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CHIROPTERAN RISK ASSESSMENT: PROPOSED HARDIN COUNTY NORTH WIND ENERGY GENERATION FACILITY HARDIN COUNTY, OHIO

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EXECUTIVE SUMMARY

JW Great Lakes, LLC (JW) contracted BHE Environmental, Inc. (BHE) to complete a bat risk assessment for the proposed Hardin County North Wind Farm project near the towns of Ada and Dola, Hardin County, Ohio. JW has proposed to install between 19-27 wind turbines at 100 meter hub height and 90-100 meter diameter rotors on the approximately 3,371 acre site dominated by intensive row crop agriculture production (Figure1). Nearly all of the Project area is cropland.

The Hardin County North Wind Farm site is on privately owned farmland. The terrain on the site is nearly flat. There are paved and gravel section roads throughout the project area and a single set of railroad tracks crosses the property. The area was effectively drained in the 1940s and deep linear drainage ditches cross the property and feed into Hog Creek Ditch, which drains the site to the west. The property is predominantly intensively managed for Soybean and corn agriculture.

Risk to bats is expected to be low.

There are no records of federally threatened or endangered bats in or within 5 miles of the proposed Project planning area.

The Project area is within the range of only one federally listed bat: the endangered Indiana bat (*Myotis sodalis*).

The closest Indiana bat maternity colony recorded is approximately 48 km (30 mi) away from the Project planning area, though closer colonies may be discovered around Wolf Creek approximately 21 km (13 mi) southeast of the Project area.

It is unlikely that Indiana bats will occupy the Project planning area during summer. Habitat conditions in the Project planning area, which is nearly devoid of trees and is composed largely of open fields/agricultural land, is less than suitable for foraging or roosting bats. Indiana bats, even if present, are likely to be very rare at the Hardin County North Project area during summer, and are likely to be active at heights largely below the rotor-swept area. As such, the chance of collisions between Indiana bats and turbine blades during the summer is extremely low. Studies completed to date have documented very low mortality during spring and summer months, even when concurrent mist net surveys and/or ultrasound acoustic detection devices indicate the presence of substantial numbers of bats (Arnett et al. 2008). No effects to Indiana bats during summer are expected.

Furthermore, other bat species that may experience mortality at the Hardin County North Project area are widely dispersed in the U.S. and only a very small minority of each species' population will forage in, roost in, travel through, or migrate over the Hardin County North Project area.

Indiana bats are not likely to be roosting, foraging, or migrating within the Project planning area, due to the poor habitat conditions. Indiana bats are more likely to use the Scioto River and Tymochtee Creek that are 13 and 19 km (8 and 12 mi) away from the planning area and not at risk.

The closest bat hibernaculum is Ohio Caverns in Champaign County over 56 km (35 mi) southeast of the project area.

The closest hibernaculum used by Indiana bats in Ohio, Lewisburg Limestone Mine, is approximately 116 km (72 mi) southwest of the Project area.

It is reasonable to expect that the direction of flight of Indiana bats, and of other species of bats utilizing the Lewisburg Limestone Mine hibernaculum in Preble County or the other nearby hibernacula in Champaign County, is not random. These movements are likely concentrated along the only forested rivers in the vicinity. No contiguous forested tracts link the Hardin County North Project planning area to forested rivers corridors or to any of the hibernacula. In summer, Murray and Kurta (2004) found that Indiana bats will choose to travel along forested corridors as opposed to non-forested corridors, even if the distance traveled is greater. This suggests that all of the waterways crossing the Project planning are minimally suitable as travel corridors for Indiana bats. If Indiana bats also choose forested corridors for migration, they will not use the Hardin County North site. No effects to Indiana bats during spring and fall migration to and from the Lewisburg Limestone Mine in Preble County or the other bat hibernacula in Champaign County are expected.

Habitat loss will be low considering the Project area is nearly all agricultural and only about 4 percent of the area will be disturbed for construction.

1.0 INTRODUCTION

JW Great Lakes Wind, LLC (JWGL) of Cleveland, Ohio, proposes construction of the Hardin County North wholesale wind energy generation facility in Hardin County, Ohio (Figure 1). The general location of the Hardin County North facility ("Project planning area") spans 13.5 square kilometers (km^2; 5.2 square miles [mi^2], 1,353 hectares [ha], or 3,351 acres [ac]) of northwestern Hardin County near the towns of Ada and Dola (Figures 1 and 2). The project planning area is approximately 0.2 percent forested, with forested areas restricted to residential yards and those along farm drains and perennial streams. The closest heavily forested areas are along the Scioto River southeast of Kenton in central Hardin County and along Tymochtee Creek near Marseilles in southwestern Wyandot County 13 km (8 mi) and 19 km (12 mi) from the planning area respectively. Land use within the Project planning area is primarily agricultural (Figure 2).

The Project planning area represents the maximum area considered for placement of turbines and facility infrastructure. The actual area occupied by the turbines and access roads that will comprise the facility will be a very small percentage of the Project planning area.

Though number and specific model of turbines has not yet been selected, the Hardin County North facility will consist of 19 to 27 wind turbines located in strings or arrays within the Project planning area. Models and number of turbines under consideration include Kenersys K100 (19 turbines), Siemens SWT 2.3-101 (21 turbines), or Vestas V90 (27 turbines). This risk assessment is applicable to all of the layout options.

The Siemens SWT 2.3-101 model will have a nameplate generating capacity of 2.3 MW, yielding a total nameplate project capacity of 48.3 MW. The proposed hub height is about 100 m (328 ft) agl. Rotor diameter will be approximately 101 m (331 ft) and individual blades will be approximately 50.5 m (166 ft) long. With the rotor tip in the 12 o'clock position, the wind turbines will reach a maximum height of approximately 150.5 m (494 ft) agl. At the 6 o'clock position, the rotor tip will be approximately 49.5 m (163 ft) agl. The turbine rotor will turn at a maximum operating speed of 16 rpm. The turbines have a nominal "cut-in speed" of 4 m/s (8.9 mph). Wind speeds above 4 m/s will result in blade speeds of 6 to 16 rpm, depending upon wind speeds.

The Vestas V90 model will have a nameplate generating capacity of 1.8 MW, yielding a total nameplate project capacity of 48.6 MW. The maximum hub height is about 100 m (328 ft) agl. Rotor diameter will be approximately 90 m (295 ft) and individual blades will be approximately 45 m (145 ft) long. With the rotor tip in the 12 o'clock position, the wind turbines will reach a maximum height of approximately 145 m (476 ft) agl. At the 6 o'clock position, the rotor tip will be approximately 55 m (180 ft) agl. The turbine rotor will turn at a maximum operating speed of 16.6 rpm. The turbines have a nominal "cut-in speed" of 4 m/s (8.9 mph). Wind speeds above 4 m/s will result in blade speeds of 9.3 to 16.6 rpm, depending upon wind speeds. With a 27 turbine layout this layout would disturb the most acreage and is the layout used for the worst case analysis in this report.

The Kenersys K100 model will have a nameplate generating capacity of 2.5 megawatts (MW), yielding a total nameplate project capacity of 47.5 MW. The proposed hub height is about 100 m (328 feet [ft]) above ground level (agl). Rotor diameter will be approximately 100 m (328 ft) and individual blades will be approximately 50 m (164 ft) long. With the rotor tip in the 12 o'clock position, the wind turbines will reach a maximum height of approximately 150 m (492 ft) above ground level (agl). At the 6 o'clock position, the rotor tip will be approximately 50 m (164 ft) agl. The turbine rotor will turn at a maximum operating speed of 14.1 revolutions per minute (rpm). The turbines have a nominal "cut-in speed" of 3.5 meters per second (m/s; 7.9 miles per hour [mph]). That is, winds of 3.5 m/s contain sufficient energy to support the generation of electric power by the turbine. At wind speeds below 3.5 m/s, as measured by an anemometer atop each nacelle, the turbine's "primary brake" is applied (i.e., the turbine blades are feathered by orienting the primary surface of each blade parallel to the wind direction). With the primary brake applied, the blades will not rotate around the hub, or will rotate very slowly (less than 1 rpm). Control systems allow the cut-in wind speed to be set independently at each turbine. Wind speeds above 3.5 m/s will result in blade speeds of 1 to 14.1 rpm, depending upon wind speeds. If wind speeds at an operating (spinning) turbine drop below the cut-in speed, the primary brake is applied and the blades come to a stop within approximately one minute.

BHE assumes turbines will be lit with red strobe-like or incandescent flashing lights. Lighting will be limited to the minimum number required by the Federal Aviation Administration (FAA) for aircraft safety.

Based on other sites using the similar turbine models, BHE assumes each turbine tower will be set upon a concrete pad with an aboveground diameter of approximately 4.5 m (15 ft). Nominally, crops and other vegetation within approximately 55 m (180 ft) of each tower site will be cleared, yielding a maximum of 27, 1.2-ha (2.9-ac) openings (32.4 ha or 78.3 ac of clearing for tower sites). The total cleared area required for erection of turbines will be approximately 0.32 km^2 (0.1 mi^2), or approximately 2.0 percent of the total Project planning area. A 2.5 MW turbine array would require only 19 units so 30% less land would be disturbed. As tree cover is extremely sparse within the planning area and most land use is cropland, little or no tree removal is expected to be necessary for construction of turbines or access roads.

Collisions between bats and other aerial manmade structures are well documented. Numerous impacts with television towers, other communication towers, large buildings, power lines, and fences have been reported (Terres 1956, Timm 1989, Martin et al. 2005). Interactions between wind turbines and birds and bats are a known and documented occurrence as well. Utility-scale wind turbines can directly and indirectly affect bats that occur in or migrate through the wind energy generation facility. In some cases, bat collisions with wind turbine blades appear to occur at higher rates. At this time, such cases of higher fatality rates appear to be limited to sites located on forested Appalachian ridgelines (e.g., the Meyersdale, Pennsylvania, Mountaineer, West Virginia, and Buffalo Mountain, Tennessee wind energy generation facilities discussed later in this document; Arnett et al. 2008; Fiedler et al. 2007).

In evaluating the risk of bat mortality at this site, which is located on primarily flat, agricultural land, it is useful to consider mortalities at other operating utility-scale wind energy generation facilities in the Midwestern United States. Bat mortality studies with statistical corrections for searcher efficiency and scavenger removal have been completed at the following wind development sites in the Midwestern United States. (Figure 3):

- 54.5 MW (33 turbines) Crescent Ridge wind power project, Bureau County, Illinois; located approximately 463 km (287 mi) northwest of the Hardin County North Project planning area;

- 80.1 MW (89 turbines) Top of Iowa wind power development site, Worth County, Iowa; located approximately 791 km (491 mi) northwest of the Project planning area;

- 20.5 MW (31 turbines) wind power development site near Lincoln, Kewaunee County, Wisconsin; located approximately 489 km (304 mi) northwest of the Project planning area; and

- 236 MW (354 turbines) Buffalo Ridge wind power development site, Lincoln and Pipestone counties, Minnesota; located approximately 1,033 km (642 mi) northwest of the Project planning area.

This report documents design and site attributes of the proposed Hardin County North wind energy generation facility, evaluates the avenues by which bats may be affected by the Hardin County North facility, and provides a review of information pertaining to bat mortality at existing wind energy generation facilities. Based upon these data, and upon information provided by state wildlife agencies and the U.S. Fish and Wildlife Service (USFWS), we qualitatively estimate the risk of effects to bats posed by the Hardin County North facility.

2.0 DESCRIPTION OF THE PROJECT AREA

2.1 REGIONAL CONDITIONS

The following text describes the ecological region in which the proposed Hardin County North wind energy generation facility (the "Project") occurs. This description is useful in understanding the nature and important ecological aspects of the area.

The Project lies within the Eastern Broadleaf Forest (Continental) Ecological Province of the United States (USFS 1994). Within this Province, the Project is located in Ecoregion Section 222H—Central Till Plains, Beech-Maple (Figure 4). Of all the wind energy generation facilities at which bat mortality studies have been completed, none are within this same Ecological Province or Ecoregion Section. Ecological aspects of Crescent Ridge, Top of Iowa, Lincoln, and Buffalo Ridge (four Midwestern operating wind energy generation facilities at which bat mortality studies have been completed) are shown in Table 1 for comparison. These wind energy generation facilities occupy areas dominated by agriculture and cropland comparable to the Hardin County North Project planning area.

Ecoregion Section 222H comprises part of the Central Lowlands geomorphic province and is characterized by flat to gently rolling till-plain, broad bottomlands, shallow entrenchment of drainages, and a few major river valleys. Section 222H is predominantly Wisconsinan glacial till and dominant soils include Udalfs and Aqualfs (USFS 1994).

The potential natural vegetation of Section 222H is beech-maple forests with some oak-hickory forests and bluestem prairie. Most of the land in Section 222H is now highly productive farmland, with most forest stands in small, isolated tracts less than 101 ha (250 ac) in size (USFS 1994, Appendix A).

Precipitation averages 900 to 1030 mm (35 to 40 in) per year. Mean annual temperature is approximately 10 to 13 °C (50 to 55°F). The growing season ranges from 155 to 180 days (USFS 1994).

Approximately 28 percent of Hardin County is forested (12 percent coniferous, 11 percent deciduous, 3 percent forested wetlands, and 2 percent mixed forest; USGS 2001).

2.2 SITE-SPECIFIC CONDITIONS

BHE visited the site October 31, 2008, and representative portions were photographed (Appendix A). Topography in the Project planning area is nearly flat, and land use is primarily agricultural (predominantly corn and soybeans). Project area views, from horizon to horizon, are nearly entirely farmland, with small groups of trees, tree lines, or partially treed, narrow riparian strips sometimes visible. Wooded habitat is very uncommon, and occurs primarily in residential yards within the project area and along fencerows and small, isolated woodlots outside the project boundary but within view of the site. The area surrounding the Project planning area is similar, with the majority of the landscape dedicated to row crop production. Many of the watercourses are ditched, or occur in gullies where they are isolated from their floodplains. Active tillage therefore extends in many cases nearly to the ditch's edge.

The planning area lacks significant land features such as ridgelines, river corridors, or forested expanses that may be used as landmarks by migrating bats. The quality of bat habitat at the site is low.

2.3 BATS

Eleven species of bats have been documented in Ohio. Except for the eastern small-footed bat (*M. leibii*) and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) each of the remaining nine species has potential to occur on the Project area (Table 2).

These nine bat species that occur in Ohio include year-round residents as well as species present only during certain seasons (Table 2). The Indiana bat (*M. sodalis*) is federally listed as endangered. The remaining eight species are not federally listed, are not proposed for listing, and are not candidates for federal listing. The Indiana bat is listed as endangered by the State of Ohio. None of the other bat species potentially present at the Project area is listed by the State of Ohio (ODNR 2009). Descriptions of each species potentially present at the Project area are provided below.

2.3.1 Indiana Bat (*Myotis sodalis*)

The Indiana bat was listed by the federal government as endangered on March 11, 1967 and is listed as endangered by the Ohio Endangered Species Protection Board. Populations across the species range (as recorded from hibernacula counts) have declined since the late 1950s. Recent estimates place the total species population at approximately 468,000 (USFWS 2008a). A principal cause of decline is destruction of hibernacula from collapse, flooding, or vandalism by humans. Suspected contributing factors include loss of suitable summer habitat and contamination by pesticides (USFWS 2007a). A recovery plan for Indiana bats was developed in 1983 (USFWS 1983) and revised in 1999 (USFWS 1999) and in 2007 (USFWS 2007a).

In winter (mid-November through March), Indiana bats hibernate in caves and abandoned underground mines. For the remainder of the year, Indiana bats roost in trees (Barbour and Davis 1969). In April and again in August-September, Indiana bats migrate between winter and summer habitat. Some individuals may travel 483 to 575 km (300 to 357 mi) between summer and winter roosts (USFWS 2007a, Winhold and Kurta 2006). Others, particularly males, may roost in trees near hibernacula in summer. In Pennsylvania and New York, radiotelemetry studies indicate Indiana bats migrate between 16 to 97 km (10 and 60 mi) (USFWS 2007a). Migrating bats have been documented traveling along power line and pipeline rights-of-way, along highways, hedgerows, tree lines, and along stream courses (Murray and Kurta 2004, Johnson and Strickland 2003, USFWS 2007a, Verboom and Huitema 1997). Limited recovery records of banded Indiana bats from the Midwest indicate females and some males migrate north in the spring upon emergence from hibernation (USFWS 2007a).

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

Indiana bats typically arrive in summer habitat (primarily upland and riparian forests) in early to mid-May. This species roosts under exfoliating bark or in cavities of trees. Pregnant females form maternity colonies that may contain up to 100 or more adult bats (USFWS 2007a). Male Indiana bats tend to roost singly or in small all-male groups (USFWS 2007a). Males may occur in summer anywhere throughout the range of the species, including near hibernacula (Whitaker and Brack 2002).

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

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

The Indiana bat has potential to occur in Ohio year-round (Figure 5; Appendix B). The USFWS assumes the Indiana bat may occur in every county in Ohio (USFWS 2008b). Most counties in Ohio with records of Indiana bats only have summer records. Those few with summer and winter records are located along the in the southern part of the state. Lewisburg Limestone Mine is the closest known Indiana bat hibernaculum, located approximately 116 km (72 mi) southwest of the project area in Preble County, Ohio (Figure 5; Boyer, pers. comm.). The mine is a Priority II Indiana bat hibernaculum based upon the prioritization scheme outlined in the 2007 Indiana Bat Recovery Plan (USFWS 2007a). Though the USFWS and ODNR conducted the most recent census in the hibernaculum in 2009, survey results have not been analyzed (Boyer, pers. comm.). As of 2006, 7,405 Indiana bats were observed (USFWS 2008a). This hibernaculum has been surveyed every other year since 1996. During the course of these surveys, the number of Indiana bats observed has decreased from 9,298 to 7,405 individuals.

Other bat hibernacula in the region include Ohio Caverns, Sanborn's Cave, and an unnamed cave near Sanborn's Cave (Lott, pers. comm.), all found in Champaign County over 56 km (35 mi) from the Project planning area. None of these hibernacula are known to have Indiana bats.

A search of the Ohio Natural Heritage Database in January 2009 revealed that no federal Threatened, Endangered or Candidate bat species have been documented within the Project planning area (Appendix C). Though there are no records of Indiana bats in or within 8 km (5 mi) of the Project planning area, there were two Indiana bats captured along Wolf Creek at least 21 km (13 mi) southeast of the Hardin County North site in south central Hardin County (Boyer, pers. comm.). One of these bats was a lactating female; therefore, it is likely there is a maternity roost near the capture location. The closest confirmed Indiana bat maternity colonies are located southeast of Bellefontaine approximately 48 km (30 mi) south of the Project planning area (Lott, pers. comm.).

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

The northern long-eared bat ranges from southern Canada and the central and eastern United States through northern Florida (Appendix B). The northern long-eared bat is migratory (Table 2; Whitaker and Hamilton 1998). In winter (October/November through March/April), this species hibernates in caves and mines. It may hibernate in caves occupied by several other species. Northern long-eared bats occasionally emerge from hibernation and have been observed in flight during winter (Whitaker and Hamilton 1998).

In summer, this species typically roosts in trees (under exfoliating bark or in crevices and hollows) and in manmade structures (Harvey 1992, Foster and Kurta 1999). Foster and Kurta (1999) identified northern long-eared bats roosting singly or in small groups that averaged 17 individuals. This species forages along forested hillsides and ridges, often through dense vegetation (Harvey et al. 1999).

2.3.3 Little Brown Bat (*M. lucifugus*)

The little brown bat is abundant throughout forested areas of the United States as far north as Alaska (Appendix B).

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

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

2.3.4 Eastern Pipistrelle (*Perimyotis [Pipistrellus] subflavus*)

The eastern pipistrelle occurs in the eastern United States, and ranges throughout Ohio (Appendix B, Barbour and Davis 1969). This species appears abundant throughout its range. Summer and winter ranges are identical. In summer, eastern pipistrelles have been found roosting in foliage and, rarely, in buildings. They may roost singly or in colonies of up to 30 bats (Barbour and Davis 1969). In winter, eastern pipistrelles hibernate in mines, quarries, caves, and rock crevices.

2.3.5 Big Brown Bat (*Eptesicus fuscus*)

The big brown bat is common throughout its range (Appendix B) from Alaska and Canada to Mexico and South America. Big brown bats do not migrate; there appears to be no difference in range from summer to winter (Table 2; Barbour and Davis 1969). They roost in rock crevices, expansion joints of bridges and dams, hollow trees, and manmade structures. Maternity colonies containing several hundred individuals have been recorded from attics, barns, and other buildings (Harvey 1992).

2.3.6 Eastern Red Bat (*Lasiurus borealis*)

The eastern red bat occurs from southern Canada, throughout the United States, to Mexico and Central America (Appendix B, Barbour and Davis 1969). It is common in the Midwest and central states, including Ohio (Harvey 1992, Whitaker and Hamilton 1998). Eastern red bats are migratory; however, migration patterns are poorly understood. In winter, eastern red bats may hibernate in tree foliage for short periods, but arouse and forage during warm winter nights.

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

2.3.7 Hoary Bat (*L. cinereus*)

The hoary bat is widespread throughout the United States, but in eastern regions, the species' distribution varies seasonally (Appendix B, Whitaker and Hamilton 1998). Breeding individuals are known from Canada south to Arkansas, Louisiana, and Georgia (Barbour and Davis 1969). The range of the hoary bat includes Ohio (Harvey et al. 1999).

It appears that the sexes are separate during summer, with females inhabiting the northeast region (Cryan 2003, Whitaker and Hamilton 1998). Reproductive females are found in the northeast as far south as Pennsylvania and Indiana (Whitaker and Hamilton 1998). Female hoary bats give birth between mid-May and early July (Cryan 2003).

In August, this species moves south to winter habitat in southeastern and southwestern states, the Caribbean, and Central and South America (Cryan 2003, Whitaker and Hamilton 1998). In the eastern United States, hoary bats winter in northern Florida and southern Georgia, Alabama, Louisiana, and South Carolina (Whitaker and Hamilton 1998). Hoary bats apparently migrate in groups, with large numbers passing through an area over several nights in spring and fall (Whitaker and Hamilton 1998, Zinn and Baker 1979). Females precede males in spring migration. In the north, some may hibernate rather than migrate (Whitaker 1980). Hoary bats migrate north from March through April (Whitaker and Hamilton 1998).

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

2.3.8 Silver-Haired Bat (*Lasionycteris noctivagans*)

The silver-haired bat is common in forested areas throughout much of North America, although it is characterized as a northern species (Appendix B, Whitaker and Hamilton 1998). This species typically is found in parts of its range containing stands of coniferous or mixed coniferous and deciduous forests (Whitaker and Hamilton 1998).

Silver-haired bats commonly roost in tree cavities, often switching roosts during the maternity season. Silver-haired bats typically are solitary, but may congregate in small maternity colonies usually numbering fewer than 10 individuals (Whitaker and Hamilton 1998).

Females are thought to migrate farther than males, and it is possible males remain in winter habitat year-round (Whitaker and Hamilton 1998). During migration, silver-haired bats have been found roosting in trees along a ridge (Whitaker and Hamilton 1998). Typical winter roosts for this species include trees, buildings, wood piles, and rock crevices (Harvey et al. 1999). Whitaker and Hamilton (1998) depict the species' winter range as extending as far north as the southern tip of Ohio. Occasionally silver-haired bats will hibernate in caves or mines, especially in northern regions of their range.

Silver-haired bats roost in forested areas and feed predominantly in openings such as small clearings and along roadways or streams (Whitaker and Hamilton 1998). The silver-haired bat typically leaves the roost and begins to forage relatively late, with major foraging activity peaks 3, and 7 to 8 hours after sunset (Kunz 1973).

2.3.9 Evening Bat (*Nycticeius humeralis*)

The evening bat occurs throughout the eastern United States, including a large portion of Ohio (Appendix B), and is abundant throughout its range. Evening bats are known to form large maternity colonies, often including up to several hundred individuals. These maternity colonies are generally formed in hollow trees, behind loose bark, or occasionally in buildings and attics. The evening bat is considered a true forest bat and is almost never observed in caves. Little is known about the migration patterns of this species; however, evening bats have been shown to put on high amounts of fat in the fall, a possible indication of a long migration. Banded evening bats have been found up to 547 km (340 mi) south of their initial banding sites. It is believed that evening bats remain active during the winter.

3.0 POTENTIAL EFFECTS TO BATS

Construction and operation of wind energy facilities present potential concerns regarding direct and indirect effects upon bats through three primary avenues:

- Bats may be directly affected by moving turbine blades either through collision or barotrauma .
- Construction of the turbines and associated appurtenances may degrade habitat quality through the removal of trees causing indirect effects.
- Bats may also be indirectly affected through displacement by operating turbines.

3.1 BAT MORTALITY AT WIND ENERGY GENERATION FACILITIES

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

A report published in winter 2008 summarized 21 studies of bat mortality at 19 wind energy generation facilities across the United States and one Canadian Province. The 21 studies include five in the Pacific Northwest, one in the Rocky Mountains, three in Alberta, Canada, three in the Midwest, one in south-central United States, and six in the eastern states (Arnett et al. 2008). Average mortality in these 21 studies ranged from 0.1 to 69.6 bat fatalities per turbine per year. Methods used in these studies varied; mortality estimates were adjusted in many cases for the biases presented by searcher efficiency and removal of carcasses by scavengers during mortality monitoring studies. A majority of studies (13 of 21) used bird carcasses as surrogates for bats while conducting searcher efficiency trials and calculating scavenging rates (Arnett et al. 2008). Bat mortality has been recorded both anecdotally and in ongoing studies at other wind energy generation facilities as well.

Documented bat fatalities at North American wind energy generation facilities have been generally highest in the east (Appalachian Mountains), moderate in the Midwest, and lowest in the western states. In most cases, documented mortality was low - less than five bats per turbine per year. Nationwide, more than 93 percent of fatalities documented in the U.S. as of winter 2006 (Arnett et al. 2008) have been of six species, with hoary bats accounting for nearly one-half of all mortality:

- hoary bat (40.7 percent),
- eastern red bat (21.2 percent),
- silver-haired bat (15.4 percent),
- eastern pipistrelle (8.0 percent),
- little brown bat (6.0 percent), and
- big brown bat (2.4 percent).

"Tree bats" (hoary bats, silver-haired bats and eastern red bats) typically roost in trees during summer months and often migrate long distances to southern winter habitat. These migratory bats accounted for the great majority of mortality. Bats that roost (winter and/or summer) in caves, sometimes referred to as "cave bats," comprised the remainder.

Although mortality has been documented in all months when bats are not hibernating, a significant majority of mortality has been documented in mid-July through mid-October during the post-maternity dispersal from summer habitat to winter habitat. At the Buffalo Mountain Windfarm in Tennessee, 70 percent of all bat fatalities occurred between August 1 and September 15 (Fiedler 2004). At Crescent Ridge, 20 of 21 bat fatalities were found in September and October. Overall, mortality appears highest between approximately July 15 and September 15. However, at the Summerview facility in Alberta, Canada, 6 percent of the 272 silver-haired bat fatalities occurred in May and June, suggesting that some mortality does occur during the spring migration period. These findings were supported in Buffalo Mountain, Tennessee, where 84 percent of the 19 silver-haired bat fatalities occurred between mid-April and early June (Arnett et al. 2008). Mortality is very low during the summer maternity period, even when substantial numbers of bats are present at or near wind energy generation facilities (Arnett et al. 2008). In a study in Minnesota at the Buffalo Ridge Wind Power Development, researchers found bat activity as measured by ultrasound detectors during summer was not correlated with bat mortality (Johnson et al. 2003a).

To date only one study has attempted to correlate the timing of fatalities between sites. Kerns et al. (2005) conducted simultaneous fatality searches from August 1 to September 13, 2004 at the Mountaineer and Meyersdale facilities in West Virginia, and Pennsylvania, respectively. The timing of all fatalities, while periodic and highly variable during the study was highly correlated between the two sites. Additionally, the timing of hoary and eastern red bat fatalities were positively correlated for the two sites (Kerns et al. 2005).

The sites at which the highest mortality has been documented occur at approximately 840 m (2,760 ft) above mean sea level (amsl; Meyersdale, Pennsylvania), 1,025 m (3,363 ft) amsl (Mountaineer, West Virginia), and 1,010 m (3,314 ft) amsl (Buffalo Mountain, Tennessee). All three sites are on forested Appalachian Mountain ridgelines. At this time, the greatest risk of bat mortalities is expected at sites on forested Appalachian Mountain ridgelines.

The presence of FAA-approved lighting on towers has been the subject of speculation regarding bat mortality. Studies completed in 2003 at the Mountaineer site (Kerns and Kerlinger 2004), in 2004 at the Mountaineer and Meyersdale sites (Arnett 2005), and in 2005 at the Buffalo Mountain site (Fiedler et al. 2007) found no significant difference in mortality at unlit towers and at towers lit by L-864-type flashing red strobe-like or incandescent lights. Similar results were documented at the Vansycle Ridge site in Oregon (Erickson et al. 2000), in northern Wisconsin (Howe et al. 2002), the Stateline project (Erickson et al. 2003a), the Nine Canyon project in Washington State (Erickson et al. 2003b), the Klondike facility in Oregon (Johnson et al. 2003b), the Summerview project in Alberta (Brown and Hamilton 2006), and the Maple Ridge project in New York (Jain et al. 2007). It also appears that mortality does not vary among the types of lighting used on wind turbines. At the Top of Iowa project, all turbines are lit with FAA lighting: 46 with non-pulsating red beacons, 37 with pulsating red beacons, and six with a combination of flashing white beacons and non-flashing red beacons. Jain (2005) found no significant difference in bat mortality among these towers.

Many of the nine species of bats with potential to be present during some portion of the year at the Hardin County North Project planning area have been fatalities at one or more operating wind energy generation facilities. No fatalities of federally listed bat species have been documented at wind energy generation facilities in the U.S. Based upon results of mortality monitoring completed to date, hoary bats, silver-haired bats, and eastern red bats account for the majority of bat fatalities. These species accounted for approximately 77 percent of the mortality in turbine searches conducted through the end of 2006 (summary of mortality studies contained in Arnett et al. 2008). At the three project sites in the Midwest that were included in Arnett et al. (2008), these species accounted for 84.5 percent of the mortality observed. A study conducted in Bureau County, Illinois, had similar results: all of the bat carcasses recovered during mortality studies were hoary bats, silver-haired bats, or eastern red bats (Kerlinger et al. 2007). Based on these findings, we expect these three species to account for a majority of the mortality associated with the proposed Hardin County North project. Little information exists upon which to base conclusions regarding the biological significance of bat mortality at wind energy generation facilities, because total population estimates do not exist for any of the bat species known to have experienced mortality at wind energy generation facilities.

Reasonably accurate population estimates exist for the federally endangered Indiana bat, one of the most uncommon North American species. In 2007, there were an estimated 468,184 Indiana bats in existence (USFWS 2008a). Although neither this species nor any other federally listed bat species has been identified during bat mortality studies at wind energy generation facilities, we mention the size of the population of this species for context. Populations of species that have experienced fatalities at wind energy generation facilities are much more common than this listed species, and may be an order of magnitude (or more) higher.

3.2 BAT COLLISION MORTALITY

Specific pre-construction techniques/protocols that accurately predict risk of chiropteran mortality at wind sites do not exist. Post-construction mortality monitoring remains the best source for these data. Therefore, comparison of the Hardin County North Project area to nearby similar sites with known mortality is a useful approach.

As discussed above, the highest levels of bat mortality documented to date have occurred at three wind energy generation facilities located in West Virginia (Mountaineer), Pennsylvania (Meyersdale), and Tennessee (Buffalo Mountain). These sites are mountainous with elevated topography (i.e., ridgelines), elevation (i.e., 840 to 1,025 m [2,760 to 3,363 ft] amsl), and geographic location (i.e., eastern U.S.), and are markedly dissimilar to the proposed Project site described herein. Wind energy generation facilities with lower mortality are more similar to the Hardin County North Project planning area (e.g., the Lincoln site in Wisconsin; the Buffalo Ridge site in Minnesota; or the Top of Iowa site in Iowa) are located in Midwestern states, are located on flat terrain, and have been constructed in agricultural areas or other non-forested sites (e.g., short grass prairie/sagebrush, pasture; Table 1). As discussed in Section 2.0, the Hardin County North Project planning area described herein is nearly devoid of tree cover (Appendix A, Figure 2).

Based upon published and unpublished information available at this time, similarities in the projects discussed in Table 1, and anticipated similarity in the behavior of bats at these sites, it is likely that mortality resulting from the Project will be most similar to that at the Crescent Ridge site in Illinois, Top of Iowa site in Iowa, the Lincoln site in Wisconsin, and the Buffalo Ridge site in Minnesota. Annual mortality estimates based upon post-construction monitoring studies was 8.04 bats per turbine per year at Top of Iowa; 4.26 bats per turbine per year at Lincoln; and 1.32 bats per turbine per year at Buffalo Ridge. Post-construction studies at Top of Iowa, Lincoln, and Buffalo Ridge, were all multi-year studies encompassing spring through fall (approximately mid-March through mid-November for each).

Mortality studies at Crescent Ridge were conducted from August through November 2005, March through May 2006, and August 2006, and the total estimate of bat mortality during the whole of the survey was approximately 9 bats per turbine (Kerlinger et al. 2007). Mortality at the Crescent Ridge facility in Illinois was highly seasonal: almost all (20 out of 21) documented bat fatalities occurred in late fall (September and October). A single bat carcass was documented in August, and no bat fatalities were documented in spring. No monitoring was completed in either year during the months of June or July, when it is reasonable to expect some mortality to take place; thus the extrapolated estimate of 9 bat fatalities per turbine may not be as accurate an estimate of annual mortality as might be found in a study that included June and July.

The Hardin County North Project is not proximate to an Indiana bat hibernaculum. The nearest known hibernaculum used by Indiana bats is the Lewisburg Limestone Mine in Preble County, Ohio (Figure 5). The center of the Hardin County North Project planning area is approximately 72 miles (116 km) from the Lewisburg Limestone Mine hibernaculum.

It is reasonable to expect that the direction of flight of Indiana bats, and of other species of bats utilizing the Lewisburg Limestone Mine hibernaculum in Preble County or the other nearby hibernacula in Champaign County, is not random. These movements are likely concentrated along the only forested rivers in the vicinity. No contiguous forested tracts link the Hardin County North Project planning area to forested rivers corridors or to any of the hibernacula. In summer Murray and Kurta (2004) found that Indiana bats will choose to travel along forested corridors as opposed to non-forested corridors, even if the distance traveled is greater. This suggests that all of the waterways crossing the Project planning are minimally suitable as travel corridors for Indiana bats. If Indiana bats also choose forested corridors for migration, they will not use the Hardin County North site. No effects to Indiana bats during spring and fall migration to and from the Lewisburg Limestone Mine in Preble County or any other bat hibernacula in Champaign County are expected.

The ODNR reports summer records of Indiana bats in south central Hardin County captured along Wolf Creek and in southeastern Logan County near Bellefontaine southeast of the Project planning area. The Ohio Natural Heritage Database has no records of Indiana bats in the Project planning area (Appendix C). The closest know maternity colonies are southeast of Bellefontaine in Logan County. However, the bats captured along Wolf Creek include a lactating female and are currently being tracked to their roost. Though no roost has been identified yet, there is likely a maternity roost along or near Wolf Creek approximately 21 km (13 mi) southeast of the Project planning area. Bats from these colonies are likely to forage along the forested streams and forests connected to such streams. No contiguous forested corridors connect these streams to waterways in the Project planning area. Though bats along such streams may venture out into the open fields, most tend to remain along forested waterways as insects are more abundant and trees provide protection from aerial predators.

It is unlikely that Indiana bats will occupy the Project planning area during summer. Habitat conditions in the Project planning area, which is nearly devoid of trees and is composed largely of open fields/agricultural land, is less than suitable for foraging or roosting bats. Indiana bats, even if present, are likely to be very rare at the Hardin County North Project area during summer, and are likely to be active at heights largely below the rotor-swept area. As such, the chance of collisions between Indiana bats and turbine blades during the summer is extremely low. Studies completed to date have documented very low mortality during spring and summer months, even when concurrent mist net surveys and/or ultrasound acoustic detection devices indicate the presence of substantial numbers of bats (Arnett et al. 2008). No effects to Indiana bats during summer are expected.

Furthermore, other bat species that may experience mortality at the Hardin County North Project area are widely dispersed in the U.S. and only a very small minority of each species' population will forage in, roost in, travel through, or migrate over the Hardin County North Project area. For example, if the range-wide population of hoary bats is assumed to be 4,681,840 (10 times the population of Indiana bats), and if hoary bats comprise 50 percent of potential mortality (0.5 x ~802 = 401), then annual fatalities of hoary bats would equate to 0.009 percent of the species' population.

3.3 HABITAT DEGRADATION

The landscape within the Project planning area is dominated by agriculture and tree cover is sparse. Construction of the Project in this agricultural area will have little to no effect upon habitat features important to bats, because few, if any, of these characteristics exist within the thoroughly disturbed and degraded habitat within the Project planning area, e.g. forested area, suitable roost trees, roost structures (e.g., barns), available prey, or other habitat attributes in this area of thoroughly disturbed and degraded habitat.

The USFWS is routinely consulted regarding potential impacts to the Indiana bat associated with a wide variety of projects. Their concerns commonly focus upon habitat modifications near hibernacula and maternity sites, and modification of proximate forested habitat. Where such habitat modifications occur, the USFWS often recommends project-specific consultation and avoidance/conservation measures. However, the Hardin County North Project planning area is almost devoid of trees (Appendix A, Figure 2). Furthermore, tree clearing during construction is unlikely.

3.4 DISTURBANCE AND DISPLACEMENT OF BATS

Speculations have been made concerning the potential disturbance of bats by operating wind energy generation facilities, and the potential for resulting displacement of bats from otherwise suitable habitat. Data do not exist to dismiss the risk of such disturbance or displacement, but preliminary information now available supports the conclusion that wind turbines and their blades do not substantially disturb/displace bats. In 2004 at the Mountaineer and Meyersdale wind energy generation facility sites, bats were commonly observed foraging in forest openings at turbine sites. Thermal imaging equipment was used to investigate bat behavior near wind towers. Bats landed on towers, foraged near rotating blades, pursued rotating blades, and flew in patterns that appeared to indicate purposeful collision avoidance (Horn et al. 2008). The presence of bats near operating turbines was also documented at the Buffalo Ridge site in Minnesota (Johnson et al. 2003a), and the Buffalo Mountain site in Tennessee (Fiedler 2004). Based upon the best available information it appears operating turbines do not significantly disturb or displace bats, and this should especially be the case at the Hardin County North Project planning area because of the lack of roosting and foraging habitat.

4.0 CONCLUSIONS

A summary of the conclusions this bat risk assessment for the proposed Hardin County North wind energy generation facility in Hardin County, Ohio, is listed below.

- Risk to bats is expected to be low.
- There are no records of federally threatened or endangered bats in or within 5 miles of the proposed Project planning area.
- The Project area is within the range of only one federally listed bat: the endangered Indiana bat (*Myotis sodalis*).
- The closest bat hibernaculum is Ohio Caverns in Champaign County over 56 km (35 mi) southeast of the project area.
- The closest hibernaculum used by Indiana bats in Ohio is approximately 116 km (72 mi) southwest of the Project area.

- The closest Indiana bat maternity colony recorded is approximately 48 km (30 mi) away from the Project planning area, though closer colonies may be discovered around Wolf Creek approximately 21 km (13 mi) southeast of the Project area.
- Indiana bats are not likely to be roosting, foraging, or migrating within the Project planning area, due to the poor habitat conditions. Indiana bats are more likely to use the Scioto River and Tymochtee Creek that are 13 and 19 km (8 and 12 mi) away from the planning area and not at risk.
- Habitat loss will be low considering the Project area is nearly all agricultural and only about 4 percent of the area will be cleared for construction.

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TABLES

Table 1. Attributes of the Hardin County North Project area as compared to other Midwestern wind energy generation facilities where post-construction studies of bat mortality have been conducted.

Feature	Hardin County North (Hardin Co., OH)			Crescent Ridge (Bureau Co., IL)	Lincoln (Kewaunee Co., WI)	Buffalo Ridge (Lincoln and Pipestone Cos., MN)	Top of Iowa (Worth Co., IA)
Ecoregion (Section)	Central Till Plains, Beech-Maple Section			Central Loess Plains Section	Northern Great Lakes Section	North-Central Glaciated Plains Section	Minnesota and Northeastern Iowa Morainal, Oak Savannah Section and North-Central Glaciated Plains Section
Position	Towers to be placed in open agricultural areas			Towers located in agricultural areas	Towers located on ridges of glacial till approximately 30-60 m (98-197 ft) above the surrounding lowlands	Towers located on ridge consisting of terminal moraines and stream dissected lands	Towers located in agricultural areas surrounded by grasslands and wetlands
Approximate average elevation (above msl)	284 m (934 ft)			274 m (900 ft)	240-270 m (787-886 ft)	546-610 m (1,791-2001 ft)	366-396 m (1,200 - 1,300 ft)
Vegetative cover	Primarily corn and soybeans			Primarily corn and soybeans	Pasture and agricultural land	Primarily corn, soybeans, pastures, and grasslands	Primarily cropland
No. of turbines	19 (2.5 MW)	21 (2.3 MW)	27 (1.8 MW)	33 (1.65 MW)	31 (0.66-MW)	354 (0.75-MW)	89 (0.90-MW)

Table 1. Attributes of the Hardin County North Project area as compared to other Midwestern wind energy generation facilities where post-construction studies of bat mortality have been conducted.

Feature	Hardin County North (Hardin Co., OH)			Crescent Ridge (Bureau Co., IL)	Lincoln (Kewaunee Co., WI)	Buffalo Ridge (Lincoln and Pipestone Cos., MN)	Top of Iowa (Worth Co., IA)
Turbine string(s)	19 turbines spread across 1,353 ha (3,343 ac) in an irregular array	21 turbines spread across 1,353 ha (3,343 ac) in an irregular array	27 turbines spread across 1,353 ha (3,343 ac) in an irregular array	Irregular array along 9-mile ridge, installed in 2 phases.	14 WPS turbines in 3 rows within 1.5 km (0.9 mi) of one another; 17 MGE turbines in 2 irregular clusters approximately 3.5 km (2.2 mi) apart	Phase 1: 10 turbine strings each with 3 - 20 turbines spaced at 91-183 m (298-600 ft) intervals (73 turbines total) Phase 2: 26 turbine strings each with 2 - 12 turbines spaced at 100-200 m (328-656 ft) intervals (143 turbines total) Phase 3: 36 turbine strings each with 2-13 turbines spaced at 250-500 m (820-1640 ft) intervals (138 turbines total)	89 turbines spread across 865 ha (2,137 ac) in an irregular array
Hub height	100 m (328 ft)	100 m (328 ft)	80 m (262 ft)	78 m (256 ft)	65 m (213 ft)	Phase 1: 36 m (118 ft) Phase 2 and 3: 50 m (164 ft)	72 m (237 ft)
Rotor diameter	100 m (328 ft)	101 m (331 ft)	90 m (295 ft)	82 m (269 ft)	47 m (154 ft)	Phase 1: 33 m (108 ft) Phase 2 and 3: 46 and 48 m (151-157 ft)	52 m (171 ft)
Max. rotor height	150 m (492 ft)	150.5 m (494 ft)	125 m (410 ft)	119 m (390 ft)	89 m (292 ft)	Phase 1: 53 m (174 ft) Phase 2 and 3: 74 m (243 ft) or 73 m (240 ft)	98 m (322 ft)
Min. rotor height	50 m (164 ft)	49.5 m (162 ft)	35 m (115 ft)	37 m (121 ft)	42 m (138 ft)	Phase 1: 19.5 m (70 ft) Phase 2 & 3: 26 m (85 ft) or 27 m (88 ft)	46 m (151 ft)

Table 1. Attributes of the Hardin County North Project area as compared to other Midwestern wind energy generation facilities where post-construction studies of bat mortality have been conducted.

Feature	Hardin County North (Hardin Co., OH)			Crescent Ridge (Bureau Co., IL)	Lincoln (Kewaunee Co., WI)	Buffalo Ridge (Lincoln and Pipestone Cos., MN)	Top of Iowa (Worth Co., IA)
Rotor swept area	7,854 m^2 (84,540 ft^2) per turbine; 149,226 m^2 (1,606,255 ft^2) total	8,012 m^2 (86,240 ft^2) per turbine; 168,249 m^2 (1,811,017 ft^2) total	6,362 m^2 (68,480 ft^2) per turbine; 171,767 m^2 (1,848,885 ft^2) total	5,281 m^2 (56,844 ft^2) per turbine; 174,273 m^2 (1,875,859 ft^2) total	1,735 m^2 (18,675 ft^2) per turbine; 53,785 m^2 (578,937 ft^2) total	Phase 1: 855 m^2 (9,203 ft^2) per turbine; 62,437 m^2 (672,066 ft^2) total Phase 2: 1,735 m^2 (18,675 ft^2) average per turbine; 248,105 m^2 (2,670,580 ft^2) total Phase 3: 1,735 m^2 (18,675 ft^2) average per turbine; 239,430 m^2 (2,577,203 ft^2) total	2,124 m^2 (22,863 ft^2) per turbine; 189,036 m^2 (2,034,767 ft^2) total
Operating rotor rpm	14.1	16	16.6	14.4	28.5	Phase 1: 14 to 50 Phase 2 and 3: 16 to 30	15 or 22
Turbine cut in speed	3.5 m/s (7.9 mph)	4 m/s (8.9 mph)	4 m/s (8.9 mph)	3.5 m/s (7.9 mph)	4.0 m/s (8.9 mph)	Phase 1: 4.0 m/s (9 mph) Phase 2 and 3: 3.6 m/s (8 mph)	Data not available
Lighting	Per FAA regulations	Per FAA regulations	Per FAA regulations	10 of 33 turbines lighted	Data not available	Phase 1: no lighting Phase 2: 6 turbines lighted Phase 3: 69 turbines lighted	46 of 89 towers lighted

Table 1. Attributes of the Hardin County North Project area as compared to other Midwestern wind energy generation facilities where post-construction studies of bat mortality have been conducted.

Feature	Hardin County North (Hardin Co., OH)			Crescent Ridge (Bureau Co., IL)	Lincoln (Kewaunee Co., WI)	Buffalo Ridge (Lincoln and Pipestone Cos., MN)	Top of Iowa (Worth Co., IA)
Bat species in the region (bats listed for all sites other than Hardin County North are those species detected in mortality searches. Percent of total detected mortality is indicated).	Big brown Silver-haired Eastern red Hoary Little brown N. long-eared Indiana Evening Eastern pipistrelle	Big brown Silver-haired Eastern red Hoary Little brown N. long-eared Indiana Evening Eastern pipistrelle	Big brown Silver-haired Eastern red Hoary Little brown N. long-eared Indiana Evening Eastern pipistrelle	Hoary (38.1%) Eastern red (28.6%) Silver-haired (28.6%)	Eastern red (37.5%) Hoary (34.7%) Silver-haired (18.1%) *Myotis* spp. (8.3%) Big brown (1.4%)	Hoary (67%) Eastern red (17%) Silver-haired (3%) Big brown (3%) Eastern pipistrelle (2%) Little brown (2%)	Hoary (28%) Eastern red (23.5%) Little brown (23.5%) Silver-haired (11.8%) Big brown (10.5%) Eastern pipistrelle (2.6%)

Table 2. Bats potentially present within the proposed Hardin County North Planning Area during summer, winter, and spring/fall migration.

Species	Status	Potential Seasonal Presence within the Hardin County North Project Planning Area[1]		
		Summer	Winter	Migration
Big brown bat (*Eptesicus fuscus*)	None	Yes	Yes	Yes[2]
Silver-haired bat (*Lasionycteris noctivagans*)	None	Yes	No	Yes
Eastern red bat (*Lasiurus borealis*)	None	Yes	No	Yes
Hoary bat (*Lasiurus cinereus*)	None	Yes	No	Yes
Little brown bat (*Myotis lucifugus*)	None	Yes	No	Yes
Northern long-eared bat (*Myotis septentrionalis*)	None	Yes	No	Yes
Indiana bat (*Myotis sodalis*)	Federal: endangered OH: endangered	Yes	No	Yes
Evening bat (*Nycticeius humeralis*)	None	Yes	No	Yes
Eastern pipistrelle (*Perimyotis subflavus*)	None	Yes	No	Yes

[1]Based upon species range maps and natural history.
[2]Species is not migratory, and may be present during spring and fall.

FIGURES

Figure 1. Overview of the proposed planning area for the Hardin County North wind energy generation facility, Hardin County, Ohio.

N / W / E / S	150 0 150 300 Miles	July 2009
	Project No. 1865.004	Basemap: NAIP Aerial Imagery (2006)

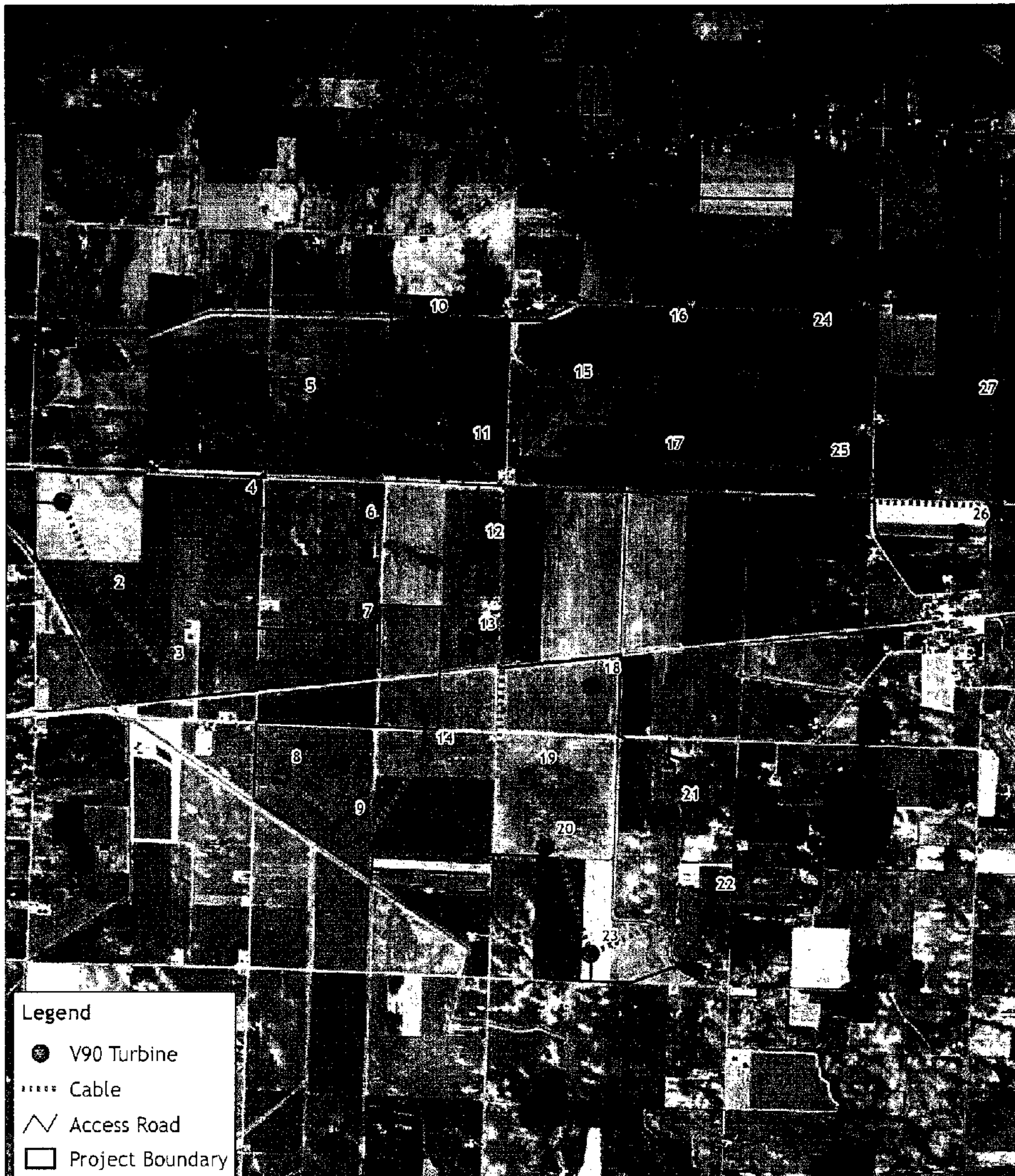

Figure 2. Project boundary based on V90 turbine layout for JW Great Lakes Wind, Hardin County North Project, Ohio.

N / W / E / S

Feet: 2,000 0 2,000 4,000

July 2009

Project No. 1865.004

Basemap:
Microsoft Virtual Earth Imagery© 2009

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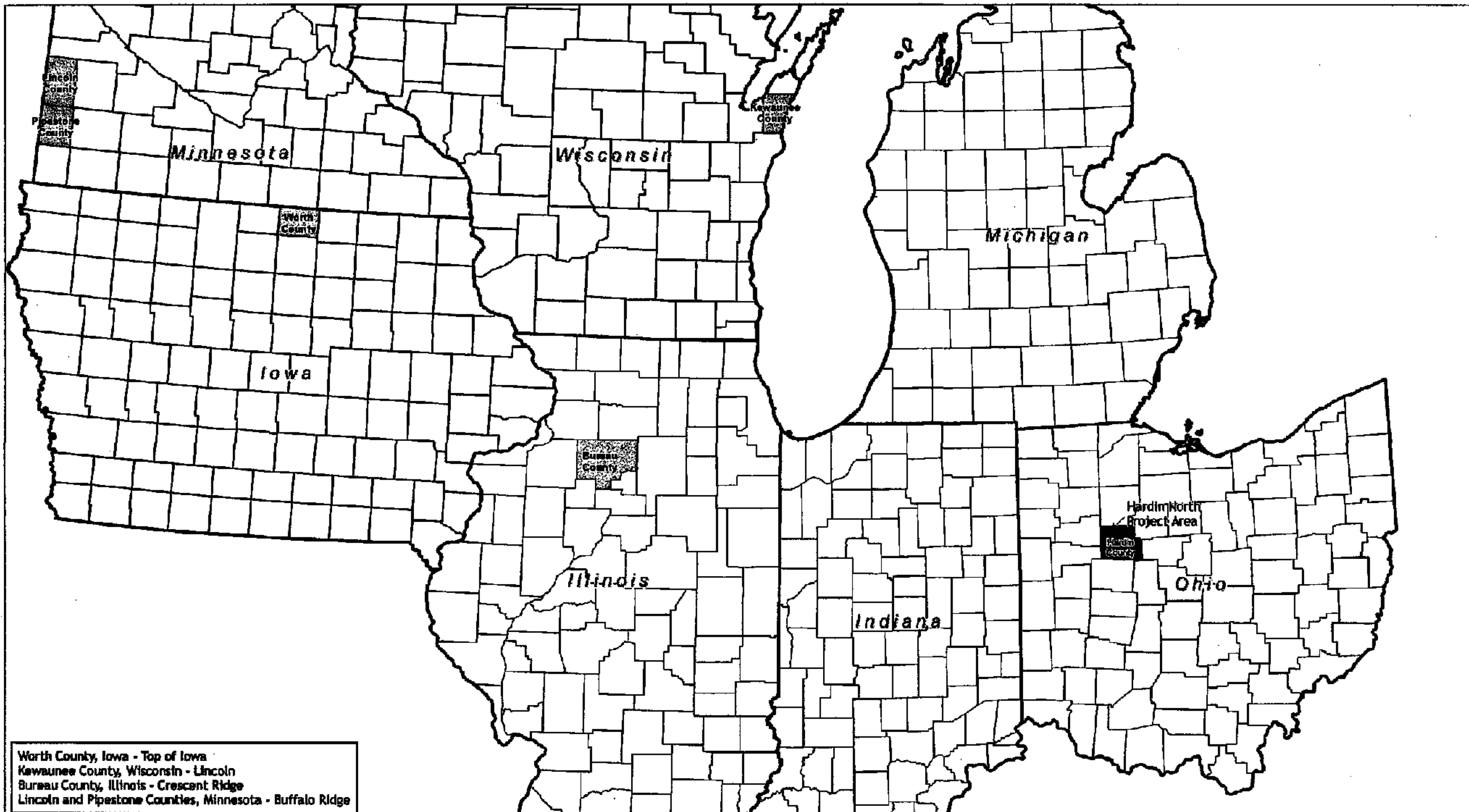


Figure 3. Nearby wind energy generation facilities at which bat mortality studies have been completed.

Project No. 1865.004

July 2009

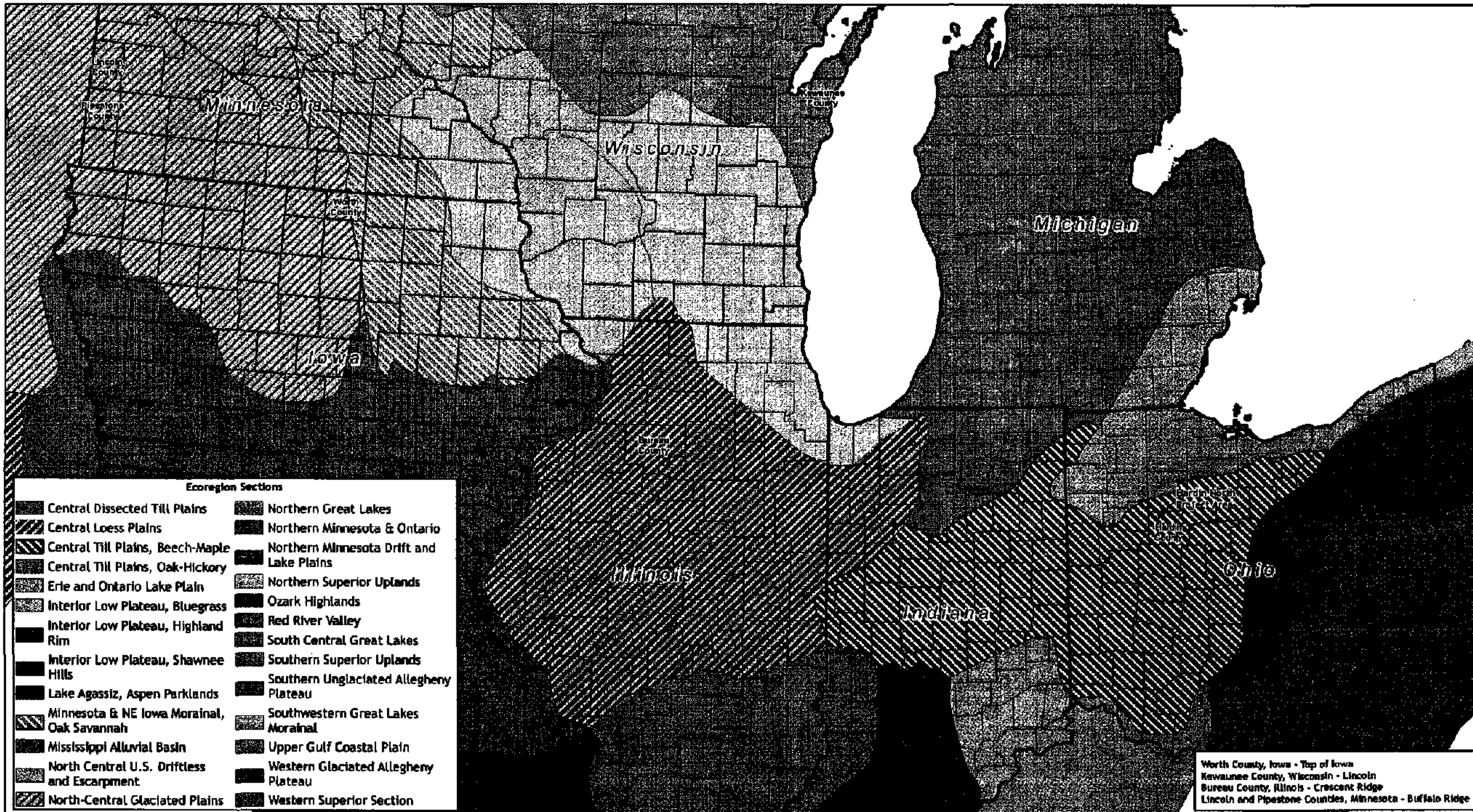


Figure 4. Ecoregion sections at Hardin County North and other nearby wind energy generation facilities.

Project No. 1865.004

July 2009

N
W E
S

Figure 5. Counties in which the Indiana bat (*Myotis sodalis*) occurs near the proposed planning area for the Hardin County North wind energy generation facility, Hardin County, Ohio.

Project No. 1865.004	July 2009

BHE ENVIRONMENTAL

APPENDIX A

Photographs of the Hardin County North Project Planning Area

Photo 1. Typical agricultural land use.

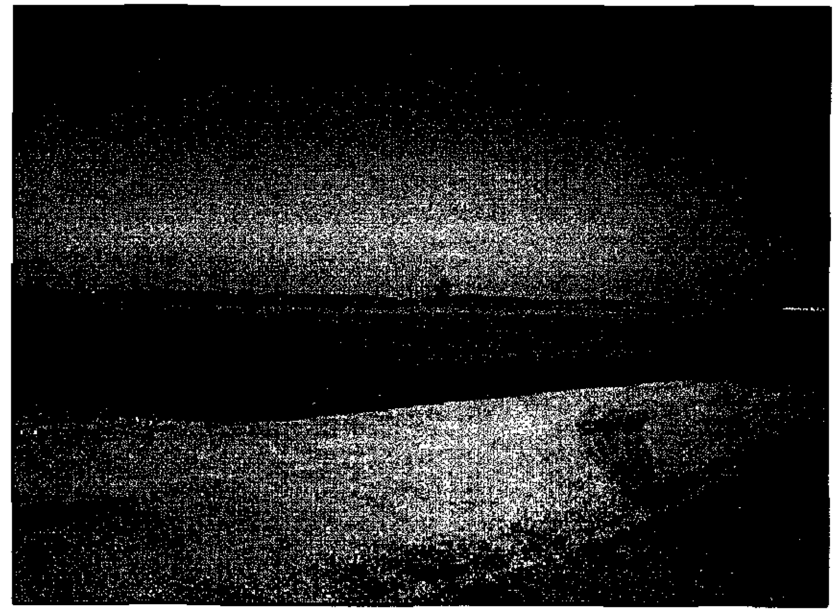


Photo 2. Typical agricultural land use.

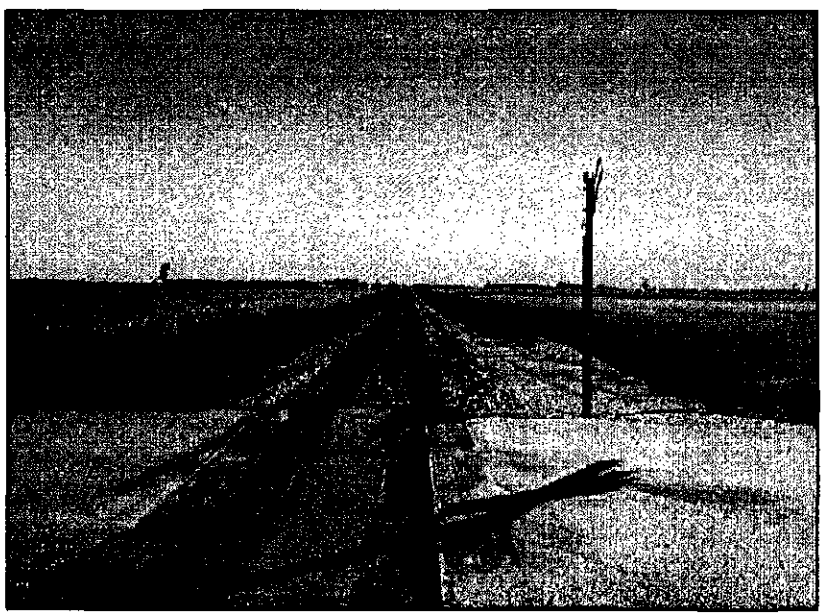


Photo 3. Grassy vegetation along rail road through the project area.

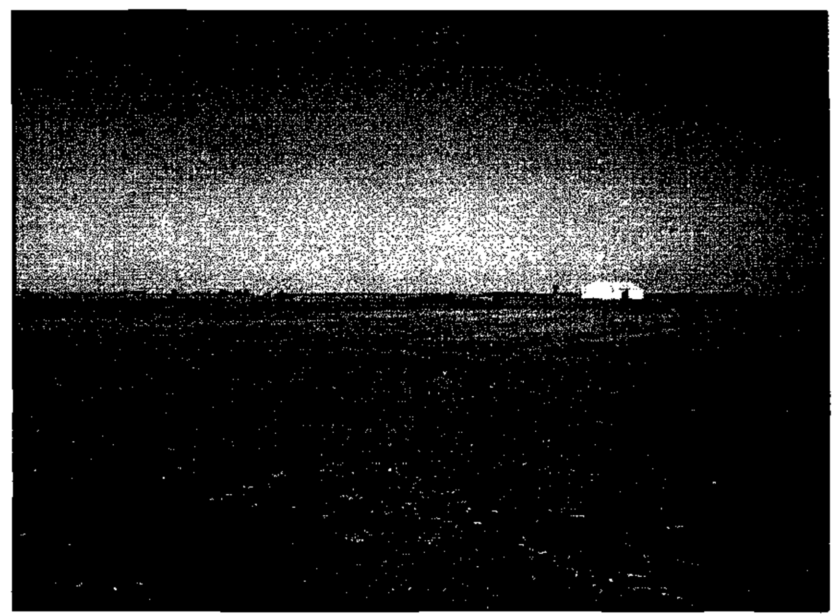


Photo 4. Typical agricultural land use.

Photo 5. Typical agricultural land use.

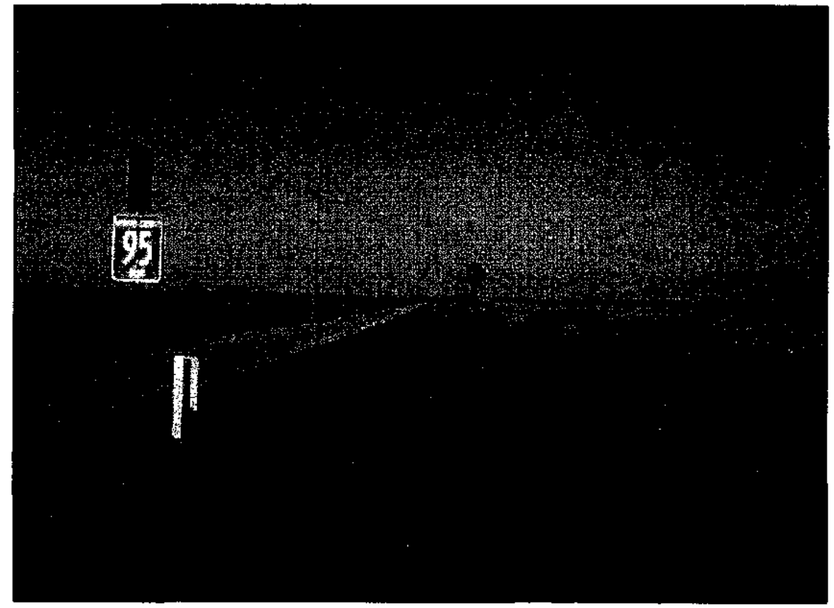


Photo 6. Typical degraded, channeled/grassy watercourse.

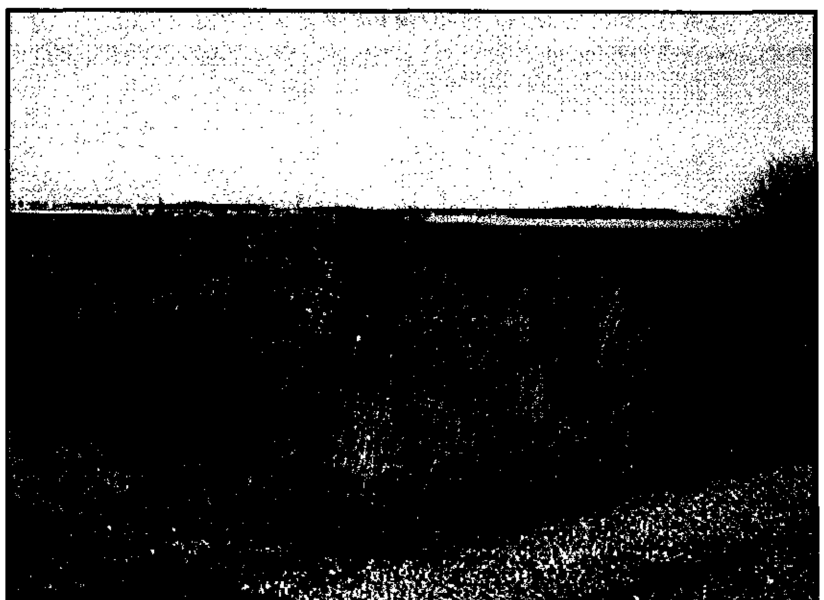


Photo 7. Shrubby vegetation along a road.

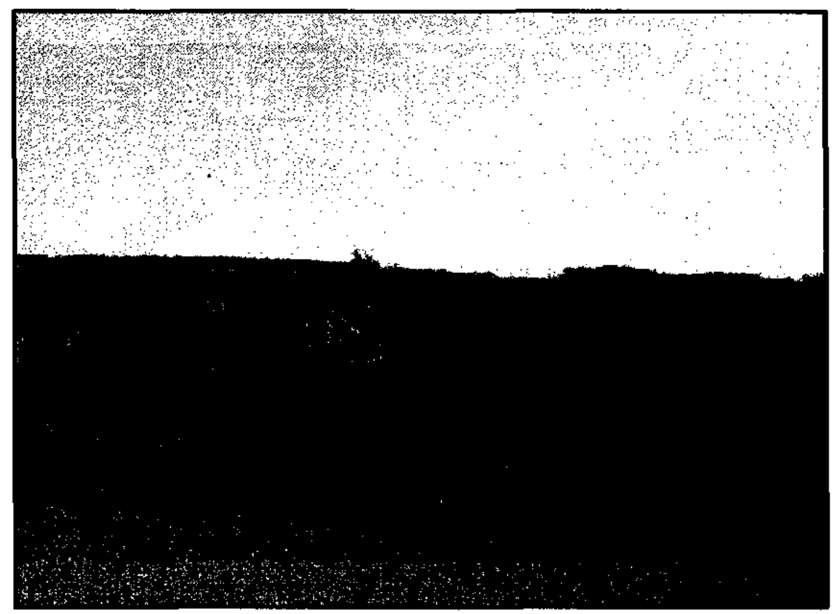


Photo 8. Typical degraded, channeled/grassy watercourse.

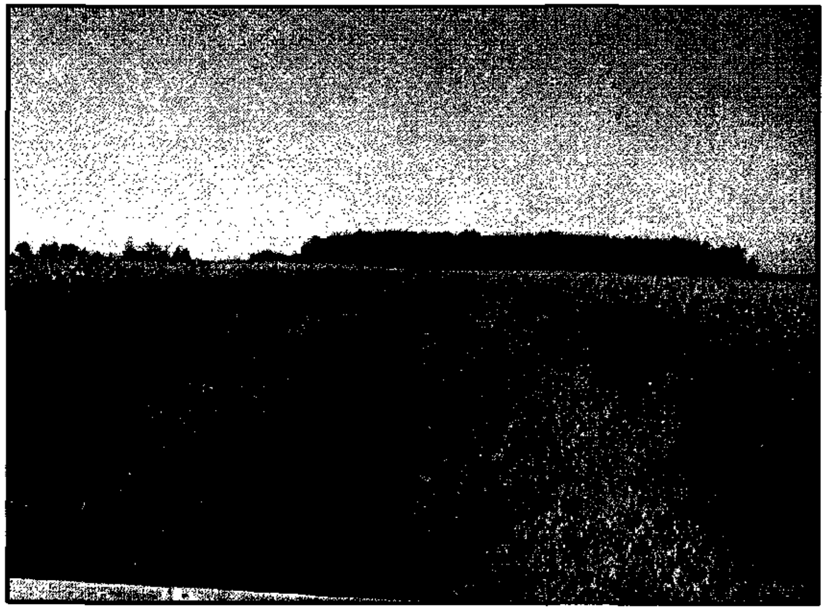


Photo 9. Typical degraded, channeled/grassy watercourse and typical isolated woodlot.

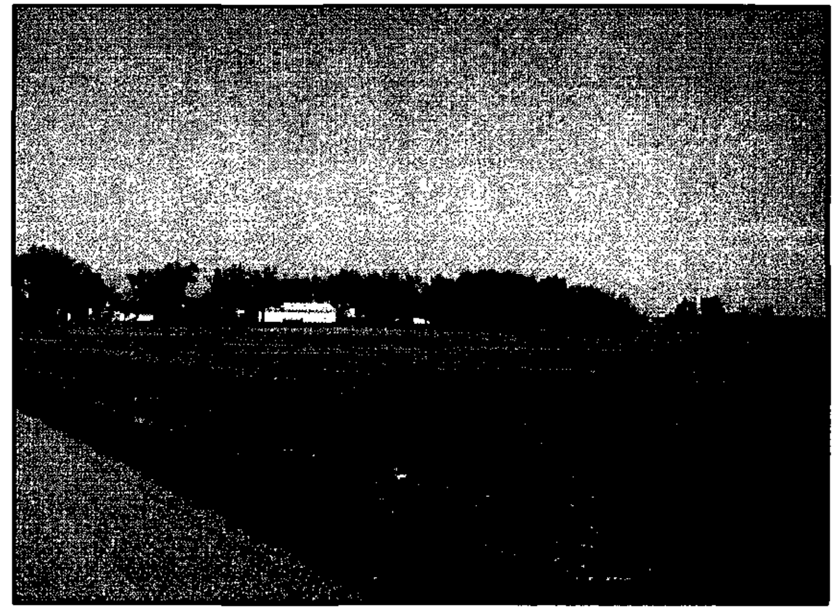


Photo 10. Typical isolated woodlot and trees clustered in a yard.

Photo 11. Trees clustered in a yard.

Photo 12. Typical woodlot.

APPENDIX B

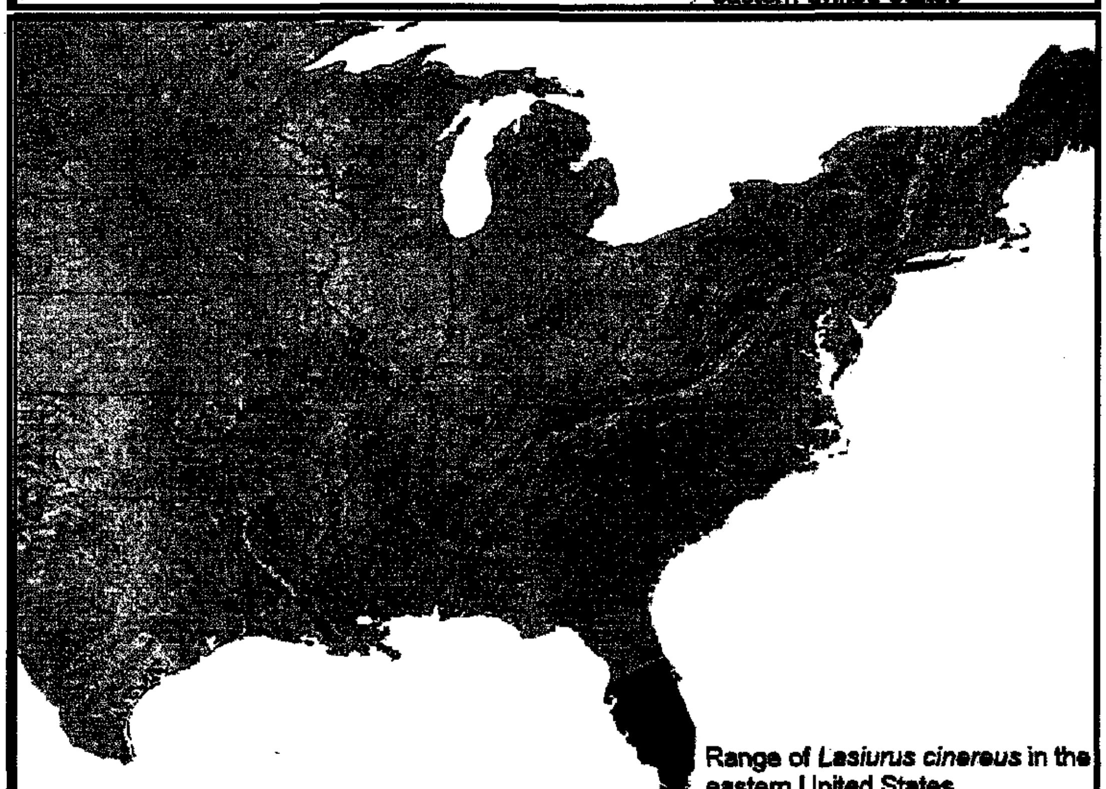
Bats of the Hardin County North Project Planning Area:
Range Maps

Range of *Eptesicus fuscus* in the eastern United States

Range of *Lasionycteris noctivagans* in the eastern United States

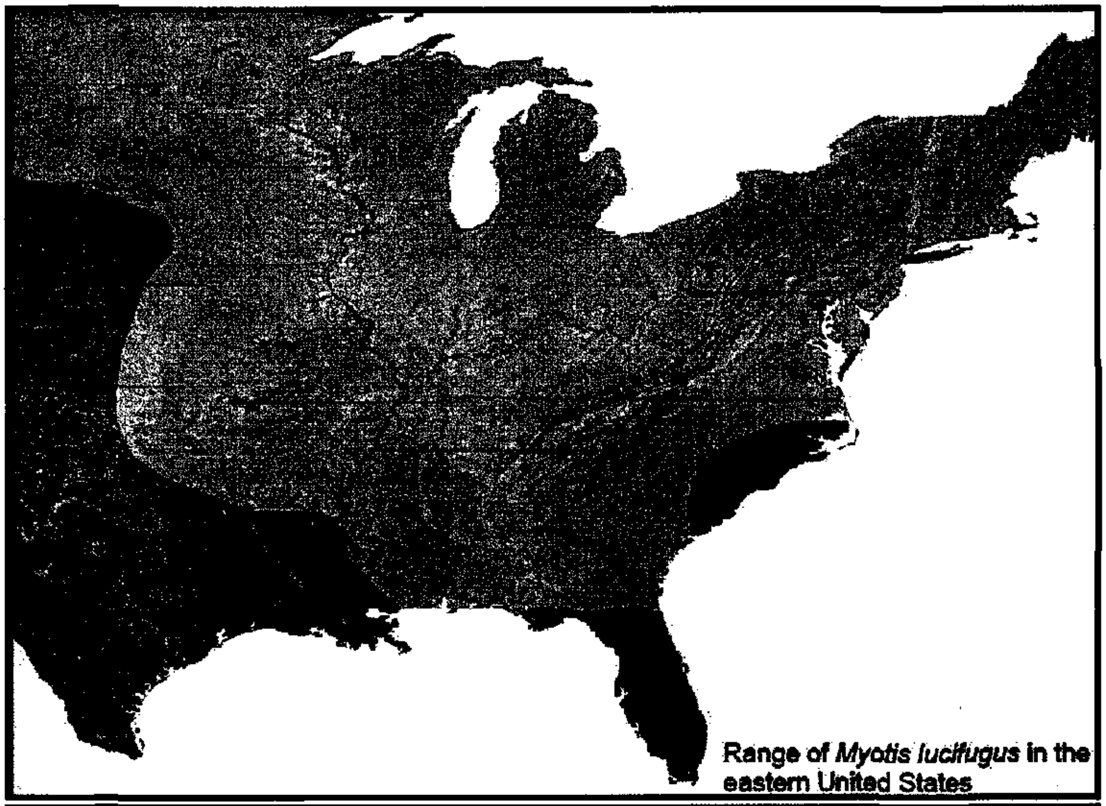
Bat range data obtained from http://www.natureserve.org/getData/mammalMaps.jsp (06/21/2005)

Range of *Lasiurus borealis* in the eastern United States



Range of *Lasiurus cinereus* in the eastern United States

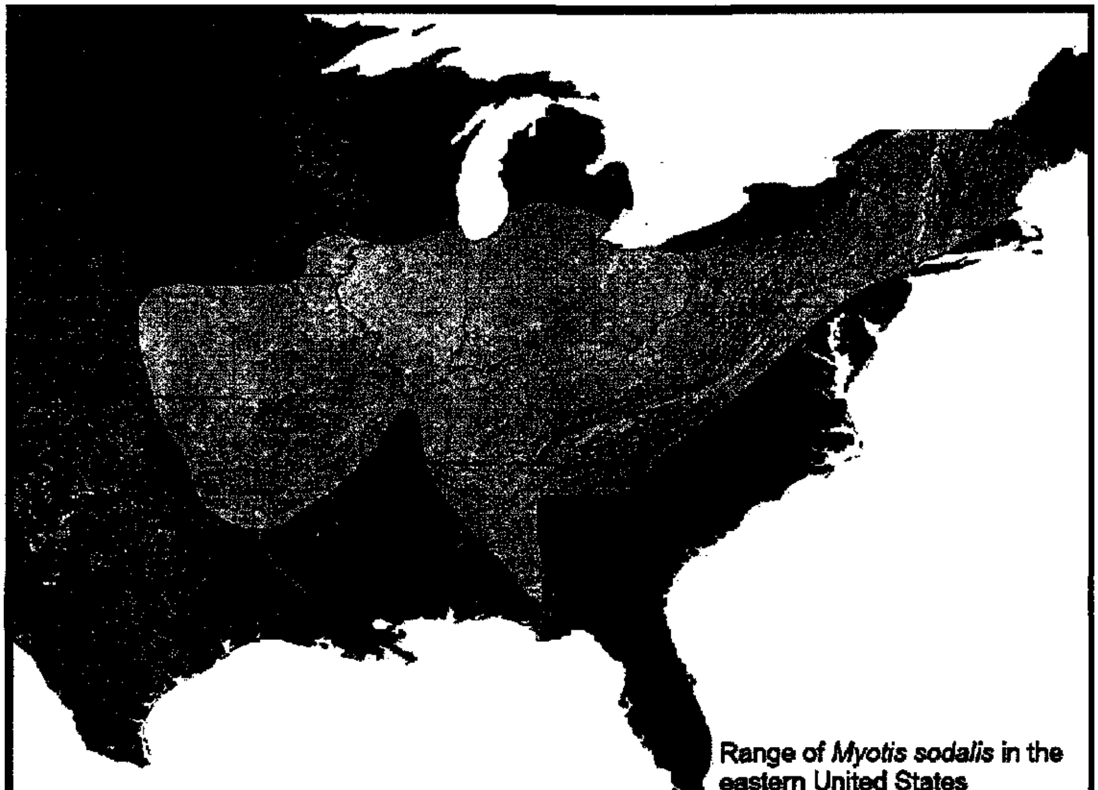
Bat range data obtained from http://www.natureserve.org/getData/mammalMaps.jsp (06/21/2005)



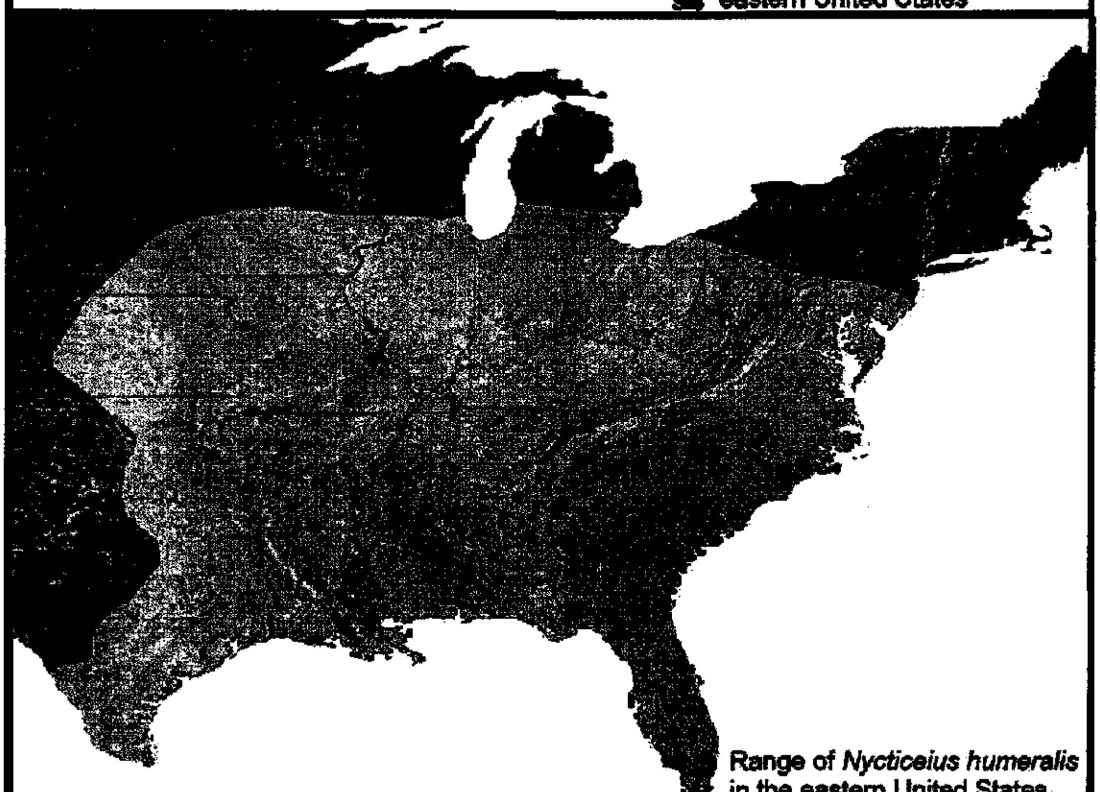
Range of *Myotis lucifugus* in the eastern United States

Range of *Myotis septentrionalis* in the eastern United States

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

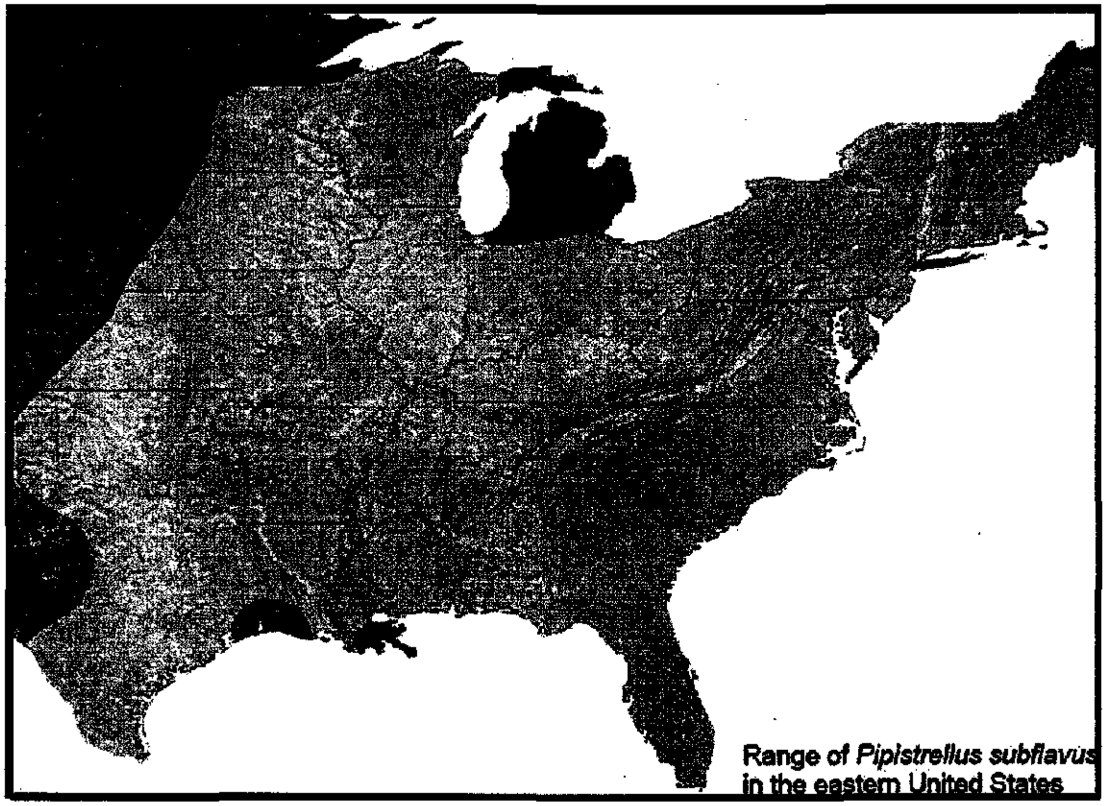


Range of *Myotis sodalis* in the eastern United States



Range of *Nycticeius humeralis* in the eastern United States

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



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

APPENDIX C

Agency Queries

Ohio Department of Natural Resources

TED STRICKLAND, GOVERNOR — SEAN D. LOGAN, DIRECTOR

Division of Natural Areas & Preserves
Steven D. Maurer, Chief
2045 Morse Road, F-1
Columbus, OH 43229-6693
Phone: (614) 265-6453 Fax: (614) 267-3096

July 15, 2009

Mike Sponsler
BHE Environmental, Inc.
5300 E. Main St., Suite 101
Columbus, OH 43224

Dear Mr. Sponsler:

After reviewing our Natural Heritage maps and files, I find the Division of Natural Areas and Preserves has no records of rare or endangered species within 5 miles of the BHE Environmental, Inc. Hardin County North Wind Farm project #1865.004. The site is located in Secs. 8, 9, 10, 16, 17, 18, 20, and 21, Washington Twp., Hardin Co., Ada and Dunkirk Quadrangles.

There are no existing or proposed state nature preserves within 5 miles of the project site. We are also unaware of any unique ecological sites, geologic features, breeding or non-breeding animal concentrations, state parks, state forests, scenic rivers, or wildlife areas within 5 miles of the project area.

Our inventory program has not completely surveyed Ohio and relies on information supplied by many individuals and organizations. Therefore, a lack of records for any particular area is not a statement that rare species or unique features are absent from that area. Although we inventory all types of plant communities, we only maintain records on the highest quality areas.

Please contact me at (614) 265-6409 if I can be of further assistance.

Sincerely,

Butch Grieszmer, Data Specialist
Resource Services Group