials will be conducted throughout the monitoring period to incorporate the effects of varying weather, climatic conditions, and scavenger densities. Species used for carcass persistence trials will be the same as used for searcher efficiency trials. Approximately 50 discretely marked bat or surrogate carcasses will be randomly placed in the two types of search plots in different seasons to determine the rates at which they are removed by scavengers or disappear by other means, such as mowing, plowing, and consumption by insect larvae. Field personnel will monitor carcass persistence trials for 30 days, checking trial carcasses every day for the first four days, and then on days 7, 10, 14, 20, and 30 after placement. At the end of the 30-day period, any evidence of the carcass will be removed.

<u>*Take Estimation*</u>

The EoA model (Section 4.2.2 and Appendix A) will be used to assess take rates and cumulative take of both Covered Species each year. The rolling average 6-year take rate (λ in the EoA model) will be updated each year to assess whether the short-term adaptive management trigger (Section 5.4.3) has been met and adaptive management responses are needed. The cumulative (ITP term to date) take estimate will be updated each year to assess whether the projected cumulative take amount (M*) has met the permitted take amount. For a discussion of adaptive management triggers, see Section 5.4.3.

5.4.2 Mitigation Effectiveness Monitoring

The Applicant will work with the mitigation entity to ensure a detailed habitat management plan is developed for each proposed mitigation project. Those plans will be submitted to the USFWS for approval before being finalized.

The habitat management plan will include the scope and rationale for the plan, including documentation of the planning process that was followed to develop it, and the vision that the plan aims to realize; the location of the project (including detailed maps that highlight resources important to the Covered Species), its physical or geographic setting, descriptions of its management units if more than one, habitat changes from historic to current conditions, current habitat conditions, and changes associated with global climate change, both documented and anticipated; identification of the habitat requirements of the Covered Species and how habitat management will ensure that those requirements are maintained or provided, including adaptive management; habitat goals and objectives; habitat management strategies selected and prescriptions for achieving goals and objectives; a threats analysis, including its findings and contingency plans for dealing with likely threats; a monitoring and reporting plan; and deeds, conservation easements, permits, and other pertinent documents. Furthermore, the plan will describe 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.

The effectiveness of a mitigation project will be gauged through monitoring, a highlighted element in the habitat management plan. Effectiveness monitoring may include surveys that evaluate habitat and other variables associated with the objectives identified in the habitat management plan. It will also assess the adequacy of protection measures and update the threats analysis. For hibernaculum protection projects, monitoring will examine gates and schedule maintenance or replacement if required. It will also evaluate the condition of the protected habitat surrounding the hibernaculum. For habitat protection projects, monitoring will ensure that habitat conditions are maintained and that protections are adequate. For habitat restoration projects, monitoring will certify when restoration objectives in the habitat management plan have been achieved, such as meeting planting density targets.

If a qualified conservation bank or in-lieu fee program (e.g., Range-Wide Indiana Bat In-Lieu Fee Program) is utilized as a mitigation option for the Covered Species, it will already have a habitat management plan approved by the USFWS and it will not be necessary for the Applicant to develop a plan.

5.4.3 Adaptive Management

Adaptive management will be used to ensure that the Project's take of Covered Species does not exceed the permitted level of take due to uncertainty in predicting take. The EoA model will provide an estimate of the take rate (λ) and the cumulative take (M*) based on data collected during compliance monitoring (Section 5.4.1). 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 met 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 actuating a response to the long-term test. 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.

<u>5.4.3.1 Short-Term and Reversion Triggers</u>

Short-term triggers are built into the EoA estimation framework to assess the average rate of take within a defined rolling window; the window has been set to a six-year rolling window for this HCP to ensure that at least one year of intensive monitoring data are available to inform the estimate of λ in any given window. Nonetheless, if data collected during the first five years of the ITP provide early indication of an ITP compliance issue, the Applicant may respond sooner than the end of the first six-year window. If, within any six-year rolling window, the estimated take rate exceeds the predicted annual take rate (4.0 Indiana bats/year, 1.4 northern long-eared bat/year) with 90% confidence, the short-term trigger will be activated. Activation of the trigger is an indication that the minimization plan may need to be adjusted to ensure that the cumulative take estimate (the median of M*) remains within the permitted limit over the ITP term. By default the EoA model sets the trigger at a high confidence level of 99% to prevent premature adaptive management responses. The Applicant has chosen to reduce the confidence level for the trigger to 90% to make it more sensitive and therefore more protective against greater than expected take with the interval monitoring plan. The short-term trigger will be evaluated in each monitoring report (Section 5.4.4), and any required response will be implemented before the start of the next monitoring cycle (i.e., April). The USFWS will be notified prior to the implementation of any proposed adaptive management response.

In the event that the short-term adaptive management trigger is activated, the Applicant may adjust the turbine cut-in speed to further minimize take. Alternatively, so long as the take limit has not been met, the Applicant may choose to implement a different response to a short-term trigger, such as adjustments to the temperature threshold, implementation of deterrents, increased monitoring, adjustments to the turbine operation algorithms, etc. The Applicant reserves some flexibility in choosing a response because while the short-term trigger is designed to provide an early indication that cumulative take over 30 years may exceed the permitted level, it does not indicate that there has yet been a violation of the ITP. If an alternative response, such as changing the minimization temperature threshold, is determined, based on the monitoring data and in coordination with USFWS, to have a similar or greater effect on mortality as could be expected from the standard response (i.e., raising cut-in speed by 0.5 m/s), the Applicant may implement this response instead.

For example, an alternative response could be a change in the minimization temperature threshold. This may be appropriate if monitoring data indicate that 25% or more of documented fatalities of all bats occur on nights when average temperature is below 10˚C. This would suggest that at least 25% of Covered Species fatalities may also occur below the temperature threshold. If this were the case, the adaptive management response could be to maintain turbine operational adjustments for the entire night irrespective of temperature[21]. The expected result would be an additional 12.5% or more reduction in bat fatality (0.5 minimization effect [per Section 5.2.2] * 25%).

The Applicant may implement a reversion trigger if monitoring data indicate that the take rate is below either (i) the expected average annual take rate or (ii) the average annual take rate as measured during the first three years of standardized monitoring, whichever is less. In this case, the Applicant may reduce the minimization measures specified in Section 5.2 of this HCP. The Applicant will reevaluate the trigger after each subsequent monitoring year to assess whether reduced minimization measures should be implemented. The reversion trigger may also fire after a short-term adaptive management response has been implemented, i.e., if subsequent

[21] Should the Applicant be required to disable the temperature-controlled cut-in wind speed adjustment parameter, the turbine control software would be reconfigured remotely and rolled out to each individual turbine.

monitoring data collected indicate the take rate no longer exceeds the predicted take rate. In that case, the prior adaptive management response could be reversed. For instance, in the previous example the Applicant retains the option to re-implement the temperature threshold if subsequent monitoring data show that more than 75% of documented fatalities occur on nights when average temperature is above 10°C. This would suggest that the original assumptions about the effectiveness of the temperature threshold are supported and the take rate of the Covered Species should be minimized as predicted.

If a short-term adaptive management trigger response or a reversion trigger response is fired in a given year, or if an Indiana bat carcass and/or a northern long-eared bat carcass is found incidentally during O&M monitoring, the Applicant will schedule standardized monitoring (at a *g* of 0.25) in the next year. The purpose of this monitoring will be to update the take estimate and check for changes in the take rate. Because there will not be an opportunity to conduct bias trials the year prior to the rescheduled year of monitoring, the monitoring protocol will be designed using best available data from the most recent bias trials conducted at the site. The monitoring schedule will resume such that the next bias trials are conducted five years after the previous monitoring and standardized searches are conducted every sixth year after the rescheduled monitoring. If the short-term trigger is activated by the results of this monitoring, the Applicant will again implement a response as described above.

5.4.3.2 Long-Term Trigger

In addition to the short-term and reversion triggers, the EoA estimation framework includes a long-term trigger, which indicates that the permitted level of take has been met (based on the cumulative estimated take using the median of M*). If the long-term trigger is activated, the Applicant will implement an operational plan, approved by the USFWS, under which take of the Covered Species is not likely to occur (i.e., an avoidance strategy such as the current USFWS recommendation to feather turbines at wind speeds below 6.9 m/s). The Applicant will then coordinate with the USFWS to determine whether the Project will operate under the avoidance strategy or pursue a permit amendment.

5.4.4 Reporting

The Applicant will prepare data sheets and report templates for monitoring that will be reviewed and approved by the USFWS prior to initiation of the first year of compliance monitoring under the ITP. During active monitoring, raw data forms will be stored on site and at the offices of the independent monitoring contractor. Individual bat carcasses collected will be stored in a freezer located at the Project's O&M facility. Raw data forms will be made available to the USFWS upon request. For each bat carcass found, the following information will be maintained in a database that will be provided to the USFWS annually or upon request: date and time of collection, species, UTM coordinates, closest turbine number, and, if available, nighttime temperatures and wind speeds preceding a *Myotis* bat fatality (of any *Myotis* species, not just Covered Species).

In the event that a Covered Species fatality is documented during compliance monitoring (both standardized and O&M), the USFWS and the ODNR will be notified by phone within 24 hours of positive species identification. Any unknown or suspected fatalities of the Covered Species will be submitted for DNA testing to a USFWS-approved laboratory. The USFWS and the ODNR will also be notified by phone within 24 hours of positive identification of a carcass of an eagle, any non-Covered Species listed as endangered or threatened under the ESA, or any state-listed threatened or endangered species. Additionally, any carcasses of listed species or eagles discovered will be turned over to the USFWS within two business days of positive identification.

The Applicant will submit a compliance monitoring report to the USFWS no later than January 31 following each monitoring year (approximately three to four months following completion of the monitoring studies). Reports will be presented in standard scientific format (Introduction, Methods, Results, Discussion, and References). Each report will include the results of compliance monitoring, take estimates, data demonstrating turbine operations, and any adaptive management actions taken according to the firing of short-term or long-term triggers. The report will also include the protocol for the next year of monitoring, designed based on the monitoring data in the report. Once USFWS has reviewed and commented on the draft compliance monitoring report, a final report will be issued, including to the ODNR.

After each year of mitigation effectiveness monitoring, the Applicant will obtain or compile and submit to the USFWS a report that summarizes the results of mitigation monitoring as reported by the mitigation provider(s). The report will include a description of the status of the habitat, an assessment of the functionality of the habitat protection measures, and identification of any adaptive management measures necessary. To ensure that any required management actions can be implemented prior to the subsequent maternity period, the monitoring report for any summer/swarming mitigation will be submitted by January 31 of the next year. To ensure that any required management actions can be implemented prior to the subsequent hibernation period, the monitoring report for any winter mitigation will be submitted by June 30 of the next year.

If requested by USFWS, the Applicant will meet with the USFWS by conference call or webinar to discuss the monitoring reports following completion of the studies in each monitoring year. The purpose of these meetings will be to review monitoring methods, discuss the results of the compliance and effectiveness monitoring, and recommend changes in future monitoring. The meetings will also provide opportunities to discuss the effectiveness of the HCP and evaluate mitigation projects. If the USFWS requests a meeting, the Applicant will schedule the meetings to occur in February/March. This will allow the USFWS to review the monitoring reports and have adequate time before the start of the next bat-active period to implement any recommended changes.

6.0 FUNDING ASSURANCES

Section 10(a)(2)(B)(iii) of the ESA stipulates that the USFWS shall issue an ITP if it finds that, among other issuance criteria, “the applicant will ensure that adequate funding for the HCP will be provided.” The ESA implementing regulations require that the funding assurances provided include the requirements to monitor, minimize and mitigate for the impacts of the taking. For the duration of the ITP, the Applicant will ensure adequate funding through two financing mechanisms: the Project’s annual operating revenue and an irrevocable letter of credit, corporate guarantee, or bond from a Surety. The Surety shall be (i) a United States commercial bank or (ii) a U.S. branch of a commercial bank with sufficient assets in the U.S. as determined by the USFWS, having a credit rating of at least A- from Standard & Poor's or A3 from Moody's. In the twelve-month period prior to a year when monitoring and/or mitigation expenses will be incurred, the Applicant will provide the USFWS with a letter signed by a corporate representative with authority to bind the company stating that the Applicant will cover those expenses through operating revenue (with the exception of Year 1, when this letter will be provided within a month after the ITP has been issued). If operating revenue is insufficient to fully implement monitoring and mitigation, or if the Applicant fails to timely submit the required letter and does not cure such failure within 30 days of receipt of notice thereof from the USFWS, then the financial assurance may be drawn upon to cover the balance and be replenished within 90 days. The Applicant shall continue to replenish the financial assurance as needed throughout the Permit term. The amount of the financial assurance is detailed in Section 6.3.

6.1 Recurring Costs

The Applicant will fund recurring costs associated with implementation of the HCP through operating revenue generated by the Project. These recurring costs (Table 6.1) will be included in the Project's operating budget.

The Project has secured a power purchase agreement that guarantees that the Project will be paid for each megawatt-hour of electricity produced. These payments will finance the recurring costs of the activities described below. In the unlikely event that the Project does not operate (and does not generate electricity and revenue), then the turbines will be locked and no take of the Covered Species will occur. In such a situation, the recurring costs in Table 6.1 will not be incurred. Recurring costs cover:

- **Compliance Monitoring** – The Applicant will fund compliance monitoring through the Project's annual operating revenue. In the twelve-month period prior to when standardized monitoring is scheduled (Table 5.3), the Applicant will obtain a proposal from an independent contractor to conduct the standardized monitoring. To provide further assurance that compliance monitoring will occur, the Applicant will submit to the USFWS by March 1 of each monitoring year of the requested ITP a letter signed by a corporate representative with authority to bind the company that the Applicant has executed a contract with a qualified party to conduct the required monitoring activities for that year consistent with the protocol described in the compliance monitoring report for the previous monitoring year.

  The cost estimate for compliance monitoring assumes that it will be conducted according to the schedule in Table 5.3. The Year 1 estimates of $349,698 (standardized monitoring) and $73,067 (clearing crops, sowing grass, and reimbursing landowners for lost production in search areas in years when standardized monitoring is conducted, required to achieve a probability of detection of 0.25; see Table 5.4) were based on current cost, and future years were increased by 3% per year to account for inflation. The example protocol in Table 5.4 was used for deriving the monitoring costs in Table 6.1. While the example protocol may not be implemented exactly as described, it represents the approximate level of effort, and consequently the approximate financing required, to meet the target g value of 0.25.

To estimate reporting costs, a meeting with the USFWS was assumed to be held following each year of standardized monitoring to review monitoring results and whether adaptive management has been triggered. This meeting will take place before the start of the bat-active season on April 1.

- **HCP Overhead and Administration** – General overhead and administrative costs were estimated at $4,000 in Year 1, then increased 3% per year thereafter to account for inflation. Costs include travel to USFWS meetings and other expenses outside of the Applicant's operating budget, such as on-site coordination of monitoring studies, submitting reports, scheduling meetings, and coordinating O&M monitoring measures as necessary.

6.2 Non-Recurring Costs

Non-recurring costs for HCP implementation are also identified in Table 6.1. Non-recurring costs will be paid out of the operating budget and assured through an irrevocable letter of credit, corporate guarantee, or bond from a Surety meeting the requirements set forth in Section 6.0. These costs include:

- **Mitigation Measures** – Mitigation projects have not yet been selected, but selection criteria have been established. Projects will be limited to those that conform to the criteria and set forth in Section 5.3.2 above, which allows for projects involving hibernaculum protection, protection or restoration of maternity colony habitat, and/or protection of swarming habitat. Mitigation projects will be implemented in a series of tranches during the ITP term, as described in Section 5.3.1. The mitigation requirement for each tranche will be based on the estimated impact of cumulative take (or M_{50}) generated by the EoA estimator and REA Model output informed by data collected during the previous tranche. Mitigation credits will be applied to remain ahead of take, but they will be adjusted downward or upward for each tranche based on credits (bats produced by the mitigation) or debits (impact of the taking) accrued during the preceding tranche.

  Initial Tranche: Although specific mitigation parcels have not yet been selected, the Applicant has established a contract with a mitigation entity for the first approximately 50% of mitigation required under this HCP (the Mitigation Deposit described in Section 5.3.1). This contract includes an agreement with the mitigation entity to secure and place under conservation easement, a summer habitat parcel or parcels (yet to be identified), and to provide for ongoing mitigation, management, and reporting services for the full term of the ITP in accordance with this HCP. The number of credits to be provided under this contract was based on the number necessary to offset the impact of approximately 50% of the taking authorized in the ITP. The cost per mitigation credit for the project was based on providing these credits through the protection of habitat providing both roosting and foraging functions. The total cost of the first mitigation project, as established in the contract between the Applicant and the mitigation entity, is $1,768,700. This contract amount includes implementation of all USFWS-approved mitigation actions and mitigation work (see Section 5.3.2), as well as periodic monitoring of the mitigation project(s) and reporting to the USFWS and the Applicant (see Section 5.4.2).

Subsequent Tranches: The Applicant anticipates securing the remaining mitigation necessary (to be determined based on the results of compliance monitoring, but assumed for purposes of funding assurance to be the full second half, approximately 50% of the impact of the taking authorized in the ITP) in Year 15 or later during the requested ITP. The cost of this mitigation will be adjusted for inflation and added to the financial assurance. The cost of additional mitigation to offset the remaining impact of the take over the 30-year ITP term was estimated based on the cost of a summer habitat protection project in Year 1 increased by 3% annual inflation over 15 years, using the following formula:

$$Pn = P(1 + 0.03)^n$$

where Pn = total inflated estimated cost, P = the base estimated cost, in this case, $1,768,700, the estimated cost of a restoration project in Year 1; 0.03 = the inflation rate; n = the difference between the base year, 2020 (Year 1), and the selected year, 2034 (Year 15), or 14 years; and $(1 + i)^n$ = the inflation factor, calculated to be 1.51. The result is Pn = $2,675,317.

A summer habitat protection project was chosen because it is the type of project most likely to be achievable in Ohio Additional mitigation project(s) would be implemented as necessary according to the mitigation implementation schedule in Section 5.3.1, between Years 15 and 30 of the requested ITP. The specific year(s) in which future mitigation projects will be implemented is unknown, but the earliest it is estimated to occur would be Year 15, since the Mitigation Deposit is expected to provide sufficient mitigation credit to offset the impact of take from at least the first 15 years of Project operations under the ITP. Note that if the first additional mitigation project(s) is implemented after Year 15, it would indicate that the impact of the taking has been less than what was predicted (which is likely given the conservative nature of the take prediction as discussed in Section 4.1.2). Consequently, additional mitigation project(s) implemented after Year 15 would be designed to offset a lower impact of take, resulting in a smaller project(s) the cost of which would therefore be covered within the Year 15 cost estimate.

After accounting for inflation, the total cost of the remaining mitigation is estimated to be no more than $2,675,317. This amount includes costs for implementation of all USFWS-approved mitigation actions and mitigation work (see Section 5.3.2), as well as periodic monitoring of the mitigation project(s) and reporting to the USFWS and the Applicant (see Section 5.4.2). This amount will be included in the financial assurance.

- **Changed Circumstances** – When a changed circumstance is triggered (see Section 8.2), the resulting response will be funded with operating revenue. But if operating revenue is insufficient to fully implement the response, then the financial assurance will be drawn on and replenished within 90 days. However, in the event the Project permanently ceases operation and a USFWS analysis indicates that the impact of the taking that has occurred to that date has been adequately mitigated, the financial assurance will not be drawn upon, and would instead be released. If the impacts of the taking have not been adequately mitigated as a result of changed circumstances, then the financial assurance will be drawn upon to complete the necessary mitigation.

  The Applicant has estimated the foreseeable costs associated with the specified responses to those changed circumstances identified in Section 8.2 at $210,850, and this plus the second half of the mitigation (estimated at $2,675,317) will be the original amount of the financial assurance obtained from the surety (total of $2,886,167). This estimate for addressing changed circumstances includes additional coordination with the USFWS, monitoring, and evaluation with respect to one of the changed circumstances,[22] plus the estimated cost to address mitigation project viability, should that become an issue. The estimate is based on a low likelihood of occurrence of any specific natural disaster affecting the mitigation project(s) (see Section 8.2.5), the implementation of mitigation within one year of ITP issuance, and the Applicant's obligation to offset only the remaining impact of take at the time of the changed circumstance (as determined using the REA model). Additional mitigation is unlikely to be necessary to address a changed circumstance because of the conservative nature of the take predictions as discussed in Chapter 4. Thus, the mitigation costs for changed circumstances would most likely be limited to partial restoration in response to one natural disaster. The Applicant cannot estimate the potential costs that may be associated with operational adjustments or ITP modifications that might become necessary in response to some of the changed circumstances (for example, a change in migration dates, additional species listings, new technology, etc.), since the nature and extent of the potential adjustments and modifications cannot be predicted. However, these costs would necessarily be reflected and accounted for in the revised operating budgets for the Project, per the funding structure described above for other recurring costs of the HCP (i.e., any reductions in revenue or increases in expenses would be reflected in the Applicant's net income, and if the Project could not operate profitably as a result, then and the Applicant would either operate the Project at avoidance levels or discontinue operations so that no further take would occur).

6.3 Amount of the Financial Assurance

All costs associated with the additional mitigation and changed circumstances will be paid from operating revenue backed by an irrevocable letter of credit, corporate guarantee, or bond from a

[22] In the event that a changed circumstance is triggered twice, the Changed Circumstances Fund will have sufficient funds to address the changed circumstance given that the funding mechanism is the operating budget backed by a financial assurance that is replenished if drawn down.

Surety meeting the requirements set forth in Section 6.0. The purpose of the financial assurance is to ensure that funding is available in the event that operating revenue is insufficient to fully implement the additional mitigation and changed circumstance responses as budgeted in Table 6.1. Financial assurance in the amount of $2,886,167 will be secured during the first six months of the ITP and replenished within 90 days thereafter if and when it is ever drawn down. This amount was established based on the cost of mitigating 50% of the impact of the taking in Year 15 or later (estimated at $2,675,317) plus the estimate to address changed circumstances ($210,850). The derivation of these costs is explained in Section 6.2.

6.4 Other Costs Not Included in the Financial Assurance

- **Minimization Measures –** The Applicant will implement a turbine operations protocol that is intended to reduce potential impacts to the Covered Species by limiting turbine rotation during periods when the Covered Species are considered to be at risk, specifically during the spring and fall migration seasons when wind speeds are below certain thresholds and temperatures are above a certain threshold at night (Section 5.2.2). The lost revenue associated with these operational adjustments will be absorbed in the annual O&M budgeting process. Thus, minimization measures are not included as a recurring cost of the HCP.

  As described in Section 5.2.1, other measures to avoid and minimize take were implemented during Project design and planning. Costs associated with these measures were included, and paid for, as part of the Project development budget prior to the commercial operation of the Project. Those costs also are not included as recurring costs of the HCP, because no further funding requirements for Project design and planning measures are anticipated.

Table 6.1 Estimated costs for implementing the Timber Road II, III, and IV Wind Farms Habitat Conservation Plan.

Budget Item	First Year Cost	Permit Term Total	Cost Basis and Assumptions
Recurring Costs			
Compliance Monitoring	$349,698	$3,129,360	Interval monitoring (n=7) for estimating take and evaluating the turbine operational strategy; includes logistics, reporting, and agency meetings, with 3% inflation over the 30-year ITP term. Takes into account that only 79 of the 134 turbines will be operating in the last standardized monitoring year. **Funding mechanism:** Project's annual budget/operating revenue.
Crop Clearing for Compliance Monitoring	$73,067	$718,464	Costs for clearing crops, sowing grass, and landowner reimbursements in search areas in years when standardized monitoring is conducted (see Tables 5.1 and 5.2), with 3% inflation over the 30-year ITP term. **Funding mechanism:** Project's annual budget/operating revenue.
Carcass Removal Bias Trials for Compliance Monitoring	$13,153	$86,095	Carcass removal bias trials conducted the year prior to Years 9, 15, 21, and 27, when standardized monitoring occurs (see Table 5.1), with 3% inflation over the 30-year ITP term. **Funding mechanism:** Project's annual budget/operating revenue.
General Administration, Management, and Overhead	$4,000	$190,302	Travel costs to meetings with USFWS and other miscellaneous expenses additive to Applicant's normal (non-HCP) operational budget, with 3% inflation over the 30-year ITP term. **Funding mechanism:** Project's annual budget/operating revenue.
Total Recurring Costs		**$4,124,222**	**(see Section 6.1)**
Non-Recurring Costs			
Mitigation Projects – first 50%	n/a	$1,768,700	Contracted amount for a mitigation project that protects summer habitat equivalent to offsetting approximately 50% of the impact of the take; no inflation was applied because the first mitigation project will be implemented in Year 1 of the requested ITP. **Funding mechanism:** Executed contract with mitigation entity, to be paid out of operating budget.
Mitigation Projects – second 50%	n/a	$2,675,317	Based on costs of the type of mitigation project most likely to be achievable in Ohio – protection of summer habitat, budgeted in Year 1 and adjusted for 3% annual inflation because the remaining mitigation will be implemented in Year 15

Table 6.1 Estimated costs for implementing the Timber Road II, III, and IV Wind Farms Habitat Conservation Plan.

Budget Item	First Year Cost	Permit Term Total	Cost Basis and Assumptions
			or later of the requested ITP. **Funding mechanism:** Operating budget backed by an irrevocable letter of credit, corporate guarantee, or bond from a Surety.
Changed Circumstances Fund	n/a	$210,850	Additional consultation and monitoring/evaluation or mitigation necessary to respond to one changed circumstance, equivalent to 5% of the total mitigation costs due to low likelihood of occurrence, low likelihood of large-scale habitat destruction, early implementation of mitigation that sets the mitigation ahead of the impacts, and the obligation to offset remaining impact of take at the time of the changed circumstance. **Funding mechanism:** Operating budget backed by an irrevocable letter of credit, corporate guarantee, or bond from a Surety.
Total Non-Recurring Costs		**$4,654,867**	**(see Section 6.2)**

HCP = Habitat Conservation Plan, ITP = Incidental Take Permit n/a = not applicable, USFWS = US Fish and Wildlife Service

7.0 ALTERNATIVES CONSIDERED

The HCP Handbook states, “Section 10 of the ESA and its regulations require that an HCP describes actions the applicant considered as alternatives to the take that would result from the proposed action and the reasons why they are not using those alternatives. When describing alternative actions in the HCP, the applicant should focus on significant differences in project design that would avoid or reduce the take” (USFWS and NMFS 2016).

In evaluating potential alternatives, the ESA §10(a)(2)(B)(ii) provides that the USFWS shall issue an ITP if, among other things, it finds that “the applicant will, to the maximum extent practicable, minimize and mitigate the impacts of such [incidental] taking.” Because the Project is already constructed and operating, the only alternative available to avoid take of Indiana bats and northern long-eared bats entirely would be long-term operation under turbine operational adjustments recommended by the USFWS for avoiding take of these species during the bat-active period.

The avoidance alternative would require that all turbines be fully feathered at wind speeds below 6.9 m/s from 0.5 hour before sunset to 0.5 hour after sunrise during the bat migration seasons (April 1-May 15 and August 1-October 15). Under this regimen, the USFWS would not consider take to be reasonably certain to occur. The Applicant would not pursue or implement this HCP and no ITP would be issued.

This alternative was not selected because it would not meet the purpose and need for the Project and it would result in a financially unviable Project that could not be carried forward. The purpose of the Project is to maximize energy production using wind – a clean, renewable energy source. The need for the Project is its contribution toward meeting national renewable energy objectives. The Project will increase the nation's energy security by utilizing a renewable, domestic energy source, diversifying the electricity generation portfolio, and buffering price volatility of other energy sources, such as natural gas.

Under the avoidance alternative, the Project would not be economically viable, its renewable energy production would not occur, it would not contribute to national renewable energy objectives, and contracts for purchase of the Project's energy would not be fulfilled. Additionally, the Project would not provide an economic benefit to the local economy, jobs associated with the operation and maintenance of the Project would be lost, and participating land owners would not receive lease payments over the expected life of the Project. For these reasons, the avoidance alternative was not considered further, and the Applicant proceeded with the proposed plan as described in this HCP.

The Applicant also considered implementation of an operational minimization plan more restrictive than the proposed plan (Table 4.3), for example, feathering below 6.0 m/s during fall migration, rather than below 5.0 m/s. However, based on the existing available data concerning the effect of increased cut-in speeds, such an alternative would not reliably achieve significantly greater minimization than the proposed plan. As indicated in Table 4.2, there is substantial overlap in the mean percent reduction in bat mortality observed at projects where cut-in speeds were raised from the applicable manufacturer's rated cut-in speed (3.0 or 3.5 m/s) to a cut-in speed of 5.0 m/s or 6.0 m/s. However, because power derived from the wind by a wind turbine increases by the cube of wind speed [$P = A * v^3 * \rho * \eta$ where P = power, A = rotor swept area, v = wind velocity, ρ = air density, and η = efficiency factor], the loss of renewable energy generation between 5.0 m/s and 6.0 m/s is exponential (wind at 6.0 m/s has 73% more power than wind at 5.0 m/s). Thus, this alternative would substantially reduce the amount of renewable energy generated by the Project in return for an uncertain but likely marginal decrease in take. Further, because the level of take under such an alternative would likely be comparable to the proposed plan, costs of mitigation and monitoring would likely remain similar. For these reasons, the Applicant determined that an increased cut-in speed alternative was not viable, and pursued development of this HCP based upon the proposed plan.

As proposed in this HCP, the Project is projected to generate 2.56 billion kWh of clean, renewable energy annually, enough electricity to power the homes of 238,500 residential utility customers (US Energy Information Administration).[23] It will also reduce greenhouse gas emissions by 1.9 million metric tons of carbon dioxide, a major contributor to global warming, by replacing fossil-fuel-based electricity production. This is equivalent to taking approximately 410,000 passenger vehicles off of the road (US Environmental Protection Agency 2017). The Project will also reduce emissions of nitrogen oxide, which causes smog, and sulfur dioxide, which causes acid rain.

[23] Figuring a 35% capacity factor.

The Project will also benefit the local economy through lease payments to land owners, paychecks to local workers, and tax revenue to the local township and county. During the construction phase, the Project generated 276 full-time equivalent jobs. During operations, the Project has created 13-15 full-time, local jobs. These economic benefits to the local community would be lost or diminished if the Project were forced to operate under an avoidance alternative.

8.0 HCP ADMINISTRATION

8.1 HCP Implementation and Other Such Measures that the Secretary May Require

As a mandatory condition of the requested ITP, the Applicant will implement this HCP for the duration of the ITP term. The Applicant will be solely responsible for implementing the measures described in this HCP and meeting the terms and conditions of the requested ITP. Additionally, the Applicant will allocate sufficient personnel and resources to ensure effective implementation of the HCP and coordination with the USFWS during the permit term.

To ensure proper implementation of the HCP, the Applicant may designate an HCP Coordinator. The role of the HCP Coordinator will be to oversee the HCP implementation; plan and coordinate meetings with the USFWS; organize training of management and O&M staff; oversee allocation of funding for mitigation, monitoring, adaptive management, and changed circumstances, if necessary; and ensure delivery of monitoring reports to the USFWS.

8.2 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 USFWS and that can be planned for" (50 CFR 17.3 [1975]). The HCP should discuss feasible measures developed by the applicant to address reasonably foreseeable changed circumstances that may occur during the permit term, possibly by incorporating adaptive management measures as necessary for the covered species in the HCP (USFWS and NMFS 2016). To the extent practicable, an applicant should identify potential problems in advance and identify specific strategies or responses in the HCP for addressing them, so that adjustments can be made as necessary without the need to amend the HCP (USFWS and NMFS 2016).

After consultation with the USFWS, the Applicant believes the following are reasonably foreseeable changed circumstances warranting planning consideration:

- Change in the migration dates of the Covered Species;
- White-nose syndrome impacts to the populations of the Covered Species are greater than anticipated;
- Listing of additional species, such as little brown bat and tri-colored bat, due to population declines;

- New technology or information that improves monitoring, estimating, and/or minimizing mortality
- Changes in mitigation project viability; and
- Change in summer risk for the Covered Species.

Pursuant to the "No Surprises" Rule, if the USFWS determines that additional conservation and mitigation measures are necessary and have been addressed in the HCP, implementation of those measures is required (50 CFR § 17.22(b)(5)(i) [1985]). However, if the USFWS determines that additional conservation and mitigation measures are necessary that were not provided for in the HCP, such conservation and mitigation measures will not be required of the Applicant without its consent (50 CFR § 17.22(b)(5)(ii) [1985]). If additional measures are deemed necessary to respond to an unforeseen circumstance, then additional conservation and mitigation measures will not involve the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources without the consent of the applicant (50 CFR § 17.22(b)(5)(iii) [1985]). Unforeseen circumstances are covered in Section 8.3.

8.2.1 Change in Migration Dates of the Covered Species

Climate change is ongoing and has the potential to affect the timing of migration of the Covered Species. For example, warmer temperatures may allow Indiana bats and northern long-eared bats to leave hibernacula earlier and remain in summer habitat longer, pushing the dates of spring migration earlier and fall migration later. If that were to occur, the timing of Covered Species mortality at the Project could change, warranting a response by the Applicant.

8.2.1.1 Trigger

1) The USFWS notifies the Applicant that it has documentation of a shift in the timing of spring or fall migration of the Covered Species in Ohio; or

2) The carcass of a Covered Species is discovered incidentally at the Project during the early spring or late fall season.

8.2.1.2 Response

1) The Applicant will evaluate the dates of bat carcass finds in the Permit Area to determine if the spring or fall peak in fatalities has shifted. This analysis will rely on all bat carcass finds, given that take of the Covered Species may never be documented. If, over the two most recent years of standardized monitoring, a greater proportion of bat carcasses have been found during the first two weeks of the spring season or the last two weeks of the fall season than in any other two-week period during those seasons, or than was found during the first three years of intensive monitoring, the Applicant will shift the minimization and monitoring period. While the dates may be shifted, the minimization and monitoring period will not be expanded or contracted unless recent (within 10 years) data on bat carcass

finds at the Project[24] indicate the migration period has expanded or contracted (i.e., the temporal distribution of carcasses is broader or narrower than six weeks in the spring or 11 weeks in the fall). In that case, the minimization and monitoring period would be expanded or contracted accordingly. The Applicant will then feather all turbines at wind speeds below 3.5 m/s during the redefined season of spring migratory risk or at wind speeds below 5.0 m/s during the redefined season of fall migratory risk from 0.5 hour before sunset to 0.5 hour after sunrise when temperatures are above 10°C in fall. If spring, fall, or both minimization protocols have been modified as the result of adaptive management, the modified protocol will be implemented.

2) If a Covered Species fatality is discovered in early spring or late fall, the Applicant will notify the USFWS within 24 hours of positive identification. The Applicant will shift the timing of the minimization and monitoring period to encompass the date of the estimated time of death of the carcass in response to the changed circumstance. This shift will be a movement of the entire minimization and monitoring period to earlier or later in the season, rather than an expansion of the period, unless the timing of any other recent (within 10 years) Covered Species fatalities at the Project or regionally[25] indicate that the migration period has expanded or contracted rather than shifted (i.e., the temporal distribution of carcasses is broader or narrower than six weeks in the spring or 11 weeks in the fall). In that case, the minimization and monitoring period would be expanded or contracted accordingly. The Applicant will then feather all turbines at wind speeds below 3.5 m/s during the redefined season of spring migratory risk or at wind speeds below 5.0 m/s during the redefined season of fall migratory risk from 0.5 hour before sunset to 0.5 hour after sunrise when temperatures are above 10°C in fall. If spring, fall, or both minimization protocols have been modified as the result of adaptive management, the modified protocol will be implemented.

8.2.2 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 for *Myotis* bat populations in Ohio, the MRU, or USFWS Region 3. If WNS should reduce the population of either Covered Species to the extent that the take permitted in this HCP threatens to have a significant population effect (defined as a decline by more than 88%, which is double the decline observed between 2013 and 2017 in Ohio per USFWS 2017a, based on cave counts, hibernacula emergence surveys, and other relevant data, such as population viability analyses), and in the worst-case scenario, jeopardize the continued existence of that species, then the Applicant will evaluate this changed circumstance with respect to the impact of the permitted level of take. The Applicant will also evaluate the likelihood that the take level has already been reduced because there are fewer individuals of the Covered Species on the landscape. At the end of each regular cave survey season, the Applicant will coordinate with the USFWS to evaluate whether or not this

[24] Data from other wind energy facilities in the region or Covered Species migration research studies may also be considered in determining the response, as appropriate.

[25] Data from other wind energy facilities in the region or Covered Species migration research studies may also be considered in determining the response, as appropriate.

changed circumstance has been triggered. The Applicant will require that the relevant survey results are presented that justify any positive conclusion that the trigger has been met.

8.2.2.1 Trigger

USFWS notification that WNS impacts are more severe than anticipated, to the point that the authorized take level threatens to have a significant population effect and is likely to lead to jeopardy of the Covered Species. This determination will be based on cave counts, hibernaculum emergence surveys and any other relevant data, such as population viability analyses.

8.2.2.2 Response

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 ITP would be adjusted to this level of reduced take for the duration of the permit term, unless cave 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.

Once the permitted take level of Indiana bat or northern long-eared bat has been adjusted, the Applicant will conduct an analysis, in coordination with the USFWS, to determine the appropriate course of action. The analysis will evaluate whether the cumulative level of take reported for the Project to date is on track with the permitted level of take, or whether the cumulative level of take lags behind the permitted level of take (as a decrease in take may be reasonably expected to occur with decreasing Covered Species populations). In addition to site-specific data, research regarding Indiana bat and northern long-eared bat risk at wind energy facilities and existing mortality data for the species will be considered in the analysis, as available. If the cumulative level of take is found to be low and already in compliance with the adjusted ITP, the Applicant will continue to implement the minimization measures in Section 5.2.2 and monitor mortality as described in Section 5.4.1. If the cumulative level of take is found to be above the permitted level of take, the Applicant will determine, in consultation with USFWS, how the HCP's minimization measures need to be adjusted to maintain take of the Covered Species below the adjusted permitted level.

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.

8.2.3 Additional Species Listings

As a result of current population declines due primarily to WNS, other bat species (such as little brown bat and tri-colored bat) may become listed under the ESA as threatened or endangered, or may be up-listed from threatened to endangered, during the term of the ITP. Other wildlife species may also become listed as federally threatened or endangered during the term of the requested ITP due to the impacts of climate change, habitat loss, or other factors. Therefore, the Applicant believes listing of a new bat species or other species of wildlife constitutes a foreseeable changed circumstance that warrants consideration in this HCP.

8.2.3.1 Trigger
USFWS notification of a proposed rule to list under the ESA any bat species or other species of wildlife that may occur in the Permit Area but is not covered by the HCP, or to up-list a species of wildlife that may occur in the Permit Area, will trigger a response by the Applicant.

8.2.3.2 Response
The Applicant will evaluate data from all monitoring years up to the time of the proposed rule, as well as additional scientific information related to the impacts of wind turbines on the species proposed for listing, to determine if take of the species has occurred or is likely to occur in the future as a result of the Covered Activities. In the event that take has been documented or is considered likely to occur, the Applicant will consult with the USFWS to determine what additional avoidance, minimization, or mitigation measures beyond those already specified in this HCP may be appropriate. If the USFWS issues a final rule listing the species, the Applicant will either modify the Project operations to avoid take of the newly listed species or prepare a formal amendment to this HCP (see Section 8.4 below) that predicts the level of take of the newly listed species that is expected to occur and sets forth the additional conservation measures agreed upon with the USFWS to be added to this HCP to support inclusion of the species as a Covered Species under the ITP.

8.2.4 New Technology and Information

Over the ITP term, new information on the Covered Species and bat/wind-power interactions is likely to become available, new methods for monitoring or estimating mortality are likely to be developed, and new technology may be developed to minimize bat mortality at wind turbines. The Applicant may wish to incorporate new information, methods, and/or technology into the operations and monitoring plans in this HCP. For example, it is expected that over time results of post-construction monitoring and research related to bat/wind-power interactions will be useful in determining changes to improve the minimization measures at the Project. New methods, procedures, or analytical approaches for monitoring studies are likely to be developed during the term of the ITP that provide more accurate results for determining the appropriate Project management actions (e.g., adjusting turbine operations) to minimize impacts.

Currently, there are studies ongoing that examine the influence of weather on bat fatalities which may inform improvements in the operation of turbines to meet the HCP goals and objectives and increase Project output. In addition, studies and research on the Covered Species are likely to provide useful information related to location, timing, and characteristics of migration or periods when risk is elevated; such information could inform mortality estimates and identify the most efficient curtailment strategies for minimizing the impact of take of the Covered Species at the Project. Deterrent technologies (e.g., acoustic deterrents, visual deterrents) are also being investigated and new advances may make these technologies effective at avoiding and minimizing take while also improving Project productivity. Ideally, these types of technological advances and new information will be used to improve the ability to estimate mortality and maximize the effectiveness of the minimization and monitoring measures associated with the Project and this HCP.

8.2.4.1 Trigger

Alternative monitoring, mortality estimation, or minimization measures have been demonstrated, based on the best available science, to be as effective as or more effective than the methods described in this HCP. New measures or technologies will only be considered if they meet the above criteria and will not require an increase in the take authorization for the Project, are cost effective, and are deemed acceptable by the USFWS.

8.2.4.2 Response

The Applicant will inform the USFWS about the new methods, how they would be implemented, and any special conditions that may be needed. The Applicant will work with the USFWS to ensure that any new information or techniques used are compatible with the biological goals and objectives of the HCP and that they will not result in a level of take that is higher than that predicted in the HCP (Sections 4.2.4 and 4.3.4). Any new method, information, or technology will only be considered if it has been demonstrated in an acceptable scientific study, and/or has been approved by the USFWS, as the best available science and will not require an increase in the take authorization for the Project. Any changes to the minimization measures will result in at least one additional year of monitoring at a *g* value of 0.25 to confirm the effectiveness of the new measures. The monitoring study plan may be modified, in consultation with, and approved by, the USFWS, to best suit the new information or technologies implemented. To provide further assurance that the monitoring will occur, the Applicant will submit to the USFWS by March 1 of the proposed monitoring year, a letter signed by a corporate representative with authority to bind the company that the Applicant has executed a contract with a qualified party to conduct the year's required monitoring activities consistent with the approved protocols.

8.2.5 Change in Mitigation Project Viability

The purpose of mitigation projects is to offset the impacts of the taking by improving summer survival rates and fecundity, or winter survival rates, of populations of Indiana bats and northern long-eared bats. The mitigation projects are intended to provide long-term protection of, and to reduce threats to, maternity habitat, swarming habitat, and/or winter habitat for Indiana bats and northern long-eared bats. The expectation is that the mitigation sites will secure habitat for Indiana bats and northern long-eared bats, as well as for other bats species, for the life of the requested ITP. This changed circumstance addresses the possibility that mitigation projects fail to offset the impacts of taking due to the effects of a natural disaster, such as a drought, flood, storm (including tornadoes), or fire, on habitat quality at a mitigation site.

Based on the selection criteria and priorities for the mitigation projects under consideration, it is anticipated that the selected mitigation projects will more than offset the impact of take for Indiana bats and northern long-eared bats by securing high-quality habitat and improving survival and reproduction rates. Nonetheless, in the event that a natural disaster destroys all or part of the habitat at any of the mitigation sites, the ability of the mitigation projects to offset the take may be compromised. If there is reason to believe that a natural disaster has impacted one or more of the mitigation sites, the Applicant will coordinate with the USFWS to conduct a site visit and assess the status of the impacted mitigation projects within three months of learning about the impact (e.g., from USFWS or other parties).

8.2.5.1 Trigger

Assessment results indicate that one or more of the mitigation sites no longer provide a sufficient amount of suitable habitat to mitigate the remaining impact of the taking of the Covered Species, as determined through a habitat assessment and application of the REA models that USFWS has issued and/or the USFWS *Guidelines for Non-REA Staging/Swarming Mitigation Option*. Because natural disasters are generally localized and occur with low frequency in Ohio, this trigger is expected to occur only once during the ITP term.

8.2.5.2 Response

Within three months of conducting a site visit to assess the status of the impacted mitigation project(s), the Applicant will coordinate with the USFWS to calculate the impact of take projected to occur over the remainder of the ITP term that has not already been offset by the mitigation project. This calculation will be based on monitoring results and REA model output. The Applicant will then work with the USFWS to evaluate potential options for offsetting the remaining impact of take. These options may include: 1) restoring the mitigation project; 2) purchasing credits from a conservation bank or in lieu-fee program (e.g., Range-wide Indiana Bat In-Lieu Fee Program); 3) funding WNS remediation effort(s), if a USFWS-approved option is available; 4) contributing to a bat conservation fund(s), if a USFWS-approved option is available; or 5) securing an additional mitigation project to offset the remaining impact of take. The first four options would be implemented by the Applicant within one year of agreement on the option with the USFWS. The fifth option may require more time to implement due to the logistics of identifying and securing mitigation projects. The Applicant would begin the process of identifying mitigation projects within one year of agreement upon the option with the USFWS, with the goal of securing the projects within two years.

8.2.6 Change in Summer Risk for the Covered Species

Though risk to Covered Species is not anticipated during the summer maternity season (Section 3.4.3), there is the possibility that new summer maternity colonies may form or that a previously unidentified maternity colony may be found in the vicinity of the Project during the permit term. If that occurs, 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.

8.2.6.1 Trigger

This changed circumstance may be triggered in the following ways:

1) The Applicant detects the carcass of a pregnant or lactating female or a juvenile (first-year) individual of the Covered Species through its standardized monitoring or O&M (WIRS) monitoring, and the mortality is estimated to have occurred between May 16 and July 31.
2) The USFWS or a third party discovers the carcass of or captures a pregnant or lactating female or juvenile (first-year) Indiana bat, with an estimated mortality date or while conducting summer surveys, respectively, between May 16-July 31 at an off-site location, and (i) the carcass discovery or capture location is within a 5-mile buffer of a Project turbine, or (ii) the captured bat is tracked to a roost tree that is located within 2.5 miles of a Project turbine.
3) The USFWS or a third party discovers the carcass of or captures a pregnant or lactating female or juvenile (first-year) northern long-eared bat, with an estimated mortality date or while conducting summer surveys, respectively, between May 16-July 31 at an off-site location, and (i) the carcass discovery or capture location is within a 3-mile buffer of a Project turbine, or (ii) the captured bat is tracked to a roost tree that is located within 1.5 miles of a Project turbine

The Service will notify the Applicant if trigger 2 or 3 occurs. Notification to the Applicant must include the relevant survey results that led the USFWS to conclude the trigger has been met.

8.2.6.2 Response

For Trigger 1: The Applicant will notify USFWS within 24 hours of identifying the carcass of an Indiana bat or northern long-eared bat determined to have been killed during 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 between ½ hour before sunset to ½ hour after sunrise when temperatures are greater than 50 degrees F) during the summer season (May 16-July 31). The carcass discovered incidentally will be accounted for in the Project take estimate using the truncated prior approach identified in Section 5.4.1.1 and described in more detail in Appendix A. In addition, the Applicant will then re-evaluate the extent of the summer risk of take at the Project by conducting an updated habitat assessment and/or presence-absence surveys as soon as logistically feasible. Using the results of the re-evaluation, the Applicant and the Service will work together to determine the new set of the Project's turbines that present a risk of take and begin to operate those turbines during the summer season according to the minimization measures for fall migration. Alternatively, the Applicant may forego the re-evaluation and assume that summer risk is present at, and apply the minimization measures to, all Project turbines. In addition to application of minimization measures, the Applicant will extend the compliance monitoring regime described in section 5.4.1.1 to include the summer season; the monitoring study design for all subsequent standardized monitoring years will reflect the contribution to the cumulative annual g value of the additional summer take.

For Triggers 2 and 3: If USFWS notifies the Applicant of the discovery of a carcass, capture or colony that meets the specified conditions, the Applicant will re-evaluate the extent of the summer risk of take at the Project by conducting an updated habitat assessment and/or presence-absence surveys as soon as logistically feasible. Using the results of the re-evaluation, the Applicant and the Service will work together to determine the new set of the Project's turbines that present a risk of summer take and begin to operate those turbines 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 between ½ hour before sunset to ½ hour after sunrise when temperatures are greater than 50 degrees F) during the summer season (May 16-July 31). Alternatively, the Applicant may forego this re-evaluation and assume that summer risk is present at, and apply the minimization measures to, all Project turbines. In addition to application of minimization measures, the Applicant will extend the compliance monitoring regime described in section 5.4.1.1 to include the summer season; the monitoring study design for all subsequent standardized monitoring years will reflect the contribution to the cumulative annual g value of the additional summer take.

The application of the additional summer minimization and monitoring measures will continue for the remainder of the permit term unless supplemental information is collected which indicates that summer risk no longer exists at some or all of the Project turbines, in which case the application of the summer minimization and monitoring will be adjusted to reflect this change.

Following activation of any of the above triggers and implementation of the indicated response actions, the take estimates obtained through the compliance monitoring program (as expanded to account for the addition of summer risk at the identified turbines) will reflect any additional take attributable to the summer season. These take estimates will continue to inform the Applicant's adaptive management program as set forth in Section 5.4.1, and the mitigation project implementation schedule as set forth in Section 5.3.1, ensuring that take from the Project remains within the permitted limits for the duration of the permit term, and that mitigation implementation remains ahead of the take.

8.3 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). The USFWS bears the burden of demonstrating that an unforeseen circumstance has occurred and must use the best available scientific and commercial data in evaluating the unforeseen circumstance (50 CFR 17.22(b)(5)(iii)(C) [1985] and 17.32(b)(5)(iii)(C) [1985]).

According to the HCP Handbook, in deciding whether an unforeseen circumstance has occurred that might warrant additional mitigation from a permittee, the USFWS shall consider, but not be limited to, the following factors: a) size of the current range of the affected covered species, b) percentage of range adversely affected by the HCP, c) percentage of range conserved by the HCP, d) ecological significance of that portion of the range affected by the HCP, e) level of knowledge about the affected species and the degree of specificity of the species' conservation program under the HCP, f) whether the HCP was originally designed to provide an overall net benefit to the affected species and contained measurable criteria for assessing the biological success of the HCP, and g) whether failure to adopt additional conservation measures would appreciably reduce the likelihood of survival and recovery of the affected species in the wild (USFWS and NMFS 2016, p. 9-40).

If an unforeseen circumstance arises, the USFWS will not require the permittee to commit 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 HCP and beyond the level otherwise agreed upon for the species covered by the HCP without the consent of the permittee (50 CFR 17.22(b)(5)(iii)(A) [1985]). If additional minimization and mitigation measures are deemed necessary to respond to unforeseen circumstances, the USFWS may require additional measures of the permittee where the HCP is being properly implemented only if such measures are limited to modifications within conserved habitat areas, if any, or to the HCP's operating conservation program for the affected species, and shall maintain the original terms of the HCP to the maximum extent possible (50 CFR 17.22(b)(5)(iii)(B)). Additional minimization and mitigation measures will not involve 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 HCP without the consent of the permittee (USFWS and NMFS 2016).

Notwithstanding these assurances, nothing in the No Surprises rule "will be construed to limit or constrain the [USFWS], 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] and 17.32(b)(c) [1985]; 50 CFR 222.307(h) [2011]).

8.4 Permit Amendment

The HCP Handbook states that an ITP should be amended when the permittee significantly modifies the covered activities, the project, or the minimization or mitigation measures from the description in the original HCP. Such modifications may include changes in the permit area, changes in funding, addition of species to the ITP that were not addressed in the original HCP, or adjustments to the HCP due to strategies developed to address unforeseen circumstances. Depending on the circumstances, these could be made without a formal amendment request, or may require a formal amendment accompanied by public notice and analyses to varying extents, as described below. Any permit amendment must satisfy ESA § 10 review requirements, and as the scale and scope of an amendment increases, other responsibilities, such as additional NEPA or ESA § 7 review, may be triggered (USFWS and NMFS 2016).

8.4.1 Changes Made Without a Formal Amendment Request

Some changes or corrections to this HCP or to its requested ITP may be agreed upon between the Applicant and the USFWS without a formal amendment request. These changes are primarily corrective revisions where the take levels and project activities are not substantively altered. Examples are: correcting insignificant mapping errors, modifying avoidance and minimization measures to a small degree, modifying reporting protocols, making small changes to monitoring protocols, making changes to funding sources, and changing the names or addresses of responsible officials (USFWS and NMFS 2016). These changes 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. USFWS-approved changes will be documented in a note to the Project file.

8.4.2 Formal Amendments

Amendments may constitute an exchange of formal correspondence between the USFWS and the Applicant, addenda to the HCP, revisions to the HCP, or ITP amendments. The extent of NEPA and ESA § 7 analyses and public notice processes accompanying an amendment is determined by the USFWS and depends on the scale and scope of the amendment. Amendments that do not increase the levels of incidental take and do not change the covered activity in ways that were not analyzed in the original NEPA or ESA § 7 documents do not usually require advertising for public notice or additional analysis under NEPA or ESA § 7. Amendments that require ITP amendment and publication in the Federal Register 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 permittee to implement the HCP; changes to covered activities not previously addressed; changes to covered lands; and significant changes to the conservation strategy, including changes to the mitigation measures (USFWS and NMFS 2016).

8.5 Permit Renewal

The Applicant requests that the ITP associated with this HCP be renewable pursuant to 50 CFR 13.22. In the event that the Applicant plans to continue to operate the Project after the permit term, and the cumulative take documented for the Project is less than the take level originally authorized in the ITP, the Applicant may file a renewal request at least 30 days prior to the expiration of the ITP. Per the HCP Handbook, the USFWS will honor the No Surprises assurances as much as practicable, but a renewed permit must satisfy applicable statutory and regulatory requirements in force as of the date of the approval of the renewal request. Permit renewals must be published in the FR before the USFWS issues a decision, even if there are no revisions (USFWS and NMFS 2016).

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Appendix A. Use of the US Geological Survey Evidence of Absence Statistical Framework to Develop Take Predictions and Estimates for Indiana Bats and Northern Long-Eared Bats

1.0 INTRODUCTION

EDP Renewables has prepared a Habitat Conservation Plan (HCP) in support of an Incidental Take Permit (ITP) application for Indiana bats and northern long-eared bats (Covered Species) for the Timber Road II, III, and IV Wind Farms (Project). HCPs include predictions of the numbers of Covered Species that will be taken and specify methods for monitoring and estimating numbers of Covered Species that have been taken to assess permit compliance. The Timber Road II, III, and IV Wind Farms HCP used the Evidence of Absence (EoA; Huso et al. 2015) approach to fatality estimation to develop a take prediction and monitoring for the HCP will use EoA to determine take compliance. This document describes how EoA was used to predict take (section 5 of this appendix) and will be used to estimate take during monitoring (section 4 of this appendix).

'Evidence of Absence' refers to a variety of different concepts. In general, it refers to a Bayesian fatality estimator (Huso et al. 2015). It can also refer to a software library for the R statistical computing platform that implements some variants of the EoA estimator (EoA software; Dalthorp et al 2014)[26]. It additionally refers to the Design Tradeoffs module within the EoA software, which determines the outcome of different monitoring design parameters on the probability to detect carcasses during searches, or *g*. Also within the EoA software, 'Evidence of Absence' can refer to the Scenario Explorer module, which investigates likely outcomes of adaptive management regimes during the course of ITP permits via simulation. Finally, outside of the direct application of statistical methodology, 'Evidence of Absence' refers to an adaptive management framework that assumes use of the EoA estimator to track compliance with HCPs (Dalthorp and Huso 2015).

In this document, EoA refers broadly to the Bayesian fatality estimator. Reference to the software, the adaptive management framework, or other modules within the software are explicitly noted as such. The Evidence of Absence framework is rich with notation; Table 1 at the end of this appendix lists all parameters and indices used in this appendix, which models they inform, and how they are obtained.

2.0 EVIDENCE OF ABSENCE OVERVIEW

2.1 Model Form

The EoA estimator takes as inputs the number of carcasses, X, found during searches along with an estimate of the accompanying probability to detect those carcasses, g. From these, it estimates the minimum number of carcasses, *m,* which arrived during the study:

$$Pr(M \geq m \mid X, g) \leq \alpha \tag{1}$$

[26] The citation is the user manual for version 1.0. The EoA software is currently in version 1.06 with version 2.0 in beta testing, but the most recent documentation is for version 1.0.

where

M is the total number of carcasses (Poisson-distributed),

m is the point estimate at the credibility level $1-\ \alpha$,

X is the count of carcasses from searches (binomially-distributed),

g is the probability to detect a carcass, given that it occurred (beta-distributed), and

$1-\ \alpha$ is the desired credibility for the estimate.

In the use of this model, α is specified in a way appropriate to the situation (i.e., it is driven by policy), X is known exactly from data, g is unknown and estimated as $\hat{g}$, and a prior distribution is specified for M. The estimate of fatality m is obtained by calculating the posterior distribution for M and extracting the $100(1-\ \alpha)\%$ upper credible bound (or quantile) from the posterior distribution. When the desired estimate is a fatality rate rather than a total number of fatalities, EoA can estimate the posterior distribution of λ, the underlying fatality rate parameter for the Poisson distribution that generates M. That is,

$$M \sim Poisson(\lambda), \tag{2}$$

and EoA estimates the posterior of λ

$$Pr(\lambda \mid X, g). \tag{3}$$

Variants of the EoA estimator discussed in this document and available through the EoA software differ with respect to estimation of $\hat{g}$ and may differ with respect to the prior distribution assumed for $\widehat{M}$ or $\hat{\lambda}$. Otherwise, the parameters are identical to those in the EoA software.

2.1.1 Prior Distributions

EoA software versions 1.05 through 2.0 (beta), and the analyses presented in this HCP, implement a reference prior distribution for $\widehat{M}$:

$$Pr(M) \propto \int_{m}^{m+1} \frac{1}{\sqrt{m}}\, dm \tag{4}$$

and a Jeffrey's prior distribution for $\hat{\lambda}$:

$$Pr(\lambda) \propto \frac{1}{\sqrt{\lambda}} \tag{5}$$

Dalthorp and Huso (2015) provide the rationale for choice of these priors. The choice of prior distributions for $\widehat{M}$ and $\hat{\lambda}$ are not definitive features of the EoA estimator. The EoA software also implements uniform priors and informed priors (Dalthorp et al. 2014, Huso et al. 2015). At present, the reference prior for $\widehat{M}$ and the Jeffrey's prior for $\hat{\lambda}$ are thought to be the most robust for general use, but alternatives may be developed in the future.

The default reference prior distribution for $\widehat{M}$ described above will be used in all cases except when carcasses are found "incidentally" (i.e., carcasses found outside of the standardized search area, or within a search area on a day when a scheduled search is not taking place). To formally account for these incidental carcasses, a truncated Jeffrey's prior will be used, with the distribution truncated at the number of incidental carcasses in hand. The truncated Jeffrey's prior is defined as $\Pr(M) \propto 1/\sqrt{M}$ for $M < x_i$, where x_i is the number of incidental carcasses in hand. This prior stipulates that there is zero probability of *M* being less than x_i.

3.0 MODEL PARAMETERS

3.1 Estimation of *g*: Overall Probability to Observe a Carcass

A key input to the EoA fatality estimator is the probability to detect a carcass, g, given that a carcass has arrived at the wind farm. Like the choice of priors, the method to estimate g is not a definitive feature of EoA (Huso et al. 2015). Analyses presented and proposed in this document calculate g following the methods in the EoA software v1.06[27]. The estimate of g is the product of the fraction of turbines searched, γ, the probability that a carcass at a searched turbine falls within a searched area, a, and the probability that a carcass falling in a searched area persists and is detected by a searcher, $\hat{\pi}$. The estimates of $\hat{\pi}$ are derived from several other models: searcher efficiency, the rate at which searcher efficiency changes with subsequent searches, k, carcass persistence, and carcass arrival phenology. Each component of g is described in turn in the following sections.

3.1.1 Probability That a Carcass Falls within a Searched Area (Weighted Distribution Method)

Fatality monitoring protocols may include search plots that are not large enough to capture all carcasses that arrive at turbines. Estimates of g include a component (area correction, a) that accounts for carcasses that may have fallen outside of searched areas (or the probability that a carcass at a searched turbine falls within a searched area), whether search plots were too small to capture all carcasses, or whether plots were irregularly shaped (e.g., road and turbine pad plots).

Carcass fall density is not uniform around turbines; rather, the relative density of carcasses nearer to turbines tends to be greater than the relative density of carcasses far from turbines (Hull and Muir 2010). It is necessary to model the fall distribution of carcasses relative to the turbine mast via distance (hereafter, "distance distribution") so that the fraction of carcasses that occur within searched areas can be estimated. Modelling the fall distribution of carcasses is complicated because the observed fall distribution is influenced by a finite search radius (i.e., the underlying distribution is truncated) and because the observed fall distribution is distorted by unequal detection probability based on carcass distance from turbines. For these reasons, calculating the area correction, a, is complicated.

[27] These methods are not formally documented elsewhere but are described here based on a close reading of the EoA software code.

Area correction, a, is calculated by estimating the proportion of carcasses expected to fall within searched areas:

$$a = \sum_{x=1}^{u} H_x \times \sigma_x \quad (6)$$

where a is the area correction factor, x indexes a series of 1-m-wide annuli centered on the turbine, u is the maximum search radius in meters, σ_x is the fraction of the x^{th} annulus searched (calculated in a Geographic Information System), and H_x is the proportion of all carcasses occurring within the x^{th} annulus.

H_x is calculated as:

$$Pr(x-1 < Y < x) = H_x = \int_{x-1}^{x} h(y|\hat{\theta})\, dy \quad (7)$$

where $h(x)$ is the estimated distance distribution of carcasses (from turbine center) and $\hat{\theta}$ are the parameters associated with the distance distribution.

The distance distribution of carcasses (from turbines) is assumed to follow one of six probability distributions (normal, gamma, Weibull, log-logistic, Gompertz, or Rayleigh), and sample-size corrected Akaike's Information Criterion (AICc, Burnham and Anderson 2002, Burnham and Anderson 2004) is used to select the best model for the available data. The raw observed distances of carcasses from turbines (hereafter, "observed distance distribution") do not represent the true underlying distance distribution because the proportion of searchable area may vary with distance from turbine. Also, the carcass distance data may be aggregated over several search strata with different detection probabilities.

A maximum likelihood estimation approach (MLE) is used to fit a weighted distribution (D. Dalthorp, USGS, pers. comm.) to the data, where the weights reflect relative probabilities of detection to account for the divergence between the observed and underlying distance distributions.

If the underlying distance distribution is described by some probability density function, $h(x|\theta)$, where x is distance from the turbine, θ is the associated parameter vector, and the weights are described by a function, $w(x)$, then the weighted distribution is:

$$h^*(x|\theta) = \frac{w(x) \times h(x|\theta)}{\int_0^{\infty} w(y) \times h(y|\theta) dy} \quad (8)$$

where the $w(x)$ in the numerator accounts for the distortion of the underlying distance distribution, $h(x|\theta)$, that arises due to variable detection probability, and the integral in the denominator ensures that the weighted distribution is still a valid probability function.

Although the parameters, $\hat{\theta}$ are obtained by maximizing the likelihood associated with $h^*(x|\theta)$, the underlying density distribution in Equation (7) is approximated as $h(x|\hat{\theta})$.

By using $h(x|\hat{\theta})$ in (7) the area correction accounts for differential detection probabilities within search areas, as well as carcasses that may have fallen beyond the boundaries of the search area.

The weight function needs to include any factor that influences the probability to detect a carcass. Although some components of the weight function are not individually distance-dependent, they become so when combined with data across several search strata with different search radii. The weight function is difficult to approximate because most of its components need to be estimated. The weight function is approximated as

$$w(x) = \frac{\sum_{z=1}^{n} \pi_z \times \lambda_z \times \sigma_{z,x} \times t_z}{\sum_{z=1}^{n} t_z}, \quad (9)$$

for distances from $0 \leq x \leq r$ meters, and assigned a value of 0 for all other distances. In Equation (9), *n* is the number of search strata represented in the sample, π_z is the detection probability for a carcass in stratum *z* (Section 3.1.6: *Probability That a Carcass That Falls in a Searched Area Persists and is Detected by a Searcher*), λ_z is the fatality rate in stratum *z*, t_z is the number of turbines included in stratum *z*, and $\sigma_{z,x}$ is the average proportion of area searched in the x^{th} annulus in stratum *z.* If all of the search strata contributing data to the weighted distribution estimate have the same search radius, the weight function can be simplified to:

$$w(x) = \pi_z \times \sigma_{z,x} \quad (10)$$

because fatality rates do not vary systematically with search plot size.

3.1.2 Searcher Efficiency

Searcher efficiency is the probability that a searcher will successfully detect a carcass that is present within the search area during a search.

Searcher efficiency p follows a simple binomial model and is estimated from experimental trials as:

$$\hat{p} = \frac{number\ of\ trial\ carcasses\ that\ were\ detected\ by\ searchers}{number\ of\ trial\ carcasses\ that\ were\ available\ to\ searchers} \quad (11)$$

3.1.3 Change in Searcher Efficiency through Successive Searches

For a given carcass, searcher efficiency is not constant through time, but changes with successive searches. First, carcasses decay and eventually disintegrate as they age. Second, easy-to-see carcasses are more readily detected during earlier searches, meaning that carcasses that remain through subsequent searches tend to be inherently more difficult to see.

If searcher efficiency is assumed constant through time, estimates of detection probability will be biased high, and fatality estimates will be biased low, and the converse also holds. Accurate fatality estimates that make best use of the search data require an understanding of how searcher efficiency changes through time.

The multiplicative parameter k describes changing searcher efficiency through time via:

$$p_{j+1} = p_j \times k \tag{12}$$

where p_j is the searcher efficiency on the j^{th} search.

Estimating k requires that searcher efficiency trial carcasses be deployed and left in place through multiple searches, and generally requires large numbers of trial carcasses to ensure adequate sample size beyond the first search. When data that track trial carcasses through a number of searches are available, searcher efficiency can be calculated for successive searches (p_j, where j is an index for searches) and k can be estimated using Bayesian or frequentist methods.

Data to estimate k often are not available. Huso et al. (*in press*) have analyzed bat searcher efficiency data from numerous studies in North America and suggest that in the absence of data, 0.67 is a reasonable value to use for k for bats. A value of 0.67 means that if searcher efficiency is p for a carcass that has been subjected to no previous searches, it will be $p \times 0.67$ for a carcass that has been available for one search (and missed), $p \times 0.67^2$ for a carcass that has been available for two searches (and missed), and so-on.

3.1.4 Carcass Persistence

Not all carcasses that arrive at the wind farm persist on the landscape long enough to be discovered. Scavengers, agricultural activity, or other forces may remove carcasses before searchers have an opportunity to detect them. The average probability of persistence of a carcass is estimated from an interval-censored survival model (Huso et al. 2012). Given a search interval of length I, the Huso et al. (2012) approach estimates the average probability that a carcass arriving $\{0, 1, 2, \ldots, I\}$ days before the search will persist until the search. Assuming carcass persistence times follow a probability distribution $f(d)$ with cumulative probability function $F(d)$, the probability of "survival," or persistence, until day d is $1 - F(d)$. If carcass arrival is uniform in time so that the probability of arrival is constant between 0 and I, the average persistence probability r until the first search after a carcass arrives is:

$$r_{1,1} = \frac{\int_0^I 1-F(d)\, dd}{I} \tag{13}$$

A minor modification of this formula accommodates carcasses that may be missed on the first search and discovered on a subsequent search (the *j^th^* search). The average probability that a carcass which has persisted from the $(j-1)^{th}$ search also persists until the j^{th} search is:

$$r_{1,j} = \frac{\int_{(j-1)\times I}^{j\times I} 1-F(d)\,dd}{\int_{(j-2)\times I}^{(j-1)\times I} 1-F(d)\,dd} \quad (14)$$

where $j \geq 2$.

3.1.5 Carcass Arrival Phenology

The detection probability for any particular carcass depends on when it arrives at the wind farm. This is because carcasses that arrive earlier during the study period have the potential to persist through more searches, and therefore have more opportunities to be discovered than carcasses arriving later in the study period. Assume that there are q searches during the study period that occur on days $\{d_1, d_2, \ldots\ d_q\}$ and assume there are no carcasses available when the study period begins on day $d_0 = 0$. The time interval $\{d_{i-1}, \ldots, d_i$ is the i^{th} arrival interval, and the proportion of carcasses arriving during the i^{th} arrival interval is c_i, where we ensure that all of the carcasses arrive during an interval by ensuring that,

$$\sum_{i=1}^{q} c_i = 1.0 \quad (15)$$

Equality of all of the c_i implies the same relative arrival rate of carcasses between each search interval (i.e., over the entire study period). This would be the case if, for example, the arrival phenology of carcasses is uniform in time and the search interval is constant between searches. The c_i can be adjusted to reflect non-constant arrival phenology, non-constant search interval, or both.

When carcass arrival is pulsed (as it may be if there is a seasonal migration), it is likely that the relative abundance of carcasses during a pulse forms a bell-shaped curve, but it is rare to have appropriate data to estimate the shape of the curve. Even with adequate carcass arrival data, large year-to-year variation in phenology precludes the assumption that one year's estimate will be adequate to predict for a subsequent year.

Consequently, arrival phenology is assumed to be uniform through the intervals within a season and adjustments to the c_i are made on the basis of relative fatality rates from season to season. If seasonal and annual fatality estimates are not available for the target species, fatality estimates for a larger group of species (e.g., all bats) may be used as a surrogate.

3.1.6 Probability That a Carcass That Falls in a Searched Area Persists and is Detected by a Searcher

The probability that a carcass arrived during the i^{th} interval persists and is detected on the i^{th} or subsequent searches (*interval-specific detection probability*) is calculated recursively for each search from i to q, where q is the last search. The probability that a carcass persists and is detected on the first search after arrival is:

$$\pi_{i,i} = r_{i,i} \times p \quad (16)$$

where $r_{i,i}$ is the probability of persistence (Equation 14) and p is the probability of detection (Equation 11). The probability that the carcass persists and is detected on the second or subsequent searches after arrival is:

$$\pi_{i,j} = \pi_{i,i} + \sum_{\psi=i+1}^{j}(1 - \pi_{i,\psi-1}) \times (r_{i,\psi} \times p \times k^{\psi-i}) \tag{17}$$

where $\pi_{i,j}$ is the probability that a carcass arriving during the i^{th} interval persists and is detected during the j^{th} search and *k* is the factor by which searcher efficiency changes from one search to the next.

For a study with a total of q search intervals, $\pi_{i,j}$ can be calculated for any $0 \leq i \leq j \leq q$, but in practice we are interested in the probability that a carcass arriving during the i^{th} interval is detected at *some* point before the end of the study, i.e. $\pi_{i,q}$.

The first element of the product in the summand of Equation (17) represents the probability that the carcass is missed during all previous searches and the second element of the product in the summand of Equation (17) represents the probability that the carcass is discovered during the j^{th} search.

The overall probability of detection for a carcass is the average of the interval-specific arrival probabilities weighted by the arrival fraction c_i:

$$\pi = \sum_{i=1}^{q} \pi_{i,q} \times c_i. \tag{18}$$

3.1.7 Overall Probability of Carcass Detection

For a wind farm with z search strata having T_z turbines in each of the z strata, of which t_z are searched, the overall probability that a carcass arriving at the wind farm will fall in a searched area, remain available for searchers, and be detected is:

$$g = \sum_{i=1}^{z} \frac{t_i}{T_i} \times a_i \times \pi_i \tag{19}$$

The variance of this estimator is unknown. Bootstrap resampling procedures are used to approximate confidence intervals for this estimator when required.

4.0 FATALITY ESTIMATION

Fatality estimation in EoA is straightforward: carcass counts and probabilities of detection are analyzed using EoA, and a take estimate M is obtained with the desired level of credibility.

4.1 Single-Site, Single-Year Fatality Estimation

The EoA software provides functionality to calculate a fatality estimate for a single site during a single year. The estimating model is exactly as given in Section 2.1: *Model Form*. This module of the EoA software is the only module that calculates g based on user-supplied information about the arrival function, search schedule, probability that a carcass falls in a searched area, searcher efficiency, and carcass persistence. The form of the information accepted by the software varies by version; Versions 2.0 (beta) and higher return g as the two parameters that describe a beta distribution, while earlier versions return g with 95% confidence intervals, calculated in Section 3.1.7: *Overall Probability of Carcass Detection.*

The EoA software takes the probability of carcass detection, g, and the count of carcasses from searches, X, as inputs and returns the posterior distribution of total fatality. Versions 2.0 and later also return the posterior distribution of the fatality rate, λ.

4.2 Multiple Year (or Multiple Season) Fatality Estimation

When data are available from multiple search periods (years or seasons), the EoA software can provide a cumulative estimate of fatality that covers the entire search history. The estimating model is exactly as given in Section 2.1: *Model Form*. Inputs to the EoA software are in the form of a matrix with one row for each search period.

For versions 1.06 and earlier, the columns contain carcass counts, the point estimate of g, upper and lower 95% confidence bounds for g, and annual weights. For versions 2.0 and later, the columns contain carcass counts, the two parameters of a beta distribution that describe g, and annual weights. The annual weights are proportional to the expected relative fatality rates for each sampling period.

Although fatality rates are unknown, weights may vary with wind farm size (if, for example, a wind farm doubles in size between two sample periods) or with adaptive management actions (e.g., a wind farm implements an adaptive management action that is expected to reduce fatality by half). The weights are used to calculate a weighted average g:

$$g = \frac{\sum_{b=1}^{sampling\ periods} g_b \times v_b}{\sum_{b=1}^{sampling\ periods} v_b} \qquad (20)$$

where g_b and v_b are the sampling-period-specific probabilities of detection and weights, respectively.

The multiple year module of the EoA software returns an estimate of total cumulative fatality, M, or an estimate of the average fatality rate, λ. If λ is returned, it carries units of carcasses per wind farm per sampling period and it is scaled to be relative to a wind farm operating with a weight of 1.0.

4.3 Multiple Site (or Search Stratum) Fatality Estimation

When data are available from multiple sites or multiple search strata within a site, the EoA software can provide a cumulative estimate of fatality covering the entire searched area. The estimating model is exactly as given in Section 2.1: *Model Form*. Inputs to the EoA software are in the form of a matrix with one row for each stratum.

For versions 1.06 and earlier, the columns contain carcass counts, the point estimate of π, upper and lower 95% confidence bounds for π, and stratum weights. For versions 2.0 and later, the columns contain carcass counts, the two parameters of a beta distribution that describe π, and stratum weights.

The stratum weights are the fraction of carcasses that are expected to fall within each search stratum (i.e., a from Section 3.1.6: *Probability That a Carcass That Falls in a Searched Area Persists and is Detected by a Searcher*). In version 2.0 and later, the stratum weights must sum to 1.0 and the input matrix always includes an unsearched stratum (with $\pi = 0$) to account for unsearched turbines or areas.

The weights are used to calculate a weighted average g:

$$g = \sum_{z=1}^{sampling\ strata} \pi_z \times a_z \qquad (21)$$

where π_z and a_z are the stratum-specific probabilities of detection and area corrections, respectively.

The multiple site module of the EoA software will return an estimate of total fatality, M, or an estimate of the fatality rate, λ. If λ is returned it carries units of carcasses per sampling period and it covers the entire area represented within the input data table.

4.4 Selecting Credible Bounds from Evidence of Absence Estimates

Because EoA is a Bayesian model, the estimates it returns are distributions of total take, or the take rate. When a single number is needed to set a threshold or determine compliance, it is necessary to select a credible bound from the posterior distribution. There is no objective way to select credible bounds; the decision is based on a subjective assessment of the risks of setting the wrong threshold that would result in being in noncompliance with an incidental take permit (ITP). In general, the 50th credible bound, or median of the distribution, is a good value to use for a point estimate: in this case, there is 50% confidence that the true value is not greater than that estimated value. As larger credible bounds are chosen, confidence increases that the true value will not be larger than the estimated value.

5.0 FATALITY PREDICTION

It is often desirable to obtain fatality predictions based on past fatality estimates but unless a fatality prediction is desired for the same time interval and the same area that informed the prediction, it is not possible to use the estimate of M in fatality prediction. The estimate of M is specific to the duration, area, and operational regime (i.e., turbine cut-in speed) where data were collected. Similarly, an estimate of M that is calculated for a wind farm with two equally-sized phases cannot be rescaled to represent one phase of the wind farm. This is because M is a credible bound from a Poisson posterior, and the quantiles of Poisson distributions do not scale in a linear way.

When a fatality prediction is needed, the procedure is to estimate the fatality rate, λ, for a wind farm that is sufficiently comparable to the wind farm for which a prediction is desired. Unlike M, the credible bounds of λ can be rescaled to represent larger or smaller facilities, or longer or shorter time periods, or facilities with different operational regimes. For example, if λ is estimated (at a desired level of credibility: Q_λ) for a wind farm with 100 turbines over a 2-year period and a prediction is needed for a 200-turbine wind farm for 30 years, the predicted fatality rate (with the same Q_λ) will be $\lambda_{pred} = 2 \times 15 \times \lambda$.

Getting from λ_{pred} to a predicted number of fatalities for the purpose of developing a take prediction to set a take authorization number for an ITP requires the selection of a credible bound (Q_M) for the prediction of M. The predicted number of fatalities is then the Q_M credible bound (= Q_M quantile) from a Poisson distribution with a rate parameter equal to λ_{pred}.

6.0 MONITORING DESIGN

The EoA software has a *Design tradeoffs* module that is useful when designing fatality monitoring. The module calculates g as described in Section 3.1: *Estimation of g: Overall Probability to Observe a Carcass,* given user input and returns the results in graphical format.

Table 1. Parameters and indices used in this appendix, which models they inform, and how they are obtained.

Parameter	Definition	How Obtained	Models in Which it is Used
α	One minus the credibility of an estimate	Subjective decision	
$\boldsymbol{a}$	area correction- the proportion of carcasses expected to fall within searched areas	Estimated	Overall probability of detection
$\boldsymbol{b}$	Index for sampling periods within a multiple- year or multiple-season EoA estimate	Index	Evidence of Absence
$\boldsymbol{c_i}$	Fraction of carcasses arriving during the i^{th} interval	Assumed uniform within seasons; Estimated among seasons	Overall probability of detection
$\boldsymbol{d}$	Time (days) to carcass removal	Function input	Carcass persistence
$\boldsymbol{f(d)}$	Probability distribution function for persistence times (d; days) of carcasses	Estimated	Carcass persistence
$\boldsymbol{F(d)}$	Cumulative distribution function for persistence times (d; days) of carcasses	Estimated	Carcass persistence
$\boldsymbol{g}$	Overall probability that a carcass arriving at the wind farm persists and is detected by searchers	Estimated	Overall probability of detection

Table 1. Parameters and indices used in this appendix, which models they inform, and how they are obtained.

Parameter	Definition	How Obtained	Models in Which it is Used
$\boldsymbol{g_{i,j}}$	Probability that a carcass arriving during the i^{th} interval persists until and is discovered during the j^{th} interval, conditional on having persisted until the $j-1^{th}$ interval	Estimated	Overall probability of detection
$\boldsymbol{\gamma}$	Proportion of turbines searched	Known	Overall probability of detection
$\boldsymbol{H_x}$	Proportion of carcasses in the annulus that covers between $x-1$ and x meters from turbines	Estimated	Area correction
$\boldsymbol{h(x\,\vert\theta)}$	Probability distribution function for distances (x; meters) of carcasses from turbines	Estimated	Distance distribution
$\boldsymbol{h^*(x\,\vert\theta)}$	Weighted probability distribution function for distances (x; meters) of carcasses from turbines	Estimated	Distance distribution
$\boldsymbol{I}$	Duration of search interval; number of days between searches	Known	Carcass persistence
$\boldsymbol{i}$	Index for intervals	Index	Carcass persistence, overall probability of detection
$\boldsymbol{j}$	Index for searches	Index	Carcass persistence, overall probability of detection
$\boldsymbol{k}$	Factor by which searcher efficiency (p) changes between searches	Assumed ($k = 0.67$) or estimated	Overall probability of detection
$\boldsymbol{\lambda}$	Fatality rate	Estimated	Model form
$\boldsymbol{M}$	Total fatality	Estimated	Model form
$\boldsymbol{n}$	Number of search strata contributing data to the distance distribution ($h^*(x \mid \theta)$) of carcasses from turbines	Known	Distance distribution of carcasses
$\boldsymbol{p}$	Searcher efficiency; this is the probability that a carcass that is in a search area during a search is detected by a searcher	Estimated	Overall probability of detection
$\boldsymbol{Pr}$	Abbreviation for *Probability*	Abbreviation	
$\boldsymbol{\pi}$	Probability that a carcass within a searched area will be available to searchers and detected	Estimated	Overall probability of detection
$\boldsymbol{Q}$	Credible bound for estimation or prediction of λ or M	Subjectively selected	Fatality estimation
$\boldsymbol{q}$	Number of searches and search intervals during the study	Known from field data	Overall probability of detection
$\boldsymbol{r_{i,j}}$	Average probability that a carcass arriving during interval i persists until search j	Estimated	Carcass persistence, overall probability of detection
$\boldsymbol{s}$	Index for carcasses informing the distance distribution	Index	Distance distribution

Table 1. Parameters and indices used in this appendix, which models they inform, and how they are obtained.

Parameter	Definition	How Obtained	Models in Which it is Used
$\boldsymbol{S}$	Total number of carcasses informing the distance distribution	Known from field data	Distance distribution
$\boldsymbol{\sigma_x}$	Average proportion of area searched between $x-1$ meters and x meters from the turbine	Estimated in GIS	Distance distribution
$\boldsymbol{\sigma_{z,x}}$	Average proportion of area searched between $x-1$ meters and x meters from the turbine in stratum z	Estimated in GIS	Distance distribution
$\boldsymbol{T_z}$	Total number of turbines in sampling stratum z	Known from field data	Distance distribution
$\boldsymbol{t_z}$	Number of turbines sampled within a sampling stratum z	Known from field data	Distance distribution
$\boldsymbol{\theta}$	Parameters associated with the probability distribution function for distances of carcasses from turbines $h(x \mid \theta)$	Estimated	Distance distribution
$\boldsymbol{\hat{\theta}}$	Estimated parameters associated with the weighted probability distribution function for distances of carcasses from turbines $h^{*}(x \mid \theta)$	Estimated	Distance distribution
$\boldsymbol{u}$	Maximum search distance (meters)	Known from field data	Distance distribution
$\boldsymbol{v}$	Sampling period weights for a multiple-year or multiple-season EoA estimate	Estimated	Searcher efficiency, overall probability of detection
$\boldsymbol{w(x)}$	Weighting function (of distance, x; meters) used to fit the weighted distance distribution of carcasses from turbines $(h^{*}(x \mid \theta))$	Estimated	Distance distribution
$\boldsymbol{X}$	Count of carcasses from monitoring searches	Known from data	Model form
$\boldsymbol{x}$	Distance (meters) of carcasses from turbines	Function input	Distance distribution
$\boldsymbol{z}$	Index for search strata	Index	Distance distribution, overall probability of detection

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Appendix B. Project Location and References for the 50 Publicly Available Mortality Monitoring Studies in the Eastern and Midwestern United States and Canada Reporting the Sex of Bat Carcasses Found

Appendix B. Project location and references for the 151 publicly available mortality monitoring studies in the Eastern and Midwestern United States and Canada reporting the sex of bat carcasses found.

Project	State or Province	Reference
Barton I and II (2010-2011)	IA	Derby et al. 2011b
Beech Ridge (2012)	WV	Tidhar et al. 2013a
Beech Ridge (2013)	WV	Young et al. 2014a
Big Blue (2013)	MN	Fagen Engineering 2014
Big Blue (2014)	MN	Fagen Engineering 2015
Bingham (2017)	ME	TRC 2017a
Bishop Hill (2012)	IL	Simon et al. 2014
Blue Sky Green Field (2008-2009)	WI	Gruver et al. 2009
Buffalo Ridge (1994/1995)	MN	Osborn et al. 1996, 2000
Buffalo Ridge (2000)	MN	Krenz and McMillian 2000
Buffalo Ridge (Phase I; 1996)	MN	Johnson et al. 2000
Buffalo Ridge (Phase I; 1997)	MN	Johnson et al. 2000
Buffalo Ridge (Phase I; 1998)	MN	Johnson et al. 2000
Buffalo Ridge (Phase I; 1999)	MN	Johnson et al. 2000
Buffalo Ridge (Phase II; 1998)	MN	Johnson et al. 2000
Buffalo Ridge (Phase II; 1999)	MN	Johnson et al. 2000
Buffalo Ridge (Phase II; 2001/Lake Benton I)	MN	Johnson et al. 2004
Buffalo Ridge (Phase III; 1999)	MN	Johnson et al. 2000
Buffalo Ridge (Phase III; 2001/Lake Benton II)	MN	Johnson et al. 2004
Buffalo Ridge I (2010)	SD	Derby et al. 2010d
Buffalo Ridge II (2011)	SD	Derby et al. 2012a
Bull Hill (2013)	ME	Stantec Consulting, Inc. (Stantec) 2014a
Bull Hill (2014)	ME	Stantec 2015b
Casselman (2008)	PA	Arnett et al. 2009
Casselman (2009)	PA	Arnett et al. 2010
Cedar Ridge (2009)	WI	BHE Environmental 2010
Cedar Ridge (2010)	WI	BHE Environmental 2011
Cohocton/Dutch Hill (2009)	NY	Stantec 2010
Cohocton/Dutch Hill (2010)	NY	Stantec 2011
Cohocton/Dutch Hill (2013)	NY	Stantec 2014b
Crescent Ridge	IL	Kerlinger et al. 2007
Criterion (2011)	MD	Young et al. 2012b
Criterion (2012)	MD	Young et al. 2013
Criterion (2013)	MD	Young et al. 2014b
Crystal Lake II (2009)	IA	Derby et al. 2010b
Elm Creek (2009-2010)	MN	Derby et al. 2010e
Elm Creek II (2011-2012)	MN	Derby et al. 2012b
Forward Energy Center	WI	Grodsky and Drake 2011
Fowler I (2009)	IN	Johnson et al. 2010a
Fowler I, II, III (2010)	IN	Good et al. 2011
Fowler I, II, III (2011)	IN	Good et al. 2012
Fowler I, II, III (2012)	IN	Good et al. 2013a
Fowler III (2009)	IN	Johnson et al. 2010b
Fowler Ridge (2015)	IN	Good et al. 2016
Fowler Ridge (2016)	IN	Good et al. 2017
Fowler Ridge (2017)	IN	Good et al. 2018
Grand Ridge I (2009-2010)	IL	Derby et al. 2010a
Hancock (2017)	ME	TRC 2017b
Harrow (2010)	ON	Natural Resources Solutions Inc. (NRSI) 2011

Appendix B. Project location and references for the 151 publicly available mortality monitoring studies in the Eastern and Midwestern United States and Canada reporting the sex of bat carcasses found.

Project	State or Province	Reference
Heritage Garden (2012-2014)	MI	Kerlinger et al. 2014
Howard (2012)	NY	Tidhar et al. 2013c
Howard (2013)	NY	Lukins et al. 2014
Jersey Atlantic	NJ	New Jersey Audubon Society 2008a, 2008b, 2009
Kewaunee County	WI	Howe et al. 2002
Kibby (2011)	ME	Stantec 2012
Lakefield Wind	MN	Minnesota Public Utilities Commission 2012
Laurel Mountain (2013)	WV	Stantec 2014c
Laurel Mountain (2014)	WV	Stantec 2015a
Lempster (2009)	NH	Tidhar et al. 2010
Lempster (2010)	NH	Tidhar et al. 2011
Locust Ridge II (2009)	PA	Arnett et al. 2011
Locust Ridge II (2010)	PA	Arnett et al. 2011
Madison	NY	Kerlinger 2002
Maple Ridge (2006)	NY	Jain et al. 2007
Maple Ridge (2007)	NY	Jain et al. 2009a
Maple Ridge (2008)	NY	Jain et al. 2009b
Maple Ridge (2012)	NY	Tidhar et al. 2013b
Mars Hill (2007)	ME	Stantec 2008
Mars Hill (2008)	ME	Stantec 2009a
Melancthon I (2007)	ON	Stantec Consulting Ltd. (Stantec Ltd.) 2007
Meyersdale (2004)	PA	Arnett et al. 2005
Moraine II (2009)	MN	Derby et al. 2010f
Mount Storm (Fall 2008)	WV	Young et al. 2009b
Mount Storm (2009)	WV	Young et al. 2009a, 2010b
Mount Storm (2010)	WV	Young et al. 2010a, 2011b
Mount Storm (2011)	WV	Young et al. 2011a, 2012a
Mountaineer (2003)	WV	Kerns and Kerlinger 2004
Mountaineer (2004)	WV	Arnett et al. 2005
Munnsville (2008)	NY	Stantec 2009b
Noble Altona (2010)	NY	Jain et al. 2011a
Noble Altona (2011)	NY	Kerlinger et al. 2011
Noble Bliss (2008)	NY	Jain et al. 2009c
Noble Bliss (2009)	NY	Jain et al. 2010c
Noble Bliss/Wethersfield Comparison Study (2011)	NY	Kerlinger et al. 2011
Noble Chateaugay (2010)	NY	Jain et al. 2011b
Noble Clinton (2008)	NY	Jain et al. 2009d
Noble Clinton (2009)	NY	Jain et al. 2010a
Noble Ellenburg (2008)	NY	Jain et al. 2009e
Noble Ellenburg (2009)	NY	Jain et al. 2010b
Noble Wethersfield (2010)	NY	Jain et al. 2011c
NPPD Ainsworth (2006)	NE	Derby et al. 2007
Oakfield (2016)	ME	Stantec 2016
Oakfield (2017)	ME	TRC 2018
Odell (2016-2017)	MN	Chodachek and Gustafson 2018
Passadumkeag (2016)	ME	Ritzert et al. 2017

Appendix B. Project location and references for the 151 publicly available mortality monitoring studies in the Eastern and Midwestern United States and Canada reporting the sex of bat carcasses found.

Project	State or Province	Reference
Pinnacle (2012)	WV	Hein et al. 2013a
Pinnacle Operational Mitigation Study (2012)	WV	Hein et al. 2013b
Pioneer Prairie II (2013)	IA	Chodachek et al. 2014
Pioneer Prairie Phase II (2011-2012)	IA	Chodachek et al. 2012
Pioneer Trail (2012-2013)	IL	ARCADIS U.S., Inc. 2013
Pleasant Valley (2016-2017)	MN	Tetra Tech 2017b
Prairie Rose (2014)	MN	Chodachek et al. 2015
PrairieWinds ND1 (Minot) (2010)	ND	Derby et al. 2011d
PrairieWinds ND1 (Minot) (2011)	ND	Derby et al. 2012d
PrairieWinds SD1 (Crow Lake) (2011-2012)	SD	Derby et al. 2012c
PrairieWinds SD1 (Crow Lake) (2012-2013)	SD	Derby et al. 2013
PrairieWinds SD1 (Crow Lake) (2013-2014)	SD	Derby et al. 2014
Prince Wind Farm (2006)	ON	NRSI 2008b
Prince Wind Farm (2007)	ON	NRSI 2008a
Prince Wind Farm (2008)	ON	NRSI 2009
Rail Splitter (2012-2013)	IL	Good et al. 2013b
Record Hill (2012)	ME	Stantec 2013a
Record Hill (2014)	ME	Stantec 2015c
Record Hill (2016)	ME	Stantec 2017
Ripley (2008)	ON	Jacques Whitford 2009
Ripley (Fall 2009)	ON	Golder Associates 2010
Rollins (2012)	ME	Stantec 2013b
Rollins (2014)	ME	Stantec 2015d
Roth Rock (2011)	MD	Atwell, LLC 2012
Rugby (2010-2011)	ND	Derby et al. 2011c
Sheffield (2012)	VT	Martin et al. 2013
Sheldon (2010)	NY	Tidhar et al. 2012a
Sheldon (2011)	NY	Tidhar et al. 2012b
Spruce Mountain (2012)	ME	Tetra Tech 2013
Spruce Mountain Wind Project (2014)	ME	Tetra Tech 2015
Steel Winds I (2007)	NY	Grehan 2008
Steel Winds I & II (2012)	NY	Stantec 2013c
Steel Winds I & II (2013)	NY	Stantec 2014d
Stetson II (2014)	ME	Stantec 2015e
Stetson Mountain I (2009)	ME	Stantec 2009c
Stetson Mountain I (2011)	ME	Normandeau Associates 2011
Stetson Mountain I (2013)	ME	Stantec 2014e
Stetson Mountain II (2010)	ME	Normandeau Associates 2010
Stetson Mountain II (2012)	ME	Stantec 2013d
Thunder Spirit (2016-2017)	ND	Derby et al. 2018
Top Crop I and II (2012-2013)	IL	Good et al. 2013c
Top of Iowa (2003)	IA	Jain 2005
Top of Iowa (2004)	IA	Jain 2005
Waverly Wind (2016-2017)	KS	Tetra Tech 2017a
Wessington Springs (2009)	SD	Derby et al. 2010c
Wessington Springs (2010)	SD	Derby et al. 2011a
Wildcat (2016)	IN	Stantec Consulting Services, Inc. (Stantec Consulting) 2017
Wildcat (2017)	IN	Stantec Consulting 2018
Winnebago (2009-2010)	IA	Derby et al. 2010g

Appendix B. Project location and references for the 151 publicly available mortality monitoring studies in the Eastern and Midwestern United States and Canada reporting the sex of bat carcasses found.

Project	State or Province	Reference
Wolfe Island Report 1 (May-June 2009)	ON	Stantec Ltd. 2010a
Wolfe Island Report 2 (July-December 2009)	ON	Stantec Ltd. 2010b
Wolfe Island Report 3 (January-June 2010)	ON	Stantec Ltd. 2011a
Wolfe Island Report 4 (July-December 2010)	ON	Stantec Ltd. 2011b
Wolfe Island Report 5 (January-June 2011)	ON	Stantec Ltd. 2011c
Wolfe Island Report 6 (July-December 2011)	ON	Stantec Ltd. 2012
Wolfe Island Report 7 (January-June 2012)	ON	Stantec Ltd. 2014

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Appendix C. Resource Equivalency Analysis Model Public_v1_Dec2016 Calculations

Calculations from USFWS (2016) REA Model Public_v1_Dec2016 for Summer Habitat Protection for Habitat Suitable for Both Indiana Bat and Northern Long-Eared Bat

Simplified Reproduction Services Model - Including lifetime of progeny

Input Parameters			
Permit start year:	2020		2050
Injured Adult Females Annually:	6.91		
Permitted take years	30	years to 2050	
Lambda condition	Declining		
Adult Female Breeding Rate	0.562	pups/female/year = AP*AB	
Adult F-F Breeding Rate	0.281	female pups/female/year	
Juvenile Female Breeding Rate	0.130	pups/female/year	
Juvenile F-F Breeding Rate	0.065	female pups/female/year	
Pup Survival to juvenile	0.585	rate	
Juvenile Annual Survival	0.674	rate	
Adult Annual Survival	0.857	rate	

Output		
Debit Accrued		
Undiscounted		
Direct take	207	female adults
Total lost reproduction	330	female pups
Total Lost	538	
Mitigation Credit Accrued		
Undiscounted		
Direct females added by project	184	female adults
Summer habitat protection	184	female adults
Hibernaculum protection	-	female adults
Maternity habitat restoration	-	female adults
Total reproduction gained	361	female pups
Total Gain	545	females
Mitigation Credit Due		
Net gained	7	
Total qualifying mitigation acr	754	must be >46 acres

Note that the mitigation project targets 545 female Indiana bats (rather than 538) to account for stacking with 89 northern long-eared bats. See Section 5.3.

Summer habitat protection			
Project Details:			
Project start year	2020		
Project end year (include 10 years beyond last monitoring year)	2060		
Habitat function served by the "to be protected" habitat	Roosting & Foraging	1.00	
Acres "to be protected" of occupied forest block/at terminus 1	754		Qualifying acreage 754
Acres of "to be protected" corridor habitat	90	10	
Acres of "to be protected" forest at terminus 2	46	46	
Required Conditions:		1.00	implies 46 acres/bat
Is the "to be protected" roosting and foraging habitat≥5 acres?	Yes	1.00	
Are the termini blocks >500 ft apart?	Yes	1.00	
Are the occupied termini blocks ≥ 5acres?	Yes	1.00	
Will or are both termini forest blocks protected?	Yes	1.00	
Level of threat	Habitat threatened	1.00	
Expected female gain	16.39		Expected K #####

Calculations from USFWS (2016) REA Model Public_v1_Dec2016 for Summer Habitat Restoration for Habitat Suitable for Both Indiana Bat and Northern Long-Eared Bat

Simplified Reproduction Services Model - Including lifetime of progeny

Input Parameters			
Permit start year:	2020		2050
Injured Adult Females Annually:	6.91		
Permitted take years	30	years to 2050	
Lambda condition	Declining		
Adult Female Breeding Rate	0.562	pups/female/year = AP*AB	
Adult F-F Breeding Rate	0.281	female pups/female/year	
Juvenile Female Breeding Rate	0.130	pups/female/year	
Juvenile F-F Breeding Rate	0.065	female pups/female/year	
Pup Survival to juvenile	0.585	rate	
Juvenile Annual Survival	0.674	rate	
Adult Annual Survival	0.857	rate	

Output		
Debit Accrued		
Undiscounted		
Direct take	207	female adults
Total lost reproduction	330	female pups
Total Lost	538	
Mitigation Credit Accrued		
Undiscounted		
Direct females added by project	184	female adults
Summer habitat protection	-	female adults
Hibernaculum protection	-	female adults
Maternity habitat restoration	184	female adults
Total reproduction gained	360	female pups
Total Gain	545	females
Mitigation Credit Due		
Net gained	7	
Total qualifying mitigation acr	3032	must be >46 acres

Note that the mitigation project targets 545 female Indiana bats (rather than 538) to account for stacking with 89 northern long-eared bats. See Section 5.3.

Summer habitat restoration			
Project Details:			
Project start year	2020		
Project end year (include 10 years beyond last monitoring year)	2060		
Habitat function	Roosting & Foraging	1	
Acres of "to be restored" forest adjacent to (within 500' of) occupied habitat	3032	3032	Qualifying acreage
Acres of "to be restored" corridor habitat	10.0	10	
Acres of "to be restored" forest at unoccupied terminus	0	0	
Habitat Conditions:			
Existing % forest cover	51% to 75%	0.75	
Required Conditions:		1.00	implies 46 acres/bat
"To be restored" forest area ≥5 acres	NA	1	
Unoccupied terminus forested block >500' from occupied forest block	Yes	1	
Unoccupied terminus forest block ≥20 ac	Yes	1	
Will or are both termini forest blocks protected	Yes	1	
Expected female gain	49.43	49.43	Expected K

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