Bird responses to wind turbine proximity in Iowa

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Abstract

The greatest threat facing birds today is habitat loss or degradation due to human development and disturbance. Previous studies at wind farms in Iowa have focused on the impact of direct mortality for birds from wind turbines, but none have looked at the indirect effects such as possible bird displacement. We hypothesized that birds with different life histories would have varied responses to turbines depending on factors such as the nesting and foraging requirements of the species. These effects could range from no effect to attraction (e.g., Killdeer because of graveled access roads) or avoidance behavior (e.g., many area-sensitive grassland birds). We evaluated the response of six common Iowa breeding birds to wind turbines in three Iowa counties (Story, Osceola, and Hancock). From June 1 through July 15 of 2011 and 2012, we conducted >1500 point counts utilizing distance sampling to assess bird community responses at wind farms and paired control sites. We used Program MARK to estimate the detection probability in relation to site- and observer-specific covariates and then estimated densities for each species as a function of distance from turbines. Evidence for avoidance behavior and attraction was found in different species. It seems clear that birds may respond differently to the presence of wind turbines, which is why it is important to consider such possible effects across a range of species when creating guidelines for placement in various habitats.

Introduction

Due to the lack of emissions from wind energy, it has been viewed as an ideal energy source, providing cost-competitive energy. This is especially true in areas of the country highly suitable for development such as Iowa. For these reasons, the U.S. Department of Energy has set a goal of reaching 20% of U.S. energy needs by wind energy by 2030 (U.S. Department of Energy 2008). Yet concerns over the effect of wind energy on wildlife continue to be raised, with evidence for both direct mortality as well as the potential for habitat loss.

Most previous studies have focused on the direct mortality of birds from wind turbine collisions rather than any potential habitat loss. Our goal is to quantify bird densities in relation to proximity to turbines in order to determine whether certain species exhibit any avoidance behavior that may lead to habitat loss.

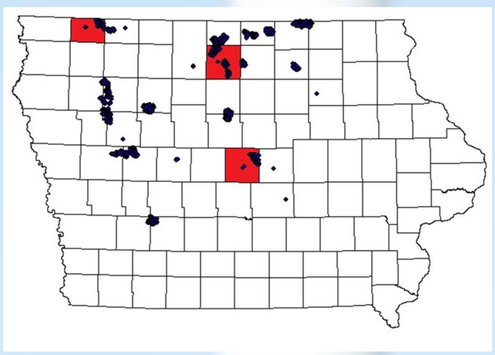

Figure 1: Locations of current wind turbines in Iowa (black dots) and the counties included in our survey (red).

Figure 2: Typical wind farm habitat in Iowa; all points could be classified as either corn, soybean or grassland.

Methods

We chose study sites from wind farms in central, north central, and northwestern Iowa(Figure 1), where there are concentrations of wind farms due to the high average wind speeds. From each wind farm, we randomly selected 15-20 wind turbines to be the focus of our point count surveys. We also chose a control site within 2 to 5 km of the wind farm, a distance that is beyond the influence of the wind farm (U.S. Fish and Wildlife Service 2003) while still being close enough to minimize differences in topography, land use, or other factors (Figure 2). At each wind farm and control site, we conducted bird point counts every 250 m from the turbine base out to a distance of 1000 m from the turbine base. At the control sites, the transects were started in the middle of the field, mimicking where a turbine would potentially be placed.

A total of 1,879 point counts were conducted from 1 June through 15 July of 2011 and 2012, which encompassed the breeding season of most species in Iowa. We binned sightings into five bins, 0 - 25 m, 25 - 50 m, 50 - 75 m, 75 – 100 m and > 100 m (Lueders et al. 2006) and also into 2-minute intervals (Farnsworth et al. 2002). We also collected data on wind speed, cloud cover, time of point count, day of season and distance from turbine, and incorporated these covariates into our analysis of detection probability in program MARK. We conducted a methodological approach (Arnold 2010) to create models of detection probability under the Huggins Closed Capture analysis in program MARK, and used the estimates of detection probability from the best model based upon Akaike's Information Criterion (AIC) to then estimate the density of each species in relation to proximity to turbine.

To test our hypothesis that species would differ in their response to turbine proximity based upon their life-history strategy, we examined six common breeding species from three distinct life-history strategies (Table 1):

- Agricultural species which are known to utilize and prefer cropland
- Generalist species which are found throughout the landscape
- Grassland species which utilize grassy ditches and patches of prairie

Table 1: Bird species studied at Iowa wind farms in 2011-2012 along with their general life history strategies.

Life History Strategy	Species
Agricultural	Killdeer
	Vesper Sparrow
Generalist	American Robin
	Red-winged Blackbird
Grassland	Dickcissel
	Western Meadowlark

Results

Detection probability was effected by the observer, the distance of the bird from the observer, the percent cloud cover, the day from the beginning of the season, the distance from the point count to the turbine, the wind speed, and a wind and turbine interaction effect (Table 2). The effect of proximity to turbine ranged from no effect and attraction to the turbines to avoidance even at 1000 m from the turbine base. Density estimates for three of the six species showed variable responses to wind turbines and highlight the complex patterns exhibited by different species (Figure 3).

Table 2: The six species analyzed in program MARK, and the covariates which effected detection probability in the top model from AIC ranking. Distance bin was the distance of the bird from the observer, CloudCover was the percent cloud cover at the time of the count, Day was the day from the beginning of the season (June 1), turbine was the distance of the point from the turbine, wind was the wind speed in kilometers per hour, and Turbine*Wind was an interactive effects of distance to turbine and wind speed. A single symbol (+ or -) indicates a non-significant trend in either the positive (+) or negative (-) direction, a double symbol (++ or --) indicates a significant trend (α=0.05).

Species	Effects on detection probability
Killdeer	Observer, DistanceBin(--)
Vesper Sparrow	CloudCover (- -)
American Robin	Day (-)
Red-winged Blackbird	Observer, Turbine(+), Wind(+), Turbine*Wind(- -)
Dickcissel	Observer, Turbine(- -)
Western Meadowlark	DistanceBin(+)

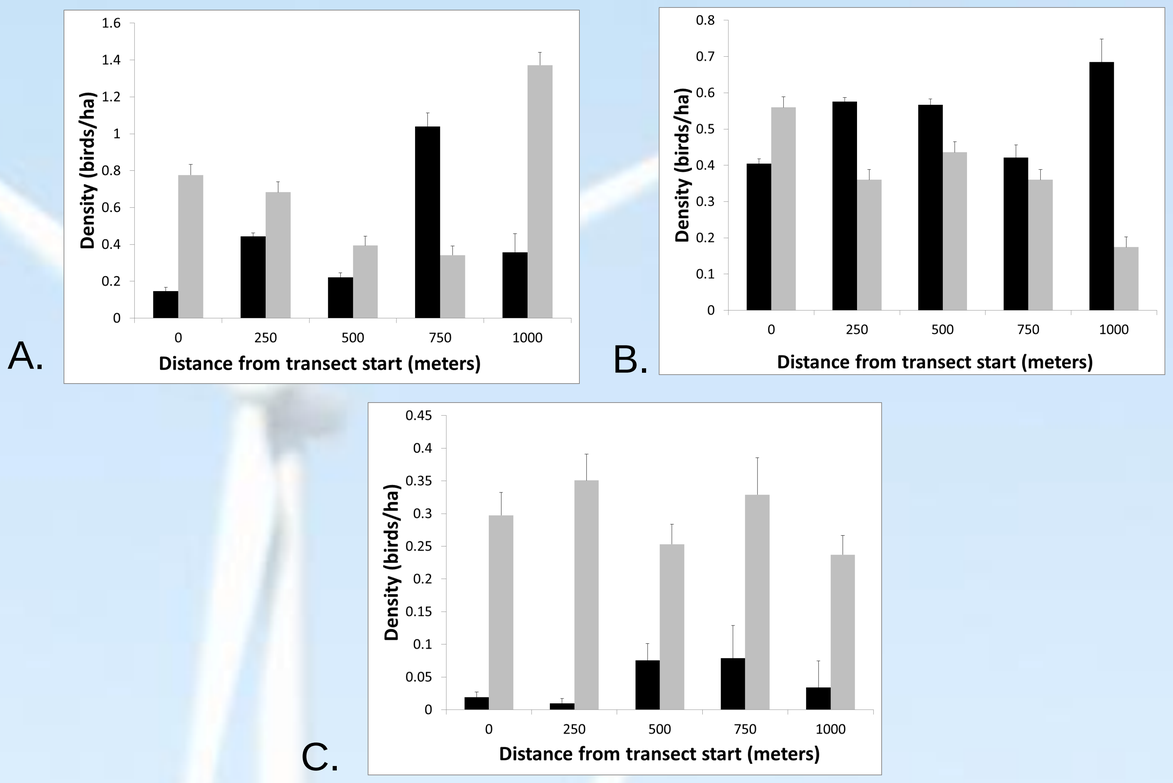

Figure 3: Density (95% confidence limit) for American Robin (A), Vesper Sparrow (B), and Western Meadowlark (C) in relation to distance from transect start/turbine for wind farm (solid black bars) and control sites (gray bars) at three Iowa wind farms in Story, Hancock and Osceola counties, 2011-2012.

Table 3: The effect of proximity to turbine on the density of each species studied, with attraction classified as statistically higher densities (α=0.05), avoidance classified as statistically lower densities and no difference when the confidence intervals overlapped. Effects were based on the majority of sites.

Species	Effect of proximity to a turbine
Killdeer	No difference at some sites and attraction at others out to 1000 meters
Vesper Sparrow	Avoidance out to 250 meters
American Robin	Avoidance out to 750 meters, but evidence of breeding
Red-winged Blackbird	Avoidance out to 500 meters, continued avoidance up to 1000 meters at 1 site
Dickcissel	Avoidance out to 1000 meters, continued avoidance at 1000 meters at 2 sites
Western Meadowlark	Avoidance to >1000 meters

Discussion

As concerns continue to rise over the costs and environmental impacts of traditional fuel sources such as fossil fuels and nuclear energy, wind energy is becoming an increasingly important factor in future energy development. While many studies have assessed the impact of direct mortality for birds from wind, there are many areas regarding the indirect effects of wind turbines that still require research.

By observing bird responses to wind turbine farms, we can see how wind turbine development in various habitats is fragmenting the habitat, and offer suggestions for future placement of developments which will limit the effect of the wind farm on the surrounding habitat while still offering the benefits of "green" energy. Our research indicates that wind farms should be places at least 1000 meters away from grassland habitat, as both species of grassland bird showed avoidance even at 1000 meters from the turbine base. Since we saw avoidance across all three life history strategies, additional research into species of concern would be important for determining wind siting guidelines in Iowa.

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Literature Cited

Arnold, T. 2010. Uninformative parameters and model selection using Akaike's Information Criterion. Journal of Wildlife Management 74(6):1175-1178.

Farnsworth, G. L., K. H. Pollock, J. D. Nichols, T. R. Simmons, J. E. Hines and J. R. Sauer. 2002. A removal method for estimating detection probabilities from point-count surveys. The Auk. 119.2:414-425.

Lueders, A. S., P. L. Kennedy and D. H. Johnson. 2006. Influences of management regimes on breeding bird densities and habitat in mixed-grass prairie: an example from North Dakota. Journal of Wildlife Management. 70.2:600-606.

U.S. Department of Energy. 2008. 20% Wind Energy by 2030. [online] http://www.20percentwind.org

U.S. Fish and Wildlife Service. 2003. Interim guidelines to avoid and minimize wildlife impacts from wind turbines [online] http://www.fws.gov/habitatconservation/wind.pdf

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