Avian Studies for the Norwood Proposed Wind Energy Site:
Summary of Fall 2009 Field Season

Prepared By:
Joelle Gehring, Ph.D.
Senior Conservation Scientist-Zoology Leader
Michigan State University, Michigan Natural Features Inventory
P.O. Box 30444 Lansing, MI 48909-7944

Prepared For:
Heritage Sustainable Energy
121 East Front Street
Traverse City, MI 49684-2570

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Executive summary

Many areas in Michigan possess winds adequate for the efficient generation of wind energy, especially areas near the shorelines of the Great Lakes. These shorelines have also been documented to provide important habitat for wildlife, including migratory songbirds and raptors. Avian collisions with wind turbines have been documented, but the frequency of those collisions is site and situation specific. Informed siting of wind turbines can minimize impacts to birds. In addition to collision risks, some grassland or open-land nesting bird species are not adapted to nesting near any tall structure, including a wind turbine, and can be displaced. Due to the potential for avian collisions with wind turbines or turbine related avian displacement from nesting areas, we conducted surveys of large birds to better understand the densities of birds in the project areas, as well as the species composition, habitat use and flight behaviors. These data, in addition to the data proposed for collection in 2010 will help wind energy developers and resource managers to make appropriate decisions regarding the potential impacts to birds and the methods by which they might reduce those impacts.

We established 4 raptor and other large bird viewing stations in the Norwood project areas. We conducted 3-hour surveys at the stations in October and November 2009. During surveys, each raptor, large bird, and sensitive status species was recorded in addition to the bird's flight path, flight direction, approximate flight altitude, and the distance to each bird from the observer. Technicians also recorded the behavior and habitat use of each bird, and weather characteristics. Examination of the fall 2009 large bird survey data suggests that most species' flight behaviors do not put them at frequent risk of collisions. While Bald Eagles were detected, their flight heights were almost entirely at a higher altitude than the likely rotor-swept area (RSA) of turbines. The high numbers of Canada Geese, Sandhill Cranes, and American Crows, and the overlap between these species' average flight heights and the estimated RSA height suggests that the risk of collisions for these species may be higher than for many of the other species observed in the areas. Several species had significant overlap between their flight heights and the potential RSA but were typically detected in low numbers which should minimize overall collisions of these species. Additional data collection and the future consideration of external, ongoing

research may be useful in determining the potential risk that wind turbine construction would provide for these species.

A query of Michigan Natural Features Inventory's NatureServe database for Element Occurrences found records for seven species of rare plants, three invertebrate animal species, three bird species, two unique community types, and one fish in or near the project area. Avoiding development of wind turbines and related infrastructure within 1 mile of the Lake Michigan shoreline, minimizing impacts to wetlands, minimizing road construction and habitat fragmentation would be important steps in protecting these species.

Additional large bird surveys will likely be conducted in the project area in the spring of 2010, as well as a possible breeding songbird survey. There is potential for these additional data to be combined with the existing data; thereby, increasing our overall knowledge of the avian use of the project areas over time.

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Introduction

Many areas in Michigan possess winds adequate for the efficient generation of wind energy, especially areas near the shorelines of the Great Lakes. These shorelines have also been documented to provide important habitat for wildlife, including migratory songbirds and raptors. Shoreline areas have been suggested to be important as stopover sites for Neotropical migratory birds (Ewert 2006, Diehl et al. 2003) and as concentration or funneling areas for migrating raptors which avoid crossing large areas of water (Kerlinger 1989). Waterfowl (e.g., Common Loon) and waterbirds (e.g., gulls, herons, cranes) also use shoreline areas especially during the breeding and migration seasons.

Avian collisions with wind turbines have been documented but the frequency of those collisions is site and situation specific. Songbird collisions with turbines, as well as

with other tall structures, are related to the lighting systems of the structure (Gehring et al. 2009). Songbirds can become attracted to non-blinking lights, especially during nocturnal migration; thereby, increasing their risk of collision with any structure illuminated with these types of lights. Most turbines are lit with Federal Aviation Administration recommended blinking lights which decreases the likelihood of songbirds becoming attracted into the site. Birds that use the airspace within the rotor swept area of a turbine are at risk of a collision and therefore the frequency of avian collisions at turbine sites can be directly correlated to the density of birds in the local area.

In addition to collision risks, some grassland or open-land nesting bird species are not adapted to nesting near any tall structure, including a wind turbine (Strickland 2004). These species can be displaced from traditional nesting areas upon construction of a nearby wind turbine (Leddy et al. 1999).

Due to the potential for avian collisions with wind turbines we studied the large bird use and movement within the project area to better understand the densities of birds in the area, as well as the species composition, habitat use and flight behaviors. These data, in addition to the data collected in 2010 will help wind energy developers and resource managers to make appropriate decisions regarding the potential impacts to birds and the methods in which they might reduce those impacts.

Study Site and Methods

Study site and description

Research was conducted in the Norwood project area in Charlevoix and Antrim counties, located in the northern lower peninsula of Michigan, USA (Appendix 1 and 2). The land use / land cover of the project area is a mixture of agricultural fields (e.g, corn, soybeans), orchards (e.g., apple, cherry), pastures, deciduous forested areas, wooded wetlands, and some inland lakes. This area is mainly course-textured glacial till and in the 1800s was vegetated with hemlock-white pine forests, cedar swamps, and mixed conifer swamps (Albert 1995). The forest overstory typically includes components of white pine (*Pinus strobes*), aspen (*Populus* spp.), maple (*Acer* spp.), and oak (*Quercus* spp.) species. The project area is approximately 1.5 - 4.5 miles from the Lake Michigan shoreline.

Large bird surveys

We established 4 raptor and other large bird viewing stations in the project area. These stations provided the best possible viewsheds of the proposed project sites (Figs. 1 and 2). Following methods similar to those used by Hawkwatch International, we conducted 3-hour surveys at the stations in October and November 2009 (Fig. 3). When conducting outdoor research, some flexibility in scheduling is needed and some surveys were missed due to dangerous conditions.

During surveys each raptor, large bird, and sensitive status species was recorded in addition to the bird's flight path, flight direction, approximate flight altitude (lowest and highest flight altitude), whether it flew within the proposed project area, and the distance to each bird from the observer. Technicians used landmarks as reference when measuring distance to birds and flight altitude. Technicians also recorded the behavior and habitat use of each bird. Behavior categories were as follows: perched (PE), soaring (SO), flapping (FL), flushed (FH), circle soaring (CS), hunting (HU), gliding (GL), and other (OT, noted in comments). Any comments or unusual observations were also noted. Weather data were collected in concert with large bird surveys; specifically, temperature, wind speed, wind direction, and cloud cover. The date, start, and end time of observation period, species or best possible identification, number of individuals, sex and age class, distance from plot center when first observed, closest distance, height above ground, activity, and habitat(s) were recorded.

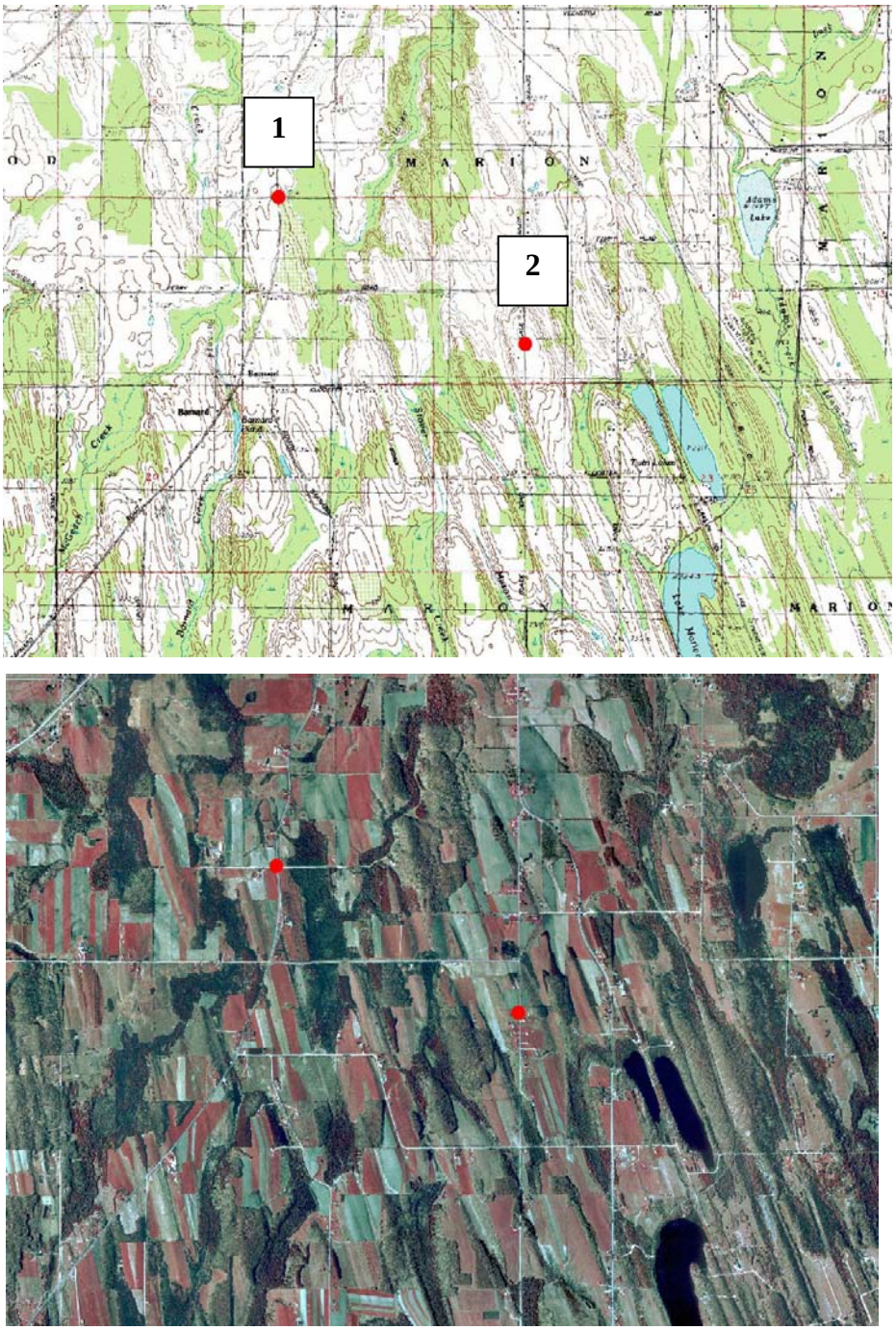

Figure 1. Large bird viewing stations (red dots) were established Charlevoix County, MI in and around the northern portion of the Norwood project site. Large bird surveys were conducted at the viewing stations in the fall of 2009.

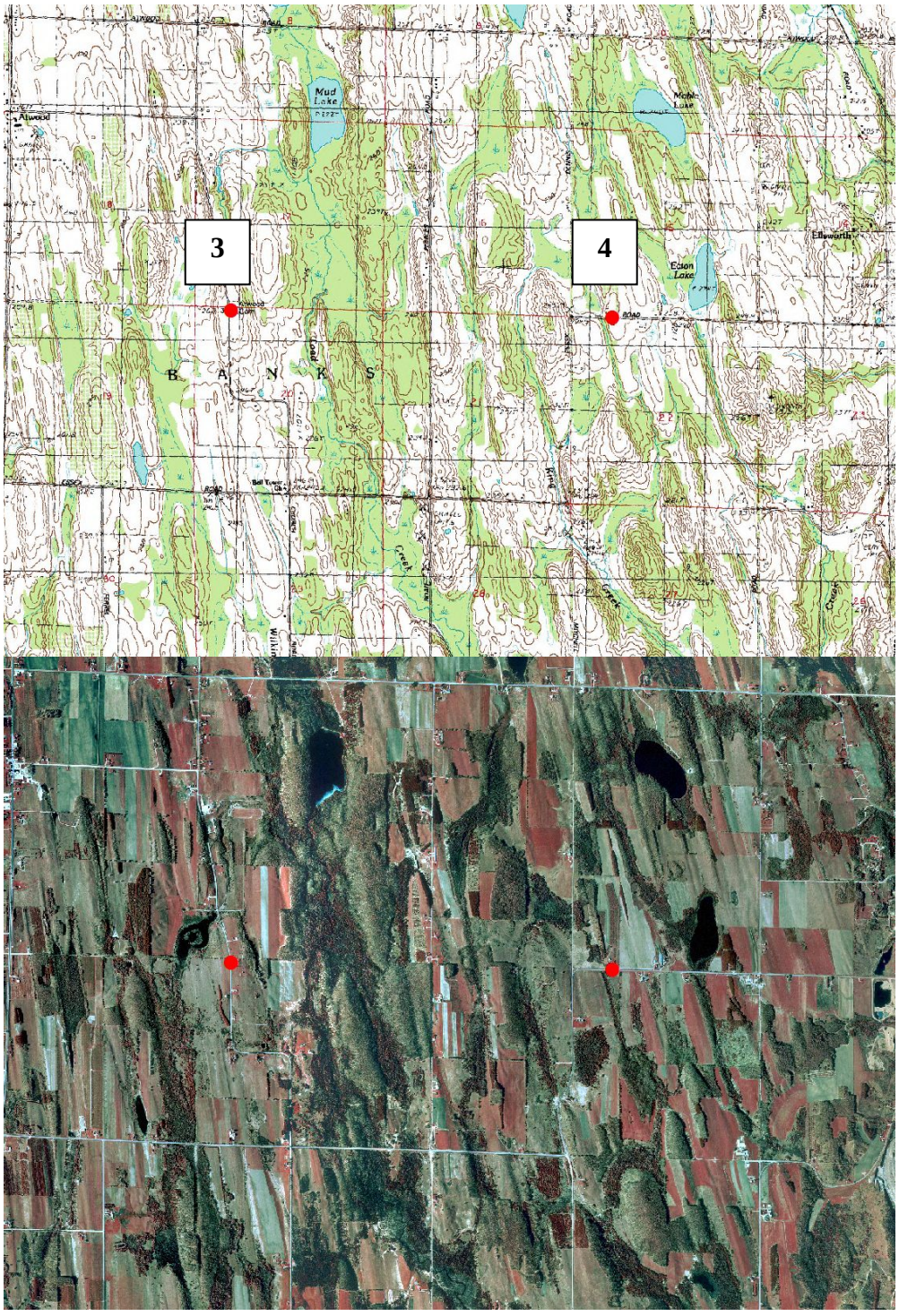

Figure 2. Large bird viewing stations (red dots) were established Antrim County, MI in and around the southern portion of the Norwood project site. Large bird surveys were conducted at the viewing stations in the fall of 2009.

Figure 3. In the fall of 2009 observers surveyed the viewshed for large birds from the viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI.

Results and Summary

Large bird surveys – all observation sites combined

During the 48 large bird surveys, observers detected 4,180 large birds of 22 species. There was a mean of 87.1 birds detected per survey (29.0 birds / hour) (Table 1). The waterfowl group (e.g., Canada Goose, ducks) was the most abundant of the bird groups surveyed with 58.3 birds / survey (19.4 birds / hour, Fig. 4, Table 2), corvids (e.g., American Crow, Common Raven) were the second most common species with 22.1 birds / survey (7.4 birds / hour, Fig. 5, Table 2), followed by the waterbird group (e.g., gulls, herons, cranes; 4.9 birds / survey, 1.7 birds / hour, Fig. 6, Table 2), and the raptors (e.g., hawks, eagles, vultures; 1.5 birds / survey, 0.5 birds / hour; Fig. 7, Table 2). The Canada Goose was the most common waterfowl species detected during the surveys (2,752 birds, Table 3). This species and other waterfowl can be found in high numbers associated with agricultural fields that provide waste grain for foraging and open areas for subsequent

loafing. The American Crow was the second most common species detected. They are present throughout the year compared to most of the other large birds that migrate out of the northern regions of the United States during the winter months. Gulls were also common in the project area (Table 3) and are likely associated with proximity of the project area to Lake Michigan as well as the farming practices (e.g., tilling, planting) that expose invertebrates and other food items. The raptor group is often a focus of concern when considering the potential impacts of wind farm construction. The Red-tailed Hawk was the most common raptor species (30 birds, Table 3). The Turkey Vulture and the Bald Eagle (16 birds and 12 birds, respectively; Table 3) were also detected as well as 5 other raptor species in lower numbers (Table 3). Many of the observed raptor species move through the area during migration but do not remain during the breeding and wintering seasons (Figs. 9-15).

Assuming the wind turbine rotor-swept area (RSA) would be 54 – 146 m above the ground, 76% of all birds used areas below the RSA, 15% within the RSA, and 10% flew above the RSA. The mean flight altitude of the most common species, Canada Goose, was 148.4 m with 74% flying below the RSA, 14% within the RSA, and 13% above the RSA. The majority of the Canada Goose observations were in agricultural fields as the birds congregated on the ground while they foraged on waste grain.

Table 1. Large bird abundance and richness in Charlevoix and Antrim Counties, MI in and around the Norwood project site proposed for the development of wind energy by Heritage Sustainable Energy. Data were collected in the fall of 2009 at 4 large bird survey sites.

		Large Bird Survey			
	Total	No. 1	No. 2	No. 3	No. 4
No. Species	22	13	10	11	12
Mean No. Species / Survey	0.9	1.1	0.7	0.9	1.0
Mean No. Species / Hour	0.3	0.4	0.3	0.3	0.3
Mean No. Birds / Survey	87.1	164.8	51.3	53.7	65.5
Mean No. Birds / Hour	29.0	54.9	17.1	17.9	21.8

Table 2. Mean bird abundance in Charlevoix and Antrim Counties, MI in and around the Norwood project site proposed for the development of wind energy by Heritage Sustainable Energy. Data were collected in the fall of 2009 at 4 large bird survey sites.

Group	Mean Abundance [a]				
	Total	No. 1	No. 2	No. 3	No. 4
Waterfowl	58.3	135.6	29.2	26.4	34.8
Corvids	22.1	25.4	19.9	20.6	17.6
Waterbirds	4.9	2.3	0.6	4.6	11.8
Raptors	1.5	0.8	1.5	2.0	1.3

[a] Mean Abundance = mean number of individuals observed per survey

Table 3. Species composition in Charlevoix and Antrim Counties, MI in and around the Norwood project site proposed for the development of wind energy by Heritage Sustainable Energy. Data were collected in the fall of 2009 at 4 large bird survey sites.

Species	No. Birds			
	Total	No. 1	No. 2	No. 3	No. 4
American Crow	979	263	265	243	208
Bald Eagle	12	0	5	3	4
Canada Goose	2752	1625	401	342	384
Cooper's Hawk	2	1	0	0	1
Common Loon	1	1	0	0	0
Common Raven	83	42	13	25	3
Herring Gull	1	1	0	0	0
Mallard	9	1	8	0	0
Northern Harrier	7	0	0	5	2
Northern Shrike	1	0	0	1	0
Pileated Woodpecker	2	0	2	0	0
Ring-billed Gull	67	5	3	29	30
Red-tailed Hawk	30	2	10	15	3
Rough-legged Hawk	1	0	0	0	1
Sandhill Crane	25	11	0	0	14
Sharp-shinned Hawk	1	0	0	1	0
Turkey Vulture	16	6	4	1	5
Unknown large raptor	2	0	1	1	0
Unknown Gull	144	11	5	31	97
Unknown duck	35	0	0	1	34
Wild Turkey	9	9	0	0	0

Large bird surveys – Fall 2009, Site 1

During the 12 large bird surveys, observers detected 1,978 large birds of 13 species. There was a mean of 164.8 birds detected per survey (54.9 birds / hour, Table 1). The waterfowl (e.g., Canada Goose, ducks) group was the most abundant of the bird groups (135.6 birds / survey, 45.2 birds / hour; Table 2; Fig. 4), followed by the corvid group (e.g., American Crow, Common Raven; 25.4 birds / survey, 8.5 birds / hour, Table 2; Fig. 5), waterbirds (e.g., gulls, herons, cranes; 2.3 birds / survey, 0.8 birds / hour, Table

2, Fig. 6), and raptors (e.g., hawks, eagles, vultures; 0.8 birds / survey, 0.3 birds / hour, Table 2, Fig. 7). Canada Goose was the most common waterfowl species detected during the surveys (1625 birds, Table 3), American Crows were the second most common species detected (263 birds, Table 3). Both of these common species were observed throughout the survey period (Figs. 4 and 5). Only three raptor species were observed at Site 1 (Table 3).

Assuming the wind turbine rotor-swept area (RSA) would be 54 – 146 m above the ground, 67% of all birds flew below the RSA, 15% within the RSA, and 18% flew above the RSA. The mean flight altitude of the most common species, Canada Goose, was 50.8 m with 67% flying below the RSA, 15% within the RSA, and 18% above the RSA.

Large bird surveys – Fall 2009, Site 2

During the 14 large bird surveys, observers detected 718 large birds of 10 species. There was a mean of 51.3 birds detected per survey (17.1 birds / hour, Table 1). Similar to Site 1, the waterfowl group (e.g., Canada Goose, ducks) was the most abundant of the bird groups (29.2 birds / survey, 9.7 birds / hour; Table 2, Fig. 4), followed by the corvid group (e.g., American Crow, Common Raven; 19.9 birds / survey, 6.6 birds / hour, Table 2, Fig. 5), raptors (e.g., hawks, eagles, vultures; 1.5 birds / survey, 0.5 birds / hour, Table 2, Fig. 7), and waterbirds (e.g., gulls, herons, cranes; 0.6 birds / survey, 0.2 birds / hour, Table 2, Fig. 6). Canada Goose was the most common waterfowl species detected during the surveys (401 birds, Table 3), American Crows were the second most common species detected (265 birds, Table 3). Both of these common species were observed throughout the survey period (Figs. 4 and 5). Four raptor species were observed at Site 2, including five Bald Eagles and one Northern Goshawk (Table 3).

Assuming the wind turbine rotor-swept area (RSA) would be 54 – 146 m above the ground, 84% of all birds flew below the RSA, 6% within the RSA, and 10% flew above the RSA. The mean flight altitude of the most common species, Canada Goose, was 45.9 m with 83% flying below the RSA, 15% within the RSA, and 16% above the RSA.

Large bird surveys – Fall 2009, Site 3

During the 13 large bird surveys, observers detected 698 large birds of 11 species. There was a mean of 53.7 birds detected per survey (17.9 birds / hour, Table 1). The waterfowl group (e.g., Canada Goose, ducks) was the most frequently detected of the bird groups (26.4 birds / survey, 8.8 birds / hour; Table 2, Fig. 4). Corvids were the next most frequently detected (e.g., American Crow, Common Raven; 20.6 birds / survey, 6.9 birds / hour, Table 2, Fig. 5), followed by waterbirds (e.g., gulls, herons, cranes; 4.6 birds / survey, 1.5 birds / hour, Table 2, Fig. 6), and raptors (e.g., hawks, eagles, vultures; 2.0 birds / survey, 0.7 birds / hour, Table 2, Fig. 7). Similar to Sites 1 and 2, Canada Goose was the most common waterfowl species detected during the surveys (342 birds, Table 3), American Crows were the second most common species detected (243 birds, Table 3). Both of these common species were observed throughout the survey period (Figs. 4 and 5). Five raptor species were observed at Site 3 (Table 3).

Assuming the wind turbine rotor-swept area (RSA) would be 54 – 146 m above the ground, 83% of all birds flew below the RSA, 16% within the RSA, and 1% flew above the RSA. The mean flight altitude of the most common species, Canada Goose, was 39.0 m with 77% flying below the RSA, 23% within the RSA, and 0% above the RSA.

Large bird surveys – Fall 2009, Site 4

During the 12 large bird surveys, observers detected 786 large birds of 12 species. There was a mean of 65.5 birds detected per survey (21.8 birds / hour, Table 1). The waterfowl (e.g., Canada Goose, ducks) group was once again the most abundant of the bird groups (34.8 birds / survey, 11.6 birds / hour; Table 2, Fig. 4), followed by the corvid group (e.g., American Crow, Common Raven; 17.6 birds / survey, 5.9 birds / hour, Table 2, Fig. 5), waterbirds (e.g., gulls, herons, cranes; 11.8 birds / survey, 3.9 birds / hour, Table 2, Fig. 6), and raptors (e.g., hawks, eagles, vultures; 1.3 birds / survey, 0.4 birds / hour, Table 2, Fig. 7). Similar to Sites 1-3, Canada Goose was the most common waterfowl species detected during the surveys (384 birds, Table 3). American Crow, of

the corvid group, was the second most common species detected (208 birds, Table 3). Both of these common species were observed throughout the survey period (Figs. 4 and 5). Six raptor species were observed at Site 4 (Table 3).

Assuming the wind turbine rotor-swept area (RSA) would be 54 – 146 m above the ground, 75% of all birds flew below the RSA, 21% within the RSA, and 4% flew above the RSA. The mean flight altitude of the most common species, Canada Goose, was 47.6 m with 74% flying below the RSA, 23% within the RSA, and 3% above the RSA.

Summary of large bird flight behavior in the project area

Although our data collection period started later than ideal we did capture the migration period of most of the focal species and late portions of the raptor migration. This is evident by the fluctuating numbers of migrant birds observed throughout the survey weeks (Figs. 4-15).

Upon examination of the fall 2009 large bird survey data it appears that the majority of birds flew below the RSA. However, flight altitudes of several species are consistent with the potential estimated RSA of the wind turbines suggesting that the risk of collisions for these species may be higher than for the other species observed in the area (Fig. 16-19). This is potentially the case with the high numbers of American Crows, gulls, and Canada Geese. Site 1 had the highest numbers of Canada Geese and Common Ravens; however, Site 4 had higher proportions of birds flying within the RSA than other sites. Data collected at Site 2 determined that the majority of the birds were using altitudes below the RSA. The majority of the Canada Goose detections were related to the species loafing and foraging in agricultural fields within the project area. While our collective understanding of avian collision issues is always increasing, currently waterfowl are not believed to collide with wind turbines as frequently as some other avian groups such as raptors. Some waterfowl species have actually been documented to avoid turbines in their flight paths (Desholm and Kahlert 2006).

While Bald Eagles were detected during surveys at most of the survey sites, their flight height was almost entirely at a higher altitude than the RSA of turbines (with exception of site 3); thereby, minimizing their risk of collision. Given the diverse

topography of the site (ridges and hills) it is important to consider that the flight altitude of birds tended to be higher when flying over the valleys but lower when flying over the hilltops. Additional data collection and the future consideration of external, ongoing research may be useful in determining the potential risk that wind turbine construction would provide for avian species.

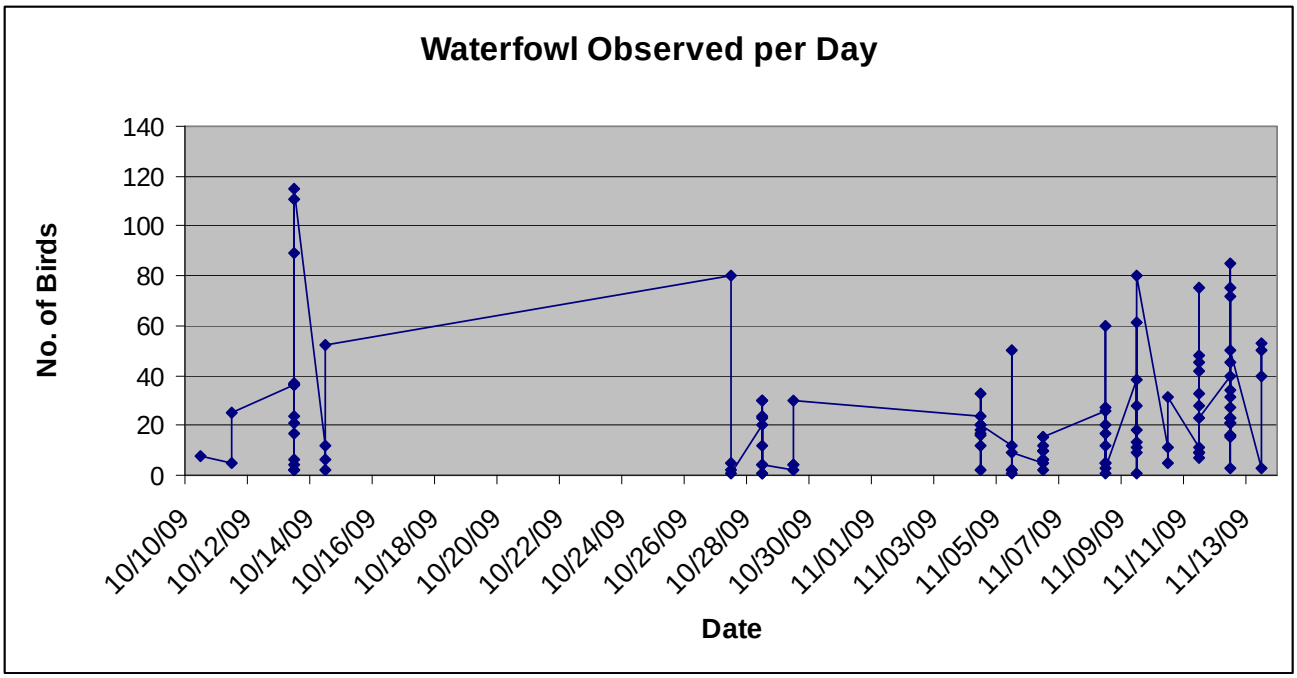

Figure 4. In the fall of 2009 observers surveyed the viewshed for large birds from the viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI. The numbers of waterfowl detected were quantified by survey day.

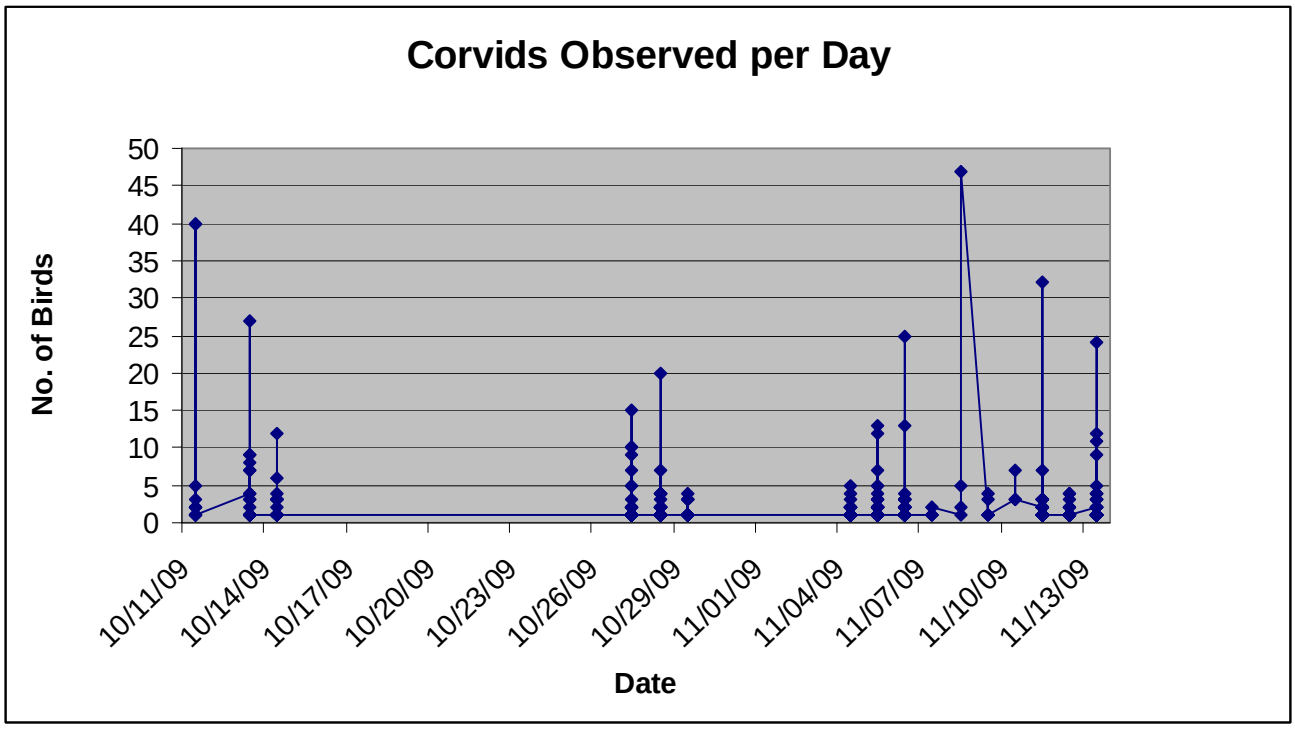

Figure 5. In the fall of 2009 observers surveyed the viewshed for large birds from the viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI. The numbers of corvids detected were quantified by survey day.

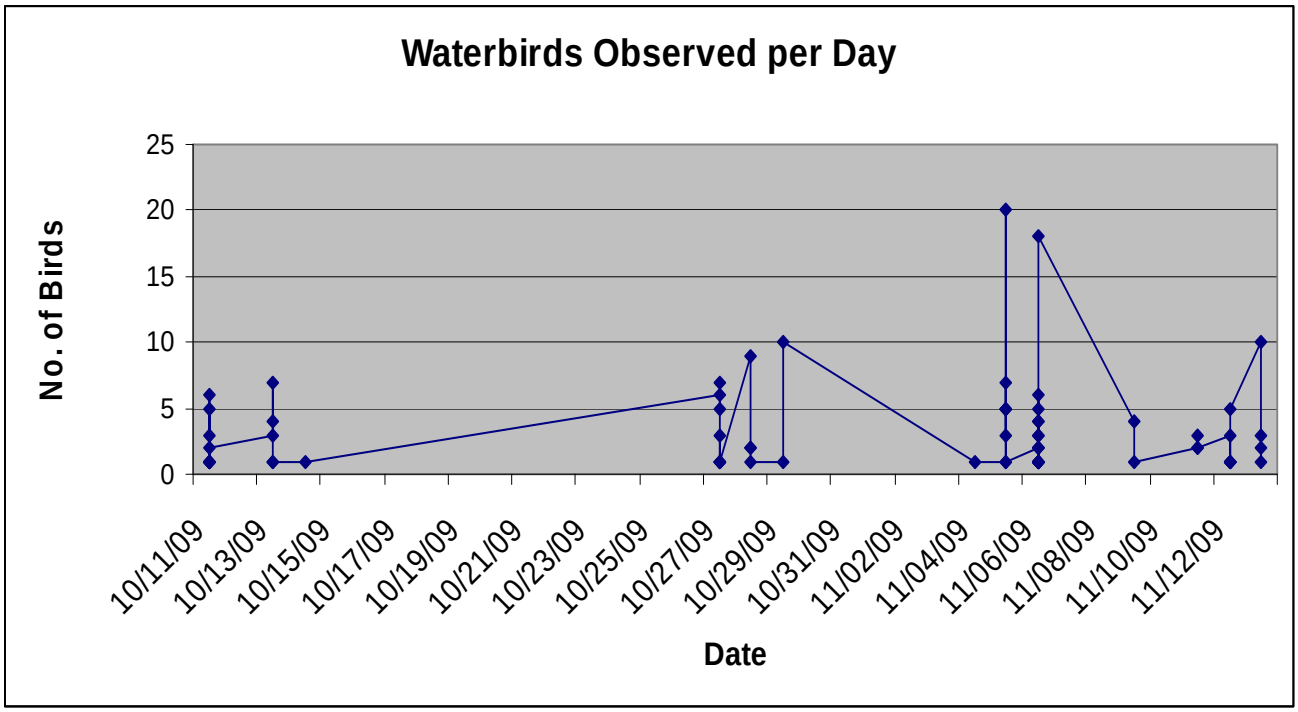

Figure 6. In the fall of 2009 observers surveyed the viewshed for large birds from the viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI. The numbers of waterbirds detected were quantified by survey day.

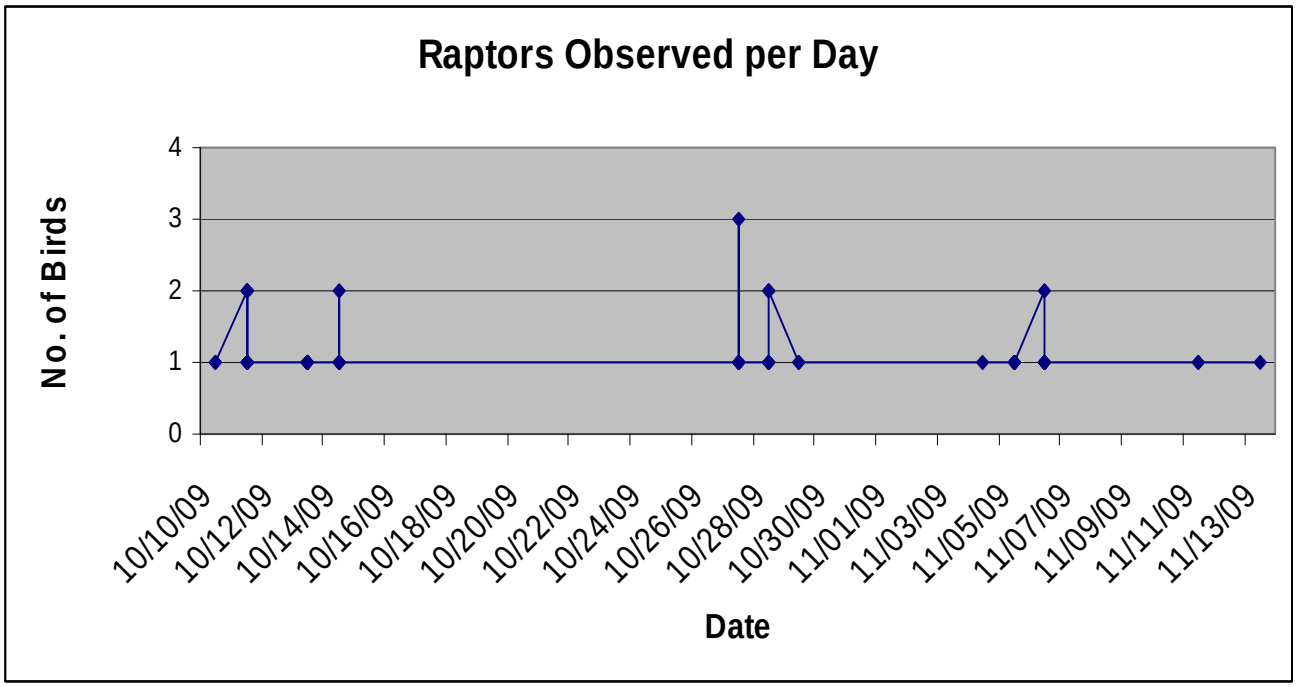

Figure 7. In the fall of 2009 observers surveyed the viewshed for large birds from the viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI. The numbers of raptors detected were quantified by survey day.

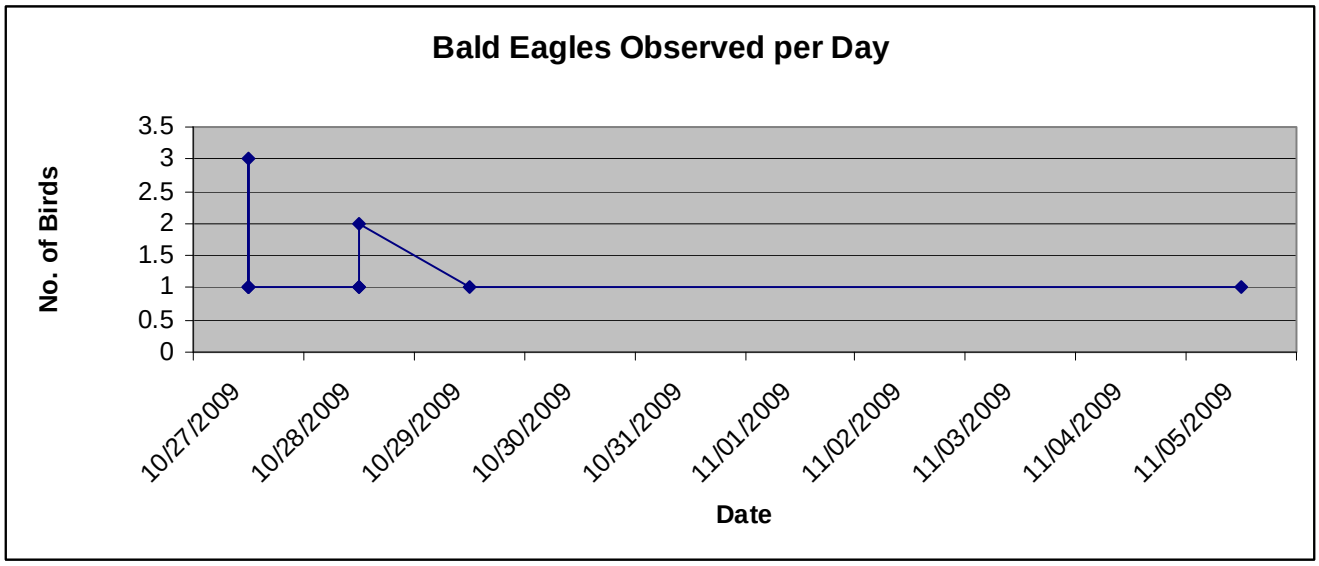

Figure 8. In the fall of 2009 large bird surveys were conducted in viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI, Michigan. The numbers of Bald Eagles detected were quantified by survey day.

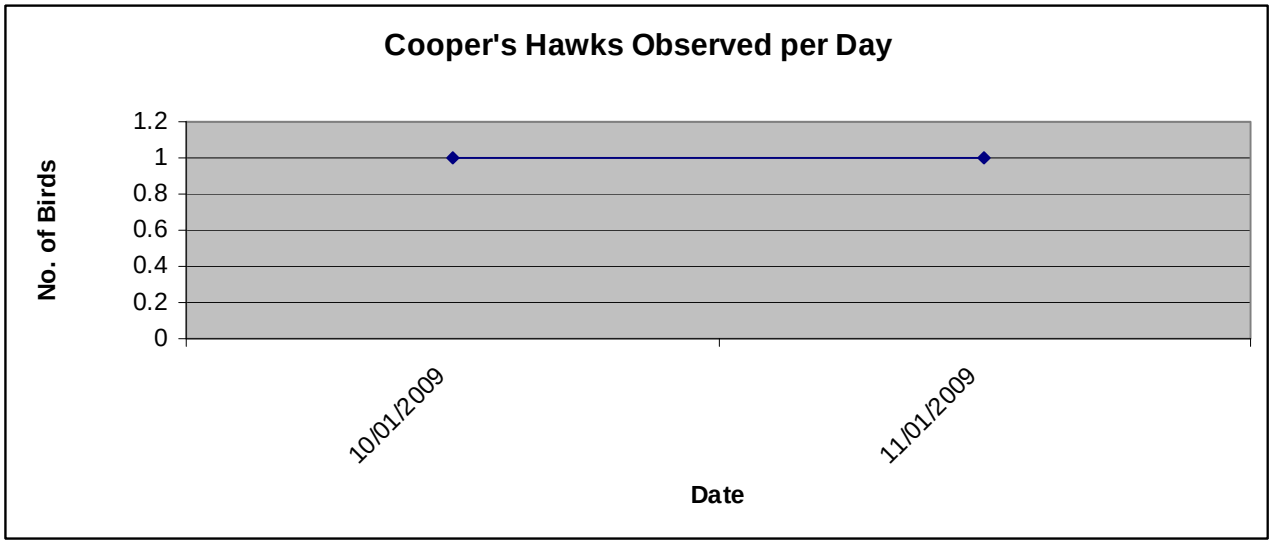

Figure 9. In the fall of 2009 large bird surveys were conducted in viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI, Michigan. The numbers of Cooper's Hawks detected were quantified by survey day.

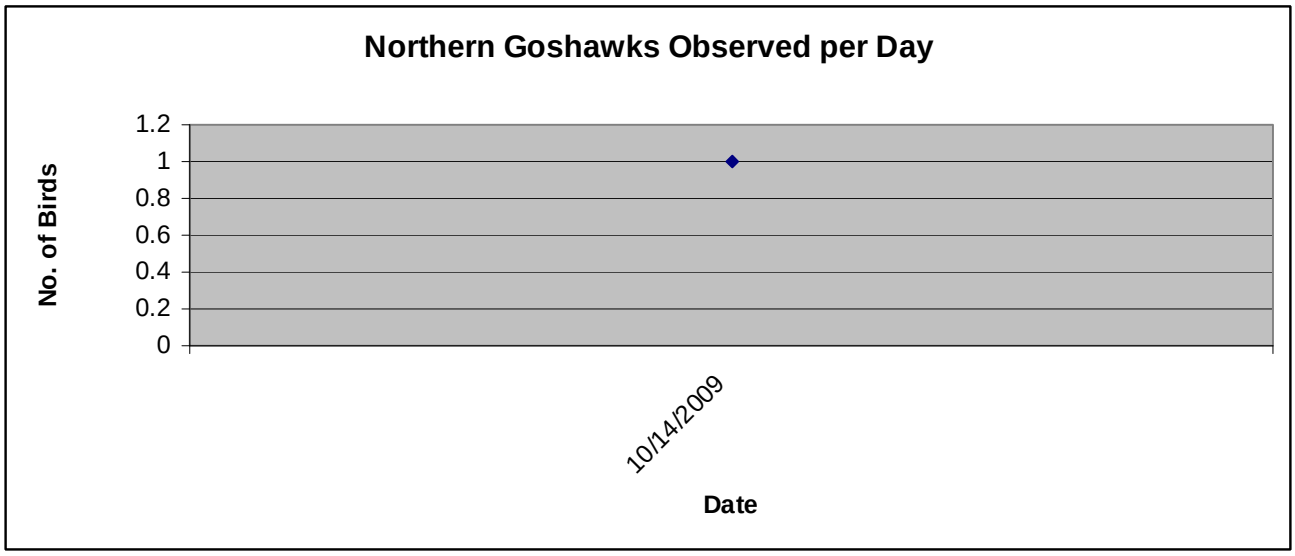

Figure 10. In the fall of 2009 large bird surveys were conducted in viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI, Michigan. The numbers of Northern Goshawk detected were quantified by survey day.

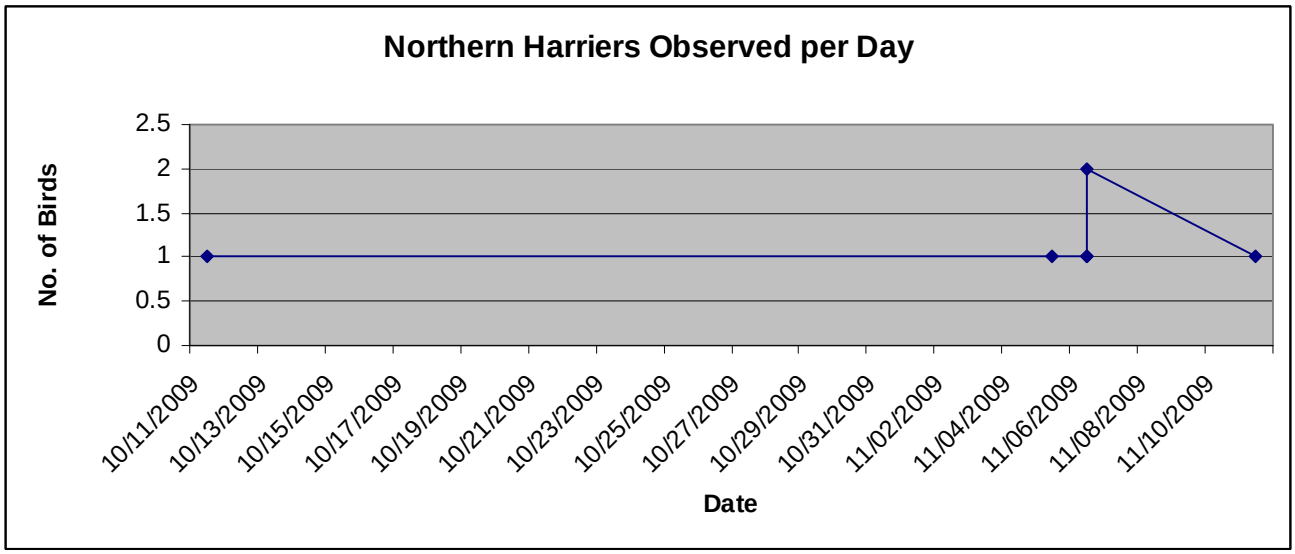

Figure 11. In the fall of 2009 large bird surveys were conducted in viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI, Michigan. The numbers of Northern Harrier detected were quantified by survey day.

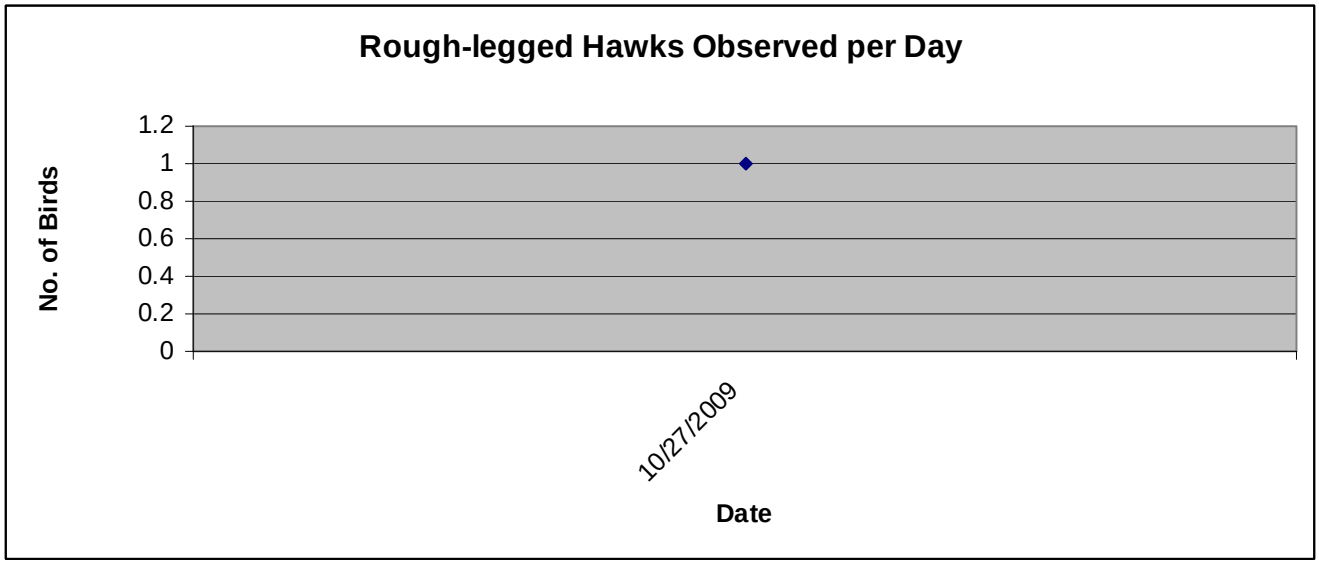

Figure 12. In the fall of 2009 large bird surveys were conducted in viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI, Michigan. The numbers of Rough-legged Hawks detected were quantified by survey day.

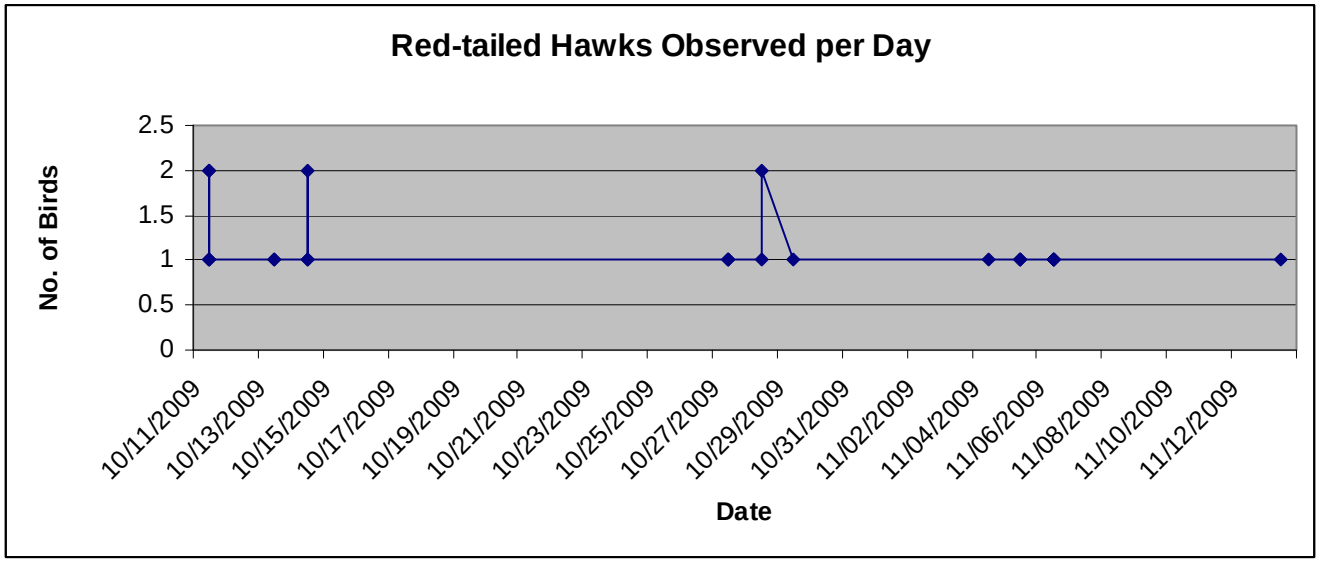

Figure 13. In the fall of 2009 large bird surveys were conducted in viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI, Michigan. The numbers of Red-tailed Hawks detected were quantified by survey day.

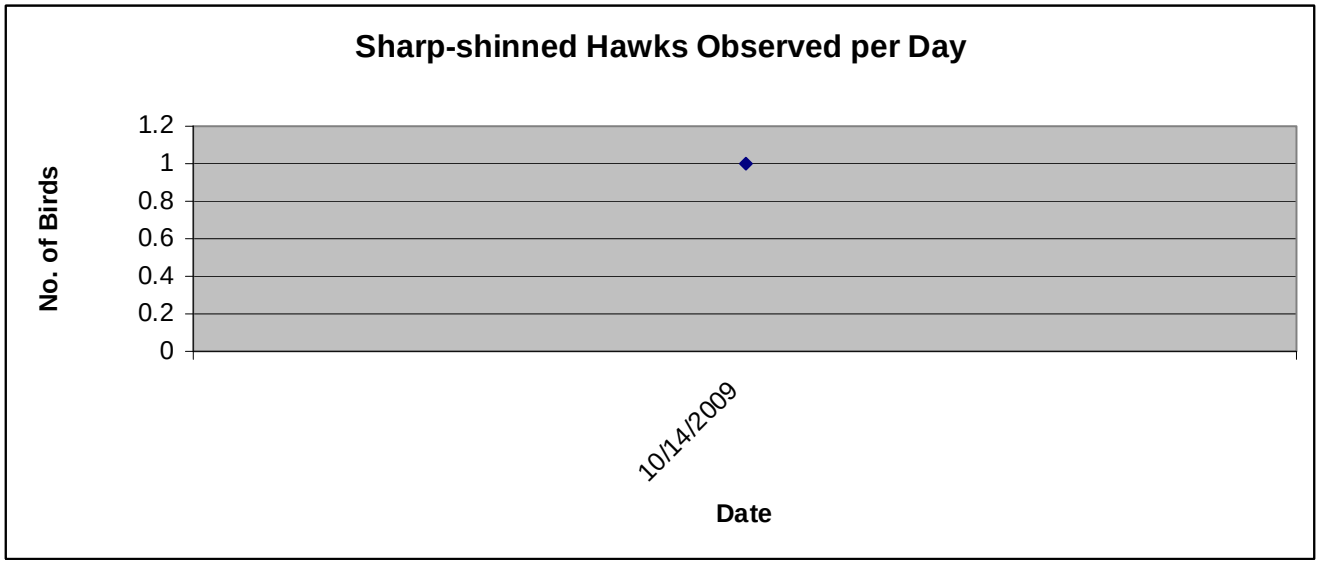

Figure 14. In the fall of 2009 large bird surveys were conducted in viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI, Michigan. The numbers of Sharp-shinned Hawks detected were quantified by survey day.

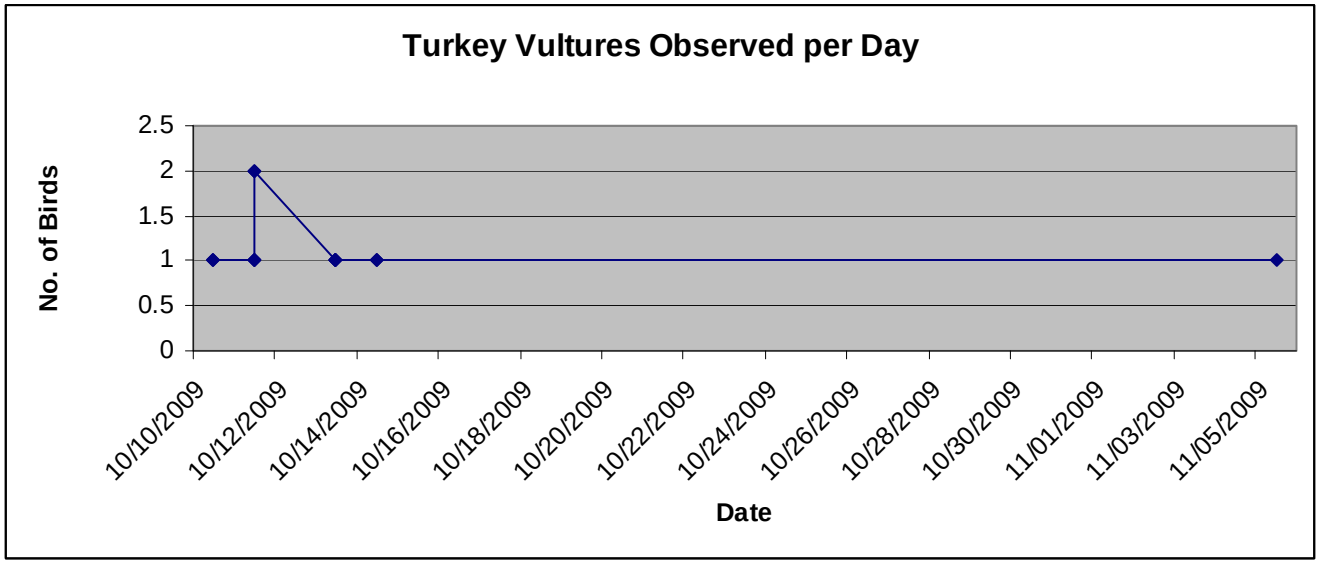

Figure 15. In the fall of 2009 large bird surveys were conducted in viewing stations in the Norwood project area, Charlevoix and Antrim Counties, MI, Michigan. The numbers of Turkey Vultures detected were quantified by survey day.

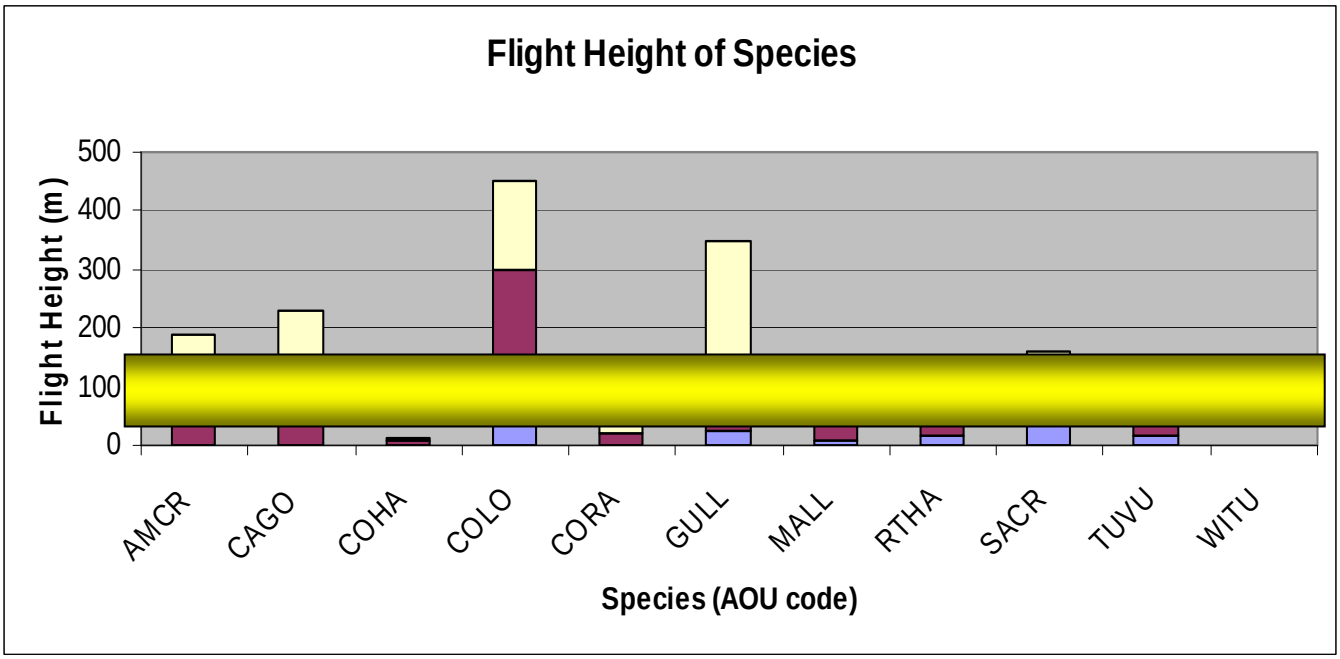

Figure 16. In the fall of 2009 large bird surveys were conducted at viewing station Site 1 in the Norwood project area, Charlevoix County, MI, Michigan. The AOU species codes are detailed in Table 4, the top of the blue bars represent the minimum height of flight, the top of the dark red bar represents the mean height of flight, and the top of the cream bar represents the maximum flight height of each species. All WITU were observed foraging on the ground; therefore flight altitudes were 0 m above ground level. The horizontal gold bar is approximately the rotor swept area of a wind turbine.

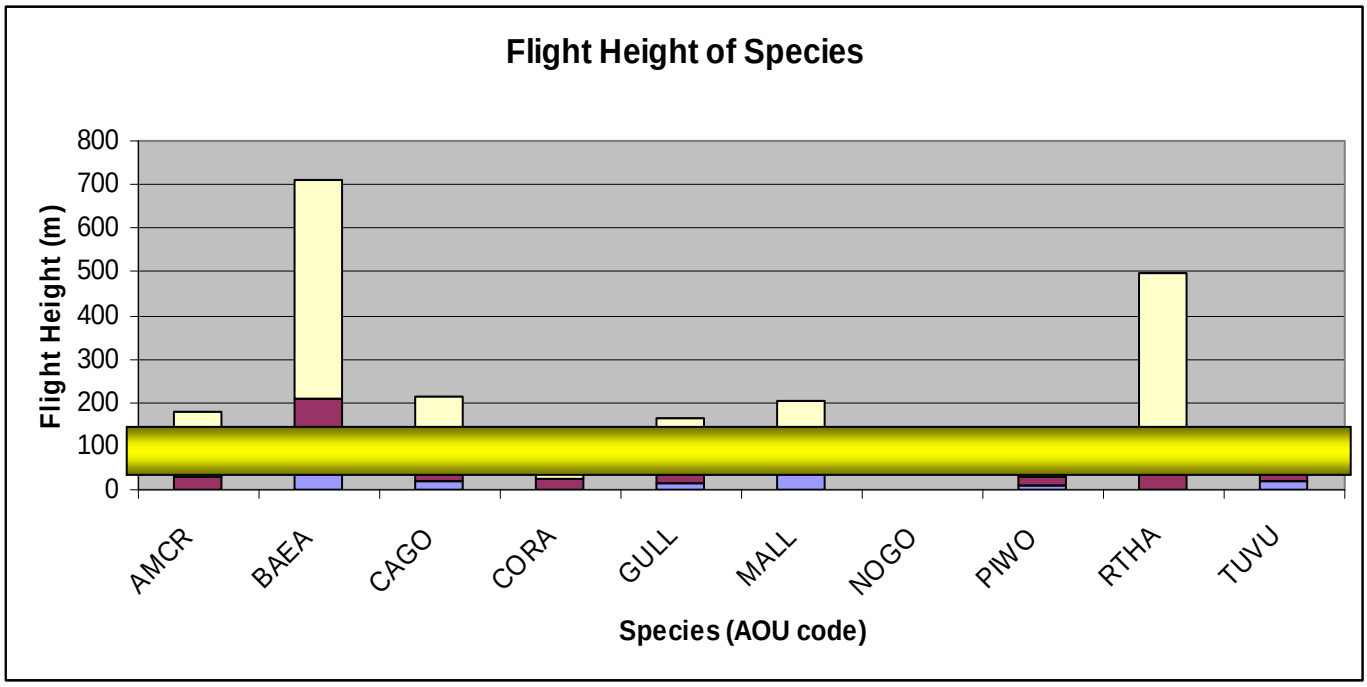

Figure 17. In the fall of 2009 large bird surveys were conducted at viewing station Site 2 in the Norwood project area, Charlevoix County, MI, Michigan. The AOU species codes are detailed in Table 4, the top of the blue bars represent the minimum height of flight, the top of the dark red bar represents the mean height of flight, and the top of the cream bar represents the maximum flight height of each species. The NOGO was observed perched; therefore flight altitudes was 0 m above ground level. The horizontal gold bar is approximately the rotor swept area of a wind turbine.

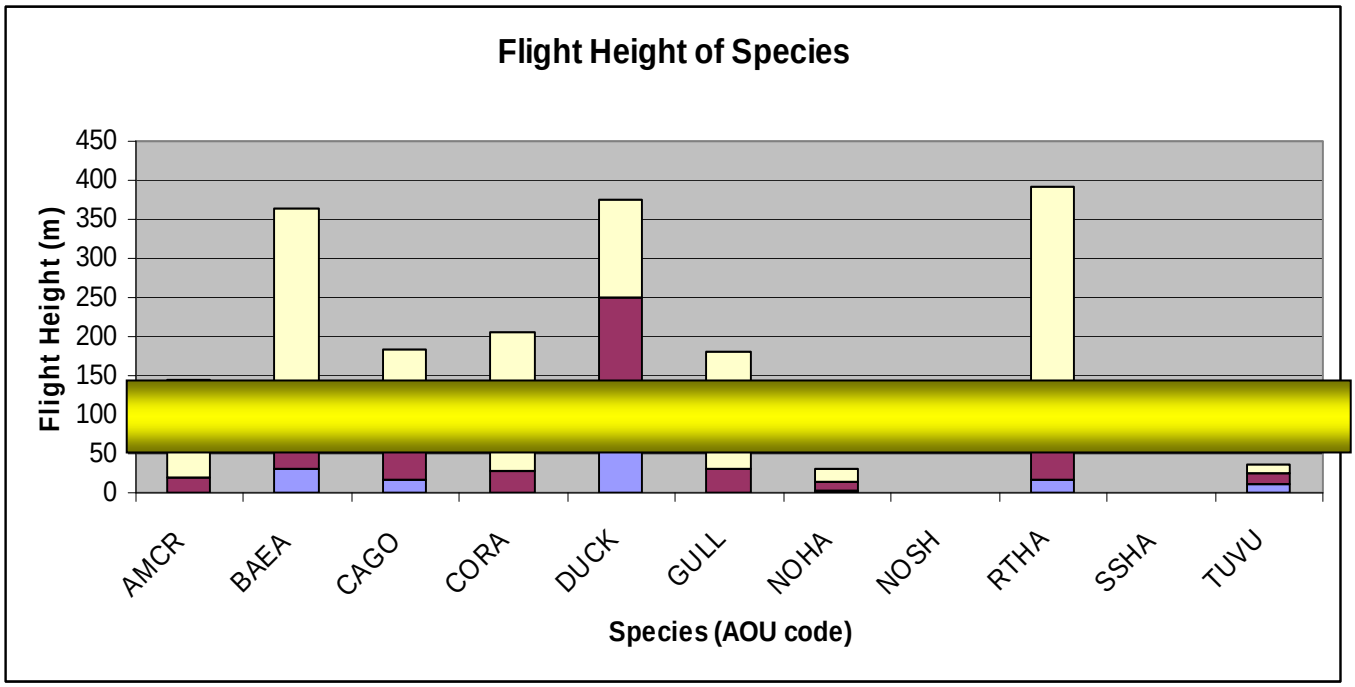

Figure 18. In the fall of 2009 large bird surveys were conducted at viewing station Site 3 in the Norwood project area, Antrim County, MI, Michigan. The AOU species codes are detailed in Table 4, the top of the blue bars represent the minimum height of flight, the top of the dark red bar represents the mean height of flight, and the top of the cream bar represents the maximum flight height of each species. The NOSH and SSHA were observed perched; therefore flight altitudes were 0 m above ground level. The horizontal gold bar is approximately the rotor swept area of a wind turbine.

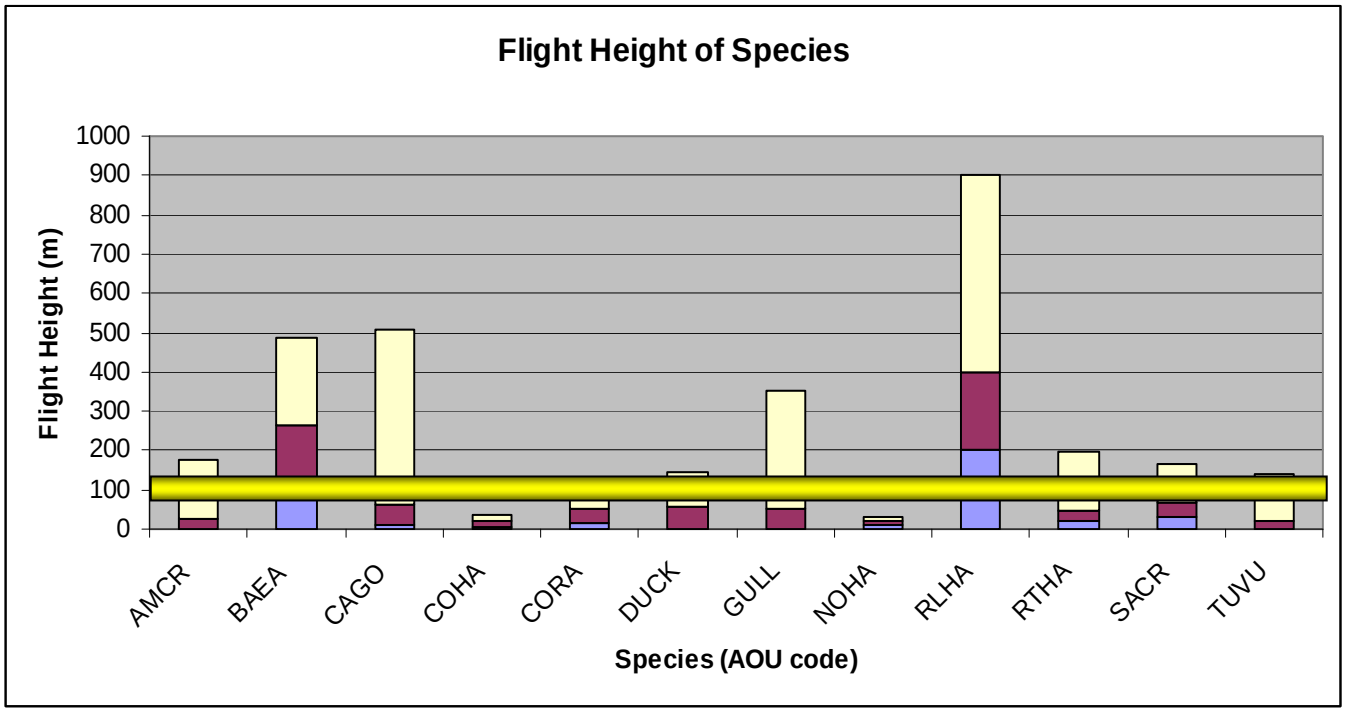

Figure 19. In the fall of 2009 large bird surveys were conducted at viewing station Site 4 in the Norwood project area, Antrim County, MI, Michigan. The AOU species codes are detailed in Table 4, the top of the blue bars represent the minimum height of flight, the top of the dark red bar represents the mean height of flight, and the top of the cream bar represents the maximum flight height of each species. The horizontal gold bar is approximately the rotor swept area of a wind turbine.

Table 4. List of bird species observed in Charlevoix and Antrim Counties, MI in and around the Norwood project site proposed for the development of wind energy by Heritage Sustainable Energy. Data were collected in the fall of 2009 at 4 large bird survey sites.

Species[a]	AOU code
Common Loon	COLO
Canada Goose	CAGO
Mallard	MALL
Wild Turkey	WITU
Turkey Vulture	TUVU
Sharp-shinned Hawk	SSHA
Cooper's Hawk	COHA
Red-tailed Hawk	RTHA
Rough-legged Hawk	RLHA
Northern Harrier	NOHA
Bald Eagle	BAEA
Sandhill Crane	SACR
Herring Gull	HEGU
Ring-billed Gull	RBGU
Northern Shrike	NOSH
Pileated Woodpecker	PIWO

[a] names of birds follow the *AOU Check-list of North American Birds*

Element Occurrence Database Search

A query of Michigan Natural Features Inventory's NatureServe database for Element Occurrences found records for seven species of rare plants, three invertebrate animal species, three bird species, two unique community types, and one fish in or near the project areas (see bolded names below and Appendix 4). Records for animal Element Occurrences require that birds show evidence of breeding at the location. Although the same standard is attempted with reptiles, fish, and invertebrates, additional verifiable records are included for non-breeding individuals provided appropriate habitat is present upon observation (NatureServe 2008).

Many of the NatureServe database records for rare species that were found near the project area are strictly associated with the sensitive dune areas located along the lakeshores within 1 mile of the Great Lakes. This includes **Pumpelly's bromegrass** (*Bromus pumpellianus*), a threatened, medium-sized grass with leaves that are hairy on the upperside, and long hairs on the stem nodes. It was last observed in Charlevoix and

Antrim counties in 1996. Similarly, **Lake Huron tansy** (*Tanacetum huronense*) is a threatened species that grows in the open dune systems of the Great Lakes shorelines. This perennial forb grows in clumps of hairy, compound leaves with long-stalked, yellow flower heads (13-19 mm broad). It was found in Charlevoix and Antrim counties in 1996-2004. Most of the state threatened **Houghton's goldenrod** (*Solidago houghtonii*) is found in the Mackinaw Straits region and is usually found near the Great Lake's shore in linear interdunal areas and former embayments. It was last found in Charlevoix County in 1996. **Pitcher's thistle** (*Cirsium pitcheri*), a federally and state threatened species is also found in the open Great Lakes dune systems. This perennial thistle has bluish-green leaves with few spines, and it is densely covered by white-woolly hairs. Pitcher's thistle was last found in Antrim and Charlevoix counties in 2004. The **Lake Huron locust** (*Trimerotropis huroniana*) is a state threatened, small, ash-gray grasshopper with darker brown and white markings and wings with a prominent dark band. This species is also ecologically linked to the sparsely vegetated, high-quality Great Lakes sand dunes along northern Lake Michigan, northern Lake Huron, and eastern Lake Superior. It eats mainly dune grass, beach grass, and wormwood, but will also eat the threatened pitcher's thistle. This species was last detected in Charlevoix County in 1996. The **Piping Plover** (*Charadrius melodus*), a federally and state listed endangered bird species was last found in Charlevoix County in 2004. This species is also strictly associated with beaches and shoreline areas. The **Open Dunes** community type is an ecosystem that is recognized, recorded, and tracked by Michigan Natural Features Inventory. This community type was identified in Charlevoix County in 1992. Open Dunes are grass- and shrub-dominated and located on wind-deposited sand formations near the shorelines of the Great Lakes. Open Dunes are found within and as a part of forested landscapes. Another lakeshore related, recognized, community type is the **Interdunal Wetland**. Identified in Charlevoix County in 1992, Interdunal Wetlands are rush-, sedge-, and shrub-dominated wetlands found in low areas among Open Dunes and/or between beach ridges along the Great Lakes. The lakeshore related ecosystems and associated species require the protection of habitat and the maintenance of natural dune processes (e.g. shoreline fluctuation, erosion, sand deposition, wind, water level fluctuation, sand movement). This includes protection from development, ORV damage, foot traffic and the invasion of

non-native species (especially plants). Given the specific location of these community types and their associated rare species, wind turbine development activities taking place farther than 1 mile from the lakeshore are unlikely to have a direct impact (Michigan Natural Features Inventory 2007).

Similarly, by avoiding development activities in wetlands the project can minimize its impacts to most of the remaining records of rare species found in our NatureServe database. Typically, most development activities avoid wetlands due to construction challenges and additional wetland permit requirements. Avoiding wetlands would also avoid impacts to the **English sundew** (*Drosera anglica*) which is a plant species of special concern occurring in fens (i.e., alkaline wetlands) along northern shores. It was last detected in Charlevoix County in 1894. The **eastern flat-whorl** (*Planogyra asteriscus*) is a tiny brown land snail with a flattened spiral shell that is 1.8 mm in diameter and 0.9 mm tall. The eastern flat-whorl inhabits calcareous wetlands with northern white-cedar, tamarack, speckled alder and sedges but is not found in sphagnum-dominated wetlands. This species of special concern was last detected in Charlevoix County in 1929. **Hill's pondweed** (*Potamogeton hillii*) is found in cold, alkaline streams on sandy, mucky, and marly substrates with water up to one meter deep. Last detected in Charlevoix County in 1984, this species is listed as threatened in Michigan. The **Lake herring or Cisco** (*Coregonus artedi*) is a threatened species that is found in deep inland lakes as well as the Great Lakes at 18-53 m but spawn in waters 9-12 m deep. Last detected in Charlevoix County in 1990, lake herring are negatively impacted by exotic species, eutrophication of inland lakes, and local pollution. The **Common Loon** (*Gavia immer*) is a threatened species that was last detected in Charlevoix County in 2004. This bird species nests on less developed inland lakes typically greater than 4.5 hectares (11 acres). Loons are sensitive to human disturbance during the breeding season and activities within 1/4 mile of active nests should be minimized. The **Bald Eagle** (*Haliaeetus leucocephalus*) is another wetland related species that has been detected in or near the project area (Antrim County in 2005). This bird typically nests in snags or large live trees near open water. Similar to Common Loons, Bald Eagles are extremely sensitive to human activity during the breeding season and a ¼-mile buffer zone around the nest is recommended to minimize disturbance to this species of special concern.

Wetland areas, streams, and lakes within the project area should be avoided or protected from construction impacts to minimize disturbance to these rare and declining species. Alterations to the hydrology, construction run-off, removal of the forest canopy, road building, excessive trampling, and ORV use can have negative impacts on these wetland related species (Michigan Natural Features Inventory 2007).

The **Spike-lip Crater** (*Appalachina sayanus*) is the only rare species detected in our NatureServe project area database that is not directly related to lakeshore dune areas or wetlands. This tiny land snail is a species of special concern in Michigan and is in Antrim and Charlevoix counties. Found in moist leaf litter, near logs on wooded hillsides in mesic to wet-mesic deciduous forests and in areas with calcareous soils, it often lives near cedar swamps, forested floodplains, or lowland hardwoods. Similar to the other rare species discussed in this report the removal of forest canopy cover, road construction, trampling, and ORV use are considered to be threats to this species (Michigan Natural Features Inventory 2007).

Although 16 rare species and community types were identified in or near the project area, impacts to these rare natural features can be avoided and minimized by constructing turbines, transmission lines, and roads farther than 1 mile from the Great Lakes shoreline and in non-wetland areas. Given construction and permitting constraints this is likely consistent with current project plans. As the Norwood project develops further micrositing of turbines, transmission lines, and related road systems would be helpful to ensure that activities are avoiding impacts to these rare species and habitats.

Additional surveys to possibly be conducted in 2010

Additional large bird surveys have been discussed with Heritage Sustainable Energy for the spring of 2010. Given that the project area is within 3 miles of the shores of Lake Michigan it is likely that there will be some agency concern that the area supports high densities of migrant songbirds. In these situations migrant and breeding songbird surveys will likely be recommended for 2010. There is potential for these additional data to be combined with the existing data presented in this report; thereby, increasing our overall knowledge of the avian use of the project areas over time.

As the project plans progress, the estimated rotor-swept area presented in this report should be revisited to validate that it is capturing the correct height estimate for the specific turbines to be used in the project.

Acknowledgments

M. Sanders, C. Dykstra, S. Bridwell, S. Roys, T. Cummings, V. Dozeman, and J. Gehring collected the majority of the data for this project. I would like to express my gratitude to Heritage Sustainable Energy for their efforts to incorporate natural resource issues into the development of wind energy projects. My colleagues at the Michigan Natural Features Inventory provide logistical and technical support; especially, Brian Klatt, Sue Ridge, Nancy Toben, and Rebecca Rogers.

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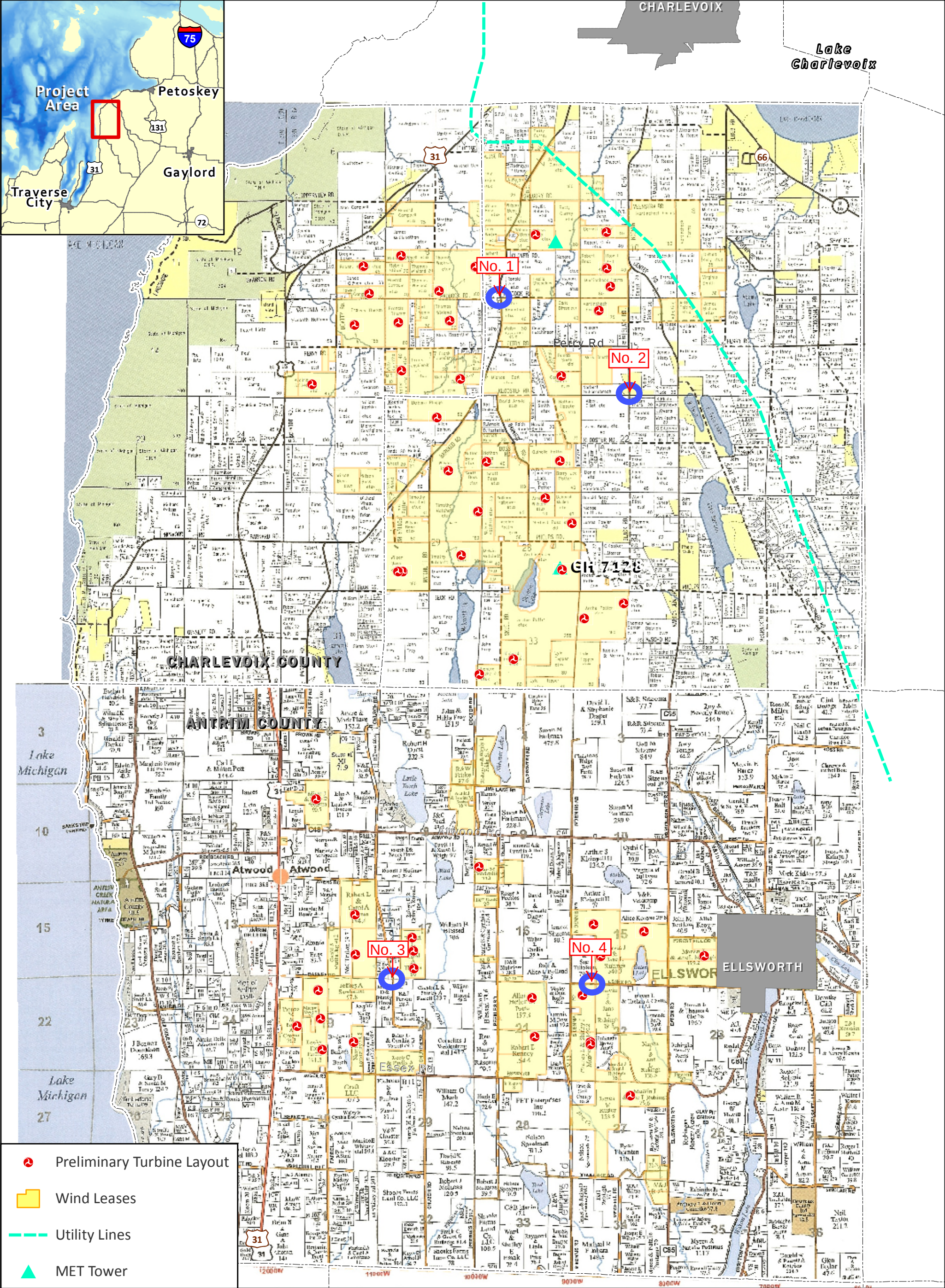
Appendix 1. The Norwood project area in Michigan is predominantly agricultural lands with some interspersed forested areas. Numbered sites are large bird observation sites.

Appendix 2. The Norwood project area in Michigan is predominantly agricultural lands with some interspersed forested areas. The topography includes ridges and valleys.

Appendix 3. Michigan Natural Features Inventory Information Request from January 2010.



Heritage Sustainable Energy

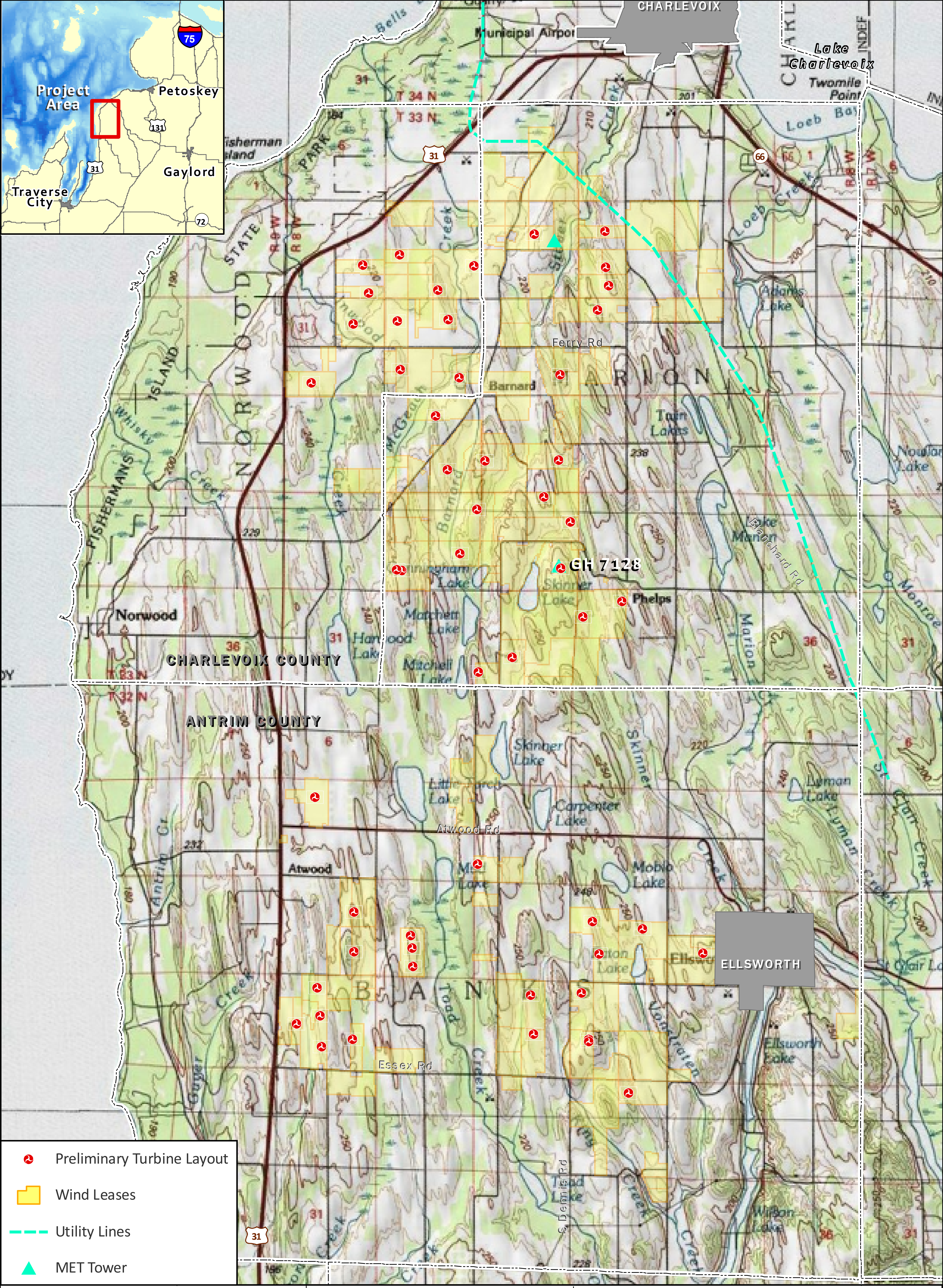
Date: April 2009
Map by: Xio Cordoba
File: M:\Wind Energy\Mapping Data BU\ Project Maps\norwood\windresource.mxd
Land cover / land use aerial from 2005.

Miles
0 1.5 3

TOTAL LEASED ACREAGE: 8,329 acres.

CONFIDENTIAL - Do Not Share

Norwood Area - Wind Lease Hold



Heritage *Sustainable Energy*

Date: April 2009
Map by: Xio Cordoba
File: M:\Wind Energy\Mapping Data BU\Project Maps\norwood\windresource.mxd
Land cover / land use aerial from 2005.

Miles
0 1.5 3

TOTAL LEASED ACREAGE: 8,329 acres.

CONFIDENTIAL - Do Not Share

Norwood Area - Wind Lease Hold

Michigan Natural Features Inventory Information Request

Requestor: **Heritage Sustainable Energy**

Project: **Norwood Area**

Location: **part of Charlevoix and Antrim County, Michigan**

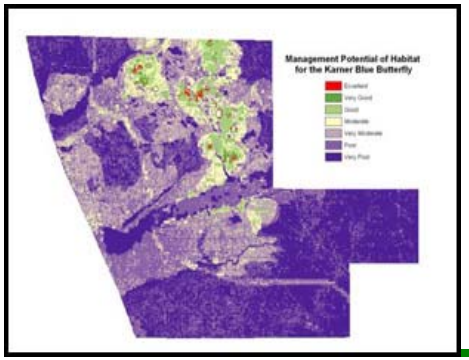
Request submission date: **January 21, 2010**

Print Date: **January 21, 2010**

Detailed information on the species listed in this report can be found in abstracts and the rare species explorer on the Michigan Natural Features Inventory (MNFI) website. The MNFI website can be found at: http://www.msue.msu.edu/mnfi

The species in this report are listed alphabetically by scientific name. Each record from the database is listed individually. Therefore you may see multiple listings for the same species. The locational and survey date information may be the only differentiating factors when looking at multiple occurrences for a given species. Heritage methodology is followed when entering species occurrences into the MNFI database. Detailed information on heritage methodology can be obtained on NatureServe's website at the link listed below.
http://www.natureserve.org/prodServices/heritagemethodology.jsp

By acceptance of the information services made available through MNFI the recipient understands that access to the information is provided for primary use only. MNFI requests that the user respect the confidential and sensitive nature of the information. There should be no redistribution of the information. Indiscriminate distribution of information regarding locations of many rare species represents a threat to their protection. Additionally, since the information is constantly being updated MNFI requests that any information service provided by MNFI is destroyed upon completion of the primary use. This information should be considered valid for one year only.



Appalachina sayanus — Spike-lip crater — Invertebrate Animal

FEDERAL STATUS:	STATE STATUS: SC	GLOBAL RANK:G5	STATE RANK: SU	LAST OBSERVED DATE:

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508522/Ellsworth, 4508523/Atwood, 4508532/Ironton, 4508533/Charlevoix

COUNTY: Antrim, Charlevoix

WATERSHED: Boardman-Charlevoix, Lake Michigan

TOWN RANGE	SECTIONS
T32NR07W	5, 6
T32NR08W	1, 2, 3, 4, 5, 6, 9, 10, 11
T33NR07W	5, 6, 7, 8, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, 33
T33NR08W	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36
T33NR09W	1, 12, 13, 24, 25, 36
T34NR07W	19, 30, 31
T34NR08W	14, 23, 24, 25, 26, 27, 28, 29, 31, 32, 33, 34, 35

Bromus pumpellianus — Pumpelly's bromegrass — Vascular Plant

FEDERAL STATUS:	STATE STATUS: T	GLOBAL RANK:G5T4	STATE RANK: S2	LAST OBSERVED DATE: 1996

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508533/Charlevoix

COUNTY: Charlevoix

WATERSHED: Lake Michigan

TOWN RANGE	SECTIONS
T33NR09W	1

Bromus pumpellianus — Pumpelly's bromegrass — Vascular Plant

FEDERAL STATUS:	STATE STATUS: T	GLOBAL RANK: G5T4	STATE RANK: S2	LAST OBSERVED DATE: 2006-06-14

USGS TOPOQUAD MAPSHEET CODE/NAME:
COUNTY: Antrim
WATERSHED: Lake Michigan

TOWN RANGE	SECTIONS
T32NR09W	11

Charadrius melodus — Piping plover — Vertebrate Animal

FEDERAL STATUS: LE	STATE STATUS: E	GLOBAL RANK: G3	STATE RANK: S1	LAST OBSERVED DATE: 2004-07-23

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508533/Charlevoix
COUNTY: Charlevoix
WATERSHED: Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR09W	1

Cirsium pitcheri — Pitcher's thistle — Vascular Plant

FEDERAL STATUS: LT	STATE STATUS: T	GLOBAL RANK: G3	STATE RANK: S3	LAST OBSERVED DATE: 2004-06

USGS TOPOQUAD MAPSHEET CODE/NAME:
COUNTY: Antrim
WATERSHED: Lake Michigan, Boardman-Charlevoix

TOWN RANGE	SECTIONS
T32NR09W	14

Cirsium pitcheri — Pitcher's thistle — Vascular Plant

FEDERAL STATUS: LT	STATE STATUS: T	GLOBAL RANK: G3	STATE RANK: S3	LAST OBSERVED DATE: 1996-08-21

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508523/Atwood

COUNTY: Charlevoix

WATERSHED: Lake Michigan, Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR09W	22, 23, 25, 26, 27, 34, 35, 36

Cirsium pitcheri — Pitcher's thistle — Vascular Plant

FEDERAL STATUS: LT	STATE STATUS: T	GLOBAL RANK: G3	STATE RANK: S3	LAST OBSERVED DATE: 1996-SUM

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508533/Charlevoix

COUNTY: Charlevoix

WATERSHED: Lake Michigan, Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR08W	6
T33NR09W	1

Coregonus artedi — Lake herring or Cisco — Vertebrate Animal

FEDERAL STATUS:	STATE STATUS: T	GLOBAL RANK: G5	STATE RANK: S3	LAST OBSERVED DATE: 1990

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508531/Bayshore, 4508522/Ellsworth, 4508521/Boyne City, 4508532/Ironton

COUNTY: Charlevoix

WATERSHED: Boardman-Charlevoix

TOWN RANGE	SECTIONS
T32NR07W	3, 4, 9, 10, 14, 15, 16, 22, 23
T33NR06W	6, 7, 8, 17, 18, 19, 20, 21, 26, 27, 28, 29, 30, 32, 33, 34, 35
T33NR07W	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, 22, 24, 27, 28, 33, 34
T33NR08W	1, 2
T34NR07W	19, 29, 30, 31, 32, 33
T34NR08W	24, 25, 26, 35, 36

Drosera anglica — English sundew — Vascular Plant

FEDERAL STATUS:	STATE STATUS: SC	GLOBAL RANK: G5	STATE RANK: S3	LAST OBSERVED DATE: 1894-08-26

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508531/Bayshore, 4508532/Ironton, 4508533/Charlevoix

COUNTY: Charlevoix, Emmet

WATERSHED: Lake Michigan, Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR07W	1, 2, 3, 4, 5, 6, 7, 8, 11, 17, 18
T33NR08W	1, 2, 3, 11, 12, 13
T34NR06W	6, 7, 18, 19, 30, 31
T34NR07W	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36
T34NR08W	12, 13, 14, 23, 24, 25, 26, 27, 28, 33, 34, 35

Gavia immer — Common loon — Vertebrate Animal

FEDERAL STATUS:	STATE STATUS: T	GLOBAL RANK: G5	STATE RANK: S3S4	LAST OBSERVED DATE: 2004

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508522/Ellsworth
COUNTY: Charlevoix
WATERSHED: Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR07W	19
T33NR08W	24

Haliaeetus leucocephalus — Bald eagle — Vertebrate Animal

FEDERAL STATUS:	STATE STATUS: SC	GLOBAL RANK: G5	STATE RANK: S4	LAST OBSERVED DATE: 2005-03-29

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508523/Atwood
COUNTY: Antrim
WATERSHED: Boardman-Charlevoix

TOWN RANGE	SECTIONS
T32NR08W	8, 17

Interdunal Wetland — Alkaline Shoredunes Pond/marsh, Great Lakes Type — Terrestrial Community - Other Cla

FEDERAL STATUS:	STATE STATUS:	GLOBAL RANK: G2?	STATE RANK: S2	LAST OBSERVED DATE: 1992-07-30

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508533/Charlevoix
COUNTY: Charlevoix
WATERSHED: Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR09W	1

Open Dunes — Beach/shoredunes, Great Lakes Type — Terrestrial Community - Other Cla

FEDERAL STATUS:	STATE STATUS:	GLOBAL RANK: G3	STATE RANK: S3	LAST OBSERVED DATE: 1992-07-30

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508533/Charlevoix
COUNTY: Charlevoix
WATERSHED: Lake Michigan, Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR08W	6
T33NR09W	1

Planogyra asteriscus — Eastern flat-whorl — Invertebrate Animal

FEDERAL STATUS:	STATE STATUS: SC	GLOBAL RANK: G4	STATE RANK: S3	LAST OBSERVED DATE: 1929-PRE

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508532/Ironton, 4508533/Charlevoix
COUNTY: Charlevoix
WATERSHED: Boardman-Charlevoix, Lake Michigan

TOWN RANGE	SECTIONS
T33NR08W	2
T34NR08W	23, 24, 25, 26, 27, 28, 33, 34, 35

Potamogeton hillii — Hill's pondweed — Vascular Plant

FEDERAL STATUS:	STATE STATUS: T	GLOBAL RANK: G3	STATE RANK: S2	LAST OBSERVED DATE: 1984-07-03

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508522/Ellsworth, 4508523/Atwood
COUNTY: Charlevoix
WATERSHED: Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR08W	23

Solidago houghtonii — Houghton's goldenrod — Vascular Plant

FEDERAL STATUS:	STATE STATUS:	GLOBAL RANK:	STATE RANK:	LAST OBSERVED DATE:
LT	T	G3	S3	1996

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508533/Charlevoix

COUNTY: Charlevoix

WATERSHED: Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR09W	1

Tanacetum huronense — Lake Huron tansy — Vascular Plant

FEDERAL STATUS:	STATE STATUS:	GLOBAL RANK:	STATE RANK:	LAST OBSERVED DATE:
	T	G5T4T5	S3	2004-06

USGS TOPOQUAD MAPSHEET CODE/NAME:

COUNTY: Antrim

WATERSHED: Boardman-Charlevoix, Lake Michigan

TOWN RANGE	SECTIONS
T32NR09W	11, 14

Tanacetum huronense — Lake Huron tansy — Vascular Plant

FEDERAL STATUS:	STATE STATUS:	GLOBAL RANK:	STATE RANK:	LAST OBSERVED DATE:
	T	G5T4T5	S3	1996-08-21

USGS TOPOQUAD MAPSHEET CODE/NAME:

COUNTY: Charlevoix

WATERSHED: Boardman-Charlevoix, Lake Michigan

TOWN RANGE	SECTIONS
T33NR09W	22, 23

Tanacetum huronense — Lake Huron tansy — Vascular Plant

FEDERAL STATUS:	STATE STATUS: T	GLOBAL RANK: G5T4T5	STATE RANK: S3	LAST OBSERVED DATE: 1996

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508533/Charlevoix

COUNTY: Charlevoix

WATERSHED: Lake Michigan, Boardman-Charlevoix

TOWN RANGE	SECTIONS
T33NR09W	1

Trimerotropis huroniana — Lake Huron locust — Invertebrate Animal

FEDERAL STATUS:	STATE STATUS: T	GLOBAL RANK: G2G3	STATE RANK: S2S3	LAST OBSERVED DATE: 1996-08-21

USGS TOPOQUAD MAPSHEET CODE/NAME: 4508533/Charlevoix

COUNTY: Antrim, Charlevoix

WATERSHED: Boardman-Charlevoix, Lake Michigan

TOWN RANGE	SECTIONS
T32NR09W	3, 10, 11, 14
T33NR08W	6
T33NR09W	1, 11, 12, 14, 22, 23, 27, 34

Michigan Natural Features Inventory Information Request

Print Date: January 21, 2010
Information valid for one year.

Enclosed is the data requested from Michigan Natural Features Inventory (MNFI). This information is a list of Element Occurrences (EO) at the section level. In some cases, the extent of an animal's range or a community type may extend past the sections listed.

The MNFI database is an ongoing and continuously updated information base. The database is the only comprehensive single source of existing information on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. This database cannot provide a definitive statement on the presence, absence, or condition of the natural features in any given locality, since most sites have not been specifically or thoroughly surveyed for their occurrence. Furthermore, plant and animal populations and natural communities change with time. Therefore, the information services provided should not be regarded as a complete statement on the occurrence of special natural features of the area in question. In many cases the information may require the interpretation of a trained scientist.

The recipient(s) of the information understand that state endangered and threatened species are protected under state law (Act 451 of 1994, the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection). Any questions, observations, new findings, violations or clearance of project activities should be conducted with the Michigan Department of Natural Resources, Wildlife Division. Contact Lori Sargent or Todd Hogrefe at (517) 373-1263. The recipient(s) of the information understand that federally endangered and threatened species are protected under federal law (Endangered Species Act of 1973). Any questions, observations, new findings, violations or clearance of project activities should be conducted with the U.S. Fish and Wildlife Service in East Lansing. Their phone number is (517) 351-2555. Recipients of the information are responsible for ensuring the protection of protected species and obtaining proper clearance before project activities begin.

By acceptance of the information services made available through MNFI the recipient understands that access to the information is provided for primary use only. MNFI requests that the user respect the confidential and sensitive nature of the information. There should be no redistribution of the information. Indiscriminate distribution of information regarding locations of many rare species represents a threat to their protection. Additionally, since the information is constantly being updated MNFI requests that any information service provided by MNFI is destroyed upon completion of the primary use. This information should be considered valid for one year only.

This information is used to guide conservation and land management activities. Some of the element records are historical. While this information may not be important for regulatory purposes, it is important for management and restoration purposes and for scientific use.

State Protection Status Code Definitions
E = Endangered
T = Threatened
SC = Special concern

Federal Protection Status Code Definitions
LE = Listed endangered
LT = Listed threatened
LELT = Partly listed endangered and partly listed threatened
PDL = Proposed delist
E(S/A) = Endangered based on similarities/appearance
PS = Partial status (federally listed in only part of its range)
C = Species being considered for federal status

Global Heritage Status Rank Definitions
The priority assigned by NatureServe <http://www.natureserve.org>'s national office for data collection and protection based upon the element's status throughout its entire world-wide range. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences range-wide or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g. a single western state, a physiographic region in the East) or because of other factor(s) making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.
G4 = Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.
G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
GH = Of historical occurrence throughout its range, i.e. formerly part of the established biota, with the expectation that it may be rediscovered (e.g. Bachman's Warbler).
GU = Possibly in peril range-wide, but status uncertain; need more information.
GX = Believed to be extinct throughout its range (e.g. Passenger Pigeon with virtually no likelihood that it will be rediscovered).
G? = Incomplete data
Q = Taxonomy uncertain
T = Subspecies
U = Unmappable through out the global geographic extent
? = Questionable

Subnational Heritage Status Rank Definitions
The priority assigned by the Michigan Natural Features Inventory for data collection and protection based upon the element's status within the state. Criteria not based only on number of occurrences; other critical factors also apply. Note that ranks are frequently combined.

S1 = Critically imperiled in the state because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation in the state.
S2 = Imperiled in state because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.
S3 = Rare or uncommon in state (on the order of 21 to 100 occurrences).
S4 = Apparently secure in state, with many occurrences.
S5 = Demonstrably secure in state and essentially ineradicable under present conditions.
SA = Accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range.
SE = An exotic established in the state; may be native elsewhere in North America (e.g. house finch or catalpa in eastern states).
SH = Of historical occurrence in state and suspected to be still extant.
SN = Regularly occurring, usually migratory and typically nonbreeding species.
SR = Reported from state, but without persuasive documentation which would provide a basis for either accepting or rejecting the report.
SRF = Reported falsely (in error) from state but this error persisting in the literature.
SU = Possibly in peril in state, but status uncertain; need more information.
SX = Apparently extirpated from state.