Final Report

New Mexico Lesser Prairie-Chicken Project 2001

Effects of Shrub Control and Grazing on Lesser Prairie-Chicken Reproductive Success, Year 1

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EXECUTIVE SUMMARY

1. An important feature of the Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) habitat in eastern New Mexico is the presence of extensive areas of shinnery oak. It is thought by some that the oak has become more widespread and more dense in the past century. There has been concern that these changes in shinnery oak cover may have reduced grass cover, and that in turn could affect Lesser Prairie-Chickens detrimentally. Therefore, use of an herbicide, tebuthiuron (brand name "Spike"®) is being considered to reduce the amount of shinnery oak and manage the habitat for Lesser Prairie-Chickens. This idea has been controversial.
2. In Spring 2001 we studied the Lesser Prairie-Chicken in Roosevelt County, eastern New Mexico. Our objectives were to compare plots under two treatments (treated with tebuthiuron vs. not treated with tebuthiuron) with regards to prairie-chicken habitat use, nest success, and adult mortality. We were to describe habitat used by the birds with regard to plant species composition, grass density and height, ground cover, and shinnery oak cover and density. We also were to characterize the breeding-season habitat use of the prairie-chickens, and examine differences in movements and home range sizes between sexes.
3. We made 96 total captures (including recaptures), of 77 individual birds (including one trapping mortality).
4. We tracked a total of 101 individuals, including seven originally captured in 1999 and 24 originally captured in 2000.
5. Vegetation was measured and characterized at 77 random points and at 168 prairie-chicken vegetation location points during the breeding season, from 13 May to 23 June 2001.
6. Annual survivorship was 25% – 59%.
7. We located 18 nests in 2001. Ten of these were successful, with a Mayfield nest success probability of 50.2%.
8. Nest success did not differ between the tebuthiuron-treated areas of the Weaver Ranch and untreated areas on North Bluitt PCA.
9. Prairie-chicken hens generally selected areas for nesting that had less shinnery oak but greater tallgrass canopy cover, less basal cover by shortgrass and other woody plant species, a greater maximum vegetation height, greater number of shinnery oak and other woody plant species stems than did random non-nest sites.
10. Successful and unsuccessful nests did not differ statistically significantly in any vegetation character, although unsuccessful nests tended to have greater shortgrass basal cover and greater vegetation density in the lower level.
11. At non-nest non-lek locations prairie-chickens selected areas with greater amounts of sand sagebrush and shortgrass canopy cover than was found in the area in general, and with greater vegetation density in the middle level. They chose areas with less basal cover by shortgrass and other species.
12. Although there were slight differences in the North Bluitt PCA and Weaver Ranch, these differences did not appear to translate to effects on the prairie-chickens. The tebuthiuron treatment probably did not affect the habitat greatly in the nesting season of 2001.
13. Conclusions can be seen on Page 58.

INTRODUCTION

Lesser Prairie-Chickens (*Tympanuchus pallidicinctus*) occur in shinnery oak (*Quercus havardii*) grasslands and sand sagebrush (*Artemisia filifolia*) grasslands of western Texas, northwestern Oklahoma, eastern New Mexico, southwestern Kansas, and southeastern Colorado. Like many other species of prairie grouse, the prairie-chicken has experienced considerable declines in both occupied range and population density in recent years. In 1995, the U.S. Fish and Wildlife Service (USFWS) received a petition to list Lesser Prairie-Chickens as Threatened under the Endangered Species Act. Nearly three years after that date, in June 1998 the USFWS declared the species to be "warranted but precluded" from listing. This finding means that the species becomes a candidate for future listing and that its status must be re-evaluated annually.

Prior to the beginning of the 20th century, it was estimated that as many as two million Lesser Prairie-Chickens occurred in the Texas Panhandle (Litton 1978). Taylor and Guthery (1980) claimed that range-wide distribution decreased by 78% between 1963 and 1980. Both the occupied range and population size has continued to decline since that time (e.g. Oklahoma Department of Wildlife Conservation data indicate an 87% decline in Oklahoma from 1982 through 2001).

Past efforts in saving declining forms of other prairie-chickens have met with little success. The best conservation strategies known during the latter half of the 19th century and early part of the 20th century were practiced with the Heath Hen (*Tympanuchus cupido cupido*), but in spite of these efforts, this eastern prairie-chicken became extinct in 1932. The same scenario is being played out in southern Texas today with the Attwater's Prairie-Chicken (*Tympanuchus cupido attwateri*), where fewer than 50 birds remain in the wild.

Factors responsible for declines in Lesser Prairie-Chickens may vary between locations, but it is expected that at least some of those factors may be consistent across sites as well. Some of the factors seem obvious, such as extended periods of drought and wide-scale conversion of prairies into cultivated fields. However, smaller agricultural areas (milo, beans, or winter wheat, for example) interspersed within native grasslands may provide food sources that could benefit the species. Subtle changes in plant composition in native prairies may be altering the availability of nesting or roosting habitat or food supplies.

George M. Sutton Avian Research Center (GMSARC) staff became involved with Greater Prairie-Chicken (*Tympanuchus cupido pinnatus*) research in Osage County, northeastern Oklahoma in 1997, after it was realized that Greater Prairie-Chickens were also experiencing significant declines in many parts of their range. It was clear that the trapping and radio tracking techniques used and perfected by GMSARC in the study of the Greater Prairie-Chicken could be easily modified and applied to Lesser Prairie-Chicken research. In 1999, funding became available from the Western Governor's Association, USFWS, and private sources to begin research on Lesser Prairie-Chickens in Beaver, Ellis, and Harper counties, northwestern Oklahoma, and Roosevelt County, southeastern New Mexico. Mr. Jim Weaver, former Peregrine Fund biologist, Lesser Prairie-Chicken Interstate Working Group participant, and rancher in New Mexico volunteered his property for research in New Mexico by GMSARC. This research was fully endorsed and encouraged by the Lesser Prairie-Chicken Interstate Working Group, the Western Governor's Association, and the USFWS. After the first year of trapping and radio tracking, the New Mexico Department of Game and Fish (NMDG&F) contracted with GMSARC to further the research efforts, especially to assess the current management of New Mexico Game Commission prairie-chicken management areas in Roosevelt County. That work culminated in a report produced in October 2000 (Sutton Avian Research Center 2000).

We began trapping and radioing Lesser Prairie-Chickens in Roosevelt County, New Mexico, in April 1999, and have now captured and radio tagged 160 birds there. In spring 2001 we began a study of the effects on Lesser Prairie-Chicken nesting of shinnery oak control using the herbicide tebuthiuron.

PROBLEM

An important feature of the Lesser Prairie-Chicken habitat in eastern New Mexico is the presence of extensive areas of shinnery oak. Although shinnery oak is a native species, it is thought by some that the oak has become more widespread and, especially, more dense in the past century, when plowing of the land and subsequent wind erosion reduced grass cover and allowed the shinnery oak to become more dominant. There has been concern that these perceived changes in shinnery oak cover may have reduced grass cover, and that in turn could affect Lesser Prairie-Chickens detrimentally in a variety of ways. Therefore, use of an herbicide, tebuthiuron (brand name "Spike"®) is being considered to reduce the amount of shinnery oak and manage the habitat for Lesser Prairie-Chickens. This idea has been controversial.

It has been shown in Oklahoma that Lesser Prairie-Chicken numbers can be negatively correlated to shinnery oak canopy cover (Cannon and Knopf 1981). It is also known that Lesser Prairie-Chickens require some broad-leaved plants in their environment, as sources of food and cover (for example, see Doerr and Guthery 1980). Except at high application levels, tebuthiuron treatment does not decrease forb cover, although it clearly will reduce acorn and gall supplies (Doerr and Guthery 1983), both of which can be food items for Lesser Prairie-Chickens. The birds also require grass cover, which may provide some of the same resources. Use of tebuthiuron can also increase plant diversity (Olson et al. 1994), and this may increase supplies of food plants and cover. However, Olawsky and Smith (1991) found no difference in prairie-chicken numbers between tebuthiuron-treated and untreated areas five years after the treatment. What is controversial about use of tebuthiuron for Lesser Prairie-Chicken management, however, is what amount of shrub cover is necessary and what is detrimental.

In fall 2000 Jim Weaver began an experiment, in coordination with the New Mexico Department of Game and Fish but also with the help of the Natural Resources Conservation Service and U. S. Fish and Wildlife Service, to reduce the cover of shinnery oak on the Weaver Ranch, and thereby to increase the grass cover. This reduction was to be carried out through application of tebuthiuron.

An important part of that experiment is monitoring the effects on prairie-chickens, as well as other organisms, including other species of birds, mammals, reptiles, insects, and the effects of the vegetation changes (including seed crop changes) caused by reduction of the shinnery oak. A set of 16 study plots was set up by Dr. Charles Dixon in fall 2000 to obtain baseline data, and will be monitored through the next ten years. Although Dixon is monitoring many organisms on the study plots, a major interest by all parties involved, including Jim Weaver, New Mexico Department of Game and Fish, and the Sutton Avian Research Center, has been how the Lesser Prairie-Chickens respond to the reduction of shinnery oak and the concomitant changes that will produce.

It is to address these questions that we have been monitoring Lesser Prairie-Chicken use of the plots for general habitat uses (foraging, roosting, etc.) and nesting. It is on these plots that we focus the majority of this report.

OBJECTIVES

The original objectives for this study were to include consideration of the effects of grazing on Lesser Prairie-Chickens. However, because fencing was not in place to control grazing on a portion of the study area (North Bluitt Prairie-Chicken Area), the grazing treatments were not carried out for this study. (Note that control of grazing was not a portion of the contract with Sutton Avian Research Center that produced this report. Control of grazing on North Bluitt Prairie-Chicken Area was the responsibility of New Mexico Department of Game and Fish. Due to various permitting problems, NMDG&F was not able to build the needed fences and to control grazing on the North Bluitt Prairie-Chicken Area.)

Because the grazing treatments were not available, the objectives have been modified to ignore the effects of grazing. The objectives for this study therefore are:

Compare plots under two treatments (treated with tebuthiuron vs. not treated with tebuthiuron) with regards to Lesser Prairie-Chicken habitat use, nest success, and adult mortality.

Null hypotheses:

- H_o: Use of habitat by prairie-chicken adults is equal among treatments.
- H_o: Prairie-chicken nest success is equal among treatments.
- H_o: Prairie-chicken adult mortality is equal among treatments.

Describe habitat used by the prairie-chickens with regard to plant species composition, grass density and height, ground cover, and shinnery oak cover and density. We will characterize the breeding-season habitat use of the prairie-chickens, and examine differences in movements and home range sizes between sexes.

Note however that the results of this study in 2001 may not be of general use in comparing the effects of tebuthiuron treatment of shinnery oak. See section below (Page 12) on warning about results of this study.

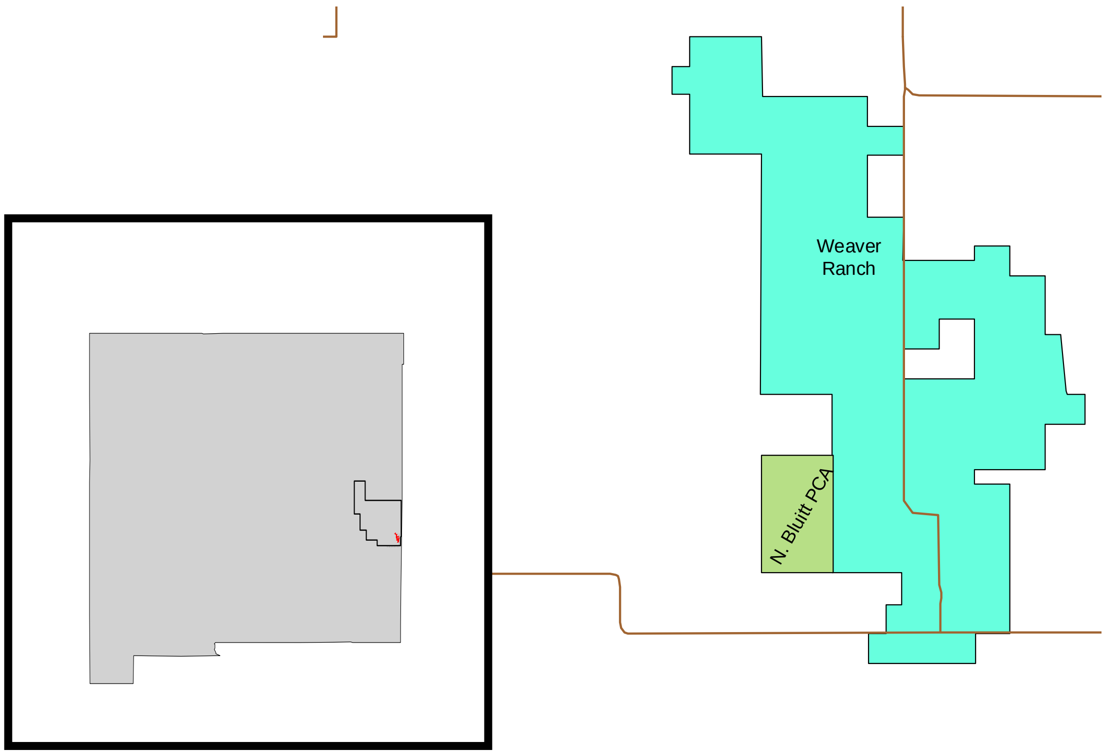
METHODS

Study Area

Our study area includes about 52,000 ha (200 mi^2) in southeastern Roosevelt County, New Mexico, although this report will focus on a much smaller area of about 16,500 ha (64 mi^2) centered at the north end of the North Bluitt Prairie-Chicken Area ("Prairie-Chicken Area" will hereinafter be abbreviated PCA). Most of the land is privately owned. However, the New Mexico Game Commission owns several prairie-chicken management areas, which comprise about 3700 ha of our study area. These include the Milnesand, North Bluitt, and South Bluitt PCAs.

The study area is located on the western edge of the Llano Estacado, and is characterized by sandy soils on top of caliche bedrock, sand dunes and associated blowouts, and scattered playas (which make up the only surface water). The dominant vegetation is shinnery oak, which mostly occurs in the clonal shrub form, although a few hybrid mottes can be found reaching a height of about three to four meters. Other common woody vegetation includes sand sagebrush, honey mesquite (*Prosopis glandulosa*), cholla (*Opuntia imbricata*), broom snakeweed (*Gutierrezia sarothrae*), and yucca (*Yucca* spp.). Common grasses include sand bluestem (*Andropogon hallii*), silver bluestem (*Bothriochloa laguroides*), little bluestem (*Schizachyrium scoparium*), dropseeds (*Sporobolus* spp.), grama grasses (*Bouteloua* spp.), and buffalo grass (*Buchloe dactyloides*). Peterson and Boyd (1998) give a comprehensive list of other plants associated with shinnery oak communities.

Fig. 1. Study area, south of Causey, New Mexico. The Weaver Ranch is the aquamarine area, and the darker green indicates the approximate boundaries of the North Bluitt PCA. The remainder of the area is composed of other private ranches. The inset shows New Mexico and the location of Roosevelt County, and the small red area within the county marks the Weaver Ranch.



Although most of the land area is native shinnery oak / mixed grass prairie or reclaimed agricultural lands, some (<10%) is currently under cultivation, primarily in cotton production. Past and present oil production accounts for about 5% of the land area, being caliche oil pads, and caliche, limestone, or dirt roads. A few brine scars can also be found near active or old oil wells, but the rarity and small size of these scars amount to an insignificant portion of the land area.

Tebuthiuron Treatment Study Plots

Tebuthiuron (0.6 lbs active ingredient per acre; 0.67 kg / ha) was applied to the portions of the study area (including the tebuthiuron study plots—see below) in late October to early November 2000. The study of the effects of the tebuthiuron treatment will be ongoing for four to ten years. However, because Spring 2001 was the first growing season after the treatment was applied, significant effects may be expected in this first year (see warning, below, page 12). This would include die-off of the shinnery oak and possibly a large increase in grass cover.

The plots on which tebuthiuron was applied and the control plots to which they will be compared will be referred to in this report as the "tebuthiuron study plots" or the "tebuthiuron study area." The tebuthiuron study plots were established by Charles Dixon of Wildlife Plus, who is monitoring vegetational changes. Each plot is one-quarter section (0.25 mi^2 or 64.7 ha). Although the Sutton Avian Research Center general study area includes much land outside of those plots, much of the focus of this report will be specifically on comparisons of the tebuthiuron study plots.

In the long-term design of the tebuthiuron study there are four treatments with four replicates each, producing 16 study plots. These treatments are tebuthiuron-treated / grazed; tebuthiuron-treated / ungrazed; untreated / grazed; and untreated / ungrazed. The layout of the plots can be seen in Figs. 2 and 3. However, please note that in 2001 all plots were ungrazed. Therefore, only two treatments will be considered in this report: tebuthiuron-treated and untreated.

The plots are identified using a three-character code. The first character is B (North Bluitt PCA) or W (Weaver Ranch). All plots treated with tebuthiuron are on the Weaver Ranch and no plots on the North Bluitt PCA were treated, so B plots are all untreated and W plots are all treated. The second character indicates whether a plot is to be grazed (G) or not (N), although in 2001 all plots were ungrazed. The third character is the replicate number, 1-4. The table below shows which plots are in each treatment.

Table 1. Tebuthiuron study treatment plot identifier codes. For locations of these plots see Fig. 3. Keep in mind that in 2001 all plots were ungrazed.

	Grazed	Ungrazed
Tebuthiuron-treated (W)	WG1, WG2, WG3, WG4	WN1, WN2, WN3, WN4
Untreated (B)	BG1, BG2, BG3, BG4	BN1, BN2, BN3, BN4

Fig. 2. Tebuthiuron study plots established by Charles Dixon. The plots in solid gray are those on the North Bluitt PCA, and were not treated with tebuthiuron, but are planned to have various grazing regimes (although in the period covered by this report, none were grazed). Plots in beige are on the Weaver Ranch and were treated with tebuthiuron, but were also ungrazed in 2001.

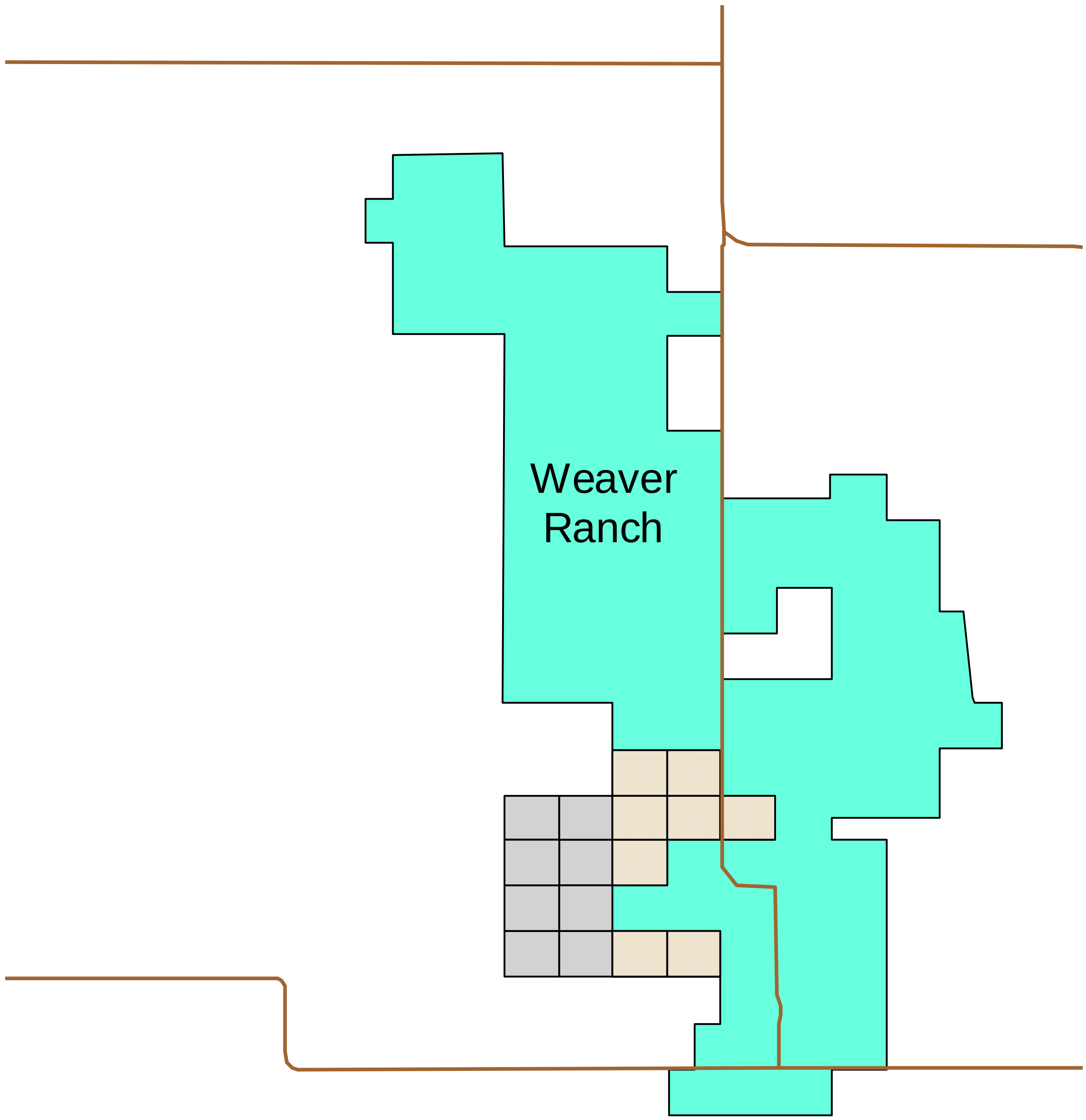
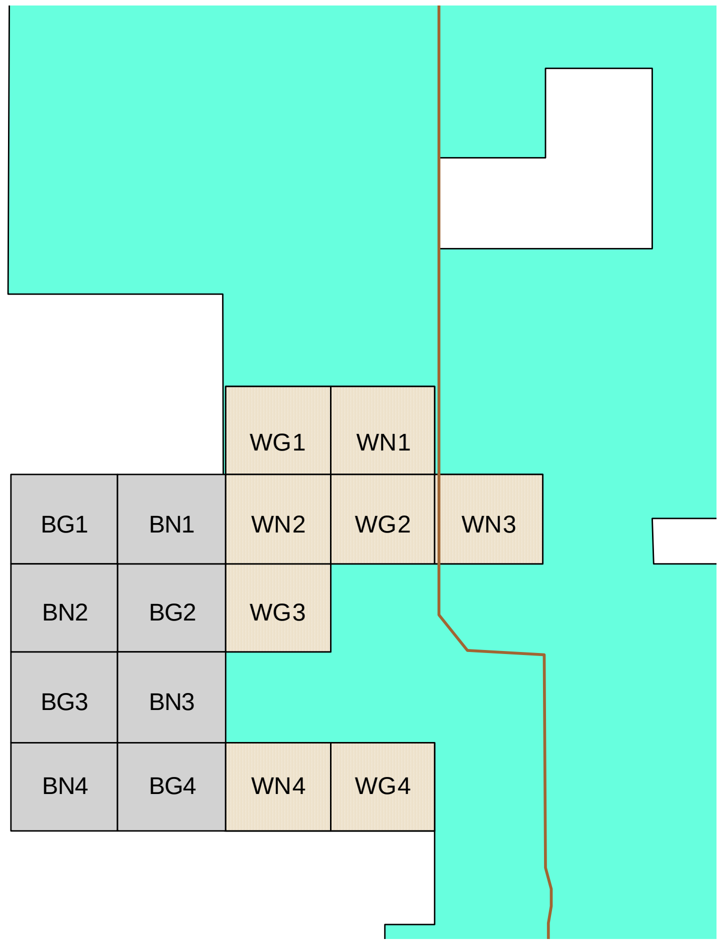


Fig. 3. Tebuthiuron study plots, showing plot identification numbers. See text for explanation of codes. As in Fig. 2, the plots in solid gray are those on the North Bluitt PCA, and were not treated with tebuthiuron, but are planned to have various grazing regimes in future years. Plots in beige are on the Weaver Ranch and were treated with tebuthiuron. No plots were grazed in 2001.



Warning: Tebuthiuron and Grazing Treatments, 2001

Please note some important warnings as to the generality of the results of this study in 2001.

Doerr and Guthery (1983) showed that there was little effect of tebuthiuron treatment at levels below 0.8 kg / ha on vertical structure and density of vegetation even at four to five months after application and most of a growing season. Although the tebuthiuron was applied at the current study site in late October to early November 2000, the herbicide did not affect the woody plants, primarily shinnery oak, until the growing season of 2001, beginning in May 2001. Data were collected for this study beginning in March 2001. *Therefore, most of the tebuthiuron application did not begin to affect the habitat until late in the period of the current study. This may have resulted in non-*

representative results for this study in 2001. For example, a prairie-chicken hen may have chosen her nest site in April or early May 2001, before the effects of the tebuthiuron treatment began to be apparent. Therefore, she may have chosen a nesting site that was suitable at the time she chose it, but which later became unsuitable through defoliation as the tebuthiuron treatment became apparent.

Not only were the effects of the tebuthiuron treatment not apparent during all of our study, but also it should be kept in mind that the effects did gradually become apparent through the season. Therefore, please note that the effects of the treatment may have made a significant difference on our results (especially of vegetation measurements) taken later in the season, in late May and June.

In addition, because required fencing that was not in place by early 2001, the grazing treatments on the North Bluitt PCA and Weaver Ranch were not carried out. *All plots on the North Bluitt PCA and Weaver Ranch were therefore non-grazed in 2001*, although the long-term study design calls for eight plots (BG1 through BG4 and WG1 through WG4) to be grazed.

Because of these effects, results of this report may be non-representative of results in the future, a period when the tebuthiuron treatments have been in effect for more than one year, and when the grazing treatments are fully in place.

Trapping

We trapped birds on their gobbling grounds in spring 1999, fall 1999, spring 2000, and spring 2001. In spring 2001 trapping was focused on leks within 4 km (2.5 mi) of the center of the North Bluitt PCA, so that most birds trapped and radio-tagged could presumably have access to the tebuthiuron study plots and might be expected to use those plots (whether controls or treated plots).

Trapping was accomplished by using a series of walk-in funnel traps connected by 8 m (25 foot) lengths of plastic drift fence in a large “W” array. Anywhere from seven to 20 traps were used on each gobbling ground, depending on the gobbling ground size and trap availability. Traps were constructed from 2x4 inch (5x10 cm), 12.5-gauge welded wire, are 122 cm (48 inches) in diameter and 71 cm (28 inches) tall, and have four funnel openings. Nylon netting is stretched tight across the trap at a height of 41 cm (16 inches). The traps also have a welded wire top, and the 30 cm between the top and the net keeps the birds from injuring themselves on the top of the trap, as well as offers protection from above in the unlikely case of a raptor attempting to catch a bird inside a trap. All cut wire ends were filed smooth to prevent birds cutting themselves, and traps were inspected daily for broken welds, loose wires, etc. Traps were never left unattended when they were set for catching birds. When trapping ceased each day, at least two access doors on the traps were wired open to allow for an exit if a bird entered a trap when we were not present.

Once one bird was inside a trap, a second or third bird was likely to get caught in the same trap. So, to facilitate further trapping we would leave birds in traps for up to an hour or so. We would continue to observe the bird, and were ready to intervene immediately if the bird seemed stressed, hurt, or was fighting with a second bird. Birds were removed by opening one or two of the access doors, and reaching in and grabbing the bird by hand. The handler would immediately place an infant-sized sock over the bird's head to keep it calm, and place it in a large cotton bird bag. If three or more birds were caught in a trapping session, they were placed in wooden holding boxes to keep them calm and cool until they could be processed.

Processing consisted of weighing the bird to the nearest 10 g while still in the bag (the empty bag was weighed after the bird was removed, and that weight subtracted from the first to get the bird's weight). We then measured the wing chord length and tail length. We also measured the diameters of the shafts of primaries 8 and 9, which were used to calculate the bird's age (other aging methods were used as well, including the shape of the primaries and relative wear on the primary tips). All birds were fitted with a 7/16 inch (11 mm) diameter, serially-numbered aluminum band to allow for positive identification when recaptured or recovered. About 1 cc of blood was taken with a syringe from the ulnar vein to be used for genetic analyses and for survey of possible retroviruses, and the bird was examined for the presence of ectoparasites (lice and ticks)[1].

Birds were then fitted with a 15 g bib-mounted radio transmitter with a loop antenna. These transmitters weighed ≤2% of the bird's weight. The transmitters were custom-made to our specifications by Telemetry Solutions, Inc. and Wildlife Materials, Inc. The loop antenna is believed to be safer for the bird than the more commonly used whip antennas, which are suspected to cause higher mortality due to flight feather abrasion. The bib-mount is also thought to be safer than the more common ligature devices used on most necklace-mounted transmitters, as there is no possibility of attaching it too tightly. The bib material is made of brown-colored 19 oz. vinyl-coated nylon, and the transmitter itself is attached to the bib with cyanoacrylate cement and monofilament. The transmitters were attached to the birds by cutting a small hole (about 1 cm diameter) in the bib in the middle of the antenna loop, and cutting eight slits radiating from the center. The transmitters would then be test-fitted to the birds, and if necessary the opening enlarged to go snugly over the bird's head. If the transmitter slipped over too easily (i.e. the hole was too large), a different transmitter was used. Once over the bird's head, the transmitter was worked down the neck toward the breast, and breast feathers were pulled through the opening. This assured that the transmitter was totally or mostly hidden, as well as unlikely to come off since the feathers helped hold it in place. Transmitter frequencies ranged from 148.010 MHz to 149.990 MHz, and each was separated from other transmitters by at least 10 kHz, thus a maximum of 198 unique frequencies could be deployed.

Once all data were collected on a bird, transmitters mounted, and blood taken, the bird was held upright for several minutes to allow it to equilibrate and regain its balance. If the bird showed any sign of scrapes or cuts from the traps, alum (clotting agent) and /

[1] The analyses of the blood samples are not part of this report.

or Neosporin® (antibiotic ointment) was applied to the wound. Cyanoacrylate cement (super glue) was kept on-hand in case a larger cut needed to be closed, but it was never necessary. The birds were then set gently on the ground at a location free of obstructions (fences, trees, cholla, etc.), so that they could escape by flying or walking.

Prior to the spring of 2000, all the radio transmitters deployed had a rated battery life of about 12 months. Some of these transmitters, however, have lasted as long as 24 months. Based on our experience with the battery life of these transmitters, we project that the normal range of normal battery life really falls between 12 and 24 months. In spring 2000, some transmitters were deployed with a rated battery life of up to 20 months, but which we expect will also have a greater useful life.

All of the hens and a number of the cocks captured in 2001 received transmitters with a rated life of 20 months. All new transmitters placed into use in the future will have a rated battery life of 20 months, although some refurbished transmitters with 12-month batteries will still be deployed on males. Battery life of 20 months greatly reduces the need to recapture birds for battery replacement, as very few individuals should outlive the battery life of the transmitters. Campbell (1972) estimated an annual survivorship of 35%; assuming this is true, on the average, less than 20% of the birds are expected to live longer than 20 months.

Transmitters were replaced on some of the birds in July and August 2000. For a description of the method used to replace the transmitters in summer, see Sutton Avian Research Center (2000).

Radio Tracking

Radio tracking of birds began the same day they were first captured and radioed. Birds were then tracked as often as time allowed (on average about once every three days), and at varying times of day and night. Radio tracking equipment consists of five-element, handheld Yagi antennas and ATS Inc. model R-2000 or R-4000 receivers. These receivers have built-in memory banks and scanners to aid in detecting birds. Once a bird was detected, our personnel would walk toward the bird until signal strength noticeably increased, at which time they would start walking around the bird, keeping it on one side of them until they had proceeded at least 90 degrees around it and within 50 meters of it. Great care was practiced in tracking to avoid accidentally flushing the birds. Occasionally, however, birds were intentionally flushed, for example, when a bird was found to be at the same location for two or more consecutive days (mortality switches might not be working or scavengers might be moving the transmitter around), or if there was some concern over the bird's health, intentional flushes were initiated. Once an individual's location was confirmed, a handheld Global Positioning System (GPS) unit was used to determine the latitude and longitude (to the nearest 0.01 minute). The latitude, longitude, date, time, and any pertinent notes were recorded in a pocket notebook, and transcribed onto standardized data forms later in the day. A 10 meter vegetation sampling transect was completed each time a bird was tracked.

Depending on the number of birds being tracked and the number of field personnel, each technician was assigned a group of up to 35 birds to track. Each person was scheduled to begin the first day of the five-day work week at 1400, and work until 2300. Each subsequent day, began and ended two hours earlier; by the last day of the workweek, the technician was working 0600-1500. This schedule facilitated tracking birds at various times of the day and night, and maximized the number of hours / day that someone was in the field (e.g., with four field personnel, someone was starting at 0600 four days each week, three days someone was starting at 0800, and four days someone was out until 2300). During the trapping season, this schedule was modified so that we could maximize the available personnel for early morning trapping.

As movements by radio-tagged birds of more than about 2 km would occasionally cause technicians to lose track of the birds, searching from the air allowed us to relocate lost birds. Flights were chartered out of Clovis, NM, Morton, Texas, or Woodward, Oklahoma, every two to three weeks from April through June. Two four-element Yagi antennas were mounted to the struts of a Cessna 172 or 182 for this purpose.

If a bird was found dead (our transmitters have a mortality feature incorporated into them that causes the pulse rate to double if the transmitter does not move for 12 hours), the carcass or remains were photographed, all remains were collected, and the area was searched for tracks, feces, etc. Other information collected at the mortality site included the distance to the nearest fence, the distance to the nearest power lines, the type of habitat, the distance to the nearest cultivated field, etc. The carcasses were examined for clues (stripped tendons, bite marks on bones or transmitters, plucked feathers, chewed feathers, etc.) that could aid in determining mortality causes (Dumke and Pils 1973).

Often when scanning, more than one bird would be detected. Personnel would usually track the individual that had gone the longest since last being tracked. Also, during nesting season, hens were tracked more frequently than cocks, sometimes even to the exclusion of tracking cocks. When trapping on gobbling grounds, a scan was made every 30 minutes to determine which birds were present; sometimes birds were detected at these intervals, but appeared merely to be in the area and not on the gobbling ground. In all of these cases, birds detected but not tracked were still recorded as detected, as their presence can be used to calculate daily survivorship rates.

Triangulation on signals to determine a bird's location was rarely necessary. Triangulation was used only when situations (land access, etc.) made obtaining a location by any other means impractical, or when more than one bird was being tracked simultaneously. In addition, we try to avoid the use of triangulation because it does not allow us to conduct vegetation sampling at bird locations or precisely determine the habitat usage.

Nest Monitoring

From late April through the end of June, hens were followed closely (usually daily) in anticipation of their nesting. Once a hen was thought to be nesting (same location for two consecutive days), field personnel would carefully move in close to determine whether or not the bird was on a nest. Usually the bird could be seen in an incubating posture from as far as 10 meters, and could be recorded as nesting without being flushed. Once a nest was confirmed (or assumed), a marker radio was placed two meters directly north of the nest. Marker radios were salvaged from dead birds or from birds with replaced transmitters. They were washed thoroughly with dish detergent (to remove any blood or odor), rinsed, wrapped with camouflage duct tape, and placed into plastic bags with dried cattle dung (the odor of cattle dung being part of the total camouflage process). The placement of these marker radios eliminated needing any visual markers (flagging, etc.) to relocate a nest. Also, whether or not the hen was incubating could be determined from a safe distance (~100 meters), thus eliminating subsequent disturbance to her or the surrounding vegetation. Every three to four days, the technician who found the nest (the same person who found the nest would monitor it in order to avoid accidental disturbance by someone unfamiliar with the nest location) would come to within about 100 meters and dial up the hens' frequency and the marker radio's frequency, and then take a compass bearing on each to confirm her location. After it was confirmed that a hen was no longer incubating on the nest (not present for two consecutive visits), the marker radio could be used to relocate the nest.

After a nest either failed or hatched, the entire nest and contents were photographed, and the egg remains were collected (nest success could be evaluated from the egg remains). Technicians would then return within 24 hours to complete vegetation sampling at and around the nest. For many nests, an "artificial" clutch consisting of three or four Ring-necked Pheasant (*Phasianus colchicus*) eggs and one clay egg (pliable, non-hardening modeling clay) were placed in the nest, and a hair-catcher (dowel rod wrapped with double-sided tape) was suspended ten to 20 cm above the nest. We would continue monitoring this nest until this clutch was destroyed or until the artificial clutch had been in place for four weeks. From these artificial clutches, we could identify predators potentially responsible for destroying actual prairie-chicken clutches (positive identification was possible from tooth impression in the clay egg and hairs stuck to the hair-catcher). Also, the patterns of egg destruction or consumption could then be compared to actual depredated prairie-chicken eggs, thereby allowing a reasonable level of confidence in determining the predator species. These artificial clutches were also collected and cataloged after they were destroyed.

Vegetation Sampling

Beginning in early 2001 we modified our vegetation sampling methods slightly from those used previously (Sutton Avian Research Center 2000). The new methods were chosen to allow us to increase the number of random vegetation points that were measured and to allow us to begin collecting vegetation data at the actual locations at which prairie-chickens were located. Because the method used previously had required at least one hour to collect all data (which was very detailed), the new method was designed to collect less information but also to be completed in less time, allowing more points to be sampled. These changes allowed us to increase the number of random points at which vegetation was characterized from 20 detailed to 60 – 90 less-detailed points, and to allow us to characterize the vegetation at each point at which a bird was tracked, about 150 points per month.

The new method is compatible with the methods used previously, and comparable to methodology used in research conducted by Davis et al (1981). It differs in having a total transect length of only ten meters, as opposed to the 100 meters total transect length for the previous method. Because all measurements taken are the same, the two methods can be compared. Because we consider the information taken at nest sites to be of great importance, we continued to use the method described in Sutton Avian Research Center (2000) for nest vegetation points. Because the two methods are compatible, the nest and other vegetation measurements are still comparable.

Vegetation data are collected at random points, and at non-nest, non-lek locations at which prairie-chickens are tracked. These latter sites are called "prairie-chicken vegetation locations[2]"). Vegetation sampling at randomly determined points was also conducted monthly.

Sampling transects were 10 meters long. For random points, the transect was centered on a predetermined point (located by using GPS units). The sampling transect went five meters each direction from this point to the northeast and southwest. This orientation is chosen to avoid running parallel to manmade features such as roads and fence lines, which tend to run north / south or east / west. For the prairie-chicken vegetation locations, a similar transect was run, although its origin was selected to be either at the point where the prairie-chicken was located (when the bird was accidentally flushed) or in similar habitat as close as possible (<50 meters) to where the bird was located (when the bird was not flushed).

At every meter along the 10 meter transect (for a total of 11 points), the amount and type of canopy (at this site "canopy" is rarely over knee high) and basal cover were determined with a ¼-inch (6.4 mm) diameter contact rod. Davis et al. (1981) used a plumb bob, but we decided that the contact rod would yield the same results and would be more accurate, as it would be unaffected by wind, and, in addition, could be accomplished more quickly.

At five meter intervals, the number and types of woody stems were counted within a 0.5 meter radius of the point. Vegetation density, as measured by number of vegetation contacts with the same ¼ inch rod as used for determining canopy and basal contacts, was recorded at three levels (<10 cm, 10-50 cm, and >50 cm). Canopy height was also

[2] Throughout this report "prairie-chicken vegetation locations" will refer to those points away from the gobbling ground and away from a nest where Lesser Prairie-Chickens were located and vegetation data collected.

measured at the five meter intervals, and maximum height within a one meter radius of the point was measured and recorded. Other data recorded included type of habitat (native prairie, cultivated, Conservation Reserve Program [CRP] lands, etc.), whether the area was grazed or not, and whether the area is tebuthiuron-treated or untreated. For prairie-chicken vegetation locations the bird identification number for the individual that was tracked at that location was also recorded. For all points, of course, we also recorded the date and time of the measurements.

As mentioned above, nest vegetation measurements were more detailed. Nest vegetation characteristics were measured at each nest immediately after it failed or hatched, to avoid disturbing the nest. The same vegetation characteristics as described above were recorded at the nest, with the primary differences being that at nests the sampling transects were 50 meters by 50 meters, arranged in a large X centered at the nest, with 25 meters extending in each of the four cardinal directions, and that woody stems were recorded in a one meter radius circle rather than a 0.5 meter radius. As described above for random and prairie-chicken vegetation locations, at every meter along these transects, amount and type of canopy and basal cover were determined with a ¼-inch (6.4 mm) diameter contact rod. At five meter intervals, the number and types of woody stems were counted for a one meter radius circle centered on the five meter point, vegetation density was measured at three levels (<10 cm, 10-50 cm, and >50 cm) using a contact rod, canopy height was measured, and maximum height within a one meter radius was measured. Other data recorded included type of habitat (native prairie, cultivated, CRP lands, etc.), date, time, identity of nest, grazing and tebuthiuron treatment. Only at nest points, nest concealment ratings were assigned from one meter north, south, east, west, and above the nest (Ralph, et. al. 1993). The type, height, and density of vegetation at the nest also were measured, and the nest cup dimensions were measured.

Statistical Methods

All mapping was carried out using ArcView 3.2. Base maps are the U.S. Census Bureau's TIGER 98 files.

Home range analysis was performed using HRE: The Home Range Extension for ArcView (Rodgers and Carr 1998). Home ranges were determined using the minimum convex hull of 100% of the locations collected from February to June 2001. A kernel smoothing technique was not used, because kernel smoothers appear to overestimate the home range size of prairie-chickens. Because prairie-chickens, especially cocks, spend a great deal of time on the gobbling grounds, kernel smoothers tend to over-weight the lek areas and to produce a biased estimate of the home range. Although the minimum convex polygon may underestimate the home range size, it appears to give a closer estimate to home range size than do the kernel smoother methods.

Statistical analyses were carried out using SYSTAT 7.0 (SPSS Inc. 1997) and Microsoft Excel 2000®.

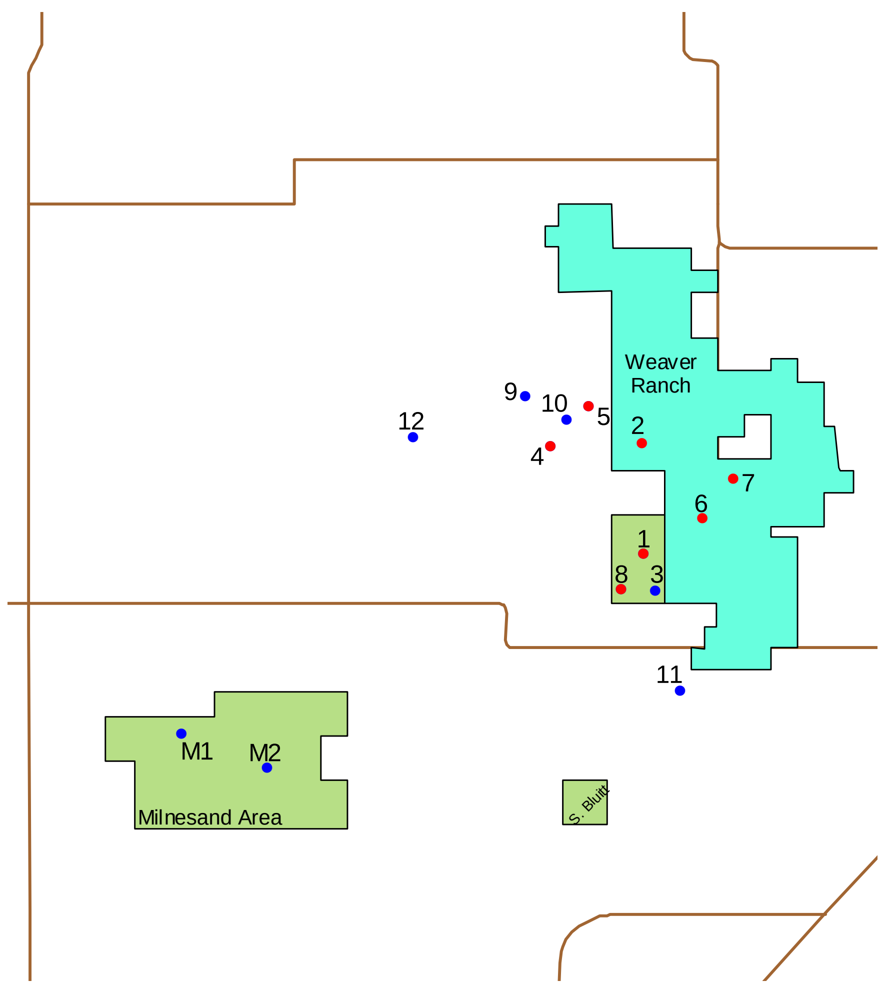
RESULTS AND DISCUSSION

Leks

We located 14 active gobbling grounds in spring 2001 in the overall study area. We trapped birds at seven of these grounds, mostly located near the tebuthiuron study plots. The locations of these leks can be seen in the figure below.

Note that most of this report will focus on birds trapped at the four leks in the tebuthiuron study area Leks 1, 6, 7, and 8. The four leks were within 0.8 km (0.5 mi) of the tebuthiuron study plots. For the purposes of this report, leks 1 and 8 will be referred to as control-area leks and leks 6 and 7 as tebuthiuron-area leks.

Fig. 4. All known leks in study area in spring 2001. Number is the lek identification number. Trapping of prairie-chickens took place at the leks indicated by red dots; no trapping took place at leks marked in blue. The Weaver Ranch is the aquamarine area, and the darker green indicates the approximate boundaries of the North Bluitt PCA and other PCAs.



Trapping

Results of trapping of prairie-chickens for spring 2001 are presented below. Trapping was carried on at seven trapping sites (Fig. 4 and Table 2), including the four tebuthiuron study area leks (1, 6, 7, and 8).

We made 96 total captures, of 77 individual birds (including one trapping mortality). The number of captures is higher because it includes birds captured more than once. Of these 77 individuals, 70 were new birds never captured before. These birds include 49 males (70%) and 21 females (30%). This is a slightly lower percentage of new females than the 35% that was captured in 2000, but because more new individuals were captured this year, the total number of females captured in 2001 was higher than in 2000 (21 vs. 20).

Of 77 total individuals captured, seven were birds captured in 1999 or 2000. Of these, three were cocks originally captured in 1999 and four were cocks captured in spring 2000.

One bird, a male, died from an undetermined cause while being held for radio tagging. As a proportion of the 96 captures, this one trapping mortality produces a trapping mortality rate of about 1%. In a study of Lesser Prairie-Chickens captured in Texas in spring 2001, 78% of the birds were found to be afflicted by avian bronchitis (Nova Silvy, *personal communication*). Considering this high proportion of infected birds and the potential severity of avian bronchitis, the carcass of the bird that died in our study will be examined for signs of bronchitis or other diseases. Labored breathing due to bronchitis may be complicated by the stress of being captured and held, and may have been a factor in the bird's death.

Table 2. All Lesser Prairie-Chickens captured in spring 2001, by lek. For locations of leks see Fig. 4. Note that no trapping was carried out at Lek 3 in 2001, because only one or two birds were ever present at that lek. Figures in parentheses are percentage of each row. Note that leks 1 and 8 were control-area leks and leks 6 and 7 were tebuthiuron-area leks. Leks 2, 4, and 5 were outside the tebuthiuron study area, and trapping at these leks primarily occurred early or late in the spring, and not at times of peak hen visitation.

Lek Number	Males	Females	Total
Lek 1	6 (60%)	4 (40%)	10
Lek 2	9 (64%)	5 (36%)	14
Lek 4	17 (94%)	1 (6%)	18
Lek 5	6 (100%)	0 (0%)	6
Lek 6	8 (62%)	5 (38%)	13
Lek 7	6 (84%)	1 (14%)	7
Lek 8	4 (44%)	5 (56%)	9
TOTAL	56 (73%)	21 (27%)	77

Trapping of prairie-chickens began in February 2001, and continued through early May. However, because lek activity had dramatically decreased in early May, trapping was ended in the first week of May, and no trapping was carried out at all during June.

Although males are caught in all trapping months, the large majority of females are trapped in April (Table 3). Of 21 females caught this year, 20 (95%) were caught in a four-week period beginning in the last few days of March. This pattern is consistent over the three years (1999, 2000, 2001) of the project. In fact, 45 (94%) of 48 hens caught during these three years have been caught during the four-week period from 28 March to 25 April each year.

Table 3. Lesser Prairie-Chickens captured in spring 2001, by month. These include only the first capture of each bird this year. Figures in parentheses are percentage of each row.

Month	Males	Females	Total
February	13 (100%)	0 (0%)	13
March	20 (91%)	2 (9%)	22
April	22 (56%)	19 (44%)	41
May	1 (100%)	0 (0%)	1
TOTAL	56 (73%)	21 (27%)	77

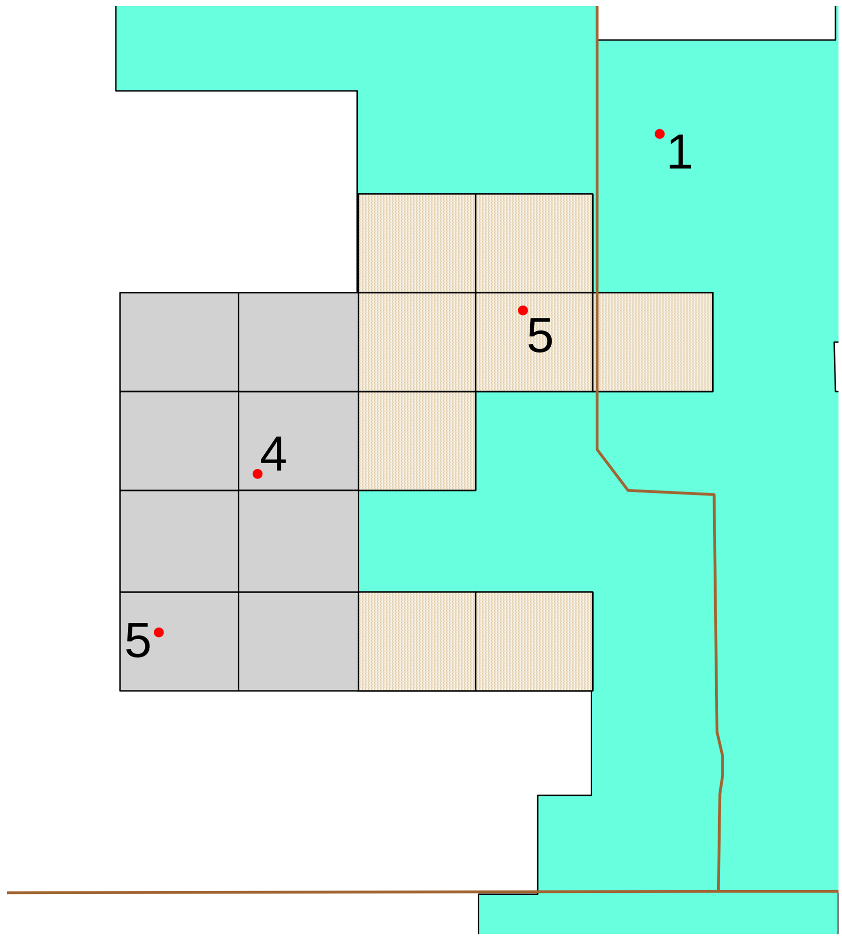
In addition to the 77 birds captured this year, we continued to track a few individuals that were originally trapped in earlier years but which were never captured in 2001. This included eight hens (one originally captured in 1999 and seven captured in 2000) and 16 cocks (four originally captured in 1999 and 12 captured in 2000). Therefore, the total number of birds being tracked in Spring 2001 was 101. The large majority of birds being tracked in 2001 were birds first captured this year (Table 4).

Table 4. The number of birds being tracked in Spring 2001, by year of first capture and sex. Figures in parentheses are percentages of each column.

Area	Males	Females	Total
1999	7 (10%)	1 (3%)	8 (8%)
2000	16 (22%)	7 (24%)	23 (23%)
2001	49 (68%)	21 (72%)	70 (69%)
TOTAL	72	29	101

Note that the objectives of this study focus on nests in the tebuthiuron study plot area. Therefore, we will generally focus on birds that had access to that area. This includes birds trapped at Leks 1 and 8 (control-area leks), and 6 and 7 (tebuthiuron-area leks) this year plus individuals from previous years that were tracked in the tebuthiuron study plot area. These birds include two hens that were trapped before spring 2001 and 15 that were trapped this year. The gobbling grounds and the number of hens trapped on each can be seen in the figure below.

Fig. 5. Gobbling grounds in proximity to the tebuthiuron study plots. The number indicates how many new hens were trapped at the gobbling ground in spring 2001. Two other hens, trapped in 1999 and 2000 also used the area. The aquamarine area is the Weaver Ranch, beige areas are tebuthiuron-treated plots, and gray areas are control plots on North Bluitt PCA.



Survivorship

Annual and Seasonal Survivorship

A total of 60 (38%) of 160 birds radio-tagged from April 1999 to June 2001 have been found dead from predation or collisions with power lines. Of all birds captured in

1999, 20 (59%) of 34 have been found dead and eight (24%) are classified as missing. Of all 56 birds captured in 2000, 24 (43%) have been found dead and 18 (32%) are classified as missing. Of 70 birds captured in 2001, 16 (23%) have been found dead.

Survivorship for the annual period 2000 – 2001 can be seen in Table 5 and for 1999 – 2000 in Table 6. (Note: Table 6 is copied from GMSARC 2000.) The annual survivorship of all birds in the past year is probably somewhat lower than 50% (between 25% and 59%), and probably closer to 40%. This is slightly lower than the estimate from 1999 – 2000, and compares well with Campbell's (1972) estimate of 35% annual survivorship between 1962 and 1970 in eastern New Mexico. In 2000 – 2001, the survivorship of cocks and hens was fairly similar, although the minimum survivorship for hens is lower than for cocks. (Because the sample sizes are small, no statistical analysis was performed.) The survivorship for hens was likely higher in 2000 – 2001 than in 1999 – 2000.

Table 5. Annual survivorship of the Lesser Prairie-Chicken cohort known alive in April – June 2000 to June 2001. The maximum survivorship is calculated using only birds known dead and assuming that missing birds are alive. The minimum survivorship is calculated using the known-dead birds and assuming all missing birds to also be dead.

Cate-gory	Number at Beginning, April – June 2000	Known Alive in April – June 2001	Known Dead in April – June 2001	Missing in April – June 2001	Maximum Possible 1-year Survivorship	Minimum Possible 1-year Survivorship
All Birds	64	16	26	22	59%	25%
Cocks Only	43	12	18	13	58%	28%
Hens Only	21	4	8	9	62%	19%

Table 6. Annual survivorship of the Lesser Prairie-Chicken cohort trapped and tagged in April – June 1999. Some of the birds known alive in April – June 2000 are known to have subsequently died. As in the table above, maximum survivorship is calculated using only birds known dead and assuming that missing birds are alive. The minimum survivorship is calculated using the known-dead birds and assuming all missing birds to also be dead. Table is copied from Sutton Avian Research Center (2000).

Category	Number at Beginning, April – June 1999	Known Alive in April – June 2000	Known Dead in April – June 2000	Missing in April – June 2000	Maximum Possible 1-year Survivorship	Minimum Possible 1-year Survivorship
All Birds	23	10	10	3	56.5	43.5
Cocks Only	17	10	5	2	70.6	58.8
Hens Only	6	0	5	1	16.7	0.00

The low annual survivorship of hens, especially if the actual values fall nearer to the minimum estimates, may not allow the population to maintain numbers. Even if nest success is high, but the proportion of hens surviving and producing nests is low, the population may not be able to replace itself.

Mortality of the Lesser Prairie-Chickens in 1999 –2001 has been highest in the first six months of the year (Fig. 6). For both sexes combined (Fig. 6A), the percent mortality has exceeded 10% in January, March, and April, and the lowest mortality has occurred in the summer months, from July through September. In fact, except for relatively high mortality in October, the percent of birds killed is quite low from June through December. This pattern generally holds true for the first six months of 2001, for which we have data, but with an unusually high proportion of birds killed in April 2001. Almost all of the birds killed in April 2001 were cocks (12 of 13 killed).

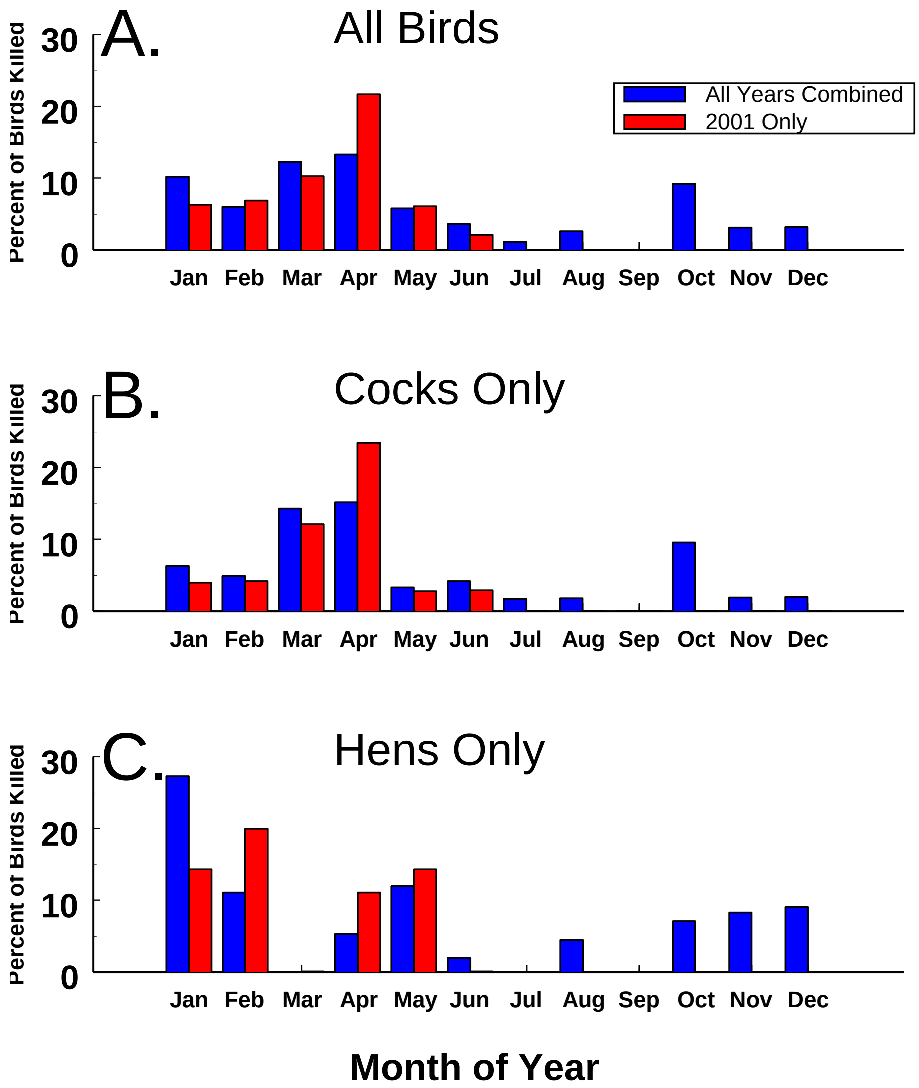
Largely because the number of cocks being tracked at any one time is usually three to four times as high as the number of hens being tracked, the pattern of mortality of cocks by month (Fig. 6B) is similar to that of all birds combined. However, the mortality for cocks peaks more sharply in March and April. The pattern of mortality for cocks in 2001 was the same as the general pattern, although the number peaked in April at 24%.

Hens show a somewhat different pattern of mortality through the months (Fig. 6C), although this may be partially an artifact of the small numbers of hens, often around ten, being tracked in some months. Mortality of hens is generally high during the period from January to May. However, despite this general pattern, there were no known hen mortalities in March of 2000 or 2001. The highest monthly percentage mortality was recorded for hens in January, with 27% mortality. Mortality exceeded 10% for all years combined in January, February, and May, and for 2001 only it exceeded 10% in January, February, April, and May.

The high period of mortality for both hens and cocks corresponds to the mating season, when birds are attending the gobbling grounds. When the birds are at the leks, they are especially vulnerable to predators, because they are usually in an open, highly visible location, and the males are making gobbling sounds and calls, which may attract the attention of predators.

Although the mortality rate of cocks drops off in May when gobbling activity declines, it remains high for the hens, which are then on nests incubating. Hen mortality rates decline also in June, although many hens may still be incubating (especially if a first nest failed), and hens with successful nests will have chicks, which they may be brooding. Interestingly, in this study hen mortality has been high in the winter months of January and February, at a time when they are neither attending leks nor nesting. This pattern does not seem to hold for the cocks.

Fig. 6. Proportion of birds killed, by month. The proportion is the number of birds tracked (and therefore known to be alive) in the previous three months. This includes only birds known dead; missing birds are not included. Note that blue bars are for all three years combined (1999 – 2001), and red bars are for 2001 only.



Comparison of Survivorship Among Treatments

No hens known to be in the tebuthiuron study area, either in tebuthiuron-treated or untreated areas, were lost or died during the study period (March through June 2001). Therefore, no comparison can be made of the effects of the tebuthiuron treatment on hen survivorship.

Of cocks that inhabited the tebuthiuron study area, seven died during the study period. Four were birds from the tebuthiuron-treated area, and three were inhabitants of the untreated area. Four birds became "missing" during the study period, two each from the treated and untreated areas (see table below).

With this small sample, no statistical test is possible to compare survivorship in the tebuthiuron-treated and untreated areas. Although it appears that survivorship may have been slightly lower in the untreated areas than in the tebuthiuron-treated plots, had a single additional bird that inhabited the tebuthiuron-treated areas died or been killed, the results would have been reversed.

Table 7. Survivorship of males in the tebuthiuron study area during the study period (March – June 2001).

Category	Known Alive in March – June 2001	Known Dead in March– June 2001	Missing in March – June 2001	Maximum Possible three-month Survivorship	Minimum Possible three-month Survivorship
Tebuthiuron-treated Area	15	4	2	66.7	50.5
Untreated Area	10	3	2	63.9	41.5

Mortality Factors

Determining the cause of prairie-chicken mortality from recovered carcasses can be extremely difficult. In general, mortality in this study has been attributed to mammalian predators, avian predators, and fence / power line collisions. Although it is assumed that the causes of mortality occur in the order listed, exact ratios have yet to be determined (this requires thorough examination of each carcass as well as some educated interpretation in order to distinguish predation from scavenging). For example, a Greater Prairie-Chicken in Wisconsin was killed by a power line collision. Within hours it was seen scavenged by a Red-tailed Hawk (*Buteo jamaicensis*), dropped and hanging on a barbed wired fence, and finally carried away by a farm dog (Toepfer 1988). Such scavenging can easily confuse any effort to classify the cause of mortality.

Counting recaptured birds, we have made over 200 captures of Lesser Prairie-Chickens in New Mexico. One hen in 1999 and one cock in 2001 died during processing due to undetermined causes. (In nearly 1000 captures of Lesser and Greater Prairie-Chickens in Oklahoma and New Mexico, we have had only seven trapping casualties.)

Aside from the aforementioned trapping casualties, we have experienced no other trapping-related mortality in New Mexico. Five birds were found dead within one week of capture or recapture, one of which had a prior injury that appeared to be the result of a fence collision. A total of 13 other birds were found dead within one month of capture or recapture, ranging from 15 to 30 days after capture. In comparison, ten birds were found dead a year after capture (11 to 13 months). Therefore, we feel reasonably sure that these mortalities were likely a result of vulnerability during the gobbling season and not trapping related.

Movement Distances and Home Ranges

Maximum Movement Distances

The maximum distance moved by the prairie-chickens can give an estimate of their home range size. To measure this, we selected only those birds known alive during the period from 1 February to 30 June 2001 that were still alive at the end of the period. In addition, because many birds are recorded repeatedly at only a few locations, such as on the lek or when hens are incubating on a nest, we chose to analyze only birds for which there were at least four non-lek and non-nest (for hens) locations. The maximum distance moved by an individual was measured as the greatest distance between any two points, including the lek and nest locations, where the bird was recorded.

The maximum distance moved by one of the 17 hens in the tebuthiuron study area was 7.1 km (Table 8). This distance was moved by a hen trapped on Lek 1 in April 2001, but which moved in early June to an area 7 km to the northwest, where she remained. The smallest maximum distance moved during the same time period, moved by a hen from Lek 8, was 1.2 km.

If either of the treatments had an effect on quality of prairie-chicken habitat during this time period, one might expect to see that the birds from either treatment (control or tebuthiuron sprayed) would move a greater distance, possibly seeking better-quality habitat. On average, the hens from the tebuthiuron-area leks tended to move a slightly longer maximum distance than did hens from the control area leks (Table 8). However, this difference was not significant ($t = -0.31$, $df = 15$, $P = 0.38$).

Table 8. Maximum movement distances for female Lesser Prairie-Chickens from 1 February to 30 June 2001, by treatment. Leks 1 and 8 are control-area leks and leks 6 and 7 are tebuthiuron-area leks. Only birds still alive at the end of the period, and for which there were at least four non-lek and non-nest locations are given. All distances are in km.

Treatment	Average	Range	S	N
Tebuthiuron-area leks	2.9	1.5 – 5.3	1.2	7
Control-area leks	2.7	1.2 – 7.1	2.0	10
All Birds	2.8	1.2 – 7.1	1.7	17

As has been known for Greater Prairie-Chickens, on average, male Lesser Prairie-Chickens move shorter maximum distances than do females (compare tables 8 and 9; t = 2.32, df = 25, P = 0.01). This is largely explained by the fact that cocks spend most of their spring season at the gobbling ground.

As with the hens, on average the cocks from the tebuthiuron-area leks tended to move slightly longer maximum distances than did cocks from the control area leks (Table 9). However, as with the hens, this difference was not significant (t = -1.05, df = 5, P = 0.17).

Table 9. Maximum movement distances for ten randomly selected male Lesser Prairie-Chickens from 1 February to 30 June 2001, by treatment. Leks 1 and 8 are control-area leks, and leks 6 and 7 are tebuthiuron-area leks. Only birds which were still alive at the end of the period, and for which there were at least four non-lek and non-nest locations are given. All distances are in km.

Treatment	Average	Range	S	N
Tebuthiuron-area leks	1.2	1.4 – 2.4	0.5	5
Control-area leks	0.7	0.5 – 3.5	1.3	5
All Birds	1.0	0.5 – 3.5	1.0	10

Home Range Size

The area of home ranges was measured for the same set of birds as the maximum movement distance, that is, only those with at least four non-lek, non-nest locations during the period from 1 February to 30 June 2001 and which were still alive at the end of the period. Home range sizes varied from about 0.5 km^2 to 9 km^2 (Table 10). The hen with the largest home range was a Lek 7 bird.

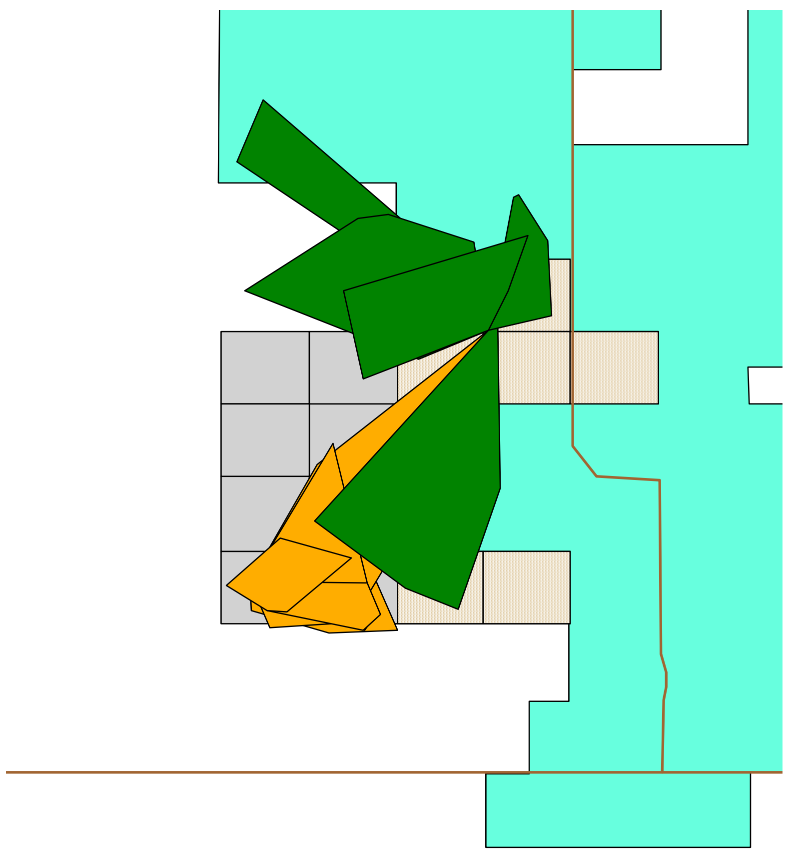
As with maximum movement distance, if either of the treatments had an effect on quality of prairie-chicken habitat, one might expect to see that the birds from either treatment (control or tebuthiuron-treated) would move a greater distance if they were seeking better-quality habitat and therefore have a greater home range size. On average, the hens from the control-area leks tended to have smaller home ranges than hens from the tebuthiuron-area leks (Table 10), but the difference was not significant (t = -1.05, df = 9, P = 0.16).

Table 10. Home range areas for female Lesser Prairie-Chickens from 1 February to 30 June 2001. Only birds still alive at the end of the period, and for which there were at least four non-lek and non-nest locations are given. All areas measured in km^2.

Treatment	Average	Range	S	N
Tebuthiuron-area leks	3.0	0.6 – 9.2	2.8	7
Control-area leks	1.8	0.5 – 5.7	1.6	10
All Birds	2.3	0.5 – 9.2	2.2	17

In Fig. 7 are home ranges for ten hens from two leks. Note that the home ranges of the Lek 8 birds tended to be smaller, and all but one of those birds remained on the North Bluitt PCA throughout spring 2001. The hens from Lek 6 seem to have moved farther. Although Lek 6 is on the Weaver Ranch, the home ranges of the Lek 6 birds included parts of the North Bluitt PCA and the adjacent ranch.

Fig. 7. Home ranges of five hens from control-area Lek 8 (orange) and five hens from tebuthiuron-area Lek 6 (green). The aquamarine area is the Weaver Ranch, beige areas are tebuthiuron-treated plots, and gray areas are control plots on North Bluitt PCA.



As with the maximum movement distance, male Lesser Prairie-Chickens have smaller home ranges than females (compare tables 10 and 11; t = 2.00, df = 25, P = 0.03). And as with maximum movement distance, this is largely explained by the fact that cocks spend most of their spring season at the gobbling ground.

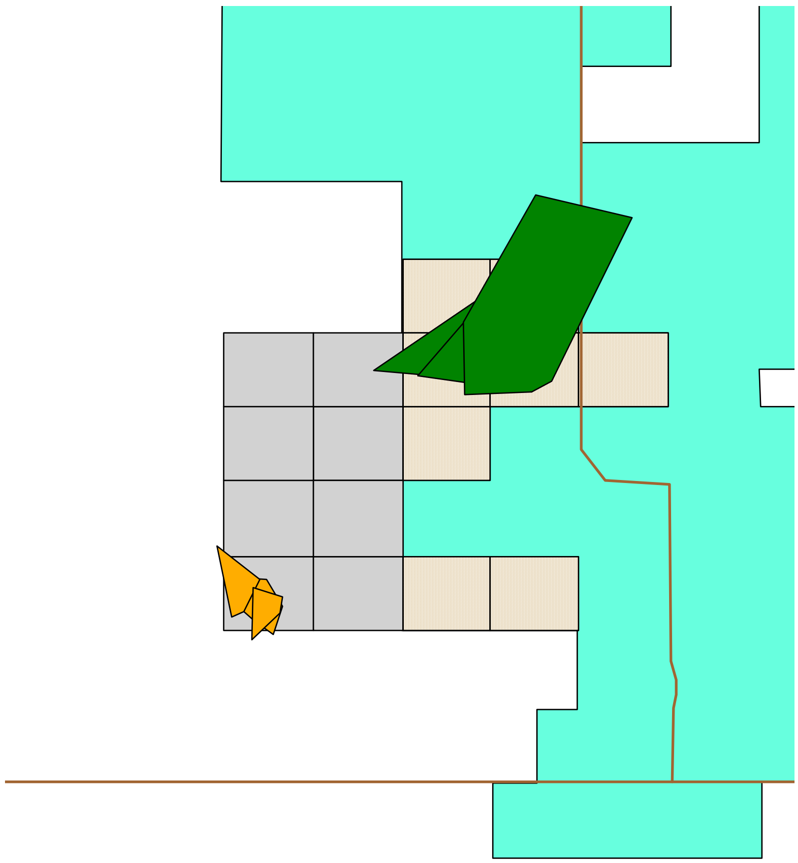
The home ranges of cocks from the tebuthiuron-area leks were almost identical to those of cocks from the control area leks (Table 11). This difference was not significant (t = 0.01, df = 6, P = 0.50).

Table 11. Home range areas for ten randomly selected male Lesser Prairie-Chickens from 1 February to 30 June 2001, by treatment. Leks 1 and 8 are control-area leks and leks 6 and 7 are tebuthiuron-area leks. Only birds still alive at the end of the period, and for which there were at least four non-lek and non-nest locations are given. All distances are in km.

Treatment	Average	Range	S	N
Tebuthiuron-area leks	0.9	0.4 – 2.3	0.8	5
Control-area leks	1.0	0.1 – 4.0	1.7	5
All Birds	1.0	0.1 – 4.0	1.2	10

In Fig. 8 are home ranges for six cocks from the same two leks as in the Fig 7. As with the hens, note that the home ranges of the Lek 8 birds tended to be smaller, and all but one of those birds remained on the North Bluitt PCA throughout the spring 2001. The cocks from Lek 6 seem to have moved farther.

Fig. 8. Home ranges of six cocks, three from control-area Lek 8 (orange) and three from tebuthiuron-area Lek 6 (green). The aquamarine area is the Weaver Ranch, beige areas are tebuthiuron-treated plots, and gray areas are control plots on North Bluitt PCA.



The average distance moved by hens from the tebuthiuron-area leks was slightly greater than that of hens from the control-area leks (Table 8), but not significantly so. The area of the home ranges of hens from the tebuthiuron-area leks was also larger (Table 10), but again the difference was not significant. Although the sample sizes are small, this suggests that movements and home ranges of the female Lesser Prairie-Chickens was not affected by the tebuthiuron treatment in spring 2001. This general pattern also holds for the males. This may, however, be a result of the fact that the tebuthiuron treatment did not begin to show effects on the habitat until relatively late in the study period of this project. That is, before the growing season, when the tebuthiuron began to defoliate the shinnery oak and before grass began to grow, there may have been little or no effect on the habitat by the tebuthiuron treatment, and therefore little or no effect on the prairie-chicken movements and home ranges.

Maximum movement distances and home range sizes of the males and females did indeed differ, with the hens having the greater movement distances and larger home ranges. This would be expected, since males especially tend to be closely associated with their gobbling grounds during the breeding season, and rarely wander far from them. It is unlikely that this difference between males and females can be attributed to effects or lack of effects of the tebuthiuron treatment, but is rather a general result of prairie-chicken biology.

The maximum movement distances and home range sizes shown in this report further support the results of the previous study (Sutton Avian Research Center 2000). Prairie Chicken Areas such as the South Bluitt PCA, with an area of about 2.6 km^2 and a maximum corner-to-corner length of 2.3 km probably do not serve well to provide the entire home range for most Lesser Prairie-Chickens. Although it is possible to fit a prairie-chicken home range within a land parcel the size of the South Bluitt PCA, it is likely that most prairie-chickens living within the area would still probably range outside it for part of their home range. The much larger Milnesand PCA, however, with an area of about 42 km^2 and a corner-to-corner length of about 8.4 km probably could provide the area for not only one but several non-overlapping ranges. The larger land area is probably necessary, as well, because while most birds have home ranges of only a few square km, a few individuals may require much more space.

Nest Location

Locations of Nests

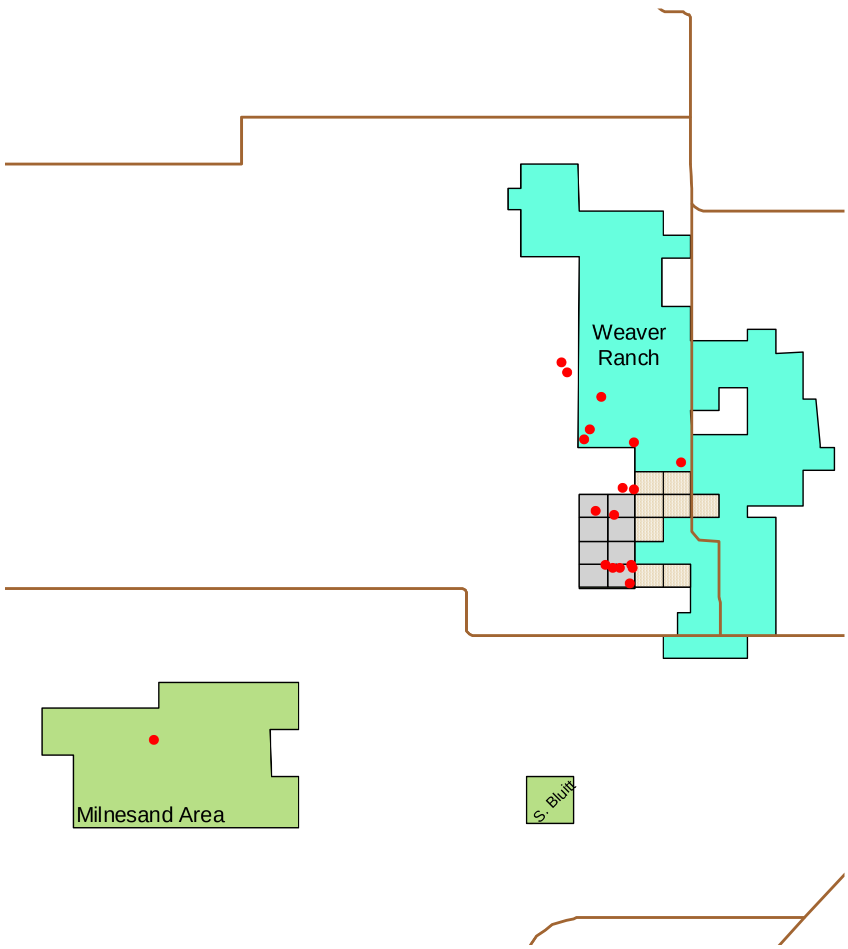
The locations of all 18 nests discovered in 2001 are given in Table 12 and can be seen in Fig. 9. Of the 18 nests, eight were found on the 16 tebuthiuron study plots. However, none of these were located on the tebuthiuron-treated plots on the Weaver Ranch; all were located on the North Bluitt PCA. (Note that no grazing took place on any of the tebuthiuron study plots in 2001. Therefore, grazing is ignored in this analysis.) Of these eight, one was on BG1, one on BN1, one on BN4, and five on BG4.

All nests but one were located on the Weaver Ranch, North Bluitt PCA or the adjacent ranches. The one other nest was found on the Milnesand PCA. This distribution largely reflects the fact that the large majority of our effort was concentrated on the Weaver Ranch and North Bluitt PCA, and all trapping was concentrated there in spring 2001. The nest on Milnesand PCA was found from a hen radio-tagged in spring 2000 and still being tracked in spring 2001.

Table 12. Locations of 18 nests found in spring 2001.

Location	Number of Nests	Number of Successful Nests
Weaver Ranch	5	2
North Bluitt PCA	8	5
Other private ranches	4	2
Milnesand PCA	1	1

Fig. 9. Locations of all 18 nests of Lesser Prairie-Chickens located by Sutton Avian Research Center in New Mexico in spring 2001. As on other figures, the aquamarine area is the Weaver Ranch, beige areas are tebuthiuron-treated plots, gray areas are control plots on North Bluitt PCA, and the green areas are Milnesand PCA (large area in southwest) and South Bluitt PCA (square area in south).



Nest Location Relative to Lek

For 13 of the 18 nests, the hen establishing the nest was recorded only at one lek each. This does not mean that the hens did not visit more than one lek, but only that they were never detected on more than one. Those 13 hens placed their nests at an average distance of 1.33 km (0.83 mi; range from 0.56 to 3.25 km) from the lek they were known to have visited. The nest placed closest to the lek was 0.56 km (0.35 mi), and the farthest was 3.25 km (2.02 mi). The average is higher than the 0.96 km recorded in 2000 (Sutton Avian Research Center 2000). The nest placed closest to the lek in 2001 was slightly closer than in 2000 (0.68 km), but the farthest nest in 2001 was more than twice as far from the respective lek as the 1.29 km recorded in 2000. These figures generally agree with those reported in Giesen (1998).

Nest Success

Estimates of Nest Success

In all three nesting seasons since our study began, hens (one in 1999, four in 2000, and six in 2001) were tracked that were never found to be on nests. Perhaps some of these hens experienced failures during the egg laying stage or during early incubation before we had a chance to locate their nests. Additionally, one hen in 1999, three hens in 2000, and three hens in 2001 were found dead before any nest was found. It is possible that these hens were killed on nests and carried away by predators (one hen was found killed on a nest in 1999).

Three nests from radioed hens were located in 1999. One (33%) of these was successful. The Mayfield hatching success rate can be calculated using only two of the nests, and yields a rate of 50.4% hatching success.

Four (57%) of seven nests found in 2000 were successful. Two of the failed nests failed on the day after they were discovered, giving only one exposure day for each. This greatly reduces the Mayfield estimate. The Mayfield hatching success probability estimate for the nests in 2000 is 40.7%.

In 2001, ten of 18 nests were successful, giving a raw nest success rate of 55.5% and a Mayfield hatching success rate of 50.2%. This figure is higher than the Mayfield hatching estimate for 2000, and very nearly the same as that for 1999 (although the 1999 estimate was made with only a very few nests).

Combining the nests from all three years (for a total of 27 usable nests), the raw nest success is 55.5% (as in this year) and the Mayfield hatching success rate is 49.2%. This is a very high number, much higher than most hatching or nest success estimates for Lesser Prairie-Chickens or other ground-nesting birds, and probably reflects chance events, rather than true, long-term hatching success rate. The usual nest success rate averages 28% (Giesen 1998), although with a range among ten different researchers from 0 – 67%.

The average clutch size (calculated only from eight nests for which the clutch was known to have been completed) was 10.3 eggs. It ranged from nine to 12, with 10 being the modal clutch size.

Egg hatchability was high. Of 82 eggs in nests that were successful, that is, where the eggs were not depredated before hatching, 80 hatched. This gives an egg hatchability of 97.6%. This value is higher than the value for a large sample of Greater Prairie-Chickens, which is around 91% (John Toepfer, *personal communication*).

Causes of Nest Failures

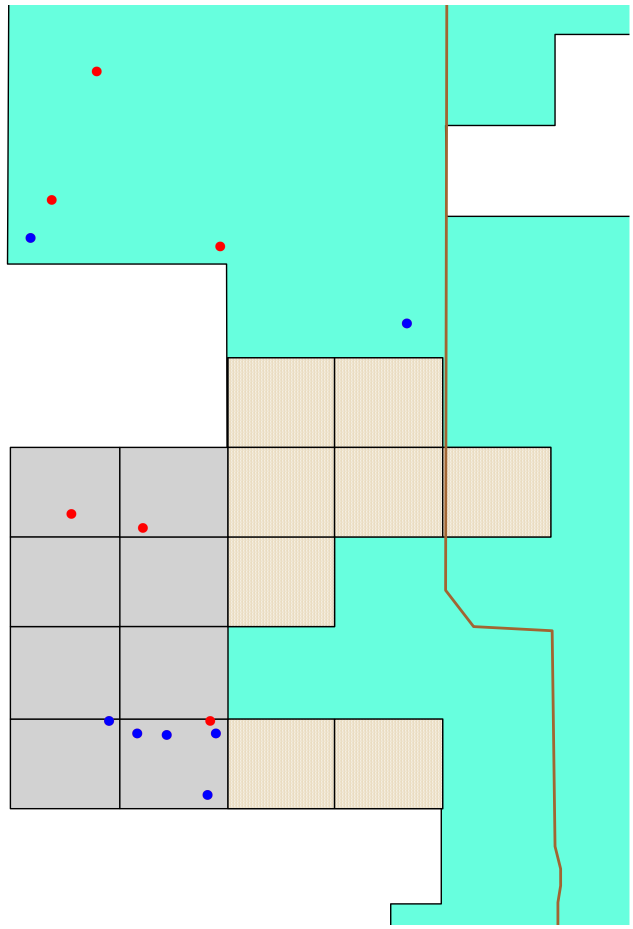
Predation accounted for all nest failures in all three years. In most cases, predation was attributed to mammals. At five failed nests in 2001, all eggs were removed, suggesting that snake predation might be involved; however, canids are known to remove entire clutches as well.

Comparison of Nest Success Among Treatments

Because no nests were found on the tebuthiuron-treated study plots, no comparison can be made between nests (habitat, success, etc.) among treatments on the study plots. However, because most of the Weaver Ranch was treated with tebuthiuron, some analysis will be made here comparing the five nests on the Weaver Ranch (tebuthiuron-treated) with the eight nests found on the North Bluitt PCA (not tebuthiuron-treated).

Of the 13 nests on the Weaver Ranch and North Bluitt PCA, seven (54%) were successful. Of these, five (of eight) were on the North Bluitt PCA and two (of five) were on the Weaver Ranch. The locations of the nests can be seen in the figure below. There was not a significant difference between nest success on these two areas / treatments ($\chi^2 = 0.63$, df = 1, P = 0.43).

Fig. 10. Locations and success of nests on the Weaver Ranch and North Bluitt PCA. Successful nests are indicated by blue dots; failed nests by red dots. As on other figures, the aquamarine area is the Weaver Ranch, beige areas are tebuthiuron-treated plots, and gray areas are control plots on North Bluitt PCA.



Of the 13 nests not found on the Weaver Ranch (that is, combining the North Bluitt and Milnesand PCAs and other private ranches) and therefore not exposed to tebuthiuron-treatment, eight were successful (62%). Chi-square test comparing the nest success of these 13 against the five from (tebuthiuron-treated) Weaver Ranch, however, was also not statistically significant (χ^2 = 0.68, df = 1, P = 0.41).

These results suggest there was little effect of the tebuthiuron treatment on nest success during this first year of the tebuthiuron treatment study. However, this may be a result of small sample sizes of nests in either treatment regime; see also the warning about generality of these results on page 12.

Habitat in Tebuthiuron-treated and Untreated Areas

Although the tebuthiuron treatment was not apparent at the beginning of the study period in March 2001 (see page 12 for warning about changes in study area), we will compare the vegetation characteristics of the portions of the tebuthiuron study area treated with tebuthiuron (Weaver Ranch) with the same characteristics on the untreated area (North Bluitt PCA). More information and a further analysis of the vegetation on these study areas can be obtained from Dr. Charles Dixon. However, we will here present our results, for comparison with our measurements taken at nests, random vegetation locations, and at prairie-chicken vegetation locations.

For this comparison of vegetation characteristics between the Weaver Ranch and North Bluitt PCA, we selected only data collected during the nesting period, from 13 May to 23 June 2001 (see next section for more details as to why this period was selected). For the areas being considered this includes 23 points, 17 on the Weaver Ranch and six on North Bluitt PCA. A map showing the locations of the points is also part of the next section below (Fig. 11). Please note that none of the tebuthiuron study area was grazed, although other areas of the Weaver Ranch may have been grazed. In addition, almost all of both areas is native prairie habitat.

Table 13. Vegetation characteristics at random points on the North Bluitt PCA and Weaver Ranch. The t-test value, degrees of freedom, and probability are given only for those tests where $p<0.100$.

Characteristic	N. Bluitt	Weaver	t, df, p
Canopy Cover (%)			
Shinnery oak	30.3	14.5	*; t=2.39, df=9, p=0.039
Tallgrass	19.7	11.7	n.s.
Sand sagebrush	1.5	0.0	n.s.
Shortgrass	7.5	3.2	n.s.
Mesquite	3.0	0.5	n.s.
Other	3.0	2.6	n.s.
Basal Cover (%)			
Shinnery oak	0.0	0.5	n.s.
Tallgrass	6.1	3.7	n.s.
Sand sagebrush	0.0	0.0	n.s.
Shortgrass	7.5	10.2	n.s.
Mesquite	0.0	0.0	n.s.
Other	1.5	1.6	n.s.
Maximum Veg. Ht. (cm)	91.3	67.2	*; t=2.71, df=7, p=0.032
Canopy Height (cm)	24.7	10.8	*; t=2.64, df=6, p=0.040
Density (contacts)			
Less than 10 cm	2.06	1.45	n.s.
10 to 50 cm	1.89	0.80	t=2.27, df=6, p=0.062
Greater than 50 cm	0.17	0.00	n.s.
No. Woody Stems Per m^2			
Shinnery oak	24.19	24.64	n.s.
Sand sagebrush	0.28	0.15	n.s.
Mesquite	0.00	0.00	n.s.
Other	0.36	0.65	n.s.

In general, the tebuthiuron-treated areas (Weaver Ranch) had less shinnery oak canopy cover than did the untreated areas (North Bluitt PCA). This is in keeping with the expected effects of the tebuthiuron treatment, although the shinnery oak may not have been defoliated during the entire season. The Weaver Ranch also had lower maximum vegetation height and lower canopy height, and tended to have less vegetation density in the middle level (10 to 50 cm above ground). This may be a result of previous years' grazing on the Weaver Ranch. The North Bluitt PCA has been completely ungrazed since 1991 (erratum to Sutton Avian Research Center 2000).

Nesting Habitat

We will compare nesting habitat three ways: 1) between nests and non-nest habitat; 2) between nests on the two treatment areas (Weaver Ranch and North Bluitt PCA); and 3) between successful and unsuccessful nests.

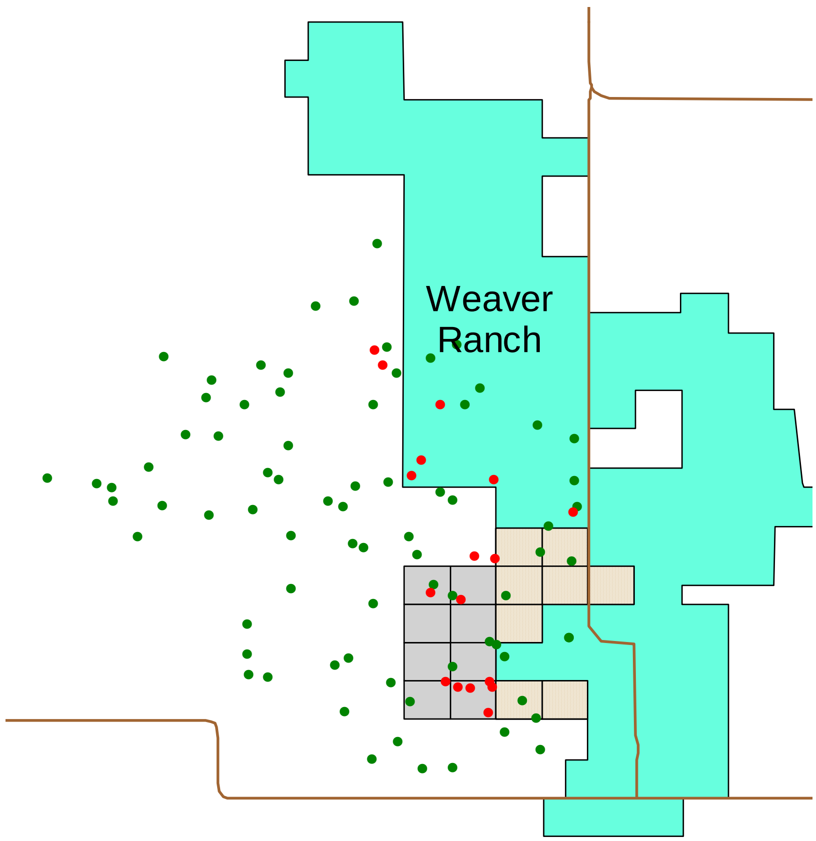
To allow these comparisons of nesting habitat, we measured the vegetation at a point centered on each nest (as well as at random points and bird locations; see Methods, above). All nest vegetation measurements were made after the nest had hatched or had failed, so that we did not disturb the nest when it was active. This may cause some bias, because the vegetation characteristics that were present at the time the hen chose the nest site may not be present when the vegetation data were finally collected, after up to four weeks of incubation. However, this is an unavoidable problem. We also made measurements of vegetation characteristics at a randomly selected set of points within the study area.

The vegetation measurements at a nest were more extensive than those made elsewhere, but the non-nest measurements are a subset of the nest measurements. Therefore, by using only the same subset of measurements at the nest, the nest and non-nest points are comparable. In addition, to make the nest and non-nest vegetation measurements temporally comparable, we used vegetation measurements collected at non-nest points only within roughly the same time span as measurements made at the nests. This therefore reduces bias as much as possible, by equalizing the amount of growth by the vegetation, amount of time areas have been grazed by cattle (where grazed), etc. All vegetation measurements for the nests were obtained between 20 May and 16 June 2001.

Comparison of Nest and Non-nest Habitat

We compared the nest vegetation measurements with non-nest points on the Weaver Ranch, North Bluitt PCA, and the adjacent private ranches, for the period from a week before the nest vegetation measurements were taken to a week after, that is, from 13 May to 23 June 2001. This includes 77 vegetation points. A map showing the locations of the nest and non-nest locations is given below (Fig. 12). We used 23 points for comparisons only between the Weaver Ranch (17 points) and North Bluitt PCA (six points).

Fig. 12. Locations of random and nest vegetation characterization points. Nest locations are in red; non-nest locations are in green. As on other figures, the aquamarine area is the Weaver Ranch, beige areas are tebuthiuron-treated plots, and gray areas are control plots on North Bluitt PCA.



Of the 77 random vegetation points, all were in native prairie habitat except one on "other" (which is likely an oil well pad; other does not include any cultivated or CRP land uses). All 18 nests were in the native prairie habitat type. Of the 18 nests, however, 14 (78%) were located on ungrazed land (see table below), while only 30 (39%) of the random points were on ungrazed land. This difference is significant ($\chi^2 = 8.84$, df = 1, P = 0.003), and indicates that the prairie-chickens were choosing to place their nests on ungrazed lands.

Table 14. Grazing type categories of the vegetation characterization points, by nest and random (non-nest) points, on the North Bluitt PCA, Weaver Ranch, and on the other private ranches.

	Non-Nest		Nest	
Type	Number	Percent	Number	Percent
Cattle grazing	47	61	4	22
No grazing	30	39	14	78
TOTAL	77	100	18	100

The comparison of other vegetation characteristics of nests and all random vegetation points on the North Bluitt PCA, Weaver Ranch, and on the other private ranches can be seen in Table 15. The results of these comparisons indicate that Lesser Prairie-Chickens in the area studied were selecting locations for nesting with a greater amount of shinnery oak stems but less shinnery oak canopy cover. (This may be an effect of the tebuthiuron treatment; the shinnery oak may have been defoliated and therefore presented no canopy cover, but a large number of oak stems were still present.) They also selected areas with a greater number of stems of other woody plant species (broom snakeweed, yucca, cholla, etc.) than was found at the random points. The birds selected areas with a greater maximum vegetation height, which may be a result of greater tallgrass canopy cover. They generally selected areas with less cover at ground level, as measured by lower shortgrass and other woody plant species basal cover.

Table 15. Vegetation characteristics at all nests and random points on the North Bluitt PCA, Weaver Ranch, and on the other private ranches. The t-test value, degrees of freedom, and probability are given only for those tests where p<0.100.

Characteristic	Non-Nest	Nest	t, df, p
Canopy Cover (%)			
Shinnery oak	22.4	16.4	*; t=-2.04, df=48, p=0.047
Tallgrass	6.7	13.7	*; t=2.51, df=25, p=0.019
Sand sagebrush	0.5	1.6	n.s.
Shortgrass	3.6	2.5	n.s.
Mesquite	0.7	0.0	n.s.
Other	2.8	4.0	n.s.
Basal Cover (%)			
Shinnery oak	0.7	0.6	n.s.
Tallgrass	4.2	5.5	n.s.
Sand sagebrush	0.0	0.0	n.s.
Shortgrass	7.1	2.6	**; t=-2.89, df=91, p=0.005
Mesquite	0.0	0.0	n.s.
Other	1.9	0.4	*; t=-2.45, df=93, p=0.016
Maximum Veg. Ht. (cm)	67.1	88.8	***; t=4.23, df=27, p<0.001
Canopy Height (cm)	12.8	18.4	n.s.
Density (contacts)			
Less than 10 cm	0.90	0.69	n.s.
10 to 50 cm	0.99	1.04	n.s.
Greater than 50 cm	0.02	0.04	n.s.
No. Woody Stems Per m^2			
Shinnery oak	34.87	121.79	***; t=6.80, df=19, p<0.001
Sand sagebrush	0.19	0.33	n.s.
Mesquite	0.03	0.05	n.s.
Other	0.57	1.53	*; t=2.38, df=22, p=0.026

The maximum vegetation height we recorded in the vicinity of the nest (89 cm) was slightly lower than the 102 cm recorded last year in this area (Sutton Avian Research Center 2000), but this may be a result of different climate conditions in the two years resulting in different availability of taller grasses. Both values were higher than those recorded immediately at the nest by other researchers (43-81 cm; Giesen 1998). Otherwise, nest characteristics recorded in this study seem typical of those reported by others in Giesen (1998).

A further comparison with the results in 2000 (Sutton Avian Research Center 2000) shows some similarities and differences. Nests in 2000 tended to have greater shinnery oak canopy cover than those in this study. Both showed a greater number of shinnery oak stems at the nests. Both also showed lower basal cover by shortgrass and other woody species at the nests. In the current study this did not translate to a significantly lower vegetation density (as measured by rod contacts) at the ground level. In general, however, both studies agree on most nest vegetation characteristics.

Haukos and Smith (1989) found that overhead cover and side-screening cover at the nest were the most important vegetation characteristics at nests they studied. Although our vegetation measures are not directly comparable with those they used, the higher amount of tallgrass canopy cover would fit in especially well with their results. They also found that the Lesser Prairie-Chickens preferred ungrazed bluestem (a tallgrass) grasses for nesting. They suggested that lands treated with tebuthiuron to reduce shinnery oak should be only lightly grazed, to allow the grasses to grow taller and more dense and provide cover for prairie-chicken nests.

Comparison of Nesting Habitat Among Treatments

To further examine the effects of the tebuthiuron treatment, we compared nest vegetation characteristics of only those eight nests on the North Bluitt PCA with the five nests located on the Weaver Ranch.

The habitat at the nests differed little between the two treatments in spring 2001. In fact, the nests on the two treatments differed only in one of the characters, tallgrass canopy cover, which was greater on the North Bluitt PCA (Table 16), although there is a tendency for the canopy height and maximum vegetation height to also be higher on the PCA. These canopy height measures, however, are probably related to the tallgrass canopy cover.

Table 16. Vegetation characteristics at eight nests on the North Bluitt PCA and five nests on the Weaver Ranch. The t-test value, degrees of freedom, and probability are given only for those tests where p<0.100.

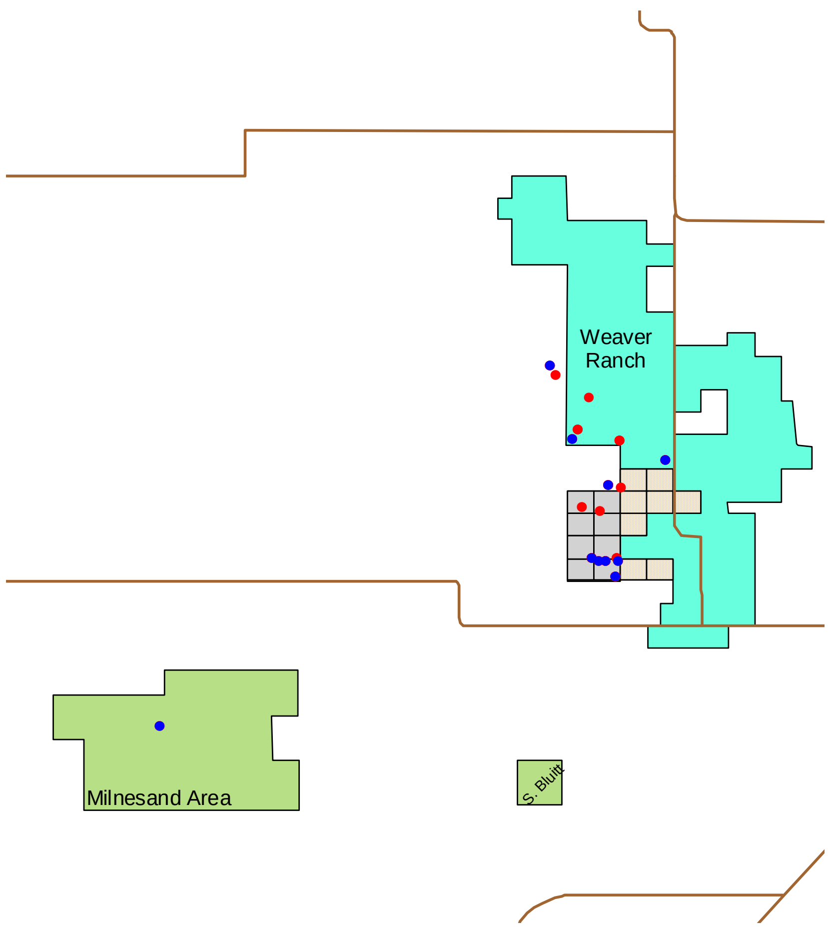
Characteristic	N. Bluitt	Weaver	t, df, p
Canopy Cover (%)			
Shinnery oak	18.6	17.5	n.s.
Tallgrass	22.3	8.7	**; t=3.27, df=11, p=0.007
Sand sagebrush	2.3	0.0	n.s.
Shortgrass	1.4	3.6	n.s.
Mesquite	0.0	0.0	n.s.
Other	5.5	2.9	n.s.
Basal Cover (%)			
Shinnery oak	0.9	0.7	n.s.
Tallgrass	6.8	6.5	n.s.
Sand sagebrush	0.0	0.0	n.s.
Shortgrass	2.7	2.2	n.s.
Mesquite	0.0	0.0	n.s.
Other	0.5	0.7	n.s.
Maximum Veg. Ht. (cm)	95.4	82.8	n.s.
Canopy Height (cm)	28.8	12.7	n.s.
Density (contacts)			
Less than 10 cm	0.71	0.93	n.s.
10 to 50 cm	1.58	0.73	n.s.
Greater than 50 cm	0.08	0.00	n.s.
No. Woody Stems Per m^2			
Shinnery oak	122.23	134.07	n.s.
Sand sagebrush	0.42	0.00	n.s.
Mesquite	0.10	0.00	n.s.
Other	1.96	2.20	n.s.

That the Weaver Ranch (tebuthiuron-treated) and North Bluitt PCA (untreated) differed little, even in amount of shinnery oak cover and stem counts, is probably a result of the fact that the tebuthiuron treatment did not become effective until relatively late in the breeding season in 2001 (see Page 12). Differences between the treatments may be more apparent in 2002 and years beyond.

Comparison of Nesting Habitat Between Successful and Unsuccessful Nests

Besides determining in what habitat the prairie-chickens place their nests, it is important to determine in what habitat those nests are successful. Because nest habitat on the Weaver Ranch and North Bluitt PCA differed little, all nests will be used in this comparison. Of the 18 nests located in 2001, ten were successful and eight failed. Their locations can be seen in Fig. 13.

Fig. 13. Locations of the successful and unsuccessful nests, spring 2001. Red points indicate unsuccessful nests; successful nests are in blue. As on other figures, the aquamarine area is the Weaver Ranch, beige areas are tebuthiuron-treated plots, gray areas are control plots on North Bluitt PCA, and the green areas are Milnesand PCA (large area in southwest) and South Bluitt PCA (square area in south).



Of the ten successful nests, two were on the Weaver Ranch, five on the North Bluitt PCA, two were on other private ranches, and one was on the Milnesand PCA (see also Table 12).

The comparison of the habitat characteristics can be seen in Table 17, below. As with the comparison between the tebuthiuron-treated and untreated areas (Table 16, in section above), there is little difference in the habitat between the successful and unsuccessful nests. Only two vegetation characteristics approach statistical significance (shortgrass canopy cover and vegetation density in the less than 10 cm level).

Table 17. Comparison of vegetation characteristics at ten successful and eight unsuccessful nests in spring 2001. The t-test value, degrees of freedom, and probability are given only for those tests where p<0.100.

Characteristic	Successful	Failed	t, df, p
Canopy Cover (%)			
Shinnery oak	16.0	16.8	n.s.
Tallgrass	15.3	11.8	n.s.
Sand sagebrush	2.5	0.5	n.s.
Shortgrass	1.1	4.1	t=2.16, df=10, p=0.057
Mesquite	0.0	0.0	n.s.
Other	4.0	4.1	n.s.
Basal Cover (%)			
Shinnery oak	0.4	0.9	n.s.
Tallgrass	4.0	7.3	n.s.
Sand sagebrush	0.0	0.0	n.s.
Shortgrass	2.5	2.7	n.s.
Mesquite	0.0	0.0	n.s.
Other	0.0	0.9	n.s.
Maximum Veg. Ht. (cm)	92.7	84.0	n.s.
Canopy Height (cm)	21.0	15.1	n.s.
Density (contacts)			
Less than 10 cm	0.40	1.04	t=1.76, df=14, p=0.099
10 to 50 cm	1.10	0.96	n.s.
Greater than 50 cm	0.03	0.04	n.s.
No. Woody Stems Per m^2			
Shinnery oak	102.37	146.05	n.s.
Sand sagebrush	0.42	0.22	n.s.
Mesquite	0.09	0.00	n.s.
Other	1.57	1.54	n.s.

There is a tendency for canopy vegetation in the vicinity of successful nests to have less shortgrass cover, more tallgrass, and greater height than in the vicinity of unsuccessful nests. Basal cover tends to be lower at successful nests, and this is also reflected in lower vegetation density at those nests. Shinnery oak stems tend to be fewer at successful nests, although this is not reflected in less shinnery oak canopy cover. However, because none of the vegetation characters differed significantly, little can be said definitively.

Giesen (1998) reported that successful nests were positively correlated with height and density of residual grasses, nests within or adjacent to tall bunchgrasses or shrubs were more likely to be successful, and successful nests were associated with more litter and less bare ground. Our data generally support these earlier conclusions. It is not clear, however, how our data on basal cover relate to Giesen's (1998) information on litter and bare ground.

Habitat Use at Non-Nesting Locations

Although nesting habitat is very important to the prairie-chickens, information on the general habitat used by the birds is also important. We compared vegetation characteristics at locations used by the prairie-chickens ("prairie-chicken vegetation locations") and at points not used by prairie-chickens ("random locations"). These locations do not include gobbling grounds or nest sites. PLEASE NOTE THAT THE TERMS "PRAIRIE-CHICKEN VEGETATION LOCATIONS" AND "RANDOM VEGETATION LOCATIONS" USED HERE REFER TO VEGETATION POINTS.

Almost all locations in the study area were in Native Prairie habitat (Table 18), with only three of 245 points in a different habitat type. Because both the random and prairie-chicken vegetation locations were in one habitat type, it is not possible to determine if the prairie-chickens had selected a specific habitat type, since they were given little in the way of habitat type choices.

Table 18. Habitat type categories of the vegetation characterization points, by prairie-chicken vegetation locations and random locations.

	Prairie-chicken Vegetation Locations		Random Locations	
Type	Number	Percent	Number	Percent
Plowed / No growth	1	1	0	0
Other	0	0	1	1
Native Prairie	166	98	76	99
Other / Unknown	1	1	0	0
TOTAL	168	100	77	100

The prairie-chickens did have a choice of areas grazed by cattle and ungrazed areas. Of the random vegetation locations, 61% were grazed (Table 19). However, the prairie-chickens were located on ungrazed lands slightly more than half the time. This difference was not quite significant at the p = 0.05 level ($\chi^2 = 3.48$, df = 1, P = 0.062), but it does indicate that the birds tended to prefer ungrazed lands.

Table 19. Grazing type categories of the vegetation characterization points, by prairie-chicken vegetation locations and random vegetation locations.

Type	Prairie-chicken Vegetation Locations		Random Locations	
	Number	Percent	Number	Percent
Cattle grazing	81	48	47	61
No grazing	87	52	30	39
TOTAL	168	100	77	100

The prairie-chickens did select areas with greater amounts of sand sagebrush and shortgrass canopy cover than was found in the area in general, and with greater vegetation density in the middle level (10 to 50 cm). They also tended to choose areas with greater canopy height and less canopy cover by shinnery oak (Table 20). They chose areas with less basal cover by shortgrass and other species (for example, cholla, yucca, or broom snakeweed).

Table 20. Vegetation characteristics at prairie-chicken vegetation locations and random vegetation locations. The t-test value, degrees of freedom, and probability are given only for those tests where p<0.100.

Characteristic	Prairie-chicken Veg. Locations	Random Veg. Locations	t, df, p
Canopy Cover (%)			
Shinnery oak	18.5	22.4	t=-1.76, df=115, p=0.081
Tallgrass	6.1	6.7	n.s.
Sand sagebrush	1.4	0.5	*; t=2.10, df=243, p=0.036
Shortgrass	6.1	3.6	*; t=2.29, df=137, p=0.023
Mesquite	0.1	0.7	n.s.
Other	3.9	2.8	n.s.
Basal Cover (%)			
Shinnery oak	1.2	0.7	n.s.
Tallgrass	2.6	4.2	n.s.
Sand sagebrush	0.1	0.0	n.s.
Shortgrass	3.6	7.1	*; t=-2.42, df=98, p=0.017
Mesquite	0.0	0.0	n.s.
Other	0.7	1.9	*; t=-2.07, df=95, p=0.041
Maximum Veg. Ht. (cm)	69.5	67.1	n.s.
Canopy Height (cm)	14.6	12.8	t=1.72, df=144, p=0.088
Density (contacts)			
Less than 10 cm	1.04	0.90	n.s.
10 to 50 cm	1.30	0.99	*; t=2.28, df=182, p=0.024
Greater than 50 cm	0.05	0.02	n.s.
No. Woody Stems Per m^2			
Shinnery oak	35.84	34.86	n.s.
Sand sagebrush	0.10	0.19	n.s.
Mesquite	0.01	0.03	n.s.
Other	0.57	0.57	n.s.

Sutton Avian Research Center (2000) found that the prairie-chicken vegetation locations generally had higher shinnery oak canopy cover than random vegetation locations, and did not find differences in canopy cover by sand sagebrush and shortgrass, as was found in this study. Both studies agree that random locations had greater basal cover by shortgrass and "other" plants. Vegetation density at the middle level (10 to 50 cm above ground) was significantly greater at prairie-chicken vegetation locations than at random locations in both studies, and canopy height tended to be greater. In contrast, however, the number of shinnery oak stems was very significantly greater at prairie-chicken vegetation locations than at random points in the previous study; in the current study, there was no significant difference.

The differences between these two studies may be a result of using different study areas. The study in 2000 included distant areas such as Milnesand PCA, whereas the current study includes only North Bluitt PCA, Weaver Ranch, and the immediate surrounding areas.

Prairie-Chicken Population Estimate

It is very difficult to estimate the population density or even to provide an index to density from our present data. The numbers of birds recorded at the gobbling grounds through the trapping season of 2001 are shown in Table 21. Note however that the numbers of birds counted on the lek generally do not include hens, but generally only reflect the number of males on the gobbling ground. *Therefore, the numbers given probably do not reflect the total prairie-chicken population in the area, which may be nearly twice the figures given (assuming as many hens as cocks in the population).*

Using the maximum numbers from each lek gives a maximum number of Lesser Prairie-Chickens at the 12 leks of 119 birds. However, this probably over-counts the number of individuals, because some individuals may have been counted at more than one lek during the spring. (On the other hand, it probably does not include many hens, so the number may be nearly twice that figure.) April has the greatest activity at the gobbling grounds. Using only the data from April plus data for the leks not counted in April (leks 3, 5, 9, 10, 11, and 12) produces an estimate of 106 (male) birds.

Because it is not known if other leks or how many other leks existed in the study area, or exactly what are the limits of the area from which the population is drawn, this number cannot be used to calculate a density of birds or to compare bird densities between sites or treatments. The estimate in 2001 of 106 birds is larger than the estimate from spring 2000 of 87 birds (Sutton Avian Research Center 2000), although a different set of leks covering different areas was counted in each year, so the data are not exactly comparable. However, five new leks were found in spring 2001 that were not known in spring 2000, which may indicate that there was an actual increase in the total number of birds. For example, Lek 8 is near Lek 1, but was not known to have any birds on it in spring 2000.

In the previous year's report (Sutton Avian Research Center 2000), counts are reported from some of the same leks surveyed in 2001, and the counts were made in the same months of 2000; thus some comparison can be made for these leks. The leks that were counted in both years are 1, 6, 7, and 4 (all counted during April) and 5 (counted in March). The maximum number of birds reported at these leks in 2000 was 48, with 46 recorded in 2001; the difference by lek was not significant (paired $t = 0.39$, $df = 4$ $P = 0.717$). The average number of birds recorded at these leks in 2000 was 38.3 birds, with an average of 35.8 recorded in the current study. This difference was also not statistically significant (paired $t = 0.61$, $df = 4$, $P = 0.573$). This suggests that at these five leks the numbers are similar in 2001 and 2000.

Please keep in mind that these numbers probably do not reflect the total prairie-chicken population in the area, which may be nearly twice the figures given (assuming as many hens as cocks in the population).

Table 21. Numbers of birds recorded in 2001 at gobbling grounds, by month and by location. **NOTE**: The number does not distinguish between males and females. Few females are generally recorded on the gobbling grounds. Therefore, the number of birds actually in the area may be as much as twice as high as the numbers given here.

The average is the average for the month of the *maximum recorded on a particular day*. The maximum value given is the maximum value recorded at the lek for the entire month. The No. Days is the number of days data were recorded at the lek. The leks are grouped according to whether located in the tebuthiuron study area or outside the study area; whether located on the North Bluitt PCA (untreated), Weaver Ranch (tebuthiuron-treated), or on other private ranches. "WR" is the Weaver Ranch; Lek 2 is on the Weaver Ranch and in an area that was tebuthiuron-treated, but is outside the tebuthiuron study area.

	Tebuthiuron Study Area					Outside Tebuthiuron Study Area							TOTAL
	North Bluitt PCA			Weaver Ranch		WR	Other Private Ranches						
Lek ID	1	3	8	6	7	2	4	5	9	10	11	12	
Feb.													
Ave.	5.0						14.0						19.0
Max.	6						14						20
No. Days	3						1						4
Mar.													
Ave.	2.5	3.0		7.3	8.2	15.0	11.0	8.5	10.0				65.5
Max.	5	3		16	13	16	12	10	10				85
No. Days	2	1		4	5	4	2	4	1				23
Apr.													
Ave.	5.7		7.4	8.1	6.5	15.3	7.0						50.0
Max.	6		13	11	9	16	10						65
No. Days	3		8	9	4	4	6						34
May													
Ave.							10.0	7.0		6.0	8.0	4.0	35.0
Max.							10	10		6	8	4	38
No. Days							1	3		1	1	1	7

GENERAL DISCUSSION

Effects of Grazing

Because none of the tebuthiuron study plots was grazed in spring 2001 (counter to the original experimental design), no effects of grazing on the Lesser Prairie-Chicken population or nesting could be determined by this study. See also Page 12.

Effects of Tebuthiuron Treatment

Haukos and Smith (1989) found a significantly greater number of nests located on untreated lands as opposed to areas treated with tebuthiuron to control shinnery oak. In the present study, however, no comparisons were possible, because nests were not found on the tebuthiuron-treated portion of the tebuthiuron study area, but were found outside the tebuthiuron study area nearby in tebuthiuron-treated areas of the Weaver Ranch.

As noted on Page 12, the current study probably should not be considered representative of the effects of tebuthiuron treatment of shinnery oak on Lesser Prairie-Chicken populations and nesting. Tebuthiuron affects growing-season woody plants such as shinnery oak. Because the herbicide was applied before the current growing season, and because the growing season did not begin until about mid-way through the current study, the effects of the tebuthiuron treatment were not apparent until fairly late in the current study. Therefore, the results of the current study may not be representative of the long-term effects of application of tebuthiuron. Differences in habitat between the North Bluitt PCA and Weaver Ranch may be a result of the differences in historical use of the two properties: the PCA has not been grazed for many years, whereas the Weaver Ranch is a working ranch and has been at least lightly grazed.

Comparison of North Bluitt PCA and Weaver Ranch

Although differences between the PCA and the Weaver Ranch cannot necessarily be attributed to tebuthiuron treatment, there were some differences in the habitat. (A more extensive comparison of the PCAs and the Weaver Ranch and surrounding private ranches can be seen in Sutton Avian Research Center 2000, although most comparisons in that report include Milnesand PCA in addition to North Bluitt PCA.) In general, the Weaver Ranch had less shinnery oak canopy cover, and lower maximum vegetation and canopy heights (Table 13). It also tended to have lower vegetation density in the mid level 10 to 50 cm above ground. These characteristics generally were shown to be the same in the previous report (Sutton Avian Research Center 2000), although in some cases to a greater or lesser magnitude.

Even though there were slight differences between the North Bluitt PCA and Weaver Ranch, these differences did not appear to translate to effects on the prairie-chickens. Maximum movement distances and home range sizes did not differ. Nesting was also not affected; nest success was not significantly different, and vegetation characteristics at the nest were also not significantly different except for tallgrass canopy cover.

The tebuthiuron treatment probably did not affect the habitat greatly in the nesting season of 2001. However, the effects of the herbicide may become more apparent in future years. As shown by Olawsky and Smith (1991), forbs and grasses should increase over the next three to five years in the treated areas, while shrub cover should decrease. Olawsky and Smith (1991), however, were not able to show that these changes had affected the population of prairie-chickens. They suggested that Lesser Prairie-Chickens might benefit from a mosaic of treated and untreated areas.

CONCLUSIONS

- Annual survivorship was 25% – 59% for all birds combined, but was probably slightly lower for hens.
- Seasonal survivorship was lowest for both sexes during the gobbling season, and was highest in the summer months. Surprisingly, seasonal survivorship was not lower for hens with nests or broods.
- No hens died or were lost in the tebuthiuron study area, so no difference could be determined for hens between the two study areas. Seven cocks died and four were lost in the study area, but there was no significant difference between the tebuthiuron-treated and untreated areas.
- The maximum distance moved by prairie-chicken hens was on average about 2.8 km, while the cocks moved less, only about 1.0 km. The average home range size of hens was about 2.3 km^2, and for cocks was about 1.0 km^2. These distances and range sizes did not differ between the tebuthiuron-treated and untreated areas.
- Hens generally chose to nest within about 1.3 km of the gobbling ground on which they were recorded.
- Ten of 18 nests were successful, for a Mayfield hatching success estimate of 50.2%. For 27 nests located in 1999 – 2001, the Mayfield hatching success estimate is 49.2%.
- Nest success did not differ between the tebuthiuron-treated areas of the Weaver Ranch and untreated areas on North Bluitt PCA.
- The vegetation of the tebuthiuron-treated areas and untreated areas differed primarily in having greater shinnery oak canopy cover and greater maximum vegetation and canopy heights on the North Bluitt PCA than on the tebuthiuron-treated Weaver Ranch.
- For nest sites, the prairie-chickens selected ungrazed over grazed areas.
- All nest sites combined had less shinnery oak but greater tallgrass canopy cover, less basal cover by shortgrass and "other" (mainly forbs), a greater maximum vegetation height, and a greater number of shinnery oak and other woody plant species (broom snakeweed, yucca, cholla, etc.) stems than did random non-nest sites.
- The nest sites in the tebuthiuron study area showed few differences in vegetation characteristics. Those nests differed only in amount of tallgrass canopy cover, which was greater in the untreated areas.
- For all nests combined, the difference in no vegetation characteristic between successful and unsuccessful nests was statistically significant, although unsuccessful nests tended to have greater shortgrass basal cover and greater vegetation density in the lower level (from 0 to 10 cm above ground).
- At non-nest non-lek locations the prairie-chickens selected areas with greater amounts of sand sagebrush and shortgrass canopy cover than was found in the area in general, and with greater vegetation density in the middle level (10 to 50 cm). They tended to choose areas with greater canopy height and less canopy cover by shinnery oak, and they chose areas with less basal cover by shortgrass and other species (for example, cholla, yucca, or broom snakeweed).

- Possibly 106 individual Lesser Prairie-Chickens were counted on 12 leks during spring 2001, although some may have been duplicate counts. This compares with a total of 87 birds in spring 2000. On five leks at which counts were made in 2000 and 2001, the numbers in 2001 were slightly but not statistically significantly lower.
- Although there were slight differences in vegetation characteristics in the North Bluitt PCA and Weaver Ranch, these differences did not appear to translate to effects on the prairie-chickens in spring 2001. The tebuthiuron treatment probably did not affect the habitat greatly in the nesting season of 2001. However, the effects of the herbicide may become more apparent in future years.

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