Indiana Bat and Northern Long-Eared Bat Habitat Conservation Plan

for the Bitter Ridge Wind Farm

Jay County, Indiana

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TABLE OF CONTENTS

1.0 INTRODUCTION 6
1.1 Overview and Background 6
1.2 Purpose 6
1.3 Permit Duration 6
1.4 Plan and Permit Areas 7
1.5 Covered Species 7
1.6 Regulatory Environment 7
1.6.1 Endangered Species Act 7
1.6.2 National Environmental Policy Act 9
2.0 PROJECT DESCRIPTION AND COVERED ACTIVITIES 11
2.1 Project Components 11
2.1.1 Wind Turbines 11
2.1.2 Meteorological Towers 11
2.1.3 Roads and Pads 11
2.1.4 Underground Electrical and Communications Cables 11
2.1.5 Generator Lead Line 11
2.1.6 Substation and Switchyard 12
2.2 Operations and Maintenance 12
2.3 Decommissioning 13
2.4 Covered Activities 13
3.0 COVERED SPECIES ECOLOGY AND ENVIRONMENTAL BASELINE 14
3.1 Environmental Setting 14
3.1 Covered Species 15
3.1.1 Indiana Bat 15
3.1.1.1 Life History and Demographics 15
3.1.1.2 Habitat Requirements 18
3.1.1.3 Seasonal Movements 19
3.1.1.4 Range and Distribution 22
3.1.1.5 Species Status and Occurrence 24
3.1.2 Northern Long-Eared Bat 33
3.1.2.1 Life History and Demographics 33
3.1.2.2 Habitat Requirements 34
3.1.2.3 Seasonal Movements 35
3.1.2.4 Range and Distribution 37

3.1.2.5 Species Status and Occurrence 37
4.0 TAKE ASSESSMENT 40
4.1 Take Prediction Prior to Minimization Measures 41
4.1.1 Take Prediction Model – Species Composition 41
4.1.2 Incorporating and Quantifying Uncertainty 41
4.1.3 Data Used in Calculating Predicted Take 42
4.2 Take Prediction Adjusted for Minimization Measures 46
4.2.1 Effectiveness of Turbine Curtailment 46
4.2.2 Incidental Take Limits 50
4.3 Impacts of the Take 50
4.3.1 Impact Assessment Model – Resource Equivalency Analysis Framework 50
4.3.2 Impacts to Indiana Bats 51
4.3.3 Impacts to Northern Long-Eared Bats 53
5.0 MINIMIZATION, MITIGATION, AND MONITORING PLAN 55
5.1 Biological Goals and Objectives 56
5.2 Measures to Avoid and Minimize the Impact of the Taking 57
5.2.1 Avoiding Impacts through Project Design and Planning 57
5.2.1.1 O&M and Substation Lighting 57
5.2.1.2 Wind Turbine Lighting 57
5.2.1.3 Construction 57
5.2.2 Minimizing Impacts through Project Operations 58
5.3 Measures to Mitigate the Impact of the Taking 59
5.3.1 Mitigation Implementation 59
5.3.2 Selection of Mitigation Projects 60
5.3.3 Selected Mitigation Projects 61
5.4 Monitoring and Adaptive Management 61
5.4.1 Compliance Monitoring 61
5.4.1.1 Monitoring Methods 62
5.4.1.2 Monitoring Protocol and Schedule 65
5.4.2 Mitigation Monitoring 67
5.4.3 Adaptive Management 67
5.4.4 Reporting 69
6.0 FUNDING ASSURANCES 70
6.1 Project Design and Planning 71
6.2 Anticipated Funding Requirements for Operating Expenses 71
6.2.1 Compliance Monitoring and Reporting 71

6.2.1.1 Monitoring 72
6.2.1.2 Reporting 72
6.2.2 HCP Overhead and Administration 72
6.3 Funding Requirements for Costs Not Budgeted in Operating Expenses 73
6.3.1 Mitigation 73
6.3.2 Changed Circumstances 74
7.0 ALTERNATIVES CONSIDERED 76
7.1 Alternative 1: Operational Avoidance 76
7.2 Alternative 2: Increased Operational Minimization 76
8.0 HABITAT CONSERVATION PLAN ADMINISTRATION 77
8.1 No Surprises Assurances 77
8.2 Changed Circumstances 77
8.2.1 Repowering the Project 78
8.2.2 Additional Species' Listings 78
8.2.3 New Technology and Information 79
8.2.4 Change in Timing of Seasonal Risk 80
8.2.5 Discovery of New or Previously Unidentified Maternity Colony of a Covered Species 82
8.2.6 Change in Mitigation Project Viability 83
8.2.7 The Impacts of White-nose Syndrome Are Greater than Anticipated 84
8.3 Unforeseen Circumstances 85
8.4 Permit Modifications 86
8.4.1 Modifications Made Without an Incidental Take Permit Amendment 87
8.4.2 Habitat Conservation Plan and Incidental Take Permit Amendments 87
8.5 Permit Renewal 87
9.0 REFERENCES 88
9.1 Literature Cited 88
9.2 Laws, Acts, and Regulations Cited 100

LIST OF TABLES

Table 3.1 Land cover types in the Bitter Ridge Permit Area according to the 2011 National Land Cover Database....15
Table 3.2 Indiana bat population estimates for the Midwest Recovery Unit (USFWS 2019a). ...27
Table 4.1. Publicly available records of Covered Species fatalities at North American wind energy facilities....41
Table 4.2. Fowler Ridge Wind Farm pre-curtailment data: which years used for various elements of the Bitter Ridge Covered Species take predictions. 44
Table 4.3. Expected number and percentage of Project turbines with collision risk, by season, for the Covered Species. 44
Table 4.4. Overall bat fatality estimates by season for 2010 – 2011 at the Fowler Ridge Wind Farm....45
Table 4.5. Carcass counts from post-construction monitoring conducted at the Fowler Ridge Wind Farm from 2009 – 2011. 45
Table 4.6. Estimated species proportions for 2009 – 2011 at the Fowler Ridge Wind Farm. 45
Table 4.7. Take predictions for the Covered Species in the absence of minimization measures. 46
Table 4.8. Results from publicly available turbine curtailment effectiveness studies....47
Table 4.9. Take requests for the Covered Species....49
Table 4.10. The inputs and results of the resource equivalency analysis for Indiana bats. 52
Table 4.11. The inputs and results of the resource equivalency analysis for northern long-eared bats. 55
Table 5.1. Operational minimization plan for the Bitter Ridge Wind Farm....58
Table 5.2. Example compliance monitoring schedule for Covered Species at the Bitter Ridge Wind Farm....66
Table 6.1 Estimated operating costs for implementing the Bitter Ridge Wind Farm Habitat Conservation Plan. 74

LIST OF FIGURES

Figure 1.1. Permit Area and turbine layout for the Bitter Ridge Wind Farm Habitat Conservation Plan. 10
Figure 3.1. Landcover within the Bitter Ridge Wind Farm Permit Area. 16
Figure 3.2. Range of the Indiana bat as shown by the US Fish and Wildlife Service Indiana bat Recovery Units. 23
Figure 3.3. Indiana bat summer records in Indiana and neighboring states, as documented by the US Fish and Wildlife Service....25

Figure 3.4. Indiana bat hibernacula in the Midwest Recovery Unit, as classified by the US Fish and Wildlife Service. 28

Figure 3.5. Acoustic detector locations with Indiana bat detections at the Bitter Ridge Wind Farm. 29

Figure 3.6. Mist-net survey locations and Indiana bat roost trees documented at the Bitter Ridge Wind Farm during summer 2017. 31

Figure 3.7. Turbine locations and potential summer habitat for Indiana bats at the Bitter Ridge Wind Farm. 32

Figure 3.8. Geographic range of northern long-eared bat in the United States and Canada (USFWS 2014b). 38

Figure 4.1. The proposed location of Bitter Ridge and the location of Fowler Ridge, which was used in the reference bat fatality dataset (Hoen et al. 2018). 43

Figure 4.2. A comparison of estimated bat casualty rates and 90% confidence intervals for Fowler Ridge Wind Farm. The 2010 estimate represents turbines operating at manufacturer cut-in speeds (3.0 m/s). The 2012-2017 estimates represent data collected at turbines that were feathered below 5.0 m/s. The red dotted line represents a 50% reduction in bat casualty rates compared to the 2010 estimate (Good et al. 2018). 49

LIST OF APPENDICES

Appendix A. Predicting Take Using a Species Composition Approach

Appendix B. Bat Habitat Mitigation Plan

1.0 INTRODUCTION

1.1 Overview and Background

The Bitter Ridge Wind Farm (Project) consists of 52 wind turbines with a total generating capacity of approximately 130 megawatts (MW). The Project is located on private land in Jay County in east central Indiana and is owned by Bitter Ridge Wind Farm, LLC (Applicant), a Delaware limited liability company. The Applicant has prepared this Habitat Conservation Plan (HCP) in order to apply for an Incidental Take Permit (ITP) under § 10(a)(1)(B) of the Endangered Species Act (ESA).

1.2 Purpose

During Project development and early coordination with the U.S. Fish and Wildlife Service (USFWS), the Applicant determined that the Project could pose a risk to Indiana bats (*Myotis sodalis*) and northern long-eared bats (*M. septentrionalis*), species listed under the ESA. Based on these determinations, the Applicant decided to prepare this HCP in support of an ITP application.

The implementing regulations for ESA § 10(a)(1)(B) (50 Code of Federal Regulations [CFR] 17.22) identify the criteria by which a permit allowing the incidental take of endangered and threatened species listed under the ESA (listed species) may be obtained. The purpose and need for the ITP is to ensure that incidental take resulting from the operation of the Project (Covered Activities) and mitigation measures prescribed in this HCP will not appreciably reduce the likelihood of the survival and recovery of the Indiana bat and northern long-eared bat (Covered Species) in the wild.

ESA § 10(a)(1)(B) requires that an HCP be developed and submitted to the USFWS along with any ITP application. An HCP must describe the predicted impacts of take of the Covered Species for which authorization is sought and how those impacts will be minimized and mitigated to the maximum extent practicable. In addition, an HCP must describe monitoring that will be implemented to ensure compliance with the ITP, and the funding mechanism that will be used to implement monitoring, mitigation, and responses to any changed circumstances. This HCP includes these and other elements necessary to meet the criteria for ITP issuance (Section 1.6.1).

1.3 Permit Duration

The proposed ITP term is 35 years. This spans the duration of the projected functional operational life of the turbines, with an anticipated ITP start date before the end of 2020. If, at the end of the 35-year ITP term, the Applicant continues to operate the Project, the Applicant may seek a renewal or an amendment, as appropriate. The continued operation of the Project through re-powering is considered a foreseeable changed circumstance and is addressed further in Chapter 6.

1.4 Plan and Permit Areas

The lands addressed by this HCP include the Plan Area and the Permit Area. The Plan Area is the geographic area that and includes all areas that may be within the HCP's sphere of influence. The Applicant has determined that the Plan Area for the HCP includes the Permit Area (Figure 1.1), as well as all areas influenced by the biological goals and objectives associated with this HCP (see Section 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 incidental take of the Covered Species may occur and is authorized by the ITP. Operation of Project wind turbines is the only activity that is likely to cause take of the Covered Species. The Permit Area includes the area in which turbines are located (Figure 1.1).

The Permit Area includes all easements, fee lands, and leased land associated with the Project. The Permit Area covers approximately 8,972 ha (22,170 ac) and is privately owned. The predominant landcover/vegetation type within the Permit Area is agricultural, primarily corn (*Zea mays*) and soybean (*Gylcine max*) fields.

1.5 Covered Species

During Project development and early coordination with the USFWS, the Applicant determined that the Project could pose a risk to Indiana bats and northern long-eared bats, and has designated these as the Covered Species. The Indiana bat is listed as an endangered species under the ESA (USFWS 1967) and the northern long-eared bat is listed as threatened (80 Code of Federal Regulations [FR] 17974; USFWS 2013a, 2015a).

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

1.6 Regulatory Environment

1.6.1 Endangered Species Act

The purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved" (ESA § 2(b), 16 USC 1531(b)). 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)). ESA § 9(a)(1)(B) prohibits the take of any species of fish or wildlife listed under the ESA as an endangered species (16 USC 1538(a)(1)(B)). The USFWS extended by regulation the take prohibition to threatened species, unless the USFWS promulgates a special species-specific rule that applies the take prohibition in full or in part to that species (50 CFR 17.31(a)).

ESA § 10(a)(1)(B) provides that the Secretary of the Interior and the Secretary of Commerce may authorize, under certain terms and conditions, any taking otherwise prohibited by 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 Project proponent must apply to the USFWS or National Marine Fisheries Service (NMFS) for an ITP, and develop, fund, and implement a USFWS- or NMFS-approved HCP to minimize and mitigate to the maximum extent practicable the impact of the proposed taking.

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

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

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

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

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

1) biological goals and objectives,
2) adaptive management,
3) monitoring,
4) ITP duration, and
5) public participation.

The USFWS considers issuance of an ITP to be a federal agency action triggering § 7 of ESA (16 USC 1536). 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 listed species or result in the 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 terminates with the preparation of a Biological Opinion, which provides the Service's determination as to whether the proposed action of ITP issuance is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat.

1.6.2 National Environmental Policy Act

The National Environmental Policy Act, 42 USC § 4321, *et. seq.* (NEPA) requires federal agencies to examine environmental impacts of actions which they authorize and to provide for public participation. The USFWS considers issuance of an ITP to be 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 an analysis of direct, indirect, and cumulative impacts of issuing the ITP on the human environment, and includes analysis of a reasonable range of alternatives. The public will have the opportunity to comment on the NEPA document and the HCP as part of the NEPA process.

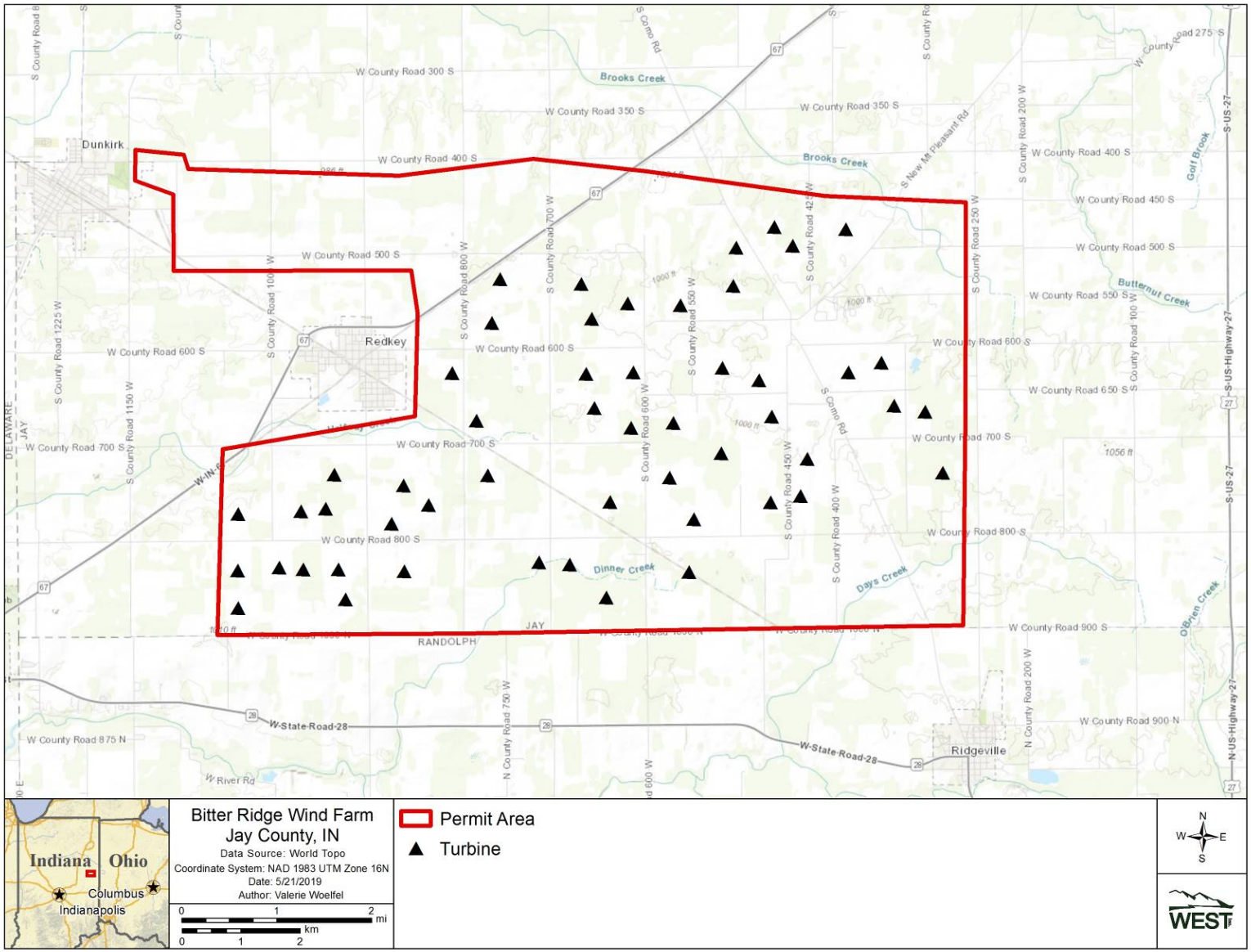

Figure 1.1. Permit Area and turbine layout for the Bitter Ridge Wind Farm Habitat Conservation Plan.

2.0 PROJECT DESCRIPTION AND COVERED ACTIVITIES

2.1 Project Components

2.1.1 Wind Turbines

The Project consists of 52 General Electric 2.82-MW-127 turbines with a nameplate capacity of 2.82-MW each. Turbine towers are approximately 89 meters (m; 292-feet [ft]) in height and the rotor blade is 62-m (204-ft) long. The maximum height of the turbines from tower base to highest blade tip is 152-m (499-ft) above ground level.

2.1.2 Meteorological Towers

One 100-m (328-ft) and four 60-m (198-ft) met towers are currently operating within the Permit Area. Two to four 100-m towers will be permanently operated within the Project during operation. The permanent met towers will be guyed, and the guy wires will be marked with appropriate wire markers.

2.1.3 Roads and Pads

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

All new roads were constructed for the specific purpose of Project construction, operation, and maintenance. The permanent width of access roads is approximately 5 m (16 ft). All roads include road base, surface materials, appropriate drainage, and culverts where necessary.

The crane pad at each turbine site consists of an approximately 20 x 40-m (65 x 131-ft) permanent gravel pad extending from the roadway to the turbine foundation.

2.1.4 Underground Electrical and Communications Cables

Electrical power generated by the wind turbines is transformed and collected through a network of underground collection cables. The underground collection cables total approximately 61.2 kilometers (km; 38.0 miles [mi]) in length. Communications cables will also be buried underground with the collection cables in approximately 0.9 to 1.2-m (3.0 to 4.0-ft) deep trenches located between turbines and along access roads.

2.1.5 Generator Lead Line

The 8-km (5-mi) 138-kilovolt (kV) generator lead line is owned by the Applicant. The right-of-way (ROW) for the generator lead line will follow a county road ROW.

2.1.6 Substation and Switchyard

The substation is connected to the interconnection point, an existing 138-kV substation, by the new generator lead line. The substation consists of transformation and switching equipment to collect the energy from the Project to make it suitable for delivery into the bulk power system. The interconnect switchyard is an electrical station with switching and protection equipment that acts as a hub between the bulk power system and the Project.

2.2 Operations and Maintenance

The O&M facility consists of an approximately 658-m^2 (7,080 ft^2) building containing offices, storage space, bathrooms, and a kitchenette.

The Project will be operated both locally from the control room in the O&M building and remotely through an operations control center. A permanent staff of two to four 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 and identification of potential problems. A local wind technician is either on-site or on-call to respond in the event of emergency notification or critical outage.

A preventative maintenance and inspection schedule will be implemented for the Project. Typical O&M activities will include wind turbine inspections and maintenance activities, as required. Some repair activities may require the use of heavy equipment, such as cranes, to assist in the repairs of components 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 retain previously-cleared areas associated with Project infrastructure (roads, generator lead line) and ROWs. Mowing maintains cleared areas in an herbaceous or shrub-scrub condition. The need for mowing will be evaluated by site operations staff periodically during the growing season and the mowing will occur on an as-needed basis during daytime hours. Maintenance will also consist 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 line.

Required Federal Aviation Administration (FAA) lighting will be installed on the nacelles of selected wind turbines (FAA 2015). The O&M facility will have outside safety lights that may be operated manually or via motion detectors. Additionally, the O&M facility will have exterior lighting on the building, as well as the parking lot, which will be operated by dusk-to-dawn sensors.

Despite the potential for Covered Species to occur in some portions of the Permit Area (see Section 3.2), maintenance (e.g., turbine maintenance, road grading, maintenance facility upkeep, SCADA upgrades, and grounds keeping) activities are not expected to lead to take. Maintenance of the turbines involves periodic activities typically conducted inside turbines or the O&M building;

occasionally maintenance activities may require the use of a crane to access the rotors or nacelles. These types of activities do not present hazards to the Covered Species because they do not generate excessive noise or activity that could lead to disturbance of these species which may potentially occur within the Permit Area. Additionally, during all seasons, maintenance activities would be conducted primarily during daylight hours when the Covered Species are not active.

If removal of hazard trees is necessary outside of the hibernation season, the Applicant will, if the tree may potentially be used by roosting bats, have a qualified biologist conduct an emergence survey at the tree(s) requiring removal. If no bats are observed during the emergence survey, the high-risk hazard tree(s) will be promptly removed. This will reduce the risk of removing a potential roost tree while bats are active. If bats are observed, the Applicant will conduct further consultation with the USFWS. Therefore, maintenance activities are not expected to result in impacts that could lead to take.

2.3 Decommissioning

The projected operating life of the Project is 35 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 will be decommissioned after 35 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 approved and appropriate waste management facilities. Decommissioning activities will occur during daylight hours and will not create hazards for active bats, including the Covered Species. Turbines will be locked to prevent spinning during decommissioning, which will avoid the potential for collision of Covered Species with spinning turbines.

Similar to maintenance activities, any tree removal necessary for decommissioning is expected to be limited and conducted during hibernation season when bats will not be roosting in trees. Decommissioning of the Project is not expected to cause take of the Covered Species and is therefore not a requested Covered Activity under the requested ITP.

2.4 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.” 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; 50 CFR 222.305(b)). “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 in a county that issues building permits to individuals with conditions to implement the terms of the HCP), or
3. entities have an interagency agreement establishing the permittee's legal control […]." (USFWS and NMFS 2016).

The Applicant has determined which Project-related activities are reasonably certain to result in incidental take of the Covered Species and over which the Applicant has control. As Sections 2.2 and 2.3 show, the Applicant has determined that maintenance and decommissioning of the Project are not likely to result in take of the Covered Species, and is not including these actions as Covered Activities under the HCP.

Spinning rotor blades are known to cause injury and mortality of bats through collision (Horn et al. 2008), including mortality and injury of the Covered Species. Due to the potential mortality of the Covered Species, the operation of the 52-turbine Project is included as a Covered Activity in this HCP. The Applicant therefore has identified that take from the operation of 52 turbines over the 35-year ITP term is likely to lead to take and is considered a Covered Activity under the HCP, and the Applicant will implement measures to minimize and mitigate the impacts of the take that may occur as a result of Project operations.

3.0 COVERED SPECIES ECOLOGY AND ENVIRONMENTAL BASELINE

3.1 Environmental Setting

The Project is located in east-central Indiana and falls within the Eastern Corn Belt Plains Ecoregion, which encompasses a large portion of central and southeastern Indiana and central and southwestern Ohio (US Environmental Protection Agency 2017). The Eastern Corn Belt Plains Ecoregion is primarily a rolling glacial till plain with local end moraines. The Ecoregion is characterized by flat to gently undulating topography. The Permit Area is flat to gently rolling with no ridges or other areas of starkly elevated topography. Elevations within the Permit Area range from approximately 285-320 m (936-1,052 ft).

The Permit Area encompasses approximately 8,972 ha (22,170 ac) in southwest Jay County. According to the 2011 National Land Cover Database (NLCD; US Geological Survey [USGS] NLCD 2011, Homer et al. 2015), the dominant cover type within the Permit Area is cultivated cropland (mainly corn and soybeans) composing 82% of the total land area (Table 3.1, Figure 3.1). Deciduous forest and developed open space are the second most abundant cover types, composing 8% and 5% of the Permit Area, respectively. Deciduous forest in the Permit Area mainly occurs as scattered, small woodlots, riparian corridors, and shelterbelts along the edges of agricultural fields and residences. Hay/pasture composes 4% of the Permit Area, while the other land cover types each compose less than 1% of the total Permit Area. Developed areas are generally confined to residences and farms scattered throughout the Permit Area. Water

sources in the Permit Area include tributaries of the Mississinewa River in the north and tributaries of the White River in the south. There are also several unnamed streams and a few farm ponds in the Permit Area.

Table 3.1 Land cover types in the Bitter Ridge Permit Area according to the 2011 National Land Cover Database.

Land Cover	Hectares	Acres	% Composition
Cultivated Crops	7,365	18,200.3	82.1%
Deciduous Forest	718	1,775.4	8.0%
Developed, Open Space	435	1,074.9	4.8%
Hay/Pasture	327	808.7	3.6%
Herbaceous	52	127.5	0.6%
Developed, Low Intensity	31	76.5	0.3%
Open Water	20	49.0	0.2%
Shrub/Scrub	7	18.4	0.1%
Woody Wetlands	5	12.8	0.1%
Emergent Herbaceous Wetlands	5	12.7	0.1%
Developed, Medium Intensity	5	11.2	0.1%
Evergreen Forest	1	1.6	<0.1%
Developed, High Intensity	<1	0.5	<0.1%
Total	**8,972**	**22,169.5**	**100**

Data from U.S. Geological Survey National Land Cover Dataset 2011 (Homer et al. 2015).

3.1 Covered Species

As introduced in Section 1.5, the Applicant has determined that the Project could pose a risk to Indiana bats and northern long-eared bats, and therefore has identified these as the Covered Species. As relevant to Project minimization and mitigation, the biology of each of the Covered Species is described here.

3.1.1 Indiana Bat

The Indiana bat is federally protected as endangered under the Endangered Species Act. It is a small insectivorous bat first described as a separate species in 1928 (Miller and Allen 1928), and was given its name based on its identification from museum specimens collected in 1904 from Wyandotte Cave in Crawford County, Indiana.

3.1.1.1 Life History and Demographics

Despite the Indiana bat's small size, it is relatively long-lived (Barclay and Harder 2005). Female Indiana bats give birth to one offspring per year (Humphrey et al. 1977, Kurta and Rice 2002). Mating occurs in the vicinity of hibernacula in late summer and early fall, and fertilization is delayed until the spring (Guthrie 1933).

Timing of parturition (birth) and lactation are likely dependent in part on latitude and weather conditions. For example, in Iowa, female Indiana bats arrive at maternity colonies at the end of April and parturition is completed by mid-July (Clark et al. 1987). Female and juvenile Indiana bats may remain in the maternity colony area until migration to hibernacula.

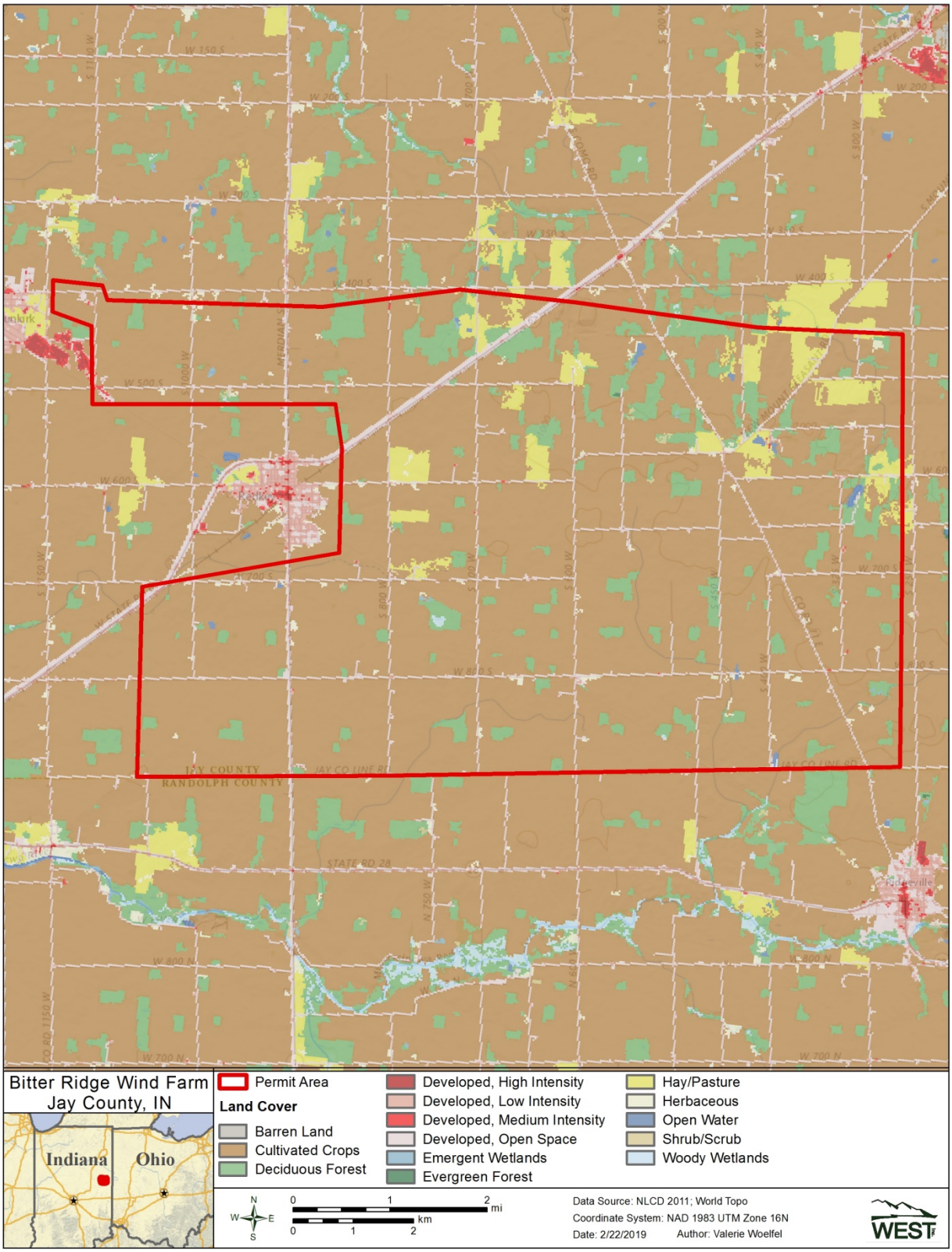

Figure 3.1. Landcover within the Bitter Ridge Wind Farm Permit Area.

Indiana bats return to the vicinities of hibernacula in late summer and early fall where Indiana bats exhibit a behavior known as “swarming”. This involves large numbers of Indiana bats flying in and out of the cave entrances from dusk to dawn, though relatively few of the Indiana bats roost in the cave 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 2007). It is at this time that Indiana bats gain fat stores vital not only for winter survival, but also for when mating occurs during swarming.

While females enter the hibernaculum soon after arrival at the site, males remain active for a longer period and may also travel between hibernacula, both behaviors that may increase mating opportunities (USFWS 2007). 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 after emergence (Winhold and Kurta 2006).

O’Shea et al. (2004) summarized survival rates for a number of species, including the little brown bat (*Myotis lucifugus*), 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, studies indicated that survival for first-year juveniles was generally lower than for adults in general. 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 a population that produce young in a year is thought to be fairly high (USFWS 2007). In one study, greater than 90% of the females produced young each year (Humphrey et al. 1977), and in another study, it was estimated that 89% of adult females 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 white-nose syndrome (WNS) may lead to lower reproduction rates (USFWS 2011a). 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.org 2017), and it is currently the most severe threat facing Indiana bat populations range-wide (USFWS 2009). The disease infects hibernating bats and is caused by a fungal pathogen (*Pseudogymnoascus destructans* [*Pd*]; Blehert et al. 2009, 2011; Minnis and Lindner 2013). See Section 3.2.1.5 for a detailed discussion of WNS and its effects on Indiana bats.

3.1.1.2 Habitat Requirements

Indiana bats have two distinct habitat requirements: 1) a stable environment in which to hibernate during the winter, and 2) woodland habitat in which to roost during the summer (USFWS 2007).

Winter Habitat

Indiana bats generally hibernate from October to April (USFWS 2007). The majority of hibernacula are located in karst areas of the east-central US. Indiana bats are also known to hibernate in other cave-like structures. In 2005, approximately 30% of the population hibernated in man-made structures (predominantly mines), with the rest using natural caves (USFWS 2007). There are no known hibernacula within the Permit Area.

Summer Habitat

Suitable summer habitat includes roosting areas, foraging areas, and travel corridors. Roosts are usually located in dead trees, though partly dead or live trees (e.g., if the tree species has naturally peeling bark) may also be used (USFWS 2007). An important characteristic for the location of maternity roost sites is a mosaic of woodland and open areas, with the majority of maternity colonies having been found in agricultural areas with fragmented forests (USFWS 2007). Mean values of canopy cover were highly variable among studies (20-88%; USFWS 2007). Roosts found in closed-canopy forests, particularly primary roosts, were often associated with natural or man-made gaps (e.g., openings created when nearby trees fell, riparian edges, and trail or forest road edges). Indiana bat roosts have been created by the death of a single large-canopy tree (A. King, USFWS, pers. comm. 2005 as cited in USFWS 2007). 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).

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 are connected to roosting or foraging areas (USFWS 2007).

While the primary and alternate roosts of a maternity colony may change over the years, it is thought that foraging areas and travel corridors are relatively stable (Barclay and Kurta 2007). In general, the distance from the roost tree to foraging areas varies from 0.5 to 8.4 km (0.3 to 5.3 mi; USFWS 2007). In Pennsylvania, the mean distance from the roost to the nearest edge of a foraging area was 2.7-km (1.7-mi) and ranged from 1.3 to 5.3-km (0.8 to 3.3-mi; Butchkoski and Turner 2005). In Indiana, 11 females used foraging areas on average 3.0 km, range 0.8 to 8.4km (1.9 mi, range 0.5 to 5.3mi), from their roosts (Sparks et al. 2005). In Michigan, the distance between roosts and foraging areas was 2.4 km, range 0.5 to 4.2km (1.5 mi, range 0.3 to 2.6 mi; Murray and Kurta 2004). In areas of low- density forested habitat in Ohio, the maximum foraging distances for lactating females from the primary roost tree were 9.4 to 10.8 km (5.9 to 6.7-mi; K. Lott, USFWS, pers. comm.).

Although individuals from a maternity colony appear to show fidelity to a general home range within and between years (Sparks et al. 2004), due to 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 ± 83 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). As well as differences in methodology, the range of home ranges estimated likely reflects differences in habitat quality between sites.

3.1.1.3 Seasonal Movements

Spring Emergence and Dispersal

In the spring, female Indiana bats emerge from hibernacula and disperse to their summer habitat where they form maternity colonies (Winhold and Kurta 2006). Radio-telemetry studies and band return data have shown that dispersal or migration distances vary across the species' range. 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 (Winhold and Kurta 2006, Gardner and Cook 2002).

It appears that Indiana bat migration from winter to summer habitat is fairly linear and short-term. Spring radio-telemetry studies have documented migrating Indiana bats traveling in relatively direct flight patterns towards their summer ranges shortly after they emerge from hibernacula (Britzke et al. 2006, Butchkoski and Turner 2006). Evidence from radio-tracking studies in New York and Pennsylvania indicates that Indiana bats are capable of migrating at least 48 to 64 km (30 to 40 mi) in one night (Sanders et al. 2001, Hicks 2004, Butchkoski and Turner 2006).

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, Indiana 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 in south-central Pennsylvania appeared to be moving in a generally northeast-southwest direction in line with the Appalachian Mountains (J. Chenger, Bat Conservation Management [BCM], personal communication [pers. comm.]). Similarly, 12 Indiana bats tracked during spring migration in western Virginia generally followed ridges that run northeast-southwest, with only one individual 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).

Fall Migration and Swarming

Indiana bats start leaving their summer habitat as early as late-July and begin arriving at hibernacula in August (USFWS 2007). Because female Indiana bats are likely cued into the same climatic or environmental stimuli during the spring and fall migration, there may be migratory pulses of Indiana bats moving through an area (L. Pruitt, USFWS, pers. comm. 2011, Reynolds, VDGIF, pers. comm. 2010, as cited in USFWS 2011a).

Little is known about Indiana bat behavior during fall migration compared to spring migration. Most of what is known about fall migration comes from band returns (i.e., individuals that are banded during the summer and subsequently documented during winter hibernacula counts), which provide information about migration distances and beginning and ending destinations, but not information about timing or migration routes. However, it is thought that fall migration takes longer and is less direct than the relatively direct and short-term spring migration (USFWS 2013d). Males and females appear to display different dispersal behavior, with females moving relatively quickly between hibernacula and maternity colonies, while males commonly remain in the proximity of the hibernacula or travel between hibernacula (USFWS 2007).

The maximum distance between identified roost trees and associated hibernacula varies among telemetry studies conducted during the fall roosting and swarming season. Most telemetry studies conducted during fall swarming have occurred outside of hibernacula with relatively small populations of Indiana bats. At two small P3 hibernacula in Kentucky, Indiana bats roosted primarily within 2.4 and 4.1 km (1.5 and 2.5 mi) of the cave entrances (Kiser and Elliot 1996, Gumbert 2001). In Virginia, all roost trees identified from eight male and three female Indiana bats were within 1.4 km (0.9 mi) of a P3 hibernaculum[1] (Brack 2006). In Michigan, Kurta (2000) tracked two male Indiana bats to roost trees located 2.2 and 3.4 km (1.4 and 2.1 mi) from a P4 hibernaculum.

Indiana bats were documented roosting further from hibernacula in areas with larger populations of hibernating Indiana bats. Outside of the Canoe Creek Mine (with a hibernating population of 774 Indiana bats in 2007), a male Indiana bat twice traveled 14 km (8.7 mi) from the hibernaculum where it was captured (USFWS 2007). In Missouri, radio-tagged Indiana bats traveled maximum distances of 6.4 km (4.0 mi) away from the 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 female Indiana bats were relocated 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 bats influenced how Indiana bats used the areas surrounding hibernacula (Hawkins et al. 2005). As the density of bats swarming outside of the hibernaculum increases, Indiana bats may need to move farther from the site to find available roost and prey resources.

Flight Height

Data regarding the height at which Indiana bats fly during migration are lacking. However, it is clear that at least a portion of myotid bats fly well above the tree canopy at rotor-swept height during fall migration, considering that eight of the thirteen Indiana bat fatalities that have been documented to date at wind energy facilities occurred during the fall migration period (Pruitt and Reed 2018), as well as the documented mortality of many other myotids at other wind energy facilities occurring primarily during late summer and fall (M. Seymour, USFWS, pers. comm. 2015; USFWS unpublished data as cited in 2011a). However, data indicate that cave-dwelling bat species are probably not flying within the rotor-swept zone as frequently as long-distance

[1] The author noted that Indiana 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.

migrating tree bats; of all bat mortalities detected at wind energy facilities within the range of the Indiana bat, myotids and tricolored bats (*Perimyotis subflavus*) compose less than 10% of the total bat fatalities (USFWS unpublished data, as cited in USFWS 2013d).

This assumption is supported by anecdotal and empirical data that suggest that Indiana bats primarily migrate at the 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 [NYSDEC], pers. comm. 2011 as cited in USFWS 2011a). Data from Indiana bats radio-tracked in spring in the northeast showed that Indiana bats closely follow topographic features, such as meandering stream corridors and utility ROWs for miles, and over multiple years (Chenger, BCM, pers. comm 2011, Turner, PGC, pers. comm. 2011, as cited in USFWS 2011a). 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.

Effects of Temperature on Indiana Bat Flight Activity

Bat activity is positively correlated with temperature, both over an annual time period (O'Farrell and Bradley 1970, Avery 1985, Rydell 1991) and on a nightly basis (Lacki 1984, Hayes 1997, Vaughan et al. 1997, Gaisler et al. 1998, Shiel and Fairley 1998). Bat experts consulted by the USFWS (2011a) 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 to 55°F]), are likely to result in reduced bat activity among all bat species. Recent studies show that *Myotis* bats do not fly in cold temperatures (Roby and Gumbert 2016a, Brooks et al. 2017). Roby and Gumbert (2016a, 2016b; Roby pers. comm.) found that Indiana bats did not forage or migrate when the ambient air temperature was below 10°C (50 °F) in the spring (number of bats in the sample [n] = 13) or fall (n = two). Roby and Gumbert (2016b) further reported that the mean migration temperature for four Indiana bats ranged from 13°C – 22°C (56°F – 72°F).

Furthermore, between 2002 and 2014 in Indiana, Petit and O'Keefe (2017) found that temperature was the second most important modeled parameter associated with Indiana bat spring arrival, colony formation, colony breakup, and fall migration (day of year, likely influenced by photoperiod, was the most important parameter). Temperature was correlated with migration in both the spring and fall, when bats arrived at maternity colonies as temperatures increased and left maternity colonies when temperatures decreased. Fall migration was initiated when temperatures the week before departure averaged 22°C (72°F), and every 1.0°C (1.8°F) decrease in average temperature the prior week increased the odds of fall departure by 20% (Petit and O'Keefe 2017).

Data obtained from fatality monitoring at wind energy facilities also suggests 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 (FRWF) in Indiana (Good et al. 2011, 2012, 2013) 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 (50°F) in 2010, 2011, and 2012, respectively. 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* 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.

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

3.1.1.4 Range and Distribution

The range of the Indiana bat includes most of the eastern US (Figure 3.2; Saugey et al. 1990, Clark et al. 1987, Evers 1992, Kurta and Teramino 1994, Kurta 1995).

Over the past 40 years, general population trends of Indiana bats appear to be decreasing in the south and increasing in the northern regions of its range (USFWS 2007, 2010). The species has disappeared from or 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.

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 some caveless parts of the country (Kurta and Teramino 1994). For example, approximately 123,000 Indiana bats were recently discovered in a previously unknown hibernaculum in a mine in Missouri (USFWS 2018a). Indiana bats also have been found hibernating in several man-made tunnels (Butchkoski and Hassinger 2002), 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 bat 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 2007). As of June 2019, there were 344 extant Indiana bat hibernacula in 15 states (USFWS 2019a). In 2019, over 95% of the population hibernated in just four states: Missouri (36.3%), Indiana (34.4%), Illinois (14.6%), and Kentucky (10.4%), with 90% hibernating in just 10 hibernacula (USFWS 2019a).

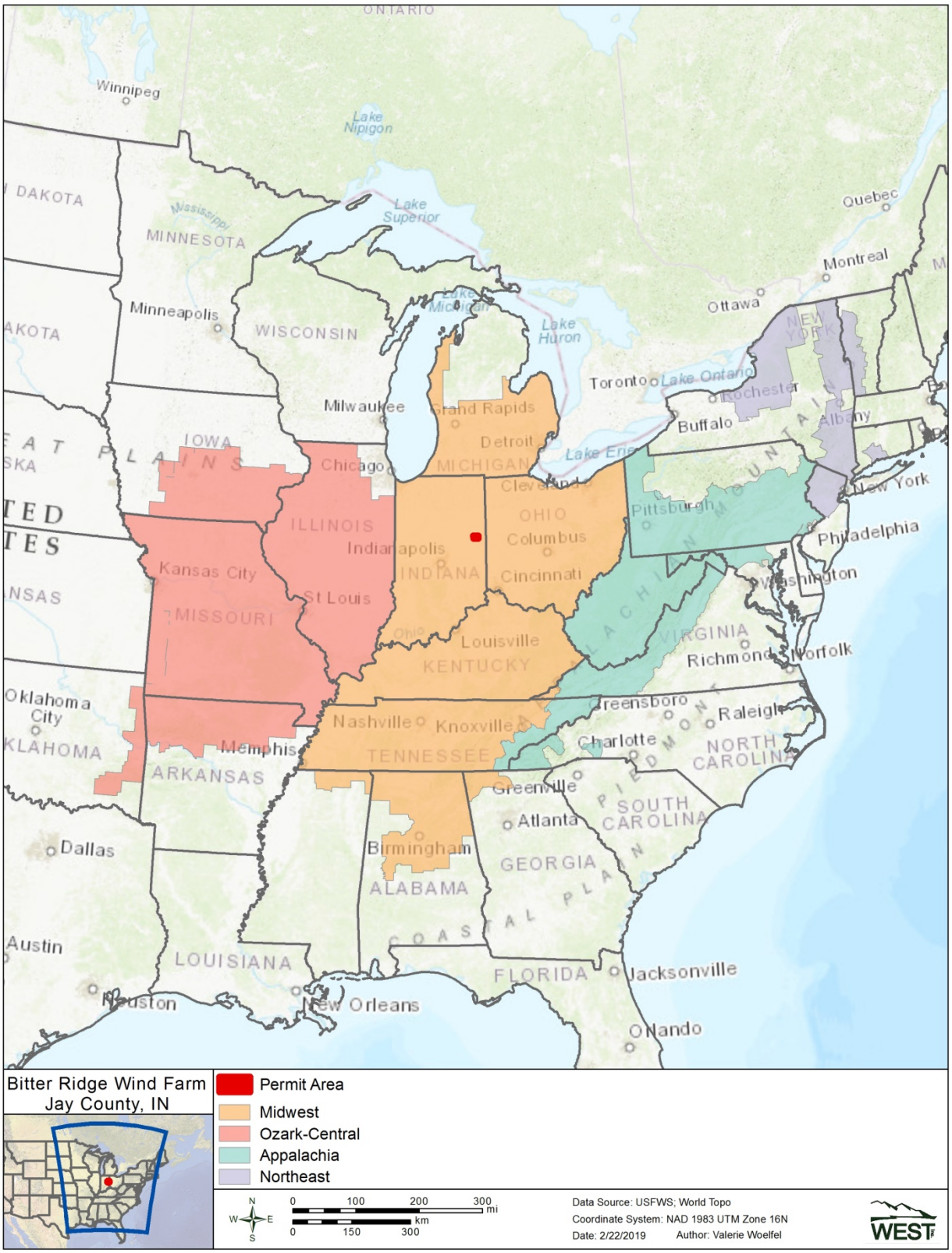

Figure 3.2. Range of the Indiana bat as shown by the US Fish and Wildlife Service Indiana bat Recovery Units.

Relatively little is known about the historic summer range of Indiana bats. It is believed that the historical summer distribution for this species was similar to that of today. However, the first maternity colony was not discovered until 1971 (Cope et al. 1974), so their historical distribution states (USFWS 2007). This likely represents only about 6-9% of the 2,859 to 4,574 colonies thought to exist based on the estimated total wintering population (Whitaker and Brack 2002, USFWS 2007). There are records of maternity colonies throughout Indiana and neighboring states (Figure 3.3).

3.1.1.5 Species Status and Occurrence

The Indiana bat was designated as an endangered species in 1967 (USFWS 1967). Important hibernation caves and mines used by Indiana bats during winter are designated as critical habitat for the species, but no critical habitat is located within the Permit Area. 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 Draft Indiana Bat Recovery Plan lists as threats to the species 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 (USFWS 2007). As previously stated, WNS is currently the most severe threat facing Indiana bat range-wide populations (USFWS 2009; see below for a detailed discussion of WNS and its effects on Indiana bats).

Range-Wide

The USFWS implements a biennial monitoring program at P1 and P2 hibernacula (USFWS 2007). In 1965, the overall population was estimated to be over 880,000 individuals; however, while variation in the data collection apparently has led to variable estimates, and in general, there has been a long-term declining population trend, with approximately 451,600 individuals reported in 2001 (USFWS 2013b). After 2001, there was a gradual population increase to 590,875 Indiana bats in 2007 (USFWS 2013b); the estimated population fell to 537,297 Indiana bats in 2019 (USFWS 2019a). A high proportion of that decline (more than 50%) is likely due to the effects of WNS (Thogmartin et al. 2012, 2013).

The 2007 Draft Indiana Bat 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 2007). Recruitment in the total Indiana bat population in recent years has been variable by recovery unit, with the Ozark-Central Recovery Unit and the Midwest Recovery Unit being relatively stable since 2007 (USFWS 2019a; Figure 3.2). Both the Northeast Recovery Unit and the Appalachian Recovery Unit have decreased substantially in recent years (USFWS 2019a; Figure 3.2), most likely due to WNS. 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; USFWS 2019a).

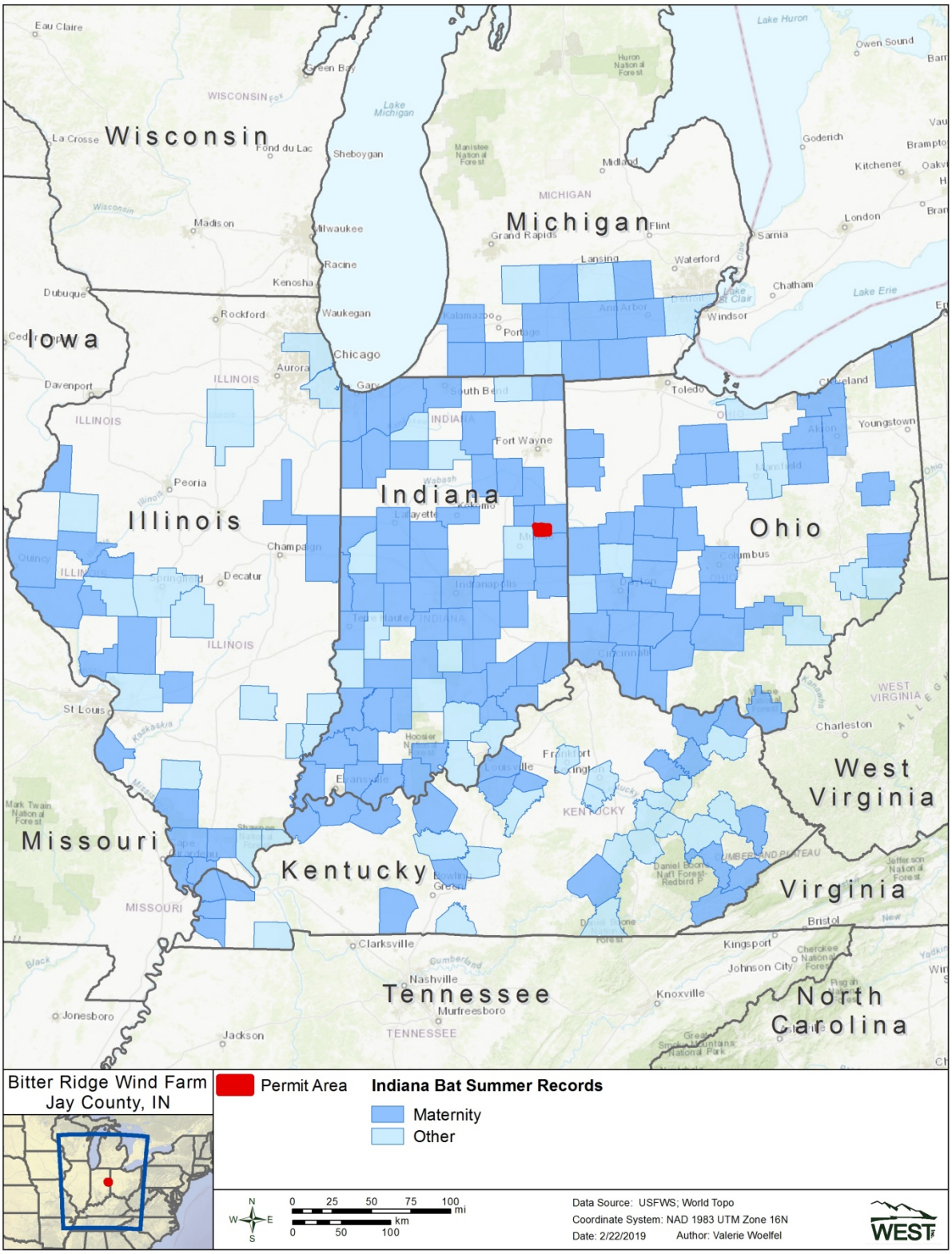

Figure 3.3. Indiana bat summer records in Indiana and neighboring states, as documented by the US Fish and Wildlife Service.

WNS was first discovered during the winter of 2006/2007 in four caves in Schoharie County, New York, and has since spread steadily throughout the Indiana bat range (IDNR 2011, USFWS 2015b, White-Nose Syndrome.org 2017). By 2010, WNS had been documented in all known Indiana bat hibernacula in New York (Frick et al. 2010). The origin of WNS remains uncertain, although anthropogenic introduction of the disease from Europe via cavers or commerce has been presented as a plausible hypothesis (Frick et al. 2010). To-date, the disease is responsible for more than 5.7 million bat fatalities in eastern North America (USFWS 2012b). In addition to observed fatalities at hibernacula, WNS has also been linked to decreased bat abundance in summer habitat (Brooks 2010, Dzal et al. 2010).

If current trends for spread and mortality continue at affected sites, WNS threatens to drastically reduce the abundance of Indiana bats across their range and potentially cause local extirpation. Large Indiana bat 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, West Virginia), population monitoring at 42 hibernacula documented a 72% decline in Indiana bats (Turner et al. 2011).

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 and the authors concluded that WNS is having an appreciable influence on trends of Indiana bat populations, stalling and in some cases reversing population gains made in the previous 20 years. White-nose syndrome 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).

General patterns in population estimates have shown a decreasing trend through the core range of the Indiana bat in the Midwest and increasing trends on the periphery and more northern states (USFWS 2007). The complete underlying causes of these population changes are unknown; however, climate change may play a role by negatively affecting hibernacula temperature (USFWS 2007). More recently, Indiana bat populations in the Eastern Recovery Unit, Appalachian Mountain Recovery Unit, and Midwest Recovery Unit (see below) have been affected by WNS.

Midwest Recovery Unit

The Project falls within the Midwest Recovery Unit (MRU), which includes the states of Indiana, Kentucky, Ohio, and Tennessee to the west of the Appalachians, Alabama, southwestern Virginia, southern Michigan, and northwest Georgia (USFWS 2007, Figure 3.2). The MRU population has experienced declines since WNS was first detected in the region in 2011, although the estimated population for the MRU did increase by approximately 1% from 2017 to 2019 (USFWS 2019a; Table 3.2). The MRU represents 45.7% of the 2019 range-wide population of Indiana bats (USFWS 2019a). According to the 2007 Draft Indiana Bat 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 2007). 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 (USFWS 2019a).

State	2009	2011	2013	2015	2017	2019
Indiana	213,244	225,477	226,572	185,720	180,583	184,848
Kentucky	57,319	70,626	62,018	64,571	58,141	55,946
Ohio	9,261	9,870	9,259	4,809	2,890	2,890
Tennessee	1,657	1,791	2,369	2,401	1,598	1,561
Alabama	253	261	247	90	85	90
SW 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**	**257,748**	**243,388**	**245,474**

Indiana

The estimated population size of Indiana bats in Indiana peaked in 2007 and remained fairly stable from 2011 to 2013 but dropped thereafter (Table 3.2; USFWS 2019a), likely due to WNS. In 2019, approximately 34% of the estimated range-wide population of Indiana bats hibernated in Indiana, and 75% of the MRU population hibernated in Indiana (USFWS 2019a). There are 37 known Indiana bat hibernacula in the state and of these, 34 had extant winter populations in 2007 (at least one record since 2000; USFWS 2007). Of these extant hibernacula, seven were classified as P1, one is P2, 15 are P3, nine are P4, and two of the hibernacula were unclassified (USFWS 2007). The P1 hibernaculum, Wyandotte Complex in Crawford County, was estimated to have 126,448 Indiana bats in 2007 and 55,095 bats in 2019 (USFWS 2008, 2019a). All of the hibernacula in Indiana are found in the south-central part of the state within the Interior Plateau Ecoregion (USFWS 2007; Figure 3.4).

The summer range of Indiana bats in Indiana is fairly ubiquitous. At the time of publication of the 2007 Draft Indiana Bat Recovery Plan, 51 counties in Indiana (out of 92 total counties) had records of summer maternity colonies; an additional 14 counties had other summer records of Indiana bats and one county had winter records only.

Permit Area and Vicinity

Prior to the project-specific studies, no active maternity colonies have been documented in Jay County, but the adjacent counties of Wells and Randolph have one and three known maternity colonies, respectively (USFWS 2007). Most of the surrounding counties have records of summer Indiana bat captures (USFWS 2007). The nearest known winter population to the Project is a P2 hibernaculum (Lewisburg Limestone Mine) located at least 38-km (24-mi) to the southeast in Preble County, Ohio (USFWS 2007).

Results from acoustic monitoring studies conducted July 14 - 23, 2017 within and adjacent to the Permit Area indicate the probable presence of Indiana bats during the summer maternity season (Brown and Bishop-Boros 2018). Acoustic detectors were deployed at 17 sites (34 locations) for two to three suitable nights per location (up to four nights at a location with at least one unsuitable night), for a total of 81 nights, of which 78 were valid (i.e., met the criteria laid out in USFWS Summer Survey Guidelines; USFWS 2017). Review by experts of bat calls indicated probable presence of Indiana bats at five of 17 acoustic presence/probable absence survey sites (seven detector locations; Figure 3.5).

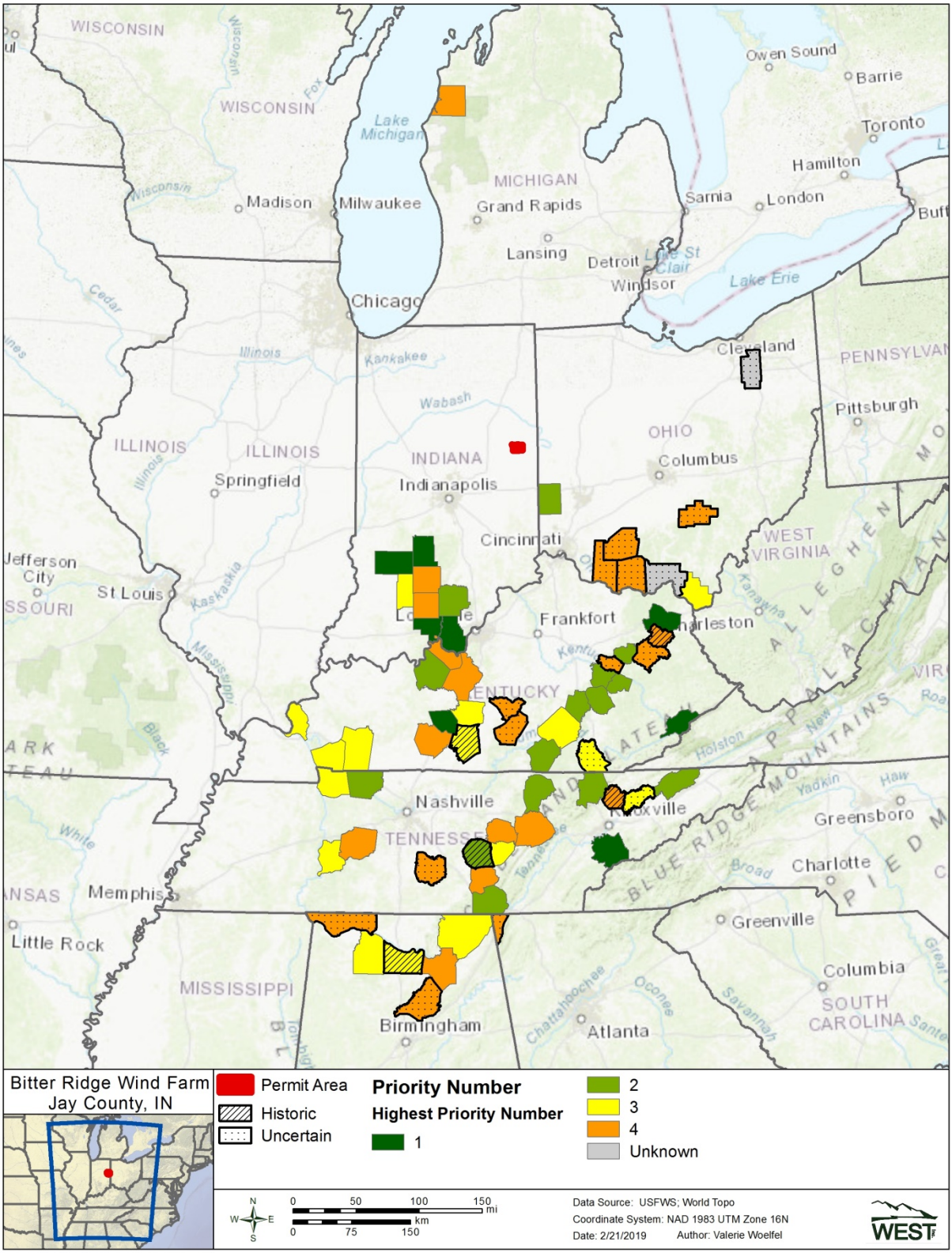

Figure 3.4. Indiana bat hibernacula in the Midwest Recovery Unit, as classified by the US Fish and Wildlife Service.

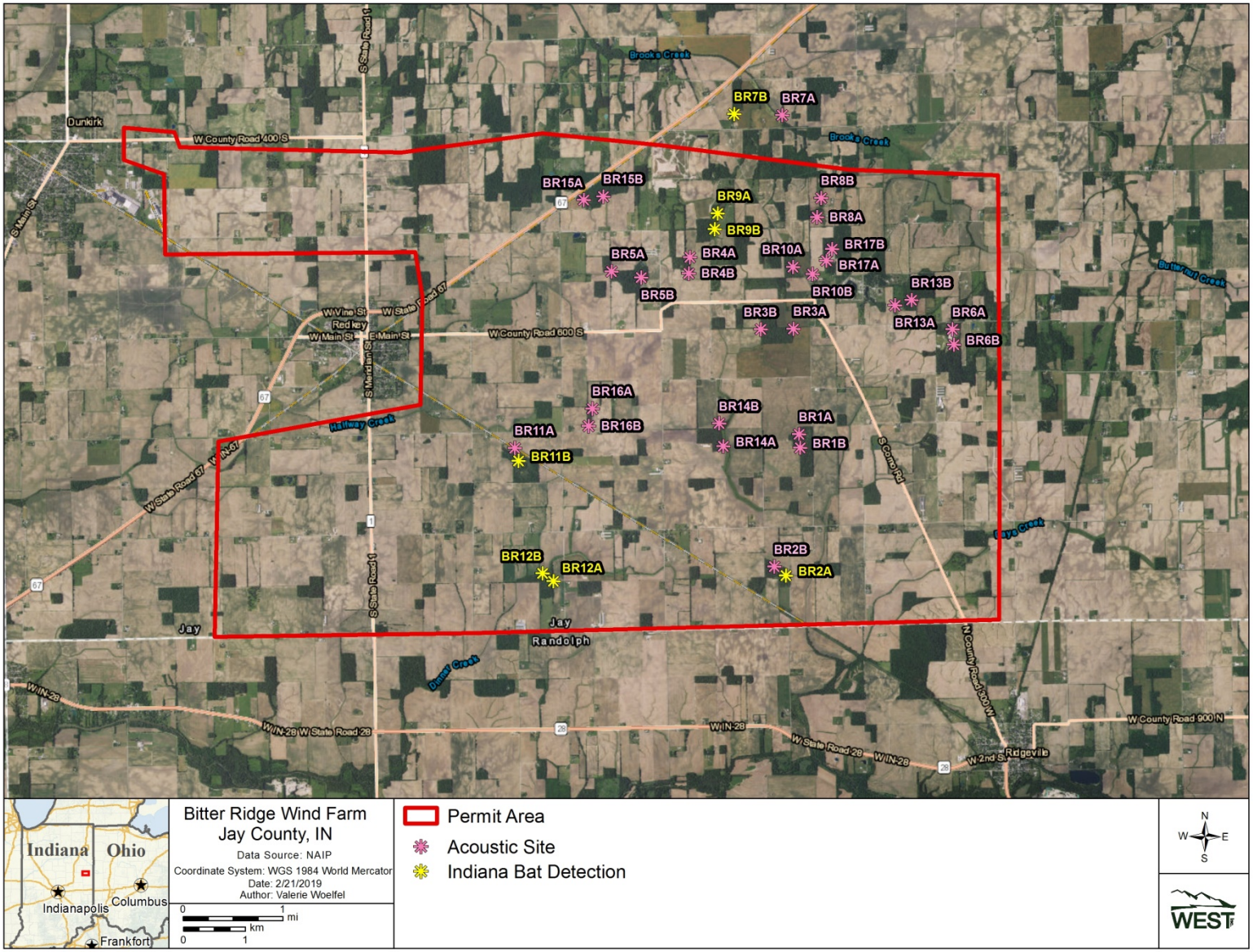

Figure 3.5. Acoustic detector locations with Indiana bat detections at the Bitter Ridge Wind Farm.

Follow-up mist-net surveys were conducted at the five sites where acoustic analysis indicated probable presence of Indiana bats. A total of 14 bats were captured at the five sites, including eight big brown bats, four eastern red bats, and two Indiana bats. One captured Indiana bat was a juvenile female and the other was a non-reproductive adult male.

The juvenile female Indiana bat was radio-tracked for seven days, from August 5 – 11 2017, to determine where day roosts were located and to determine if maternity colonies were present. Two roost sites were identified (Figure 3.6). The bat was triangulated to inaccessible land at the same approximate location during the first two days of tracking. On August 7, the bat was tracked to a dead white ash (*Fraxinus americana*) in an isolated forest patch approximately 0.62 km (0.39 mi) southeast of the capture site. Roost tree height was 27.1 m (89 ft) and diameter at breast height (DBH) was 39.9 cm (15.7 in). This tree was utilized August 7-9 and August 11. An emergence count was conducted August 7 and 8, and five bats were recorded emerging each night. On August 10, the bat was tracked to a dead cottonwood (*Populus deltoides*) tree in a larger forest patch approximately 1.7 km (1.1 mi) northwest of the capture site. Roost tree height was 22.6 m (74 ft) and DBH was 72.4 cm (28.5 in). An emergence count was conducted August 10, and only the tagged bat emerged from the roost. A second emergence count was not conducted on this tree because only one bat emerged. The bat returned to the first roost on day seven of radio-tracking.

In summary, based on the results of the 2017 presence/probable absence surveys, Indiana bats occur within the Permit Area during the summer season. Because the Permit Area is within the overall range, Indiana bats could also pass through the Permit Area during spring and fall migration periods. Therefore, this species is anticipated to be present April 1 – October 15. Based on the land cover and analysis of potential summer habitat as conducted by the USFWS (personal communication from Marissa Reed, April 23, 2018) within the Permit Area, it is assumed that potential summer roosts for the Indiana bat could be found within 305 m (1,000 ft) of up to 39 of the 52 General Electric turbine locations (Figure 3.7). Indiana bats are not expected to occur within the Permit Area during the fall swarming season (October 16 – November 15) based on the lack of known hibernacula in the Permit Area vicinity.

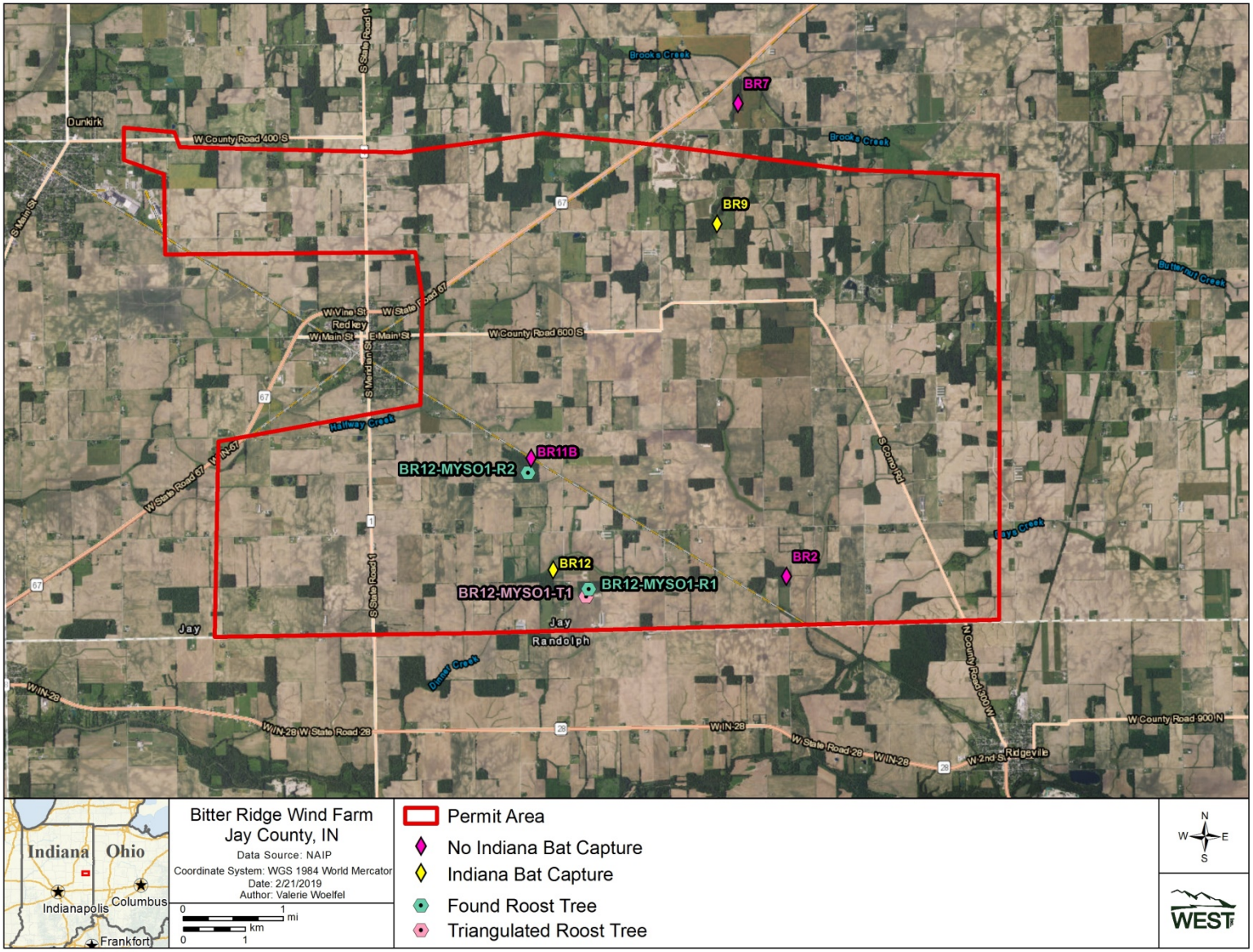

Figure 3.6. Mist-net survey locations and Indiana bat roost trees documented at the Bitter Ridge Wind Farm during summer 2017.

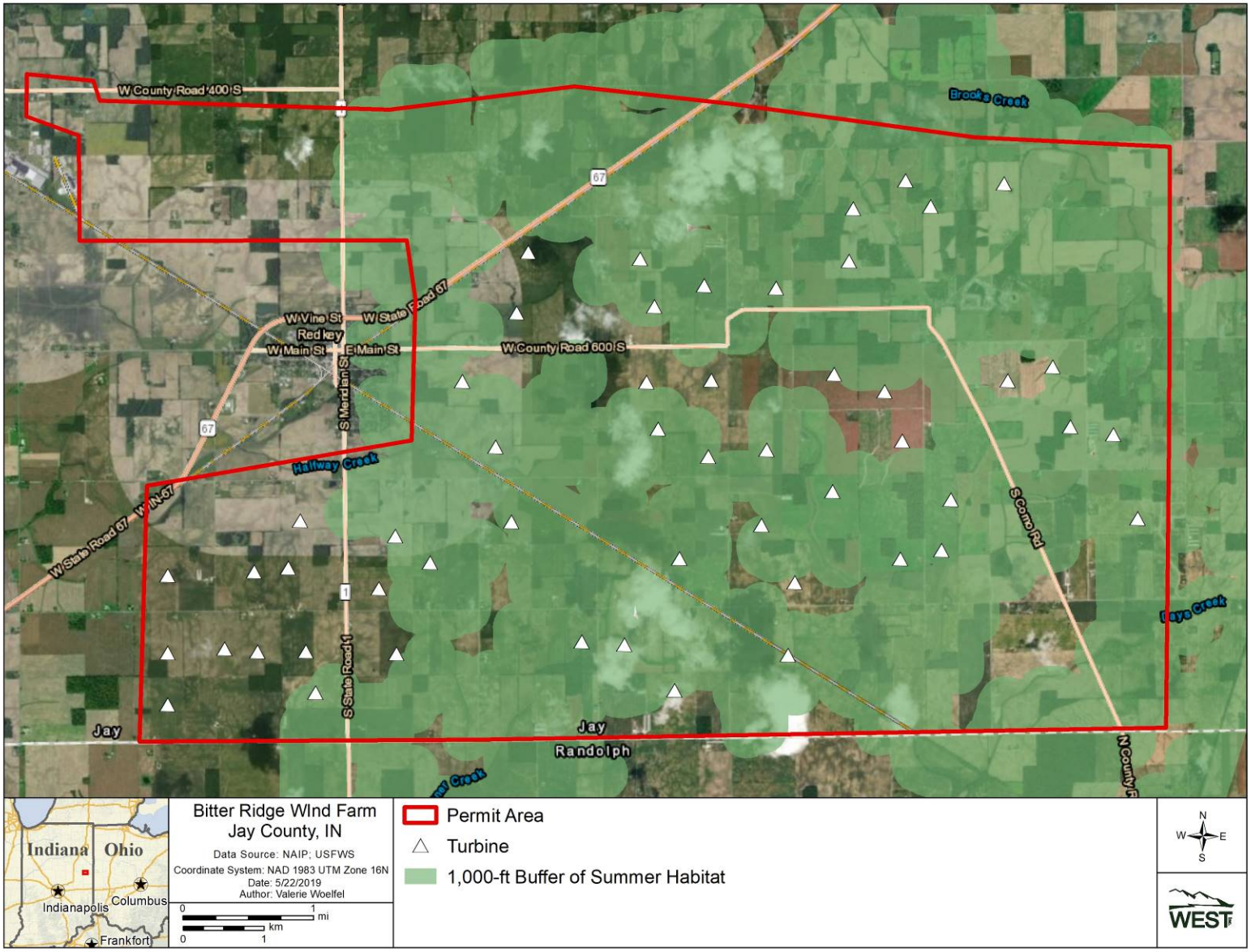

Figure 3.7. Turbine locations and potential summer habitat for Indiana bats at the Bitter Ridge Wind Farm.

3.1.2 Northern Long-Eared Bat

The northern long-eared bat is a small insectivorous bat that has been listed as threatened under the Endangered Species Act since April 2, 2015. Compared to other *Myotis* species, the northern long-eared bat has long ears; when folded forwards, the ears extend well past the nose.

3.1.2.1 Life History and Demographics

Northern long-eared bats exhibit life history traits similar to those of Indiana bats and other temperate bat species. Like most bats, northern long-eared bats are relatively long-lived (Caceres and Pybus 1997). Mating occurs in the vicinity of hibernacula from late July in northern regions to early October in southern regions and commences when males begin to swarm at hibernacula and initiate mating activity (Whitaker and Hamilton 1998, Caceres and Barclay 2000, Amelon and Burhans 2006, Whitaker and Mumford 2009). Mating also occasionally occurs again in the spring (Racey 1982).

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). Parturition likely occurs in late May or early June (Easterla 1968, Caire et al. 1979, Whitaker and Mumford 2009), but may occur as late as July (Whitaker and Mumford 2009). Studies suggest that in the southeastern portion of the northern long-eared bat range, parturition occurs between mid-May and mid-June (Cope and Humphrey 1972, Caire et al. 1979).

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, Caceres and Barclay 2000, Amelon and Burhans 2006, Whitaker and Mumford 2009).

Northern long-eared bats are likely opportunistic insectivores that both feed on aerial prey and glean prey from substrata (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).

Similar to other *Myotis* bat species, northern long-eared bats have a comparatively low reproductive rate, with females birthing one offspring per year (Barclay et al. 2004; Barbour and Davis 1969). 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, Hitchcock 1949, Pearson 1962, 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).

3.1.2.2 Habitat Requirements

Northern long-eared require a stable environment in which to hibernate during the winter, and woodland habitat in which to roost during the summer (USFWS 2014a)

Winter Habitat

Mine and cave sites have been most often reported as hibernacula for northern long-eared bats (Griffin 1940, Whitaker and Winter 1977, Stones 1981). This species reportedly hibernates in caves or abandoned mines with Indiana bats, little brown bats, big brown bats (*Eptesicus fuscus*), and tricolored bats (Mills 1971, Caire et al. 1979, Boyles et al. 2009). Northern long- eared bats generally compose a small proportion of the hibernating population of bat species in a given hibernaculum (less than 1% to 15%; Griffin 1940, Hitchcock 1949, Pearson 1962, Caire et al. 1979, Stones 1981).

Hibernating northern long-eared bats do not form large aggregations or clusters typical of some *Myotis* 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 been reported to occasionally move between hibernacula during the winter (Whitaker and Rissler 1992, USFWS 2014a).

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). Though some may roost alone, females often roost colonially. Maternity colonies are generally small, consisting of 30 (Whitaker and Mumford 2009) to 60 (Caceres and Barclay 2000) individuals, though maternity colonies of up to 100 individuals have been observed (Layne 1978, Dickinson et al. 2009, Whitaker and Mumford 2009).

Northern long-eared bats do not typically forage in intensively harvested forest stands or open agricultural areas, and instead concentrate their movement in and near intact forest whenever available (Patriquin and Barclay 2003, Henderson and Broders 2008). Northern long-eared bats 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). Northern long-eared bats are highly maneuverable in forested habitat and therefore are well-adapted to foraging in dense vegetation (Patriquin and Barclay 2003, Carter and Feldhamer 2005). This species is also frequently observed to forage in close proximity to ephemeral upland pools (Owen et al. 2003, Brooks and Ford 2005). In managed forests of West Virginia, northern long-eared bats utilized on average a 65-ha (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 male and five female bats) and five Indiana bats (all male bats) at the 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 roosts were located farther from water (117 m vs. 27 m [384 ft vs. 89 ft]), but closer to mist-net sites (0.3 km vs. 1.6 km [0.2 mi to 1.0 mi]) than Indiana bat roosts, suggesting that northern long-eared bats had shorter nightly travel distances at the 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. In general, studies indicate that northern long-eared bats show less of a preference for lower elevations for their maternity roost than Indiana bats, with a general range of 42 to 1,000 m (138 to 3,280 ft) documented in multiple studies, and multiple studies showing Indiana bat maternity roost trees in lower elevations than northern long-eared bat roost trees (Brack et al. 2002, 2003, 2006). Both northern long-eared bats and Indiana bats selected for roost trees located closer (80-100 m [262-328 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 that were identified by the study as an ephemeral resource (Schultes and Elliott 2002).

3.1.2.3 Seasonal Movements

Spring Emergence and Migration

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 Guidance and Planning Guide* (Northern Long-Eared Bat Interim Guidance), the primary spring migration season is from the beginning of April to mid-May (USFWS 2014a). As with Indiana bats, the actual migration periods may vary by latitude and weather, with spring emergence occurring earlier in more southern areas and fall migration occurring earlier in more northern 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 to 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).

Fall Migration and Swarming

According to the Northern Long-Eared Bat Interim Guidance, the primary fall migration period is from mid-August to October (USFWS 2014a). Northern long-eared bats begin arriving at hibernacula in August, and by mid-September large numbers can be seen flying about the entrances to certain caves and mines (Boyles et al. 2009). Mating occurs during this fall swarming period around hibernacula (USFWS 2014a).

Flight Height

Data regarding the height at which northern long-eared bats fly during migration are lacking. No publicly available radio-telemetry studies have been conducted to date to study the migration behavior of northern long-eared bats. However, it is clear that at least a portion of myotid bats are flying well above the tree canopy at rotor-swept height during migration, based on the 36 northern long-eared bat fatalities that have been publicly documented to date at wind energy facilities, occurring primarily during late summer and fall[2]. However, 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. Of all bat mortalities detected at wind energy facilities within the range of the northern long-eared bat, myotids and tricolored bats compose only about 10% of the total bat fatalities (USFWS unpublished data, as cited in USFWS 2011b).

Effects of Temperature on Northern Long-eared Bat Flight Activity

As described in Section 3.2.1.3, positive correlations of bat activity and temperature are common in bat literature, both over an annual time period (O'Farrell and Bradley 1970, Avery 1985, Rydell 1991) and on a nightly basis (Lacki 1984, Hayes 1997, Vaughan et al. 1997, Gaisler et al. 1998, Shiel and Fairley 1998, Roby and Gumbert 2016a, 2016b, Brooks et al. 2017, Petit and OKeefe 2017). While there are no publicly available studies that describe the migration behavior of northern long-eared bats relative to temperature, it is likely that migration activity by this species decreases as temperatures decrease, based on similarities in species biology to Indiana bats. As stated above, post-construction monitoring data from the FRWF showed only a small percentage of bat mortality occurred when temperatures were below the 10°C threshold (see Section 3.2.1.3). Winter mist-net and acoustic presence/absence studies in coastal North Carolina, which typically has milder winters than in the Midwest, have documented northern long-eared bat flight activity when nightly temperatures ranged between 5°C and 10°C (Ecological Engineering et al. 2016).

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

3.1.2.4 Range and Distribution

The northern long-eared bat is found in 39 states in the eastern and Midwestern US and across the northern Great Plains; the species also occurs across eastern and central Canada (USFWS 2014a; Figure 3.8). The species occurs in a widespread but patchy distribution, rarely occurs in large numbers (Barbour and Davis 1969), and is more common in the northern part of its range (Harvey 1992). Barbour and Davis (1969) reported that the winter and summer geographic ranges of the species appear to be identical.

3.1.2.5 Species Status and Occurrence

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 the loss of individuals, increasing the possibility that mortality caused by WNS (see below), habitat loss, or other factors will cause extirpation (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 parts 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. The USFWS listed the northern long-eared bat as a threatened species under the ESA (80 FR 17974; USFWS 2013a, 2015a).

The final 4(d) Rule for the species published January 14, 2016 (81 FR 1900) exempts from the Section 9 take prohibition the incidental take of northern long-eared bats resulting from most otherwise lawful activities[3], including incidental take of northern long-eared bats due to the operation of wind turbines. The USFWS further concluded that the designation of critical habitat was not determinable at the time of listing (USFWS 2013a).

Range-Wide

Little is known about overall population size or trends of northern long-eared bat within its range. Despite its broad range, the species has historically been most common in the Northeast and Midwest, with lower densities known in the southern and western portions of the range (USFWS 2013a).

[3] 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 Section 9 of the ESA, except: take of northern long-eared bats in their hibernacula in areas affected by WNS; take resulting from tree removal within0.4 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 through 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.

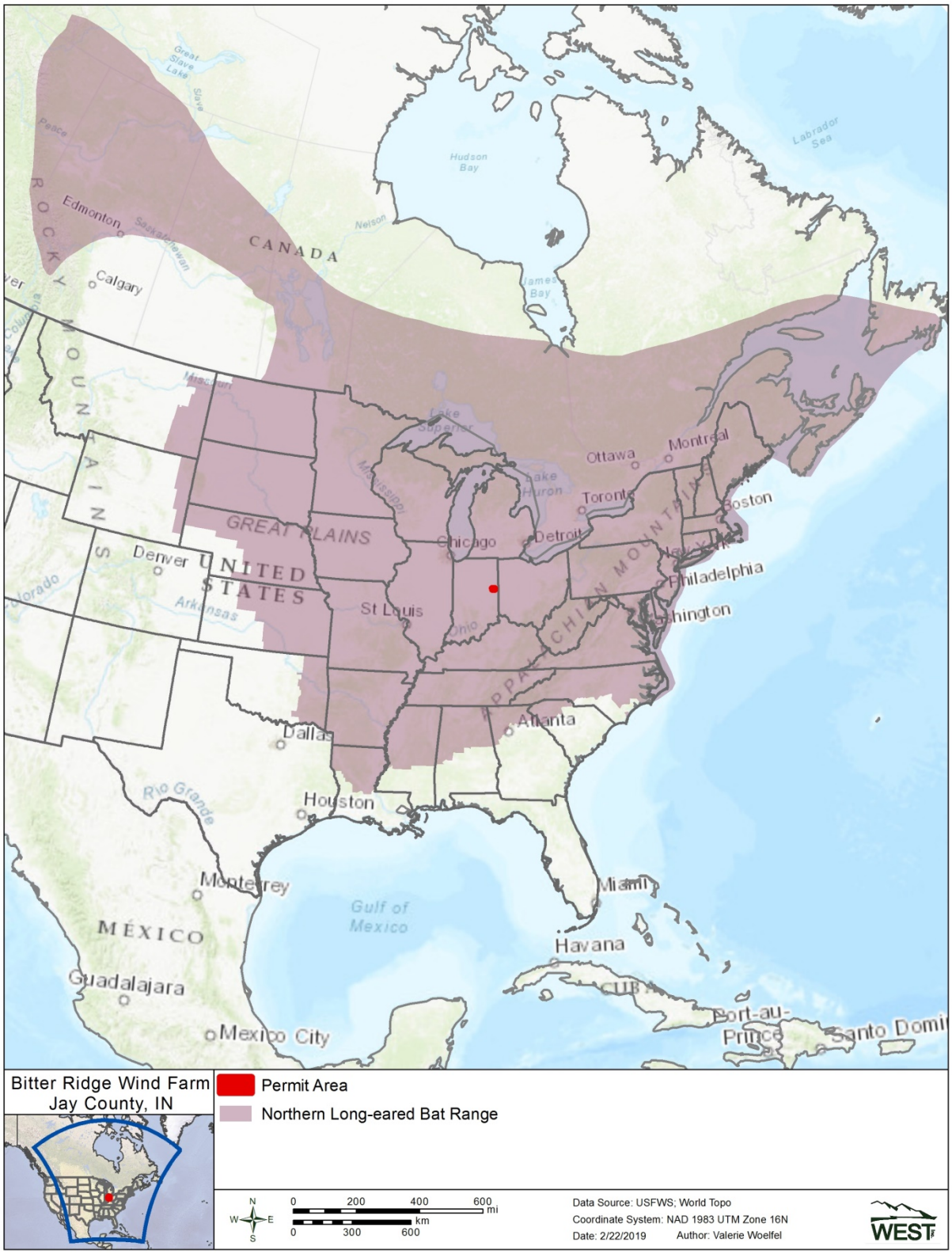

Figure 3.8. Geographic range of northern long-eared bat in the United States and Canada (USFWS 2014b).

Given its tendency to hibernate individually or in small groups, it is difficult to obtain accurate counts of wintering numbers of northern long-eared bats. However, mist-netting surveys suggest that northern long-eared bats are more numerous than hibernacula counts. The range-wide northern long-eared bat population estimate calculated in the 2016 4(d) rule biological opinion was 6,546,718 adults and 3,273,359 pups (USFWS 2016; 81 FR 1900 [January 14, 2016]). The Midwest (i.e., Illinois, Indiana, Iowa, Ohio, Michigan, and Missouri) northern long-eared bat population was estimated at four million total bats (USFWS 2015a; 80 FR 17974 [April 2, 2015]).

As with Indiana bats, WNS is the most severe threat facing northern long-eared bat populations range-wide (USFWS 2014a), and is the primary reason the species was listed as threatened under the ESA (80 FR 17974). 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 (2013c) conducted a similar analysis for an additional 12 hibernacula in Connecticut, Massachusetts, New Hampshire, and Vermont, and found the combined overall rate of decline in the eight states was approximately 99 percent. These states were also historically the core part of the species range, where the species was most abundant. White-nose syndrome is currently invading into areas in the Midwest that contain a number of large and important hibernacula, and population declines similar to those observed in the Northeast are expected over the next few years in the Midwest (USFWS 2013a).

The northern long-eared bat is facing similar threats as the Indiana bat (Section 3.2.1.5), likely due to the similarity in the two species' winter and summer habitats. In addition to WNS, disturbance during hibernation and loss of forest habitat may pose threats to the species (USFWS 2014a). The permanent or temporary removal of forested habitat may adversely affect the northern long- eared bat by reducing roosting, foraging and travel corridor 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 the species' general flexibility in roosting requirements (Owen et al. 2002, 2003; Silvis et al. 2012).

Indiana

Northern long-eared bats have been publicly recorded at 25 hibernacula consisting of abandoned mines, caves, and tunnels in Indiana (Whitaker and Hamilton 1998 as cited in 80 FR 17974). Historically, the northern long-eared bat was considered quite common throughout much of Indiana and was the fourth or fifth most abundant bat species in the state in 2009 (Whitaker and Mumford 2009 as cited in 80 FR 17974). Based on a review of mist-netting surveys in Indiana, Whitaker et al. (2002) estimated the state's northern long-eared bat population to be approximately 471,217 bats. Northern long-eared bats have been captured in at least 51 counties in Indiana, were often captured in mist-nets along streams, and were the most common bat captured by trapping at mine entrances (Whitaker and Mumford 2009 as cited in 80 FR 17974). The abundance of northern long-eared bats appears to vary within Indiana during the summer. During three summers (1990-1992) of mist-netting surveys in the northern half of Indiana, 37 northern long-eared bats were captured at 22 of 127 net sites, representing 4% of the bats captured (King 1993 as cited in 80 FR 17974). However, during three summers (2006- 2008) of

mist-netting surveys on two state forests in south-central Indiana, northern long-eared bats were the most common (38%) species captured (Sheets et al. 2013 as cited in 80 FR 17974). The northern long-eared bat range includes all 92 counties in Indiana (USFWS 2016); more information is needed on the location of hibernation sites and maternity colonies for the species within these counties.

Although data are not currently available to assess the population trend of northern long-eared bats in Indiana, WNS has been present in the state since the winter of 2010-2011 (Indiana Department of Natural Resources [IDNR] 2011, White-Nose Syndrome.org 2017) and there is no reason to believe WNS will not have a similar impact on northern long-eared bat populations in Indiana as it has had on northern long-eared bat populations in the northeast (80 FR 17974).

Permit Area and Vicinity

The locations of northern long-eared bat maternity colonies and hibernacula are largely unknown in Indiana. Although public data are not currently available to assess the distribution and abundance of the population of northern long-eared bats in Jay County, the pre-construction surveys provide information about the occurrence of northern long-eared bats within the Permit Area.

Results from acoustic monitoring and mist-net captures did not confirm the presence of northern long-eared bats during the summer season (Brown and Bishop-Boros 2018). Review by bat call experts did not identify northern long-eared bat calls, suggesting probable absence of northern long-eared bats at the 17 acoustic presence/probable absence survey sites (Figure 3.5). No northern long-eared bats were captured in the 2017 mist net surveys.

Because the Permit Area is within the overall northern long-eared bat range, the Applicant assumes that the species could pass through the Permit Area during spring and fall migration; therefore, this species is anticipated to be potentially present from April 1 – May 15 and August 1 – October 15. Based on the results of the 2017 presence/probable absence acoustic and mist-netting monitoring, the Applicant assumes that the species is probably absent from the Permit Area in the summer maternity season (May 16 – July 31). Northern long-eared bats are not expected to occur within the Permit Area during the fall swarming season (October 16 -November 15) based on the lack of known hibernacula in the Permit Area vicinity.

4.0 TAKE ASSESSMENT

This chapter quantifies the potential incidental take for each of the Covered Species that may result from collision with spinning turbine blades. The small number of carcasses documented in publicly-available data on turbine searches throughout North America indicates, however, that fatalities of the Covered Species at wind energy facilities are rare (Table 4.1).

Table 4.1. Publicly available records of Covered Species fatalities at North American wind energy facilities.

Species	Regional Fatalities	All Documented Fatalities	Reference
Indiana bat	Midwest Recovery Unit: 6 in Indiana (2009 – 2018), 3 in Ohio (2012 – 2014), 1 in Iowa (2016), 1 in Illinois (2016)	13 in 6 states from 2009 - 2018	Pruitt & Reed 2018
Northern long-eared bat	USFWS Midwest Region: 8 across Iowa, Illinois, Indiana, Michigan, and Missouri	43 in 9 states and 1 Canadian province from 1998 - 2014	USFWS 2015a

Throughout this chapter, the term "predicted take" refers to the amount of incidental take that is projected to occur at the Project under implementation of the HCP; this is done to establish the requested take authorization under the ITP (Chapter 4). The term "estimated take" refers to the amount of take that is statistically estimated to have occurred during a given monitoring period at a reference wind facility or at the Project once monitoring data have been collected (Chapter 5). Take is estimated for the purpose of evaluating compliance with the ITP. In other words, take prediction refers to quantification of potential take, while take estimation refers to quantification of take that has already occurred to monitor compliance with the take authorization.

4.1 Take Prediction Prior to Minimization Measures

4.1.1 Take Prediction Model – Species Composition

The take prediction method used here is commonly called the "species composition" approach. This approach was developed for wind energy HCPs and was first used in the Fowler Ridge Wind Farm Indiana Bat HCP (Fowler Ridge LLC 2013). It has evolved over the years from a simple calculation to a statistical approach that allows incorporation of uncertainty into take prediction (Section 4.1.2). This method requires two main components: 1) the expected number of total bat fatalities and 2) the expected fraction of all fatalities attributable to the species of interest. From post-construction monitoring data, it is possible to determine the proportion of each Covered Species out of all bat fatalities and an average, overall rate of fatalities per turbine on a seasonal basis. Conceptually, the predicted number of fatalities at the planned Project is simply a product of these two components. For example, say Indiana bats comprise 1% of all bat fatalities in a dataset. If the fatality rate were 10 bats per year at a wind facility, one could reasonably expect turbines to kill three Indiana bats over the course of a 30-year permit term (1 Indiana bat fatality per 100 bat fatalities * 10 bat fatalities per year * 30 years = 3 predicted Indiana bat fatalities). To incorporate measures of uncertainty in take predictions, the actual method used in this HCP is more nuanced, as described in detail below and in Appendix A.

4.1.2 Incorporating and Quantifying Uncertainty

Because Covered Species mortalities tend to be rare, the accuracy of take predictions is limited regardless of the statistical tool used. The Project has not yet been constructed, and therefore has not obtained post-construction fatality data. The lack of fatality monitoring data for the Project contributes to uncertainty in the take prediction. Given the type of data available, the method used here represents the best available method for predicting take of the Covered Species while also quantifying the uncertainty in the take predictions produced.

In light of uncertainty surrounding the take predictions, it is important when establishing requests for ITPs to use take rates that are high enough so that the actual take is not underestimated. To ensure that the conservation program will fully offset any take that occurs, the take limit is set above the take prediction using a buffer. In this case, the chosen buffer was the upper bound of the 80% confidence interval. This buffer gives confidence that the take limit will not be exceeded and that the mitigation is sufficient to offset the take limit. Fatality events are somewhat stochastic (i.e., there is an element of randomness to them), resulting in uncertainty (variance) in the estimate of take. Uncertainty in these estimates could arise from any number of sources, including but not limited to annual variation in bat densities, long-term population trends, and differences in study design. Quantification of this uncertainty acknowledges that an estimate or prediction is a reasonable approximation of the actual mortality that may occur, and allows the calculation of a range of possible values. This range of values that accounts for uncertainty around the take predication is called a confidence interval.[4] The lower the level of confidence (all other things being equal) the narrower the confidence interval, meaning there is less confidence that the interval captures the truth. The higher the level of confidence, the wider the confidence interval, meaning there is more confidence that the interval captures the truth. The choice of the confidence level is a balance between maximizing confidence and obtaining a useful interval. Based on an evaluation of the uncertainties involved in the take prediction and the Applicant's desire to ensure ITP compliance, the Applicant used the upper bound of the 80% confidence interval as the value for developing a take prediction. Further details of the statistical approach used to quantify uncertainty are provided in Appendix A.

4.1.3 Data Used in Calculating Predicted Take

In the absence of Project-specific, post-construction fatality data, fatality data from the Fowler Ridge Wind Farm (hereafter Fowler Ridge) were used for take prediction at the Project. Fowler Ridge is a well-studied wind facility and has made all of its post-construction monitoring studies publicly available since 2009. There are no other wind facilities in Indiana with publicly available bat fatality information. Fowler Ridge is located in Benton County, Indiana, approximately 130 miles west of the Project (Figure 4.1). Data from Fowler Ridge was therefore used as a proxy for the Project because of the facilities' similar settings: both are located in primarily agricultural, flat landscapes in Indiana, and both are located in the Indiana bat MRU.

Fowler Ridge now consists of 420 wind turbines, developed in four phases. Post-construction bat fatality studies were first conducted in 2009, during which an Indiana bat carcass was found (Johnson et al. 2010). A second Indiana bat carcass was found in 2010 (Good et al. 2011). Fowler Ridge subsequently worked with the USFWS to develop an HCP designed to minimize Indiana bat casualties (Fowler Ridge LLC 2013). Since implementing minimization measures in 2012, Fowler Ridge has reduced the number of overall bat fatalities by more than half and has not found another Indiana bat carcass (Good et al. 2018).

[4] If this range or interval is calculated using frequentist statistics it is called a confidence interval, if Bayesian statistics is used it is called a credible interval. The species composition approach used here employs both types of statistics. As credible and confidence intervals are conceptually the same, we refer to both as "confidence intervals" throughout.

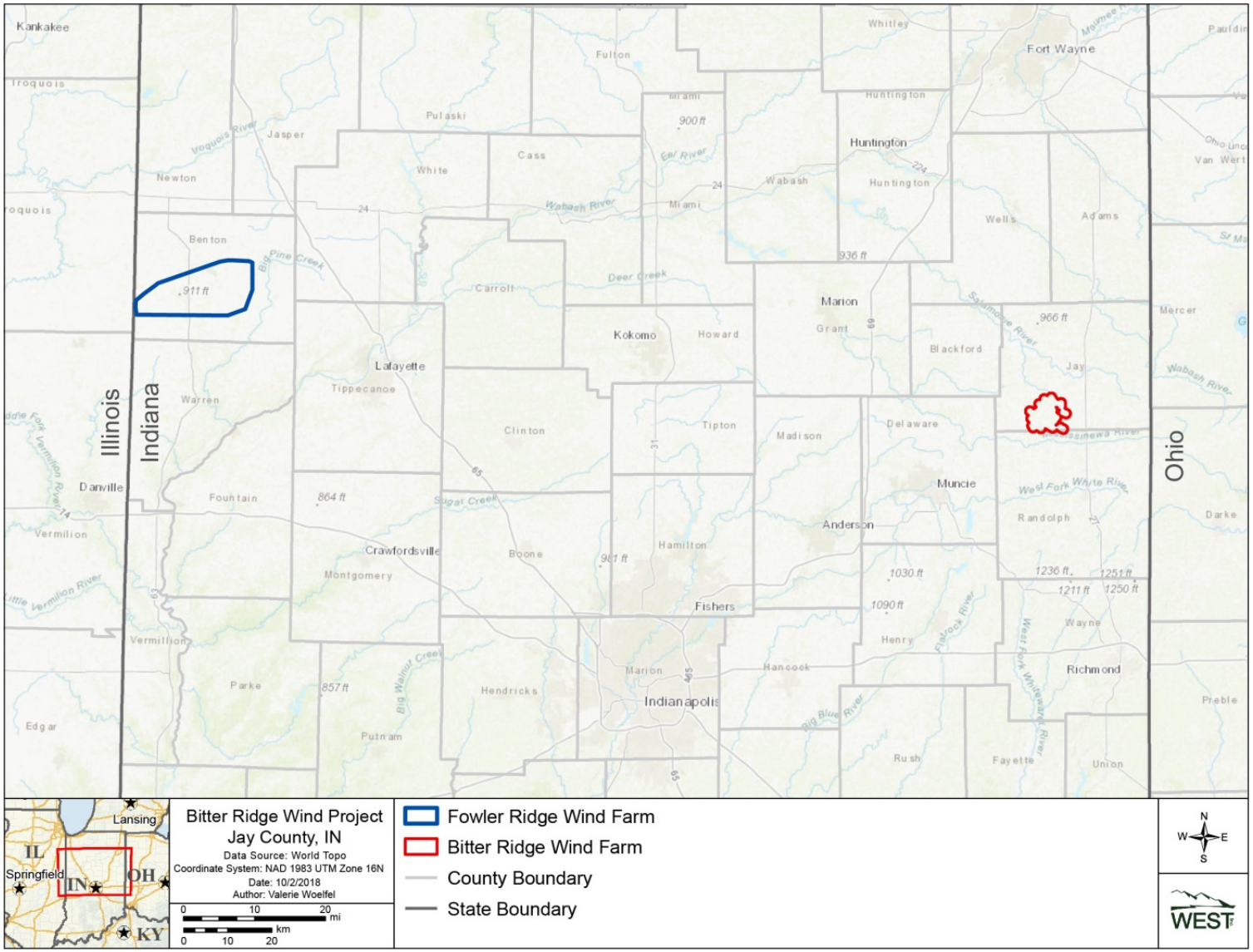

Figure 4.1. The proposed location of Bitter Ridge and the location of Fowler Ridge, which was used in the reference bat fatality dataset (Hoen et al. 2018).

For this HCP, take predictions were calculated using seasonal fatality estimates spanning the full bat-active season. From 2009 – 2011, Fowler Ridge reported overall bat fatality estimates for normally operating turbines. From 2012 onward, Fowler Ridge turbines were operating under a minimization program (curtailment) in the fall. In order to generate a take prediction that does not account for minimization, only data from normal operation years were used; therefore no data from 2012 or later (i.e., no fatality estimates that were generated when the Fowler Ridge turbines were operating under fall curtailment) were used in the pre-minimization take prediction analysis. As was done for the Fowler Ridge HCP, 2009 data was not used for estimating an average number of bat fatalities, because the 2009 study was less intensive and did not follow the same study design as the 2010 and 2011 studies and therefore the estimates generated from 2010 and 2011 were considered more robust and appropriate for use in an overall mortality estimate (Fowler Ridge LLC 2013). Therefore fatality estimates and confidence intervals from 2010 and 2011 were combined to produce an estimate of the average number of bat fatalities in the fall. Spring and summer fatality estimates for this HCP were calculated from just the 2011 Fowler Ridge data because Fowler Ridge was not monitored in the summer of 2010, and the 2011 dataset is the only one covering a full bat activity season when the Fowler Ridge turbines were operating without curtailment. For the species proportion analysis, monitoring data from 2009 – 2011 were used as it was assumed that the species composition of the local bat community was constant over this time period and would be similar regardless of exact study design. This is also consistent with the Fowler HCP. Table 4.2 summarizes which years of 2009 – 2011 data were used for which components of the species composition take prediction.

Table 4.2. Fowler Ridge Wind Farm pre-curtailment data: which years used for various elements of the Bitter Ridge Covered Species take predictions.

Year	Used in Species Proportion	Used in Spring/Summer Fatality Estimate	Used in Fall Fatality Estimate
2009	Yes	No	No
2010	Yes	No	Yes
2011	Yes	Yes	Yes

The Covered Species are assumed to be at risk for collision at all turbines during spring and fall migration. The Covered Species are anticipated to have different levels of risk in the summertime within the Permit Area, with Indiana bats presumed to be present in the summer and at risk of collision with turbines within 305 m (1,000 ft) of suitable habitat, and northern long-eared bats presumed to be absent from the Permit Area during the summer (Sections 3.2.1.5 and 3.2.1.6). The summer fatality rate was therefore adjusted for each Covered Species based on their presumed summer risk (Table 4.3).

Table 4.3. Expected number and percentage of Project turbines with collision risk, by season, for the Covered Species.

Species	Number of turbines (percentage of turbines) with collision risk		
	Spring	Summer	Fall
Indiana bat	52 (100%)	39 (75%)	52 (100%)
Northern long-eared bat		0	

Overall Fatality Rate

Based on the seasonal bat mortality rates from the Fowler Ridge dataset, the Project is expected to take approximately 33.73 bats/turbine/year (the sum of the seasonal estimates), or approximately 1,754 total bats per year over the Project's 52 turbines. The majority of take (89%) is anticipated to occur in the fall (Table 4.4). These seasonal fatality rates represent the estimated number of fatalities in the absence of minimization measures. The actual number of bat fatalities resulting from operation of the Project is expected to be substantially smaller owing to the minimization measures implemented as part of this HCP (Section 4.2).

Table 4.4. Overall bat fatality estimates by season for 2010 – 2011 at the Fowler Ridge Wind Farm.

Season	All-bat fatality estimate per turbine (90% confidence interval)
Spring	0.66 (0.32 – 1.17)
Summer	2.90 (1.57 – 4.22)
Fall	30.17 (24.60 – 37.13)

Species Proportions

Both Covered Species were found during post-construction fatality monitoring at Fowler Ridge from 2009 – 2011 (Table 4.5). During this period a total of ten species and 1,538 total carcasses were detected during fatality surveys. The Covered Species accounted for a small proportion of the total number of carcasses found (Table 4.6). These estimated species proportions and the estimated overall fatality rate (adjusted for summer risk) were combined to produce a pre-minimization take prediction for each Covered Species.

Table 4.5. Carcass counts from post-construction monitoring conducted at the Fowler Ridge Wind Farm from 2009 – 2011.

Year	Number of turbines	Indiana bat	Northern long-eared bat	Total count of all bat carcasses
2009	162	1	1	156
2010	355	1	0	809
2011	355	0	0	573
Total	-	2	1	1,538

Table 4.6. Estimated species proportions for 2009 – 2011 at the Fowler Ridge Wind Farm.

Species	Species proportion
Indiana bat	0.0016244
Northern long-eared bat	0.0009747

Take Predictions for the Covered Species Prior to Minimization Measures

Based upon the data described above, the annual Indiana bat fatality estimate for the Project from the species composition method is 2.77 individuals per year (Table 4.7). Based on an evaluation of the uncertainties involved in the take estimate and the likelihood of ITP compliance at these different confidence intervals, the Applicant used the upper bound of the 80% confidence interval as a more conservative value for deriving a take request. Based on the upper bound of the 80% confidence interval (0.65 – 4.88 Indiana bats/year), the cumulative predicted take over the ITP term is 171 Indiana bats in the absence of minimization measures (4.88 bats per year x 35 years

= 171 Indiana bats). The annual northern long-eared bat fatality estimate for the Project from the species composition method is 1.56 individuals per year (Table 4.7). Based on the upper bound of the 80% confidence interval (CI = 0 – 3.19), the cumulative predicted take over the ITP term is 112 northern long-eared bats in the absence of minimization measures (3.19 bats per year x 35 years = 112 northern long-eared bats).

Table 4.7. Take predictions for the Covered Species in the absence of minimization measures.

Species	Predicted fatalities per year (80% confidence interval)	Predicted fatalities per 35 years (80% confidence interval)
Indiana bat	2.77 (0.65 – 4.88)	96.92 (22.92 – 170.92)
Northern long-eared bat	1.56 (0 – 3.19)	54.69 (0 – 111.54)

4.2 Take Prediction Adjusted for Minimization Measures

4.2.1 Effectiveness of Turbine Curtailment

The analysis presented above and in Appendix A estimates the amount of Covered Species mortality that can be expected under normal operating conditions. However, operational adjustments will be made as a condition of this HCP to minimize the take of Covered Species. Specifically, all turbine blades will be feathered below the manufacturer's cut-in wind speed of 3.0 m/s (9.8 ft/s) for all turbines in the spring, below a raised cut-in of 5.0 m/s (16.4 ft/s) in the summer for all turbines within 305 m (1,000 ft) of suitable summer habitat, and below 5.0 m/s (16.4 ft/s) for all turbines in the fall (Section 5.2.2, Table 5.1). These measures are expected to substantially reduce all-bat mortality at the Project.

Bat mortality resulting from turbine collision in the Eastern and Midwestern US is inversely related to wind speed (Arnett et al. 2005). Raising the turbine cut-in speed and feathering turbine blades below cut-in at night, during periods of low wind, and in the late-summer through early-fall can substantially reduce bat mortality (Table 4.8)[5]. Feathering and raising the typical cut-in speed of 3.0 or 4.0 m/s by 1.5 m/s generally results in at least a 50% reduction in bat mortality (Arnett et al. 2013). At the Fowler Ridge Wind Farm, Indiana, feathering below 5.0 m/s in the fall has consistently reduced the amount of all-bat mortality to below 50% of pre-curtailment levels (Figure 4.2; Table 4.9; Good et al. 2018). The mean reduction achieved by raising the cut-in speed from 3.5 to 5.0 m/s at Fowler Ridge from 2010 to 2017 was 71% ± 4% standard error (Good et al. 2018).

[5] Confidence intervals around the mean percent reductions in some studies overlapped. In those cases, the reported effect of curtailment was 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 4.8. Results from publicly available turbine curtailment effectiveness studies.

Study	Normal 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			35		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	Peer-reviewed; not significantly different from 5.5 m/s
Wolfe Island, ON 2010	4.0		48	48	Stantec Ltd. 2011	Reduction not analyzed statistically
Fowler Ridge, IN 2011			57		Good et al. 2012	Treatment = feathering below cut-in
Anonymous Project (AN01), USFWS Region 3	3.5	4.5	47	52	Arnett et al. 2013	Treatments rotated amongst 12 turbines
Criterion, MD 2012	4.0		62	62	Young et al. 2013	Compared to 2011 monitoring results
Casselman, PA 2008			82		Arnett et al. 2010	All turbines received treatments in a randomized order
Casselman, PA 2009			72		Arnett et al. 2010	Half of turbines received randomized treatments
Fowler Ridge, IN 2010			50		Good et al. 2011	No feathering below cut-in
Fowler Ridge, IN 2012			84		Good et al. 2012	
Fowler Ridge, IN 2013			77		Good et al. 2014	
Fowler Ridge, IN 2014			78		Good et al. 2015	
Fowler Ridge, IN 2015			72		Good et al. 2016	
Fowler Ridge, IN 2016			72		Good et al. 2017	Reductions for all six years in reference to 2010 baseline.
Fowler Ridge, IN 2017			66		Good et al. 2018	
Wildcat, IN 2017	3.5		74	73	Stantec 2018	Spring only. Treatment data from 2016, normal cut-in data from 2013-2015 and 2017.
Pinnacle, WV 2012			47		Hein et al. 2013	One outlier was removed from the dataset
Pinnacle, WV 2013	3.0	5.0	54	51	Hein et al. 2014	Not significantly different from 6.5 m/s treatment

Study	Normal 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			73		Good et al. 2012	Treatment = feathering below cut-in
Wolfe Island, ON 2010	4.0		60	67	Stantec Ltd. 2011	Effect not analyzed statistically
Summerview, AB 2007			60		Baerwald et al. 2009	Peer-reviewed; no significant difference between this and 4 m/s
Anonymous Project (AN01), USFWS Region 3	3.5	5.5	72	66	Arnett et al. 2013	Treatments rotated amongst 12 turbines
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		76	76	Hein et al. 2014	Effect not significantly different from 5 m/s
Casselman, PA 2008	3.5		82		Arnett et al. 2010	12 turbines received treatments in a randomized order; no significant different between this and 5 m/s
Casselman, PA 2009	3.5		72		Arnett et al. 2010	
Fowler Ridge, IN 2010	3.5	6.5	78	77	Good et al. 2011	No feathering below cut-in
Wildcat, IN 2017	5.0		51	51	Stantec 2018	Fall only. Treatment data from 2017, baseline data from 2013-2015.
Beech Ridge, WV 2012	3.5		89		Young et al. 2014	
Beech Ridge, WV 2013	3.5	6.9	97	93	Tidhar et al. 2013	Compared to average mortality at two other West Virginia projects

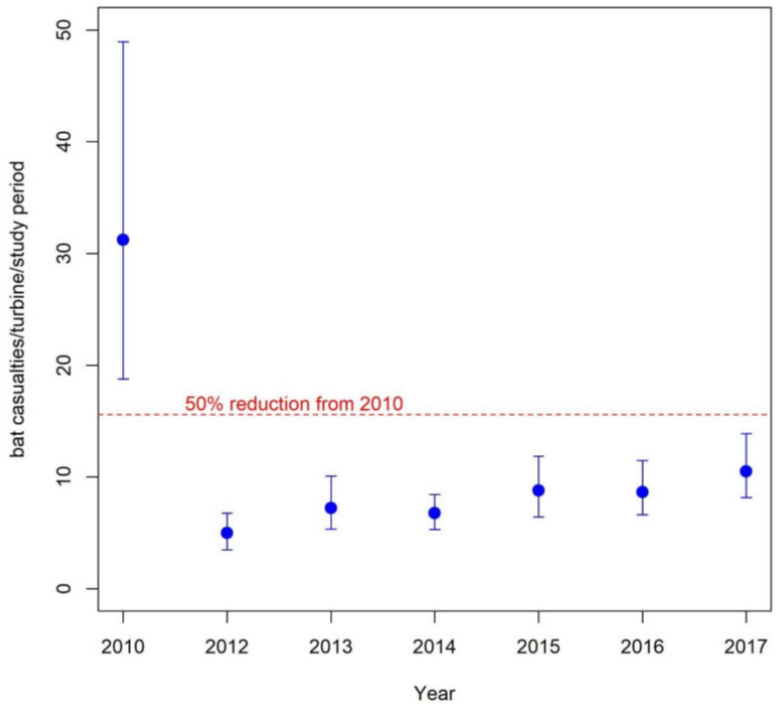

Figure 4.2. A comparison of estimated bat casualty rates and 90% confidence intervals for Fowler Ridge Wind Farm. The 2010 estimate represents turbines operating at manufacturer cut-in speeds (3.0 m/s). The 2012-2017 estimates represent data collected at turbines that were feathered below 5.0 m/s. The red dotted line represents a 50% reduction in bat casualty rates compared to the 2010 estimate (Good et al. 2018).

Table 4.9. Take requests for the Covered Species.

Species	Total take request for duration of the permit
Indiana bat	69
Northern long-eared bat	45

It is uncertain if turbine operational adjustments are equally effective at reducing mortality for all bat species or species groups. Three species of long-distance migratory (non-cave hibernating) bats account for the majority of fatalities at wind energy facilities in North America: the hoary bat (*Lasiurus cinereus*), the eastern red bat (*Lasiurus borealis*), and the silver-haired bat (*Lasionycteris noctivagans*; Kunz et al. 2007, Arnett et al. 2008). Collectively, these species comprised 75% of all documented bat fatalities in a review of studies from 19 wind energy facilities (Arnett et al. 2008). Consequently, these species make up the bulk of the all bat fatality data analyzed in curtailment studies to date. No curtailment studies have specifically analyzed the effectiveness of raised cut-in wind speeds in reducing *Myotis* fatalities.

The average reduction in mortality for all studies employing a 5.0 m/s cut-in speed is 68% ± 3% standard error (Table 4.8). Given the range of values among studies in the estimated reductions in bat mortality (Table 4.8), and potential year-to-year variation, the Applicant predicts that feathering turbine blades below a cut-in wind speed of 3.0 m/s during the spring and 5.0 m/s

during in the summer and fall would reduce all-bat mortality by at least 60% annually. This estimated reduction was applied to the pre-minimization take predictions for each Covered Species to arrive at the request for take authorization.

4.2.2 Incidental Take Limits

After adjusting the take prediction to reflect the 60% reduction in take expected to result from minimization measures, it is anticipated that the Project will take about 1.95 Indiana bats per year. The Applicant therefore requests a take limit of **69 Indiana bats** over the 35-year term of the ITP (Table 4.9).

After adjusting the take prediction to reflect the 60% reduction in take expected to result from the minimization measures, it is anticipated that the Project will take about 1.27 northern long-eared bats per year. The Applicant therefore requests a take limit of **45 northern long-eared bats** over the 35-year term of the ITP (Table 4.8).

Using the upper bound of the 80% confidence interval of the annual take rate, the requested take authorization reflects the maximum of take that is reasonably expected. The Applicant will conduct compliance monitoring and implement adaptive management if necessary to ensure that the cumulative take estimated from monitoring is equal to or less than the ITP take limit.

4.3 Impacts of the Take

4.3.1 Impact Assessment Model – Resource Equivalency Analysis Framework

Seeking a common framework for comparing resources lost through wind energy activities with resources gained through compensatory mitigation, the USFWS Region 3 developed a “resource equivalency analysis” (REA) for Indiana bats (Szymanski et al. 2013). The USFWS later developed a REA for northern long-eared bats as well.

The REA is comprised of two parts: 1) a species-specific demographic model that reflects the best scientific understanding of that species’ biology and 2) a resource equivalency model to calculate the amount of mitigation (credit) needed to offset the projected loss in reproductive potential (debit). The demographic model, which is predefined for the user, is used to calculate losses in reproductive potential from project impacts. The user provides information on permit duration, projected take, and the direction of population trends to calculate the amount of mitigation (in the form of habitat protection or restoration) required to offset those impacts. The REA is designed to evaluate the level and types of mitigation appropriate to compensate for the direct take of bats from wind energy projects. It is not constructed to analyze population-level impacts. At this time, mitigation options include winter habitat (hibernacula) protection, summer habitat protection, and summer habitat restoration. This approach currently represents the only USFWS-approved tool for quantifying Indiana and northern long-eared bat mitigation debits and credits.

Determining the significance of potential take on a species or population requires an understanding of population demographics, and in particular annual survival and reproduction

rates. One key assumption of the REA's predefined demographic model is that the loss of a female has a greater impact on the overall population than the loss of a male, because of the much greater loss in reproductive potential. The model requires the user to provide the number of "injured adult females annually" at a project, but does not provide guidance on how to generate this number. The permitted take amount is not broken down by sex or age, and thus includes males. To understand the biological impact of the Project take on bat populations, therefore, it is necessary to estimate what proportion of each species affected by take are likely to be females. As data on age and reproductive status are lacking, the analysis presented here does not distinguish between reproductive and non-reproductive females.

It is unclear based on available scientific information if there are sex-related factors that might influence collision risk during migration. Few empirical data are available on the sex ratios of bats found in mortality monitoring studies, partly because many carcasses cannot be identified to age or sex due to decomposition and scavenging by insects. The sex of bat carcasses was recently summarized in 50 publicly available mortality monitoring studies in the eastern and Midwestern US and Canada (MidAmerican 2018). Among 5,860 carcasses of all bat species, 22%, 41%, and 37% were identified as females, males, and unknown sex, respectively. For *Myotis* species in particular, among 460 carcasses, 18%, 40%, and 42% were identified as females, males, and unknown sex, respectively. Since such a large percentage of *Myotis* could not be identified to either sex (42%), 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 (39% females and 61% males). Because there is no robust information on sex-related risk of collision to bats overall, this HCP looks at each Covered Species individually to estimate the ratio of female to male bats that would be anticipated to be taken, and therefore the number of females of each Covered Species that is used in the REA for each Covered Species.

4.3.2 Impacts to Indiana Bats

The location of the Project suggests that the Indiana bats migrating through the Permit Area in the spring and fall will be mostly females. Female Indiana bats disperse from hibernacula to join summer maternity colonies, while male Indiana bats typically remain closer to hibernacula throughout the summer (Gardner and Cook 2002, Whitaker and Brack 2002). The assumed swarming radius for Indiana bats is 32 km (20 miles) for P1 and P2 hibernacula (USFWS 2011a). The nearest known winter population to the Project is a P2 hibernaculum (Lewisburg Limestone Mine) located at least 38 km (24 miles) to the southeast in Preble County, Ohio (USFWS 2007). Therefore, if collision risk is generally equal for both sexes, Indiana bat fatalities are more likely to be females due to their more frequent occurrence within the Permit Area during migration. Fatality data for Indiana bats suggest that females may be more likely to be killed by turbines, but the small sample size makes it difficult to draw conclusions. Five of the seven identifiable Indiana bat fatalities documented to date have been females (five females, two males, and six unknown sex; Pruitt and Reed 2018).

If 1) there are more adult females than males in the spring and fall migratory populations, 2) migrating juveniles occur at a 1:1 sex ratio in the fall, and 3) the Project is a little more than

20 miles from a P2 hibernaculum and therefore take during the summer will be skewed toward females, then a 3:1 ratio of female to male Indiana bats at the Project is a reasonable assumption. Therefore, without distinguishing between adults and juveniles, approximately 75% of the Indiana bats that are predicted to be taken at the project are expected to be females.

Project-Level Impacts

The Applicant predicts that a total of 1.95 Indiana bats will be taken each year during the 35-year ITP term. Approximately 75% of the incidental take is expected to be attributed to females, which would result in an annual take of 1.46 females (juveniles and adults). Using the USFWS's REA and assuming a declining population, the predicted loss in reproductive capacity during the ITP term is 81 female pups, resulting in a total predicted impact of 133 Indiana bats over the 35-year ITP term. Mitigation actions, therefore, will have a target increase of 133 Indiana bats to account for this lost reproductive capacity (Table 4.10).

Table 4.10. The inputs and results of the resource equivalency analysis for Indiana bats.

Input parameters	Value	Data type
Permit start year	2020	
Injured adult females annually	1.46	
Permitted take years	35 years to 2055	
Lambda condition	Declining	User-supplied
Adult female breeding rate	0.562 pups/female/year	
Juvenile female breeding rate	0.130 pups/female/year	
Pup survival to juvenile	0.585	
Juvenile annual survival	0.674	
Adult annual survival	0.857	Fixed
Results		
Direct take	51 female adults	
Total lost reproduction	81 female pups	
Total lost	**133 Indiana bats**	Model-generated

Population-Level Impacts

The Indiana bats residing in and migrating through the Permit Area are part of the MRU population (USFWS 2007; Section 3.2.1). Here the impacts of the taking are evaluated as they pertain to the MRU population as well as the range-wide population.

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 average maternity colony size for Indiana bats is 50 to 80 adult females (Whitaker and Brack 2002). Projected take at the Project is less than two females per year, with the majority of fatalities predicted to occur in the fall, meaning that in most years no take would be expected to occur during the maternity season. Take from the Project during the migration periods is expected to consist of individuals that are passing through the Project from various maternity colonies within a range of possible dispersal distances (Section 3.2.1.3, 3.2.1.5). Therefore, while it is possible that the Project could periodically take females from a maternity colony in or near the Project, this is not anticipated to be a regular event and if it does occur, given the average colony size, would not have a concentrated impact on any single maternity colony.

The loss of bats from hibernacula may reduce the abundance of the population and, if losses are great enough, could potentially affect the growth rate of the hibernating population. There are over 30 Indiana bat hibernacula in the state of Indiana, and as noted in above, bats may migrate long distances to summering areas (Sections 3.2.1.3, 3.2.1.5). Because take from the Project is expected to consist of individual bats migrating from various hibernacula, and is anticipated to be less than two females per year, take is not likely to have a concentrated or frequent impact on any single hibernaculum. Even if the majority of the take at the Project is associated with the nearest P2 hibernaculum, this level of take would represent between 0.02% to 0.2% of the hibernaculum's population, assuming between 1,000 and 10,000 Indiana bats in a P2 cave (USFWS 2007).

To the Applicant's knowledge, the individuals captured at the Project (Section 3.2.1) constitute the first public record of summer Indiana bat activity in Jay County. The annual fatality rate at the Project turbines under the proposed minimization strategy is predicted to be 1.95 Indiana bats per year (Section 4.2.2). At a 3:1 sex ratio, this represents 1.46 females annually. Maternity colonies of Indiana bats are reported to average 50 to 80 female adults (USFWS 2007). The loss of up to two female adults or volant female juveniles every year is not likely to have a significant effect on a maternity colony population, particularly because these fatalities are most likely to occur in the fall and not during the maternity season (Table 4.4). Without more detailed information on the locations and sizes of local maternity colonies, it is assumed that there will not be any concentrated impacts to local summer populations. While non-volant pups may not survive if their mothers die as a result of collision during the maternity season, 1) take during the summer season is expected to be relatively infrequent and 2) lost reproduction is fully accounted for within the REA models and has been included in mitigation planning.

The average annual loss of 1.95 Indiana bats represents much less than 1% of the 2019 population of 245,474 Indiana bats in the MRU (USFWS 2019a), the Indiana bat population most likely to be impacted. Even if the MRU population of Indiana bats were reduced by 90% as a result of WNS, the loss of 1.95 Indiana bats per year represents < 0.01% of a hypothetically reduced population of 24,547 Indiana bats. The loss to the range-wide population would be negligible, based on the 2019 estimated range-wide population of 537,297 Indiana bats (USFWS 2019a).

These losses represent small fractions of the MRU and range-wide Indiana bat populations. Given the expected minimal impact of Project take on overall population levels, the Applicant does not expect the Project to have a significant impact on the MRU or range-wide populations of the species at their current levels. If the population of Indiana bats in the MRU becomes substantially reduced as a result of WNS or other factors, the Applicant will take corresponding action as described in Chapter 8.

4.3.3 Impacts to Northern Long-Eared Bats

Prior to the onset of WNS, information on the sex of northern long-eared bat carcasses was not collected in most cases. Therefore, patterns related to sex of carcasses cannot be inferred from post-construction monitoring data. However, all northern long-eared bats taken during the summer season are expected to be females from maternity colonies near the Project. As

explained in Section 4.3.1, if unsexed bat carcasses 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). 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.

Unlike Indiana bat hibernacula, the locations of most northern long-eared bat hibernacula remain largely undocumented, partly due to the species' common status prior to the impact of WNS, partly due to the species' use of smaller hibernacula that are more dispersed on the landscape, and in part because unlike Indiana bats, which hibernate in large clusters on cave ceilings, northern long-eared bats hibernate singly or in small groups in hidden crevices. The closest known northern long-eared bat hibernaculum to the Permit Area is the Lewisburg Limestone Mine approximately 174 km (108 mi) to the southwest. 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 take at the Project will be attributed to reproductive females. This ratio may be an overestimate, given the evidence that male bats may be at higher risk of collision with wind turbines, but it represents a conservative approach for assessing the impact of take on the population. Conservative means that the actual ratio of females to males may be less than 1:1 and consequently that the impact of take on the population may be less than assessed in this analysis.

Project-Level Impacts

The Applicant predicts that approximately 1.27 northern long-eared bats will be taken each year during the 35-year ITP term (Section 4.2.2). Approximately 50% of the incidental take is expected to be attributed to females, which would result in an annual female take of 0.64 bats. Using the USFWS's Northern Long-Eared Bat REA, and assuming a declining population, the predicted lost reproductive capacity during the ITP term is 36 northern long-eared bat pups, resulting in a total estimated impact of 58 northern long-eared bats during the 35-year ITP term. Mitigation actions, therefore, will have a target increase of 58 northern long-eared bats to account for this lost reproductive capacity (Table 4.11).

Table 4.11. The inputs and results of the resource equivalency analysis for northern long-eared bats.

Input parameters	Value	Data type
Permit start year	2020	User-supplied
Injured adult females annually	0.64	
Permitted take years	35 years to 2055	
Lambda condition	Declining	
Adult female breeding rate	0.562 pups/female/year	Fixed
Juvenile female breeding rate	0.130 pups/female/year	
Pup survival to juvenile	0.585	
Juvenile annual survival	0.674	
Adult annual survival	0.857	
Results		
Direct take	22 female adults	Model-generated
Total lost reproduction	36 female pups	
Total lost	**58 northern long-eared bats**	

Population-Level Impacts

As discussed for Indiana bats, the general effects of the loss of individual bats on productivity and abundance of maternity colonies and hibernacula are unknown. There are limited data available to evaluate the population-level impact of this take due to the northern long-eared bat's tendency to hibernate individually or in small groups and hidden in crevices, making it difficult to obtain accurate counts of wintering individuals. However, the annual loss of 1.27 northern long-eared bats equates to much less than one percent of the estimated range-wide northern long-eared bat population of 6.5 million individuals (USFWS 2016).

The Indiana population of northern long-eared bats is the population most likely to be affected by the Project, given the species' relatively short migration distances (Section 3.2.3.3). The loss of 1.27 northern long-eared bats per year represents much less than one percent of the Indiana adult summer population of 127,842 northern long-eared bats (USFWS 2016). Even if this population were reduced by 98% as a result of WNS (the population loss reported in the northeast by Turner et al. 2011), the loss of 1.27 northern long-eared bats per year represents less than one percent of a reduced adult population of 2,557 bats. Because this loss represents a negligible portion of the estimated northern long-eared bat population in Indiana, the Applicant does not expect the Project to have a significant impact on northern long-eared bats at current or future population levels. However, if the population of northern long-eared bats becomes even more reduced as a result of WNS or other factors, the Applicant will take corresponding action as described in Chapter 8.

5.0 MINIMIZATION, MITIGATION, AND MONITORING PLAN

Consistent with ESA § 10(a)(2)(B), the Applicant plans to "minimize and mitigate the impact" of take of the Covered Species from Covered Activities "to the maximum extent practicable." Monitoring will be implemented as part of this HCP to provide the information necessary to assess ITP compliance, evaluate Project impacts, and verify progress towards meeting biological goals and objectives. The Applicant will monitor both for compliance with the permitted take limit and

the effectiveness of the mitigation program. Adaptive management will be used to address uncertainties identified in the HCP, including the accuracy of the take prediction and the effectiveness of the proposed minimization and mitigation measures.

5.1 Biological Goals and Objectives

These biological goals are the guiding principles for this HCP's conservation program. The biological objectives are meant to clarify the purpose and direction of the conservation measures through specific, measurable, achievable targets. While measures to conserve or recover an endangered or threatened species are not required under § 10 of the ESA, the biological goals and objectives of this HCP are consistent with actions to promote the recovery of the Indiana bat and northern long-eared bat.

Goal 1: Contribute to maintaining the integrity of the populations of the Covered Species in Indiana by minimizing mortality of the Covered Species in the Permit Area.

Objective 1: Implement an operational strategy in each permit year that will decrease Covered Species' fatality rates by at least 60% compared to levels of projected take without minimization for the Project, as well as implementing a monitoring and adaptive management strategy (with potential for additional minimization measures to be put in place) in order to maintain take at or below the permitted levels over the 35-year term of the ITP (Sections 4.1 through 4.3).

Goal 2: Protect vulnerable habitat for the Covered Species to contribute to the recovery of the Covered Species.

Objective 2: The Applicant has secured and will implement two mitigation projects: permanently protecting approximately 97 acres of summer maternity habitat for Indiana bats and northern long-eared bats and approximately 5 acres of staging/swarming habitat for Indiana bats. The Applicant will implement mitigation no later than in the first two years after receiving the requested ITP.

Goal 3: Optimize electrical output of the Project to realize the environmental benefit of wind energy. Specifically, increased generation from wind energy facilities has the potential to offset demand for other energy generation technologies that produce carbon emissions that have been shown to contribute to global climate change, identified as a potential risk to the Covered Species (USFWS 2007; 80 FR 17974).

Objective 3: Implement an operational strategy at the Project in each permit year that maximizes output of non-carbon-emitting, renewable energy and also meets Goal 1, minimization of the impacts of incidental take of the Covered Species.

The measures that will be used to meet these goals and objectives, and the criteria for evaluating their success, are described in the following sections.

5.2 Measures to Avoid and Minimize the Impact of the Taking

5.2.1 Avoiding Impacts through Project Design and Planning

The Applicant followed the tiered evaluation process outlined in the *USFWS Land-Based Wind Energy Guidelines* (USFWS 2012a) to assess potential impacts of the Project.

5.2.1.1 O&M and Substation Lighting

The Applicant will keep lighting at turbines, the O&M building, and the substation to a minimum to safely and securely operate its facilities. O&M personnel will be directed to extinguish nighttime exterior lights at the O&M building and substation (consistent with facility security requirements) when not in use and will be briefed on the importance of minimizing nighttime light use. Exterior lights will be hooded downward-directed lights to minimize horizontal and skyward illumination, and, whenever possible and consistent with physical security requirements, lights with motion or heat sensors and switches are used to keep lights off when not required.

5.2.1.2 Wind Turbine Lighting

Aviation hazard lighting will be minimized to that which is required by the FAA. The FAA typically requires every structure taller than 61 m (200 ft) above ground level to be lit to improve visibility to aviation traffic. In the case of wind power developments, the FAA allows a strategic lighting plan that provides complete visibility to aviators but does not require lighting every turbine. The Project's lighting plan will use the minimal level of lighting acceptable to the FAA and will employ medium-intensity red synchronously flashing lights for nighttime use and for daytime use, if needed, as recommended by the FAA and in the WEG. Further, the Applicant anticipates installing an Aircraft Detection Lighting System, if approved by FAA, meaning that the lights will only flash when aircraft are in the vicinity of the Project.

5.2.1.3 Construction

The Applicant has timed construction and pre-operational (commissioning) activities to avoid and minimize impacts to the Covered Species and their habitats. During construction, trees will only be cleared in the winter hibernation season (October 16 – March 31). In order to meet the required commercial operation date for the Project, the Applicant will be following a pre-commissioning protocol at the Project that tests turbine software, components and the communication system as each turbine is built, while limiting the testing of the turbines that involves active spinning of the blades to a short period directly before the commercial operation date. Commissioning activities that involve active spinning of the rotors above cut-in speed are proposed to occur for a six hour period for each turbine, and then over an approximately 72 hour period, when all turbines will be tested; these activities will occur within approximately three weeks before the Project is commercially operational.

Following the useful life of the Project facilities and infrastructure, the Applicant has the option to recommission or decommission the Project. In the case of recommissioning, the Applicant would either take steps to avoid take or would seek an ITP renewal or amendment to cover operations of the new turbines. Activities for the removal of turbines and other facilities during

decommissioning are not expected to lead to impacts that rise to the level of take because they would be conducted during daylight hours and will not involve Covered Species habitat disturbance or removal, aside from the possibility of hazard tree removal.

5.2.2 Minimizing Impacts through Project Operations

The Applicant will minimize the potential impacts of take on the Covered Species by adjusting turbine operations seasonally. For the ITP term, the Applicant will:

1) Minimize the rotation of turbine rotors below cut-in wind speeds (i.e., feather turbine blades) year-round, per the manufacturer's default setting;
2) Raise the cut-in speed from 3.0 to 5.0 m/s during the summer maternity season at a subset of 39 turbines (May 16 – July 31);
3) Employ a cut-in speed of 5.0 m/s during the fall migration season at all turbines (August 1 – October 15).

Minimization measures will be implemented nightly from a half hour before sunset to a half hour after sunrise, adjusted for sunset/sunrise times weekly, from May 16 - October 15 in each year of the Permit Term (Table 5.1).

Table 5.1. Operational minimization plan for the Bitter Ridge Wind Farm.

Season	Time of Day	Cut-in Speed	Feather Below Cut-in[1]	Temperature Threshold[2]
Spring Migration (April 1 – May 15)	24 hours/day	3.0 m/s	Yes	N/A
Summer Maternity (May 16 – July 31)	0.5 hour prior to sunset to 0.5 hour after sunrise[3]	5.0 m/s[4]	Yes	10˚C
Fall Migration (August 1 – October 15)	0.5 hour prior to sunset to 0.5 hour after sunrise	5.0 m/s	Yes	10˚C
Winter Hibernation (October 16 – March 31)	24 hours/day	3.0 m/s	Yes	N/A

[1] "Feathering," means that below the cut-in speed wind speed, turbine blades will be pitched into the wind such that they freewheel and rotate slowly (less than one rotation per minute).

[2] Turbines will operate at the default setting (feathered below 3.0 m/s) when temperatures are below this temperature threshold in summer and fall seasons.

[3] Civil sunset and sunrise.

[4] Only at the subset of 39 turbines with summer collision risk for Indiana bats.

Each turbine will have a supervisory, control and data acquisition (SCADA) operations and communications system to provide automated independent and remote operation of the turbine. The SCADA data give detailed information on each turbine's operation and performance, allowing real-time control and continuous monitoring to ensure optimal operation and identification of potential problems.

The only exception to feathering turbines below cut-in during the bat active season would occur on nights when temperatures are below 10°C (refer to Section 3.2.1.3 for support for this temperature threshold). Turbines will be allowed to operate at full capacity below these temperatures. Turbines will be monitored and controlled based on temperature on an individual

basis (i.e., the Project will not alter cut-in wind speed of all turbines at the same time, rather operational changes will be based on temperature conditions specific to each turbine). Turbines will begin operating under normal conditions when the 5-minute rolling average temperature drops below 10°C; feathering will be resumed if the 5-minute rolling average temperature goes above 10°C during the course of the night.

Given the relatively small proportion of time that temperatures are expected to be below 10°C during fall (when most bat mortality and most take of the Covered Species is expected), and the relatively large proportion of fatalities that occurred above 10°C at the Fowler Ridge Wind Farm and elsewhere during the fall (Section 3.2.1.3), feathering turbine blades below 3.0 m/s in spring and 5.0 m/s in summer and fall when temperatures are above this temperature threshold is expected to minimize risk to bats and achieve an overall approximate 60% reduction in all bat mortality, based on operational adjustment studies described in Table 4.8.

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, and thus minimize the impact of take. However, some incidental mortality is still expected to occur. As described in Chapter 4, the predicted level of mortality with minimization measures in place is expected to be less than or equal to 69 Indiana bats and 45 northern long-eared bats over the 35-year ITP term. The impacts of the potential fatality of 69 Indiana bats and 45 northern long-eared bats, applying the REA for each species, equate to 133 bats and 58 bats, respectively. To mitigate for the impacts of this take, the Applicant is responsible for and will coordinate and provide funding for mitigation that will fully offset the impacts of take for each of the Covered Species. The Applicant has executed a contract with a mitigation entity to secure and implement two mitigation projects: permanently protecting approximately 97 acres of summer maternity habitat for Indiana bats and northern long-eared bats and approximately 5 acres of staging/swarming habitat for Indiana bats.

5.3.1 Mitigation Implementation

Mitigation will be funded ahead of Covered Activities. The Applicant will implement mitigation as soon as possible and no later than in the first two years after receiving the requested ITP. Although it is the Applicant's intent to implement the first mitigation project as soon as logistically feasible after issuance of the ITP, as acknowledged in the HCP Handbook (USFWS and NMFS 2016), it may not be possible to avoid a lag between ITP issuance and mitigation project implementation due to the timing of ITP issuance as well as the potential for unforeseen logistical constraints associated with implementing a mitigation project, such as unexpected changes to habitat on the mitigation site prior to implementation, or resolve previously unknown legal constraints (e.g., real estate curative) on a targeted property. Because the Applicant is proposing to use a USFWS-approved mitigation project, delays longer than a month or two after ITP issuance are unlikely; however, even if the mitigation implementation lags behind the initial years of impact, the take will still be fully offset.

The HCP Handbook addresses situations in which it is not possible to implement a mitigation project prior to the beginning of the Covered Activities. It explains that the proposed mitigation,

once implemented, should take into account and offset those impacts that occur during the lag. Although the Applicant's request for a period of up to two years after issuance of the ITP to complete implementation of the mitigation project may create a minor lag between the beginning of impacts to the Covered Species and the beginning of the mitigation program, the impact of take that is anticipated to occur during this time will be more than offset by initial mitigation efforts by no later than the end of Year 2 of the ITP. Once implemented, the mitigation will thereafter stay ahead of the impact of the taking because the Applicant intends to fund mitigation at the start of the ITP that will cover mitigation for 100% of the predicted impact of the taking associated with the entire ITP term.

5.3.2 Selection of Mitigation Projects

The 2007 Draft Indiana Bat Recovery Plan includes proposed recovery actions based on four broad categories: 1) population monitoring actions, 2) conservation and management of habitat (hibernacula, swarming, summer), 3) research essential for the species' recovery, and 4) public education and outreach. The recovery plan identifies Priority 1 actions that are most important and effective for recovery or reclassification of the Indiana bat, namely, hibernacula- and summer habitat-related recovery actions as well as those "that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future" (USFWS 2007). Because a recovery plan has not yet been developed for northern long-eared bats, and based on the similarity in habitat requirements of, and threats to, the Indiana bat, the Applicant referred to the above recovery action priorities in identifying mitigation projects for both listed species.

Potential mitigation projects were limited to those specified in the REA models that the Service has issued, or the USFWS Guidelines for Non-REA Staging/Swarming Mitigation Option (in this case USFWS 2016b; see Appendix B).

The Applicant, in consultation with the USFWS and First Indiana Resource, LLC (FIR; a wholly owned subsidiary of Resource Environmental Solutions, LLC), developed mitigation criteria that served as standards for an acceptable mitigation project or projects to be undertaken. These criteria were:

1) Must be a hibernaculum; habitat (roosting, foraging, and/or travel corridor) within the swarming radius of a hibernaculum; or suitable maternity colony habitat (roosting, foraging and/or travel corridor) with documented use by Indiana and/or northern long-eared bats;
2) 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 Covered Species using the habitat;
3) 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 for Indiana and northern long-eared bats;

4) 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 a third-party conservation entity that can ensure protection of the habitat in perpetuity is enlisted;
5) Must grant the USFWS and/or a state wildlife agency future access to the mitigation site to monitor Covered Species' populations and/or use of the habitat; and
6) If the hibernaculum, swarming habitat, or summer maternity habitat is vulnerable to anthropogenic harm through multiple access points or in multiple ways, the Applicant must provide funding to fully protect the habitat for the long-term benefit of the Covered Species (e.g., gate all entrances of a cave, address all anticipated possible land use changes [including mineral extraction]).

5.3.3 Selected Mitigation Projects

The Applicant has worked with the USFWS and FIR to identify two mitigation projects to offset the impact of the taking for Indiana bats and northern long-eared bats. The Applicant is working with FIR to conserve approximately 5 acres of swarming habitat for Indiana bats and approximately 97 acres of summer maternity habitat for Indiana bats and northern long-eared bats. Brief descriptions of both projects are provided below. For more detailed descriptions of the projects and the amount of mitigation credit produced by them, refer to Appendix B.

Two properties will be utilized for mitigation for the Project: The Bear Lake Property - Phase II, comprised of two land tracts, and The Cunningham Property – Phase III, comprised of one land tract (phase number refers to the easement area used from the overall parcel). The Bear Lake Property in Martin County, Indiana is located within known summer habitat of both Covered Species, and presence of both species was last confirmed in 2018 (Appendix B). The Cunningham Property, located in Greene County, Indiana, provides swarming habitat for the Indiana bat and is situated within one mile of Ray's Cave, a Priority I hibernaculum. As of 2019, this was the sixth largest Indiana bat hibernaculum in the country, with over 25,000 individuals (USFWS 2019a).

5.4 Monitoring and Adaptive Management

A monitoring program will be implemented as part of this HCP to verify ITP compliance through evaluation of the level of take of the Covered Species, evaluate that the mitigation actions meet the biological goals and objectives, and to provide progress reports on the fulfillment of mitigation requirements (Section 5.1). The monitoring program consists of compliance monitoring to evaluate the level of take of the Covered Species at the Project, and mitigation effectiveness monitoring to ensure that the mitigation projects are implemented and functioning as planned. Monitoring results will be reported to the USFWS after each year of monitoring (Section 5.4.4).

5.4.1 Compliance Monitoring

The primary objective of compliance monitoring is to estimate the amount of take of Covered Species that has occurred as a result of the Covered Activities. The results of compliance monitoring will provide the basis for demonstrating ITP compliance and informing adaptive

management decisions (Section 5.4.3). This monitoring plan will allow tracking of the cumulative take of Covered Species throughout the ITP term through the use of statistical estimators, even in the case that zero carcasses are detected during a given monitoring period (Section 5.4.1.2). If new information becomes available to suggest improved, more cost effective, or more logistically feasible methods for estimating bat mortality, the Applicant will consult with the USFWS regarding changes to the protocol and implementation of such methods. Fatality data will not be provided for non-Covered Species.

5.4.1.1 Monitoring Methods

Take Estimation

Incidental take of the Covered Bat Species will be calculated from estimates of bat mortality at the Project using the Evidence of Absence method (EoA). Evidence of Absence is a statistical framework and software package developed by the USGS to estimate the occurrence of rare events (Huso et al. 2015, Dalthorp and Huso 2015). Of the available analytical methods for estimating take for project-specific, post-construction data, EoA provides the most precise estimates and therefore is considered the most reliable method for assessing take of the Covered Species and the need for adaptive management response. The result will provide the information necessary to monitor and track compliance with the ITP. At the end of each monitoring period, take of the Covered Species will be evaluated with EoA to estimate annual take, project potential future take, and determine whether any adaptive management or changed circumstance triggers have occurred.

EoA requires the following inputs, which are furthered described below:

- Total number of carcasses found in monitoring surveys
- Estimated probability of discovering a carcass, which is comprised of the following:
  - Searcher efficiency
  - Carcass persistence
  - Area correction
  - Arrival distribution
  - Search schedule

In order to achieve reliable estimates, it is desirable to attain a probability of detection (or *g* value) of at least 0.25 (or 25% detection) in each monitoring year. Because numerous monitoring protocol designs can achieve a target detection probability of 0.25, and because the monitoring protocol designs that can achieve this value will depend on the prior year of bias trial data, the monitoring protocol for each monitoring year will be designed at the conclusion of the previous year of monitoring. The monitoring protocol for each year will be submitted with the previous year's monitoring report (summarizing the prior year of monitoring) for USFWS approval.

If new information becomes available to suggest improved methods for estimating bat mortality, the Applicant may consult with the USFWS regarding cost effective and logistically feasible

changes to the protocol and implementation of applicable new methods, per the New Technology and Information changed circumstance (Section 8.2.3).

Data Collection and Processing

During fatality surveys, searchers will systematically search for bat carcasses within plots at selected turbines. Exact methods will be determined prior to initial surveys based on an evaluation of the Evidence of Absence which accounts for differences in the number of turbines surveyed, the size of the study plots, the interval between searches, and other variables. Based on initial evaluations, the estimate of the proportion of turbines surveyed could be up to 100%, although actual numbers may vary. If cleared plots at some turbines are used, the plots will be planted with grass and mowed regularly to maintain grass height at 10 cm (4 in) or less to increase searcher efficiency. Cleared plots (which include roads and pads) will be searched by walking transects spaced 5 m apart; searchers will walk transects at approximately 45-60 m (148-197 ft) per minute and scan the ground up to 2.5 m (8.2 ft) away from the transect. Road and pad searches will be conducted on only the gravel road and pad portions around the turbines which will be searched out to a specified search radius, up to 20 m. The distance that the transects extend past the turbine will be one of the factors evaluated during study design, as most bats fall close to turbines. The interval between searches will be evaluated prior to the initial survey, but is anticipated to range between 2 and 14 days depending on season; Section 5.4.1.2 provides more details of an example study protocol.

All bat carcasses located within the search areas (i.e., cleared plots and roads and pads) will be recorded. Injured bats will be recorded and treated as a fatality for the purposes of the analyses. The following information 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, injured or feather spot), 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 Indiana Department of Natural Resources (IDNR) 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 the 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

Searcher Efficiency

The objective of searcher efficiency trials is to estimate the proportion of available carcasses found by searchers. Searcher efficiency trials will be conducted in the same areas as carcass searches and will be estimated by search area type (cleared plot or road and pad) and season. The most appropriate searcher efficiency model among those including search area type, season, or their interaction will be selected based on Akaike's Information Criterion, adjusted for sample

size. The selected searcher efficiency model will be used to adjust the total number of bat carcasses found for those missed by searchers, thereby correcting for detection bias.

Searcher efficiency trials will be conducted during each month of the monitoring period. The person placing the carcasses will not inform the personnel conducting the searches when the trial is being conducted or where trial carcasses are placed. Approximately 15 bat carcasses or bat surrogate carcasses will be placed in roughly even numbers across search area types and across seasons. Carcasses of non-listed bat species found on-site, and carcasses of non-listed bat species that are available from labs or other sources, will be used in the trials. If an insufficient number of bat carcasses is available, brown or black mice (*Mus musculus*) carcasses may be used as surrogate bat carcasses.

All searcher efficiency trial carcasses will be placed at random locations within the search area prior to scheduled carcass surveys. Each trial carcass will be discreetly marked so that it can be identified as a study carcass after it is found. The number and location of the searcher efficiency carcasses found will be recorded. The number of carcasses available for detection during each 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 by which searcher efficiency changes as undetected carcasses age (k) is difficult to estimate in the field because it requires a large number of carcasses to be tracked through multiple searches. However, a recent analysis indicated that 0.67 is a reasonable value to use for k for bats (Huso et al. 2017). Unless a better estimate becomes available, k will be assumed to be 0.67.

Carcass Persistence

The objective of carcass persistence trials is to estimate the average probability a carcass is available to be found after an interval of time. The probability is determined by the length of time a carcass remains in the search area before being removed by scavengers or by other means. Possible means of carcass removal include removal by scavengers or insects. Estimates of carcass persistence will be used to adjust fatality estimates for removal bias.

Carcasses will be placed within search area boundaries. Carcass persistence trials will be conducted in each season (spring, summer, fall) 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 15 bat carcasses or bat surrogate carcasses will be placed during the carcass persistence trials. Persistence trial carcasses will be marked discreetly (e.g., with zip ties) for recognition by searchers and other personnel.

Field personnel will monitor carcass persistence trials for 30 days. Trial carcasses will be checked every day for the first four days, and then on day seven, day 10, day 14, day 20, and day 30 after placement. At the end of the 30-day period, any remaining evidence of the carcass will be removed.

5.4.1.2 Monitoring Protocol and Schedule

The Applicant has designed this monitoring approach in intervals to collect robust, useful data that provide confidence in the take estimates throughout the ITP term. Substantial variation in take of the Covered Species is not expected to occur at the annual scale; nine years of pre- and post-ITP monitoring at the Fowler Ridge Wind Farm have not shown large swings in Indiana bat or northern long- eared bat mortality (Good et al. 2018; Figure 4.2).

The monitoring framework relies on achieving a probability of detection sufficient to produce an estimate of zero take when no carcasses of the Covered Species are found during monitoring. This provides a fundamental level of confidence in the monitoring data. Data collected with the proposed probability of detection during the years when compliance monitoring occurs provide a more accurate assessment of the actual take occurring at a site than do data collected annually at lower monitoring intensity (i.e., with low probabilities of detection). For instance, a lower intensity of monitoring that results in a probability of detection of less than 0.2 (or less than 20% detection) would result in a non-zero estimate of take even if no Covered Species were found during the monitoring, due to the uncertainty introduced by the lower chance of finding the carcass under this scenario. The higher probability of detection during the years when compliance monitoring occurs under the proposed approach would have less uncertainty surrounding the estimated take. Therefore, the Applicant's proposed monitoring framework will provide sufficient monitoring data to support an accurate evaluation of compliance with the ITP on an interval appropriate for detecting the anticipated potential trends in Covered Species take over the ITP term.

Monitoring will be conducted in intervals throughout the 35-year ITP term according to a standard protocol for post-construction monitoring; an example schedule is provided in Table 5.2. This protocol will be updated as necessary to ensure the target probability of detection (or *g* value) of 0.25 (or 25% detection) is attained in each monitoring year. The probability of detection is sensitive to the area searched, searcher efficiency, and carcass persistence. Searches will occur throughout the bat active period (April 1 – October 15) in the first three years of the ITP to fully capture the period in which take may occur. This will provide context for both the monitoring results and analysis of the minimization measures and inform any potential adjustments to the monitoring period in subsequent years to ensure the date range in which take is most likely to occur is adequately monitored.

Table 5.2. Example compliance monitoring schedule for Covered Species at the Bitter Ridge Wind Farm.

Year of ITP	Monitoring	Probability of Detection (g)	Purpose
1 2 3	Standardized	0.25	Establish baseline take estimates under ITP, with *g*≈0.25 to provide an estimate of 0 if 0 carcasses found
4 5 6 7	Operations & maintenance (O&M)	0.001*	Document and report Covered Species Carcasses found incidentally
8	Carcass removal bias trials	0.001	Determine study design to achieve g=0.25 in year 9 assuming searcher efficiency is similar to years 1-3
9	Standardized	0.25	Update take estimates under ITP
10 11 12 13	Operations & maintenance (O&M)	0.001	Document and report Covered Species Carcasses found incidentally
14	Carcass removal bias trials	0.001	Determine study design to achieve g=0.25 in year 15 assuming searcher efficiency is similar to years 1-3 and 9
15	Standardized	0.25	Update take estimates under ITP
16 17 18 19	Operations & maintenance (O&M)	0.001	Document and report Covered Species Carcasses found incidentally
20	Carcass removal bias trials	0.001	Determine study design to achieve g=0.25 in year 21 assuming searcher efficiency is similar to years 1-3, 9, and 15
21	Standardized	0.25	Update take estimates under ITP
22 23 24 25	Operations & maintenance (O&M)	0.001	Document and report Covered Species Carcasses found incidentally
26	Carcass removal bias trials	0.001	Determine study design to achieve g=0.25 in year 27 assuming searcher efficiency is similar to years 1-3, 9, 15, and 21
27	Standardized	0.25	Update take estimates under ITP
28 29 30 31	Operations & maintenance (O&M)	0.001	Document and report Covered Species Carcasses found incidentally
32	Carcass removal bias trials	0.001	Determine study design to achieve g=0.25 in year 33 assuming searcher efficiency is similar to years 1-3, 9, 15, 21 and 27
33	Standardized	0.25	Update take estimates under ITP

* This value represents 0 in the EoA model because the model cannot accept an input of 0.

The Applicant has explored different protocols that are anticipated to result in a probability of detection of 0.25 for standardized surveys. The proposed approach will be detailed in a study plan and discussed with the USFWS prior to implementation in each standardized monitoring year, and the plan may vary somewhat from monitoring year to monitoring year. For example, the

search interval (number of days between carcass search bouts) may need to be shortened (i.e., searches will occur more frequently) if bat carcass persistence rates are relatively low. The following protocols are provided in order to show the general level of effort and types of searches being proposed.

Human Searches with Cleared Plots

Under this approach, the Applicant would clear plots out to a 50-m radius at five turbines, with the remaining turbines searched at roads and pads. This would result in approximately 9.7 acres of cleared crops in each standardized monitoring year. The turbines (both cleared plots and road and pads) would be searched once a week in spring and summer, and every two days in the fall season.

Searches Using Dog Detection Teams

Under this approach, the Applicant would utilize dog detection teams during the standardized search years; this avoids the need to clear crops because the dogs would be able to search out beyond the roads and pads even when crops obscure the view. In this proposed approach, 28 turbines would be searched out to a 50 m radius, with the rest of the turbines searched at roads and pads. In the spring and summer, all turbines would be searched every 14 days; in the fall, the plots would be searched every 7 days and the road and pad turbines would be searched every 14 days. This approach assumes that soybeans or other non-corn crops would be planted around at least 28 turbines each standardized search year, since dog detection teams would not be able to search in corn fields in the late summer or fall periods.

5.4.2 Mitigation Monitoring

The primary objective of the mitigation monitoring is to ensure that mitigation projects are functioning as planned. A detailed mitigation project management plan has been developed through coordination with the USFWS, FIR and the Applicant, and is included in Appendix B. For the summer and swarming habitat preservation projects, the purpose of the monitoring will be to ensure that the habitat conditions are maintained and that protections are adequate in accordance with the management plan. The monitoring will include an assessment of the functionality of the habitat protection measures and the need for any maintenance measures. Monitoring will include an assessment of whether any management or remedial measures are needed to retain the effectiveness of the mitigation project. Appendix B provides more detail on the proposed approach, scope, and schedule for the effectiveness monitoring.

5.4.3 Adaptive Management

Adaptive management will be used to ensure the take of Covered Species at the Project does not exceed the permitted level of take due to uncertainty in predicting take. The EoA model will provide an estimate of the annual take rate (λ) and the cumulative take (M^*) based on data collected during the monitoring. Dalthorp and Huso (2015) provide a framework for two types of adaptive management tests in EoA: 1) a short-term test of whether the annual take rate is on pace to exceed the expected annual 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.

Short-term triggers are built into the EoA model to assess the annual rate of take within a defined rolling window; the window has been set to a seven-year rolling window for this HCP to ensure that at least two years of intensive monitoring data are available to inform the estimate of λ in any given window. However, if data collected during the first three years of the requested ITP provide early indication of an ITP compliance issue, the Applicant may respond sooner than the end of the first seven-year window. If, within any 7-year rolling window, the estimated annual take rate exceeds the expected annual take rate with 95% confidence, the short-term trigger will be met. The confidence for the trigger has been reduced from the standard EoA value of 99% to make it more sensitive. This trigger will indicate that the minimization plan may need to be adjusted to ensure the cumulative take estimate (the median of M*) is within the permitted limit over the ITP term. The short-term trigger is set at a high confidence level to prevent premature responses. The short-term trigger will be evaluated in the 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.

The Applicant may adjust the turbine cut-in speed in response to a short-term trigger, but the Applicant may alternatively choose to implement a different response (e.g., adjustments to the temperature threshold, deterrents, increased monitoring, adjustments to the turbine operation algorithms, etc.) to a short-term trigger, as long as the take limit has not been met. Because the short-term trigger is designed to provide an early indication that the cumulative take estimate may not be sustainable (i.e., within the permitted level) over the ITP term but does not indicate that the take limit has been met, the Applicant reserves some flexibility in the short-term trigger response.

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 all bat 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.

The Applicant may implement a reversion trigger, as approved by USFWS, if the monitoring data collected to date indicate the annual take rate is below the annual take rate threshold (the lesser of the expected annual take rate or the median annual take rate as measured during the first three years of the ITP). In this case, the Applicant may reduce the turbines' cut-in speed in 0.5 m/s increments. 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, if monitoring data collected in the future indicate the annual take rate no longer exceeds the expected annual take rate. In this case, the adaptive management response would cease to be implemented.

If a short-term trigger or a reversion trigger 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 reschedule the next year of monitoring (at a g of 0.25) to occur 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 Project. The monitoring schedule will resume such that the next bias trials are conducted six years after the previous monitoring and standardized searches are conducted every sixth year after the rescheduled monitoring. If the short-term trigger is met by the results of this monitoring, the Applicant will again implement a response as described above.

The short-term or reversion triggers will only be tested after a monitoring year. In the event that additional monitoring years occur beyond what is shown in Table 5.2 (for example, after an incidental find of a Covered Species in a year when monitoring is not occurring), the window for the short-term trigger test will be adjusted so that at least two monitoring events are included and contain at least three years so that the window begins and end with years that have monitoring. In this case, any Covered Species found incidentally during years when monitoring does not occur will be included in the carcass count that is run through the EoA model to come up with the take estimate, not simply added to the final estimate.

In addition to the short-term triggers, the EoA model has 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). The long-term trigger will be evaluated in the monitoring report (Section 5.4.4), and any required response will be implemented before the start of the next monitoring cycle (i.e., April). In response to the long-term trigger, 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 recommendations to feather turbines at wind speeds below 6.9 m/s). The Applicant will then consult 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 O&M facility and hair and tissue samples from each bat carcass will be submitted to the USFWS after each monitoring year. Raw data forms will be made available to the USFWS upon request. For each Covered Species carcass found, the following information will be maintained in a database that will be provided to the USFWS annually or more frequently upon request: a unique identification code, sex and age when possible, date and time collected, observer, carcass condition (intact, scavenged, dismembered, injured, or feather spot), injuries, scavenging, estimated time of death, UTM location, distance and bearing from the turbine, habitat

and any relevant comments, and, if available, temperature and wind speed for the night preceding a Covered Species fatality.

A turbine operational (minimization) compliance report will be provided under confidential cover to the USFWS each year. The USFWS will randomly select a subset of turbines (between five to ten every year) and dates (two to four nights per season for a total of six to 12 nights for each turbine) for which to report operational data, such as time of day, wind speed, and how the turbine was operating in order to confirm turbines are operating under the minimization regime committed to in the HCP.

Although authorized by the ITP, in the event that a Covered Species fatality is documented during the compliance monitoring, the USFWS and the IDNR will be notified by phone within 48 hours of positive species 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 results from the compliance monitoring, data demonstrating turbine operations, and any adaptive management actions taken. The report will also include the protocol for the next scheduled monitoring year, designed based on the monitoring data in the report. A final compliance monitoring report will be prepared following review by the USFWS. This report will also be provided to the IDNR.

The Applicant will confer with the USFWS to discuss the monitoring reports following completion of each year when monitoring occurs. The Applicant will schedule a meeting with the USFWS in February or March of each year following monitoring studies. This will provide time for the USFWS to review the monitoring reports while allowing for coordination prior to the start of the next compliance monitoring period.

Effectiveness Monitoring Reports will be provided to the USFWS that identify and evaluate the status of the mitigation project(s) implemented as a part of the HCP. Reports describing the status of conservation activities undertaken will be provided as provided for in the mitigation project management plan. As noted in Section 9 of the mitigation project management plan (Appendix B), monitoring of the mitigation projects will occur at Year 1, Year 3, Year 5, Year 7 and every subsequent seven years for the remaining period of the 35-year permit term, with associated reports provided to the USFWS.

6.0 FUNDING ASSURANCES

Measures requiring funding in an HCP typically include both on-site (e.g., fatality monitoring, minimization measures) and off-site (e.g., the acquisition and monitoring of mitigation projects) measures. The Applicant will provide assurances that funding will be available to fully implement the HCP, including for the implementation of compensatory mitigation. The Applicant will ensure adequate funding for the HCP by 1) budgeting for annual operating expenses associated with implementing the HCP and 2) providing a surety bond. While a surety bond will be used for some

of the funding assurances at the start of the ITP (explained further below), the Applicant may change the funding mechanism during the ITP term. Any change will be initiated at the Applicant's election; however, any changes will be done in coordination with the USFWS to ensure it does not interfere with the permittee's ability to implement the HCP.

Direct costs of implementing the HCP were calculated using 2020 estimates that were adjusted for inflation based on the Consumer Price Index over the past 35 years (2.7%; US Department of Labor Bureau of Labor Statistics 2018). Funding for each element of the HCP is described in the following sections.

6.1 Project Design and Planning

Prior to commencement of the Covered Activities, the Applicant has implemented and funded avoidance and minimization measures included in Project design and planning of the Project's siting and construction. These measures included conducting pre-construction surveys as recommended by the USFWS Land-Based Wind Energy Guidelines to assess potential impacts from the Project (USFWS 2012a), and siting the Project in generally disturbed lands away from known bat hibernacula and where roost and foraging habitat are limited. In addition, lighting will be installed to meet FAA guidelines, which include measures to minimize impacts to birds and other wildlife (Section 2.3). Costs associated with these measures were included, and paid for, as part of the Project development and construction budgets prior to commercial operation of the Project.

6.2 Anticipated Funding Requirements for Operating Expenses

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 at risk, that is, in the summer and fall seasons during nighttime conditions of low wind speeds and warm temperatures (Section 5.2.2). The lost revenue associated with these operational adjustments, an indirect cost, was taken into consideration during the project development and financing phases and therefore no further funding requirements for minimization measures are required.

The Applicant will ensure that operating expenses associated with managing the HCP are included in the Project's annual operating budget. The parent company of the Applicant has a history of funding development and financing capital-intensive wind energy projects, including pre- and post-construction studies, demonstrating their capability and experience in developing and operating wind energy projects. Additionally, the Applicant will include in its annual report (Section 5.4.4) corporate certification in the form of a letter signed by a responsible corporate official (someone with authority within, or over the Applicant) identifying the applicable recurring costs for the following year and verifying that the Applicant has them in the next year's annual budget. The various recurring costs are described in greater detail below.

6.2.1 Compliance Monitoring and Reporting

The total operating expense for compliance monitoring and reporting over the ITP term is estimated (with annual escalation) to range from $1,594,357 (minimum, assuming no adaptive

management is necessary) to a maximum of $1,969,357, which assumes that two extra years of standardized monitoring searches are conducted due to adaptive management events. The basis for estimating and funding requirements for monitoring and reporting are further described below.

6.2.1.1 Monitoring

The Applicant will conduct compliance monitoring within the Permit Area during the ITP term (Section 5.4). The Applicant will contract with a third-party consultant to complete compliance monitoring and intends to contract with a third party to complete any fatality monitoring triggered by the Adaptive Management Plan as described in Section 5.4.4. The frequency and intensity of fatality monitoring will be based on prior monitoring results and adaptive management responses (Section 5.4). For cost estimating purposes, the Applicant has estimated that a maximum of two adaptive management events that involve additional monitoring (per Adaptive Management approach described in Section 5.4.3) will occur through the permit term. Should additional monitoring be triggered, the Applicant will ensure that appropriate costs are budgeted for the following year in the requisite amount for monitoring and adaptive management. The Applicant will also obtain a proposal from an independent consultant for any compliance monitoring deemed necessary for the upcoming year. The Applicant's annual operation and maintenance budget will be updated as necessary to reflect the amount set forth in the independent consultant's proposal, changing from year to year as appropriate.

Projected monitoring costs assume that compliance monitoring will be conducted according to the schedule in Table 5.2 for the ITP term. The Year 1 estimates of $101,025 (search costs and bias trials) and $6,162 (crop clearing costs) were based on current monitoring costs and future years were escalated by 2.7% per year. The interval monitoring approach summarized in Table 5.2 and the example protocol using human searches and cleared plots in Section 5.4.1.2 was used for budgeting amounts in Table 6.1. While the example monitoring protocol may not be the exact protocol implemented during the ITP term, it represents approximate levels of monitoring effort, and consequently operating expenses, required to meet the target *g* value (Section 5.4.1). At the end of each monitoring year, the monitoring report will include a description of the level of monitoring needed to achieve the target *g* value for the next monitoring year.

6.2.1.2 Reporting

Results of monitoring efforts will be communicated to the USFWS following each monitoring year via an emailed report (Section 5.4.5). To estimate reporting costs, an agency conference call was also assumed to occur following each standardized fatality monitoring survey season in the first quarter of the next year. This would be approximately 90 to 120 days after completion of the prior year's monitoring and before the start of the bat active period. The cost of reporting including an agency coordination call associated with each monitoring period is approximately $19,500 for Year 1.

6.2.2 HCP Overhead and Administration

General overhead and administrative costs were estimated to be $4,000 per year starting in 2020 and then escalated by 2.7% per year for the ITP term. These costs are for travel and other expenses, beyond the Applicant's normal (non-HCP) operating budget, related to general

administrative tasks, such as on-site coordination of monitoring studies, submitting reports, scheduling and attending conference calls, and coordinating O&M monitoring measures as necessary. As described in Table 5.2, standardized compliance monitoring and reporting, and therefore associated conference calls and other administrative costs, are proposed to occur on a six-year interval, after the initial three years of the permit term.

6.3 Funding Requirements for Costs Not Budgeted in Operating Expenses

Potential costs of HCP implementation that are not anticipated to be included in the annual operating expenses listed above are also identified in Table 6.1, and include costs for mitigation and changed circumstances.

6.3.1 Mitigation

The Applicant is responsible for implementing the mitigation described in Section 5.3. To assist the Applicant in fulfilling its mitigation responsibilities under this HCP, the Applicant has established a contract with FIR (or the "mitigation entity") to implement the mitigation projects described in Section 5.3.3. A certified 501(c)(3) non-profit organization will serve as the long-term grantee under the conservation easement for a summer habitat parcel and a swarming habitat parcel to provide mitigation sufficient to offset the impact of predicted take of this HCP. The Applicant has also committed to performing ongoing management, monitoring, and services for the ITP term in accordance with this HCP (Appendix B). The mitigation burden and associated cost was calculated based on the amount of mitigation necessary to offset the impact of the taking of Covered Species, using the USFWS REA models (Szymanski et al. 2013), and assuming an approximate 50/50 split of mitigation debits between protecting summer/maternity habitat, and staging/swarming habitat for Indiana bats. The cost for mitigation for habitat project was based on offsetting the impact of take with approximately 97 acres (39 ha) of habitat providing summer/maternity habitat for Indiana bats and northern long-eared bats and approximately 5 ac (2 ha) of staging/swarming habitat for Indiana bats, as follows:

- Land acquisition, development and finalization of mitigation plan: $1,070,075
- Ongoing management, monitoring and reporting activities: $330,800, including:
    - Financial assurances/Restoration/Changed Circumstances fund: $122,800

The total cost of the summer and swarming habitat projects is therefore estimated to be $1,400,875. Any project(s) selected will meet the criteria identified in Section 5.3.2.

The total cost of mitigation for the HCP is estimated to be $1,400,875, based on the amount of mitigation that would be necessary to offset the impact of the requested amount of take for this HCP. The Applicant will provide this amount of funding for mitigation in the form of a surety bond, or executed contract with qualified mitigation entities within 60 days of ITP issuance and/or at commencement of Covered Activities, whichever occurs first. The Applicant will provide notice to the USFWS that the funding for the mitigation has been remitted to the mitigation entity and

ensure that the mitigation obligations set forth in this HCP are fulfilled for the duration of the ITP term.

6.3.2 Changed Circumstances

The Applicant will provide funding assurances for responses to the changed circumstances identified in Section 8.2 that may occur during the ITP term. This "Changed Circumstance Fund" will be assured in the form of a surety bond or dedicated cash account (Table 6.1). As described above and further in Section 8.2.6, the contract that will be signed with the mitigation entity will provide funding at the outset to cover future restoration costs if the mitigation project is damaged by natural disasters to the point where the mitigation project no longer meets the criteria laid out in Section 5.3.2. The Applicant cannot estimate the potential costs that may be associated with operational adjustments that might become necessary in response to some of the changed circumstances (e.g., a change in migration dates, additional species listings, greater than anticipated impacts from WNS) since the nature and extent of the potential adjustments and modifications associated with these changed circumstances cannot be predicted. Any changes in operational adjustments or changes in migration dates will be borne through lost revenues as an indirect cost. Additional species that cannot be avoided will require additional coordination with the USFWS. Therefore, due to the overall low likelihood of occurrence of changed circumstances, the fact that funding for restoration of the mitigation project in the event of a natural disaster (Section 8.2.6) will be covered in the payment made as part of the executed contract with the mitigation entity, and the lack of data to estimate exact costs of the other changed circumstances in Section 8.2., an amount of $70,044 (using 5% of the mitigation costs as an estimate for the original surety) was determined appropriate. The Applicant will provide this amount of security for foreseeable changed circumstances cost via surety bond or dedicated cash account within 60 days of ITP issuance. If a changed circumstance occurs and the surety is drawn upon, the Applicant will replenish the surety or account to the full original amount of $70,044 within 3 months.

Table 6.1 summarizes the estimated costs for implementing the HCP.

Table 6.1 Estimated operating costs for implementing the Bitter Ridge Wind Farm Habitat Conservation Plan.

Budget Item	First Year Cost	Permit Term Total	Cost Basis and Assumptions
Costs Funded by Project's Annual Budget/Operating Revenue			
HCP Overhead and Administration	$4,000	$57,168	Applicant's overhead costs for coordination with USFWS (generally tied to monitoring years) and other miscellaneous expenses in addition to Applicant's normal (non-HCP) operational budget, with 2.7% inflation over 35 years. **Funding mechanism:** Project's annual budget/operating revenue with corporate certification in report submitted to USFWS following each monitoring year.

Budget Item	First Year Cost	Permit Term Total	Cost Basis and Assumptions
Compliance Monitoring	$120,525	$1,391,305	Interval monitoring (n=8) for estimating take and effectiveness of the turbine operational strategy; includes monitoring logistics (search costs and bias trials), reporting, and agency coordination, with 2.7% inflation over 35 years. **Funding mechanism:** Project's annual budget/operating revenue with corporate certification in report submitted to USFWS following each monitoring year.
Crop Clearing for Compliance Monitoring	$6,162	$72,834	Costs for clearing crops from search areas in standardized monitoring years, with 2.7% inflation over 35 years. **Funding mechanism:** Project's annual budget/operating revenue with corporate certification in report submitted to USFWS following each monitoring year.
Bias Trials	N/A	$73,050	Bias trials prior to monitoring years (n=5) starting in Year 8, with 2.7% inflation over 35 years. **Funding mechanism**: Project's annual budget/operating revenue with corporate certification in report submitted to USFWS following each monitoring year.
Additional Compliance Monitoring Associated with Adaptive Management	N/A	$375,000	Costs are for up to two additional compliance monitoring surveys (search and bias trial, reporting and agency coordination) that could occur if Adaptive Management response described in Section 5.4.3 is triggered **Funding mechanism:** Project's annual budget/operating revenue with corporate certification in report submitted to USFWS following each monitoring year.
Total Projected Operating Costs		**$1,594,357 - $1,969,357**	
Costs Not Funded by Annual Budget/Operating Revenue			
Summer/Swarming Habitat Mitigation Project	N/A	$1,400,875	Anticipated cost of a summer mitigation project to offset impact of the requested take for the HCP; includes mitigation project management, monitoring, and reporting. **Funding mechanism:** Executed contract with and direct payment to mitigation entity or surety bond within 60 days of ITP issuance and/or at commencement of Covered Activities, whichever comes first.
Changed Circumstances Fund	N/A	$70,044	Additional consultation and monitoring/evaluation or mitigation necessary to respond to one changed circumstance equivalent to 5% of total mitigation costs, that will be replenished if depleted. **Funding mechanism:** Surety bond or dedicated cash account.
Total Projected Extraordinary Costs		**$1,470,919**	

N/A = not applicable

7.0 ALTERNATIVES CONSIDERED

ESA implementing regulations and USFWS guidance for developing HCPs require that an HCP submitted in an application for an ITP describe “alternative actions to such taking the applicant considered and the reasons why such alternatives are not proposed to be utilized” (50 CFR 17.22(b)(1)(iii)(C)). The HCP Handbook expands on this by stating, “(w)hen 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).

To meet this HCP requirement, two alternatives that would avoid or reduce take were considered by the Applicant. Those alternatives were 1) operational avoidance and 2) increased operational minimization.

7.1 Alternative 1: Operational Avoidance

Under this take avoidance alternative, all Project turbines would be fully feathered at wind speeds below 6.9 m/s from a half hour before sunset to a half hour after sunrise during the migration seasons (April 1 - May 15 and August 1 - October 15), and from May 16 - July 31 at the 39 turbines determined to pose a risk to Indiana bats during the summer maternity season. With the Project implementing these turbine operational adjustments, the take of Indiana bats or northern long-eared bats from Project operation is unlikely to occur. Because no take would be expected from Project operations, an HCP would not be developed or implemented and an ITP would not be applied for.

This alternative would not meet the purpose of the Project of maximizing energy production using reliable sources of wind energy, as it would ultimately result in a financially unviable Project. Because it would be economically unfeasible under the avoidance alternative, the renewable energy production of the Project would be forgone. The Project 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 fail to provide economic benefits to local economies. Jobs associated with maintenance of the Project would be lost and participating landowners would not receive income from lease agreements over the expected life of the Project.

7.2 Alternative 2: Increased Operational Minimization

Under the increased operational take minimization alternative, Project turbines would be fully feathered at a wind speed greater than the proposed seasonal cut-in speeds of 5 m/s in the summer and fall but less than full avoidance (6.9 m/s) at night during the bat active season (April 1 - October 15).

The Applicant did not select this take minimization alternative because it does not meet the economic purpose of the Project (Section 1.2). Furthermore, a number of curtailment studies show that increasing cut-in speeds above 5 m/s often does not result in an appreciable or statistically significant reduction in bat fatalities (Table 4.9). The proposed cut-in speeds, therefore, strike a balance between maximizing energy production and minimizing impacts to the Covered Species.

8.0 HABITAT CONSERVATION PLAN ADMINISTRATION

This HCP will be implemented by the Applicant, in coordination with the USFWS, upon issuance of an ITP. The Applicant is solely responsible for meeting the terms and conditions of the ITP and will allocate sufficient resources to ensure effective implementation of this HCP. In order to do so, the Applicant will plan and coordinate meetings with the USFWS; oversee the allocation of funding for mitigation, monitoring, adaptive management, and changed circumstances, if necessary; and ensure delivery of monitoring reports to the USFWS. For each mitigation project, a detailed mitigation project management and monitoring plan will be submitted to the USFWS for approval. Compliance monitoring at the Project will be conducted by searchers trained in monitoring methodology and experienced in conducting bat fatality searches at wind facilities. Additionally, the Applicant will coordinate with the USFWS throughout the ITP term, in the first quarter of the year that follows each monitoring period as shown in the monitoring schedule in Table 5.2, to discuss the results of the monitoring reports and determine the need for adjustments to minimization or monitoring in accordance with the adaptive management criteria defined in Section 5.4.3. Another objective of these meetings will be to evaluate the occurrence of Changed or Unforeseen Circumstances. Additional meetings or conferences may be initiated by the Applicant and/or the USFWS to address other concerns, as necessary, including implementation and results of conservation measures.

8.1 No Surprises Assurances

According to the HCP Handbook (USFWS and NMFWS 2016), Federal No Surprises Assurances (50 CFR 17.22(b)(5), 17.32(b)(5), 222.307(g)) provide that, as long as an ITP holder “is properly implementing the HCP and the ITP, no additional commitment of land, water, or financial compensation will be required with respect to covered species, and no restrictions on the use of land, water, or other natural resources will be imposed beyond those specified in the HCP without the consent of the permittee.” The principal components of No Surprises Assurances are changed circumstances (Section 8.2), and unforeseen circumstances (Section 8.3). Conditions under which the ITP may be amended or renewed are described in Sections 8.4 and 8.5.

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] developers and the USFWS and that can be planned for” (50 CFR § 17.3). As discussed in the HCP Handbook (USFWS and NMFS 2016) with respect to foreseeable changed circumstances, the following section discusses changed circumstances by describing the potential change and the proposed response of the Applicant. The changed circumstances descriptions identify specific strategies or responses in the HCP so that adjustments can be made as necessary to future changes without the need to amend the HCP. To maximize the effectiveness of the HCP, and in compliance with the ESA implementing regulations (50 CFR 17.22), this chapter provides methods for adapting the HCP to changed circumstances.

The Applicant has identified repowering the Project, the listing of additional species, new technologies and information, changes in seasonal risk to the Covered Species, changes in mitigation site viability, and worsening impacts of white-nose syndrome as potential changed circumstances warranting consideration and planning in this HCP.

8.2.1 Repowering the Project

During the ITP term, the Applicant may elect to repower some or all of the Project wind turbines by installing new or refurbished wind turbines and/or associated components. Repowering may include an increase in the rotor diameter of repowered turbines or a decrease in the number of wind turbines at the Project. Repowering may also result in a lower manufacturer's rated cut-in wind speed. These changes could alter the risk to the Covered Species from the operation of the Project. Some repowering activities unrelated to the operation of the Project turbines, including maintenance activities such as gear box or generator replacement with the same general size and function, are not expected to change the risk of Covered Species take from the Project.

Trigger

The Applicant notifies the USFWS of the intent to repower one or more turbines at the Project. In coordination with the USFWS, the Applicant will perform an analysis to evaluate if and how the intended repowering activities may affect the HCP, including the estimated level of Covered Species take.

Response

If the intended repowering activities will not likely result in an increase in the estimated level of Covered Species take, then no amendment to the HCP will be required and the Applicant may proceed with the repowering activities. Starting in the spring of the next bat active season after the repowered Project is operational, one full season (spring through fall) of fatality monitoring will be performed to assess the level of Covered Species take occurring after the repowering activities. If compliance monitoring indicates that the level of estimated Covered Species take is the same as or less than take prior to repowering, then the Applicant will continue to implement the terms of the HCP as originally described. If compliance monitoring indicates an unexpected increase in the level of estimated Covered Species take, the Applicant will coordinate with the USFWS to determine if additional avoidance or minimization measures, or a permit amendment or separate permit, are required.

If the intended repowering activities will likely result in an increase in the estimated level of Covered Species take, the Applicant will either amend the HCP and ITP, seek a separate ITP or will coordinate with the USFWS to determine any additional avoidance or minimization measures that may be required based on the best available data and information at the time.

8.2.2 Additional Species' Listings

As a result of current population declines due primarily to WNS, other bat species may become listed as federally threatened or endangered during the ITP term. Other wildlife species may also become listed or warranted but precluded ("candidate" species) during the ITP term due to the impacts of climate change, habitat loss, or other factors. The Applicant believes the new listing of

bat species or other species of wildlife under the ESA is a foreseeable changed circumstance that warrants consideration in this HCP.

Trigger

The USFWS publishes notification of a proposed or final rule to list a species that may occur in the Permit Area but is not covered by the HCP.

Response

The Applicant will evaluate data from all monitoring years up to the time of the proposed rule, and additional scientific information related to the impacts of wind turbines on the previously unlisted species, to determine if take of the species has occurred or is likely to occur, and determine if the Covered Activities may result in future take of the species proposed for listing.

If the species is listed as threatened or endangered in a final rule and take has been documented, or the Applicant determines that take is reasonably certain to occur, the Applicant will coordinate with the USFWS to decide whether to seek coverage for the species under an amendment to the HCP (Section 8.4) or a separate ESA compliance approach (e.g., separate ITP or take avoidance strategy). The Applicant will provide the USFWS with fatality data for the newly listed species as part of this coordination. A formal amendment would include an assessment of take, impacts, benefits afforded to the species through current HCP measures, and additional conservation measures required for the newly listed species. If the species is listed as threatened in a final rule with an accompanying 4(d) rule that would exempt the Covered Activities from ESA § 9 take prohibitions, the Applicant can elect to implement the HCP and ITP without an amendment or avoidance measures for the new species. If the species is designated as a candidate species, the Applicant may consider amending the HCP to include the candidate species or implementing an avoidance strategy. Upon notice from the USFWS of such listing(s) or designations, the Applicant will coordinate with the USFWS to determine, using the best available data and information at the time, if additional avoidance, minimization, or mitigation strategies beyond those implemented for the Covered Species are warranted.

8.2.3 New Technology and Information

Over the ITP term, new information on the Covered Species and bat-wind power interactions, new methods for monitoring or estimating mortality, and new technology to minimize bat mortality from wind turbines may become available. The Applicant may wish to incorporate new information, methods, or technology into the operations and monitoring plans outlined in the HCP to improve the quality of take estimates, maximize the effectiveness of minimization measures, improve monitoring protocols, or implement more cost-effective conservation measures.

Trigger:

The Applicant will notify the USFWS of their intent to utilize alternative monitoring, mortality estimation, or minimization methods. New methods or technology will only be considered if they have been demonstrated to be at least as effective as the methods described in this

HCP, based on the best available science, are approved in writing by the USFWS, will not require an increase in the take authorization for the Project, and will not require additional funding assurances.

Response:

Prior to implementing any new measures for monitoring, estimating mortality, or minimizing take, the Applicant will confer with the USFWS to discuss the new methods, how they will 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 that are used are compatible with the biological goals and objectives of the HCP. Any changes to minimization measures will result in one full season (spring through fall) of additional fatality monitoring to confirm the effectiveness of the new measures, starting in the spring of the next bat active season. The monitoring study plan will be determined in consultation with, and approved by, the USFWS.

8.2.4 Change in Timing of Seasonal Risk

Climate change may influence the phenology of migratory species, leading to changes in the timing of spring and fall migrations, as well as the maternity season. Warmer temperatures may allow Covered Species to leave wintering grounds earlier and to remain in summer habitat longer, thus causing spring migration to happen earlier and fall migration to happen later in the year. In the event that the timing of Covered Species spring or fall migration changes, the timing of Covered Species mortality at the Project could change, warranting evaluation by the Applicant.

Trigger

The USFWS notifies the Applicant of a shift in the timing of Covered Species spring or fall migration in Indiana, as documented in peer-reviewed literature or published by the USFWS, or 2) the carcass of a Covered Species is discovered in the Permit Area with a likely time of death before April 1 or after October 15..

Response

The Applicant will evaluate the distribution of arrival dates of all bat carcasses within the monitoring period to determine if there has been a shift in the peak of spring or fall bat fatalities. Mortality of all bats, including incidental finds, will be used to evaluate this changed circumstance because it is not expected that take of the Covered Species, which may never be documented, will provide sufficient data to assess trends in seasonal distribution. Bats migrating through the Permit Area, including the Covered Species, are likely to respond to similar factors affecting the timing of seasonal movements, including temperature and insect availability (Hayes 1997).

For all comparisons, the first three years of intensive monitoring data will be used as a baseline for defining the “typical” seasonal proportions of bat fatalities. If, over the two most recent monitoring years, a significantly greater proportion[6] 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

[6] Defined as greater than 10% more than what would be expected if the number of carcasses found in a given season were distributed completely evenly.

in any other contiguous two-week period during these respective seasons or than was found in this time during the first three years of intensive monitoring, the Applicant will shift the timing of the minimization and monitoring period 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 recent (within 10 years) seasonal distribution of bat carcasses at the Project[7] indicates that the migration period has expanded or contracted compared to the Project baseline (i.e., the temporal distribution of carcasses is broader or narrower than active season start and end dates). In this case, the minimization and monitoring period would be adjusted accordingly, and the Applicant will feather turbine blades from a half hour before sunset to a half hour after sunrise when temperatures are above 10°C when wind speeds are below 5.0 m/s in the revised summer and fall seasons. This minimization measure will be applied at the 39 turbines presenting summer risk (Section 3.2.1.5) during the redefined maternity season and at all turbines during the redefined season of fall migratory risk. Springtime operating protocol (turbines operating at manufacturer's default setting, with blades feathered below 3.0 m/s) will remain in effect for the newly defined spring season dates, if any. In an example when the data indicates that spring migration has shifted to starting two weeks earlier, it would be assumed that the summer maternity season would likewise start two weeks earlier (i.e., minimization measures for summer maternity season as shown in Table 5.1 would shift to start May 2); if there is no evidence of a change in fall migration, then the start of the minimization measures associated with fall migration would stay the same. If additional minimization protocols have been triggered as the result of previous adaptive management (Section 5.4.3), the modified protocol(s) described in this Section will be implemented instead.

If a Covered Species fatality is discovered in early spring (prior to April 1) or late fall (after October 15), the Applicant will notify the USFWS within 48 hours. The Applicant will shift the timing of the minimization and monitoring period to encompass the date(s) 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[8] indicate 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 summer or fall). In this case, the minimization and monitoring period will be expanded or contracted accordingly, and the Applicant will apply their seasonal curtailment strategy (Table 5.1) to the redefined season dates. If minimization protocols have been triggered as the result of adaptive management (Section 5.4.3), the modified protocol(s) described in this Section will be implemented instead.

[7] 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.

[8] 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.

8.2.5 Discovery of New or Previously Unidentified Maternity Colony of a Covered Species

Based on results of summer surveys and analysis of potential summer habitat it is assumed that collision risk to Indiana bats may occur within 305 m (1,000 ft) of up to 39 Project turbine locations (Section 3.2.1.5). Furthermore, based on a lack of data indicating use of the Permit Area[9] in other locations by Indiana bats, as well as at any location within the Permit Area by northern long-eared bats, it is anticipated that take of the Covered Species will not occur during the summer maternity season (May 16 to July 31) outside of the area shown in Figure 3.7. However, it is possible that a new Indiana bat or northern long-eared bat summer maternity colony may form during the ITP term, or that a previously unknown colony may be unidentified. If this occurs, the Applicant may need to manage risk to the Covered Species during the summer maternity period outside of the area currently identified as presenting summer risk to Indiana bats.

Trigger
This may be triggered in any of the following ways:

1) The carcass of a pregnant or lactating female or a juvenile (first-year) individual of an Indiana bat is found within the Permit Area and outside of the area buffering the 39 turbines with predicted summer risk, or the carcass of a pregnant or lactating female or a juvenile northern long-eared bat is found within the Permit Area, and the time of mortality is estimated to have occurred between May 16 and July 31.
2) A female or juvenile Indiana bat is captured during summer surveys (between May 16 and July 31), and a 5-mile buffer of the capture point or a 2.5 mile buffer of an Indiana bat maternity roost tree overlaps the Permit Area and is outside of the area buffering the 39 turbines with predicted summer risk.
3) A female or juvenile Northern long-eared bat is captured during summer surveys, and a 3-mile buffer of the capture point or a 1.5 mile buffer of the roost tree of a NLEB overlaps the Permit Area.

The USFWS will notify the Applicant if a female or juvenile Indiana bat or northern long-eared bat is detected in the summer and a buffer overlaps with the Permit Area as described above for trigger 2 or 3. Notification to the Applicant must include the relevant survey results that led the USFWS to conclude this trigger has been met.

<u>Response</u>
The Applicant will notify USFWS within 24 hours of identifying the carcass of an Indiana bat or Northern long-eared bat during the summer. If the carcass of an Indiana bat is found within the Permit Area and outside of the area buffering the 39 turbines with predicted Indiana bat summer risk, or the carcass of a northern long-eared bat is found within the Permit Area, and the fatality is reasonably attributed to turbine collision, the turbine beneath which the carcass was found will begin operating within 48 hours of positive identification according to the minimization measures for the Indiana bat summer maternity season (applying a cut-in speed

[9] In Section 8.2.5, "Permit Area" refers to the area in which turbines are located, but does not include lands used for mitigation (See Section 1.4 and Figure 1.1).

of 5.0 m/s between ½ hour before sunset to ½ hour after sunrise when temperatures are greater than 50 degrees F, Section 5.2.2).

If USFWS notifies the Applicant that summer surveys have identified captures or maternity colonies within the buffer distances described above, the Applicant will re-evaluate the summer risk of take at the Project by completing within the Permit Area but outside the area buffering the 39 turbines with predicted Indiana bat summer risk: 1) an updated habitat assessment within 305 m (1,000 ft) of turbines, and/or 2) presence-absence surveys. Using the results of the re-evaluation, the Applicant and the USFWS will work together to determine which of the Project turbines present risk of take of either Covered Species, and the Project will operate those turbines according to the minimization measures for the Indiana bat summer maternity season (Table 5.1). The application of increased minimization measures for turbines with newly-discovered summer risk to Indiana bats or northern long-eared bats will continue for the remainder of the ITP term unless supplemental information is collected which indicates that summer risk to either Covered Species no longer exists.

If any of the trigger conditions are met, the Applicant will confer with the USFWS to determine whether the original take estimates for the Covered Species are still accurate, and if the mitigation plan will continue to fully offset the impact of take. If, after enacting the above responses, the take estimate is not more than that which is already permitted and the impact of the take is still fully offset by the mitigation described in this HCP, then no further response is required. If the updated annual take prediction for the Covered Species, projected for the remaining years of the ITP term indicates that take will exceed the amount of take authorization remaining on the ITP, the Applicant will take action expected to keep the project within the authorized take limit, or will pursue an ITP amendment within 1 year of the trigger being met.

8.2.6 Change in Mitigation Project Viability

This changed circumstance addresses the unlikely potential for deforestation (such as a result of severe storms, wildfires, floods, or drought) or encroachment of invasive species that may impact the success of the mitigation project. If a natural disaster occurs that potentially affects the viability of one or both mitigation projects, the triggers and responses outlined below would be followed, as further described in Sections 13 and 14 of the mitigation project management plan (Appendix B).

<u>Trigger</u>

Mitigation lands will be chosen for their suitability for potential occupation by Indiana and northern long-eared bats at the time of acquisition. Effectiveness monitoring will occur at regular intervals, as described in the mitigation monitoring plan (Appendix B). Following a natural disaster in the county in which the mitigation project is located, the habitat suitability of the mitigation lands will be assessed within three months. This can occur as part of regular effectiveness monitoring or as additional monitoring if the natural disaster occurs in a non-monitoring year. If 40% of the existing forest cover is documented to be lost, then a response will be triggered. Additionally, if effectiveness monitoring shows that invasive species (as

defined in Section 6 of Appendix B) exceed 20% of the understory cover at a mitigation project, a response will be triggered.

Response

If 40% or more of the existing canopy cover within a mitigation project is lost, the USFWS will be notified. The canopy loss will be assessed and mapped within three months of identification, with a replanting plan developed and replanting occurring within one year of the approval of the replanting plan (see Appendix B Section 14.2).

If 20% or more of the understory cover is identified as consisting of invasive species, invasive cover will be assessed across the entire site within three months, with an invasive management plan drafted within 9 months and completion of the invasive management plan occurring within 12 months, dependent on weather or growing season requirements (see Appendix B Section 14.1).

While it is difficult to predict the occurrence, frequency, and severity of natural disasters at the mitigation projects, the Applicant considers a natural disaster necessitating restoration of mitigation lands to be a reasonably foreseeable event. As such, as described in Section 6.3.1, the Applicant has incorporated $122,800 of potential restoration costs up front as part of the fees payed to FIR in the contract, which would cover the costs of replanting up to 100% of the mitigation projects once during the permit term, to account for potential partial deforestation of the mitigation lands caused by multiple rare events. Additionally, as noted in Section 6.3.1, the changed circumstances fund of $70,044 will be fully funded, and replenished within three months when used, throughout the duration of the ITP. Therefore, in the unlikely event that the mitigation project has unanticipated restoration needs beyond the amount funded in the initial mitigation fees, this changed circumstances fund can be used for further restoration.

8.2.7 The Impacts of White-nose Syndrome Are Greater than Anticipated

It is difficult to predict at this time what the long-term effects of WNS will be for Covered Species populations in Indiana and the Indiana bat MRU. The USFWS will inform the Applicant if USFWS evaluations indicate that population reductions due to WNS threaten to have a significant effect--and in the worst-case scenario--jeopardize that species. The Applicant will coordinate with the USFWS to evaluate if the likely level of take has also been reduced because there are fewer bats of the Covered Species at risk of collision with Project turbines.

Trigger

The USFWS informs the Applicant that WNS impacts are more severe than anticipated, to the point that the authorized take level threatens to have a significant population effect or is likely to lead to jeopardy of the Covered Species. This determination will be based on cave counts, hibernaculum emergence surveys, or any other relevant data, such as population viability analyses. The Applicant will require that the relevant survey results are presented by the USFWS that justify any positive conclusion that the trigger has been met.

Response

The Applicant will work with the USFWS to determine, using the Erickson et al. (2014) model or another population model that has been USFWS-endorsed at the time, what level of reduced take would cease to result in significant population impacts to the nearest hibernaculum under scenarios modeled with the observed WNS impacts. If deemed necessary by the USFWS, the ITP would be adjusted to this level of reduced take for the remainder of the permit term.

If the permitted take level has been adjusted downward, the Applicant will, in coordination with the USFWS determine an appropriate course of action. The Applicant will evaluate whether the cumulative level of take reported for the Project to date is on track with the adjusted 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, as available, will be considered in the analysis. If the cumulative level of take is found to be 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 on track to exceed the adjusted permitted level of take, the Applicant will determine, in coordination with USFWS, how the HCP's minimization measures need to be adjusted to maintain take of the Covered Species at or below the adjusted permitted level. Examples of adjustments to the HCP minimization measures that may be considered include changes in the turbine cut-in wind speed or temperature for part or all of the Project's turbines, changes in timing of the seasonal turbine operational adjustment period, and deployment of bat deterrent technology, if suitable technology is available.

Future cave surveys may show that WNS impacts have returned to the level 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 if the take level can be restored to the original permitted level without resulting in significant population effects or a risk of jeopardy under scenarios modeled with the newly observed WNS impacts.

Either a reduction in the permitted level of take or a reversion to the original permitted level of take outlined in this HCP are amendments that could be made without a public review of the change (Section 8.4.2).

8.3 Unforeseen Circumstances

Unforeseen circumstances are defined as those affecting a species or geographic area covered by a conservation plan that could not reasonably have been anticipated by the Applicant and the USFWS at the time of the negotiation and development of the plan and that result in a substantial and adverse change in the status of the Covered Species (50 CFR § 17.3). The USFWS bears the burden of demonstrating that unforeseen circumstances exist and must use the best available

scientific and commercial data in evaluating unforeseen circumstances (50 CFR §§ 17.22(b)(5)(iii)(C) and 17.32(b)(5)(iii)(C)).

In deciding whether unforeseen circumstances exist, the USFWS will consider, but not be limited to, the following factors:

1. The size of the current range of the affected species,
2. The percentage of the range adversely affected by the covered activities,
3. The percentage of the range that has been conserved by the HCP,
4. The ecological significance of that portion of the range affected by the HCP,
5. The level of knowledge about the affected species and the degree of specificity of the conservation program for that species under the HCP, and
6. Whether failure to adopt additional conservation measures would appreciably reduce the likelihood of survival and recovery of the species in the wild.

If unforeseen circumstances arise, the USFWS will not require the commitment of additional land, water, or financial compensation or additional restrictions on the use of land, water, or other natural resources beyond the level otherwise agreed upon for the species covered by the HCP without the consent of the permittee (50 C.F.R. §§ 17.22(b)(5)(iii)(A)) "If additional conservation 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 conservation plan's operating conservation program for the affected species, and maintain the original terms of the conservation plan "to the maximum extent possible" (50 C.F.R. § 17.22(b)(5)(iii)(B)). "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 otherwise available for development or use under the original terms of the conservation plan without the consent" of the permittee. If unforeseen circumstances are found, the permittee is not required to come up with additional resources or funds to remedy unforeseen circumstances, but the USFWS and the permittee should work together to determine an appropriate response within the original resource commitments in the HCP.

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.

8.4 Permit Modifications

Amendments to the HCP and ITP will be made in accordance with 50 CFR 13.23 and the HCP Handbook (USFWS and NMFS 2016) or renewals of the Handbook. Depending on the circumstances, modifications to this HCP could be made either through documentation of minor changes or through an amendment process. The scope of any changes would be used by the USFWS to determine whether an amendment process is necessary, as described below.

8.4.1 Modifications Made Without an Incidental Take Permit Amendment

Some revisions to this HCP or the ITP may be agreed upon between the Applicant and the USFWS without the need to amend the HCP or ITP. Minor changes would include those in which the amount of take authorized by the ITP and the Covered Activities are not substantively altered. Some examples include making small changes to monitoring protocols or changing the names of responsible officials (USFWS and NMFS 2016). Such changes may be made and documented through an exchange of written correspondence between the Applicant and the USFWS and retained in the administrative record. 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 Habitat Conservation Plan and Incidental Take Permit Amendments

For proposed modifications that are more substantial than what is described above in Section 8.4.1, an amendment process that includes Federal Register publication may be necessary. The USFWS will determine the extent of NEPA and ESA § 7 analyses and public notice processes, driven by the scale and scope of the amendment. Amendments that do not increase the levels of incidental take and do not change the Covered Activities in ways that were not analyzed in the original NEPA or ESA § 7 documents do not usually require public notice or additional analysis under NEPA or ESA § 7. Amendments that require ITP amendment and publication in the Federal Register include, but are not limited to: 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 mitigation measures (USFWS and NMFS 2016).

8.5 Permit Renewal

The Applicant requests that the ITP associated with this HCP be available for renewal pursuant to 50 CFR § 13.22. In the event that the Applicant plans to continue operating the Project after the ITP term and the total take estimated for the Project is less than the take level authorized by the ITP, the Applicant will file in writing a renewal request at least 30 days prior to the permit expiration. 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 Federal Register before the USFWS issues a decision. Extension of the ITP term constitutes an extension of the HCP for the same amount of time, subject to any modifications that the USFWS may require at the time of renewal. In the event of a renewal, the USFWS and Applicant will make every effort to retain the terms of the original HCP for the ITP-renewal term.

9.0 REFERENCES

9.1 Literature Cited

Amelon, S. and D. Burhans. 2006. Conservation Assessment: *Myotis leibii* (Eastern Small-Footed Myotis) in the Eastern United States. *In:* US Department of Agriculture (USDA) Forest Service General Technical Report NC-260: Conservation Assessments for Five Forest Bat Species in the Eastern United States.

Arnett, E. B., W. P. Erickson, J. Kerns, and J. Horn. 2005. Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines. Final Report. Prepared for Bats and Wind Energy Cooperative, Bat Conservation International, Austin, Texas. June 2005. Available online: http://www.batsandwind.org/pdf/ar2004.pdf

Arnett, E. B., K. Brown, W. P. Erickson, J. Fiedler, B. L. Hamilton, T. H. Henry, A. Jain, G. D. Johnson, J. Kerns, R. R. Koford, C. P. Nicholson, T. O'Connell, M. Piorkowski, and R. Tankersley, Jr. 2008. Patterns of Bat Fatalities at Wind Energy Facilities in North America. Journal of Wildlife Management 72(1): 61-78.Arnett, E. B., M. R. Schirmacher, M. M. P. Huso, and J. P. Hayes. 2010. Patterns of Bat Fatality at the Casselman Wind Project in South-Central Pennsylvania. 2009 Annual Report. Annual report prepared for the Bats and Wind Energy Cooperative (BWEC) and the Pennsylvania Game Commission. Bat Conservation International (BCI), Austin, Texas. January 2010.

Arnett, E. B., G. D. Johnson, W. P. Erickson, and C. D. Hein. 2013. A Synthesis of Operational Mitigation Studies to Reduce Bat Fatalities at Wind Energy Facilities in North America. A report submitted to the National Renewable Energy Laboratory (NREL), Golden Colorado. Bat Conservation International (BCI), Austin, Texas. March 2013.Dalthorp, D. and M. Huso. 2015. A Framework for Decision Points to Trigger Adaptive Management Actions in Long-Term Incidental Take Permits: U.S. Geological Survey (USGS) Open-File Report 2015-1227. 88 pp. Available online at: http://dx.doi.org/10.3133/ofr20151227

Arnold, B. D. 2007. Population Structure and Sex-Biased Dispersal in the Forest-Dwelling Vespertilionid Bat, *Myotis septentrionalis*. American Midland Naturalist 157: 374-384.

Avery, M. I. 1985. Winter Activity of Pipistrelle Bats. Journal of Animal Ecology 54(3): 721-738.

Barbour, R. A. and W. H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington, Kentucky. 286 pp.

Barclay, R. M. R. and L. D. Harder. 2005. Life Histories of Bats: Life in the Slow Lane. Pp. 209-253. *In*: T. H. Kunz and M. B. Fenton, eds. Bat Ecology. University of Chicago Press, Chicago, Illinois.

Barclay, R. M. R. and A. Kurta. 2007. Ecology and Behavior of Bats Roosting in Tree Cavities and under Bark. Pp. 17-59. *In*: M. J. Lacki, J. P. Hayes, and A. Kurta, eds. Bats in Forests: Conservation and Management. John Hopkins University Press, Baltimore, Maryland.

Barclay, R. M. R., J. Ulmer, C. J. A. MacKenzie, M. S. Thompson, L. Olson, J. McCool, E. Cropley, and G. Poll. 2004. Variation in Reproductive Rate of Bats. Canadian Journal of Zoology 82: 688-693.

Blehert, D.S. Hicks, A. Behr, M. Meteyer, C.U. Berlowski-Zier, B. Buckles, E. Coleman, J. Darling, S.R. Gargas, A. Niver, R. Okoniewski, J. Rudd, and R. W.B. Stone. 2009. Bat White-nose Syndrome: An Emerging Fungal Pathogen? Science 323(5911): 227.

Blehert, D. S., J. M. Lorch, A. E. Ballmann, P. M. Cryan, and C. U. Meteyer. 2011. Bat White-Nose Syndrome in North America. Microbe 6(6): 267-273.

Boyles, J. G., J. C. Timpone, and L. W. Robbins. 2009. Bats of Missouri. Indiana State University Center for North American Bat Research and Conservation, Publication Number 3. Indiana State University Press, Terre Haute, Indiana.

Brack, V., Jr. 2006. Autumn Activity of *Myotis sodalis* (Indiana Bat) in Bland County, Virginia. Northeastern Naturalist 13: 421-434.

Brack, V. Jr., C. W. Stihler, R. J. Reynolds, C. M. Butchkoski, and C. S. Hobson. 2002. Effect of Climate and Elevation on Distribution and Abundance in the Mideastern United States. Pp. 21-28. *In*: A. Kurta and J. Kennedy, eds. The Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International (BCI), Austin, Texas.

Brack, V., Jr., S. A. Johnson, and R. K. Dunlap. 2003. Wintering Populations of Bats in Indiana, with Emphasis on the Endangered Indiana Myotis, *Myotis sodalis.* Proceedings of the Indiana Academy of Science 112: 61-74.

Britzke, E. R., A. C. Hicks, S.L. von Oettingen, and S. R. Darling. 2006. Description of Spring Roost Trees Used by Female Indiana Bats (*Myotis sodalis*) in the Lake Champlain Valley of Vermont and New York. American Midland Naturalist 155: 181-187.

Broders, H. G. and G. J. Forbes. 2004. Interspecific and Intersexual Variation in Roost-Site Selection of Northern Long-Eared and Little Brown Bats in the Greater Fundy National Park Ecosystem. Journal of Wildlife Management 68(3): 602-610.

Broders, H. G., G. J. Forbes, S. Woodley, and I. D. Thompson. 2006. Range Extent and Stand Selection for Roosting and Foraging in Forest-Dwelling Northern Long-Eared Bats and Little Brown Bats in the Greater Fundy Ecosystem, New Brunswick. Journal of Wildlife Management 70: 1174-1184.

Brooks, R. T. 2010 Declines in Summer Bat Activity in Central New England 4 Years Following the Initial Detection of White-Nose Syndrome. Biodiversity and Conservation 20(11): 2537-2541.

Brooks, R. T. and W. M. Ford. 2005. Bat Activity in a Forest Landscape of Central Massachusetts. Northeastern Naturalist 12(4): 447-462.

Brooks, J. D., S. C. Loeb, and P. D. Gerard. 2017. Effect of Forest Opening Characteristics, Prey Abundance, and Environmental Factors on Bat Activity in the Southern Appalachians. Forest Ecology and Management 400: 19-27.

Brown, T. and L. Bishop-Boros 2018. 2017 Bitter Ridge Wind Summer Presence/Absence Surveys, Bitter Ridge Wind Project, Jay County, Indiana. Draft Report: July 14 – August 11, 2017. Prepared for Bitter Ridge Wind Farm, LLC, Boulder, Colorado. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 18, 2018.

Butchkoski, C. M. and J. D. Hassinger. 2002. Ecology of a Maternity Colony Roosting in a Building. Pp. 130-142. *In*: A. Kurta and J. Kennedy, eds. The Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International (BCI), Austin, Texas.

Butchkoski, C. M. and G. Turner. 2005. Indiana Bat (*Myotis sodalis*) Investigations at Canoe Creek, Blair County, Pennsylvania. Pennsylvania Game Commission. Harrisburg, Pennsylvania.

Butchkoski, C. M. and G. Turner. 2006. Indiana Bat (*Myotis sodalis*) Summer Roost Investigations. Project 06714. Annual job report. Pennsylvania Game Commission, Bureau of Wildlife Management Research Division. Harrisburg, Pennsylvania.

Butchkoski, C. M. and G. Turner. 2008. Indiana Bat (*Myotis sodalis*) Summer Roost Investigations. Annual job report. Pennsylvania Game Commission. Harrisburg, Pennsylvania. Caceres, M. C. and M. J. Pybus. 1997. Status of the Northern Long-Eared Bat (*Myotis septentrionalis*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 3, Edmonton, Alberta.

Caceres, M.C. and M. J. Pybus. 1997. Status of the Northern Long-eared Bat (*Myotis spetentrionalis*) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Report No. 3, Edmonton, Alberta.

Caceres, M. C. and R. Barclay. 2000. *Myotis septentrionalis*. Mammalian Species 634: 1-4.

Caire, W., R. K. Laval, M. K. Laval, and R. Clawson. 1979. Notes on the Ecology of *Myotis keenii* (Chiroptera, Vespertilionidae) in Eastern Missouri. American Midland Naturalist 102: 404-407.

Carter, T. C. and G. A. Feldhamer. 2005. Roost Tree Use by Maternity Colonies of Indiana Bats and Northern Long-Eared Bats in Southern Illinois. Forest Ecology and Management 219: 259-268.

Clark, B. K., J. B. Bowles, and B. S. Clark. 1987. Summer Status of the Endangered Indiana Bat in Iowa. American Midland Naturalist 118: 32-39.

Cope, J. B. and S. R. Humphrey. 1972. Reproduction of the Bats *Myotis keenii* and *Pipistrellus subflavus* in Indiana. Bat Research News 13: 9-10.

Cope, J. B. and S. R. Humphrey. 1977. Spring and Autumn Swarming Behavior in the Indiana Bat, *Myotis sodalis*. Journal of Mammalogy 58: 93-95.

Cope, J. B., A. R. Richter., and R. S. Mills. 1974. A Summer Concentration of the Indiana Bat, *Myotis sodalis*, in Wayne County, Indiana. Proceedings of the Indiana Academy of Science 83: 482-484.

Dalthorp, D. and M. Huso. 2015. A Framework for Decision Points to Trigger Adaptive Management Actions in Long-Term Incidental Take Permits: U.S. Geological Survey (USGS) Open-File Report 2015-1227. 88 pp. Available online at: http://dx.doi.org/10.3133/ofr20151227

Davis, W. H. and H. B. Hitchcock. 1965. Biology and Migration of the Bat, *Myotis lucifugus*, in New England. Journal of Mammalogy 46(2): 296-313.

Dickinson, M. B., M. J. Lacki, and D. R. Cox. 2009. Fire and the Endangered Indiana Bat. Pp. 51-75. *In*: GTR-NRS-P-46. Proceedings of the Third Fire in Eastern Oak Forests Conference.

Dzal, Y., L. P. McGuire, N. Veselka, and M. B. Fenton. 2010. Going, Going, Gone: The Impact of White-Nose Syndrome on the Summer Activity of the Little Brown Bat (*Myotis lucifugus*). Biology Letters 7: doi: 10.1098/rsbl.2010.0859.

Easterla, D. A. 1968. Parturition of Keen's Myotis in Southwestern Missouri. Journal of Mammalogy 49: 770.

Erickson, R.A., W.E. Thogmartin, and J.A. Szymanski. 2014. BatTool: an R package with GUI for assessing the effect of White-nose syndrome and other take events on *Myotis* spp. of bats. Source Code for Biology and Medicine. 9:9.

Evers, D. C. 1992. A Guide to Michigan's Endangered Wildlife. University of Michigan Press, Ann Arbor, Michigan.

Faure, P. A., J. H. Fullard, and J. W. Dawson. 1993. The Gleaning Attacks of the Northern Long-Eared Bat, *Myotis septentrionalis*, Are Relatively Inaudible to Moths. Journal of Experimental Biology 178: 173-189.

Federal Aviation Administration (FAA). 2015. Obstruction Marking and Lighting. Advisory Circular. AC 70/7460-1L. US Department of Transportation, FAA. December 4, 2015. Available online: https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_70_7460-1L_.pdf

Fenton, M. B. 1970. Population Studies of *Myotis lucifugus* (Chiroptera: Vespertilionidae) in Ontario. Life Sciences Contributions, Royal Ontario Museum 77: 1-34.

Ford, W. M., S. F. Owen, J. W. Edwards, and J. L. Rodrigue. 2006. *Robinia pseudoacacia* (Black Locust) as Day-Roosts of Male *Myotis septentrionalis* (Northern Bats) on the Fernow Experimental Forest, West Virginia. Northeastern Naturalist 13: 15-24.

Foster, R. W. and A. Kurta. 1999. Roosting Ecology of the Northern Bat (*Myotis septentrionalis*) and Comparisons with the Endangered Indiana Bat (*Myotis sodalis*). Journal of Mammalogy 80: 659-672.

Fowler Ridge Wind Farm I-IV, LLC. 2013. Fowler Ridge Wind Farm, Benton County, Indiana. Indiana Bat Habitat Conservation Plan. Prepared by Fowler Ridge Wind Farm I-IV, LLC, in consultation with Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming and Bloomington, Indiana. November 2013. Available online: https://www.fws.gov/midwest/endangered/permits/hcp/FowlerRidge/pdf/FowlerRidgeWindFarmFinalHCP120913.pdf

Frick, W. F., J. F. Pollock, A. C. Hicks, K. E. Langwig, D. S. Reynolds, G. G. Turner, C. M. Butchkoski, and T. H. Kunz. 2010. An Emerging Disease Causes Regional Population Collapse of a Common North American Bat Species. Science 329: 679-682.

Gaisler, J., J. Zukal, Z. Rehak, and M. Homolka. 1998. Habitat Preference and Flight Activity of Bats in a City. Journal of Zoology-London 244: 439-445.

Gardner, J. E. and E. A. Cook. 2002. Seasonal and Geographic Distribution and Quantification of Potential Summer Habitat. Pp. 9-20. *In*: A. Kurta and J. Kennedy, eds. The Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International (BCI), Austin, Texas.

Good, R. E., W. P. Erickson, A. Merrill, S. Simon, K. Murray, K. Bay, and C. Fritchman. 2011. Bat Monitoring Studies at the Fowler Ridge Wind Energy Facility, Benton County, Indiana: April 13 - October 15, 2010. Prepared for Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. January 28, 2011.

Good, R. E., A. Merrill, S. Simon, K. Murray, and K. Bay. 2012. Bat Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: April 1 - October 31, 2011. Prepared for the Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 31, 2012.

Good, R. E., M. Sonnenberg, and S. Simon, 2013. Bat Evaluation Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana. Final Report: August 1 – October 15, 2012. Prepared for Fowler Ridge Wind Farm, Fowler, Indiana. Prepared by Western EcoSystems Technology, Inc. Bloomington, Indiana

Good, R. E., G. Iskali, K. Nasman, and A. Ciecka. 2018. Bat Evaluation Monitoring Studies at the Fowler Ridge Wind Farm, Benton County, Indiana: August 1 – October 15, 2017. Prepared for Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. (WEST), Bloomington, Indiana. January 29, 2018.

Grehan, J. R. 2008. Steel Winds Bird Mortality Study, Final Report, Lackawanna, New York. Prepared for Steel Winds LLC. April 2008.

Griffin, D. R. 1940. Notes on the Life Histories of New England Cave Bats. Journal of Mammalogy 21: 181-187.

Griffin, D. R. 1945. Travels of Banded Cave Bats. Journal of Mammalogy 26: 15-23.

Griffin, D. R. 1970. Migration and Homing of Bats. Pp. 233-264. *In*: W. A. Wimsatt, ed. Biology of Bats. Academic Press, New York.

Gumbert, M. W. 2001. Seasonal Roost Tree Use by Indiana Bats in the Somerset Ranger District of Daniel Boone National Forest, Kentucky. Thesis. Eastern Kentucky University, Richmond, Kentucky.

Gumbert, M. W., P. Roby, and J. Hawkins. 2011. Spring Migration of Female Indiana Bats (*Myotis sodalis*) from Caves in Eastern Tennessee. 68 pp.

Guthrie, M. J. 1933. The Reproductive Cycles of Some Cave Bats. Journal of Mammalogy 14: 199-216.

Hall, J. S. 1962. A Life History and Taxonomic Study of the Indiana Bat, *Myotis sodalis*. Reading Public Museum and Art Gallery Publication 12: 1-68.

Hall, J. S., R. J. Cloutier, and D. R. Griffin. 1957. Longevity Records and Notes on Tooth Wear of Bats. Journal of Mammalogy 38(3): 407-409.

Harvey, M. J. 1992. Bats of the Eastern United States. Arkansas Game and Fish Commission. 46 pp.

Hawkins, J. A., J. Jaskula, A. Mann, and V. Brack, Jr. 2005. Habitat Conservation Plan: 2004 Telemetry Study of Autumn Swarming Behavior of the Indiana Bat (*Myotis sodalis*). Report prepared for the Indiana Department of Natural Resources, Indianapolis, Indiana. 25 pp.

Hayes, J. P. 1997. Temporal Variation in Activity of Bats and the Design of Echolocation-Monitoring Studies. Journal of Mammalogy 78: 514-524.

Henderson, L. E. and H. G. Broders. 2008. Movements and Resource Selection of the Northern Long-Eared Myotis (*Myotis septentrionalis*) in a Forest-Agriculture Landscape. Journal of Mammalogy 89: 952-963.

Hicks, A. 2004. Indiana Bat (*Myotis sodalis*): Protection and Management in New York State. Endangered Species Investigations Performance Report. Prepared for project number W-166-E, Segment 2003-2004, New York Department of Environmental Conservation. 15 pp.

Hicks, A. C., M. Cooper, W. Skinner, R. V. Linden, A. Bailey, J. A. Kath, and M. Sailor. 2012. Spring Migratory Behavior of Female Indiana Bats (*Myotis sodalis*) from the Blackball Mine Complex, Lasalle County, Illinois. Final Report prepared by Vesper Environmental LLC, Invenergy LLC, US Fish and Wildlife Service, and the Illinois Department of Natural Resources. Prepared for Invenergy LLC, Chicago, Illinois.

Hitchcock, H. B. 1949. Hibernation of Bats in Southeastern Ontario and Adjacent Quebec. Canadian Field Naturalist 63: 47-59.

Hoen, B. D., J. E. Diffendorfer, J. T. Rand, L. A. Kramer, C. P. Garrity, and H. E. Hunt. 2018. United States Wind Turbine Database. Available online: https://eerscmap.usgs.gov/uswtdb.

Homer, C. G., J. A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N. D. Herold, J. D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the Conterminous United States-Representing a Decade of Land Cover Change Information. Photogrammetric Engineering and Remote Sensing 81(5): 345-354. Available online: http://www.mrlc.gov/nlcd2011.php

Horn, J. W., E. B. Arnett, and T. H. Kunz. 2008. Behavioral Responses of Bats to Operating Wind Turbines. Journal of Wildlife Management 72(1): 123-132.

Humphrey, S. R. and J. B. Cope. 1976. Population Ecology of the Little Brown Bat, *Myotis lucifugus*, in Indiana and North-Central Kentucky. American Society of Mammalogists Special Publication No. 4.

Humphrey, S. R. and J. B. Cope. 1977. Survival Rates of the Endangered Indiana Bat, *Myotis sodalis*. Journal of Mammalogy 58: 32-36.

Humphrey, S. R., A. R. Richter, and J. B. Cope. 1977. Summer Habitat and Ecology of the Endangered Indiana Bat, *Myotis sodalis*. Journal of Mammalogy 58(3): 334-346.

Huso, M. M. P., D. Dalthorp, D. Dail, and L. Madsen. 2015. Estimating wind-turbine-caused bird and bat fatality when zero carcasses are observed. Ecological Applications. 25(5):1213-1225.

Huso, M. M. P., D. Dalthorp, and F. Korner-Nievergelt. 2017. Statistical Principles of Post-Construction Fatality Monitoring Design. Pp. X-X. *In*: M Perrow, ed. Wildlife and Wind Farms, Conflicts and Solutions, Volume 2, Onshore: Monitoring and Mitigation. Pelagic Publishing, Ltd, Exeter, United Kingdom.

Indiana Department of Homeland Security (IDHS). 2014. 2014 State of Indiana Standard Multi-hazard Mitigation Plan. Prepared by Indiana Department of Homeland Security and The Polis Center. Available online: https://www.in.gov/dhs/3181.htm

Indiana Department of Natural Resources (IDNR). 2011. Bat Tests Positive for White-Nose Fungus. IDNR, Indianapolis, Indiana. February 1, 2011.

Jacques Whitford Stantec Limited (Jacques Whitford). 2009. Ripley Wind Power Project Postconstruction Monitoring Report. Project No. 1037529.01. Report to Suncor Energy Products Inc., Calgary, Alberta, and Acciona Energy Products Inc., Calgary, Alberta. Prepared for the Ripley Wind Power Project Post-Construction Monitoring Program. Prepared by Jacques Whitford, Markham, Ontario. April 30, 2009.

Jain, A., P. Kerlinger, R. Curry, L. Slobodnik, A. Fuerst, and C. Hansen. 2009. Annual Report for the Noble Ellenburg Windpark, LLC, Postconstruction Bird and Bat Fatality Study - 2008. Prepared for Noble Environmental Power, LLC by Curry and Kerlinger, LLC. April 13, 2009.

Jain, A., P. Kerlinger, L. Slobodnik, R. Curry, and A. Harte. 2011. Annual Report for the Noble Wethersfield Windpark, LLC: Postconstruction Bird and Bat Fatality Study - 2010. Prepared for Noble Environmental Power, LLC. Prepared by Curry and Kerlinger, LLC, Cape May, New Jersey. January 22, 2011.

James, R. D. 2008. Erie Shores Wind Farm, Port Burwell, Ontario: Fieldwork Report for 2006 and 2007 During the First Two Years of Operation. Report to Environment Canada, Ontario Ministry of Natural Resources, Erie Shores Wind Farm LP - McQuarrie North American and AIM PowerGen Corporation. January 2008.

Johnson, G. D., M. Ritzert, S. Nomani, and K. Bay. 2010a. Bird and Bat Fatality Studies, Fowler Ridge I Wind-Energy Facility Benton County, Indiana. Unpublished report prepared for British Petroleum Wind Energy North America Inc. (BPWENA) by Western EcoSystems Technology, Inc. (WEST).

Kerlinger, P., J. Guarnaccia, L. Slobodnik, and R. Curry. 2011. A Comparison of Bat Mortality in Farmland and Forested Habitats at the Noble Bliss and Wethersfield Windparks, Wyoming County, New York. Report Prepared for Noble Environmental Power. Report prepared by Curry & Kerlinger, LLC, Cape May Point, New Jersey. November 2011.

Kerns, J. and P. Kerlinger. 2004. A Study of Bird and Bat Collision Fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual Report for 2003. Prepared for FPL Energy and the Mountaineer Wind Energy Center Technical Review Committee. February 14, 2004. 39 pp. http://www.wvhighlands.org/Birds/MountaineerFinalAvianRpt-%203-15-04PKJK.pdf

Kiser, J. D. and C. L. Elliot. 1996. Foraging Habitat, Food Habits, and Roost Tree Characteristics of the Indiana Bat, *Myotis sodalis*, During Autumn in Jackson County, Kentucky. Final report for the Kentucky Department of Fish and Wildlife Resources. 65 pp.

Kunz, T. H., E. B. Arnett, B. M. Cooper, W. P. Erickson, G. D. Johnson, R. P. Larkin, M. D. Strickland, R. W. Thresher, and M. D. Tuttle. 2007. Ecological Impacts of Wind Energy Development on Bats: Questions, Hypotheses, and Research Needs. Frontiers in Ecology and the Environment 5(6):315-324.

Kurta, A. 1995. Mammals of the Great Lakes Region: Revised Edition. M. M. Douglas, ed. The Great Lakes Environment Series. University of Michigan Press, Ann Arbor, Michigan. 392 pp.

Kurta, A. 2000. The Bat Community in Northwestern Lower Michigan, with Emphasis on the Indiana Bat and Eastern Pipistrelle. Unpublished report. US Forest Service (USFS), Huron-Manistee National Forests, Cadillac, Michigan. 43 pp.

Kurta, A. 2004. Roosting Ecology and Behavior of Indiana Bats (*Myotis sodalis*) in Summer. Pp. 29-42. *In*: K. C. Vories and A. Harrington, eds. Indiana Bat and Coal Mining: A Technical Interactive Forum. US Department of Interior, Office of Surface Mining, Alton, Illinois Coal Research Center, Southern Illinois University, Carbondale, Illinois. Louisville, Kentucky.

Kurta, A. and S. W. Murray. 2002. Philopatry and Migration of Banded Indiana Bats (*Myotis sodalis*) and Effects of Radio Transmitters. Journal of Mammalogy 83(2): 585-589.

Kurta, A. and H. Rice. 2002. Ecology and Management of the Indiana Bat in Michigan. Michigan Academician 33(3): 361-376.

Kurta, A. and J. A. Teramino. 1994. A Novel Hibernaculum and Noteworthy Records of the Indiana Bat and Eastern Pipistrelle (Chiroptera: Vespertilionidae). American Midland Naturalist 132: 410-413.

Lacki, M. J. 1984. Temperature and Humidity-Induced Shifts in the Flight Activity of Little Brown Bats. Ohio Journal of Science 84: 264-266.

Lacki, M. J. and J. H. Schwierjohann. 2001. Day-Roost Characteristics of Northern Bats in Mixed Mesophytic Forest. Journal of Wildlife Management 65: 482-488.

Lacki, M. J., S. K. Amelon, and M. D. Baker. 2007. Foraging Ecology of Bats in Forests. Pp. 83-127. *In*: M. J. Lacki, A. Kurta, and J. P. Hayes, eds. Conservation and Management of Bats in Forests. Johns Hopkins University Press, Baltimore, Maryland.

Lacki, M. J., D. R. Cox, and M. B. Dickinson. 2009. Meta-Analysis of Summer Roosting Characteristics of Two Species of Myotis Bats. American Midland Naturalist 162: 318-326.

LaVal, R. K. and M. L. LaVal. 1980. Ecological Studies and Management of Missouri Bats with Emphasis on Cave-Dwelling Species. Missouri Department of Conservation Terrestrial Series No. 8: 1-52.

Layne, J. N., ed. 1978. Rare and Endangered Biota of Florida. Volume 1. Mammals. State of Florida Game and Freshwater Fish Commission. 52 pp.

McShea, W. J. and H. Lessig. 2005. Migration of Female Indiana Bats (*Myotis sodalis*) from Winter Hibernacula to Summer Maternity Roost. Draft report to the Virginia Department of Game and Inland Fisheries, Richmond, Virginia.

Mills, R. S. 1971. A Concentration of *Myotis keenii* at Caves in Ohio. Journal of Mammalogy 52: 625.

Minnis, A. M. and D. L. Lindner. 2013. Phylogenetic Evaluation of *Geomyces* and Allies Reveals No Close Relatives of *Pseudogymnoascus destructans*, Comb. Nov., in Bat Hibernacula of Eastern North America. Fungal Biology 117: 638-649.

Mumford, R. E. and L. L. Calvert. 1960. *Myotis sodalis* Evidently Breeding in Indiana. Journal of Mammalogy 41(4): 512.

Murray, S. W. and A. Kurta. 2004. Nocturnal Activity of the Endangered Indiana Bat (*Myotis sodalis*). Journal of Zoology (London) 262: 197-206.

Myers, R. F. 1964. Ecology of Three Species of Myotine Bats in the Ozark Plateau. Dissertation. University of Missouri, Columbia, Missouri. 210 pp.

Nagorsen, D. W. and R. M. Brigham. 1993. Northern Long-Eared Myotis (*Myotis septentrionalis*). *In:* Bats of British Columbia. Royal British Columbia Museum Handbook. University of British Columbia Press, Vancouver, British Columbia. 165 pp.

National Oceanic and Atmospheric Administration (NOAA). 2019. Storm Events Database. Accessed April 15, 2019. Available online: https://www.ncdc.noaa.gov/stormevents/

Natural Resources Conservation Service (NRCS). 2017. Conservation Practice Standard: Tree/Shrub Establishment. Code 612 (Ac). April 2017. Available online: https://efotg.sc.egov.usda.gov/references/public/CA/612-std-ca-4_24_17.pdf

O'Farrell, M. J. and W. G. Bradley. 1970. Activity Patterns of Bats over a Desert Spring. Journal of Mammalogy 51(1): 18-26.

O'Shea, T. J., L. E. Ellison, and T. R. Stanley. 2004. Survival Estimation in Bats: Historical Overview, Critical Appraisal, and Suggestions for New Approaches. Pp. 297-336. *In*: W. L. Thompson, ed. Sampling Rare and Elusive Species: Concepts, Designs, and Techniques for Estimating Population Parameters. Island Press, Washington, D.C.

Owen, S. F., M. A. Menzel, W. M. Ford, J. W. Edwards, B. R. Chapman, K. V. Miller, and P. B. Wood. 2002. Roost Tree Selection by Maternal Colonies of Northern Long-Eared Myotis in an Intensively Managed Forest. US Department of Agriculture (USDA) Forest Service, General Technical Report NE-292. USDA Northeastern Research Station, Newtown Square, Pennsylvania.

Owen, S. F., M. A. Menzel, W. M. Ford, B. R. Chapman, K. V. Miller, J. W. Edwards, and P. B. Wood. 2003. Home-Range Size and Habitat Used by the Northern Myotis (*Myotis septentrionalis*). American Midland Naturalist 150(2): 352-359.

Patriquin, K. J. and R. M. R. Barclay. 2003. Foraging by Bats in Cleared, Thinned and Unharvested Boreal Forest. Journal of Applied Ecology 40: 646-657.

Pearson, E. W. 1962. Bats Hibernating in Silica Mines in Southern Illinois. Journal of Mammalogy 43(1): 27-33.

Pruitt, L. and M. Reed. 2018. Indiana Bat Fatalities at Wind Energy Facilities. US Fish and Wildlife Service (USFWS) Bloomington Indiana Field Office. Update November 2018. Available online: https://www.fws.gov/midwest/wind/wildlifeimpacts/inbafatalities.html

Racey, P. A. 1982. Ecology of Bat Reproduction. Pp. 57-104. *In*: T. H. Kunz, ed. Ecology of Bats. Plenum Press, New York, New York. 425 pp.

Roby, P. L. and M. W. Gumbert. 2016. Spring Migration of Indiana Bats (*Myotis sodalist*) and What It Means for the Wind Industry. Talk Presented at the Wind Wildlife Research Meeting XI in Broomfield, Colorado. December 2, 2016.

Roby and Gumbert 2016b. Final Report. Bats and Wind Energy: A Comparison Between Spring and Autumn Migration Behavior. Service Award Number: F14AC00766. 29 September 2016.

Rommé, R. C., A. B. Henry, R. A. King, T. Glueck, and K. Tyrell. 2002. Home Range near Hibernacula in Spring and Autumn. Pp. 153-158. *In*: A. Kurta and J. Kennedy, eds. The Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International (BCI), Austin, Texas.

Rydell, J. 1991. Seasonal Use of Illuminated Areas by Foraging Northern Bats, *Eptesicus nilssoni*. Holarctic Ecology 14(3): 230-207.

Sanders, C., J. Chenger, and B. Denlinger. 2001. Williams Lake Telemetry Study: New York Indiana Bat Spring Migration Tracking Study. Report for Bat Conservation and Management. 21 pp.

Saugey, D. A., G. A. Heidt, D. R. Heath, and V. R. McDaniel. 1990. Hibernating Indiana Bats (*Myotis sodalis*) from the Ouachita Mountains of Southeastern Oklahoma. Southwestern Naturalist 35: 341-342.

Schultes, K. L. and C. Elliott. 2002. Roost Tree Selection by Indiana Bats and Northern Bats on the Wayne National Forest, Ohio. Final Report for the US Fish and Wildlife Service (USFWS). February 11, 2002.

Sherwin, H. A., W. I. Mongomery, and M. G. Lundy. 2012. The Impact and Implications of Climate Change for Bats. Mammal Review: doi: 10.1111/j.1365-2907.2012.00214.x.

Shiel, C. B. and J. S. Fairley. 1998. Activity of Leisler's Bat *Nyctalus leisleri* (Kuhl) in the Field in South-East County Wexford, as Revealed by a Bat Detector. Biology and Environment: Proceedings of the Royal Irish Academy 98B(2): 105-112.

Silvis, A., W. M. Ford, E. R. Britzke, N. R. Beane, and J. B. Johnson. 2012. Forest Succession and Maternity Day Roost Selection by *Myotis septentrionalis* in a Mesophytic Hardwood Forest. International Journal of Forestry Research 2012: doi: 10.1155/2012/148106.

Sparks, D. W., J.O. Whitaker, Jr., and C. M. Ritzi. 2004. Foraging Ecology of the Endangered Indiana Bat. Pp. 15-27. *In*: K. C. Vories and A. Harrington, eds. Indiana Bat and Coal Mining: A Technical Interactive Forum. US Department of Interior, Office of Surface Mining, Alton, Illinois Coal Research Center, Southern Illinois University, Carbondale, Illinois. Louisville, Kentucky.

Sparks, D. W., J. O. Whitaker, and C. M. Ritzi. 2005. Foraging Ecology of the Endangered Indiana Bat. Journal of Mammalogy 86: 713-718.

Stantec Consulting, Inc. (Stantec). 2011. Cohocton and Dutch Hill Wind Farms Year 2 Post-Construction Monitoring Report, 2010, for the Cohocton and Dutch Hill Wind Farms in Cohocton, New York. Prepared for Canandaigua Power Partners, LLC, and Canandaigua Power Partners II, LLC, Portland, Maine. Prepared by Stantec, Topsham, Maine. October 2011.

Stantec Consulting Ltd. (Stantec Ltd.). 2007. Kingsbridge I Wind Power Plant Post-Construction Bird and Bat Monitoring Report: 2006. File No. 160960204. Prepared by Stantec Ltd., Guelph, Ontario. March 7, 2007.

Stantec Consulting Services, Inc. (Stantec Consulting). 2018. 2017 Post-Construction Bat Mortality Monitoring Report. Wildcat Wind Farm, Madison and Tipton Counties, Indiana. Prepared for Wildcat Wind Farm, LLC, Chicago, Illinois. Prepared by Stantec Consulting, Independence, Iowa. January 26, 2018.

Stones, R. C. 1981. Endangered and Threatened Species Program: Survey of Winter Bat Populations in Search of the Indiana Bat in the Western Upper Peninsula of Michigan. Michigan Department of Natural Resources (MDNR).

Szymanski, J., F. Clark, and D. Laughland. 2013. Region 3 Indiana Bat Resource Equivalency Analysis Model for Wind Energy Projects. Draft Version: January 31, 2013.

Taucher, J., T. Librandi-Mumma, and W. Capouillez. 2012. Pennsylvania Game Commission Wind Energy Voluntary Cooperation Agreement Third Summary Report. Bureau of Wildlife Habitat Management, Pennsylvania Game Commission (PGC), Harrisburg, Pennsylvania. December 27, 2012. Available online at: http://www.batsandwind.org/pdf/PGC%203rd%20Wind%20Energy%20Summary%20Report%202012.pdf

Thogmartin, W. E., R. A. King, P. C. McKann, J. A. Szymanski, and L. Pruitt. 2012. Population-Level Impact of White-Nose Syndrome on the Endangered Indiana Bat. Journal of Mammalogy 93(4): 1086-1098.

Thogmartin, W. E., C. A.Sanders-Reed, J. A.Szymanski, P. C.McKann, L. Pruitt, R. A. King, M. C.Runge, and R. E.Russell. 2013. White-Nose Syndrome Is Likely to Extirpate the Endangered Indiana Bat over Large Parts of Its Range. Biological Conservation 160: 162–172.

Thompson, F.R. III., ed. 2006. Conservation Assessments for Five Forest Bat Species in the Eastern United States. General Technical Report Nc-260. North Central Research Station, US Department of Agriculture (USDA) Forest Service, St. Paul, Minnesota. pp. 82 pp.

Thomson, C. E. 1982. *Myotis sodalis*. Mammalian Species 163: 1-5. doi: 10.2307/3504013.

Timpone, J. C., J. Boyles, K. Murray, D. P. Aubrey, and L. W. Robbins. 2010. Overlap in Roosting Habitats of Indiana Bat (*Myotis sodalis*) and Northern Bats (*Myotis septentrionalis*). American Midland Naturalist 163: 115-123.

Trombulak, S. C., P. E. Higuera, and M. DesMeules. 2001. Population Trends of Wintering Bats in Vermont. Northeastern Naturalist 8: 51-62.

Turner, G. 2006. Bat Migratory Behaviors and Routes in Pennsylvania and Maryland. Proceedings of the National Wind Coordinating Collaborative (NWCC) Wildlife Workgroup Research Planning Meeting VI, San Antonio, Texas. November 14-15, 2006.

Turner, G. G., D. M. Reeder, and J. T. H. Coleman. 2011. A Five-Year Assessment of Mortality and Geographic Spread of White-Nose Syndrome in North American Bats and a Look to the Future. Bat Research News 52: 13-27.

US Department of Labor Bureau of Labor Statistics. 2018. US Inflation Calculator: Consumer Price Index Data from 1913 to 2018. Available online: https://www.usinflationcalculator.com/inflation/consumer-price-index-and-annual-percent-changes-from-1913-to-2008/

US Environmental Protection Agency (USEPA). 2017. Ecoregion Download Files by State - Region 6: Arkansas. Ecoregions of the United States, Ecosystems Research, USEPA. Last updated February 8, 2017. Information and maps online: https://www.epa.gov/eco-research/ecoregion-download-files-state-region-6#pane-03

US Fish and Wildlife Service (USFWS). 1967. The Endangered Species List - 1967. 32 Federal Register (FR) 48: 4001. March 11, 1967.

US Fish and Wildlife Service (USFWS). 1999. Agency Draft Indiana Bat (*Myotis sodalis*) Revised Recovery Plan. US Department of the Interior, Fish and Wildlife Service, Region 3. Fort Snelling, Minnesota.

US Fish and Wildlife Service (USFWS). 2007. Indiana Bat (*Myotis sodalis*) Draft Recovery Plan: First Revision. US Department of Interior, Fish and Wildlife Service, Region 3. USFWS. Fort Snelling, Minnesota. 260 pp. Available online: http://ecos.fws.gov/docs/recovery_plan/070416.pdf

US Fish and Wildlife Service (USFWS). 2009. Indiana Bat (*Myotis sodalis*) 5-Year Review: Summary and Evaluation. USFWS, Midwest Region, Region 3, Bloomington Ecological Field Office, Bloomington, Indiana. September 2009.

US Fish and Wildlife Service (USFWS). 2010. 2009 Rangewide Population Estimate for the Indiana Bat (*Myotis sodalis*) by USFWS Region. USFWS Endangered Species Program: Midwest Region. April 2010.

US Fish and Wildlife Service (USFWS). 2011a. Indiana Bat Section 7 and Section 10 Guidance for Wind Energy Projects. Revised October 26, 2011. Available online: http://www.fws.gov/midwest/endangered/mammals/inba/pdf/inbaS7and10WindGuidanceFinal26Oct2011.pdf

US Fish and Wildlife Service (USFWS). 2011b. Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition to List the Eastern Small-Footed Bat and the Northern Long-Eared Bat as Threatened or Endangered. 76 Federal Register (FR) 125: 38095-38106, 50 Code of Federal Regulations (CFR) 17. June 29, 2011.

US Fish and Wildlife Service (USFWS). 2012a. Land-Based Wind Energy Guidelines. March 23, 2012. 82 pp. Available online: http://www.fws.gov/cno/pdf/Energy/2012_Wind_Energy_Guidelines_final.pdf

US Fish and Wildlife Service (USFWS). 2012b. North American Bat Death Toll Exceeds 5.5 Million from White-Nose Syndrome. USFWS News Release, USFWS Office of Communications, Arlington, Virginia. January 17, 2012.

US Fish and Wildlife Service (USFWS). 2013a. Endangered and Threatened Wildlife and Plants; 12- Month Finding on a Petition to List the Eastern Small-Footed Bat and the Northern Long-Eared Bat as Endangered or Threatened Species; Listing the Northern Long-Eared Bat as an Endangered Species. Docket No. FWS-R5-ES-2011-0024. 78 Federal Register (FR) 191: 61046- 61080. October 2, 2013.

US Fish and Wildlife Service (USFWS). 2013b. 2013 Rangewide Population Estimate for the Indiana Bat (*Myotis sodalis*) by USFWS Region. USFWS Endangered Species Program: Midwest Region. Compiled by A. King, Ecological Services Field Office, USFWS, Bloomington, Indiana. Revised August 26, 2013. Available online: http://pbadupws.nrc.gov/docs/ML1428/ML14286A006.pdf

US Fish and Wildlife Service (USFWS). 2014a. Northern Long-Eared Bat Interim Conference and Planning Guidance. USFWS Regions 2, 3, 4, 5, and 6. January 6, 2014. Available online: http://www.fws.gov/northeast/virginiafield/pdf/NLEBinterimGuidance6Jan2014.pdf

US Fish and Wildlife Service (USFWS). 2014b. Northern Long-Eared Bat: Range Map. Midwest Region, Endangered Species, USFWS. Last updated July 16, 2014.

US Fish and Wildlife Service (USFWS). 2015a. Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Northern Long-Eared Bat with 4(d) Rule; Final Rule and Interim Rule. Department of the Interior, Fish and Wildlife Service, 50 CFR Part 17. 80 Federal Register (FR) 63: 17974-18033. April 2, 2015.

US Fish and Wildlife Service (USFWS). 2015b. White-Nose Syndrome: The Devastating Disease of Hibernating Bats in North America. July 2015. Available online: https://www.fws.gov/mountain-prairie/pressrel/2015/WNS%20Fact%20Sheet%20Updated%2007012015.pdfUSFWS. 2015i?. Northern long-eared bat post-construction monitoring data. USFWS Columbus, Ohio, Ecological Services Field Office.

US Fish and Wildlife Service (USFWS). 2016. Programmatic Biological Opinion on Final 4(d) Rule for Northern Long-Eared Bat and Activities Excepted from Take Prohibitions. USFWS Regions 2, 3, 4, 5, and 6. Prepared by USFWS, Midwest Regional Office, Bloomington, Minnesota. January 5, 2016. Available online: https://www.fws.gov/Midwest/endangered/mammals/nleb/pdf/BOnlebFinal4d.pdf

US Fish and Wildlife Service (USFWS). 2016b. Midwest Regional Wind HCP -- Guidelines for Non-REA Staging/Swarming Mitigation Option 2016. December 1, 2016.

US Fish and Wildlife Service (USFWS). 2017. Range-wide Indiana Bat Survey Guidelines. USFWS Ecological Services, Midwest Region. May 9, 2017. Available online: https://www.fws.gov/midwest/endangered/mammals/inba/surveys/pdf/2017INBASummerSurveyGuidelines9May2017.pdf

US Fish and Wildlife Service (USFWS). 2018a. 2017 Rangewide Population Estimate for the Indiana Bat (*Myotis sodalis*) by USFWS Region. USFWS Endangered Species Program: Midwest Region. Revised November 13, 2018. Available online: https://www.fws.gov/midwest/Endangered/mammals/inba/pdf/2017_Population_Stats_Indiana_Bat_Revised_%2013Nov2018.pdf https://www.fws.gov/midwest/endangered/ mammals/inba/pdf/2017IBatPopEstimate5July2017.pdf

US Fish and Wildlife Service (USFWS). 2019a. 2019 Indiana Bat (*Myotis sodalis*) Population Status Update. USFWS Endangered Species Program: Midwest Region. Revised June 27, 2019. Available online: https://www.fws.gov/midwest/endangered/mammals/inba/pdf/2019_IBat_Pop_Estimate_6_27_2019a.pdf

US Fish and Wildlife Service (USFWS). 2019b. Range-wide Indiana Bat Survey Guidelines. USFWS Ecological Services, Midwest Region. April 2019. Available online: https://www.fws.gov/midwest/endangered/mammals/inba/surveys/pdf/2019_Rangewide_IBat_Survey_Guidelines.pdf

US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2016. Habitat Conservation Planning and Incidental Take Permit Processing Handbook. December 21, 2016. Updated January 18, 2018. Available online: https://www.fws.gov/endangered/what-we-do/hcp_handbook-chapters.html

US Geological Survey (USGS). 2009. Investigating White Nose Syndrome in Bats: Fact Sheet 2009- 3058. July 2009. Available online: http://pubs.usgs.gov/fs/2009/3058/pdf/fs2009-3058.pdf

US Geological Survey (USGS) National Land Cover Database (NLCD). 2011. National Land Cover Database 2011 (NLCD 2011). Multi-Resolution Land Characteristics Consortium (MRLC), National Land Cover Database (NLCD). USGS Earth Resources Observation and Science (EROS) Center, Sioux Falls, South Dakota. Information online: http://www.mrlc.gov/nlcd2011.php; Legend: http://www.mrlc.gov/ nlcd11_leg.php

Vaughan, N., G. Jones, and S. Harris. 1997. Habitat Use by Bats (Chiroptera) Assessed by Means of a Broad-Band Acoustic Method. Journal of Applied Ecology 34(3): 716-730.

Watrous, K. S., T. M. Donovan, R. M. Mickey, S. R. Darling, A. C. Hicks, and S.L. von Oettingen. 2006. Predicting Minimum Habitat Characteristics for the Indiana Bat in the Champlain Valley. Journal of Wildlife Management 70(5): 1228-1237.

Whitaker, J. O., Jr. and V. Brack. 2002. Distribution and Summer Ecology in Indiana. Pp. 48-54. *In*: A. Kurta and J. Kennedy, eds. The Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International (BCI), Austin, Texas.

Whitaker, J. O. Jr. and W. J. Hamilton. 1998. Mammals of the Eastern United States. Cornell University Press, Ithaca, New York. 583 pp.

Whitaker, J. O., Jr. and R. E. Mumford, eds. 2009. *Myotis septentrionalis* / Northern Myotis. *In:* Mammals of Indiana. Indiana University Press.

Whitaker, J. O., Jr. and L. J. Rissler. 1992. Winter Activity of Bats at a Mine Entrance in Vermillion County, Indiana. American Midland Naturalist 127: 52-59.

Whitaker, J. O., Jr. and F. A. Winter. 1977. Bats of the Caves and Mines of the Shawnee National Forest, Southern Illinois. Transactions of the Illinois Academy of Science 70: 301-313.

Whitaker, J.O., Jr., V. Brack, and J. B. Cope. 2002. Are Bats in Indiana Declining? Proceedings of the Indiana Academy of Science 1: 95-106.

Winhold, L. and A. Kurta. 2006. Aspects of Migration by the Endangered Indiana Bat, *Myotis sodalis*. Bat Research News 47(1): 1-6.

Young, D.P., Jr., W. P. Erickson, K. Bay, S. Nomani, and W. Tidhar. 2009. Mount Storm Wind Energy Facility, Phase 1 Post-Construction Avian and Bat Monitoring, July - October 2008. Prepared for NedPower Mount Storm, LLC, Houston, Texas. Prepared by Western EcoSystems Technology (WEST), Inc., Cheyenne, Wyoming. February 17, 2009.

Young, D.P., Jr., C. Nations, M. Lout, and K. Bay. 2013. 2012 Post-Construction Monitoring Study, Criterion Wind Project, Garrett County, Maryland. April - November 2012. Prepared for Criterion Power Partners, LLC, Oakland, Maryland. Prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Waterbury, Vermont. January 15, 2013.

9.2 Laws, Acts, and Regulations Cited

16 United States Code (USC) 1531. 1973. Title 16 - Conservation; Chapter 35 - Endangered Species; Section (§) 1531 - Congressional Findings and Declaration of Purposes and Policy. 16 USC 1531. (Public Law [Pub. L.] 93–205, § 2, December 28, 1973, 87 Statute [Stat.] 884; Pub. L. 96-159, § 1, December 28, 1979, 93 Stat. 1225; Pub. L. 97–304, § 9(a), October 13, 1982, 96 Stat. 1426; Pub. L. 100–478, title I, § 1013(a), October 7, 1988, 102 Stat. 2315). Available online at: https://www.gpo.gov/fdsys/pkg/USCODE-2012-title16/html/USCODE-2012-title16-chap35-sec1531.htm

16 United States Code (USC) 1532. 1973. Title 16 - Conservation; Chapter 35 - Endangered Species; Section (§) 1532 - Definitions. 16 USC 1532. (Public Law [Pub. L.] 93–205, § 3, December 28, 1973, 87 Statute [Stat.] 885; Pub. L. 94–359, § 5, July 12, 1976, 90 Stat. 913; Pub. L. 95–632, § 2, November 10, 1978, 92 Stat. 3751; Pub. L. 96–159, § 2, December 28, 1979, 93 Stat. 1225; Pub. L. 97–304, § 4(b), October 13, 1982, 96 Stat. 1420; Pub. L. 100–478, Title I, § 1001, October 7, 1988, 102 Stat. 2306). Available online at: https://www.gpo.gov/fdsys/pkg/USCODE- 2011-title16/pdf/USCODE-2011-title16-chap35-sec1532.pdf

16 United States Code (USC) 1536. 1973. Title 16 - Conservation; Chapter 35 - Endangered Species; Section (§) 1536 - Interagency Cooperation. 16 USC 1536. (Public Law [Pub. L.] 93–205, § 7, December 28, 1973, 87 Statute [Stat.] 892; Pub. L. 95–632, § 3, November 10, 1978, 92 Stat. 3752; Pub. L. 96–159, § 4, December 28, 1979, 93 Stat. 1226; Pub. L. 97–304, §§ 4(a), 8(b), October 13, 1982, 96 Stat. 1417, 1426; Pub. L. 99–659, Title IV, § 411(b), (c), November 14, 1986, 100 Stat. 3741, 3742; Pub. L. 100–707, Title I, § 109(g), November 23, 1988, 102 Stat. 4709). Available online at: https://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE- 2011-title16-chap35-sec1536.pdf

16 United States Code (USC) 1538. 1973. Title 16 - Conservation; Chapter 35 - Endangered Species; Section (§) 1538 - Prohibited Acts. 16 USC 1538. (Public Law [Pub. L.] 93–205, § 9, December 28, 1973, 87 Statute [Stat.] 893; Pub. L. 95–632, § 4, November 10, 1978, 92 Stat. 3760; Pub. L. 97–304, § 9(b), October 13, 1982, 96 Stat. 1426; Pub. L. 100–478, Title I, § 1006, Title II, § 2301, October 7, 1988, 102 Stat. 2308, 2321; Pub. L. 100–653, Title IX, § 905, November 14, 1988, 102 Stat. 3835). Available online at: https://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap35-sec1538.pdf

16 United States Code (USC) 1539. 1973. Title 16 - Conservation; Chapter 35 - Endangered Species; Section (§) 1539 - Exceptions. 16 USC 1539. (Public Law [Pub. L.] 93–205, § 10, December 28, 1973, 87 Statute [Stat.] 896; Pub. L. 94–359, §§ 2, 3, July 12, 1976, 90 Stat. 911, 912; Pub. L. 95–632, § 5, November 10, 1978, 92 Stat. 3760; Pub. L. 96–159, § 7, December 28, 1979, 93 Stat. 1230; Pub. L. 97–304, § 6(1)–(4)(A), (5), (6), October 13, 1982, 96 Stat. 1422–1424; Pub. L. 100–478, Title I, §§ 1011, 1013 (b), (c), October 7, 1988, 102 Stat. 2314, 2315). Available online at: https://www.gpo.gov/fdsys/pkg/USCODE-2011-title16/pdf/USCODE-2011-title16-chap35-sec1539.pdf

16 United States Code (USC) §§ 1531-1599. 1973. Title 16 - Conservation; Chapter 35 - Endangered Species; Sections (§§) 1531-1599. Endanged Species Act. 16 USC 1531-1599. P.L. 93-205, 84 Stat. 884 (codified as amended).

42 United States Code (USC) §§ 4321-4370h. 1970. Title 42 - the Public Health and Welfare; Chapter 55 - National Environmental Policy; Subchapters I (Policies and Goals) and II (Council on Environmental Quality); Sections (§§) 4321-4370h; National Environmental Policy Act. 42 USC 4321-4370h. [Pub. L. 91–190, § 2, Jan. 1, 1970, 83 Stat. 852.].

50 Code of Federal Regulations (CFR) 13.22. 1989. Title 50 - Wildlife and Fisheries; Chapter I - United States Fish and Wildlife Service, Department of the Interior; Subchapter B - Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants; Part 13 - General Permit Procedures; Subpart C - Permit Administration; § 13.22 - Renewal of Permits. 50 CFR 13.22. 54 FR 38148, Sept. 14, 1989, as amended at 72 FR 48446, Aug. 23, 2007.

50 Code of Federal Regulations (CFR) 13.23. 1989. Title 50 - Wildlife and Fisheries; Chapter I - United States Fish and Wildlife Service, Department of the Interior; Subchapter B - Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants; Part 13 - General Permit Procedures; Subpart C - Permit Administration; § 13.23 - Amendment of Permits. 50 CFR 13.23. 54 FR 38148, Sept. 14, 1989, as amended at 64 FR 32711, June 17, 1999.

50 Code of Federal Regulations (CFR) 17.3. 1978. Title 50 - Wildlife and Fisheries; Chapter I - United States Fish and Wildlife Service, Department of the Interior; Subchapter B - Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants; Part 17 - Endangered and Threatened Wildlife and Plants; Subpart a - Introduction and General Provisions; Section (§)17.3. Definitions. [40 FR 44415, Sept. 26, 1975, as amended at 42 FR 28056, June 1, 1977; 44 FR 54006, Sept. 17, 1979; 46 FR 54750, Nov. 4, 1981; 47 FR 31387, July 20, 1982; 50 FR 39687, Sept. 30, 1985; 63 FR 8870, Feb. 23, 1998; 63 FR 48639, Sept. 11, 1998; 69 FR 24092, May 3, 2004; 71 FR 46870, Aug. 15, 2006].

50 Code of Federal Regulations (CFR) 17.22. 1985. Title 50 - Wildlife and Fisheries; Chapter I -United States Fish and Wildlife Service, Department of the Interior; Subchapter B - Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants; Part 17 -Endangered and Threatened Wildlife and Plants; Subpart C - Endangered Wildlife; Section (§) 17.22 - Permits for Scientific Purposes, Enhancement of Propagation or Survival, or for Incidental Taking. 50 CFR 17.22. [50 Federal Register (FR) 39687, September 30, 1985, as amended at 63 FR 8871, February 23, 1998; 63 FR 52635, October 1, 1998; 64 FR 32711, June 17, 1999; 64 FR 52676, September 30, 1999; 69 FR 24092, May 3, 2004; 69 FR 29670, May 25, 2004; 69 FR 71731, December 10, 2004].

50 Code of Federal Regulations (CFR) 17.31. 1978. Title 50 - Wildlife and Fisheries; Chapter I - United States Fish and Wildlife Service, Department of the Interior; Subchapter B - Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants; Part 17 - Endangered and Threatened Wildlife and Plants; Subpart D - Threatened Wildlife; Section (§) 17.31. Prohibitions. 50 CFR 17.31. [43 Federal Register (FR) 18181, April 28, 1978, as amended at 44 FR 31580, May 31, 1979; 70 FR 10503, March 4, 2005].

50 Code of Federal Regulations (CFR) 17.32. 1985. Title 50 - Wildlife and Fisheries; Chapter I -United States Fish and Wildlife Service, Department of the Interior; Subchapter B - Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants; Part 17 - Endangered and Threatened Wildlife and Plants; Subpart D - Threatened Wildlife; Section (§) 17.32 - Permits-General. 50 CFR 17.32. [50 Federal Register (FR) 39689, September 30, 1985, as amended at 63 FR 8871, February 23, 1998; 63 FR 52635, October 1, 1998; 64 FR 32714, June 17, 1999; 64 FR 52676, September 30, 1999; 69 FR 24093, May 3, 2004; 69 FR 29670, May 25, 2004; 69 FR 71731, December 10, 2004].

50 Code of Federal Regulations (CFR) 222.305. Title 50 - Wildlife and Fisheries; Chapter II - National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce; Subchapter C - Marine Mammals; Part 222 - General Endangered and Threatened Marine Species; Subpart C - General Permit Procedures; § 222.305 - Rights of Succession and Transfer of Permits. 50 CFR 222.305. [64 FR 14054, March 23, 1999, as amended at 67 FR 57973, September 13, 2002]. Available online at: https://www.gpo.gov/fdsys/pkg/CFR-2011- title50-vol9/xml/CFR-2011-title50-vol9-sec222-305.xml

50 Code of Federal Regulations (CFR) 402.02. 1986. Title 50 - Wildlife and Fisheries; Chapter IV- Joint Regulations (United States Fish and Wildlife Service, Department of the Interior and National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Department of Commerce); Endangered Species Committee Regulations; Subchapter a; Part 402 - Interagency Cooperation-Endangered Species Act of 1973, as Amended; Subpart a - General; Section (§) 402.02 - Definitions. 50 CFR 402.02; 51 Federal Register (FR) 19957, June 3, 1986, as amended 73 FR 76286, December 16, 2008, 74 FR 20422, May 4, 2009.

50 Code of Federal Regulations (CFR) § 13.25. 1999. Title 50 - Wildlife and Fisheries; Chapter I - United States Fish and Wildlife Service, Department of the Interior; Subchapter B Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants; Part 13 - General Permit Procedures; Subpart C - Permit Administration; Section (§) 13.25 - Transfer of Permits and Scope of Permit Authorization. 50 CFR 13.25. [64 Federal Register (FR) 32711, June 17, 1999, as amended at 64 FR 52676, September 30, 1999; 69 FR 24092, May 3, 2004; 78 FR 73725, December 9, 2013].

63 Federal Register (FR) 35: 8859-8873. 1998. Habitat Conservation Plan Assurances (''No Surprises'') Rule. Final Rule. 50 CFR 17. Department of the Interior Fish and W ildlife Service. 50 CFR 222. Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service. 63 FR 8859. February 23, 1998. Available online at: https://www.fws.gov/Endangered/esa-library/pdf/f980223.pdf

80 Federal Register (FR) 63: 17974-18033. 2015. 50 CFR 17. Endangered and Threatened Wildlife and Plants; Threatened Species Status for the Northern Long-Eared Bat with 4(d) Rule. Final rule, and interim rule with request for comments. Department of the Interior Fish and Wildlife Service. 80 FR 17974. April 2, 2015. Available online at: http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/FRnlebFinalListing02April2015.pdf

81 Federal Register (FR) 9: 1900-1922. 2016. 50 CFR 17. Endangered and Threatened Wildlife and Plants; 4(d) Rule for the Northern Long-Eared Bat. Final Rule. Department of the Interior Fish and Wildlife Service. 81 FR 1900. January 14, 2016. Available online at: http://www.fws.gov/Midwest/endangered/mammals/nleb/pdf/FRnlebFinal4dRule14Jan2016.pdf

Endangered Species Act (ESA). 1973. 16 United States Code (USC) §§ 1531-1544, Public Law (PL) 93-205, December 28, 1973, as amended, PL 100-478 [16 USC 1531 *et seq.*]; 50 Code of Federal Regulations (CFR) 402.

Endangered Species Act (ESA) § 2. 1973. Section 2 - Findings, Purposes, and Policy. [As amended by Public Law (P.L.) 94-325, June 30, 1976; P.L. 94-359, July 12, 1976; P.L. 95-212, December 19, 1977; P.L. 95-632, November 10, 1978; P.L. 96-159, December 28, 1979; P.L. 97-304, October 13, 1982; P.L. 98-327, June 25, 1984; and P.L. 100-478, October 7, 1988; P.L. 107-171, May 13, 2002; P.L. 108-136, November 24, 2003].

Endangered Species Act (ESA) § 3. 1973. Section 3 - Definitions. [As amended by P.L. 94-325, June 30, 1976; P.L. 94-359, July 12, 1976; P.L. 95-212, December 19, 1977; P.L. 95-632, November 10, 1978; P.L. 96-159, December 28, 1979; P.L. 97-304, October 13, 1982; P.L. 98-327, June 25, 1984; and P.L. 100-478, October 7, 1988; P.L. 107-171, May 13, 2002; P.L. 108-136, November 24, 2003.].

Endangered Species Act (ESA) § 7. 1973. Section 7 - Interagency Cooperation. [As amended by P.L. 94-325, June 30, 1976; P.L. 94-359, July 12, 1976; P.L. 95-212, December 19, 1977; P.L. 95-632, November 10, 1978; P.L. 96-159, December 28, 1979; P.L. 97-304, October 13, 1982; P.L. 98-327, June 25, 1984; and P.L. 100-478, October 7, 1988; P.L. 107-171, May 13, 2002; P.L. 108-136, November 24, 2003.].

Endangered Species Act (ESA) § 9. 1973. Section 9 - Prohibited Acts. [As amended by P.L. 94-325, June 30, 1976; P.L. 94-359, July 12, 1976; P.L. 95-212, December 19, 1977; P.L. 95-632, November 10, 1978; P.L. 96-159, December 28, 1979; P.L. 97-304, October 13, 1982; P.L. 98-327, June 25, 1984; and P.L. 100-478, October 7, 1988; P.L. 107-171, May 13, 2002; P.L. 108-136, November 24, 2003.].

Endangered Species Act (ESA) § 10. 1973. Section 10 - Exceptions. [As amended by P.L. 94-325, June 30, 1976; P.L. 94-359, July 12, 1976; P.L. 95-212, December 19, 1977; P.L. 95-632, November 10, 1978; P.L. 96-159, December 28, 1979; P.L. 97-304, October 13, 1982; P.L. 98-327, June 25, 1984; and P.L. 100-478, October 7, 1988; P.L. 107-171, May 13, 2002; P.L. 108-136, November 24, 2003.].

Endangered Species Preservation Act (ESPA). 1966. Public Law (PL) 89-669, Statute 926. October 15, 1966.

National Environmental Policy Act (NEPA). 1970. 42 United States Code (USC) 4321-4370h. Public Law 91-190, § 2, January 1, 1970, 83 Statute 852.

National Historic Preservation Act (NHPA). 1966. 16 United States Code §§ 470 Et Seq. October 15, 1966.

Appendix A. Predicting Take Using a Species Composition Approach

Appendix A. Predicting Take Using a Species Composition Approach with Data from the Fowler Ridge Habitat Conservation Plan

INTRODUCTION

As part of any Habitat Conservation Plan (HCP), an applicant must predict the take that may result from the Covered Activities. This prediction is then used to determine the requested amount of take. Here, the species composition method was used to obtain estimates and associated variances of bat fatalities. In HCPs, the species composition method is helpful in predicting fatalities where records informing take of Covered Species are sparse. This approach was first used to predict take of bats from a wind energy facility in the Fowler Ridge Wind Farm Indiana Bat HCP (Fowler Ridge LLC 2013). For a given rare species, the method combines an estimate of all-bat (all species) fatalities with an estimate of the proportion of the rare species among all bat fatalities to yield an estimate of the expected number of fatalities for the rare species. The analysis used to estimate the all-bat fatality and species proportions using data from the Fowler Ridge HCP is detailed below; this data is then used in the species composition approach to take prediction at the Bitter Ridge Project, as described in Section 4.1 of the HCP.

ANALYSIS

All-Bat Fatality

For details on how the all-bat fatality estimates were calculated for each year of post-construction monitoring studies at the Fowler Ridge Project, see Appendix A of the Fowler Ridge HCP (Fowler Ridge LLC 2013). As described in Section 4.1.2 of this HCP, the fall estimate for all-bat fatality per turbine at the Bitter Ridge Project is assumed to be the same estimate used in the Fowler Ridge HCP. The Fowler Ridge HCP states that "because the data collection methods and sampling intensity in 2010 and 2011 were most appropriate for developing a robust estimate of mortality, annual mortality was based on cleared plot searches at control turbines in 2010 and 2011, and 2009 results were not included. All-bat mortality in 2010 and 2011 was estimated using the number of fatalities that were found during searches at cleared plots, and by adjusting this number to account for bat fatalities that occurred in unsearched areas in 2010." As further noted in Section 4.1.2 of this HCP, the spring and summer all-bat fatality estimates used for the Bitter Ridge take prediction come from 2011 monitoring data at Fowler Ridge because that is the most recent year of data that covered a full bat activity season (no monitoring occurred in the summer in 2010) and when the turbines were operating without curtailment or feathering.

The all-bat fatality estimates per turbine by season at the Fowler Ridge Project are presented in the Table A1, below. The measure of variability provided in the Fowler Ridge HCP is a 90% confidence interval. An estimate of the variance of the all-bat fatality estimate can be derived from that confidence interval. If F_a be the estimated number of bat fatalities per turbine and L and U be the bounds of a $1-\delta$ confidence interval, the variance can be derived as:

$$V_F = (max((U - F_a)/z, (F_a - L)/z))^2$$

where z is the $1 - \delta/2$ quantile from the standard normal distribution. This approach assumes that errors are normally distributed. Calculating the maximum of the two half intervals is intended to be conservative, leading to a relatively large estimate of the variance, because confidence limits on fatality estimates are generally asymmetric, having been calculated from bootstrap procedures.

Species Proportions

The species proportion is conceptually the ratio of the carcasses of bat species of interest to all bat carcasses detected at a site. The straight ratio (carcass count of species of interest to all bat carcass counts) has the potential for a bias. If the carcass count of the species of interest is zero, the ratio will be zero, which is biased low and is not useable as a proportion for getting a predicted take amount. It is also desirable to obtain a measure of variability (or variance) for the species proportion, as a measure of the degree of uncertainty associated with the proportion, which will be incorporated into the final take prediction. To overcome the potential problem of bias and to get an estimate of the variance for the species proportion, a Bayesian method (Gelman et al. 2004) is used. The Bayesian method is a way to produce a point estimate and a variance, for the species proportion, from data (carcass counts) while incorporating additional information. The additional information comes in the form of a prior distribution. In this particular case, the additional information is that the species proportion is greater than zero and detailed below. Species proportions were calculated using the data in Table A2, and relied on a beta-binomial Bayesian model (Gelman et al. 2004). Let x be the carcass count for a bat species of interest and let n be the total carcass count for all bat species. Let

$$x \sim Binomial(n, p)$$

and

$$p \sim Beta(\alpha, \beta)$$

where p is the species proportion, n is the total count of carcasses for all species, and α and β are the parameters of the Beta distribution. The Beta distribution is the prior distribution and is the source of the additional information. The posterior distribution of p, given the other parameters, is:

$$\pi(p|n, \alpha, \beta) \sim Beta(x + \alpha, n - x + \beta)$$

and the mean and variance of the species proportion are:

$$\hat{p} = \frac{x + \alpha}{n + \alpha + \beta}$$

$$V_p = \frac{(x + \alpha)(n - x + \beta)}{((x + \alpha) + (n - x + \beta))^2((x + \alpha) + (n - x + \beta) + 1)}$$

Specifying α = β = 1 is equivalent to an uninformative prior, indicating no prior (or additional) information about the proportion (that is, all proportions in the range 0 – 1 are equally likely; Figure

A1a). A distribution with $\alpha = \beta = 0.5$ is weakly informative (little additional information), indicating that the proportion is more likely to be either very small (close to 0) or very large (close to 1) and unlikely to be intermediate (close to 0.5; Figure A1b). Given that the proportion of each Covered Species is likely to be very small (because the species is rare), the choice of $\alpha = \beta = 0.5$ (the weakly informative prior shown in Figure A1b), was used. In addition to incorporating prior belief about the species proportion, the beta-binomial Bayesian method allows estimation of the proportion and variance even when there are no observations of the rare species (i.e., when $x = 0$).

Using the equations above and the data from Table A2, the estimated species ratios with variances were calculated (Table A3).

Fatality Estimates for Individual Species

The fatality estimate for each of the species of interest (F_s) was calculated by combining the all-bat fatality estimate (F_a) with the species proportion estimate ($\hat{p}$).

$$F_s = \hat{p}\, F_a$$

The variance of F_s involves the product of two independent random variables (F_a and $\hat{p}$). Using the properties of variances and expectations (Casella and Berger 2002) the variance for the product of two independent random variables is:

$$V_s = V_a V_p + \hat{p}^2\, V_a + F_a^2 V_p$$

The species composition fatality estimates are presented in Table A4 by species and season. Each estimate is on a per-turbine scale. This means that the estimate can be scaled by the number of turbines at the project that are assumed to have risk in that season, and then fatality estimates can be summed across seasons.

Take Predictions

Using the all-bat per/turbine fatality estimates (Table A1) and species proportions (Table A4) described above, median take predictions in the absence of any minimization measures at Bitter Ridge were generated, along with confidence intervals. The estimated fatalities per turbine and the variance (Table A4) were used as parameters of a normal distribution to obtain confidence intervals. The use of the normal distribution allows take predictions to be based on the median or the upper bound of a confidence interval. To provide more certainty that the requested take amount will not be exceeded during the permit term an upper bound of a confidence interval is used as the requested take amount. These are shown in Table A5 below, and in Table 4.7 in Section 4.1.3 in this HCP, and result in an annual median fatality estimate for the Bitter Ridge Project of 2.77 Indiana bats and 1.56 northern long-eared bats per year. Based on the upper bound of the 80% confidence interval, the cumulative predicted take over the 35-year permit term is 171 Indiana bats (4.88 bats per year x 35 years = 171 northern long-eared bats) and 112 northern long-eared bats (3.19 bats per year x 35 years = 112 northern long-eared bats) in the absence of minimization measures.

TABLES AND FIGURES

Table A1. All-bat fatality estimates per turbine by season with 90% confidence bounds, as reported in the Fowler Ridge HCP. The variance was calculated here for incorporation into the take predictions for the Bitter Ridge Project.

Season	Fatality Estimate	Lower Bound	Upper Bound	Estimated Variance
Spring	0.66	0.32	1.17	0.096
Summer	2.90	1.57	4.22	0.656
Fall	30.17	24.60	37.13	17.905

Table A2. Carcass counts from post-construction monitoring surveys at the Fowler Ridge Wind Farm 2009-2011, as reported in the HCP.

Year	Indiana bat	Northern long-eared bat	Little brown bat	Tri-colored bat	Total bat carcasses of all species
2009	1	1	3	0	156
2010	1	0	2	3	809
2011	0	0	2	3	573
Total	2	1	7	6	1,538

Table A3. Estimated species proportions and their associated variances. These were calculated for the purpose of the Bitter Ridge HCP with data from Table A2 using a Bayesian approach.

Species	Estimated species proportion	Variance
Indiana bat	0.0016244	1.1e-06
Northern long-eared bat	0.0009747	6.0e-07

Table A4. Species composition estimates with variance by season and species. These estimates were used to generate the take predictions found in Chapter 4 of the Bitter Ridge HCP.

Species	Season	Estimated fatalities per turbine	Variance
Indiana bat	spring	0.0010721	0.0000006
	summer	0.0047109	0.0000112
	fall	0.0490091	0.0010009
Northern long-eared bat	spring	0.0006433	0.0000003
	summer	0.0028265	0.0000063
	fall	0.0294055	0.0005937

Table A5. Take predictions at the Bitter Ridge Project for the Covered Species in the absence of minimization measures.

Species	Predicted fatalities per year (80% confidence interval)	Predicted fatalities per 35 years (80% confidence interval)
Indiana bat	2.77 (0.65 – 4.88)	96.92 (22.92 – 170.92)
Northern long-eared bat	1.56 (0 – 3.19)	54.69 (0 – 111.54)

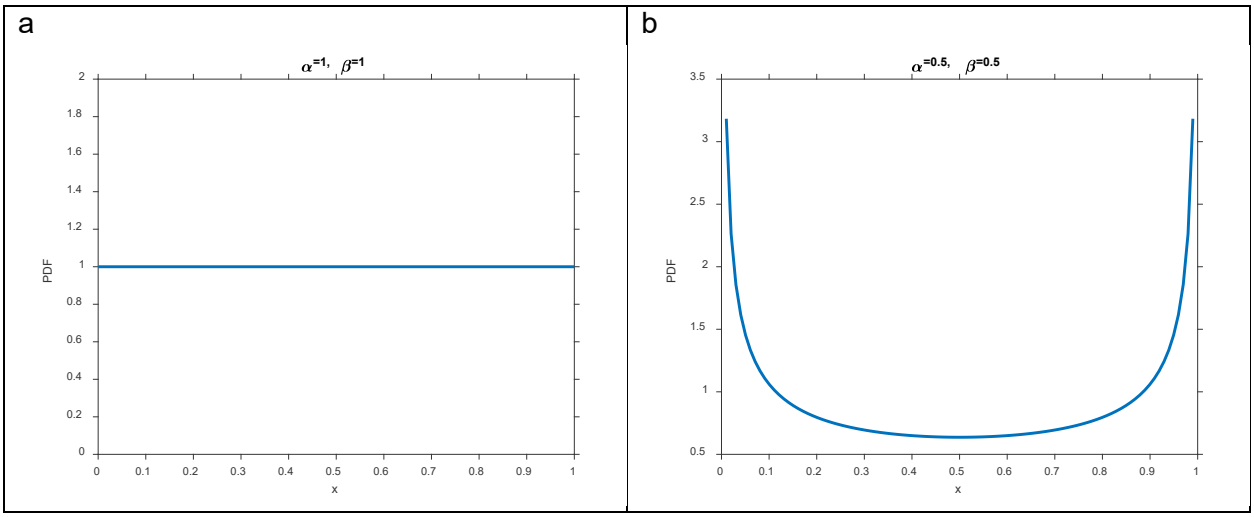

Figure A1. Beta distributions (a) with α = β = 1, an uninformed prior, and (b) $\alpha = \beta = 0.5$, a weakly informed prior.

REFERENCES

Casella, G. and R. L. Berger. 2002. Statistical Inference. Volume 2. Duxbury, Pacific Grove, California.

Fowler Ridge Wind Farm I-IV, LLC. 2013. Fowler Ridge Wind Farm, Benton County, Indiana. Indiana Bat Habitat Conservation Plan. Prepared by Fowler Ridge Wind Farm I-IV, LLC, in consultation with Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming and Bloomington, Indiana. November 2013. Available online: https://www.fws.gov/midwest/endangered/permits/hcp/FowlerRidge/pdf/FowlerRidgeWindFarmFinalHCP120913.pdf

Gelman, A., Carlin, J. B., Stern, H. S., and D. B. Rubin. 2004. Bayesian Data Analysis. Second Edition. Chapman and Hall/CRC.

Appendix B. Bat Habitat Mitigation Plan

[*see supplemental attachment*]