EFFECTS OF WIND POWER ON THE DEMOGRAPHY AND POPULATION GENETICS OF THE GREATER PRAIRIE-CHICKEN

QUARTERLY REPORT

Submitted by:

Avian Ecology Laboratory
Division of Biology
Kansas State University

Presented to:

National Wind Coordinating Committee
Kansas Department of Wildlife and Parks

NREL Technical Monitor: Karin Sinclair

Principal Investigators

Brett Sandercock
Samantha Wisely

Graduate Research Assistants

Andrew Gregory
Lance McNew

Field/Lab Technicians

Derek Broman, Tracy Cikanek, Victoria Hunter, Thomas Prebyl

October 2007

EFFECTS OF WIND POWER ON THE DEMOGRAPHY AND POPULATION GENETICS OF THE GREATER PRAIRIE-CHICKEN

NREL Technical Monitor: Karin Sinclair
NREL Subcontract Administrator:

Quarterly Report
Reporting Period: 3rd Quarter
July – October 2007

FIELD BASED HYPOTHESES

Hypothesis I) Lek Attendance: *Lek attendance on impact sites is not affected by wind-power development.*

Accomplishments Since Last Quarter

The lekking season occurs from March – May. Therefore no data were collected to address this hypothesis.

Goals For Next Quarter

The lekking season occurs from March – May; no efforts will be made to address this hypothesis in the upcoming quarter.

Hypothesis II) Avoidance of anthropogenic structures: *Prairie-chickens do not avoid wind-towers and/or other anthropogenic features on impact sites.*

Accomplishments Since Last Quarter

Wind power facilities have not yet been constructed at impact areas at this time. Effort this quarter was focused on monitoring females to quantify pre-construction habitat selection and space use. Radio-marked prairie-chickens were located $\geq$2 times/week from project trucks, an ATV, or on foot using portable radio receivers and handheld 3-element Yagi antennas. Bird locations are estimated from $\geq$2 triangulation bearings (Millspaugh and Marzluff 2001) using a maximum-likelihood estimator in program LOCATE III (Nams 2006) or flush locations were recorded with a GPS. Aerial searches are conducted using fixed-wing aircraft when birds are unable to be located from the ground for $\geq$14 days.

As of 5 October, 2,648 locations of radio-marked females have been acquired by triangulation and by approaching radio-marked birds on foot, resulting in an average of 37 locations per bird. Evaluation of home range size and space use has not been conducted, but we are on track to collect the 30-50 locations per individual per season that are required for estimation of home range size using kernel methods (Seaman et al. 1999).

We are currently documenting the location of all anthropogenic structures at all three research units. Study areas are being ground searched and the location of all anthropogenic structures are collected using a handheld GPS unit. These locations are then uploaded as a GIS layer on property landcover maps. Mapping will allow us to assess the impacts of all anthropogenic structures on the demography and space use of prairie-chickens in areas with and without wind power development. As of 5 October, approximately 17,000 ha of study site have been mapped.

Goals For Next Quarter

We will continue to document the locations of wind power structures (turbines, roads, transmission lines, and buildings) and non-wind-related human structures with a handheld GPS unit.

Hypothesis III) Impacts on Fecundity Rates: ***Wind development will not reduce nest success or chick survival.***

Accomplishments Since Last Quarter

Ninety-three females were fitted with necklace-style radio-transmitters (see previous quarterly report). In addition, 5 females captured last year with active radio-transmitters were monitored. Radio-marked hens were located by triangulation or homing ≥3 times/week from project trucks, an ATV, or on foot. When females localized in an area and their estimated location did not change for 3 successive days, we used portable radio receivers and handheld Yagi antennas to locate and flush the bird so that the eggs could be counted and nest location recorded with a GPS unit. If the nest was found during laying, nest sites were visited again in <2 weeks to assess clutch size and nest status. During this time eggs were removed and carried >200 m from the nest and floated in a small container of luke-warm water to assess stage of incubation, estimate hatch date, and estimate the date of clutch initiation by backdating. Nest sites were not visited again until it was determined that the female had departed (i.e., was located away from the nest for ≥2 consecutive days); due to brood hatch, depredation, or abandonment. Once the female departed, we classified nest fate as successful (≥1 chick produced), failed, depredated, or abandoned. For successful nests, hatchability was calculated as the percentage of eggs that hatched and produced chicks.

Within 3 days of hatching, chicks were captured, counted, measured and fitted with uniquely marked patagial tags. After processing, they were returned to the exact spot where they were captured and released along with the hen. Pre-fledge brood survival was estimated by conducting flush counts within 2 days of the 14th day post hatch (the average day of fledge) at dawn or dusk to estimate the number of chicks in the brood. For counts of 0 chicks, the brood hen was flushed the following day to be certain no chicks remained in the brood.

In 2007, 97 nests were located. Mean (±SE) clutch sizes were 11.8 ± 0.3 and 10.4 ± 0.4 for first nests and renests, respectively. Of 70 first nests, 12 nests successfully hatched chicks. Ten of 27 renesting attempts successfully hatched. Apparent nest success for all nests was 22.6%. No radio-marked females initiated a third nesting attempt. Median nest initiation dates for first nests and renests were 5 May and 20 May, respectively. Hatchability of eggs in successful nests was high at 80 ± 4.1% chicks per egg.

Four of 21 broods successfully produced fledglings for an apparent brood survival rate to fledge of 19%. Within successful broods, 69% of chicks hatched successfully fledged. Of 826 potential chicks (number of first nests * average clutch size), only 24 hatched and survived to fledge. Seven of these surviving chicks were captured at 25-days old and fitted with 2-g radio-transmitters. At the time of this report, 5 of the 7 were still alive; 1 was depredated, 1 lost its transmitter and was censored.

Goals For Next Quarter

We will use the nest survival model in Program MARK to generate maximum likelihood estimates of daily nest survival. Multiple model selection and inference will be used to evaluate the importance of multiple sources of variation on daily nest survival prior to wind power development. Variables will include: nest age, nest attempt (first or renest), hen age, VOR (dm), COVER, and distances to anthropogenic features. We will calculate the expected nest survival probability by raising the daily nest survival estimate to an exponent equal to the mean incubation interval for prairie-chickens on the study site. The duration of laying and incubation periods will be determined from observations of successful nests discovered during laying, or from published values in the literature if necessary.

Systematic flush counts were used to estimate pre-fledge (0-14 days) and post-fledge (14-60 days) survival. Because broods were not be observed daily, we will use the nest survival model type in Program MARK to evaluate daily brood survival probabilities. Covariates will include hen age, a forb:grass cover index, VOR, and average home range distance to closest anthropogenic feature. Daily brood survival probabilities will be calculated using maximum likelihood estimates.

Hypothesis IV) Impacts on Breeding Habitat: ***Placement of wind-towers and related structures does not impact the habitat use of breeding greater prairie-chickens.***

Accomplishments Since Last Quarter

Radio-marked prairie-chickens were located ≥3 times/week from project trucks, an ATV, or on foot using portable radio receivers and handheld 3-element yagi antennas. Bird locations are estimated from ≥2 triangulation bearings using a maximum-likelihood estimator in program LOCATE III or flush locations were recorded with a GPS. Vegetation structure was quantified at each nest site within 3 days of hatching or failure. We recorded visual obstruction readings (VOR in dm) and non-overlapping vegetation cover (% grass, forbs, and shrub) at nests, paired random points within 200 m of the nest, and random points across the study sites as described above to assess pre-construction habitat availability at two spatial scales.

Vegetation characteristics (i.e., local habitat conditions) were measured at 96 nests and 67 paired random points. Vegetation was also quantified at 31 brood locations and 31 random paired brood points. To quantify the availability of nesting habitat on the study areas, the same data were collected at 354 random points across all 3 research units.

Goals For Next Quarter

A GPS will be used to obtain the spatial location of all anthropogenic features (roads, meteorological towers, power lines, wind towers, etc.) and habitat edges across the study areas. These locations will be uploaded to a geographic information system (GIS) and overlaid onto a land-cover map of the study areas obtained from the Kansas Applied Remote Sensing Program at Kansas University (http://www.kars.ku.edu/products/ksid/index.shtml). An additional layer containing all nest locations will be constructed and the nearest distance (m) to lek (both nearest and lek of capture), anthropogenic feature, and habitat edge will be calculated for each nest.

Hypothesis V) Impacts on Survival: ***Wind-power development does not increase mortality rates of greater prairie-chickens.***

Accomplishments Since Last Quarter

We calculated survival for samples pooled across age-classes and study sites using the program MICROMORT to get an average estimate of greater-prairie-chicken survival during the breeding and brood-rearing season in the Flint Hills prior to wind power development. This technique assumes that daily survival probability is independent among animals and is constant over time.

Ninety-nine greater prairie-chickens were monitored during 3 March – 5 October; 42 mortalities were documented. Pooled survival of radio-marked female greater prairie-chickens across all study areas was 0.493 (95% C.I. = 0.398 – 0.611) for the 215 day spring-summer season (10 March – 5 October).

Goals For Next Quarter

A complete breeding season survival analysis will be conducted in the next quarter. We will model female survival using known-fate procedures in Program MARK. We will develop candidate models using the design matrix and logit link function, and model selection will be based on minimization of AIC_c, and AIC_c weights (w_i) to determine models best supported by the data. We will include hen age (yearling, adult), body condition at capture and study site as covariates in the survival analyses. Survival ($\hat{S}$) estimates will be calculated using the model averaging procedure if the difference in AIC_c values (ΔAIC_c) between competing models is < 2.

LABORATORY BASED HYPOTHESES

Hypothesis I) Affects on breeding behavior: ***There will be no change detected in the Ne/N.***

Accomplishments Since Last Quarter

We have extracted and amplified DNA samples, at 12 microsatellite loci, from 358 individual adult prairie-chickens captured in 2007. Brining the total number of individuals sampled and amplified from 2006-2007 up to 435 individual adults. Data quality control analysis is underway to check for potential allelic dropout among homozygotes. Allelic dropout occurs when an individual is miss-labeled as a homozygote at a particular locus due to PCR failing to amplify the allele at that locus, and not due to the genetic character of the individual. In total 360 homozygote and 76 heterozygote samples, from 2006 data set, have been re-analyzed via PCR. We currently have about 25% of the 913 homozygote and 165 heterozygote samples form the 2007 data season re-analyzed. To date we have an observed allelic dropout rate of 1.48%, although that number is expected to rise slightly as we complete the re-analysis of the 2007 samples. We have also extracted and amplified DNA 12 microsatellite loci from 62 chicks captured in 2007. Despite having genotype data for 12 microsatellite loci, we have decided to reduce the number of loci being used in this analysis to 9 loci. This change in the number of loci being used in the analysis is the result of three loci being found unsuitable for use with our data set because of linkage or non conformance with Hardy Weinberg assumptions. Probability of Identity has been run on our data to determine the power of our molecular genotyping, with these nine loci, to detect differences in population genetic structure. Probability of identity (P.I.) and Probability of Identity between sibs (P.I.sibs) calculates the likelihood that our genotyping will not correctly differentiate between individuals chosen at random from a population (P.I.) or chosen from among sib groups (P.I.sibs). With the nine loci we are using for our analysis we have P.I. = 0.00001 and P.I.sibs = 0.001. Thus we feel confident that our analysis will accurately characterize Kansas Greater Prairie-Chicken genome, be statistically rigorous and biologically defensible.

Goals for Next Quarter

Next quarter we intend to complete the quality control measures for adult chickens as outlined above, and re-amplify 167 homozygous chick samples. With this information we hope to be able to have a preliminary estimate of the effective genetic population size. We also should be able to offer more robust estimates of population genetic diversity along with confidence intervals for the predevelopment aspect of this study by the end of year report.

Hypothesis II) Influence on Natal Dispersal: ***There will be no differences detected in the dispersal patterns of prairie chickens pre and post wind-power development.***

Accomplishments Since Last Quarter

Preliminary work on assessing the influence of landscape pattern genetic pattern has been initiated. Analysis using Structure 2.2 indicates that pre-construction prairie chickens living in Unit 3, in the Cloud, County, may be genetically distinct sub-population from chickens living in either of the other two research units (LN(p) -12620). Comparisons to other research units using F_{ST} indicate that this divergence is potentially a more recent evolutionary event as F_{ST} values across all units remain low ($F_{ST} = 0.011 \pm 0.005$). Landscape contagion analysis, using the four neighbor rule, indicates that the landscape surrounding unit 3 has less grassland connectivity (C= 0.29), than do the areas around unit 1 or unit 2 (C=0.90). These results were presented at the Prairie Grouse Technical Council, 2007 meeting in Chamberlain South Dakota.

Goals for Next Quarter

During the next quarter we will begin to assess levels of inter lek relatedness as a means of measuring genetic connectivity and natal dispersal of chickens both within and between research units. We also hope to look at variation in landscape composition between the three research units to determine what role the pre-construction landscape has on prairie chicken genetic diversity within and across research sites. Finally, using inter lek relatedness we hope to be able to gain genetic based estimates of maximum dispersal distance of greater prairie chickens on the Flint Hills landscape.

Table 1. Status of radio-transmitted prairie-chickens as of 12 October 2007.

Unit	Impact		Reference		Pooled	
	AA*	M	AA	M	AA	M
1	6	4	8	2	14	6
2	8	5	7	8	15	13
3	5	0	3	0	8	0
Total	19	9	18	10	37	19

* Refers to the status of the bird; AA = Alive and accounted for, M = missing