Response of Lesser Prairie-Chickens on Leks to Aerial Surveys

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ABSTRACT Aerial surveys can be used to detect and monitor lesser prairie-chicken (Tympanuchus pallidicinctus) leks, but the need exists to understand the response of lesser prairie-chickens to survey aircraft. We conducted lek surveys in Texas and New Mexico, USA, using an R-22 Beta II helicopter and R-44 Raven II helicopter. We observed the behavior of lesser prairie-chickens at 44 leks during aerial lek surveys. We observed flush responses of 38.5% (20.2–59.4%; 95% CI) and 50.0% (26.0–74.0%) from the R-22 and R-44, respectively. We found no difference in flush response between helicopter types (P = 0.326). We used logistic regression models to predict lesser prairie-chicken flush response to aerial surveys. We found that distance from the transect was the most important flush response predictor during helicopter surveys. When flushed, lesser prairie-chickens returned to the lek and resumed predisturbance behavior in 7.0/C62.6 min (mean/C695% CI). Our results suggest aerial surveys can be conducted without disruption to the lesser prairie-chicken lek dynamic. © 2011 The Wildlife Society.

KEY WORDS aerial survey, behavior, disturbance, helicopter, lek, lesser prairie-chicken, New Mexico, Texas, Tympanuchus pallidicinctus.

Received: 11 November 2010; Accepted: 1 December 2010

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Original Article

The lesser prairie-chicken (Tympanuchus pallidicinctus) is a species of conservation concern that inhabits the Southern Great Plains of Texas, New Mexico, Oklahoma, Colorado, and Kansas, USA (Hagen 2005). Lesser prairie-chickens are traditionally monitored across their range with road-based lek surveys and lek counts (Davis et al. 2008). The goal of lek surveys is to document the location of leks or estimate lek density while the goal of lek counts is to document the number of prairie grouse on a lek at a particular time. Critical weaknesses exist with road-based lek survey methods including an absence of roads in potential habitat, man-hours necessary to survey large areas, potential bias of surveying adjacent to roads, and an unknown probability of lek detection (Martin and Knopf 1981, Grensten 1987, Applegate 2000, Anderson 2001, Butler et al. 2010). Aerial lek surveys alleviate many of those weaknesses by allowing for complete coverage of a study area or a properly designed random sample of potential habitat with documented lek-detection probabilities (McRoberts et al., in press).

Before aerial lek surveys can be accepted as an applicable management practice it is necessary to consider the potential disturbances from aircraft on lesser prairie-chickens. Aerial surveys have been conducted for prairie grouse leks in the past (Eng 1954, Lehmann and Mauermann 1963, Martin and Knopf 1981, Schroeder et al. 1992, McRoberts et al. in press), yet no assessment of the impact of aerial surveys on prairie grouse has been conducted. Efroymson et al. (2001:251) identified the need, “to provide guidance for the assessment of ecological risks from low-altitude aircraft overflights” and Delaney et al. (1999) noted that predictive models explaining the relationship between aerial disturbance and quantifiable effects on wildlife were scarce in the scientific literature. The current conservation status and possibility of federal listing of lesser prairie-chickens (U.S. Fish and Wildlife Service 2008) makes an impact assessment of aerial lek surveys particularly applicable before the technique is implemented. Therefore, we assessed the disturbance from overflights and used models to quantify aerial disturbances on lekking lesser prairie-chickens. Specifically, our study objectives were to 1) assess aircraft disturbance to lesser prairie-chickens on leks, 2) identify variables that influence flush response, and 3) determine whether flush response differs between aircraft platforms.

STUDY AREA

We collected aerial response data in Hemphill and Yoakum counties, Texas and in Chaves and Roosevelt counties, New Mexico, USA. The Hemphill County site (5,007 ha) was a short–mixed-grass prairie ecosystem with little bluestem (Schizachyrium scoparium) and sand sagebrush (Artemisia
filifolia) as predominant species. The Yoakum County site (2,905 ha) was a sand dune ecosystem with shinnery oak (Quercus havardii) and little bluestem as predominant species. The sites in Chaves (3,961 ha) and Roosevelt (3,444 ha) counties had vegetative communities similar to those of the Yoakum County site. Additional description of study areas can be found in McRoberts (2009).

METHODS

Aerial Surveys
We conducted aerial transect surveys for lesser prairie-chicken leks during the spring of 2007–2009 using an R-22 Beta II helicopter and R-44 Raven II helicopter (Robinson Helicopter Company, Torrance, CA; hereon R-22 and R-44). Transects were separated by 400 m, flown at an altitude of 15 m with target flight speeds of 60 km/hr for both helicopters. New transects were created for each survey. We began surveys at sunrise and concluded surveys no later than 2.5 hr postsunrise.

Response Monitoring
We observed lesser prairie-chicken response to aerial surveys by conducting ground-based lek observations concurrent with aerial surveys. We used flushing as our measure of lesser prairie-chicken response to aerial surveys. We used a binary variable classification (i.e., lek flushed or did not flush) because single birds within a flock usually responded as a flock (Belanger and Bedard 1989, Ward et al. 1994). We positioned lek observers near leks in either a blind or vehicle. Observation points ranged from 35 m to 200 m from the core area of the lek, depending on the characteristics and visibility of the lek. We arrived prior to sunrise and approached the observation point cautiously to prevent flushing when birds were already on the lek. We recorded the number of male and female lesser prairie-chickens on the lek at 5-min intervals. During the 5-min interval, we recorded behavior such as strutting–displaying, face-offs, fighting, stationary-loafing, stationary-alert, feeding, and copulations. By noting behavior prior to aircraft presence, we determined the time span from aerial disruption to recommencement of lekking behavior, if a flush response occurred. If lesser prairie-chickens flushed from the lek as a result of the aerial survey, we noted the time of the flush. We monitored the lek ≥1 hr after disturbance to quantify elapsed time until lesser prairie-chickens returned to the lek and resumed normal lekking behavior, or to determine whether lesser prairie-chickens did not return during the 1-hr monitoring period.

Data Analysis
We monitored known lek locations and calculated perpendicular distance from the center of the lek to the aerial transect line using the minimum–distance function in ArcGIS® 9.2 (Environmental Systems Research Institute, Inc., Redlands, CA). We generated a standardized survey date value by assigning the day of our earliest survey date, 8 March, as standardized date value 0 and consecutively numbered until our latest survey date, 17 May, which received a value of 70. The standardized date allowed us to include a comparable date value for surveys conducted in different years. We used Fisher’s exact test (Conover 1999) and a 2-sample t-test (Zar 1999) to compare flush response and return interval between helicopter platforms because of potential response variability due to the size difference of the R-22 and R-44 (length of 8.8 and 11.7 m, respectively; C. Sennett, Robinson Helicopter Co., personal communication).

We created predictive flush models using logistic regression (Hosmer and Lemeshow 2000) to model the probability of a lek flushing due to disturbance from aerial surveys. The response variable for flushing was a binary variable where 1 was flushed and 0 was not flushed. We created and evaluated 7 a priori candidate models using aircraft platform, distance to lek, and survey date as covariates. We used the second-order Akaike’s Information Criterion weights to determine the predictive accuracy of models (Burnham and Anderson 2002, Forster and Sober 2004, Anderson 2008). We evaluated the goodness-of-fit of the most parameterized model using the Hosmer–Lemeshow test (Hosmer and Lemeshow 2000). Each individual lek response was considered a unique sample.

We classified observations in 1 of 4 categories in a manner similar to that used by Krausman and Hervert (1983) to classify the response of mountain sheep (Ovis canadensis mexicana) to aerial surveys, and Andersen et al. (1989) to classify red-tailed hawk (Buteo jamaicensis) response to helicopter overflights. We classified lesser prairie-chickens as “no response” to aerial surveys if lesser prairie-chickens did not flush. We classified lesser prairie-chickens that flushed, with subsequent return, as “flush with return.” We classified lesser prairie-chickens that flushed and did not return within 1 hr as “flush with no return,” whereas lesser prairie-chickens that flushed and permanently abandoned the lek were classified as “lek abandoned.” We classified lek responses in this manner to draw inferences on rates of different disturbance responses between aircraft platforms and compare the average return time if lesser prairie-chickens flushed and returned to the lek.

RESULTS

We recorded 44 ground-based lek observations during our survey periods of 8 March 2007–17 May 2007, 12 March 2008–10 May 2008, and 3 April 2009; 26 in response to the R-22 and 18 in response to the R-44. We never observed lesser prairie-chickens walking–running from a lek in response to approaching aircraft. If lesser prairie-chickens flushed, they typically flushed as the aircraft approached, or when the aircraft was perpendicular to the lek. We observed lesser prairie-chickens flushing after the aircraft passed the lek on one occasion.

We observed lesser prairie-chickens flushing on 10 of 26 observations (38.5% [20.2–59.4%]) when surveys were conducted with the R-22 and on 9 of 18 observations (50.0% [26.0–74.0%]) when surveys were conducted with the R-44. Flush response was similar between helicopters (P = 0.326; Fisher’s exact test). We observed that lesser prairie-chickens flushed and returned to the lek on 14 occasions with an average return time of 7.0 ± 2.6 min (mean ± 95%
We found no difference (SE = 2.698, $t = 0.847$, df = 12, $P = 0.413$) between average return time when flushed by a R-22 (8.14 min, SE = 2.41) or a R-44 (5.86 min, SE = 1.20). We observed that lesser prairie-chickens flushed from the lek and did not return within the 1-hr postflush monitoring window on 5 occasions (R-22, $n = 3$; R-44, $n = 2$). However, all of these leks remained active through the lekking season. We did not observe a single instance of lesser prairie-chickens permanently abandoning a lek as a result of aerial surveys.

The most parameterized model fit the data ($\chi^2 = 1.480$, df = 8, $P = 0.993$) and our modeling exercise resulted in 3 competitive models (Table 1). The model incorporating distance had the most predictive ability ($w_i = 0.326$). This model showed that with every 1-m increase in distance from the transect line to the center of the lek there was a 0.9% decrease in probability of lesser prairie-chickens flushing (odds ratio = 0.99; Wald Statistic $[W] = 3.661$, df = 1, $P = 0.056$). Our model including distance and survey date, the second competitive model ($w_i = 0.182$), showed that with every 1-m increase in distance there was a 0.9% decrease in probability of lesser prairie-chickens flushing (odds ratio = 0.99; $W = 2.604$, df = 1, $P = 0.107$) and that as standard survey date increased by 1 day there was a 2.2% decrease in probability of lesser prairie-chickens flushing (odds ratio = 0.98; $W = 1.112$, df = 1, $P = 0.292$). Our third competitive model ($w_i = 0.145$) contained survey date and suggested that as standard survey date increased by 1 day there was a 3.0% decrease in probability of lesser prairie-chickens flushing (odds ratio = 0.97; $W = 2.258$, df = 1, $P = 0.133$). These models indicated that lesser prairie-chickens were less likely to flush as distance from the transect to the lek increased and as the spring lekking season progressed. Our fourth model ($w_i = 0.138$) contained helicopter platform and distance, and initially appeared competitive. However, the effect of platform in the model is likely spurious because the $-2 \log$-likelihood changes <0.6 when compared to the distance model (Table 1).

**DISCUSSION**

We concluded that aerial survey disturbance did not negatively impact lesser prairie-chickens. Although no leks were abandoned during our survey period, we did observe 5 occasions when lesser prairie-chickens flushed from a lek and did not return within our 1-hr postdisturbance monitoring window. These are the most troubling data because of possible missed reproductive opportunities; however, 4 of these flushes occurred outside the timeframe of peak daily lek attendance of males (i.e., 105 min after sunrise; Crawford and Bolen 1975) and 4 occurred outside the period of peak female lek attendance (i.e., second and third weeks of April; Hagen 2005).

Distance from the lek to the transect was the most important predictor within our helicopter flush-response models. As distance increased, we observed a decrease in flushing frequency. We are unable to compare this conclusion to other species of prairie grouse, but Ward et al. (1999) reached the same conclusion when modeling the response of geese (*Branta* spp.) and Delaney et al. (1999) found that as helicopter stimulus distance decreased, Mexican spotted owls (*Strix occidentalis lucida*) flush frequency increased.

We found that flush response decreased as our study progressed each spring and offer 2 explanations for the decrease in flush response through our monitoring period. The first, and what we consider more likely, is that as female lek attendance peaks during mid-April (Crawford and Bolen 1975, Hagen 2005), the resulting increase in intensity of displaying activity among males (Hagen 2005) causes fewer flush responses because of heightened interest in breeding. However, it is important to note that our surveys were completed toward the end of lekking season. If we continued to fly surveys and monitor lesser prairie-chicken response into June, we may find that flushing response increases as lekking intensity decreases at the end of the lekking season. Therefore, our conclusion that flush responses decrease with later survey date should be taken in the context of our monitoring period of mid-March to mid-May. Martin and Knopf (1981) noticed a similar pattern of greater prairie-chickens (*Tympanuchus cupido*) tending not to flush in response to aircraft as spring progressed.

The second hypothesis to explain the decreased flush response through our monitoring period was that lesser prairie-chickens habituate to aircraft disturbance. Avian species have been documented to habituate to aircraft over time (Andersen et al. 1989, Conomy et al. 1998). We do not feel this was the reason lesser prairie-chickens did not flush

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**Table 1.** Ranking of candidate logistic regression models predicting flush response from helicopter surveys for lesser prairie-chickens in Texas and New Mexico, USA, 2007–2009. For each logistic regression model, we give $-2 \times \log$-likelihood ($-2LL$), number of parameters ($K$), second-order Akaike’s Information Criterion (AIC$_c$), difference in AIC, compared to lowest AIC, of the model set ($\Delta_i$), and AIC weight ($w_i$; $n = 44$).

<table>
<thead>
<tr>
<th>Model*</th>
<th>$-2LL$</th>
<th>$K$</th>
<th>AIC$_c$</th>
<th>$\Delta_i$</th>
<th>$w_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIST</td>
<td>56.177</td>
<td>2</td>
<td>60.470</td>
<td>0.000</td>
<td>0.326</td>
</tr>
<tr>
<td>DIST + DATE</td>
<td>55.036</td>
<td>3</td>
<td>61.636</td>
<td>1.166</td>
<td>0.182</td>
</tr>
<tr>
<td>DATE</td>
<td>57.799</td>
<td>2</td>
<td>62.091</td>
<td>1.622</td>
<td>0.145</td>
</tr>
<tr>
<td>PLAT + DIST$^b$</td>
<td>55.595</td>
<td>3</td>
<td>62.195</td>
<td>1.725</td>
<td>0.138</td>
</tr>
<tr>
<td>PLAT + DATE + DIST</td>
<td>54.245</td>
<td>4</td>
<td>63.270</td>
<td>2.800</td>
<td>0.080</td>
</tr>
<tr>
<td>PLAT + DATE</td>
<td>56.931</td>
<td>3</td>
<td>63.351</td>
<td>3.061</td>
<td>0.071</td>
</tr>
<tr>
<td>PLAT</td>
<td>59.600</td>
<td>2</td>
<td>63.892</td>
<td>3.423</td>
<td>0.059</td>
</tr>
</tbody>
</table>

* DIST = perpendicular distance from transect to lek, DATE = standardized survey date of aerial survey, PLAT = aircraft platform (R-44 = 1, R-22 = 0).

$^b$ The effect of PLAT is likely spurious because the $-2LL$ of the PLAT + DIST model changes <0.6 when compared to the DIST model.
from leks. We applied our methodology to 2 new areas that had not been exposed to aircraft disturbance and these surveys coincided with periods of high lekking activity. During these surveys we detected leks from the air, yet ground observers did not observe a flush response from lesser prairie-chickens on leks. Pelletier and Krebs (1998) found that ptarmigan (*Lagopus* spp.) did not appear to habituate to aerial surveys. We believe these observations support the explanation that flush response was more greatly dependent on lekking activity rather than habituation.

We found no difference in flush response between the 2 helicopter platforms in flush response or the elapsed time for lesser prairie-chickens to resume lekking behavior if flushed from a lek. This is likely explained by the similar flyover sound intensity of the R-44 and the R-22, measured at 81.9 and 81.3 dB, respectively (C. Sennett, personal communication). Although length of the R-44 is greater than the R-22 (11.7 and 8.8 m, respectively; C. Sennett, personal communication), the difference does not appear to affect flushing.

Martin and Knopf (1981) noted that greater prairie-chickens flushed from surveys flown in a Cessna 172 fixed-wing aircraft at an altitude of 25–50 m. We observed 5 responses of lekking lesser prairie-chickens to aerial surveys conducted from a Cessna 172 surveys flown at 50 m and did not observe flushing on any occasion. Our observations are limited and further research would be needed to document flush response from fixed-wing aircraft. Lehmann and Maurer (1963) found that Attwater’s prairie-chickens (*T. c. pinnatus*) showed less response to helicopters than from an airplane, and also observed that lek courtship activity and feeding often continued uninterrupted when the helicopter was in close proximity. We are unaware of the flight parameters they implemented, but their conclusions support those of Martin and Knopf (1981) that prairie grouse respond to fixed-wing aircraft, and support our conclusion that helicopter surveys are not detrimental to the lekking system.

**MANAGEMENT IMPLICATIONS**

Our findings suggest that helicopter lek surveys separated by 400 m and flown at an altitude of 15 m can be used as a management tool during the spring lekking season without adverse effects on lesser prairie-chickens. If managers want to minimize flush responses during aerial surveys we suggest widening transects; however, data indicate transects spaced 400 m apart will not harm lekking activity. We also suggest waiting until the weeks of peak lekking activity to conduct surveys if managers hope to reduce flushing. We found that flushing decreased through the lekking season, a conclusion supported by other studies. Our recommendations are specific to the aircraft platforms used in this study. If other aircraft platforms are used to conduct surveys, investigators will need to monitor lesser prairie-chicken behavior in response to other platforms not evaluated by our study.

**ACKNOWLEDGMENTS**

We thank J. Bonner, D. Lucia, D. Wright, and D. Holdstock, Texas Parks and Wildlife Department (TPWD), for their commitment to the success of this project. We also thank V. Bevill and R. Roegner, TPWD, for their support in project funding by the Federal Aid in Wildlife Restoration Act under Pittman–Robertson project W-126–R. J. Hughes, U.S. Fish and Wildlife Service, P. McDaniel, The Nature Conservancy, and E. Jaquez and T. Allen, U.S. Bureau of Land Management, were of great assistance in logistical support during this study. We thank technicians E. Bruns and L. (Rucker) Parks for their hard work, and thank R. Herbert, S. Rode, and A. Teague for conducting ground observations. We are grateful to the private landowners of Texas and New Mexico for allowing us to monitor leks on their property. We also thank Texas Tech University Department of Natural Resources Management graduate and undergraduate students for volunteering for project field work. Financial support from the Dr. Donald and Samantha Bricker Foundation and the Houston Safari Club was greatly appreciated.

**LITERATURE CITED**


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Special Editor: Paul Krausman.