APPENDIX 5 – SUMMARY OF AVIAN IMPACT STUDIES

This Appendix contains summaries the results of two studies conducted at wind energy projects to determine effects of facilities on avian species.

TOP OF IOWA

Koford, R., A. Jain, G. Zenner, A. Hancock. 2005. Avian mortality associated with the top of Iowa wind farm. ProgressReport- Calendar Year 2004. Ames, IA.

Introduction

Construction on the Top of Iowa Wind Farm near Joice in Worth County, Iowa was completed in December 2001. The facility is composed of 89 turbines mounted on 71.6 m (235-foot) high tubular towers. Each turbine is equipped with three 25.9 m (85-foot) blades. Blade speed at the tips is approximately 337 km/h (130 mph).

Due to the presence of three large state-owned Wildlife Management Areas (WMAs) which provided a wide variety of habitat under state management (wetland, grassland and forest habitat), the project area has exhibited historically high bird use. Migrant and resident shorebirds, rails, raptors, sparrows and icterids historically moved freely between the WMAs, with their movements routinely taking them through the area that is now occupied by the windfarm. These three WMAs include: Rice Lake (~2,500 acres), Elk Creek (~2,500 acres) and Hanlontown Slough (~1,000 acres) WMAs. The proximity of these WMAs provides attractive habitat for migrating birds in an otherwise intensively farmed region of northern Iowa. In addition, the Rice Lake – Elk Creek – Hanlontown Slough complex (RL-EC-HS) provides important avian breeding habitat, particularly for wetland and grassland bird species. The quality of the habitat, coupled with the location of the a portion of the windfarm in an area that has been closed to Canada goose hunting for 30 years, results in high Canada goose usage. Two of the adjacent WMA's also contain waterfowl refuges that attract up to 40,000 Canada geese and 20,000 ducks to the area each year, resulting in 2.5 million waterfowl-use days in the vicinity of the wind farm. No other existing wind farm site in Iowa with exhibits higher potential bird use.

Study Objectives:

1) Determine bird and bat mortality resulting from impacts with wind-generator towers and turbine blades, with emphasis on mortality during the spring and fall migration periods;
2) Determine bird and bat species composition, relative abundance, habitat use, flight patterns and the relative mortality risk at turbine sites versus non-turbine sites; and,
3) Determine impacts of the wind turbines on waterfowl use of croplands by comparing waterfowl use of quarter sections containing wind turbines to similar quarter sections without turbines during the fall, with emphasis on Canada goose use of the area closed to Canada goose hunting around the Rice Lake WMA.

Project Design

Mortality

Evidence of collision-induced mortality was investigated in the vicinity of 26 randomly-selected wind turbines. Six 3 meter (m) wide transects were maintained free of vegetation, using a combination of herbicide treatments and manual weeding techniques, on each 76m x 76 m (250 ft by 250 ft) search plot under each of the 26 randomly selected towers. Transects were placed parallel to existing corn/soybean rows. Access roads and construction pads under turbines were also searched. The average total area searched under each tower comprised approximately 30 percent (1,742m^2 or 18,750 ft^2) of each 5,776m^2 (62,170 ft^2) search plot. Standardized searches of all mortality transects began April 15, 2003.

The search frequency was once every three days. From June 13, 2003, the search pattern was standardized to once every two days, in order to increase accuracy of the searches. Starting March 15, 2004, the search frequency was changed to once every two days.

Removal rates of carcasses by scavengers were measured during spring, summer, and fall by placing birds of three sizes (house sparrow, mallard/pigeon and Canada goose) on mortality transects under each of the 26 monitored wind towers. Carcasses were monitored daily for two weeks and evidence of scavenging was noted. Carcass status was reported as intact, partially scavenged, or completely removed.

Search efficiency was measured for each observer by having an independent Iowa Department of Natural Resource (IDNR) wildlife technician place small birds, such as house sparrows, on transects without the knowledge of the investigator. All evidence of bird or bat collisions discovered, including evidence planted by the IDNR wildlife technician were recorded if found. Recorded planted evidence of collisions was later removed from the database and a search efficiency rate calculated for each investigator.

Bird and Bat Species Composition and Activity.

Relative avian abundance and activity were estimated using fixed radius (100m or 328 ft) point counts from May 1, 2003 to December 1, 2003 and from March 24, 2004 to December 14, 2004. Standardized point counting techniques were used to reduce variance between observers. Observers recorded species, activity, and location of all birds within a 100m radius of the point count site. The duration of each point count was 10 minutes. Point counts were conducted in the morning from one-half hour after sunrise until 4.5 hours after sunrise, during mid-day from 11 AM to 2:00 PM, in the evening from 4:00 PM to 7:30 PM, and at night from half an hour before sunset to an hour and a half after sunset. Times were periodically adjusted to account for changes in daylight hours. Point counts were conducted at turbine location without mortality transects, as well as wind towers with mortality transects and in adjacent fields without turbines. Point counts were also conducted in crop fields approximately 4 miles southwest of the windfarm to contrast bird activity at similar sites outside the windfarm. Each site was visited approximately once every six days for each of the four time periods (morning, mid-day, evening and night). To improve the study design in 2004, point counts in the area southwest of the windfarm were restricted to the morning hours. It was determined that in order to contrast bird abundance on the windfarm with abundance at similar sites off the windfarm, the accepted methodology was to conduct only morning point counts, since bird activity is highest at that time.

Each 100 m fixed-radius point count was divided by species and season (i.e., Summer 2003 and Spring and Summer 2004) and analyzed each species-season combination separately. The seven most common bird species observed were included in the analysis.

Remote bat monitoring at turbine location was initiated in September 2003. Prior to that time, bat activity was monitored in conjunction with evening and night point counts. Anabat ultrasonic bat detectors were used to monitor bat activity from September 4, 2003 to October 9, 2003 and from May 26, 2004 to September 24, 2004. Monitors were placed at turbine sites as well as in adjacent fields without turbines.

Waterfowl Behavior and Activity

Waterfowl activity was monitored in the fall, from September 15 to December 25, 2003 and from September 27 to December 22, 2004. Waterfowl use within the area closed to Canada goose hunting around Rice Lake was estimated twice weekly. Agricultural crops and tillage practices and turbine activity were recorded during each count along with any observations that may have influenced waterfowl use. Additional relevant parameters noted were field area, distance from Rice Lake and presence/absence of wind turbines in each field. In addition, available waste grain was estimated in a number of fields with and without wind turbines in the area closed to Canada

goose hunting. Data was used to estimate the relative amounts of grain available for foraging waterfowl in the fields to determine if the fields with turbines had similar amounts of waste grain in them, making them more or less attractive to feeding geese. Waterfowl behavior was observed during morning and evening foraging periods in the same area. Behavior noted was time spent foraging (stationary and mobile) versus time spent vigilant (stationary and mobile) using scan sampling techniques A flock was scanned for two minutes, and each bird observed was assigned a combination of behaviors (foraging, vigilant, mobile, stationary or other). Observations were made in a similar manner to the foraging activity study.

Results

Point counts conducted on and near the windfarm were used to compare bird activity in fields with and without turbines. In order to estimate bird flight in the region, the following is an approximation of birds seen and heard during point counts conducted at turbine locations. An approximate abundance number of observed birds during the morning point counts in the summer of 2003 and 2004 was 1.76 birds and 1.95 birds every ten minutes of observation. The approximate abundance number of birds observed during the morning point counts in the fall of 2003 was 19 birds for every ten minutes of observation. These high numbers were primarily driven by rare sightings of large flocks of blackbirds (with numbers as high as 1000 and 5000 birds in one sighting). An approximate abundance number of birds seen during the morning point counts in the spring of 2004 was 1.6 birds for every ten minutes of observation.

The 2003 pilot study using Anabat ultrasonic bat detectors indicated there was no significant difference between bat activity at wind turbine sites and adjacent crop fields without turbines. The 2004 study (May to September 2004) found no significant difference between bat activity at wind turbine locations when compared to activity at adjacent crop fields without turbines.

Waterfowl use of the adjacent WMA's was below average for both ducks and geese in 2003 and 2004 compared to historical counts due to a late summer drought in 2003 and an unusual migration in 2004.

Waterfowl activity and behavior was monitored in the fall. Approximately 1.2 million total goose-use days and 194,000 total duck-use days were recorded in the WMA's, from September 15 to December 25, 2003, and 904,200 total goose-use days and 66,300 total duck-use days were recorded from September 27 to December 22, 2004.

Fall waterfowl use observations were analyzed for the 447 (2003) and 587 (2004) flocks of geese that were observed foraging in fields with and without wind turbines. Multiple Subset model selection was performed to determine the effect of the presence or absence of wind turbines on Canada goose use of fields. In 2003 a field with a wind turbine was 0.04 ± 0.3573 less likely to be used by Canada geese as a forage site than a non-turbine field. In 2004, a field with a wind turbine was 0.1326 ± 0.3271 less likely to used by Canada geese as a forage site than a non-turbine field. Confidence intervals for these estimates crossed zero, indicating that the effects can be considered negligible.

Spring and summer searches, both efficiency and scavenger rates were evaluated. Observers found 77% of bird carcasses in 2003 and 70% of bird carcasses in 2004. In scavenging trials, scavengers removed 5% and 8% of carcasses in 2003 and 2004 respectively.

Bat detectors were used to compare bat activity at turbine versus adjacent non-turbine sites. No consistent significant differences were found between relative bird and bat activity at turbine, turbine with transect and non-turbine sites.

Canada goose foraging behavior was monitored for a total of 447 flocks in 2003 and 587 flocks in 2004 and the presence of wind towers on goose activity was estimated to have a negligible effect.

Mortality

In 2003, the study resulted in the discovery of two birds (a yellow-throated vireo and a tree swallow) and 30 bats (hoary, red, little brown, big brown and silver-haired bats). In 2004, five bird carcasses (yellow-headed blackbird, red-tailed hawk, golden-crowned kinglet and two carcasses of unidentifiable bird species) and 44 bats (hoary, red, little brown, big brown, silver-haired and eastern pipistrelle bats) were found. Apparently, mortality resulted from collisions with wind turbines.

Based on the evidence collected in the study, the investigators stated that avian mortality at the TOI site was minimal. The investigators also stated that bat mortality during the fall migratory period was substantial, and may indicate cause for concern.

BUFFALO RIDGE

Western EcoSystems Technology, Inc. (WEST). 2000. Avian monitoring studies at the Buffalo Ridge, Minnesota wind resource area: results of a 4-year study. September. Northern States Power.

Introduction

Buffalo Ridge is a segment of the 62-mile-long Bemis Moraine, which is located in Lincoln and Pipestone Counties in southwest Minnesota and Brookings County, South Dakota. Habitats in the study area were characterized as being primarily agricultural crops including corn, soybeans, small grains, hay and pasture and Conservation Reserve Program (CRP) set-asides. Three major phases (P1, P2 and P3) of wind generation development have occurred within the Buffalo Ridge Wind Resource Area (BRWRA). In addition to those study sites within the BRWRA, a permanent reference area not scheduled for windpower development was selected along Buffalo Ridge northwest of the BRWRA in Brookings County, South Dakota.

Current knowledge of wildlife interactions with wind farms facilities suggests that a variety of factors contribute to avian mortality resulting at windfarm faculties. These factors include avian abundance and composition, geographic area, prey abundance and wind plant characteristics, weather and location of windfarm developments in migration corridors.

The study of avian and bat resources within the Buffalo Ridge Study was initiated with the performance of a biological reconnaissance of the BRWRA prior to windpower development. The conclusions of the pre-construction investigation indicated that there was relatively low potential for avian mortality to occur on at Buffalo Ridge based on the following:

1) Buffalo Ridge was not in a major waterfowl staging area or migration route;
2) Passerines usually migrate at altitudes above the turbine blades;
3) Radar studies of nocturnal avian migrants showed that abundance of migrants was relatively lower on Buffalo Ridge than other areas sampled in west-central and southwestern Minnesota; and,
4) Results of pilot avian monitoring studies conducted by South Dakota State University in 1994 and 1995 following construction of the first phase of wind plant development indicated that avian and bat mortality within the wind development area was relatively low.

Project Design

In 1996, Western EcoSystems Technology (WEST, Inc.), under contract to Northern States Power Company (NSP), developed an avian monitoring protocol for the Buffalo Ridge Wind Resource Area and implemented the protocol beginning with the 1996 field season. The primary goals of the study were to evaluate risk to birds from each phase of development and the cumulative risk to birds from future windpower developments in the BRWRA. Secondarily, the study was to provide information that can be used to reduce the risk to birds from any subsequent developments.

This monitoring study used the before/after and control/impact (BACI) design. The design and analysis used a "weight of evidence" approach to assess effects of the project on species of concern. Study design included one hundred meter radius point count surveys conducted to estimate species composition, relative abundance, habitat use, and flight behavior and relative risk during 1996 to 1999 at turbine locations and at randomly selected stations. Raptor and other large bird (RLB) 0.8-km radius-point-count surveys were also conducted at randomly located points throughout the BRWRA. Carcass searches were performed at turbine locations and at randomly non-turbine plots to estimate number of avian and bat mortalities attributable to wind turbine interactions and to relate the mortalities by species to the relative abundance of each

species, turbine characteristics, habitat and other parameters thereby determining relative risk to that species. Estimates of the total number of avian and bat fatalities in each phase of the wind development area were developed for each of three phases of the windfarm.

Results

During the four-year study, researchers documented 218 species of birds in the study area. Six of the observed species were listed as threatened by the State of Minnesota and/or U.S. Fish and Wildlife Service. Observations of threatened species included: six peregrine falcons, 51 bald eagles, three Wilson's phalaropes, 16 loggerhead shrikes, two horned grebes and one common tern. Most of these birds were observed during the spring or fall migration and were most likely migrants. Two breeding pairs of loggerhead shrikes were documented in the study area.

Point-count surveys accounted for the identification of 164 species totaling 70,727 birds. Species richness for species observed during point-count surveys was highest in the summer (1 June - 15 August), followed by spring (15 March - 31 May) and fall (16 August - 15 November), while avian abundance was highest in the fall and lowest in the summer. Avian groups with the highest abundance during the spring were blackbirds, longspurs, and sparrows. Blackbirds, sparrows and swallows were most abundant in summer, with blackbirds, longspurs, and sparrows most abundant in during the fall.

Observations of mean flight height of 15,247 flying flocks comprised of 55,607 birds indicated that mean flight heights were lowest for wrens (1.8 m), upland gamebirds (2.3 m) and sparrows (6.0 m). Waterfowl (46.9 m), waterbirds (44.3 m) and blackbirds (17.2 m) exhibited the highest mean flight heights. Due to differences in turbine heights present within the windfarm, 20.1% of flying birds were within the rotor-swept height of 19.5-52.5 m, and 11.3% were observed flying within the rotor-swept height of 26-74 m. Avian groups which were most often observed flying within the rotor-swept height were waterbirds, waterfowl, longspurs, raptors, and corvids. No significant differences in flight height as a function of habitat or presence or absence of turbines were noted.

Raptor and large bird (RLB) surveys accounted for identification of sixty-two species; totaling 20,035 birds. RLB species richness was highest in the spring, whereas RLB abundance was highest in the fall. The most abundant RLB groups during the spring were waterfowl, waterbirds, and shorebirds. In summer, the three most abundant groups were raptors, waterbirds, and waterfowl, and in fall, the three most abundant groups were waterbirds, waterfowl and corvids.

Observations of 3,156 flying flocks comprised of 18,144 birds were made during the RLB surveys. Mean flight height was highest for waterfowl (73.4 m), followed by waterbirds (36.3 m), raptors (26.6 m), shorebirds (21.5 m) and corvids (13.5 m). Forty-five percent of flying birds were within the rotor-swept height of 19.5-52.5 m, and 36% were within the rotor-swept height of 26-74 m. Avian groups most often observed flying within the rotor-swept height during RLB surveys were shorebirds, waterbirds, raptors and waterfowl. Flight height data collected during daylight hours indicate the larger rotor-sweep height may pose less risk to some groups of birds.

Species-specific turbine exposure indices were developed for all species observed during surveys. These indices were based on mean abundance, adjusted for visibility bias, proportion of daily activity budget spent flying, and proportion of flight heights within the rotor-swept height of turbines. This analysis was based on observations of birds during the daylight period and did not consider flight behavior or abundance of nocturnal migrants. Additionally, the analysis did not account for detection and avoidance differences among species, habitat selection, turbine characteristics, or other factors that may influence exposure to turbines. Thus, actual risk may be higher or lower than predicted by these indices.

Species identified during point count survey data with the highest seasonally-dependent exposure indices were Lapland longspur, red-winged blackbird, horned lark, cliff swallow, barn swallow,

and European starling. During the RLB surveys, species with the highest seasonally-dependent exposure indices were mallard, Franklin's gull, Canada goose, and double-crested cormorant.

Point count survey data indicated that avian use was highest in woodland habitat, followed by wetland, pasture, hayfields, CRP and croplands. Relative use of woodland and wetland was significantly higher than cropland and CRP; differences in use were not significant among CRP, pasture, and hayfields.

For birds recorded during RLB surveys, highest use occurred in wetlands, followed by crop fields, pasture and CRP; however, differences in use among habitats was not significant. Stepwise linear regression was used to model effects of distance to the nearest wetland and woodland on avian use. This analysis indicated a significant relationship between avian use and distance to the nearest wetland for waterfowl, upland gamebirds, sparrows and finches. A significant relationship between avian use at the plot and distance to the nearest woodland was found for several groups, including doves, woodpeckers, swallows, blackbirds, wrens, corvids, vireos/warblers, and thrushes.

BACI analysis of both point count and RLB survey data indicated that use of the wind development areas following construction was lower than expected for several groups and species of birds. Seven of 22 species of grassland breeders showed reduced use near turbines. The area of reduced use most often occurred in close proximity (i.e., < 100 m) to turbines; however, the area of reduced use was larger for certain avian groups during some seasons. Within the entire BRWRA, reduced use by birds associated with windpower development appeared to be relatively minor and would not likely have any large-scale population consequences.

A positive effect of reduced avian use around turbines would be reduced potential for collision mortality. Lower avian use where turbines are present may be due to avoidance of turbine noise, maintenance activities, and less available habitat due to the presence of maintenance roads and cleared gravel pads surrounding turbines. Another potential factor in the lowered avian use noted at turbine plots is that turbine noise may reduce observer detection rates of birds, especially those that observers detected by sound only.

Mortality

A total of 5,322 fatality searches were conducted on study plots, 2,482 (46.6%) of which were conducted on reference plots (without turbines) to estimate reference mortality in the study area, and 2,840 (53.4%) were conducted on plots associated with operational turbines. Thirty-one avian fatalities comprised of 15 species were found on reference plots during the study period, and 55 avian fatalities comprised of at least 31 species were found associated with operational wind plant features. Avian fatalities associated with turbines were comprised of 76.4% passerines, 9.1% waterfowl, 5.5% waterbirds, 5.5% upland gamebirds, 1.8% raptors and 1.8% shorebirds.

A total of 184 bat fatalities were found in 1998 and 1999 within the Buffalo Ridge windfarm. All bat mortalities were found in association with turbines and appeared to be turbine-related. Most bats were tree bats, with hoary bat being the most common fatality.

Based on the number of turbine-related casualties (adjusted for searcher efficiency and scavenger removal rates) per search, total avian mortality in the P1 wind development area was estimated to average 72 for the 8-month field season during the study. The resulting estimated annual mean fatality rate was 0.98 birds per turbine. The P2 study area avian mortality was estimated to be 265 in 1998 and 383 in 1999, resulting in a 2-year average of 2.27 fatalities per turbine. In the P3 wind plant, total avian mortality in 1999 was estimated to be 613, or 4.45 fatalities per turbine. The mean number of avian fatalities found per study plot per year was 1.10 for all reference plots combined. In the P1 study area, the estimated mean number of bird

fatalities per turbine per year was lower than the estimated mean number of bird fatalities per reference plot per year. In the P2 study area, the estimated mean, per turbine avian fatalities were approximately 2.1 times that of the reference plot mortality, and the estimated mean number of avian fatalities per turbine per year in the P3 study area was approximately 4.0 times that of expected reference plot mortality in the study area.

Total bat mortality in the P1 study area was estimated to be 19 in 1999 (0.26/turbine). In the P2 study area, total bat mortality was estimated to be 231 in 1998 and 277 in 1999, or a 2-year average of 1.78 bats per turbine. The bat fatality estimate for the P3 wind plant in 1999 was 282 (2.04/turbine).

The occurrence of avian mortalities resulting from interaction from windfarm infrastructure appeared to be strongly related the weather conditions within the windfarm. Out of the 55 bird fatalities found associated with windfarm features during the study, 48 were estimated to have been dead for less than one week, which allowed for weather conditions at the estimated time of death to be recorded. Thirty-one of the mortalities may have occurred in association with thunderstorms, six may have occurred in association with fog, four may have occurred in association with strong, gusty winds, and four possibly occurred in association with rain. Three fatalities apparently occurred when weather conditions were not a factor. Numerous studies of windfarm/avian interactions and mortalities have identified inclement weather as contributing to avian collisions with other obstacles, including power lines, buildings, and communications towers.

The largest single avian mortality event during this study occurred when 14 fresh birds (11 warblers, two flycatchers, and one vireo) were found underneath two adjacent turbines in the P3 portion of the study area. Severe thunderstorms the previous night may have forced these birds to fly at lower than normal altitudes while migrating. The tendency of migrant birds is to fly at lower altitudes during high winds, low clouds, and rain.

Presence of FAA lighting on turbines did not appear to be highly related to mortality.

Five of the 34 windpower-related mortalities (15%) whose age could be determined were juvenile birds. Immature birds may be more susceptible to turbine collisions than adults because they may not be as experienced at flying and maneuvering to avoid objects. During studies of avian mortality at a California wind development area, juvenile birds (mostly raptors) comprised a much higher proportion of turbine fatalities than expected based on the relative abundance of juveniles. Other California studies have found no relationship between age and susceptibility to collision. Most avian fatalities on Buffalo Ridge occurred during the spring migration when passerines would be considered adults.