Agriculture, Ecosystems and Environment 197 (2014) 53–59

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Nest survival of Red-winged Blackbirds in agricultural areas developed for wind energy

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ARTICLE INFO

Article history:
Received 25 July 2013
Received in revised form 17 July 2014
Accepted 18 July 2014
Available online 2 August 2014

Keywords:
Agriculture
Nest survival
Program MARK
Red-winged Blackbird
Turbine
Wind energy

ABSTRACT

Wind energy development is a major priority in the United States, both economically and environmentally. However, there are growing concerns about the impacts to wildlife, including direct mortality and indirect effects such as displacement. Yet little knowledge has been gained regarding effects on reproduction. We monitored 534 Red-winged Blackbird (*Agelaius pheoniceus*) nests at three wind farms and paired control sites in Iowa during 2011 and 2012 to determine what effect, if any, wind turbine proximity had on the survival of nests. We modeled daily nest survival rates during the incubation and nestling stages in program MARK. In addition to proximity to turbine, we included other covariates which are known to effect nest survival including nest height, vegetation above nest, Robel pole vegetation density measures, age of nest, distance to woodlot, and Brown-headed Cowbird (*Molothrus ater*) parasitism. We found no differences in survival between our control and turbine sites at any site or year, and no effect of turbine proximity during the incubation stage. The best model for the nestling stage included a small effect of turbine proximity, with nest survival being slightly higher, though not significantly so, closer to turbines. Our results indicate that, for a generalist species breeding in an agricultural landscape, wind turbine proximity has negligible effects on reproductive success.

1. Introduction

Wind energy is a growing sector, produces no emissions, and is generally considered environmentally friendly (U.S. Fish and Wildlife Service, 2003). To reach the U.S. Department of Energy's goal of having 20% of U.S. energy coming from wind by 2030 (U.S. Department of Energy, 2008), more than 240 gigawatts (GW) still need to be installed, which will require an additional 15 million hectares of land (Kiesecker et al., 2011; Grassi et al., 2012). Much of the future wind energy development may occur in Iowa, which has 10,801 megawatts (MW) of potential projects currently planned, and is ranked as the seventh best state in terms of wind resources (American Wind Energy Association, 2012). The Iowa Department of Natural Resources (IDNR) considers wind energy development a top priority for the state in terms of energy independence, but Iowa has minimal regulations on the siting of turbines (Harr and Vannoy, 2009). Direct mortality of birds from wind turbine collisions may be low in Iowa (Jain, 2005), but indirect effects from wind turbines, such as displacement or changes to reproductive success, are not as well understood (Erickson et al., 2007). In Europe, it is generally accepted that the indirect effects of wind turbines are a more pressing threat than direct mortality (Kuvlesky et al., 2007), but much of the previous research in the U. S. has focused solely on direct mortality (e.g., Erickson et al., 2001; Johnson et al., 2002). Wind farms may lower habitat quality due to increased human activity and fragmentation of the landscape, both from the turbines themselves and from the additional access roads and transmission lines (Arnett et al., 2007; Kuvlesky et al., 2007).

Bird responses to alterations in habitat quality can be measured in many ways, including shifts in community composition, a change in density or abundance, and impacts to reproductive success (Bock and Jones, 2004). We chose to investigate reproductive success because it has been studied less and may be important to understanding population-level changes in response to wind energy development. Population "sinks" can occur when nest success and population density are no longer correlated. A site can have high bird densities, but investigators may miss a population "sink" if they do not also look at nest success (Winter et al., 2003; Anteau et al., 2012). Research has shown that some nest predators, including Hooded Crows (*Corvus cornix*) in Europe, will use human-made structures such as wind turbines or transmission lines as perches when searching for prey (Wallander

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http://dx.doi.org/10.1016/j.agee.2014.07.012
0167-8809/

et al., 2006). Some species avoid human-made structures when selecting nest sites (Wallander et al., 2006; Dusang, 2011), which could result in less available habitat as wind energy infrastructure expands. Additionally, noise can change nesting success by altering predator-prey interactions (Francis et al., 2009). If nest success is altered, either positively or negatively, by the proximity of a nest to a turbine, this could have population-level effects as wind turbine development continues and becomes more widespread.

More than 10 billion birds breed in the U.S. each year (U.S. Fish and Wildlife Service, 2002). As edges and other landscape variables can alter nesting success (Winter et al., 2000; Cox et al., 2012), and wind turbine farms increase edge and change the landscape around nesting habitat, the proximity of a nest to a wind turbine may alter nesting success. The proposed expansion of wind turbines to an additional 15 million hectares of land (Kiesecker et al., 2011; Grassi et al., 2012) could result in population declines for some species if their breeding ranges overlap present and future wind developments and they respond negatively to the presence of wind turbines. Our objective was to assess the influence of wind turbine proximity, landscape context, and nest features on the nest survival of a common breeding bird, the Red-winged Blackbird (*Agelaius phoeniceus*), in Iowa. We hope this information will help us (a) understand how a generalist bird species responds to wind energy development, and (b) inform future wind turbine siting guidelines.

2. Methods

2.1. Focal species

We focused our nest searching efforts on the Red-winged Blackbird (RWBL), North America's most common marsh-breeding Icterid and one of the best studied species (Yasukawa and Searcy, 1995). Red-winged Blackbirds are a generalist species, breeding in marsh and upland habitats as well as roadside ditches and agricultural lands (Yasukawa and Searcy, 1995). They lay one egg per day until the clutch is complete (2–4 eggs) and begin incubation with the second to last egg. The incubation period lasts approximately 13 days and is followed by a 12-day nestling period (Yasukawa and Searcy, 1995). In addition to the wealth of knowledge available of RWBL breeding from previous studies, the species has large breeding populations throughout Iowa, allowing for large sample sizes of nests at all of our study sites.

2.2. Study sites

Our study investigated nesting RWBL responses to wind energy development at three Iowa wind farms operated by Nextera Energy. Study sites were chosen in part based upon cooperation of wind energy companies and were located in Hancock, Osceola, and Story counties, Iowa, where there are concentrations of wind farms due to the high mean wind speeds. Paired control sites were located within 2–5 km of each wind farm, a distance that is generally accepted to be 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 and other factors. Paired control sites allowed us to make direct comparisons between nests on and off wind farms. We collected data across multiple sites and years to enhance the reliability of the findings (Anderson et al., 1999).

2.3. Nest searches

We conducted systematic searches for nests in roadside ditches and other suitable habitat (e.g., fencerows or other habitat patches away from roadsides) starting in mid-May and continuing until the last young had fledged mid–late July. The field season began in mid-May so that observers could improve their nest searching abilities with a few days of practice and to be timed with territory establishment (Martin and Geupel, 1993; Yasukawa and Searcy, 1995). Nest searches were conducted at each of the three wind farms and the paired control sites, with one observer being responsible for searches and checks at each pair of sites. The ditches included patchy dense stands of cattail (*Typha* sp.) and horsetail (*Equisetum* sp.) and scattered small shrubs of many species that were preferentially used as nest sites by Red-winged Blackbirds. Because of the distribution of suitable nesting habitat, searches were focused on areas that included these features, resulting in a clumped distribution of nests. Other less suitable habitats were also searched, although few nests were found in these sites.

Each nest was marked with a point taken with a GPS unit and then revisited it every 3–4 days until the nest fate could be determined (Martin and Geupel, 1993). The incubation stage of the nest was determined via egg floatation (Lokemoen and Koford, 1996; Dinsmore et al., 2002) while nestling age was determined by feather development of the nestlings (Holcomb and Twiest, 1970). The ability to age a nest allowed us to estimate when the nest transitioned to the next stage (Westerskov, 1950). Sites were searched as frequently as possible (typically at 2–4 day intervals) to find nests as early in the cycle as possible for the maximum number of exposure days (Johnson, 1979; Winter et al., 2003). A nest was considered successful if one or more young hatched (for the incubation stage) or fledged (for the nestling stage; Mayfield, 1961).

Nest survival can be affected by factors such as the day of nesting season, nest height, and concealment/vegetation density, as well as larger landscape characteristics (Holm, 1973; Johnson, 1979; Martin and Roper, 1988). Several vegetation and landscape variables were measured as soon as the nest fate was determined (Table 1; Martin and Geupel, 1993). Finally, we report the effective sample size for each nest stage (Rotella et al., 2004) as a general means of assessing the quality of our dataset.

2.4. Nest survival modeling

Individual nest covariates can be incorporated into models of nest survival and often lead to a greater understanding of the

Table 1
Individual nest covariates measured at nests in Hancock, Osceola, and Story counties in Iowa, 2011 and 2012.

Covariate	Measurement
Height	Height of nest from ground (cm)
Veg	Height of vegetation above nest (cm)
Edge	Distance from nest to nearest road or fencerow (m)
Woodlot	Distance from nest to nearest woodlot (m)
Turbine	Distance from nest to nearest turbine (m)
RobelVar	Variance of Robel pole readings at nest and 1 m in each of the four cardinal directions
RobelMean	Mean of Robel pole readings at nest and 1 m in each of the four cardinal directions
Cowbird	Presence of cowbird parasitism at nest (0 = none, 1 = parasitized)