Biological Opinion for the MidAmerican Energy Company Incidental Take Permit and Habitat Conservation Plan

MidAmerican Energy Company
Wind Energy Facility Portfolio
Iowa

U.S. Fish and Wildlife Service
Iowa – Illinois Field Office
1511 47th Avenue
Moline, IL 61265

Kraig McPeek | Date
Field Supervisor
Illinois-Iowa Field Office

November 7, 2019

SUMMARY

This document transmits the biological opinion of the U.S. Fish and Wildlife Service (Service) prepared under the authority of and in accordance with Section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). This opinion is based on information provided in the July 2015 Biological Evaluation prepared by the MidAmerican Energy Company (MEC), as amended, the December 2017 Bird and Bat Conservation Strategy for MidAmerican Energy Company Iowa Wind Energy Facilities, the April 2019 Final Habitat Conservation Plan for the MidAmerican Energy Company Iowa Wind Energy Project Portfolio (HCP), and other supporting documents, literature, study reports, and data sources, as cited herein.

This biological opinion evaluates the Service's issuance of an incidental take permit (pursuant to section 10 of the Act), as the issuance of this permit is considered a federal action requiring consultation under section 7 of the Act. It evaluates the potential effects to the Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), little brown bat (*Myotis lucifugus*), tricolored bat (*Perimyotis subflavus*), and bald eagle (*Haliaeetus leucocephalus*) that may occur as a result of issuing the incidental take permit and the associated implementation of the HCP. These species are referred to herein as "covered species." The purpose of formal section 7 consultation is to ensure that any action authorized, funded, or carried out by the Federal government is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat of the species. The little brown bat, tricolored bat, and bald eagle are not species listed under the ESA, but as covered species in the HCP, they are included in this biological opinion.

The Service has determined in this opinion that the issuance of the incidental take permit will not jeopardize the continued existence of the covered species but may result in take of these species. We further find that the authorization of incidental take for the bald eagle under this permit is compatible with the preservation of the species in the wild, as mandated by the Bald and Golden Eagle Protection Act (16 U.S. Code § 668a).

The western prairie fringed orchid (*Platanthera praeclara*), eastern prairie fringed orchid (*Platanthera leucophea*), prairie bush clover (*Lespedeza leptostachya*) and Mead's Milkweed (*Asclepias meadii*), are also listed as federally threatened for the project area, but this action is expected to have no effect on these species.

Consultation History

This section 7 analysis was triggered by the submission of the HCP in April, 2018, and its subsequent notice, along with the Draft Environmental Impact Statement (DEIS) in the Federal Register on August 31, 2018. The final drafts of the HCP and EIS were noticed in the Federal Register on September 20th, 2019.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1.0 PROPOSED ACTION

1.1 DESCRIPTION OF THE PROPOSED ACTION

The proposed federal action is the issuance of an Endangered Species Act (ESA) section 10(a)(1)(B) permit to MidAmerican Energy Company (MEC). MEC has prepared a habitat conservation plan (HCP) and is seeking incidental take authorization under section 10 of the Endangered Species Act for the Indiana bat, northern long-eared bat, little brown bat, tricolored bat, and bald eagle. The incidental taking is expected to be caused by the operation of 22 existing wind energy projects, also known as Wind I-X or "covered projects" in this document. Specifically, covered species may be killed by spinning blades during wind turbine operations. Full descriptions of the covered projects and their environmental settings can be found in Chapter 3.1 of the HCP. Operation of these projects will include several conservation measures for covered species, as described in Chapter 5 of the HCP and summarized in section 4.2, below.

The ESA regulations define the term "action" to mean all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas. 50 C.F.R. §402.02. The action being evaluated in this biological opinion is the authorization of incidental take under section 10 of the ESA for the operation of covered projects. The purpose of the operation of the covered projects is the generation of electricity, and therefore any take associated with the operation of the covered projects is incidental. The incidental take will be caused by the operation of the covered projects, and therefore the effect of the wind farms on the covered species would not occur but for the issuance of the permit.

1.2 ACTION AREA

Between 2004 and 2016, MEC installed 4,048.3 MW of wind generation capacity in Iowa under their Wind I-X projects. Table 1.3-1 lists each of the covered projects, their locations, and sizes. The action area includes the locations of the turbines in the covered projects and the mitigation areas.

Table 1.2-1. Summary of covered projects within MidAmerican Energy Company's (MEC) existing wind energy portfolio in the state of Iowa.

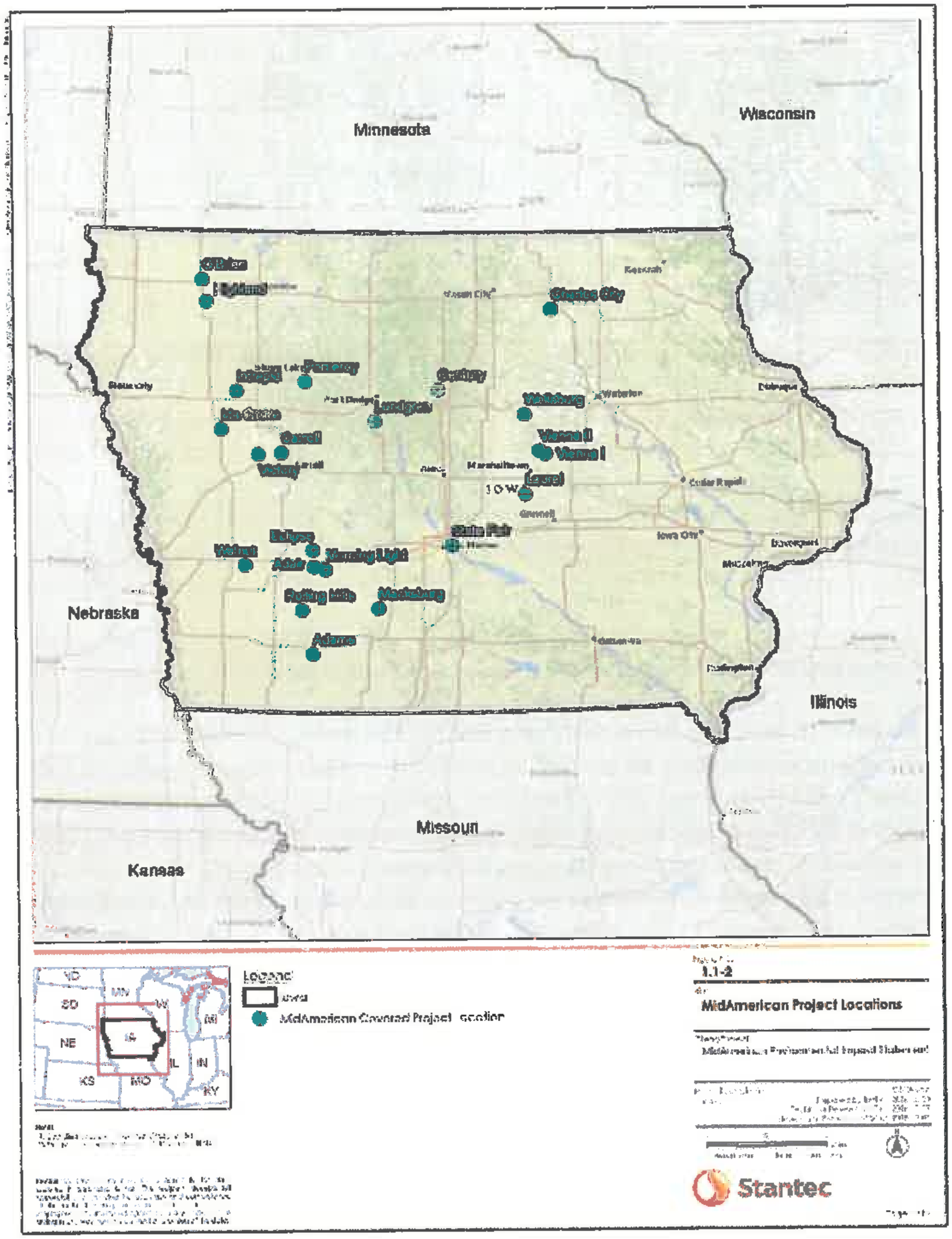
Facility	Year Constructed	Turbines	Turbine Size (MW)	Total Megawatts (MW)	Cut-in Speed[1] (m/s)
Adair	2008	76	2.3	174.8	4.0
Adams	2016	65	2.3/2.4	154.3	3.0
Carroll	2008	100	1.5	150.0	3.5
Century	2005, 2007	145	1.5/1.0	200.0	2.5-4.0
Charles City	2008	50	1.5	75.0	3.5
Eclipse	2012	87	2.3	200.1	3.0-4.0
Highland	2015	214	2.3	502.0	3.0

Facility	Year Constructed	Turbines	Turbine Size (MW)	Total Megawatts (MW)	Cut-in Speed[1] (m/s)
Ida Grove	2016	134	1.8/2.3	301.1	3.0-3.5
Intrepid	2004, 2005	122	1.5/1.0	175.5	2.5-4.0
Laurel	2011	52	2.3	119.6	3.0-4.0
Lundgren	2014	107	2.3	251.0	3.0
Macksburg	2014	51	2.3	119.6	3.0
Morning Light	2012	44	2.3	101.2	3.0-4.0
O'Brien	2016	104	2.3/2.4	250.3	3.0
Pomeroy	2007, 2008, 2011	184	1.5/2.3	286.4	3.0-4.0
Rolling Hills	2011	193	2.3	443.9	3.0-4.0
State Fair Turbine	2007	1	0.5	0.5	4.5
Victory	2006	66	1.5	99.0	3.5
Vienna I	2012	45	2.3	105.6	3.0
Vienna II	2013	19	2.3	44.6	3.0
Walnut	2008	102	1.5	153.0	3.5
Wellsburg	2014	60	2.3	140.8	4.0
Total	*n/a*	2,021	*n/a*	4,048.3	*n/a*

[1] Commercial operations of the 22 covered projects includes the operation of 2,021 turbines.

Each turbine is connected to, monitored by, and controlled by a Supervisory Control and Data Acquisition (SCADA) system to ensure operations are proceeding efficiently. Turbines begin generating power at their manufacturer's rated cut-in speed, and turbines stop rotating and producing power at their cut-out speed. Under normal operations, turbines may begin rotating at speeds less than their manufacturer's rated cut-in speed to enhance generator synchronization and to keep turbine components lubricated, warm, and ready. This rotation is minimized if the turbines are programmed to feather below the manufacturer's cut-in speed.

Figure 1.2-1. MidAmerican Project Locations



1.3 REGULATORY AND LEGAL FRAMEWORK

1.3.1 Federal Endangered Species Act (ESA)

The ESA is administered by the USFWS and National Marine Fisheries Service (NMFS). The purpose of the ESA is to provide a means whereby the ecosystems upon which threatened and endangered species depend may be conserved and to provide a program for the conservation of such threatened and endangered species. Section 9 of the ESA prohibits the unauthorized "take" of any fish or wildlife species listed under the ESA as endangered (16 U.S.C.§ 1538). Under Federal regulation, take of fish or wildlife species listed as threatened is also prohibited unless otherwise specifically authorized by regulation (50 C.F.R. 17.31). "Take", as defined by the ESA, means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S.C. § 1532(19)).

Under section 10 of the ESA, the Secretary of the Interior and Secretary of Commerce may, where appropriate, authorize the taking of federally-listed fish or wildlife if such taking occurs incidentally to otherwise legal activities. The Service is charged with regulating the incidental taking of listed species under its jurisdiction. The submission of the ESA section 10(a)(1)(B) permit application requires the development of an HCP designed to ensure the continued existence (i.e., the taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild), while allowing for any limited, incidental take of the species that might occur during the construction and operation of the project, or during mitigation activities. The implementing regulations for section 10(a)(1)(B) of the ESA, as provided in 50 C.F.R. 17.22, specify the requirements for obtaining a permit allowing the incidental take of listed species pursuant to otherwise lawful activities.

1.3.2 Bald and Golden Eagle Protection Act (BGEPA)

The Bald and Golden Eagle Protection Act of 1940 (BGEPA), 16 U.S.C. § 668, *et seq*., provides specific legal protection to bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) such that it is unlawful to take an eagle. In this statute the definition of "take" is to "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb" (16 U.S.C. 668c.). On September 11, 2009, the Service published a final rule (Eagle Permit Rule) under the BGEPA authorizing limited issuance of permits to take bald eagles and golden eagles ''for the protection of. . .other interests in any particular locality'' where the take is compatible with the preservation of the bald eagle and the golden eagle, is associated with and not the purpose of an otherwise lawful activity, and cannot practicably be avoided (74 FR 46836-46879). This rule was revised and finalized on December 16, 2016 (2016 Eagle Rule; 81 FR 91494-91554). On May 2, 2013, the Service announced the availability of the Eagle Conservation Plan Guidance: Module 1 – Land-based Wind Energy, Version 2[1] (ECPG, USFWS 2013; 78 FR 25758). The ECPG interprets and clarifies the permit requirements in the regulations at 50 CFR[2] 22.26 and 22.27, and it does not impose any binding requirements beyond those specified in the regulations.

[1] http://www.fws.gov/windenergy/PDF/Eagle%20Conservation%20Plan%20Guidance-Module%201.pdf
[2] Code of Federal Regulations (CFR)

1.4 STATUS OF FEDERAL PROTECTION OF COVERED SPECIES

1.4.1 Indiana Bat

The Indiana bat (*Myotis sodalis*) was listed as an endangered species via notice in the Federal Register on March 11, 1967 (32 Fed. Reg. 48) under the Endangered Species Preservation Act of October 15, 1966 (80 Stat. 926; 16 U. S. C. 668aa(c)). The reasons for listing the species are summarized in the 2007 Draft Recovery Plan and include destruction/degradation of hibernation habitat, loss/degradation of summer habitat, migration habitat, and swarming habitat, disturbance of hibernating bats, disturbance of summering bats, disease and parasites, predation, and various anthropogenic factors (USFWS 2007).

1.4.2 Northern Long-Eared Bat

The northern long-eared bat (*Myotis septentrionalis*) was proposed for listing as endangered on October 2, 2013, via a notice in the Federal Register (78 Fed. Reg. 191) and was formally listed as threatened on April 2, 2015. The primary reason for listing is the recent severe and ongoing decline of the species due to white-nose syndrome.

1.4.3 Little Brown Bat

The little brown bat (*Myotis lucifugus*) is not currently listed under the ESA. The Service has undertaken a discretionary status review of the species and expects to determine if listing of this species is warranted in fiscal year 2023 (National Listing Workplan, https://www.fws.gov/endangered/esa-library/pdf/Listing%207-Year%20Workplan%20Sept%202016.pdf, accessed 27 Feb, 2019).

1.4.4 Tricolored Bat

A petition to list the tricolored bat (*Perimyotis subflavus*) as threatened was received by the Service on June 16, 2016. On December 20, 2017, the Service found that the petition presented substantial scientific or commercial information indicating that the petitioned actions may be warranted. The Service commenced a review (known as a 12-month finding) to determine if listing of the tricolored bat is warranted 82 C. F. R. 60362 (December 20, 2017).

1.4.5 Bald Eagle

The bald eagle was removed from the federal list of threatened and endangered species on August 9, 2007, and is currently protected by the Bald and Golden Eagle Protection Act. 50 C.F.R. 22.11 states that "a permit that covers take of bald eagles or golden eagles under 50 CFR part 17 for purposes of providing prospective or current ESA authorization constitutes a valid permit issued under this part for any take authorized under the permit issued under part 17 as long as the permittee is in full compliance with the terms and conditions of the permit issued under part 17. The provisions of part 17 that originally applied will apply for purposes of the Eagle Act authorization, except that the criterion for revocation of the permit is that the activity is incompatible with the preservation of the bald eagle or the golden eagle rather than inconsistent with the criterion set forth in 16 U.S.C. 1539(a)(2)(B)(iv)." As incidental take authorization for the bald eagle is being sought under the section 10(a)(1)(B) of the ESA, we are including the bald eagle in this biological opinion.

2.0 STATUS OF THE COVERED SPECIES

This section presents biological or ecological information relevant to formulating this Biological Opinion (BO). Appropriate information on species' life history, habitat, and distribution, and other data on factors necessary to survival are included to provide background for analysis in later sections. This analysis documents the effects of past human and natural activities or events that have led to the current range-wide status of the species. Portions of this information are also presented in listing documents, recovery plans, findings documents, and petitions to list, among others, and are referenced accordingly.

2.1 SPECIES DESCRIPTIONS

2.1.1 Indiana Bat

The Indiana bat is an insectivorous, temperate, medium-sized bat that migrates annually from winter hibernacula to summer habitat in forested areas. The bat has a head and body length that ranges from 41 to 49 mm, with a forearm length of 35 to 41 mm. The fur is described as dull pinkish-brown on the back but somewhat lighter on the chest and belly, and the ears and wing membranes do not contrast with the fur (Barbour and Davis 1969). Although the bat resembles the little brown bat and the northern long-eared bat, it is distinguished by its distinctly keeled calcar and a long, pointed, symmetrical tragus.

2.1.2 Northern Long-Eared Bat

The northern long-eared bat is a medium-sized bat with an average adult weight of 5 to 8 grams, average body length from 77 to 95 millimeters, and forearm length between 34 and 38 millimeters (Caceres and Pybus 1997). Its fur ranges from medium to dark brown on the dorsal side, and tawny to pale-brown on the ventral side, with dark brown ears and wing membranes. As indicated by its common name, the northern long-eared bat is distinguished from other *Myotis* species by its relatively long ears (average 17 mm (0.7 in)) (Whitaker and Mumford 2009) that, when laid forward, extend beyond the nose up to 5 mm (0.2 in) (Caceres and Barclay 2000). Within its range, the northern long-eared bat is sometimes confused with the little brown bat or the western long-eared myotis (*Myotis evotis*). The northern long-eared bat is distinguished from the little brown bat by its longer ears, tapered and symmetrical tragus, slightly longer tail, and less glossy pelage (Caceres and Barclay 2000), and from the western long-eared myotis by its darker pelage and paler membranes (Caceres and Barclay 2000).

2.1.3 Little Brown Bat

The little brown bat is a medium sized bat, weighing between 7 and 14 grams with a wingspan of 22 to 27 centimeters (Harvey et al. 1999), with a body length of 76-95 mm (Laubach et al. 2004) and a forearm measurement of between 33 and 41 mm (Fenton and Barclay 1980). Its fur is glossy and ranges in color from dark brown to a yellowish brown (Fenton and Barclay 1980). The little brown bat is similar to the

Indiana bat, but can be distinguished by its calcar that is not keeled, and the presence of toe hairs that extend beyond its claws. The little brown bat is also similar to the northern long-eared bat, but the northern long-eared bat has ears that extend at least 2mm beyond the nose when laid forward and a tragus that is longer and more pointed when compared to the little brown bat (Laubach et al. 2004).

2.1.4 Tricolored Bat

The tricolored bat was classified as *Pipistrellus subflavus* and was often called the eastern pipistrelle or "pips" in literature, surveys, and guidebooks predating its reclassification in 2006. It is currently classified as *Perimyotis subflavus* per Hoofer et al. (2006). The bat is generally smaller in size to the other *Myotis* described above, with a weight of 4 to 8 grams, forearm length of 31 to 35 mm and a total length generally between 81 and 89 mm (Laubach 2004). The species' most distinguishing characteristics are the reddish forearm contrasting with the black wing membrane and the fur that shades from a dark grey base to a yellowish brown to a dark brown tip (Laubach 2004).

2.1.5 Bald Eagle

The bald eagle is a large migratory raptor endemic to North America. Females in Alaska average 5.35 kg and males average 4.23 kg (Imler and Kalmbach 1955, Buehler 2000). The Service is not aware of any published data on weights of bald eagles in the lower 48 states. Bald eagles feed primarily on fish but will consume carrion and other live avian and mammalian prey periodically and especially during the winter (Wright 1953, Spencer 1976, Steenhof 1976, Stalmaster 1987, Delong 1990, Buehler 2000). In Iowa, a great number of migratory bald eagles pass through during the winter especially along the Mississippi River. A smaller number of eagles are year-round residents and include those that nest within Iowa during the summer (Jackson et al. 1996, Shepherd 2018).

2.2 DIET AND FORAGING

2.2.1 Indiana Bat

Indiana bats forage over a variety of habitat types but prefer to forage in and around the tree canopy of both upland and bottomland forest or along the corridors of small streams. Bats forage at a height of approximately 2-30 meters under riparian and floodplain trees (Humphrey et al. 1977). They forage between dusk and dawn and feed exclusively on flying insects, primarily moths, beetles, and aquatic insects. Females in Illinois were found to forage most frequently in areas with canopy cover of greater than 80%, and typically utilize larger foraging ranges than males (Garner and Gardner 1992).

2.2.2 Northern Long-Eared Bat

The northern long-eared bat forages on a variety of insect types and does so primarily above the understory, but under the canopy in forested habitats (Nagorsen and Brigham 1993). It is capable of both capturing prey in midair and gleaning perched insects from surfaces. This gleaning ability, combined with agile flight capabilities, enables the northern long-eared bat to forage in dense forests with heavy understory (Foster and Kurta 1999). The northern long-eared bat has shown a preference for forested hillsides and ridges over riparian areas (Brack and Whitaker 2001; LaVal et al. 1977) and other data indicates that mature forests are important foraging habitat for the northern long-eared bat (Caceres and Pybus 1997).

In general, the northern long-eared bat consumes moths, flies, leafhoppers, caddisflies, and beetles. However, the most common insects found in the diet of the northern long-eared bat are moths and beetles (Feldhammer et al. 2009; Brack and Whitaker 2001). The northern long-eared bat's foraging patterns include a peak activity period within five hours of sunset, and a second peak within eight hours of sunset (Kunz 1973). Insects consumed during these periods do not seem to be significantly different (Brack and Whitaker 2001).

2.2.3 Little Brown Bat

The little brown bat prefers to forage over open water, but is also known to forage along forest edges or clearings (Harvey et al. 1999). This species is known to use edge habitat, open water, and open agricultural fields for forging more often than the northern long-eared bat. In one study, little brown bats were found to forage within 2.1m (6.9 ft) over the water within 3.2 m (10.5 ft) of the shoreline (Kurta 1982). They emerge from their summer habitats at dusk to feed on moths, leafhoppers, plant-hoppers, beetles, wasps, crane flies, mosquitoes, and midges (Harvey et al. 2011). Little brown bats capture insects using their wingtips, the captured prey is then immediately transferred into a "scoop" formed by the forward curled tail and interfemoral membrane, and then grasped with the teeth (Harvey et al. 2011). Pregnant little brown bats can forage over an area greater than 70 acres, but this area can decrease after young are born (Henry et al. 2002).

2.2.4 Tricolored Bat

Tricolored bats emerge from their summer roosts early in the evening to forage slowly over waterways and forest edges (Harvey et al. 2011). Tricolored bats feed primarily on moths, beetles, mosquitos, true bugs, ants, and leaf hoppers (Harvey et al. 1999). Tricolored bats prefer leaf hoppers, followed by ground beetles, flies, beetles, and then moths (Whitaker 1972). A radio-telemetry study conducted in Indiana found the distances traveled from roost areas to foraging grounds were less than 3 miles (Veilleux et al. 2003). Comparably, Krishon et al. (1997) found an average distance from foraging area to roost location to be 1,137 meters.

2.2.5 Bald Eagle

Bald eagles typically forage near water bodies for fish, birds, and mammals. Perch trees are often located adjacent to shallow water habitat where fish are closer to the surface (Mersmann 1989, Livingston 1990, Canton et al. 1992). Food is acquired by scavenging, capture, or stealing from other animals including ospreys and other eagles (Todd et al. 1982, Harmata 1984). Cooperative hunting on black-tailed jackrabbits in Utah (*Lepus californicus*) and cattle egrets (*Bubulcus ibis*) in Florida has also been observed and may increase the chance of successful capture of prey (Edwards 1969, Folk 1992). Along the Mississippi River in Iowa, fresh and frozen gizzard shad (*Dorosoma cepedianum*) and other fish are the primary foods for bald eagles, however, they also feed on hog carcasses discarded in fields by farmers (Southern 1964, Henny et al. 1987).

2.3 SUMMER HABITAT AND HOME RANGE

2.3.1 Indiana Bat

Female Indiana bats emerge from hibernation ahead of males; most winter populations leave by early May. Some males spend the summer near hibernacula in Missouri (LaVal and LaVal 1980) and West Virginia (Stihler, pers. observ. October 1996, in USFWS 2000). In spring when fat reserves and food supplies are low, migration is probably hazardous (Tuttle and Stevenson 1977). Consequently, mortality may be higher in the early spring, immediately following emergence.

Females may arrive in their summer habitats as early as April 15 in Illinois (Gardner et al. 1991, Brack 1979). During this early spring period, a number of roosts (e.g., small cavities) may be used temporarily, until a roost with larger numbers of bats is established. Humphrey et al. (1977) reported that Indiana bats first arrived at their maternity roost in early May in Indiana, with substantial numbers arriving in mid-May. Birth of young, typically one pup per female (Harvey et al 2011) occurs in late June and early July (Easterla and Watkins 1969, Humphrey et al. 1977) and the young are able to fly between mid-July and early August (Mumford and Cope 1958, Cope et al. 1974, Humphrey et al. 1977, Clark et al. 1987, Gardner et al. 1991a, Kurta et al. 1996). Female Indiana bats exhibit strong site fidelity to summer roosting and foraging areas. That is, they return to the same summer range annually to bear their young (Garner and Gardner 1992).

In general, Indiana bats roost in large, often dead or partially dead trees with exfoliating bark and/or cavities and crevices (Callahan et al. 1997; Farmer et al. 2002; Kurta et al. 2002). Trees in excess of 16 inch diameter at breast height (dbh) with exfoliating bark are considered optimal for maternity colony roost sites, but trees in excess of 9 inch dbh appear to provide suitable maternity roosting habitat (Romme et al. 1995). Indiana bat maternity roosts can be described as primary or alternate based upon the proportion of bats in a colony consistently occupying the roost site. Maternity colonies typically use 10 to 20 trees each year, but only one to three of these are primary roosts used by the majority of bats for some or all of the summer (Garner and Gardner 1992). Alternate roosts are used by individuals, or a small number of bats, and may be used intermittently throughout the summer or used on only one or a few days. Females frequently switch roosts to find optimal roosting conditions, switching roosts every few days on average. The reproductive condition of the female, roost type, and time of year affect switching. When switching between day roosts, Indiana bats may travel as little as 23 feet (7 m) or as far as 3.6 miles (5.8 km) (Kurta et al. 1996; Kurta et al. 2002). In general, moves are relatively short and typically less than 0.6 mile (1 km) (USFWS 1997).

The range of maternity colony sizes observed for the Indiana bat is 10-100 adult females (Kurta and Rice 2002), and 60 females is the average of the overall variability in maternity colony size. The home range of a maternity colony is the area within a 2.5-mile radius (i.e., 12,560 acres) around documented roosts or within a 5-mile radius (i.e., 50,265 acres) around capture location of a reproductive female or juvenile Indiana bat or a positive identification of Indiana bat from properly deployed acoustic devices. Based on data provided in the Indiana bat draft revised Recovery Plan (USFWS 2007), a maternity colony needs at least 10% suitable habitat (i.e., forested habitat) to exist at a given point on the landscape.

After the summer maternity period, Indiana bats migrate back to traditional winter hibernacula. Some male bats may begin to arrive at hibernacula as early as July. Females typically arrive later and by September the number of males and females is almost equal. Autumn "swarming" occurs prior to hibernation. During swarming, bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in the caves during the day. By late September many females have entered hibernation, but males may continue swarming well into October in what is believed to be an attempt to breed with late arriving females. Swarming behavior is further described below in section 2.4

Male Indiana bats may be found throughout the entire range of the species. Males appear to roost singly or in small groups, except during brief summer visits to hibernacula. Males have been observed roosting in trees as small as 3 inches dbh, but the average roost diameter for male Indiana bats is 13 inches (USFWS 2007).

2.3.2 Northern Long-Eared Bat

During the summer, the northern long-eared bat occupies forested habitat and roosts (singly or in colonies) in the cracks, crevices, and bark of both live and dead trees (Lacki and Schwierjohann 2001), but they also have been found to roost in human made structures, such as buildings, barns, sheds, cabins, etc. Also, it appears that the northern long-eared bat does not depend on any specific species of tree, but rather the tree characteristics and/or tree decay structure are the most important factors in roost selection (Foster and Kurta 1999). The northern long-eared bat has been found to roost below the canopy in forests with a variety of canopy cover percentages, but research has indicated that females do tend to roost in more open areas than males (Perry and Thill 2007a). Open areas receive greater solar insolation, which increases roost temperature and therefore pup development.

Northern long-eared bats exhibit site fidelity to their summer forested habitats (Perry 2011; Johnson et al. 2009a; Jackson 2004; Foster and Kurta 1999). Summer home range includes both roosting and foraging areas, and home range size may vary by sex. Broders et al. (2006) found the maternity roosting area and foraging area of females (mean of 8.6 ha (21.3 acres) and 46.2 ha (114.2 acres), respectively) larger than males (mean of 1.4 ha (3.5 acres) and 13.5 ha (33.4 acres)), but Lereculeur (2013) found no difference between sexes at a study site in Tennessee. Broders et al. (2006) and Henderson and Broders (2008) found the foraging areas of either sex were six or more times larger than roosting areas. At sites in the Red River Gorge area of the Daniel Boone National Forest, Lacki et al. (2009b) found female home range size to range from 19 to 172 ha (47 to 425 acres). Owen et al. (2003) estimated average maternal home range size at 65 ha (161 acres).

The mean distance between roost trees and foraging areas of radio-tagged individuals in New Hampshire was 602 m (1,975 ft) with a range of 60 to 1,719 m (197 to 5,640 ft) (Sasse and Pekins 1996). Henderson and Broders (2008) found that female northern long-eared bats on Prince Edward Island traveled approximately 1,100 m (3,609 ft) between maternity roosting and foraging areas. In New Brunswick, Broders et al. (2006) reported the mean distance between the centers of maternity roosting areas and foraging areas as 584.6 m (1,918.0 ft) for females and 405.8 m (1,331.4 ft) for males. Other sources show that northern long-eared bats have a home range of 47 to 425 acres (Lacki et al 2009), with an average maternal home range of approximately 161 acres (Owen et al. 2003). In Iowa, Roby et al (2018) found the average home range of northern long-eared bats in late summer/early fall to be 167.3 ± 33.6 acres.

Roost trees are often in fairly close proximity to each other. In Missouri, Timpone et al. (2010) radio-tracked 13 northern long-eared bats to 39 roosts and found the mean distance traveled between roost trees was 0.67 km (0.42 mi) (range 0.05–3.9 km (0.03–2.4 mi)). In Michigan, the longest distance moved by the same bat between roosts was 2 km (1.2 mi), and the shortest was 6 m (20 ft) (Foster and Kurta 1999). In the Ouachita Mountains of Arkansas, Perry and Thill (2007a) found that individuals moved among snags distributed in an area of about 2 ha (5 acres). Johnson et al. (2011) found that northern long-eared bats form social groups in networks of roost trees centered on a central-node roost, similar to a primary maternity roost tree for an Indiana bat colony, but were identified in this study by the degree of connectivity with other maternity roost trees rather than by the number of individuals using the tree.

Males and females generally roost separately (Caceres and Barclay 2000), and some studies cited above suggest differences in summer home range size between males and females. Despite these differences, males and females may share a large fraction of their foraging habitat within the occupied forested landscape. An analysis of mist net survey data in Kentucky (USFWS 2014, unpublished data cited in the final listing rule) shows that most males and non-reproductive females are captured in the same locations as reproductively active females (1,712 of 1,825 capture records or 94 percent), suggesting substantial overlap in the summer home range of reproductive females and other individuals.

Northern long-eared bats typically form their maternity colonies in June and July and have one pup per female (Harvey et al. 2011). Maternity colonies, consisting of females and young, are generally small, numbering from fewer than 30 (Whitaker and Mumford 2009, p. 212) to 60 individuals (Caceres and Barclay 2000); however, one group of 100 adult females was observed in Vermilion County, Indiana (Whitaker and Mumford 2009, p. 212). In West Virginia, maternity colonies in two studies had a range of 7 to 88 individuals (Owen et al. 2002) and 11 to 65 individuals, with a mean size of 31 (Menzel et al. 2002). Lacki and Schwierjohann (2001) found that the number of bats within a given roost declined as the summer progressed. Pregnant females formed the largest aggregations (mean=26) and post-lactating females formed the smallest aggregation (mean=4). The largest reported colony size was 65 bats. Other studies have also found that the number of individuals roosting together in a given roost typically decreases from pregnancy to post-lactation (Foster and Kurta 1999; Lacki and Schwierjohann 2001; Garroway and Broders 2008; Perry and Thill 2007a; Johnson et al. 2012).

2.3.3 Little Brown Bat

After emerging from their hibernacula in the spring, little brown bats roost in a variety of sites, including buildings, under rocks, wood piles, occasionally caves, and hollow trees if temperature conditions are right (Fenton and Barclay 1980). Maternity colonies of little brown bats have been found in a variety of man-made structures including attics, basements, under sheet metal roofs, in barn rafters, and in bat houses (Davis and Hitchcock 1965). A maternity colony of 6,700 little brown bats, discovered in an abandoned barn in Indiana, is the largest maternity colony ever documented (Whitaker and Hamilton 1998). Female little brown bats typically give birth to one pup between May, June, and July (Harvey et al. 2011).

Less is known about where most male little brown bats spend their summer, but it is thought that they likely spend the summer roosting period scattered in a variety of roost types (Harvey et al. 2011). Randall et al. (2014) found that data collected during their telemetry study in 2007 was in agreement with Broders and Forbes (2004), who reported that all female little brown bats captured in forests were found to roost in nearby buildings, whereas the males roosted in nearby trees.

In the southwestern Yukon, Randall et al. (2014); observed male little brown bats traveling significantly shorter distances (208 - 817 m) from roost trees to foraging areas than female little brown bats (214 - 5224 m). Female little brown bats occasionally traveled greater than 5km from roost site to foraging areas while males tended to roost near their foraging areas (Randall et al. 2014). A study in New York on 7 adult female little brown bats yielded a mean estimated home range of 143 ha (n=7, SE = 71) or ~353 acres, SE ~175 (Coleman et al 2014). A comparable telemetry study on a small island (200 ha) near Quebec, Canada, demonstrated that female little brown bats used a mean homerange of 30.1 ha (n=22, SE = 15.0) for pregnant females and 17.6 ha (n = 22, SE = 9.1) for lactating females (Henry et al 2002).

Following the summer roosting period, little brown bats begin migrating to their winter hibernacula and arrive between September and October (Saunders 1988). Male fidelity to hibernacula was higher than that of females, possibly reflecting local resource competition for hibernacula among female little brown bats in Canada (Norquay et al. 2013). Between the years of 1989 and 2010, Norquay et al. (2013) recaptured 1,459 of 10,432 individuals and found movement from hibernacula and/or swarming season to summer root sites ranged from 10-647 km. Consistent with previous studies, Norquay et al. (2013) found high fidelity to summer colonies and hibernacula over the years, with some individuals switching sites with a median relocation distance of 315 km. Females were found to be more likely to relocate with over 20% of individual movements over 500 km (Norquay et al. 2013).

2.3.4 Tricolored Bat

Tricolored bats are known to roost mostly in foliage, clusters of dead leaves (65%), live foliage (30%), and squirrel nests (5%; Veilleux et al. 2003). The species can occasionally be found in man-made structures (Whitaker 1998), but Veilleux et al. (2003) found that tricolored bats seem to use man-made structures less often than Myotis species. Tricolored bats accounted for only 12 (2.9%) of 401 bat colonies in buildings in Indiana (Cope et al. 1991), suggesting that most colonies are roosting in forests (Veilleux 2003). In Indiana, female tricolored bat maternity roosts occurred mostly in upland habitats (9.4%) as opposed to riparian (0.8%) and bottomland (0.2%) habitats (Veilleux et al. 2003). Preferred upland habitat by this species could be related to the greater availability of preferred roost tree species: white oak (*Quercus alba*), bur oak (*Quercus macrocarpa*), and red oak (*Quercus rubra*) (Veilleux et al. 2003).

Tricolored bats appear to exhibit site fidelity for summer roosting habitat. Veilleux (2003) found site fidelity for 18 tricolored bats in Indiana. The bats were monitored for nine days and found that bats used one to three roost trees and changed roost trees one to two times, on average. Tricolored bats remained at single roost trees for two and a half to six consecutive days on average. However, four individuals late in pregnancy or lactating remained at a roosts for two and a half to four days. Eight of eighteen individuals (~44%) returned to previously used roosts trees after initially changing to a new roost (Veilleux 2003). Tricolored females have their pups in late spring and early summer, and usually have twins (Harvey et al. 2011).

Roost areas for individuals and maternity colonies are relatively small. In Indiana, Veilleux and Veilleux (2004) radio-tracked four tricolored bats to their respective roosts trees and found that minimum and maximum distances from roosts trees were between 21 m and 926 m. Minimum roost area for all 4 individuals containing all roosts used during both years (1999-2000) ranged from 0.1 ha - 2.3 ha. A comparable study in Nova Scotia found that the average roosting area of maternity colonies varied between 1.6 and 77.4 ha, with a mean of 22.8 ha (56.3 acres)

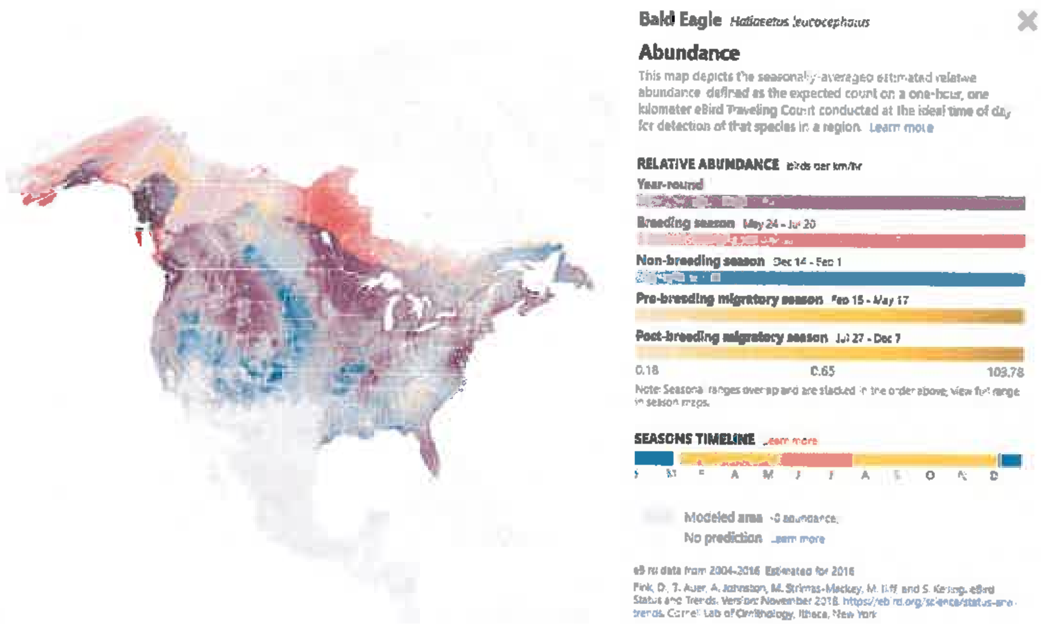
A study conducted in Ouachita Mountains of central Arkansas radio-tagged 28 male and nine female tricolored bats and found that roosts trees varied from one to three roost trees for males and one to five roost trees for females (Perry and Thill 2007b). Seven of 14 female roosts were considered to be colonies and based on exit counts and visible pups, the estimated number of bats (adults and pups) in colonies was 3-13, with an average of 6.9 (±1.5) (Perry and Thill 2007b). Perry and Thill (2007b) also found males roosting in forested habitats also occupied by females, but primarily in solitary roosts.

2.3.5 Bald Eagle

E-bird data shows year-round presence in Iowa (see figure 2.3.1). While a majority of the migratory population moves to northern areas in Canada and Alaska, a smaller breeding population remains throughout the upper Midwest including Iowa (Bowerman et al. 1994, Shepherd 2018). Summer habitat in Iowa therefore, is concentrated on areas suitable for breeding: i.e. generally in large trees adjacent to bodies of water (Livingston et al. 1990, Buehler 2000, Shepherd 2018). Nest tree species vary depending on availability (Stahlmaster 1987). Coniferous trees are used in the areas where conifers are dominant, whereas deciduous trees are primarily used when the dominant tree type is deciduous (Buehler 2000). In the Upper Mississippi River, eagles nest in eastern cottonwood (*Acer saccharinum*) or silver maples (*Populus deltoides*) 93% of the time (Mundahl et al. 2013). Bald eagle surveys conducted by the Service

(2018-2019, unpublished), and nesting records from Iowa Department of Natural Resources show higher nesting density on islands on the Mississippi River than the inland nesting sites (Shepherd 2018). On the Upper Mississippi National Wildlife Refuge, average distance between nests was 1.52 km, with a nest density range of 0.32 to 9.72 nests per 100 km^2 (Mundahl et al. 2013). Nest failure was higher in nests located closer together (Mundahl et al. 2013).

Figure 2.3-1. Temporal abundance of bald eagles across North America



2.4 MIGRATION, SWARMING AND/OR WINTER HABITAT

2.4.1 Indiana Bat

Migration Pathways

A 2011 spring migration study at the Blackball Mine hibernacula in Illinois documented that the majority of tagged Indiana bats emerging from Blackball travelled south and west down the forested Illinois River corridor (Hicks et al. 2011). This suggests that during spring migration Indiana bats may follow watershed drainage corridors enroute to their summer habitats in Illinois.

Fall migration routes or patterns for the Indiana bat are currently unknown. The recent discovery of a few Indiana bat and northern long-eared bat carcasses at various wind facilities in Illinois, Indiana, Iowa, Missouri, and Ohio in the fall demonstrates that some individuals cross open, treeless landscapes during their fall migration. Additionally, a 2014 fall migration telemetry study conducted on a population of Indiana bats and northern long-eared bats living in the Middle Fork of the Vermillion River riparian corridor showed that most tagged individuals did not appear to follow the river corridor when the maternity colonies broke up, but rather headed northeast across the open landscape (Boyles and McGuire, personal communication unpublished report). If other bats from other maternity colonies have the same tendency to cross open landscapes during fall migration, some level of mortality risk during fall migration is likely associated with wind turbines in the region. This risk is difficult to quantify with currently available data. The Service continues to engage with our partners to gather information to inform this risk.

Swarming

Indiana bats begin leaving their summer range in early August for their hibernacula (Humphrey et al. 1977, Kurta et al. 1993). Some Indiana bats may stay near their summer ranges into early October (Kurta and Rice 2002). Members of a maternity colony may not hibernate in the same cave, and may migrate to caves that are over 190 miles (300 km) apart (Kurta and Murray 2002).

Upon arrival at hibernating caves in August-September, Indiana bats swarm, during which large numbers of bats fly in and out of cave entrances from dusk to dawn, with relatively few roosting in the caves during the day (Cope and Humphrey 1977). Swarming continues for several weeks and mating occurs during the latter part of the period. Fat supplies are replenished as the bats forage prior to hibernation. With the exception of the proximity to the hibernacula, swarming habitat is essentially the same as summer habitat (see description below). During fall swarming, Indiana bats roost in standing dead trees and live hickories (Kiser and Elliot 1996). In Kentucky, Kiser and Elliot (1996) found that Indiana bats foraged in upland communities. They postulated that the temperatures within the stream corridors and riparian vegetation during the autumn were too cool, which could impact the activity and density of insects in riparian areas. Insect abundance and activity may be greater in the uplands where temperatures are generally warmer. Roost switching is common during swarming (Kiser and Elliot 1996, MacGregor et al. 1999, Gumbert et al. 2002).

Generally, Indiana bats hibernate from October through April (Hall 1962, LaVal and LaVal 1980), depending upon local weather conditions. They hibernate in large, dense clusters, ranging from 300 bats per square foot to 484 bats per square foot (Clawson et al. 1980, Clawson, pers. observ. October 1996 in USFWS 2000). Also, Indiana bats tend to hibernate in caves with large volume and structural diversity that ensures stable internal temperatures, with little likelihood of freezing (Tuttle and Kennedy 2002). These caves or mines typically have two or more entrances that have a chimney effect on air flow. Tuttle and Kennedy (2002) found that populations occupying roosts with midwinter temperatures of 3.0 – 7.2° C increased in number over the past 20 years, but those with temperatures outside of this range decreased in population size. Consistent with these ranges, preliminary data from a study being conducted by Dzurick and Tomasi (2005) suggest that the optimal hibernation temperature is approximately 5°C.

2.4.2 Northern Long-Eared Bat

The northern long-eared bat is not considered a long-distance migratory species. Researchers have documented short regional migratory movements between seasonal habitats (summer roosts and winter hibernacula) of between 56 km (35 mi) and 89 km (55 mi) (Nagorsen and Brigham 1993; Griffin 1940b; Caire et al. 1979). The spring migration period typically runs from mid-March to mid- May (Caire et al. 1979; Easterla 1968; Whitaker and Mumford 2009); fall migration typically occurs between mid-August and mid-October. Because Indiana bats and northern long-eared bats share hibernacula and have many overlapping summer habitats in Illinois, it is logical to infer that northern long-eared bats may have similar spring migration patterns. However, no spring migration route data from Illinois or Iowa exists for the northern long-eared bat, at present. See section 2.4.1 above for a discussion of potential northern long-eared bat migration routes.

The northern long-eared bat occupy their summer habitat from approximately April through August and then begin to swarm near their hibernacula in August or September (Caire et al. 1979), depending on the geographical region. The final listing rule for the northern long-eared bat identifies the active season for the species between spring and fall migration as approximately April through October. For purposes of this BO, we use April 1 to October 31 as the northern long-eared bat active season within the Action Area. In Indiana, the majority of northern long-eared bats in Copperhead Cave have been observed to enter hibernation during October, and emerge from about the second week of March to mid-April (Whitaker and Mumford 2009). Hibernation periods farther north may begin earlier and last longer (Stones and Fritz 1969; Fitch and Shump 1979). The northern long-eared bat has been observed to share hibernacula with other bat species (Whitaker and Mumford 2009), but is rarely observed in concentrations over 100 in a single hibernaculum (Barbour and Davis 1969). Northern long-eared bat individuals also rouse and may switch hibernacula throughout the winter, which makes it difficult to accurately estimate winter population numbers (Griffin 1940; Whitaker and Rissler 1992b; Caceres and Barclay 2000).

Northern long-eared bats often overwinter in caves and abandoned mines. These hibernacula have relatively constant, cool temperatures (0 to 9 degrees Celsius (°C) or 32 to 48 degrees Fahrenheit (°F)) (Raesly and Gates 1987; Caceres and Pybus 1997; Brack 2007), with high humidity and no air currents (Fitch and Shump 1979; van Zyll de Jong 1985; Raesly and Gates 1987; Caceres and Pybus 1997). The species appears to favor sites with very high humidity, such that droplets of water are often observed on their fur (Hitchcock 1949; Barbour and Davis 1969). Northern long-eared bats are typically found roosting in small crevices or cracks in cave or mine walls or ceilings, sometimes with only the nose and ears visible, which reduces the likelihood of detection during surveys (Griffin 1940a; Barbour and Davis 1969; Caire et al. 1979; van Zyll de Jong 1985; Caceres and Pybus 1997; Whitaker and Mumford 2009). Caire et al. (1979) and Whitaker and Mumford (2009) commonly observed individuals exiting caves with mud and clay on their fur, also suggesting that they had roosted in cracks and crevices.

Griffin (1945) found northern long-eared bats in December in Massachusetts in a dry well, and commented that these bats may regularly hibernate in "unsuspected retreats" where caves or mines are not available. Northern long-eared bats have been found hibernating in other types of habitat that resemble caves or mines, including:

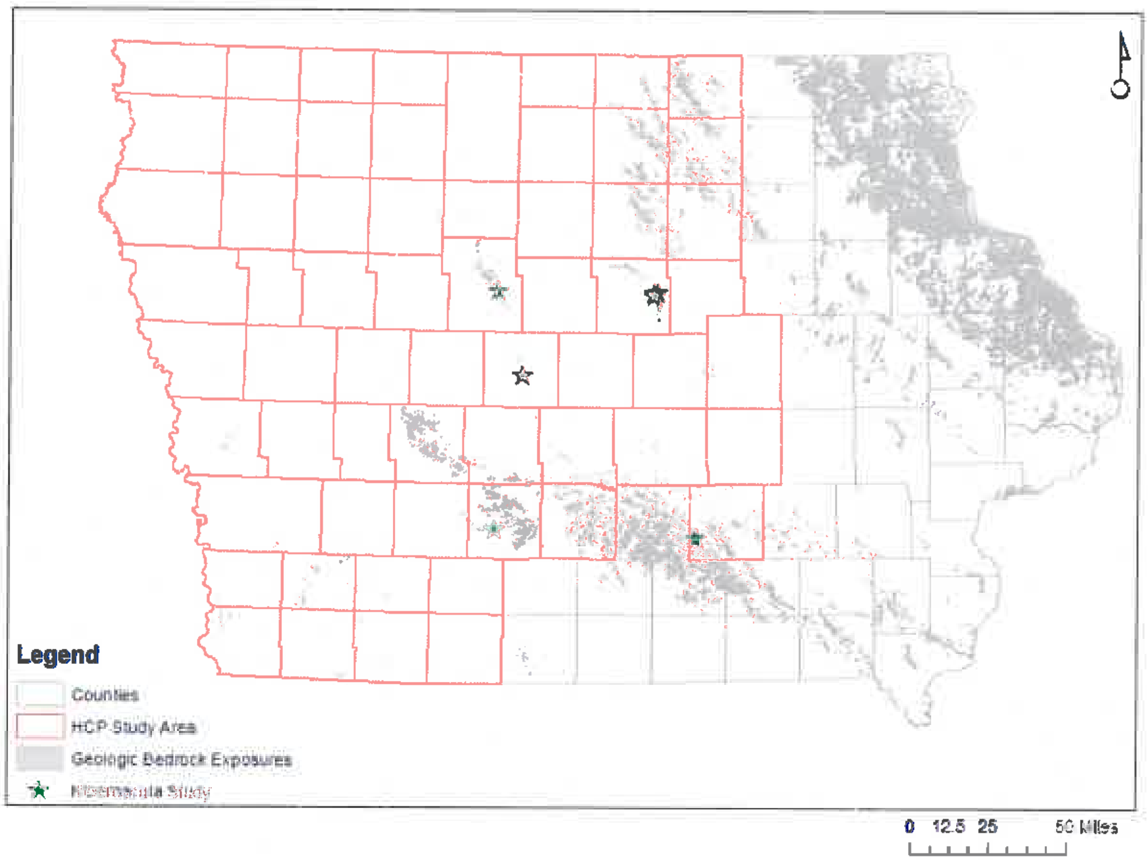
- abandoned railroad tunnels (Service 2015, unpublished data cited in final listing rule);
- near the entrance of a storm sewer in central Minnesota (Goehring 1954);
- the facilities of a hydroelectric dam in Michigan (Kurta et al. 1997); and

- the Sudbury Aqueduct (Massachusetts Department of Fish and Game 2012, unpublished data cited in final listing rule).

Related bat species (e.g., big brown bats) are known to regularly use hibernacula besides caves and mines, such as attics and hollow trees (Neubaum et al. 2006; Whitaker and Gummer 1992).

In multiple northern long-eared bat studies directed by the Iowa Department of Natural Resources (IADNR) in conjunction with federal section 6 HCPPA grants, northern long-eared bats were found to be hibernating in several locations in Iowa. These areas are located on public lands and consist of both large and small rocky outcrops and steep talus slopes located on the bluffs of stream and river corridors (Stantec 2018). These areas appear to be correlated with exposed bedrock formations and were identified as probable bat hibernacula by scent-detecting dogs (Hurt et al 201X), acoustic bat call recordings (Blanchong et al 201X), visual observation (Hurt et al 201X, Stantec 2018), and through active fall telemetry tracking (Roby et al 2018). Figure 2.4-1 below illustrates these bat hibernacula sites.

Figure 2.4-1. Locations of Suspected and Confirmed Bat Hibernacula in Iowa. Image credit: Iowa Department of Natural Resources.



2.4.3 Little Brown Bat

Little brown bats hibernate in a variety of suitable sites throughout their range, mostly consisting of caves and abandoned mines, with no records of the bats hibernating in buildings (Fenton and Barclay 1980). Studies found that high levels of humidity (>90%) and temperatures above freezing, most often characterize sites used as hibernacula by little brown bats (Hitchcock 1949, Davis and Hitchcock 1965; Fenton 1970; Humphrey and Cope 1977), but Fenton (1970) found that there are hibernacula used by little brown bats where the ambient temperature is below freezing. Hibernacula are rarely used as day roosts by little brown bats in the summer (Fenton and Barclay 1980), but near the end of August in Ontario, some individuals (usually adult males) spend the day in hibernacula (Fenton and Barclay 1980).

Populations of little brown bats at the southern part of their range may enter hibernacula around November and not exit until May, while at the northern part of the range in Ontario, individuals start to enter hibernacula in September and exit early to mid-May (Fenton and Barclay 1980). Exiting the hibernacula is dependent upon local weather conditions and the frequency of arousal from torpor (Fenton and Barclay 1980). The hibernacula sites act as the focal points for swarming activity, which dependent upon location, lasts from late August into October (Fenton and Barclay 1980).

The swarming period begins when the bats arrive at their hibernacula, approximately an hour after sunset (Fenton and Barclay 1980). Little brown bats typically feed before arriving at their hibernacula and upon entering, spend variable time flying around inside (Davis and Hitchcock 1965; Fenton and Barclay 1980; Fenton 1969). Bats that swarm at a particular site may not hibernate there (Fenton and Barclay 1980). The recovery rate of individuals banded from swarming to hibernation, or season to season, at any site is usually low (Fenton and Barclay 1980; Fenton 1969). During the swarming period, individual bats may travel significant distances, (Fenton 1970) resulting in mixing of the population of bats from different areas (Fenton and Barclay 1980).

2.4.4 Tricolored Bat

Tricolored bats are known to hibernate in caves, mines, and rock crevices during the winter months (Harvey et al. 1999). Although tricolored bats are considered one of the most common and widely distributed species in North America (Briggler and Prather 2003), little information has been published on seasonal use and site selection for this species (Briggler and Prather 2003; Raesley and Gates 1987; Sandel et al. 2001). LaVal and LaVal (1980) noted the large number of individuals captured at a hibernacula in Missouri, in late April and May and then again in late July and August, suggesting that tricolored bats are among the first to arrive at hibernacula in the autumn, and among the last to exit in the spring (Fujita and Kunz, 1984).

During hibernation, males and females are not segregated (Griffin 1940) and are noted to roost singly, as opposed to in clusters (Hitchcock 1946; Fujita and Kunz 1984). Although tricolored bats primarily hibernate singly, clusters of bats comprising of 2-3 individuals have been documented on numerous occasions (Sandel et al. 2001). Because of the small size and tendency to hibernate singly, McNab (1974) noted that tricolored bats had successfully hibernated in a cave in Florida, where the relatively high ambient temperatures excluded other bat species (Fujita and Kunz 1984). Briggler and Prather (2003) found that cave temperature had a strong influence of site selection by tricolored bats.

A presence/absence survey resulted in data that showed tricolored bats were more likely to be found in caves with higher temperatures (11.4 °C to 10.5 °C) in the winter of 2000 and lower temperatures (12.6 °C to 13.9 °C) during spring 2000 (Briggler and Prather 2003). As a result of the 54 caves surveyed over six seasons in Arkansas, Briggler and Prather (2003) noted that tricolored bats showed a preference for cave openings with east-facing aspects and avoided caves on steep slopes during winter hibernation; the preferences seemed to be a result of the influence of ambient temperature. East-facing aspects on shallow slopes were larger than those on steep, west-facing slopes; larger caves had a greater buffer capacity from weather conditions for hibernating bats (Briggler and Prather 2003).

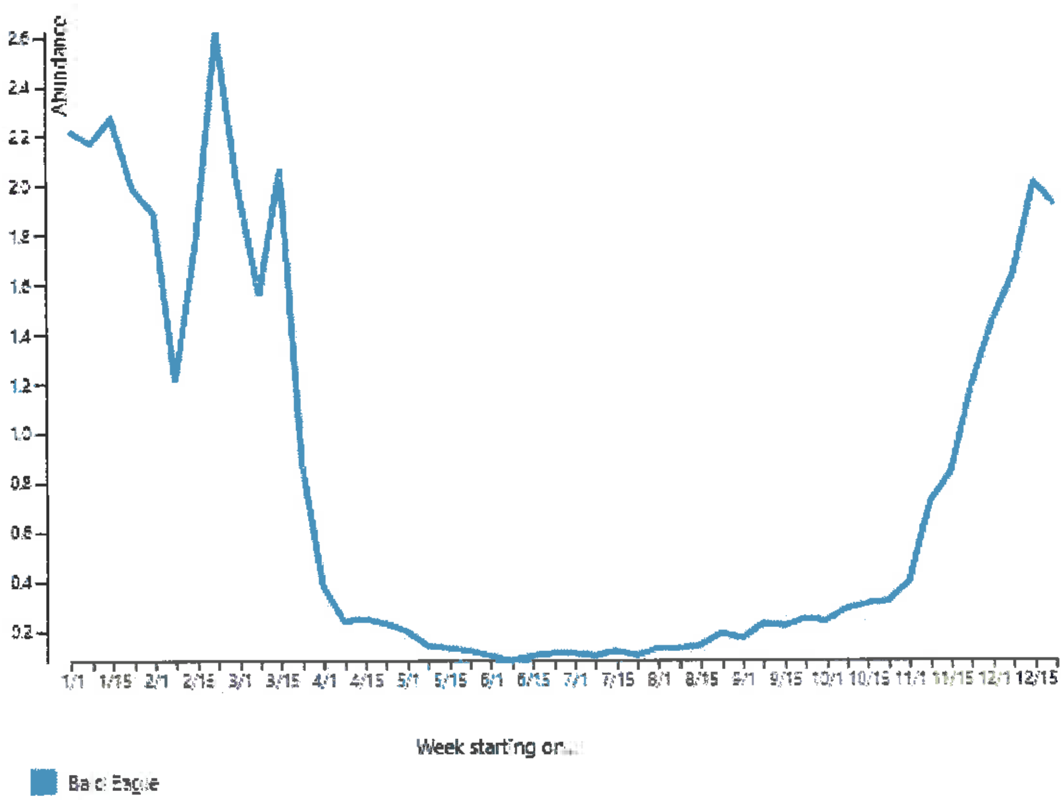
As previously noted, there is little information about tricolored bat movements, including swarming sites and hibernacula, but the species is currently believed to be a short distance regional migrant (Fraser et al. 2012; Fujita and Kunz 1984). Species engaging in regional migration travel annually from hibernaculum to summer roosting sites, and then moving among swarming locations in the autumn (Fenton 1969; Fraser et al. 2012; Hitchcock 1965). Recent research has led to some speculations that some individuals migrate farther distances than previously suspected, and that migratory behavior may differ between males and females (Davis 1959; Fraser et al. 2012). Fraser et al. (2012) investigated tricolored bat migration by conducting stable hydrogen isotope analyses of 184 museum specimen fur samples and compared the results to published values of collection site growing season precipitation. Their results suggested that 33% of males and 16% of females collected during the postulated non-molt period were south of their location of fur growth. Fraser et al. (2012) also noted that if tricolored bats only engaged in regional migration, then evidence would be expected to show equal numbers of bats migrating north and south during the non-molt period. Respectively, Fraser et al. (2012) concluded that at least some tricolored bats, of both sexes, engage in latitudinal migration.

2.4.5 Bald Eagle

Bald eagles begin to arrive in Iowa near November 1st each year and remain present throughout the winter period which ends near April 1st (Figure 1). During this period, they congregate at various communal feeding and roost sites on available habitat near open water for foraging (Millsap 1986). Foraging in groups is thought to maximize energy gain and reduce cold stress; however, juvenile eagles often may not be able to meet the daily energy demand due to social interactions such as kleptoparasitism (Stalmaster and Gessaman 1984). A smaller number of eagles nest within Iowa along riparian corridors, but some nest in the interior part of the state as well (Jackson et al. 1996, Shepherd 2018).

Figure 2.4-2. Bald eagle abundance in Iowa from January 2008-December 2018 using data from ebird.org (accessed 12-3-2018). Abundance is the total numbers of birds reported on each

submitted checklist, divided by the total number of checklists within the specified range of time and region.



2.5 DISTRIBUTION AND ABUNDANCE

2.5.1 Indiana Bat

The historical summer range of the Indiana bat is thought to be similar to its modern range. However, in various places throughout its range the bat has been locally extirpated due to fragmentation and loss of summer habitat. The current species range includes much of the eastern half of the United States, from Oklahoma, Iowa, and Wisconsin east to Vermont, and south to northwestern Florida.

Based on censuses taken at all hibernacula, the total known Indiana bat population is estimated to number about 537,297 bats (Figure 2.5-1). Population trend data showed steady increases from 2001 to 2007, a drop in 2009, an increase in 2011, and continually dropping populations until 2017. With the advent of white-nose syndrome (WNS), future population trends are uncertain.

Figure 2.5-1. Indiana bat rangewide population estimates from 1981 – 2019 (USFWS 2019).

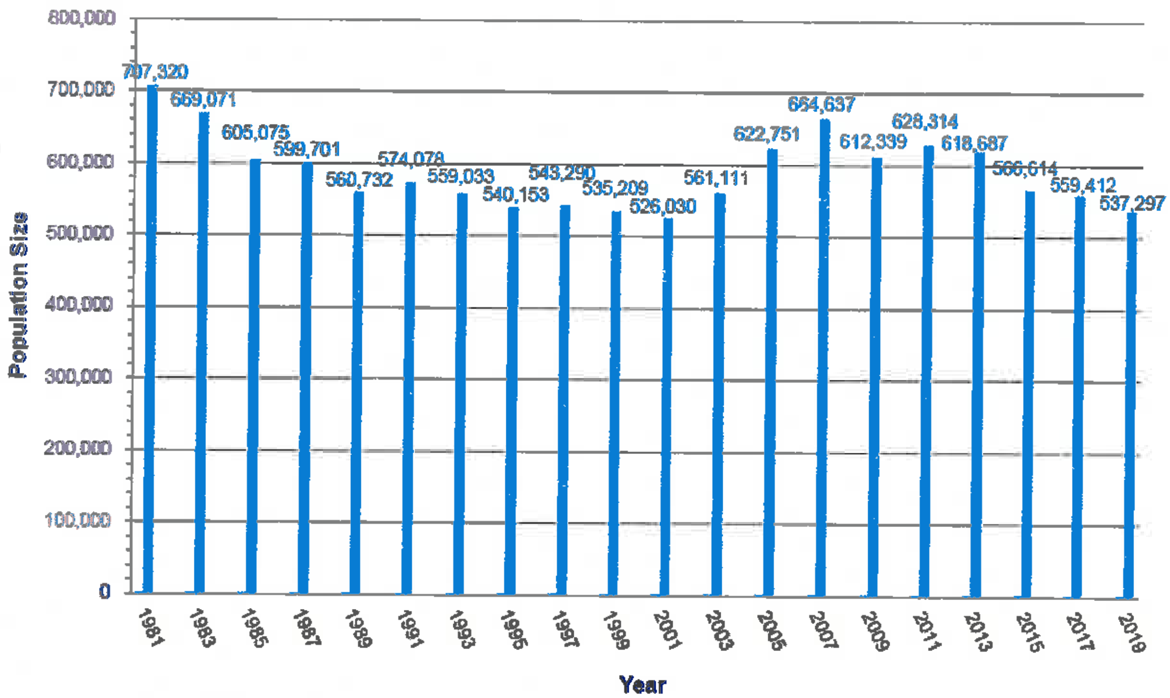


FIGURE 3. Indiana bat range-wide population estimates from 1981 to 2019.

2.5.2 Northern Long-Eared Bat

The northern long-eared bat is a wide-ranging North American species that is considered to be present in all Canadian provinces, the southern Yukon Territory and eastern British Columbia (Nagorsen and Brigham 1993, and Caceres and Pybus 1997). In the United States, the bat can be found in 39 states (including the District of Columbia) from Maine to Montana, south to Kansas and eastern Oklahoma, and southeast to the Florida panhandle (Whitaker and Hamilton 1998; Caceres and Barclay 2000; Amelon and Burhans 2006).

While the species is wide ranging, it appears to be unevenly distributed, and found in low numbers in both roosts and hibernacula (Amelon and Burhans 2006; Whitaker and Hamilton, 1998). However, populations are generally categorized into the Eastern Population, the Midwest Population, the Southern Population, the Western Population, and the Canada Population, although these will not be considered to be Distinct Population Segments under the ESA (USFWS 2013b). Historically, the species was most frequently observed in the northeastern United States and in the Canadian Provinces of Quebec and Ontario, with sightings increasing during swarming and hibernation periods (Caceres and Barclay 2000). Much of the available data on northern long-eared bats are from winter surveys, although they are typically observed in low numbers due to an apparent preference for inconspicuous roosts (Caceres and Pybus 1997). More than 1,100 northern long-eared bat hibernacula have been identified in 29 of 37 states of the species' range in the United States (80 FR 17976), although only a few (one to three) individuals were observed in many of these (Whitaker and Hamilton 1998).

Abundance and relative abundance (i.e., numbers of the species as a percentage of the total number of bats in an area) of the species varies substantially across its large range, and has declined dramatically with the spread of WNS. The final listing rule for the northern long-eared bat summarizes the abundance data available for each major region within the range, which we do not repeat here, except to note that data to support a range-wide population estimate for the species are not available at this time. However, the final listing rule at 80 FR 17979 provides a rough population estimate for the states of Illinois, Indiana, Iowa, Ohio, Michigan, and Missouri of about 4 million northern long-eared bats. This estimate is based on: (a) a population estimate for the Indiana bat in these six States derived from hibernacula counts; and (b) the ratio of Indiana bat captures to northern long-eared bat captures in summer mist-net surveys. Because these surveys were mostly conducted before the spread of WNS into some of these states, it is likely an overestimate, and the final rule stresses its limitations.

2.5.3 Little Brown Bat

The little brown bat has an extensive range across North America, extending from southern Alaska across Canada and the United States, into parts of Mexico, with the exception of portions of the southern Great Plains (Harvey et al. 2009). As a colonial species with the ability to occupy a variety of habitats and roost structures (see above), the population size is likely very large. Coarse population estimates of 6.5 million (Frick et al. 2010a) to 8 million individuals (Russell et al. 2014) have been estimated for the population of little brown bats in the eastern United States. Reproductive rates are also high but may fall after a local population has been exposed to WNS (Frick et al. 2010b).

2.5.4 Tricolored Bat

The range of the tricolored bat is estimated to span the eastern half of the United States and extend through the eastern third of Mexico into Central America (www.batcon.org, citing the IUCN Red List, accessed 13 May, 2019). See figure 5, below. There is currently no estimate of the range wide population for this species.

Figure 2.5-2. Approximate range of the tricolored bat in North America (http://www.batcon.org/resources/media-education/species-profiles/detail/2345, accessed 5-13-2019).

Approximate Range

Source: IUCN Red List

2.5.5 Bald Eagle

The bald eagle is distributed throughout North America and associated with aquatic habitats. Breeding populations exist throughout Canada, most of the contiguous United States, and Alaska (Millsap 1986, Buehler 2000). Wintering populations exist throughout the United States and a number of eagles utilize major waterways and river systems within the Midwest (Buehler 2000). A more thorough description of the distribution is available at the Birds of North America website by Cornell University (see Buehler 2000). See Figure 2.3-1 above.

2.6 THREATS AND POPULATION TRAJECTORIES

2.6.1 Indiana Bat

Not all of the causes of Indiana bat population declines have been determined. Although several known human-related factors have caused declines in the past, they may not solely be responsible for recent declines. Documented and suspected causes of Indiana bat population decline are described below.

Disturbance and Vandalism

A serious cause of Indiana bat decline has been human disturbance of hibernating bats during the decades of the 1960s through the 1980s. Bats enter hibernation with only enough fat reserves to last until spring. When a bat is aroused, as much as 68 days of fat supply is used in a single disturbance (Thomas et al. 1990). Human use (e.g. including recreational cavers and researchers) near hibernating Indiana bats can cause arousal (Humphrey 1978, Thomas 1995, Johnson et al. 1998). If this happens too often, the fat reserves may be exhausted before the bats are able to forage in the spring.

Active programs by State and Federal agencies have led to the acquisition and protection of a number of Indiana bat hibernacula. Of 127 caves/mines with populations >100 bats, 54 (43%) are in public ownership or control, and most of the 46 (36%) that are gated or fenced are on public land. Although such conservation efforts have been successful in protecting Indiana bats from human disturbance, they have not been sufficient to reverse the downward trend in many populations.

Improper Cave Gates and Structures

Some hibernacula have been rendered unavailable to Indiana bats by the erection of solid gates in the entrances (Humphrey 1978). Since the 1950's, the exclusion of Indiana bats from caves and changes in air flow are the major cause of loss in Kentucky (an estimated 200,000 bats at three caves) (USFWS 1999). Other cave gates have so modified the climate of hibernacula that Indiana bats were unable to survive the winter because changes in air flow elevated temperatures which caused an increase in metabolic rate and a premature exhaustion of fat reserves (Richter et al. 1993).

Natural Hazards

Indiana bats are subject to a number of natural hazards. River flooding in Bat Cave, Mammoth Cave National Park, drowned large numbers of Indiana bats (Hall 1962). Other cases of hibernacula being flooded have been recorded by Hall (1962), DeBlase et al. (1965), and the Service (1999). A case of internal cave flooding occurred when tree slash and debris (produced by forest clearing to convert the land to pasture) were bulldozed into a sinkhole, blocking the cave's rain water outlet and drowning an estimated 150 Indiana bats (USFWS 1999).

Another hazard exists because Indiana bats hibernate in cool portions of caves that tend to be near entrances, or where cold air is trapped. Some bats may freeze to death during severe winters (Humphrey 1978, Richter et al. 1993). Indiana bats are vulnerable to the effects of severe weather when roosting under exfoliating bark during summer. For example, a maternity colony was displaced when strong winds and hail produced by a thunderstorm stripped the bark from their cottonwood roost and the bats were forced to move to another roost (USFWS 1999).

Microclimate Effects

Changes in the microclimates of caves and mines may have contributed more to the decline in population levels of the Indiana bat than previously estimated (Tuttle, in lit. August 4, 1998). Entrances and internal passages essential to air flow may become larger, smaller, or close altogether, with concomitant increases or decreases in air flow. Blockage of entry points, even those too small to be recognized, can be extremely important in hibernacula that require chimney-effect air flow to function. As suggested by Richter et al. (1993) and Tuttle (in lit. August 4, 1998), changes in air flow can elevate temperatures which can cause an increase in metabolic rate and a premature exhaustion of fat reserves.

Land Use Practices

The Indiana bats' maternity range has changed dramatically since pre-settlement times (Giessman et al. 1986; MacCleery 1992; Nigh et al. 1992). Most of the forest in the upper Midwest has been fragmented, fire has been suppressed, and native prairies have been converted to agricultural crops or to pasture and hay meadows for livestock. Native plant species have been replaced with exotics in large portions of the maternity range, and plant communities have become less diverse than occurred prior to settlement. Additionally, numerous chemicals are applied to these intensely cropped areas. The changes in the landscape and the use of chemicals (McFarland 1998) may have reduced the availability and abundance of the bats' insect forage base. In the eastern U.S., the area of land covered by forest has been increasing in recent years (MacCleery 1992; Iverson 1994; Crocker et al. 2006). Whether or not this is beneficial to the Indiana bat is unknown. The age, composition, and size class distribution of the woodlands will have a bearing on their suitability as roosting and foraging habitat for the species outside the winter hibernation season.

Chemical Contamination

Pesticides have been implicated in the decline of a number of insectivorous bats in North America (Mohr 1972, Reidinger 1972, Reidinger 1976, Clark and Prouty 1976, Clark et al. 1978, Geluso et al. 1976, Clark 1981). The effects of pesticides on Indiana bats have yet to be studied. McFarland (1998) studied two sympatric species; the little brown bat and the northern long-eared bat as surrogates in northern Missouri and documented depressed levels of acetylcholinesterase, suggesting that bats there may be exposed to sublethal levels of organophosphate and/or carbamate insecticides applied to agricultural crops. McFarland (1998) also demonstrated that bats in northern Missouri are exposed to significant amounts of agricultural chemicals, especially those applied to corn. BHE Environmental, Inc. (1999) collected tissue and guano samples from five species of bats at Fort Leonard Wood, Missouri, and documented the exposure of bats to p,p'-DDE, heptachlor epoxide, and dieldrin.

White Nose Syndrome

White Nose Syndrome (WNS) was first documented in New York in February of 2006 and has since been observed to have spread west to Iowa and Missouri, (www.nwhc.usgs.gov). It is currently unknown if WNS is the primary cause or a secondary indicator of another pathogen, but it has been correlated with erratic behavior such as early or mid-hibernation arousal that leads to emaciation and mortality in several species of bats, including the Indiana bat (www.fws.gov). Additional information on the effects of WNS is presented below.

2.6.2 Northern Long-Eared Bat

The northern long-eared bat has been listed as threatened based on the severity of population impacts that have been realized in areas with WNS, and the expected population impacts that will likely occur with the spread of the disease in the future. There are other reasons for decline that are discussed in the listing package, but none as serious as WNS (USFWS 2015).

White-Nose Syndrome

WNS is an emerging infectious wildlife disease caused by a fungus of European origin, *Pseudogymnoascus destructans*, which poses a considerable threat to hibernating bat species throughout North America, including the northern long-eared bat (USFWS 2011). WNS is responsible for unprecedented mortality of insectivorous bats in eastern North America (Blehert et al. 2009; Turner et al. 2011). The first evidence of the disease (a photo of bats with fungus) was documented near Albany, New York, on February 16, 2006, but WNS was not actually discovered until January 2007, when it was found at four additional caves in the same vicinity (Blehert et al. 2009). Since that time, WNS has spread rapidly throughout the eastern portions of the northern long-eared bat range in the U.S. and Canada. As of February 2015, WNS was confirmed in 25 of the 37 U.S. States within the species' range and in 5 Canadian provinces (80 FR 18000). Spores of the fungus disperse to new locations primarily through bat-to-bat contact (Kunz and Reichard 2010); however, evidence suggests that humans may also transport spores between locations (USGS National Wildlife Health Center 2014), which is likely how the fungus arrived in North America.

Post-WNS hibernacula counts available from the northeast U.S., where the epizoitic began, show the most substantial population declines for the northern long-eared bat. Turner et al. (2011) compared the most recent pre-WNS count to the most recent post-WNS count for six cave bat species and reported a 98 percent total decline in the number of hibernating northern long-eared bat at 30 hibernacula in New York, Pennsylvania, Vermont, Virginia, and West Virginia through 2011. For the final listing rule, the Service conducted an analysis of additional survey information at 103 sites across 12 U.S. States and Canadian provinces (New York, Pennsylvania, Vermont, West Virginia, Virginia, New Hampshire, Maryland, Connecticut, Massachusetts, North Carolina, New Jersey, and Quebec) and found comparable declines in winter colony size. At these sites, total northern long-eared bat counts declined by an average of 96 percent after the arrival of WNS; 68 percent of the sites declined to zero northern long-eared bat, and 92 percent of sites declined by more than 50 percent. Frick et al. (2015) consider the northern long-eared bat now extirpated from 69 percent of the hibernacula in Vermont, New York, Pennsylvania, Maryland, Virginia, and West Virginia that had colonies of northern long-eared bat prior to WNS. Langwig et al.

(2012) reported that 14 populations of northern long-eared bat in New York, Vermont, and Connecticut became locally extinct within 2 years due to disease.

Long-term summer survey data (including pre- and post-WNS) for the northern long-eared bat, where available, corroborate the population decline evident in hibernacula survey data. For example, summer surveys from 2005 – 2011 near Surry Mountain Lake in New Hampshire showed a 98 percent decline in capture success of northern long-eared bat post-WNS, which is similar to the hibernacula data for the State (a 95 percent decline) (Moosman et al. 2013). Other data (mist-net and acoustic survey data received as comments on the proposed listing rule from State wildlife agencies) indicate that populations have declined following detection of WNS in the state.

Although the dispersal rate of *P. destructans* across the landscape and the onset of WNS after the fungus arrives at a new site are variable, it appears unlikely that any site within the range of the northern long-eared bat is not susceptible to WNS. Some evidence suggests that certain microclimatic conditions may hinder disease progression at some sites, but given sufficient exposure time, WNS has had similar impacts on northern long-eared bat everywhere the disease is documented. Absent direct evidence that some northern long-eared bat exposed to the fungus do not contract WNS, available information suggests that the disease will eventually spread throughout the species' range.

Other Threats

The final listing rule for the northern long-eared bat describes known threats to the species under each of the five statutory factors for listing decisions, of which disease/predation, discussed above, is the dominant factor. We summarize here the findings of the final listing rule regarding the other four factors that are relevant to this consultation.

Human and non-human modification of hibernacula, particularly altering or closing hibernacula entrances, is considered the next greatest threat after WNS to the northern long-eared bat. Some modifications, e.g., closure of a cave entrance with structures/materials besides a bat-friendly gate, can cause a partial or complete loss of the utility of a site to serve as hibernaculum. Humans can also disturb hibernating bats, either directly or indirectly, resulting in an increase in energy-consuming arousal bouts during hibernation (Thomas 1995; Johnson et al. 1998).

During the summer, northern long-eared bat habitat loss is primarily due to forest conversion, and to a lesser degree, unsustainable forest management. Throughout the range of northern long-eared bat, forest conversion is expected to increase due to commercial and urban development, energy production and transmission, and natural changes. Forest conversion causes loss of potential habitat, fragmentation of remaining habitat, and if occupied at the time of the conversion, direct injury or mortality to individuals. Forest management activities, unlike forest conversion, typically result in temporary impacts to the habitat of northern long-eared bats, but like forest conversion, may also cause direct injury or mortality to individuals. The net effect of forest management may be positive, neutral, or negative, depending on the type, scale, and timing of various practices. The primary potential benefit of forest management to the species is perpetuating forests on the landscape that provide suitable roosting and foraging habitat. The primary potential impacts of forest management are greatly reduced with the use of various measures that avoid or minimize effects to bats and their habitat, e.g., limiting the size of clearcuts, avoiding or minimizing timber harvest during the flightless period for bat pups, leaving sufficient numbers of snags and other trees suitable as roosts following harvests, etc.

Wind energy facilities are known to cause mortality of northern long-eared bats. While mortality estimates vary between sites and years, sustained mortality at particular facilities could cause declines in local populations. Wind energy development within portions of the species' range is projected to continue.

Climate change may also affect this species, as northern long-eared bats are particularly sensitive to changes in temperature, humidity, and precipitation. Climate change may indirectly affect the northern long-eared bat through changes in food availability and the timing of hibernation and reproductive cycles.

Environmental contaminants, in particular insecticides, other pesticides, and inorganic contaminants, such as mercury and lead, may also have detrimental effects on northern long-eared bats. Contaminants may bio-accumulate (become concentrated) in the tissues of bats, potentially leading to a myriad of sub-lethal and lethal effects.

Fire is one of the environmental stressors that contribute to the creation of snags and damaged trees on the landscape, which northern long-eared bats frequently use as summer roosts. Fire may also kill or injure bats, especially flightless pups. Prescribed burning is a common tool for forest management in many parts of the species' range.

There is currently no evidence that the natural or manmade factors discussed above (hibernacula modification, forest conversion, forest management, wind energy, climate change, contaminants, fire) were separately or cumulatively contributing to significant range-wide population effects on the northern long-eared bat prior to the onset of WNS).

2.6.3 Little Brown Bat

In 2016, the Service completed a Status Assessment for the Eastern Subspecies of the little brown bat. Although the little brown bat carcasses found under turbines during pre-permit studies have not been identified to subspecies, it is reasonable to assume that the analyses provided in the Status Assessment apply to this covered bat species.

In the 2016 Status Assessment, the Service determined that WNS is a significant stressor on this species (USFWS 2016f). The Service evaluated 165 winter hibernacula where WNS had been confirmed or suspected for 2 or more years. At all but two sites, post-WNS populations had declined, and the median change in population was -95% (range +84 to -100%). In the Midwest specifically, 32 hibernacula in Illinois, Indiana, Missouri, and Ohio were examined and the median change in hibernating population was estimated to be -88% within four years of the confirmation of WNS (USFWS 2016f). Also, of these 32 hibernacula, approximately half declined between 80 and 100% within those four years. The Status Assessment notes that the WNS has been present longer in the northeast than in other regions and that more severe declines have been observed in this region than others (median change of -93% and 89% of 95 studied hibernacula declined between 80 and 100%).

According to www.whitenosesyndrome.org, WNS was first suspected in the northeastern part of Iowa in the winter of 2011-2012, and first confirmed in the southeastern part of Iowa in the winter of 2014-2015. The following winter (2015-2016), it was confirmed in the central part of the state, and no new confirmations have been noted between 2016 and the present..

2.6.4 Tricolored Bat

In the 90-day Finding on a Petition to List the Tricolored Bat as Threatened or Endangered under the ESA (90-day Finding) the Service found that the petition to list had substantial supporting information regarding the threats to the species posed by logging, natural gas development, mine closures, environmental contaminants, effects of climate change, and wind energy operation. The Service also found that the petition to list provided substantial information about WNS as a threat to the species that may warrant listing due to the effects of this disease.

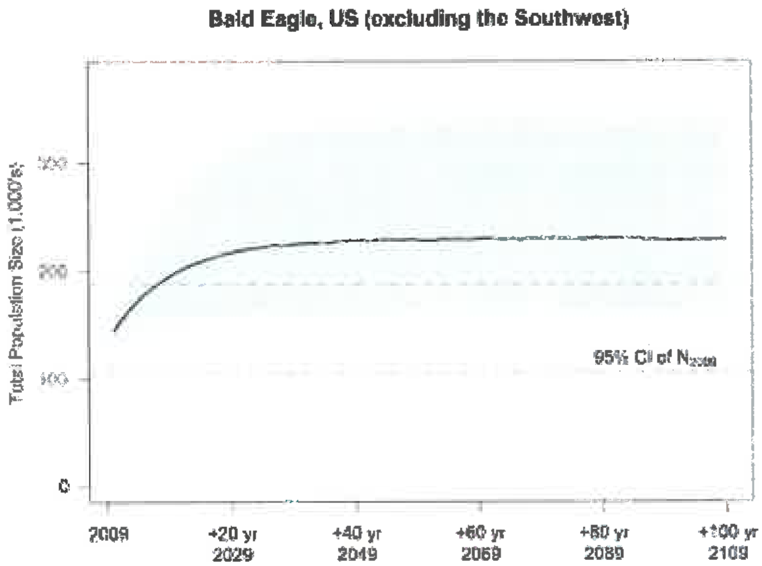
The effects of WNS on tricolored bat have not been as extensively documented as the effects on little brown bats, Indiana bats, or northern long-eared bats. However, Frick et al. (2015) reports that approximately 10% of tricolored bat winter colonies in the Northeast went extinct in the seven years after WNS emerged in New York. This is lower than the colony extinction rate for Indiana bats and northern long-eared bats (17% and 69%, respectively), but higher than the colony extinction rate for little brown bats (6%). They also estimate that tricolored bats have a similar relationship between probability of extinction and colony size to the other *Myotis* bat species, with larger winter colonies having a greater probability of survival than smaller colonies (Frick et al. 2015).

In their study area in the eastern U.S., Ingersoll et al. (2016) noted steady declines in WNS-affected populations that began prior to the first local detection of WNS. However, non-WNS population trajectories were flat, which is in contrast to non-WNS populations of little brown bats and northern long-eared bats, which varied or were notably declining both before and after the first local observation of WNS. Based on this finding, it is reasonable to conclude that WNS is a primary driver of population declines of tricolored bat populations, and that infected populations will exhibit a steady downward decline.

2.6.5 Bald Eagle

Bald eagle populations across the United States have been increasing and are expected to continue to do so for approximately the next 30 to 40 years (USFWS 2016a). Figure 2.6 illustrates the current expected increase and plateau of the bald eagle population in the U.S. (excluding the Southwest). Bald eagles continue to be impacted by several sources of take, including but not limited to collision with structures, electrocution, predation, disease, poison, habitat/nest destruction, and shooting (Russell and Franson 2014). The Service, in cooperation with the National Eagle Repository, tracks both permitted and unpermitted take to monitor and ensure the integrity of eagle populations across the U.S.

Figure 2.6-1. Projected bald eagle population in the United States extracted from USFWS 2016a.



3.0 ENVIRONMENTAL BASELINE

Environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

The purpose of the environmental baseline is to describe past and ongoing human and natural factors that have contributed to the current status of the species and its habitat in the project action area. Range-wide factors affecting the species include those listed previously under Reasons for Decline.

3.1 STATUS OF THE COVERED SPECIES IN THE ACTION AREA

3.1.1 Indiana Bat

Currently, the Indiana bat is known to occur across the southeast quadrant of Iowa, from Guthrie County west to the Mississippi River, and Boone County south to the Missouri State line. The most recent Ozark Central Recovery Unit (OCRU) population estimate (2017) indicates that there are approximately

271,254 Indiana bats in the OCRU. There is a large recently protected hibernacula in northeast Missouri containing approximately 197,419 Indiana bats. It is logical to assume that a large proportion of those bats can be expected to migrate into southeast Iowa, but the total Iowa-specific population isn't currently known. For the purposes of this biological opinion, we will use the current population of this hibernaculum (197,419) in the effects analysis because it is the population unit from which the take could most reasonably be expected to occur.

3.1.2 Northern Long-Eared Bat

3.1.2.1 Population Estimate Methodology

There are no exact population size estimates for northern long-eared bats in Iowa nor range-wide (Federal Register, Vol. 80, NO. 63). Because there is no way to directly count the number of northern long-eared bats in Iowa, we estimate population numbers using what we know about the amount of forested habitat in the state, the percent of that suitable habitat occupied by northern long-eared bats, the home range size for northern long-eared bats, and the number of bats that likely occupy that home range (bat density). We believe that the most accurate and up-to-date information about northern long-eared bats in Iowa comes from the three core studies, cited below, that were conducted in 2016, 2017, and 2018 under Phase I and Phase II of the HCPPA grant. The values derived from these studies and other relevant assumptions are described below.

1) *There are 2,875,600 acres of forested land in Iowa.*

- This number is taken from the recent (2017) inventory taken by USFS Forest Inventory and Analysis program, reported here: https://www.fs.fed.us/nrs/pubs/ru/ru_fs145.pdf

2) *The average home range size for an individual northern long-eared bat is 167.3 acres.*

- In the 2017 migration study by Copperhead Consulting, the average home range in central Iowa was calculated to be 167.3 ± 33.6 acres for foraging northern long-eared bats, most of which was forested acres (Roby et al. 2018). We believe that this Iowa study represents the best available information regarding northern long-eared bat home range size in Iowa. Other telemetry-based studies in other states also estimate a relatively small mean summer home range size for individual northern long-eared bats: 161 acres in West Virginia (range 44–241) (Owen et al. 2003); and 179 acres in Kentucky (range 46–425) (Lacki et al. 2009b). The fact that these other home range studies showed a similar size corroborates this value.

3) *The percent occupancy of suitable forested habitat is 58.2%.*

- Acoustic sampling was conducted by Iowa State University in the summer of 2016 (under Phase I of an HCP Planning Assistance grant received by the IADNR in partnership with MEC). Survey teams placed acoustic detectors in suitable habitat in 60 counties in Iowa, with two unique sites per county. All 120 sites were in different HUC 12 watersheds and were greater than 3 miles apart. According to maximum likelihood (MLE) values where both programs agreed, northern long-eared bats were present in 93 out of the 120 sites. These sites were concentrated in north-central and south-central Iowa. Fewer sites were documented in southwest Iowa, and the fewest were documented in northwest Iowa. Based on 2016 results, northern long-eared bats occupied 77.5 % of the suitable forested habitat sampled (Baker and Blanchong 2017).

- Iowa State repeated this sampling protocol in 2017, and most sites were selected in HUC 12 watersheds that were not sampled in 2016. This was under Phase II of the HCPA grant. A subset of the 2016 sites were repeated in 2017. A total of 116 sites were sampled in 2017, new and resampled sites inclusive. According to MLE values where both acoustic analysis programs agreed, northern long-eared bats were present in 70 out of the 116 sites. Again, more sites were documented in north-central Iowa, but southwest Iowa had more occupied sites in 2017. Based on 2017 results, northern long-eared bats occupied 60.3% of suitable forested habitat. (Baker and Blanchong 2017).

- A third year of acoustic sampling was conducted by Iowa State University covering 30 sites. Fifteen of these sites were resampled and fifteen were new sites. According to MLE values where both acoustic analysis programs agreed, 11 out of 30 sites had positive MLE values for northern long-eared bats, yielding a 36.7% occupancy rate.

- Among the three sampling years, northern long-eared bats occupied an average of 58.2% of the suitable forested habitat sampled. Note that this is a higher rate than is reported in the 4d rule BO (41.7%) and the previous BO for Phases I and II (37%). However, we feel that the most accurate sources of information for percent occupancy are these studies because they cover the majority of Iowa, samples were collected during the same seasons, and sampling was conducted with acoustic detectors which are expected to have a greater detection rate than mist-netting and therefore more accurately reflect occupancy.

4) *Population density of northern long-eared bats is assumed to be between 15 and 23 bats per the average 167.3 acre home range, with males, females, and juveniles inclusive.*

- Acoustic detection data is not suitable for estimating population size because it is impossible to distinguish between one bat making multiple calls and multiple bats consecutively making one call. Therefore, we must rely on mist-netting to estimate the density of bats on the landscape. To the best of the Service's knowledge, no mark-recapture studies have been done in Iowa to estimate local population sizes. The most recent information and site-specific information that we have comes from the netting done in August in support of the two fall migration studies conducted in 2016 and 2017 under Phase I and Phase II of the HCPA grant, described below.

- Extensive mist-netting was conducted by WEST, Inc. during the 2016 fall migration studies, respectively. The earliest long-distance movements (attributed to migration) were observed during the first week of September (except one bat on August 29, 2016). Therefore, we consider bats caught during the August portion of the study to represent summer bat populations. Fifteen bats were captured in August within the core study area, which was approximately 105 acres.

Only one bat was recaptured, so we infer that the population size in this area was at least 15 bats. Furthermore, we assume that the bats caught in August consist of all sexes and ages present on the landscape because both males and females that were reproductive, post-lactating, and non-reproductive were captured during the netting.

- During the 2017 migration study by Copperhead Consulting, no single parcel area was netted as extensively in August as in the WEST study, and netting began during the last week of August. However, over four nights of netting in August within five separate locations, 10 northern long-eared bats were captured, which is a rate of 2.5 bats per night. In the 2016 study, the 15 northern long-eared bats were captured on nine separate nights, which is a rate of 1.6 per night. (We note that bat captures per net-night would be a better comparison metric, but the Service does not have that information for the WEST study, currently.) Because the capture rate was 1.5 times higher at the 2017 sites, we infer that northern long-eared bat density in the areas could be at least 23 bats per 167.3 acres (the average home range) in the 2017 study areas.

- We chose to calculate a range of population numbers using bat densities of both 15 and 23 bats per 167.3 acres. If northern long-eared bat populations are present in higher densities in areas with more habitat and hibernacula (e.g. the 2017 study area), and in lower densities in areas with less habitat and potential hibernacula (e.g. the 2016 study), then it follows that the total population in the state is probably somewhere in between. It is important to note that mist-netting only captures a small sample of the bats flying in an area on a given night. So, it is very possible that the actual population may be larger than the values presented.

3.1.2.2 Current Population Estimate of Northern Long-Eared Bats in Iowa

Based on the above parameters, we use the following formula for estimating the northern long-eared bat population in Iowa:

(Acres of forest in Iowa × occupancy rate) ÷ (acres per northern long-eared bat home range) × (number of bats occupying a home range) = Estimated number of northern long-eared bats in Iowa

Using 15 bats or 23 bats per 167.3 acre home range, respectively, yields:

Using 15 bats per 167.3 acre home range: (2,875,600 x .582) /167.3 x 15 = 150,054 northern long-eared bats in Iowa

Using 23 bats per 167.3 acre home range: (2,875,600 x .582) /167.3 x 23 = 230,082 northern long-eared bats in Iowa

Based on the above, we believe a reasonable estimate of the northern long-eared bat population in Iowa is between approximately **150,000** and **230,000** bats.

We note here that the northern long-eared bat population values reported are slightly different than those used in the FEIS for this project (102,330 northern long-eared bats). The reason is that the study results used in this BO were not available at the time of the analysis done for the FEIS

3.1.2.3 Other Northern Long-Eared Bat Iowa Population Estimates Considered but Dismissed

Three other Service BOs have attempted to estimate northern long-eared bat populations in Iowa. They are described in brief, below, for comparison. We chose to use the northern long-eared bat population estimate above because it incorporates the best and most current available information about the species in Iowa.

Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities Excepted from Take Prohibitions:

This document, dated January 5, 2016, used approximately 3 million acres of forested habitat in Iowa, a 41.7% occupancy rate combined with assumptions about the ratio of males to females, maternity colony size, and maternity colony home range to estimate bats in Iowa and other states across the range. This method yielded an estimate of 102,330 total adults and 51,165 pups for a total of 153,495 northern long-eared bats in Iowa.

Biological Opinion for the Habitat Conservation Planning Assistance Grant to the Iowa Department of Natural Resources; Phase III

This document, dated June 4, 2018, used occupancy and home range data collected on northern long-eared bats in conjunction with Phases I and II of the HPPA Grant to estimate the population of northern long-eared bats in Iowa. The estimate was between 177,899 and 272,778 northern long-eared bats.

Biological Opinion for the Habitat Conservation Planning Assistance Grant to the Iowa Department of Natural Resources; FY2015 Cooperative Endangered Species Conservation Fund Grant Program

This document, dated August 26, 2015, used three different methods to provide population estimates for Iowa. One used home range and colony size from the literature combined with Iowa occupancy rates to estimate 83,142 northern long-eared bats. The second extrapolated northern long-eared bat occurrence and density data from acoustic surveys conducted at MEC wind projects, yielding 208,963 northern long-eared bats. The third used the total Midwest population estimate from the northern long-eared bat Listing Package divided by the forested area in Iowa to produce an estimate of 212,000 northern long-eared bats

3.1.3 Little Brown Bat

3.1.3.1 Current Population Estimate of the Little Brown Bat in Iowa

The most recent and robust estimate of little brown bat population size that we could find in the literature comes from Russell et al (2014). In this paper, little brown bat populations east of the 100th meridian (the eastern half of the US) were modeled based on several factors, including potential hibernacula locations, estimated overwintering population sizes in known hibernacula, information from state field biologists, and an expert elicitation. The result was a pre-WNS mean population estimate of approximately 8 million bats.

Russell et al (2014) further provides an estimated mean number of little brown bats in hibernacula by county for each of the states in the study area. According to their estimates, 84 of the 99 counties in Iowa contain between 1 and 5,000 overwintering bats. This yields a state-wide estimate of between 84 and 420,000 little brown bats, the midpoint of which is 210,000.

Alternately, the distribution of the 8 million little brown bats can also be coarsely extrapolated to Iowa using forest resources. Of the 18 states east of the 100th meridian studied in Russell et al (2014), Iowa contains approximately 1.55% of the forest resources (forest land area data taken from USFS forest fact sheets, accessible from https://www.fs.fed.us.) Making the broad assumption that little brown bats are evenly distributed among the forest resources, it could also be inferred that 1.55% of the 8 million little brown bats estimated in the study occur in Iowa. This yields an estimate of approximately 127,000 little brown bats in Iowa. This estimate does not account for the fact that little brown bats very often use man-made structures, such as barns, and are not solely reliant on forested resources for foraging. This estimate also does not account for variability in the density of little brown bats across the landscape. Because of these caveats, we believe that 127,000 little brown bats likely represents a reasonable lower bound of little brown bats in Iowa.

3.1.3.2 Other Little Brown Bat Population Estimate Methods Considered but Dismissed

Little Brown Bats in the Acoustic Data Collected Through the Section 6 HCPPA

In conjunction with the northern long-eared bat acoustic information, as described above, Iowa State University also analyzed acoustic data for little brown bat occurrences. The results varied widely depending on the automated acoustic analysis program used to process the data. In Phase I, little brown bats were present in either 92 or 23 out of 120 sites (BCID = 92, Echoclass = 23). In Phase II, little brown bats were present in 90 or 9 sites out of 116 (BCID = 90, Echoclass = 9). And in Phase III, little brown bats were present in 22 or 1 out of 30 sites (BCID = 22, Echoclass =1). There is such disparity in these results that we do not believe this information can be used to confidently determine a percent occupancy of habitat by little brown bats and relate that to an Iowa population estimate, as we have done for northern long-eared bats. This species also inhabits man-made structures across the landscape (Benedict et al. 2017), and we do not have enough information to confidently determine the percent occupancy of this habitat resource either. Therefore, we rely on the population estimates provided in the above section.

Little Brown Bat Population Estimates from the MEC HCP and FEIS

The MEC HCP presents two alternative estimates of the little brown bat population in Iowa. These estimates are provided in Section 3.4.6.2 of the HCP, and are 118,496 and 470,709. The FEIS prepared for the proposed action relies on the data in Russell et al (2015) and assumes that the little brown bat population is approximately 420,000 individuals. We chose to use the above methodology to estimate the little brown bat population in Iowa because it incorporates the best available information we were able to find regarding the population of this species in the literature.

3.1.4 Tricolored Bat

3.1.4.1 Population Estimate Methodology

While there are no rangewide or statewide population estimates for tricolored bats, we can establish a rough estimate of tricolored bats in Iowa for the purposes of our impact analysis. The most accurate and current information about tricolored bat occurrence in Iowa comes from the 2017 and 2018 Iowa State University acoustic studies conducted under Phase II and Phase III of the HCPA grant (Baker and Blanchong 2018). These studies provide a percent occupancy of forested habitat across Iowa. When percent occupancy is combined with available habitat, home range size, and bat density across the landscape, we can establish a general estimate of tricolored bat populations in Iowa. The values derived from these core studies and other relevant assumptions are described below.

1) *There are 2,875,600 acres of forested land in Iowa.*
   This number is taken from the most recent inventory reported by USFS Forest Inventory and Analysis program (2017), found here: https://www.fs.fed.us/nrs/pubs/ru/ru_fs145.pdf

2) *The average roost area per tricolored bat is 6.85 acres.*
   For the purposes of estimating a population size for Iowa, we are assuming that individual tricolored bats have a roosting area of approximately 2.3 ha (5.7 acres). We also assume maternity colonies have an average roosting area of 22.8 ha (56.3 acres). Assuming an average maternity colony size of 7 bats, this is approximately 8 acres per bat. The average of 5.7 acres and 8 acres is 6.85 acres per bat, males, females, and juveniles, inclusive. (See section 2.3 for a discussion of tricolored bat roosting habits and maternity colonies.)

3) *The percent occupancy of suitable forested habitat is 34%.*
   Acoustic sampling was conducted by Iowa State University in the summers of 2016, 2017, and 2018 as described above for the population estimate of northern long-eared bat in Iowa. Percent occupancy for tricolored bats was not reported for 2016, but it was reported for 2017 and 2018. Based on sites where BCID and Echoclass both agreed that presence of tricolored bats was likely (MLE p-value of < 0.05), tricolored bats occupied 33 out of 116 sites in 2017, and 12 out of 30 sites in 2018. This yields a result of 28% occupancy in 2017 and a 40% occupancy in 2018, for an average of 34% occupancy.

3.1.4.2 Current Population Estimate of Tricolored Bats in Iowa

Based on the above parameters, we use the following formula for estimating the tricolored bat population in Iowa:

(Acres of forest in Iowa × occupancy rate) ÷ (acres per tricolored bat) = Number of tricolored bats in Iowa

(2,875,600 x 0.34) /6.85 = 142,730 tricolored bats in Iowa

3.1.4.3 Other Tricolored Bat Population Estimate Methods Considered but Dismissed

The MEC HCP presents three other methods of estimating the tricolored bat population in Iowa. These estimates are provided in Section 3.5.6.2 of the HCP, and range from 10,311 to 294,603 bats, with a median of 161,731 bats. The FEIS prepared for the proposed action assumes that the tricolored bat population is at least as big as the estimate of northern long-eared bat populations in Iowa (calculated in that document to be 102,330 bats). We choose to use the tricolored bat population estimate above because it incorporates the best and most current available information about the species distribution and abundance in Iowa.

3.1.5 Bald Eagle

Iowa is in the USFWS Mississippi Flyway eagle management unit which supports the highest density of eagles after Alaska (USFWS 2016a). Major river systems, such as the Des Moines, Missouri, and Mississippi rivers, harbor the largest concentration of eagles during the winter. Lower occurrences can be found on the Iowa, Skunk, Wapsipinicon, Turkey, South Maquoketa, Maquoketa, and Cedar rivers.

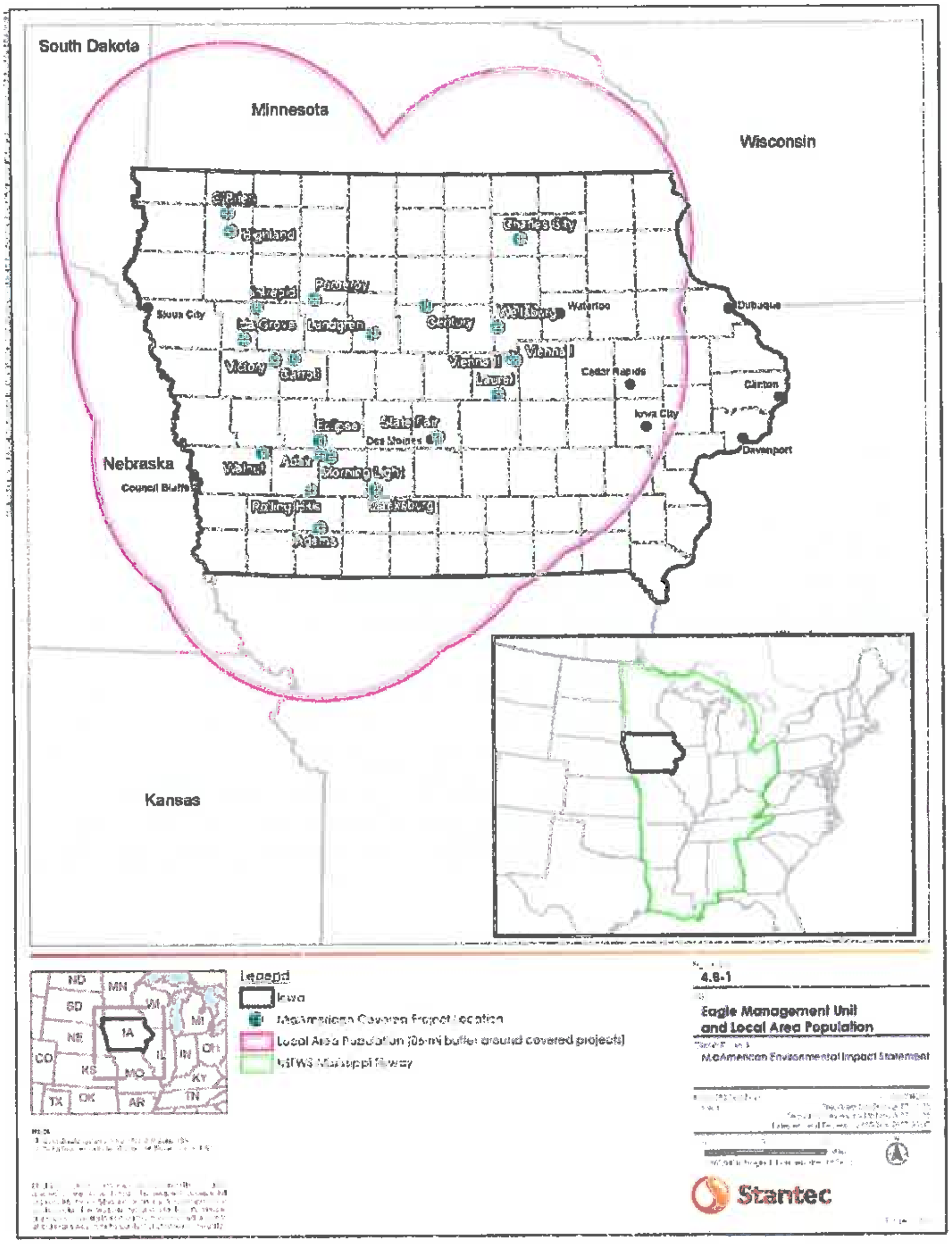
Eagle nests have been reported from all 99 counties in Iowa, and over 863 territories have been reported to the IADNR since 1977 (IADNR 2016, as cited in MEC 2017). In 2016, 412 territories were documented as "active" by the state, and 238 had an unknown activity status (IADNR 2016). Thus, the actual number of active nests likely ranges between 412 and 650 (assuming some of the unknown nests were active), though it may be higher due to nests which have not been reported to the IADNR. An upward trend of nesting bald eagles in Iowa has been reported by the IADNR since the delisting of the bald eagle (Shepherd 2018)

The Service manages bald eagle take at two geographic scales, regional Eagle Management Units (EMUs) and the Local Area Population (LAP), which are both discussed in detail below and shown on Figure 3.1.

3.1.5.1 Mississippi Flyway Eagle Management Unit

Iowa falls within the Mississippi Flyway EMU (Figure 3.1-1), which has a population of 31,706 eagles (USFWS 2016c). A sustainable take rate threshold of 6% has been established by the Service within this Flyway.

Figure 3.1-1. MidAmerican Project Locations



3.1.5.2 Local Area Population

To determine the local area population for MEC, an 86 mile. buffer was placed around the 22 covered projects (the natal dispersal distance for bald eagles; USFWS 2016b), which results in a total area of approximately 84,874 square miles. The density of bald eagles within the Mississippi River Flyway is estimated at 0.045 eagle per square mile, resulting in a bald eagle population estimate of 3,819 bald eagles. The impact of taking 10 bald eagles per year represents 0.26% of the LAP, which is well below the sustainable take threshold of 5% set by the Service (USFWS 2016b).

3.2 FACTORS AFFECTING THE COVERED SPECIES WITHIN AND ADJACENT TO THE ACTION AREA

3.2.1 White Nose Syndrome

All four covered species of bats are hibernating bats that are affected by WNS. It is difficult to predict exactly how WNS will impact these species in Iowa over the term of this biological opinion. Some states have seen significant declines in bat populations three years after WNS detection, and others have experienced a longer lag between detection and declines (https://www.fws.gov/midwest/endangered/mammals/nleb/ nlebFinalListFAQs.html, accessed 1 Jun 2018). Frick et al. (2015) examined multiple winter colonies of hibernating bat species in North America and Europe to explore how WNS alters local abundance patterns of bats. They studied the effects of WNS on local populations during the first seven years after WNS emergence and found that the declines in median abundance of bat populations post-WNS ranged from 60-98%, depending on species. In all species except northern long-eared bats, the probability of local extinction was significantly related to the pre-WNS size of the colony. In northern long-eared bats, colony size prior to WNS emergence made no difference in the probability of extinction (Frick et al. 2015). Ingersoll et al. (2016) noted that populations of little brown bats and northern long-eared bats appeared to be declining prior to the first documentation of WNS in the studied populations. However, tricolored bat populations were stable until WNS was detected, and non-affected populations remained stable through the period of study.

It is reasonable to expect that populations of all covered bat species will have declined due to WNS when the term of this BO has concluded. We have applied the bat population dynamics model (Erikson et al. 2014), hereafter referred to as the "Thogmartin Model," to analyze the effects of the proposed take on the covered *Myotis* bat species (see Chapter 4 below). This model was designed as a general *Myotis* model (Thogmartin, pers. comm. 2019), but we can also make logical inferences from the model and apply them to the tricolored bat analysis, as explained in Chapter 4, below. This model provides for the effect that WNS is expected to have on the populations of bats affected by the covered wind projects when it is predicting the impacts to the species of the permitted take. In this way, we have accounted for the declines in covered bat populations due to WNS in our impact analyses.

3.2.2 Known Covered Species Fatalities from Wind Turbines and Currently Permitted Wind Projects in the Upper Midwest

Two Indiana bat carcasses have been reported to the Service from Illinois and Iowa (one each) in the 2005-2019 timeframe. Additionally, five northern long-eared bat carcasses have been reported over the same timeframe (three from Illinois, two from Iowa). To-date, six take permits have been issued to wind facilities in Region 3. The Fowler Ridge Wind Farm in northwestern Indiana is currently authorized to take 184 Indiana bats over the project's permitted life (2014-2035), which is approximately nine bats per year. The Wildcat Wind Farm in central Indiana is permitted to take up to 162 Indiana bats and 81 northern long-eared bats over a 27 year permit term. The Headwaters Wind Farm, in east-central Indiana, is permitted to take 258 Indiana bats and 68 northern long-eared bats over the 27 year permit term. The Pioneer Trail Wind Farm Project in east-central Illinois has been authorized to take 129 Indiana bats and 86 northern long-eared bats over a 43 year permit term. The Hoopeston Wind Farm, also in east-central Illinois is authorized to take 60 Indiana bats and 60 northern long-eared bats over the 30 year permit term. A take permit also has been issued to the Buckeye Wind Project in Ohio for the taking of up to 130 Indiana bats over a 25-year permit term, but this facility is not yet operational. Of these, Fowler Ridge, Wildcat, and Buckeye are in the Midwest Recovery Unit, and the Pioneer Trail Wind Farm and the Hoopeston Wind Farm are in the OCRU, but are located on the border between the Midwest and OCRU.

At present, 49 little brown bat carcasses from Illinois and Iowa have been reported to the Service from non-MEC wind projects between 2005 and 2018. Thirty one of these carcasses were reported from one facility in Iowa outside of the MEC project action area. Five were reported from a single turbine project in Illinois, and the remaining 13 were reported from other facilities in Illinois. Sixty-two tricolored bat fatalities from Illinois and Iowa have been reported to the Service during the same timeframe, and there is no discernable pattern to those fatalities. We do not have access to fatality records for these two species from other wind facilities in Region 3. No other wind HCP's in Region 3 have little brown bats or tricolored bats as covered species.

The Rock Creek Wind Project in Missouri falls within the Mississippi River Flyway Eagle Management Unit. It currently holds a BGEPA incidental take permit for the take of approximately 18 bald eagles per year.

3.2.3 Other Factors

The covered projects (actual wind energy facilities) portion of the action area is expected to continue to produce agricultural crops as normal, and no major land use changes are expected during the term of the action. Some agricultural crops may be cleared around turbines to facilitate mortality searches, but this is not expected to impact covered species. No commercial development greatly altering bat habitat in or immediately adjacent to the action area is expected, as these communities are agricultural-based. Occasionally, landowners clear forested areas for timber harvest or other reasons. However, the extent of this potential future clearing, if any, cannot be predicted.

Regular federal actions having the most effect on the covered species currently in Iowa include those actions that include tree clearing as a component of the project. Clean Water Act-permitted projects, roadway projects, pipeline installations, transmission line development and maintenance, and waterway alteration projects generally have a federal nexus and therefore constitute federal actions. Endangered species impacts of these federal actions are analyzed under section 7 of the ESA.

4.0 EFFECTS OF THE ACTION

The effects of the action are "all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action." (See 50 CFR § 402.17).

4.1 ESTIMATED INCIDENTAL TAKE

4.1.1 Covered Bat Species

All covered bat species are residents or migrants through the Midwest, and have the potential to collide with spinning turbine blades, which usually causes mortal injury or death. Additionally, flying in very close proximity to spinning turbine blades may cause barotrauma to bats, which may also be lethal. The operation of the covered projects, which involve spinning of wind turbine blades to generate electricity, is expected to cause lethal take of the covered species.

Under the section 6 HCPPA studies, MEC collected fatality data across the covered projects and calculated the estimated take of the projects for the permit term. Fatality monitoring under wind turbines involves searchers visiting turbines periodically to look for fallen carcasses. It is impossible to directly count all fatalities of animals struck by turbines. For example, carcasses can be carried off or consumed by scavengers. Carcasses are also difficult to see, and not all are found by searchers. It is also impractical to search all of the area in which carcasses may fall because of the time it would take and the requirement to clear and maintain thousands of acres of farmland around wind turbines. Therefore, carcass counts must be corrected to account for these factors.

When carcass counts are corrected, there is a degree of uncertainty in fatality estimates, even after applying correction factors. Estimates of take from fatality data – and predictions based on those data – have confidence intervals around them. That is, fatality estimates and associated take predictions are described as a mean prediction within a range of values. Actual fatalities are likely to occur within that range with a specified probability. For example, we may predict that a facility is likely to have killed between X and Y bats each year and that there is a 90% chance that actual fatalities will fall within that range. The higher the specified probability (e.g. 90%), the greater certainty one has that the actual bats killed per turbine is within the specified range.

MEC has analyzed the data from the aforementioned fatality studies, adjusted estimates for the reductions expected from the cut-in speed adjustments and provided two estimated take numbers for covered bats in their HCP. The first number, the "implementation take" is the mean number. This number is most commonly used to describe fatality rates of bat species among wind energy researchers. However, as explained in the above paragraph, this number always has an upper and lower confidence interval around it, because of the unavoidable uncertainty associated with carcass searches. The second number is the "authorized take". This number is the upper bound of the 90% confidence interval. MEC has stated in the HCP that the implementation take rate for covered bat species is the take that is expected, and have based their up-front mitigation measures on this value. However, MEC has requested that they be permitted at the "authorized take" level, and have provided adaptive management triggers and measures to add additional conservation measures and mitigation, should their take exceed the implementation take. We believe that it is reasonable to apply the mean take rate and the 90% confidence interval of that take rate from the pre-permit monitoring to the projected take estimates, as is described in the HCP. The detailed methods of take estimation can be found in Appendix D of the HCP, and are incorporated here by reference.

The Service finds that this approach uses the best available data and provides the greatest certainty for our impact analyses on the covered bat species. By issuing the permit and analyzing the impacts at the authorized take level, we will have accounted for the uncertainty inherent in bat fatality monitoring and estimating take over 30 years. Should adaptive management measures be triggered during the course of the permit due to take rates that are higher than the implementation take, the Service will have already analyzed the impacts to the covered species, up to the authorized take under the permit.

Table 4.1-1. Summary of Implementation and Authorized Take Rates at MEC Covered Projects.

Type of Take	Indiana Bat	Northern Long-Eared Bat	Little Brown Bat	Tricolored Bat
Implementation Take, Annual	10	9	640	387
Authorized Take, Annual	25	21	736	459
Total Implementation Take (30 years)	300	270	19,200	11,610
Authorized Take, Permit Limit (30 years)	750	637	22,099	13,774

This take is expected to be distributed fairly evenly across the project area and permit period, at the rate described. However, due to environmental stochasticity, this number may vary from year to year and potential take could occur more frequently at a subset of facilities than at the rest. Adaptive management measures are in place, however, to ensure that the take across the action area stays below the authorized level. Take coverage will begin upon signature of the section 10(a)(1)(B) permit and all other required documents, including this biological opinion. Take coverage will be in effect for thirty years.

4.1.2 Bald Eagle

A complete description of take estimation methods for bald eagles is presented in Appendix D of the HCP. MEC explored multiple methods to estimate take, including the Bayesian collision risk model, as referenced in the Service's Eagle Conservation Plan Guidelines with priors developed from data collected on golden eagles in the western United States (Method 1), the Bayesian collision risk model adapted to include priors developed from the site-specific bald eagle use and fatality data collected at the projects during the pre-permit studies (Method 2), and the USGS Evidence of Absence model (Method 3). These methods estimated annual take of bald eagles at 6.94, 9, and 6 individuals. MEC has estimated their requested take using the Bayesian collision risk model adapted to include priors developed from bald eagle use and fatality data collected at the project sites (Method 2). More specifically MEC has requested a take of 10 eagles per year for the duration of the permit, which is 10% higher than the 80th percentile (9) to account for uncertainty around growing eagle populations over the term of the permit. The Service estimates that the current population of bald eagles (excluding the southwest) is approximately 200,000 breeding pairs. During the permit, the population is expected to grow to approximately 220,000 breeding pairs (a change of approximately 10%) and stabilize, according to the Population Demographics and Estimation of Sustainable Take in the United States, published by the Service in 2016. We therefore find that the use of the 80th percentile and the 10% accommodation for eagle population growth is reasonable and provides credibility that the Service is conservatively analyzing the potential impacts to the bald eagle.

Table 4.1-2. Summary of Implementation and Authorized Take Rates at MEC Covered Projects.

Type of Take	Bald Eagle
Annual Take Rate	10
Total Take (30 years)	300

4.1.3 Mitigation Measures

Bat mitigation actions will consist of restoration or preservation of forested habitat and creation or restoration of artificial roost structures. More specifically, bat mitigation actions are expected to include tree planting, girdling, thinning, invasive species control, prescribed fire, and other silviculture practices, as well as building or maintenance of artificial roost structures. Details of the mitigation measures, parameters for mitigation parcel selection, and focal areas for the placement of mitigation lands are in Section 5.3.3 of the HCP. The mitigation is designed to have a beneficial impact on the covered species and offset the impact of the permitted take. The amount of forested habitat mitigation needed to fully offset the impact of the permitted take was calculated with the Services 2016 Bat Resource Equivalency

Analysis models (USFWS 2016c, USFWS 2016d, USFWS 2016e), and accounted for potential foraging competition among the covered bat species. See also Section 5.3.3 of the HCP and Appendix G of the HCP.

The bat mitigation actions (forest restoration and/or preservation) will be conducted in areas that are occupied by the covered species. Forested habitat restoration is expected to connect and enlarge existing forested areas and provide additional foraging areas to support bat populations. Over time, forested habitat restoration areas are expected to mature and eventually provide roosting habitat. Forested habitat protection and stewardship will protect and improve the quality of occupied forested habitat for the covered species.

Bald eagle mitigation measures will support the sustainability of eagle populations in Iowa through rehabilitation efforts of injured eagles, habitat projects, and/or abatement of toxic substances. Each of these measures is expected to reduce stressors and/or injury to bald eagles. Rehabilitation will support the reintroduction of previously injured bald eagles into the wild. Habitat projects are expected to provide additional summer nesting or winter roosting opportunities for bald eagles in the state. Reducing the exposure of eagles to toxic substances through education efforts and toxic substance exchange programs is expected to increase the survival rate of bald eagles in the wild.

4.2 CONSERVATION MEASURES

The applicant has committed to conservation measures that are expected to reduce fatality rates of the covered species. These include feathering turbine blades below certain wind speeds at select times of the year in specific locations to minimize bat fatalities. They also include carrion removal and landowner education to reduce attractants for bald eagles. Detailed descriptions of the conservation measures are found in Section 5.3 of the HCP.

The applicant will fully offset the impact of the taking through strategic forested habitat conservation/restoration, maintaining or creating artificial roost structures, toxic substance abatement programs, and rehabilitation programs. Take rates will be monitored throughout the permit term, and adaptive management triggers and actions are in place to ensure that the take rates of covered species are not exceeded and are fully mitigated. In addition, the applicant has committed to reevaluating the impact of the permitted take if covered bat populations fall below 80% of current levels by conducting a population viability analysis. Additional minimization and/or mitigation measures will occur, if warranted. A complete description of conservation measures, adaptive management, changed circumstances, and mitigation measures are found in Chapters 5 and 8 of the HCP and are incorporated into this document here by reference.

4.3 EFFECT OF THE TAKE

4.3.1 Indiana Bat

Due to the large geographic scale of the project, the smallest population level at which the take can be meaningfully attributed is at the hibernacula level. The closest known hibernaculum to the population of Indiana bats in Iowa is located in east central Missouri. This hibernaculum is currently estimated to contain approximately 197,419 Indiana bats. The 25 total bats (authorized take) that could be taken annually in the MEC project area comprise approximately 0.012% of this population. The Service used the Thogmartin Model (Erickson et al. 2014) to evaluate the probability of extinction of the hibernacula population with no project take and with the authorized project take occurring. According to the model output, there was no difference between the two scenarios (probability of extinction in 50 years = 0.00%). Given that the effect of the take at the hibernacula level was negligible, the effect of the take on the survival and recovery of the species at the recovery unit and rangewide level, which have larger population sizes, is also expected to be negligible.

4.3.2 Northern Long-Eared Bat

As described above in Section 3, Environmental Baseline, the smallest population unit for which we can reasonably estimate northern long-eared bat population size is at the scale of the state of Iowa, which we have estimated to have a population of between 150,054 and 230,082 bats.[3] We currently do not have information about population sizes at smaller units, such as hibernacula. Twenty-one bats taken annually from the Iowa population is approximately 0.014% to 0.009% of that population. As with the Indiana bat analysis, the Thogmartin Model was used to evaluate the probability of extinction at the statewide population level with the authorized project take and without the project take. According to the model, there was no difference between the two scenarios (probability of extinction in 50 years = 0.00%) under either population estimate. Given that the effect of the take was negligible on the population of northern long-eared bats in Iowa, it is reasonable to conclude that the effect of the take on the survival and recovery of this species across its range will also be negligible.

4.3.3 Little Brown Bat

As described above in Section 3, Environmental Baseline, we estimate that the population of little brown bats in the state to be approximately 127,000 bats. Therefore, 736 bats taken from this population annually constitutes 0.57% of the statewide population. The Service used the Thogmartin Model to evaluate the probability of extinction of the statewide population with no project take and with the authorized project take. According to the model output, there was no difference between the two scenarios (probability of extinction in 50 years = 0.00%) under either population estimate. Given that the

[3] Northern long-eared bat populations are not structured according to political boundary lines. However, we chose to estimate the population within the boundaries of the state because there is not currently a way to describe the species' population structure based on biological features such as hibernacula. Evaluation of the effects of the proposed action on the northern long-eared bat relative to the number of bats in Iowa provides a reasonable context, however, for the species-level evaluation.

effect of the take was negligible at the statewide level, it is our opinion that the effect of the take on the survival and recovery of this species across its range will also be negligible.

4.3.4 Tricolored Bat

As described above in Section 3, Environmental Baseline, we estimate that the population of northern long-eared bats in the state to be approximately 142,730 tricolored bats. Therefore, 459 bats taken annually from this population constitutes 0.32% of the population.

There is no population viability model for tricolored bats currently available. However, we believe that it is reasonable to apply the probability of extinction result calculated for the little brown bat (see section 4.1.5.3 above) to the tricolored bat. Firstly, the population size of approximately 142,730 tricolored bats is higher than the estimated 127,000 little brown bats. Second, tricolored bats typically have a higher reproductive rate than the other covered bat species (average of 2 pups/year instead of 1). Third, tricolored bats are expected to be affected by WNS similarly to the other *Myotis* species (See section 2.6.4). And fourth, the authorized take rate is less than that of the little brown bat. Given the larger population size, lower take rate, higher reproductive rate, and similar impact of WNS, it is reasonable to conclude that the probability of extinction with the authorized take is also 0.00% over the next 50 years. Given that the effect of the take is expected to be negligible at the statewide level, it is our opinion that the effect of the take on the survival and recovery of this species across its range will also be negligible.

4.3.5 Bald Eagle

The Service manages bald eagle take at two geographic scales: Eagle Management Units (EMUs) and the Local Area Population (LAP). Iowa falls within the Mississippi Flyway EMU (Figure 3.1-1), which has a population of 31,706 eagles (USFWS 2016a). The impact of taking 10 bald eagles per year represents 0.03% of the EMU population, which is well below the sustainable threshold of 6% set by the Service (USFWS 2016b, see also Appendix D). The 10 annual bald eagle fatalities are anticipated to be spread across the 2,021 existing turbines. To determine the local area population for MEC, an 86-mi. buffer was placed around the 22 covered projects (see chapter 4.3.2 of the FEIS), which results in a total area of approximately 84,874 square miles. The Service has estimated that the Local Area Population estimate of bald eagles is 4,173 (see Appendix C). The impact of taking 10 bald eagles per year represents 0.24% of the LAP, which is well below the sustainable take threshold of 5% set by the Service (USFWS 2016b). Over the course of the permit term, the bald eagle population is expected to increase by approximately 10% (USFWS 2016a). We therefore conclude that the effect of the take on the survival and recovery of this species will be negligible and that this level of take will not jeopardize the continued existence of this species.

4.4 CUMULATIVE EFFECTS

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation. The action area (see section 1.2) is the location of the turbines in the covered projects and the mitigation lands. Future effects to the covered species that are not associated with a federal action are rare in the project action area due to the vastly agricultural nature of the landscape and the fact that mitigation lands will be permanently protected. More specifically, the turbine locations themselves in the covered projects portion of the action area contains no roosting habitat and minimal foraging habitat for the covered species. Therefore, State or private actions that will impact the covered species are unlikely to occur. Regarding mitigation lands, we do not expect future state or private actions to impact the species occupying these lands because they will be permanently protected and managed specifically for benefits to the covered species.

We do not believe that changes to the covered project operations which would affect the covered species beyond what is contemplated in this biological opinion are reasonably certain to occur. However, if they do occur, a permit amendment may be required. This would be a future federal action requiring separate consultation and analysis pursuant to section 7 of the ESA, and therefore is not considered here.

4.5 CONCLUSION

After reviewing the current status of the covered species, the environmental baseline for the action area, the effects of the proposed actions, and the cumulative effects, it is the Service's biological opinion that the federal action and the associated covered activities, as proposed, are not likely to jeopardize the continued existence of the covered species. Critical habitat is not present in the action area, and therefore no destruction or adverse modification of critical habitat is anticipated.

The basis for this conclusion is as follows:

- Covered Bat Species
    - We used the best available occupancy, life history, and/or survey information to estimate the likely population sizes of the affected population units of bats. The population units of bats were chosen based on the scope and scale of the project. For Indiana bats, this was the nearest known large hibernacula to the action area. For the remaining covered bat species, this was the summer resident population of bats in Iowa.
    - We modeled the effect of the proposed authorized take rate of the Indiana bat, northern long-eared bat, and little brown bat on those population units using the best available population dynamics model for *Myotis* species. The model indicated that no greater likelihood of extinction of the population units would occur with the permitted take, even when accounting for the effects of WNS.
    - No population dynamics model exists for the tricolored bat. However, when compared to the little brown bat: the Iowa population size of tricolored bats is very similar, the proposed take rate of tricolored bats is less, the effect of WNS on tricolored bat populations is expected to be similar, and the reproduction rate (number of pups born per year) is higher in tricolored bats. Based on these factors, we conclude that the result of the Thogmartin Model for little brown bats provides an appropriate basis for assessing

overall impacts to tricolored bats. The Thogmartin Model result for little brown bats indicated that no greater likelihood of extinction of the Iowa population of little brown bats is expected with the permitted take, and therefore we conclude that this is also true for the Iowa population of tricolored bats.

  - Based on the information set forth in this biological opinion, we conclude that it is unlikely that the proposed action will cause appreciable reductions in the likelihood of survival and recovery of the covered bat species in the wild.

- Bald Eagles

  - We compared the proposed take rate of bald eagles to take thresholds established by the Service (USFWS 2016b) at the Mississippi Flyway EMU and the LAP scales. Bald eagle take numbers below the established thresholds have been analyzed independently (USFWS 2016b) and extirpation has been determined to be unlikely if take rates remain below these thresholds. The proposed take rate is well below these thresholds, and the applicant also has provided for mitigation to offset the impact of the take. Therefore, it is our opinion that the effect of the take on the survival and recovery of this species will be negligible and the take is compatible with the preservation of the bald eagle in the wild.

5.0 INCIDENTAL TAKE STATEMENT

The proposed HCP and its associated documents clearly identify (1) the anticipated impacts to affected species likely to result from the proposed 10(a)(1)(B) incidental take permit and (2) the measures that are necessary and appropriate to minimize those impacts. The proposed incidental take permit will authorize all of the incidental take of the covered species that we anticipate to occur as a result of the activities described in the HCP and its associated documents. Therefore, it is not necessary for this incidental take statement to exempt take for the applicant and there is no need for additional terms and conditions.

6.0 REINITATION NOTICE

As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any actions causing such take must cease pending reinitiation.

APPENDIX A – LIST OF PREPARERS

Name	Organization	Project Role and Qualifications
Amber Schorg	USFWS	Biologist, IL-IA Ecological Services Field Office
Ryan Anthony	USFWS	Biologist, IL-IA Ecological Services Field Office
Kraig McPeek	USFWS	Field Office Supervisor, IL-IA Ecological Services Field Office
Jena Dalzot	USFWS	Biotechnician, IL-IA Ecological Services Field Office
Phil Delphey	USFWS	ESA Section 7 Coordinator, Region 3 Regional Office

APPENDIX B – LITERATURE CITED

Amelon, S., and D. Burhans. 2006. Conservation assessment: Myotis septentrionalis (northern long-eared bat) in the eastern United States. Pages 69-82 in Thompson, F. R., III, editor. Conservation assessments for five forest bat species in the eastern United States. U.S. Department of Agriculture, Forest Service, North Central Research Station, General Technical Report NC-260. St. Paul, Minnesota. 82 pp.

Baker, J. and J. Blanchong. 2017. Executive summary for 2016 for the Iowa northern long-eared bat acoustic monitoring project. Prepared for Iowa Department of Natural Resources. 6 February 2017.

Baker, J. and J. Blanchong. 2018. Executive summary for 2017 for the Iowa northern long-eared bat acoustic monitoring project. Prepared for Iowa Department of Natural Resources. 28 February 2018.

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

Benedict, R.A, S.K. Benedict, D.L. Howell. 2017. Use of buildings by Indiana bats (*Myotis sodalis*) and other bats in south-central Iowa. American Midland Naturalist 178(1): 29-35.

BHE Environmental, Inc. 1999. 1998 Annual report: implementation of reasonable and prudent measures and terms and conditions in the Biological Opinion for BRAC implementation at Fort Leonard Wood. Unpubl. Rept. 3D/E Group of BHE Environmental, Inc., Cincinnati, OH. 199 pp. + app.

Blehert D.S., A.C. Hicks, M. Behr, C. U. Meteyer, B. M. Berlowski-Zier, E. L. Buckles, J. T. H. Coleman, S. R. Darling, A. Gargas, R. Niver, J. C. Okoniewski, R. J. Rudd, and W. B. Stone. 2009. Bat white-nose syndrome: an emerging fungal pathogen? Science 323:227.

Bowerman, W.W., E.D. Evans, J. P. Giesy, and S. Postupalsky. 1994. Using feathers to assess risk of mercury and selenium to bald eagle reproduction in the Great Lakes region. Archives of Environmental Contamination and Toxicology 27:294–298.

Brack, V., Jr. 1979. Determination of presence and habitat suitability for the Indiana bat (*Myotis sodalis*) and gray bat (*Myotis grisescens*) for portions of three ditches, Big Five Levee and Drainage District, Union and Alexander Counties, Illinois. U.S. Army Corps of Engineers, St. Louis, MO. 23 pp.

Brack, V., Jr. 2007. Temperatures and locations used by hibernating bats, including the endangered Indiana bat (*Myotis sodalist*), in a limestone mine. Environ. Manage. 40, 739-746.

Brack, V., Jr. and Whitaker, J.O., Jr. 2001. Foods of the northern myotis, *Myotis septentrionalis*, from Missouri and Indiana, with notes on foraging. Acta Chiropterologica 3:203-210.

Briggler, J.T. and J.W. Prather. 2003. Seasonal use and selection of caves by the eastern pipistrelle bat (*Pipistrellus subflavus*). The American Midland Naturalist 149(2):406–412.

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 70:1174–84.

Buehler, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalis*), version 2.0. In The Birds of North America (A.F. Poole and F.B. Gill, Editors), Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.506

Caceres, M.C., and R.M.R. Barclay. 2000. *Myotis septentrionalis*. Mammalian species no. 634. American Society of Mammalogists. pp 1–4.

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, AB.

Caire, W., R. K. LaVal, M. L. LaVal, and R. Clawson. 1979. Notes on the ecology of MYOTIS KEENII (Chiroptera, Vespertilionidae) in Eastern Missouri. American Midland Naturalist 102(2):404-407.

Callahan, E., R. D. Drobney, R. L. Clawson. 1997. Selection of Summer Roosting Sites by Indiana Bats (*Myotis sodalis*) in Missouri. Journal of Mammalogy 78: 818-825.

Carter, T.C. and G.A. Feldhammer. 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.

Clark, D.R., Jr. 1981. Bats and environmental contaminants: a review. USDI Fish and Wildlife Service Special Scientific Report. Wildlife No. 235. 27 pp.

Clark, D.R., Jr., R.K. LaVal, and D.M. Swineford. 1978. Dieldrin-induced mortality in an endangered species, the gray bat (*Myotis grisescens*). Science 199:1357-1359.

Clark, D.R., Jr., and R.M. Prouty. 1976. Organochlorine residues in three bat species from four localities in Maryland and West Virginia, 1973. J. Pestic. Monitor. 10:44-53.

Clawson, R.L., R.K. LaVal, M.L. LaVal, and W. Caire. 1980. Clustering behavior of hibernating *Myotis sodalis* in Missouri. Journal of Mammalogy, 61:245-253.

Clawson. R.L. 2002. Trends in population size and current status. *In* The Indiana bat: biology and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas. 253 pp.

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

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.

Crocker, S.J., W.K. Moser, G. J. Brand, and A. Flickinger. 2006. Forest Resource Trends in Iowa, North Central Research Station Resource Bulletin NC-263. North Central Research Station, Forest Service U.S. Department of Agriculture,. St Paul, MN.

Davis, W.H. 1959. Disproportionate sex ratios in hibernating bats. Journal of Mammalogy 40: 16–19.

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

DeBlase, A.F., S.R. Humphrey, and K.S. Drury. 1965. Cave flooding and mortality in bats in Wind Cave, Kentucky. Journal of Mammalogy, 46:96.

Delong, Jr., D.C. 1990. Effects of food on bald eagle distribution and abundance on the northern Chesapeake Bay: an experimental approach. Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg.

Dzurick, C., and T. Tomasi. 2005. The Effects of Various Temperatures on the Successful Hibernation of Indiana Bats. Preliminary data provided in abstract submitted to the 2006 Missouri Natural Resources Conference. Missouri State University, Springfield, Missouri.

Easterla, D.A. 1968. Parturition of Keen's myotis in southwestern Missouri. J. Mammal. 49: 770.

Easterla, D.A., and L.C. Watkins. 1969. Pregnant *Myotis sodalis* in northwestern Missouri. Journal of Mammalogy, 50:372-373.

Erikson, R.A., W. E. Thogmartin, 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. BioMed Central. DOI: 10.1186/1751-0473-9-9

Edwards C.C. 1969. Winter behavior and population dynamics of American eagles in western Utah. Phd Thesis, Brigham Young Univ., Provo, UT.

Farmer, A., B.S. Cade, and D.F. Staufer. 2002. Evaluation of a habitat suitability index model. Pages 172-181 in The Indiana bat: biology and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Feldhamer, G.A., T.C. Carter, J.O. Whitaker Jr. 2009. Prey Consumed by Eight Species of 5 Insectivorous Bats from Southern Illinois. The American Midland Naturalist 162(1):43-51.

Fenton M. B. 1969. Summer activity of Myotis lucifugus (Chiroptera: Vespertilionidae) at hibernacula in Ontario and Quebec. Canadian Journal of Zoology 47:597–602.

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

Fenton, M.B. and R.M.R. Barclay. 1980. *Myotis lucifugus*. Mammal. Species No. 142. American Society of Mammologists Nov 20, 1980. 8pp.

Fitch, J.H. and K.A. Shump, Jr. 1979. *Myotis keenii.* Mammalian Species, No. 121:1-3.

Folk M.J. 1992. Winter behavior and population dynamics of American eagles in western Utah. Ph.D Thesis, Brigham Young Univ., Provo, UT.

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(2):659-672.

Fraser, E.E., L.P. McGuire, J.L. Eger, F.J. Longstaffe, M.B. Fenton. 2012. Evidence of Latitudinal Migration in Tri-colored Bats, *Perimyotis subflavus*. PLoS ONE 7(2): e31419. https://doi.org/10.1371/journal.pone.0031419

Frick, W.F., J.F. Pollock, A.C. Hicks, K.E. Langwig, D.S. Reynolds, G.G. Turner, C.M. Butchkoski, T.H. Kunz. 2010a. An Emerging Disease Causes Regional Population Collapse of a Common North American Bat Species. Science 329(5992): 679-682

Frick, W.F., D.S. Reynolds, T.H. Kunz. 2010b. Influence of climate and reproductive timing on demography of little brown myotis *Myotis lucifugus*. Journal of Animal Ecology 79: 128-136.

Frick W.F., S.J. Puechmaille, J.R. Hoyt, B.A. Nickel, K. E. Langwig, J.T. Foster, K.E. Barlow, T. Bartonicka, D. Feller, A.J. Haarsma, C. Herzog, I. Horacek, J. van der Kooij, B. Mulkens, B. Petrov, R. Reynolds, L. Rodrigues, C.W. Stihler, G.G. Turner, A.M. Kilpatrick. 2015. Disease alters macroecological patterns of North American bats. *Global Ecology and Biogeography*, Published online:1-9.

Fujita, M.S., and T.H. Kunz. 1984. *Pipistrellus subflavus*. Mammalian Species, No. 228:1–6

Gardner, J. E., J. D. Garner, and J. E. Hofmann 1991. Summer roost selection and roosting behavior of *Myotis sodalis* (Indiana bat) in Illinois. Final report. Illinois Natural History Survey, Illinois Dept. of Conservation, Champaign, IL. 56 pp.

Garner, J.D. and J.E. Gardner. 1992. Determinations of summer distribution and habitat utilization of the Indiana bat (*Myotis sodalis*) in Illinois. Final Report: Project E-3. End. Sp. Act Sec. 6 Rpt. Illinois. Dept. of Conservation, Springfield, IL.

Garroway, C.J., and H.G. Broders. 2008. Day roost characteristics of northern long-eared bats (*Myotis septentrionalis*) in relation to female reproductive status. EcoScience 15: 89-93.

Geluso, K.N., J.S. Altenbach, and D.E. Wilson. 1976. Bat mortality: pesticide poisoning and migratory stress. Science 194:185-186.

Giessman, N., T.W. Barney, T.L. Haithcoat, J.W. Meyers, and B. Massengale. 1986. Distribution of forestland in Missouri. Transactions of the Missouri Academy of Science 20:5-14.

Goehring, H.H. 1954. *Pipistrellus subflavus obscurus, Myotis keenii*, and *Eptesicus fuscus fuscus* hibernating in a storm sewer in central Minnesota. Journal of Mammalogy 35: 434-435.

Good, R.E., W. 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. 28 January 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 Fowler Ridge Wind Farm. Prepared by Western EcoSystems Technology, Inc. 31 January 2012.

Griffin, C.R. and R.S. Baskett. 1985. Food availability and winter range sizes of immature and ‘ adult Bald Eagles. Journal of Wildlife Management 49:592-594.

Griffin, D.R. 1940. Reviewed notes on the life histories of New England cave bats. Journal of Mammalogy 21(2):181-187.

Griffin, D.R. 1945. Travels of banded cave bats. Journal of Mammalogy 26(1): 15-23.

Gumbert, M.W., J.M. O'Keefe, J.R. MacGregor, 2002. Roost fidelity in Kentucky, In: Kurta, A., Kennedy, J. (Eds.), The Indiana Bat: Biology and Management of An Endangered Species. Bat Conservation International, Austin, TX, pp. 143-152.

Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Reading Public Museum and Art Gallery. Scientific Publication No. 12, 68pp, Reading, PA.

Harmata, A. R. 1984. Bald eagles of the San Luis Valley, Colorado : their winter ecology and spring migration. Doctoral Dissertation, Montana State University. 221 pp.

Harvey, M.J., J.S. Altenbach, T. L Best. 1999. Bats of the United States. Arkansas. Arkansas Game and Fish Commission.

Harvey, M.J., J.S. Altenbach, A.L. Best. 2011. Bats of the United States and Canada. Baltimore, MD. John Hopkins University Press.

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(4):952-963.

Henny C.J., E.J. Kolbe, E.F. Hill, and L.J. Blus 1987. Case histories of Bald Eagles and other raptors killed by organophosphorus insecticides topically applied to livestock. Journal of Wildlife Diseases 23:292-295.

Henry, M., D.W. Thomas, R. Vaudry, M. Carrier. 2002. Foraging distances and home range of pregnant and lactating little brown bats (*Myotis lucifugus)*. Journal of Mammology 83(3): 767-774

Hitchcock, H.B. 1949. Hibernation of bats in southeastern Ontario and adjacent Quebec. Canadian Field-Naturalist, 63: 47-59.

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, 58:334-346.

Humphrey, S.R. 1978. Status, winter habitat, and management of the endangered Indiana bat, *Myotis sodalis.* Florida Scientist 41:65-76.

Imler, R.H. and E.R. Kalmbach. 1955. The Bald Eagle and its economic status. U.S. Fish Wildlife Service. Circular 30. Washington D.C.

Ingersoll, T.E., B.J. Sewall, and S.K. Amelon. 2016. Effects of white-nose syndrome on regional population patterns of 3 hibernating bat species. Conservation Biology 30(5): 1048-1059.

Iverson, L. 1994. Forest Resource Trends in Illinois. Erigenia 13. Northeastern Forest Experiment Station. U.S. Forest Service, Delaware, OH.

Jackson L.S., C.A. Thompson, J.J. Dinsmore. 1996. The Iowa Breeding Bird Atlas. Iowa City, Iowa. University of Iowa Press.

Jackson, L.J. 2004 Effects of Wildlife Stand Improvements and Prescribed Burning on Bat and Insect Communities; Buffalo Ranger District, OZARK-ST. Francis National Forest. 1-162

Johnson, J.B., J.W. Edwards, and W.M. Ford. 2011. Nocturnal activity patterns of northern myotis (*Myotis septentrionalis*) during the maternity season in West Virginia (USA). Acta Chirpoterologica, 13(2): 391-397, 2011

Johnson, J.B., W.M. Ford, and J.W. Edwards. 2012. Roost networks of northern myotis (*Myotis septentrionalis*) in a managed landscape. Forest Ecology and Management 266:223-231.

Johnson J.B., J.W. Edwards, W.M. Ford, J.E. Gates. 2009. Roost tree selection by northern myotis (*Myotis septentrionalis*) maternity colonies following prescribed fire in a central Appalachian mountains hardwood forest. Forest Ecology and Management 258: 233–242

Johnson, S.A., V. Brack, Jr., and R.E. Rolley. 1998. Overwinter weight loss of Indiana bats (*Myotis sodalis*) from hibernacula subject to human visitation. American Midland Naturalist 139:255-261.

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 Rep. E-2. Frankfort, KY: Kentucky Department of Fish and Wildlife Resources. 65p.

Krishon D.M., M.A. Menzel, T.C. Carter, and J. Laerm. 1997. Notes on the home range of four species of Vespertilionid bats (Chiroptera) on Sapelo Island, Georgia. Georgia Journal of Science 55:215–223.

Kunz, T.H. 1973. Temporal and Spatial Components of Bat Activity in Central Iowa. Journal of Mammalogy 54(1):14-32.

Kurta, A. 1982. Flight patterns of *Eptesicus fuscus* and *Myotis lucifugus* over a stream. Journal of Mammalogy 63(2):335-337.

Kurta, A. and H. Rice. 2002. Ecology and management of the Indiana bat in Michigan. Michigan Academician (Papers of the Michigan Academy of Science, Arts, and Letters), 33(3):361-376.

Kurta, A., J. Kath, F.R. Smith, M.W. Orick, and R. Ross. 1993. A maternity roost of the endangered Indiana bat (*Myotis sodalis*) in an unshaded, hollow, sycamore tree (*Platanus* *occidentalis*). American Midland Naturalist. 130:405-407.

Kurta, A., K.J. Williams, and R. Mies. 1996. Ecological, behavioral, and thermal observations of a peripheral population of Indiana bats (*Myotis sodalis*). Pp. 102-117 *in.* RMR Barclay and R.M. Bringham (eds.), Bats and Forests Symposium, Research ranch, British Colombia Ministry of Forests, Victoria, BC, Canada

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.

Lacki, M.J. and J.H. Schwierjohann. 2001. Day-roost characteristics of northern bats in Mixed Mesophytic Forest. The Journal of Wildlife Management 65(3):482-488

Lacki, M.J., D.R. Cox, L.E. Dodd, and M.B. Dickinson. 2009. Response of northern bats (*Myotis septentrionalis*) to prescribed fires in eastern Kentucky forests. Journal of Mammalogy 90(5): 1165-1175

Langwig, Kate E. (2012-07-02) Sociality, density-dependence and microclimates determine the persistence of populations suffering from a novel fungal disease, white-nose syndrome. Ecology Letters, 1-n/a. DOI: 10.1111/j.1461-0248.2012.0189.x

Laubach, C.M., J.B. Bowles, R. Laubach. 2004. A Guide to the Bats of Iowa. Des Moines, Iowa. Iowa Department of Natural Resources.

LaVal, R.K., R.L. Clawson, M.L. LaVal and W. Caire. 1977. Foraging Behavior and Nocturnal Activity Patterns of Missouri Bats, with Emphasis on the endangered species *Myotis grisescens* and *Myotis sodalis.* Journal of Mammalogy 58(4):592-599

LaVal, R.K. and M.L. LaVal. 1980. Ecological studies and management of Missouri bats, with emphasis on cave-dwelling species. Missouri Dept. of Conservation Terrestrial Series 8:1-53.

Lereculeur, A.E. 2013. Summer roosting ecology of the northern long-eared bat (*Myotis septentrionalis*) at Catoosa Wildlife Management Area. Tennessee Technological University, ProQuest, UMI Dissertations Publishing; 1539738.

Livingston, S.A., C.S. Todd, W.B. Krohn, and R.B. Owen Jr. 1990. Habitat models for nesting Bald Eagles in Maine. Journal of Wildlife Management 54:644-653.

MacCleery, D.W. 1992. American forests - a history of resiliency and recovery. USDA Forest Service publication. FS-540. Forest History Society, Durham, NC. 58 pp.

MacGregor, J.; Kiser, J.D.; Gumbert, M.W.; Reed, T.O.; 1999. Autumn roosting habitat of male Indiana bats (*Myotis sodalis*) in a managed forest setting in Kentucky. In: Stringer, J. W.; Loftis, D. L. eds. Proceedings 12th central hardwood forest conference; 1999

February 28pMarch 1-2; Lexington, KY. Gen. Tech. Rep. SRS-24. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 169-170.

McFarland, C.A. 1998. Potential agricultural insecticide exposure of Indiana bats (*Myotis sodalis*) in Missouri. Unpubl. M.S. thesis, University of Missouri - Columbia. 256 pp. \

McNab, B.K. 1974. The behavior of temperate cave bats in a subtropical environment. Ecology, 55:943-9

Menzel, M.A., S.F. Owen, W.M. Ford, J.W. Edwards, P.B. Wood, B.R. Chapman, and K.V. Miller. 2002. Roost tree selection by northern long-eared bat (*Myotis septentrionalis*) maternity colonies in an industrial forest of the central Appalachian mountains. Forest Ecology and Management 155:107-114.

Mersmann T.J. 1989. Foraging ecology of Bald Eagles on the northern Chesapeake Bay with an examination of techniques used in the study of Bald Eagle food habits. Master's Thesis, Virginia Polytechnic Inst. and State Univ., Blacksburg.

MidAmerican Energy Company. 2017. Bird and bat conservation strategy; MidAmerican Energy Company Iowa wind energy facilities.

Millsap, B.A. 1986. Status of wintering Bald Eagles in the conterminous 48 states. Wildlife Society Bulletin 14:433-440.

Mohr, C.E. 1972. The status of threatened species of cave-dwelling bats. Bulletin of the National Speleological Society 34:33-37.

Moosman P.R, J.P. Veilleux, G.W. Pelton, and H.H. Thomas. 2013. Changes in capture rates in a community of bats in New Hampshire during the progression of White-nose Syndrome. Northeastern Naturalist 20(4):552–558.

Mumford, R.E., and J.B. Cope. 1958. Summer record of *Myotis sodalis* in Indiana. Journal of Mammalogy 39:586-587.

Mundahl, N.D., A.G. Bilyeu, and L. Maas. Bald Eagle Nesting Habitats in the Upper Mississippi River National Wildlife and Fish Refuge. Journal of Fish and Wildlife Management 16.

Nagorsen, D.W., and R.M. Brigham. 1993. The Mammals of British Columbia. 1. Bats. Royal British Columbia Museum, Victoria, and the University of British Columbia Press, Vancouver. pp. 164

Neubaum, D.J., T.J. O'Shea, and K.R. Wilson. 2006. Autumn migration and selection of rock crevices as hibernacula by big brown bats in Colorado. Journal of Mammalogy 87:470-479.

Nigh, T.A., W.L. Pflieger, P.L. Redfearn, W.A. Schroeder, A.R. Templeton, and F.R. Thompson, III. 1992. The biodiversity of Missouri - definition, status, and recommendations for its conservation. Biodiversity Task Force, Jefferson City, MO. 53 pp.

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.

Owen, S.F., M.A. Menzel, W.M. Ford, J.W. Edwards, B.R. Chapman, K.V. Miller, P.B. Wood. 2002. Roost tree selection by maternal colonies of northern long-eared myotis in an intensively managed forest. USDA Forest Service, General Technical Report NE-292, Northeastern Research Station, Newtown Square, PA, p. 6.

Perry, R.W., and R.E. Thill. 2007a. Roost selection by male and female northern long-eared bats in a pine-dominated landscape. Forest Ecology and Management 247(1-3):220-226.

Perry, R.W., and R.E. Thill. 2007b. Tree roosting by male and female eastern pipistrelles in a forested landscape. Journal of Mammalogy 88(4):974-981.

Perry, R.W. 2011. Fidelity of bats to forest sites revealed from mist-netting recaptures. Journal of Fish and Wildlife Management 2(1):112-116.

Raesly, R.L. and J.E. Gates. 1987. Winter habitat selection by north temperate cave bats. The American Midland Naturalist 118: 15-31.

Randall, L.A., T. S. Jung, R. M.R. Barclay. 2014. Roost-site selection and movements of little brown myotis (*Myotis lucifugus*) in southwestern Yukon. Northwestern Naturalist 95(3): 312-318.

Reidinger, R.F. 1972. Factors influencing Arizona bat population levels. Unpubl. Ph.D. dissertation, University of Arizona, Tucson. 172 pp.

Reidinger, R.F. 1976. Organochlorine residues in adults of six southwestern bat species. Journal of Wildlife Management 40:677-680.

Richter, A.R., S.R. Humphrey, J.B. Cope and V. Brack, Jr. 1993. Modified cave entrances: thermal effect on body mass and resulting decline of endangered Indiana bats (*Myotis sodalis*). Conservation Biology. 7:407-415.

Roby, P., R. Borthwick, M. Gumbert, C. McNees. 2018. Autumn migration of northern long-eared bats (*Myotis septentrionalis*) in North Central Iowa. Prepared for Iowa Department of Natural Resources. May, 2018.

Russell R.E. and J.C. Franson. 2014. Causes of mortality in eagles submitted to the National Wildlife Health Center 1975-2013. Wildlife Society Bulletin 38(4):697-704.

Russell, R.E., Tinsley, K., Erikson, R.A., Thogmartin, W.E., Szymanski, J., 2014. Estimating the spatial distribution of wintering little brown bat populations in the Eastern United States. Ecology and Evolution 19: 3746–3754.

Romme. R.C., K. Tyrell, and V. Brack, Jr. 1995. Literature summary and habitat suitability index model: components of summer habitat for the Indiana bat, *Myotis sodalis*. Report submitted to the Indiana Dept. Natural Resources, Div. of Wildlife, Bloomington, IN by 3D/Environmental Services, Inc., Cincinnati, OH. Fed. Aid Project E-1-7, Study No. 8. 38pp.

Sandel, J.K., G.R. Benatar, K.M. Burke, C.W. Walker, T.E. Lacher, R.L. Honeycutt. 2001. Use and selection of winter hibernacula by the eastern pipistrelle (*Pipistrellus subflavus*) in Texas. Journal of Mammalogy 82(1):173–178

Sasse, D. B., and P.J. Perkins. 1996. Summer roosting ecology of northern long-eared bats (*Myotis septentrionalis*) in the White Mountain National Forest. In: Barclay, R.M.R.; Brigham, R. M. eds. Bats and forest symposium, Working Paper 23/1996. Victoria, BC: British Columbia Ministry of Forests. 91- 101.

Saunders, D. A. 1988. Adirondack Mammals. Syracuse, New York: State University of New \ York, College of Environmental Science and Forestry. 216pp

Schroeder, W.A. 1981. Presettlement Prairie of Missouri. Missouri Dept. of Conservation, Jefferson City, MO. 35pp.

Shepherd S. 2018. Bald Eagle (*Haliaeetus leucocephalis*) status in Iowa. Iowa Department of Natural Resources.

Southern , W. E. 1963. Additional observation on wintering Bald Eagle populations: including remarks on biotelemetry techniques and immature plumages. Wilson Bulletin 76:121-137.

Sparks, D.W., C.M. Ritzi, J.E. Duchamp, and J.O. Whitaker. 2005. Foraging habitat of the Indiana bat (*Myotis sodalis)* at an urban-rural interface. Journal of Mammology 86:713-718.

Spencer D. A. 1976. Wintering of the migrant Bald Eagle in the lower 48 states. Washington, D.C: National Agricultural Chemical Association.

Stalmaster, M.V. and J.A. Gessaman. 1984. Ecological energetics and foraging behavior of overwintering Bald Eagles. Ecological Monographs 54:407-428.

Stalmaster, M.V. 1987. The Bald Eagle. New York: Universe Books.

Stantec Consulting Services Inc. 2015. 2014 Bird and Bat Post-Construction Monitoring Report – Laurel Mountain Wind Energy Project, Randolph and Barbour Counties, West Virginia. Prepared for AES Laurel Mountain Wind, LLC. January 2015.

Steenhof, K. 1976. The ecology of wintering Bald Eagles in southeastern South Dakota. Master's Thesis, University of Missouri, Columbia.

Stones, R.C. and W. Fritz. 1969. Bat studies in upper Michigan's copper mining district. The Michigan Academician, p. 77-85.

Terracon, Inc. 2013. Biological Assessment for the LaFarge North America Quarry Expansion Project. St. Louis, Missouri. 56 pp.

Thomas, D.W., M. Dorais, and J.M. Bergeron. 1990. Winter energy budgets and cost of arousals for hibernating little brown bats (*Myotis lucifugus*). Journal of Mammalogy 71:475-479.

Thomas, D.W. 1995. Hibernating bats are sensitive to non-tactile human disturbance. Journal of Mammalogy. 76:940-946.

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

Todd, C. S., L. S. Young, Jr. Owen, R. B. and F. J. Gramlich. 1982. Food habits of Bald Eagles in Maine. Journal of Wildlife Management 46:636-645.

Turner, G.G., D.M. Reeder, and J.T.H. Colman. 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(2): 13-27.

Tuttle, M.D. and D.E. Stevenson. 1977. An analysis of migration as a mortality factor in the gray bat based on public recoveries of banded bats. American Midland Naturalist. 97:235-240.

Tuttle, M.D. and J. Kennedy. 2002. Thermal requirements during hibernation. Pp. 68-78 *in* A. Kurta and J. Kennedy (eds.), The Indiana bat: biology and management of an endangered species. Bat Conservation International, Austin, TX.

U.S. Fish and Wildlife Service (USFWS). 1983. Recovery Plan for the Indiana Bat. Twin Cities, MN. 23 pp.

U.S. Fish and Wildlife Service (USFWS). 1997. Biological opinion on the impacts of forest management and other activities to the Indiana bat on the Cherokee National Forest, Tennessee. Cookeville, TN: U.S. Department of the Interior, Fish and Wildlife Service.

38 pp.

U.S. Fish and Wildlife Service (USFWS). 1999. Agency Draft Indiana Bat (*Myotis sodalis*) Revised Recovery Plan. Fort Snelling, MN. 53 pp.

U.S. Fish and Wildlife Service (USFWS). 2000. Biological Opinion for the Nantahala and Pisgah National Forests Land and Resource Management Plan, Amendment 5, on the Indiana bat. Asheville Ecological Services Field Office, Asheville, North Carolina.89 pp.

U.S. Fish and Wildlife Service (USFWS). 2007. Agency Draft Indiana Bat (*Myotis sodalis*) Revised Recovery Plan. Fort Snelling, MN. 260 pp.

U.S. Fish and Wildlife Service (USFWS). 2013a. 2013 rangewide population estimate for the Indiana bat (*Myotis sodalis*) by USFWS Region and Recovery Unit. U.S. Fish and Wildlife Service, Bloomington, Indiana, USA.

U.S. Fish and Wildlife Service (USFWS). 2013b. 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. 78 Fed. Reg. 191.

U.S. Fish and Wildlife Service (USFWS). 2016a. Bald and Golden Eagles – Population demographics and estimation of sustainable take in the United States, 2016 update. U.S. Fish and Wildlife Service Division of Migratory Bird Management. April 26, 2016.

U.S. Fish and Wildlife Service (USFWS). 2016b. Eagle Permits; Revisions to regulations for eagle incidental take and take of eagle nests, Final Rule. Federal Register 81 (242): 91494-91554.

U.S. Fish and Wildlife Service (USFWS). 2016c. Region 3 Indiana Bat Resource Equivalency Analysis Model for Wind Energy Projects: Public V1, December 2016. Bloomington, Indiana.

U.S. Fish and Wildlife Service (USFWS). 2016d. Region 3 Northern Long-Eared Bat Resource Equivalency Analysis Model for Wind Energy Projects: Public V1, December 2016. Bloomington, Indiana.

U.S. Fish and Wildlife Service (USFWS). 2016e. Region 3 Little Brown Bat Resource Equivalency Analysis Model for Wind Energy Projects: Public V1, December 2016. Bloomington, Indiana.

U.S. Fish and Wildlife Service (USFWS). 2016f. Status review for the eastern subspecies of the little brown bat (*Myotis lucifugus lucifugus*). November 21, 2016.

U.S. Fish and Wildlife Service (USFWS). 2018. Listing the northern long-eared bat as threatened; questions and answers; Available from:

https://www.fws.gov/midwest/endangered/mammals/nleb/nlebFinalListFAQs.html, accessed 1 Jun 2018).

U.S. Fish and Wildlife Service (USFWS). 2019. 2019 Indiana bat (*Myotis sodalis*) population status update. Available from: https://www.fws.gov/Midwest/endangered/mammals/inba/pdf/2019_IBat_Pop_Estimate_6_27_2019a.pdf, accessed 1 November 2019.

Van Zyll de Jong, C.G. 1985. Handbook of Canadian mammals. 2. Bats. National Museum of Natural Sciences, National Museums of Canada. Ottawa, Ontario, Canada. 212 pp.

Veilleux, J. P., J. O. Whitaker, S. L. Veilleux. 2003. Tree-roosting ecology of reproductive female eastern pipistrelles, *Pipistrellus subflavus*, in Indiana. Journal of Mammalogy 84(3): 1068-1075.

Veilleux, J.P., and S.L. Veilleux. 2004. Intra-annual and interannual fidelity to summer roost areas by female eastern pipistrelles, *Pipistrellus subflavus*. American Midland Naturalist 152(1):196–200.

Whitaker, J. O. 1972. Food habits of bats from Indiana. Canadian Journal of Zoology 50(6):877-883.

Whitaker, J.O., Jr., and S.L. Gummer. 1992. Hibernation of the Big Brown Bat. *Eptesicus fuscus*, in buildings. Journal of Mammalogy 73: 312-316.

Whitaker, J.O. and L.J. Rissler. 1992. Seasonal activity of bats at copperhead cave. Proceedings 17 of the Indiana Academy of Science, 101: 127-134.

Whitaker, J.O. and W.J. Hamilton. 1998. Mouse-eared bats, Vespertilionidae. P. 89-102. In *Mammals of the eastern United States, Third Edition.* Comstock Publishing Associates, a Division of Cornell University Press, Ithaca, New York.

Whitaker, J.O. and R.E. Mumford. 2009. Northern Myotis. P. 207-214. In *Mammals of Indiana*. Indiana University Press, Bloomington, Indiana.

Wright, B.S. 1953. The relation of Bald Eagles to breeding ducks in New Brunswick. Journal of Wildlife Management 17:55-62.

APPENDIX C – BALD EAGLE CUMULATIVE EFFECTS TOOL SUMMARY ANALYSIS

logfile start
US FWS Cumulative Effects Tool
Summary Results (Bald Eagle)
run 2019-02-05 07:37:35

Focal Project: MidAmerican Energy Wind IX

Predicted eagle take (annual)	10

Local Area Population (LAP) Estimates by Local Area Density Unit (LADU):

Focal Project_Density Unit	Estimated Number of Eagles
MidAmerican Energy Wind IX_Great Lakes	4235.59
MidAmerican Energy Wind IX_Rocky Mountains a	38.92
MidAmerican Energy Wind IX LAP (total)	4274.51

1% LAP Benchmark	42.74
5% LAP Benchmark	213.7

'Permitted' & 'Other' Projects with Overlapping LAPs:

Project ID	Estimated Annual Take	Percent Overlap With Focal Project	Overlapping Area (Sq Mi)
No overlapping 'Permitted' or 'Other' projects			
All Projects (total)	0		

Results	Number of Eagles	Percent of LAP
Total Overlapping Take	0	0.00%
Focal Project Predicted Take	10	0.24%
Focal Project + Total Overlapping Take	10	0.24%

Unpermitted Take Summary

Bald Eagle	All Unknown	Reported Years	Discovery Period 1950-2019
Trauma:Collision with wire		1 2009-2009	
Unknown		45 2002-2018	
Other		66 2002-2018	
Trauma		26 2002-2018	
Electrocution		32 2004-2018	
Trapped		1 2001-2001	
Collision with wind turbine		7 2012-2019	
Killed/injured by animal		1 2016-2016	
Determination pending		1 2016-2016	
Infection		1 2016-2016	
Entangled		1 2016-2016	
Collision with wire		6 2007-2016	
Disease		4 2013-2018	
Poisoned (lead)		47 2002-2018	
Electrocution;Trauma		4 2002-2009	
Poisoned		2 2012-2018	
Starvation		2 2012-2017	
Trauma:Collision		2 2002-2008	
Shot		32 2002-2015	
Collision with vehicle		11 2003-2016	
Trauma:Poisoned (lead)		1 2005-2005	
Collision		4 2015-2017	
Emaciation		1 2017-2017	
Emaciation;Oiled		1 2007-2007	
Poisoned (pesticide)		15 2002-2018	

TOOL INPUT PARAMETERS

Focal project layer	C:\CET\MEC\WindIXMCP.shp
Other layer(s):	
No layers assigned	
Permitted take	C:\CET\lmr\PermittedCETShapefile.shp
Unpermitted take	C:\CET\lmr\UnpermittedTakeCETShapefile.shp
Management Unit shapefile	C:\CET\BAEA_LADUs_20170929.shp
Natal dispersal distance (miles)	86
Take benchmark % (lower)	1
Take benchmark % (upper)	5
Date range	1950-2019
Summary output file	C:\CET\MEC [illegible] .txt

logfile start
US FWS Cumulative Effects Tool
Summary Results (Bald Eagle)
run 2019-02-05 07:37:35

Focal Project: MidAmerican Energy Wind IX
Predicted eagle take (annual)

Local Area Population (LAP) Estimates by Local Area Density Unit (LADU):
Focal Project_Density Unit
MidAmerican Energy Wind IX_Great Lakes
MidAmerican Energy Wind IX_Rocky Mountains and Plains
MidAmerican Energy Wind IX LAP (total)

1% LAP Benchmark
5% LAP Benchmark

'Permitted' & 'Other' Projects with Overlapping LAPs:
Project ID
No overlapping 'Permitted' or 'Other' projects
All Projects (total)

Results
Total Overlapping Take
Focal Project Predicted Take
Focal Project + Total Overlapping Take

Unpermitted Take Summary
Bald Eagle
1 Trauma:Collision with wire
45 Unknown
66 Other
26 Trauma
32 Electrocution
1 Trapped
7 Collision with wind turbine
1 Killed/injured by animal
1 Determination pending
1 Infection
1 Entangled
6 Collision with wire
4 Disease
47 Poisoned (lead)
4 Electrocution;Trauma
2 Poisoned
2 Starvation
2 Trauma:Collision
32 Shot
11 Collision with vehicle
1 Trauma:Poisoned (lead)
4 Collision
1 Emaciation
1 Emaciation;Oiled
15 Poisoned (pesticide)

Appendix D – Bald Eagle Management unit Cumulative Take analysis
November 7, 2019

APPENDIX D – BALD EAGLE MANAGEMENT UNIT CUMULATIVE TAKE ANALYSIS