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THE NEED

Populations of grassland and shrub-steppe bird species are declining more precipitously than any other group of North American bird species (Peterjohn and Sauer 1999). Much of the decline appears associated with habitat loss, fragmentation, and degradation of grassland and shrub-steppe habitats. Agricultural development is the greatest cause of grassland loss (Knopf 1994). Urban development and range management practices also contribute to loss of grasslands and biodiversity within remaining grasslands (Vickery et al. 1999, Fuhlendorf and Engle 2001). Because of the permanence and fragmenting nature of urban development, this form of grassland conversion may have more severe and longer-term negative effects than impacts such as agriculture (Marzluff and Ewing 2001). Although changes wrought by these forces have been occurring for some time, there is no clear understanding of their direct and indirect effects on grassland and shrub-steppe species. A more recent development in many grasslands is the expanding wind industry. The Great Plains, where most natural grasslands in North America occur, also has tremendous wind resources. Concerns arise about the direct effect of wind farms associated with bird strikes and the indirect effects due to habitat alteration and possible avoidance of wind farms by breeding birds. Relatively little is known about these issues.

The purpose of this document is to offer some guidelines for studies directed at assessing the influence of wind developments on breeding grassland birds, particularly passerines (songbirds). It addresses the issue of avoidance, not strikes. It is not intended to be definitive, but will need to be modified to meet particular study objectives and logistic constraints. Further, as more studies are conducted, improvements in methodology may become evident. The guidelines indicated are for reconnaissance evaluations; in particular instances more substantive research may be appropriate.

The focus of monitoring and research at most U.S. wind projects has been on direct mortality (Erickson et al. 2002). Indirect effects such as the displacement of breeding songbirds from habitat near wind facilities or impacts on productivity of birds are not well understood. By displacement we mean that birds tend to avoid an area. Avoidance of an area may or may not imply effects on population parameters such as population size, but crowding of birds into the remaining suitable habitat, or the use of less-suitable habitat, is thought to depress productivity or increase mortality or both. Measuring avoidance is one step toward understanding the effects of wind development and is more easily measured than other demographic parameters such as survival and recruitment.

A few studies of avoidance of wind generators by grassland birds have been conducted. At a large wind plant in a mix of cultivated agricultural fields (e.g., corn, soybeans, alfalfa) and grassland (mostly grasslands restored by the Conservation Reserve

Program, and some native grasslands) on Buffalo Ridge in Minnesota, the abundance of shorebirds, waterfowl, upland game birds, woodpeckers, and several groups of passerines was statistically significantly lower at survey plots with turbines than at plots without turbines across all habitats considered (Johnson et al. 2000). However, little effect was detected on bird use of survey plots in relation to distance from turbines, suggesting that the area of reduced use by these species was limited primarily to within 100 m of the turbines. Part of the effect may have been due to the direct loss of habitat near the turbine from construction of turbine pads and associated roads. Support for this idea comes from Osborn et al. (1998), who reported that bird use was lower near turbines at Buffalo Ridge than at reference areas. Also at Buffalo Ridge, Leddy et al. (1999) found that densities of male songbirds were significantly lower in Conservation Reserve Program (CRP) grasslands containing turbines than in CRP grasslands without turbines. Densities of grassland birds measured at transects in reference fields and at transects at least 180 m from turbines were four times greater than in portions of study plots located near turbines. Reduced avian use near turbines was attributed to avoidance of turbine noise and maintenance activities and reduced habitat attractiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000).

Preliminary studies at the Stateline Wind Project in Oregon and Washington documented significantly lower densities of grassland songbirds within 50 m of the wind turbines and associated facilities (roads) during the first year after operation (Erickson et al. 2004).

At Foote Creek Rim, Wyoming, a population of mountain plovers (*Charadrius montanus*) was reduced from a mean of 50 during the two years prior to wind-plant construction to a mean of 25 in the three years following construction. However, a similar decline occurred during the same time period at a reference area and at another regional study on the Pawnee National Grassland, suggesting the decline at the wind plant site may have been at least in part due to factors other than the wind plant. F. L. Knopf (U.S. Geological Survey, Fort Collins, Colorado, pers. comm.) suggested that the declines were possibly attributed to a series of wet springs, which led to heavy vegetation growth and reduced habitat suitability for mountain plovers. This example illustrates the importance of collecting information at comparable control plots to compare with treatment plots.

GOALS AND OBJECTIVES

The goal of displacement research, such as studies conducted by WEST, Inc. and by the U.S. Geological Survey, Northern Prairie Wildlife Research Center (NPWRC), is to quantify the indirect impacts of wind projects on grassland-breeding songbirds over a rather large area. Ideally, data at multiple wind projects in grassland and shrub-steppe habitats should be collected in a standardized manner, with the overall objective of quantifying the level of displacement of breeding grassland and shrub-steppe songbird species. One hypothesis currently being tested with displacement research by WEST and NPWRC is that densities of grassland songbird species do not vary with distance from wind turbines. These researchers are also quantifying the extent of any displacement effects.

We advocate a focus on identifying possible reductions in *densities* of breeding songbirds, rather than on *reproductive success*, for three primary reasons. First, reproductive success tends to be highly variable spatially and temporally and is influenced by a variety of factors, which make it difficult to distinguish effects of individual factors such as proximity to wind turbines. Second, in most studies of reproductive success on study areas the size of wind farms, the sample sizes of nests are rarely sufficient to draw even tentative conclusions. And third, even if nesting is common, finding sufficient numbers of nests to assess reproductive success is challenging (Winter et al. 2003), requiring large investments in time and labor.

APPROACH

Research that quantifies the displacement effect according to distance of a wind-turbine facility on breeding grassland and shrub-steppe songbirds would allow predictions about the impacts of site development, may reduce pre-project data requirements for future projects, and may identify possible approaches to effective mitigation.

We considered two types of experimental designs. Importantly, both approaches require study both before and after construction. The first approach, used by WEST, Inc., involves a combination of the gradient analysis design and the Before/After design (Morrison et al. 2001). Songbird density data and vegetation data are collected along a continuum from the turbines out to some specified distance, where the distance selected is assumed to be greater than any anticipated displacement distance. For example, Leddy (1996) documented reduced densities out to 180 m for several species of grassland birds near the Buffalo Ridge Wind Facility. A gradient analysis (Morrison et al. 2001) was used to examine the relationship between density of grassland birds and distance from turbines. Application of a gradient analysis assesses whether a relationship exists between distance from project structures and abundance or use of the area. The "Before" and "After" periods are incorporated into an analysis by conducting a gradient analysis on the changes in densities from the pre- to post-construction periods. For example, differences between grassland bird densities during the post-construction period and the pre-construction period for each 50-m segment can be calculated. The averages of these differences by distance category can be compared against the null hypothesis value of 0 using *t*-tests and confidence intervals to test whether a reduction in density is statistically significant and to identify the distance at which it occurred. An illustration of this analysis is provided in Figure 1 with data collected in the Stateline Wind Project (Erickson et al. 2004).

The second type of design, adopted by NPWRC, involves bird use and vegetation information in relation to distance from the turbines, and also includes one or more separate reference areas where bird use and vegetation characteristics are measured. Analysis of data from this design is similar to that for the first design but also incorporates any differences in bird density during the pre-construction and the post-construction period at the reference site. This design is preferable if a displacement effect is manifested throughout the sampled treatment area (turbine area). This design allows for the detection of displacement effects at greater distances than can be detected solely at the wind project site. Use of the reference area may also increase the power to detect an effect in general, and may be necessary when the wind turbine site is relatively small, limiting sample sizes, especially at larger distances from a turbine. One difficulty of the approach, however, is finding reference sites that are similar to the wind project site.

The size of the study area will depend on the size of the development. It cannot be larger than the area of similar habitat surrounding the development, unless reference areas away from the development are incorporated. As in most field studies, the larger, the better. That is, the greater the area studied, especially at differing distances from turbines, the stronger the inference about those turbines will be.

Length of Study

We recommend a minimum of two years of pre-construction study to estimate densities of bird species. However, the typical schedule of permitting and development for projects and the uncertainty in the specific project layouts often limit pre-project sampling to a single year. A bare minimum of two years is recommended for post-construction study, so that longer-term effects can be distinguished from transient ones. A longer period after construction would definitely be better (Parker and Wiens 2005); some studies (e.g., Wiens et al. 1986) have identified inertia in site tenacity among breeding birds, in that some of them will return in a subsequent year to a site they had used before even if it had since become unsuitable. A longer period of evaluation after construction also will allow vegetation that was temporarily impacted by construction to recover, will allow for possible habituation of birds to the turbines, and will reduce the influence of unusual events such as El Niño. If cost constraints limit the number of years of a study, sampling could be spread over the post-construction period (e.g., sample in year 1, year 3 and year 5 after construction).

Field Data Collection

A qualified observer will walk pre-established transects and record detections of target species that are either seen or heard. For example, studies by NPWRC mark the entire study area with flags 50 m apart in one direction and 200 m apart in the other. The flags facilitate accurate mapping of bird locations. Transects are walked along the line with flags 200 m apart, and birds within 50 m on either side of the transect are recorded. Transects should be as close together as possible to maximize the number of transects, but to also minimize double-counting. The location of each bird detected (visual or auditory) is mapped and the distance to each turbine is later calculated. A minimum of two visits to each sample site (transect or plot) should be made during the defined breeding season of the target species. Certainly more visits would allow better estimation of densities. The precision in estimates depends on the number of sites and to a lesser degree the number of visits. It is recommended that prior to the beginning of a study the level of uncertainty resulting from the number of transects and site visits be evaluated.

Vegetation Characterization

Measuring the vegetation characteristics of the study sites is important for distinguishing the effects on bird densities of wind facilities from the effects of habitat differences, precipitation levels, and grazing intensity between sites and among years. Some differences in bird use can be attributed to obvious differences in habitats, such as a prairie dog colony, a patch of woody vegetation, or a wetland. Other differences may be more subtle and required more detailed analysis. To date, such detailed analyses have not been incorporated into any study of wind development and grassland bird use. The protocol used by NPWRC to measure vegetation is given in Appendix A.

Limitations

The results from studies described here would provide information on the displacement distances from the wind facility but most likely could not ascertain whether the effects are from the turbine noise, the presence of tall structures, the increased vehicular and human traffic associated with routine maintenance of turbines, or some combination of these influences. However, it should not matter because all of the effects are due to the wind facility.

Also, single studies are unlikely to provide definitive results, in part due to small sample sizes and in part due to unique features associated with each wind development and the site at which it is located. Clearly, metareplication (sensu Johnson 2002) is needed to gain a full understanding of how wind developments influence the use of grasslands by breeding birds.

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LITERATURE CITED

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science 33:43-64.

Erickson, W. P., J. Jeffrey, K. Kronner, and K. Bay. 2004. Stateline Wind Project Wildlife Monitoring Final Report, July 2001 – December 2003. Technical report peer-reviewed by and submitted to FPL Energy, the Oregon Energy Facility Siting Council, and the Stateline Technical Advisory Committee.

Erickson, W., G. Johnson, D. Young, D. Strickland, R. Good, M. Bourassa, and K. Bay. 2002. Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality information from proposed and existing wind developments. Prepared for Bonneville Power Administration, Portland, Oregon. Available at www.west-inc.com.

Fuhlendorf, S. D., and D. M. Engle. 2001. Restoring heterogeneity on rangelands: ecosystem management based on evolutionary grazing patterns. BioScience 51:625-632.

Johnson, D. H. 2002. The importance of replication in wildlife research. Journal of Wildlife Management 66:919-932.

Johnson, G. D., W. P. Erickson, M. D. Strickland, M. F. Shepherd, and D. A. Shepherd. 2000. Avian Monitoring Studies at the Buffalo Ridge Wind Resource Area, Minnesota: results of a 4-year study. Technical report prepared for Northern States Power Co., Minneapolis, Minnesota. 212 pages. Available at www.west-inc.com.

Knopf, F. L. 1994. Avian assemblages on altered grasslands. Pages 247-257 *in* J. R. Jehl, Jr. and N. K. Johnson, editors. A century of avifaunal change in western North America. Studies in Avian Biology 15.

Leddy, K. L. 1996. Effects of wind turbines on non-game birds in Conservation Reserve Program grasslands in southwestern Minnesota. M. S. thesis. South Dakota State University, Brookings, SD, USA.

Leddy, K. L., K. F. Higgins, and D. E. Naugle. 1999. Effects of wind turbines on upland nesting birds in Conservation Reserve Program grasslands. Wilson Bulletin 111:100-104.

Marzluff, J. M., and K. Ewing. 2001. Restoration of fragmented landscapes for the conservation of birds: a general framework and specific recommendations for urbanizing landscapes. Restoration Ecology 9:280-292.

Morrison, M. L., W. M. Block, M. D. Strickland, and W. L. Kendall. 2001. Wildlife study design. Springer-Verlag, Inc. New York, NY.

Osborn, R. G., C. D. Dieter, K. F. Higgins, and R. E. Usgaard. 1998. Bird flight characteristics near wind turbines in Minnesota. American Midland Naturalist 139:29-38.

Owensby, C. E. 1973. Modified step-point system for botanical composition and basal cover estimates. Journal of Range Management 26:302-303.

Parker, K. R., and J. A. Wiens. 2005. Assessing recovery following environmental accidents: environmental variation, ecological assumptions, and strategies. Ecological Applications 15:2037-2051.

Peterjohn, B. G., and J. R. Sauer. 1999. Population status of North American grassland birds from the North American breeding bird survey, 1966-1996. Studies in Avian Biology 19:27-44.

Robel, R. J., J. N. Briggs, A. D. Dayton, and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. Journal of Range Management 23:295-297.

Vickery, P. D., P. L. Tubaro, J. M. C. Silva, B. G. Peterjohn, J. R. Herkert, and R. B. Cavalcanti. 1999. Conservation of grassland birds in the western hemisphere. Studies in Avian Biology 19:2-26.

Wiens, J. A., J. T. Rotenberry, and B. Van Horne. 1986. A lesson in the limitations of field experiments: shrubsteppe birds and habitat alteration. Ecology 67:365-376.

Winter, M., S. E. Hawks, J. A. Shaffer, and D. H. Johnson. 2003. Guidelines for finding nests of passerine birds in tallgrass prairie. Prairie Naturalist 35:197-211.

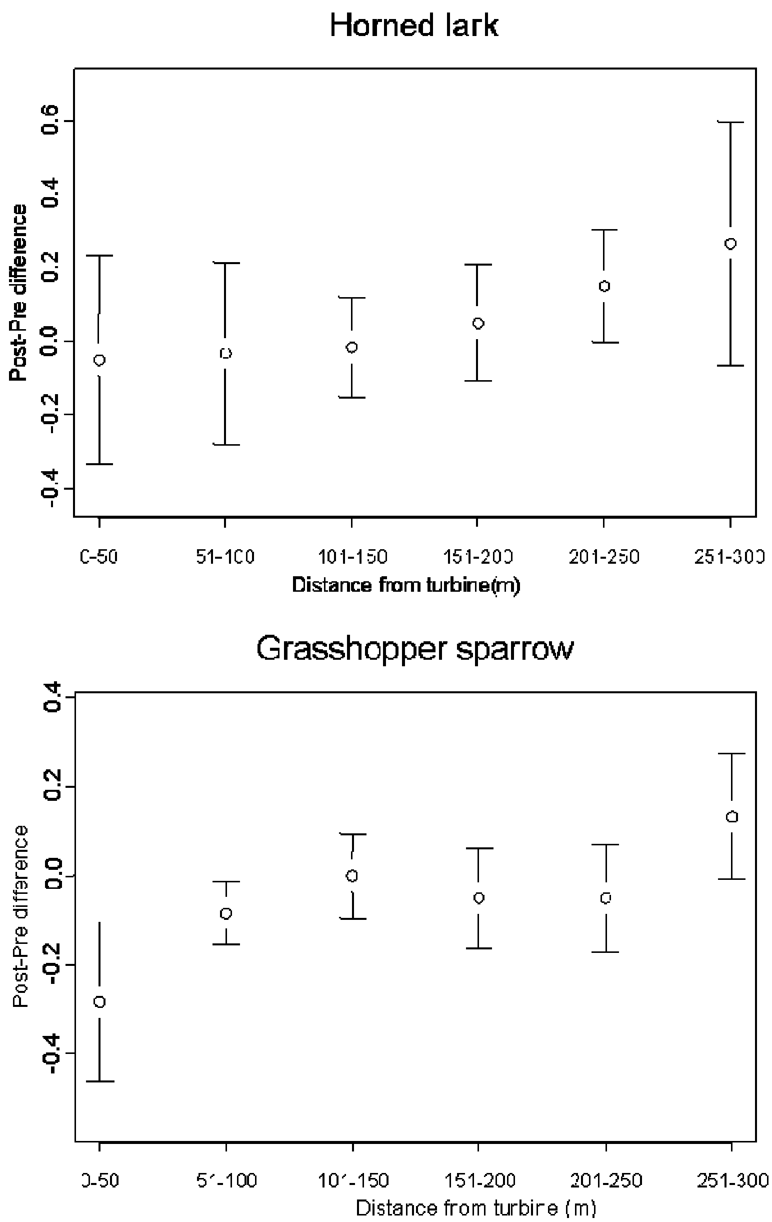

Figure 1. Differences in mean use (number observed per 50-m transect segment during one survey) between the first breeding season post-construction and the breeding seasons prior to construction and associated 90% confidence intervals for horned larks (*Eremophila alpestris*) and grasshopper sparrows (*Ammodramus savannarum*). Confidence intervals that do not overlap the value 0 indicate statistically significant effects.

Appendix A. An example of protocols used by the USGS Northern Prairie Wildlife Research Center to measure vegetation.

Each study plot will be mapped into five major habitat types: 1) xeric herbaceous vegetation, 2) mesic herbaceous vegetation, 3) woody (shrubby) vegetation, 4) wetland, and 5) prairie-dog colonies. Mapping will be based on U.S. Department of Agriculture National Agriculture Imagery Program aerial photographs and on-site inspection.

Vegetation measurements will be taken in systematic fashion using as sampling units the 50 m by 200 m cells that are formed by the survey grid. Two 50-m sampling lines will be placed within each cell. Because the immediate area around a grid point can be trampled due to walking during censusing, the first line will cover the interval from 25 to 75 m of the lower half of the cell. Using as an example a cell bounded by Grid Points A0, A50N, B50N, and B0, the observer will pace 10 m along the transect from Point A0 to Point A50N and pace 25 m over from the 10 m location. The first 50-m sampling line will start at this location. The second sampling line will cover the interval from 125 to 175 m of the upper right quarter of the cell. The observer will pace 40 m along the transect from Point A0 to Point A50N and pace 125 m over from the 40 m location. The second 50-m sampling line will start at this location.

Five sets of vegetation measurements will be taken within each 50-m line, with the first set of measurements starting 10 m from the beginning of the line and subsequent measurements taken every 10 m thereafter. A set of measurements includes recording life form, vegetation height, litter depth, and visual obstruction. A step-point sample will be used to assess percent composition of six basic life forms: bare ground (bare ground, cow pie, rock), grass, forb, shrub, standing residual, and lying litter (Owensby 1973). A meter stick will be used to measure maximum vegetation height and litter depth. A Robel pole will be used to measure visual obstruction (Robel et al. 1970).