Ecological Assessments of the Lesser Prairie-chicken (*Tympanuchus pallidicinctus*) in Southeastern New Mexico

by

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ABSTRACT

In this study of lesser prairie-chickens (*Tympanuchus pallidicinctus*), I constructed artificial leks using audio playback (aural stimuli) and decoys (visual stimuli) on active leks, as well as on abandoned lekking locations to examine the effect of aural and visual cues from conspecifics on daily patterns of attendance on active and abandoned lekking locations during the breeding season. I monitored 10 active leks for 6 consecutive days; 3 days without audio playback and decoys followed by 3 days with audio playback and decoys. I also monitored 10 abandoned lekking locations. Attendance on active leks in absence of additional stimuli did not differ significantly from attendance on these leks with additional aural and visual stimuli. Use of audio playback and decoy stimuli attracted 1-3 birds to 6 of 10 abandoned lekking locations. Behavioral observations and patterns of attendance indicated that audio playback and decoys stimulated increased activity and duration of displaying at leks, and attracted birds to abandoned lekking locations. Use of audio playback and decoys in monitoring and management of small populations of lesser prairie-chickens was also examined. I examined 32 abandoned lekking locations and one active lek in southeastern New Mexico. I used decoys of lesser prairie-chickens and an audio system to broadcast sounds of displays to simulate an active lek on abandoned lekking locations. Locations were in areas near reported sightings of lesser prairie-chickens and where active leks were no longer known to exist. These artificial leks were monitored for 3 consecutive days with audio playback and decoy stimuli present. Of 32 abandoned lekking locations monitored, lesser prairie-chickens were observed on five lekking

locations. Observation of individuals on three of the five locations appeared to be in response to audio playback, whereas observations on two locations occurred in absence of audio playback and decoys. Results offered evidence that lesser prairie-chickens respond to presence of conspecifics and may use attraction by conspecifics to select breeding habitats. I also assessed vegetative characteristics of pastures associated with active leks and pastures associated with abandoned lekking locations to determine which characteristics of habitat were associated with areas used by lesser prairie-chicken. Data provided by J. L. Hunt were analyzed using logistic regression and resulting models indicated that habitat characteristics for lesser prairie-chickens had a positive correlation with *Andropogon*, *Aristida*, *Prosopis*, *Quercus*, and *Senecio*; and a negative correlation with *Artemesia*, *Eriogonum*, *Muhlenbergia*, *Panicum*, forbs, and bare ground. Results are symptomatic of the negative effects of overgrazing and treatment with herbicides. Finally, I examined characteristics of 17 Habitat Evaluation Areas (HEAs) established by the Bureau of Land Management in southeastern New Mexico. Composition of vegetation on HEAs consisted primarily of shinnery oak (*Quercus havardii*), sand dropseed (*Sporobolus cryptandrus*), and purple threeawn (*Aristida purpurea*), and represented 73% of vegetation on HEAs. Most HEAs included shinnery oak, sand dropseed, purple threeawn, and yucca. In addition to vegetation, cover was on average 19% bare ground (range 6-34%) and 37% litter (range 22-60%). Structure matrices of discriminant-function analyses indicated that vegetative cover of HEAs differed from pastures containing active leks primarily in amount of *Sporobolus*, *Cenchrus*, and *Andropogon*. HEAs typically had significantly more *Sporobolus* and *Cenchrus,* and less *Andropogon* than pastures containing active leks. Average vegetative cover of HEAs, as determined from Robel visual-obstruction values, was 20.85 for the 17 HEAs in 2007-2008 (range = 9.93-40.26); 20.37 for the 7 assessed in 2007, and 21.53 for the 10 assessed

in 2008. Robel-values decreased for each of 16 HEAs reassessed in 2012 to an average of 14.16, a 30.45% decrease on average (range 10.98-60.16%). Despite the decrease in vegetative cover on HEAs by 2012, cover remained 31.61% greater ($P < 0.001$), than the average for pastures containing active leks, and 37.50% greater ($P < 0.001$) than the average for pastures containing abandoned lekking locations. Despite adequate vegetative cover, populations of lesser prairie-chickens have not rebounded.

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CHAPTER 1

RESPONSE OF THE LESSER PRAIRIE-CHICKEN (*TYMPANUCHUS PALLIDICINCTUS*) TO AUDIO PLAYBACK AND DECOYS ON LEKS

Cues indicating presence of conspecifics may play an important role in selecting habitats for breeding. Some birds may cue in on evidence or displays of conspecifics rather than searching only for an appropriately structured habitat for breeding. Cues from conspecifics may be necessary to attract individuals to the breeding area and serve as a stimulus for establishing territories (Muller et al. 1997, Parker et al. 2007). Conspecific attraction, the tendency for individuals of a species to settle near one another (Schlossberg and Ward 2004, Ahlering and Faaborg 2006), has been used in the conservation of colonial birds for ≥25 years (Burger 1988, Ward and Schlossberg 2004).

Lekking is a mating system that consists of a gathering of males called a lek that females visit solely for the purpose of mating (Höglund and Alatalo 1995). Males give elaborate aural and visual displays at lekking locations during the breeding season. These displays may serve as conspicuous cues to advertise location of leks, location of territories, fitness of males, intentions of courtship, to defend territories from neighboring males, and to establish relative dominance among males (Sharpe 1968, Höglund and Alatalo 1995). Leks may provide conspecifics with information on quality of habitat, information on access to females, sexual stimulation, and benefits such as protection from predators (Höglund and Alatalo 1995).

Many species of lekking birds are in decline. Loss of habitats due to drought, fragmentation, overgrazing by livestock, and conversion of habitats to agriculture have reduced populations of most prairie grouse in North America (Johnsgard 2002). Additional threats to populations of prairie grouse include continued loss of habitat due to development of wind farms and extraction of oil and gas, and may also include compounding effects of climatic change, reduced viability of small populations, and emergent diseases (Bailey and Williams 2000, Johnsgard 2002).

Techniques such as audio playback of calls (aural stimuli) and decoys (visual stimuli) may attract conspecifics, providing a new tool for management of many species. Efforts to conserve populations of prairie grouse and other species of birds have used these techniques to simulate presence of conspecifics to attract individuals to newly established or restored breeding areas. Prairie grouse can be attracted to lekking locations using audio playback and decoys of displaying conspecifics (Hamerstrom and Hamerstrom 1960, Silvy and Robel 1967, Artmann 1970, Eng et al. 1979, Rodgers 1992). Artmann (1970) attracted sharp-tailed grouse (*Tympanuchus phasianellus*) using decoys and audio playback. Recorded vocalizations also have attracted greater prairie-chickens (*Tympanuchus cupido*) to lekking locations in efforts to increase trapping success (Silvy and Robel 1967). Hamerstrom and Hamerstrom (1960) stimulated the breeding display of male greater prairie-chickens and male sharp-tailed grouse to study their social displays. A few studies have used audio playback and decoys to facilitate establishment of leks. Eng et al. (1979) attracted sage grouse (*Centrocercus urophasianus*) from an existing lek to a human-constructed location by using decoys and audio playback. A study involving reintroduction of sharp-tailed grouse was successful in establishing leks using these procedures (Rodgers 1992). However, these techniques have not been used to study the lesser prairie-chicken (*Tympanuchus pallidicinctus*).

The lesser prairie-chicken is one of 12 species of grouse that occur in North America. This species inhabits areas of short or mixed-grass prairie in Colorado, Oklahoma, Kansas, New

Mexico, and Texas. The lesser prairie-chicken is a candidate species for listing as threatened or endangered under the Endangered Species Act because of substantial reductions in populations and geographic range (Johnsgard 2002, United States Fish and Wildlife Service 2011). Adult males congregate on leks to perform courtship displays and to mate with females each spring, usually from mid-March to late May (Johnsgard 2002). Displays consist of: cackling, whining, and booming vocalizations; non-vocal cues, such as stamping feet, shaking wings, fluttering wings and tail; and leaps, runs, and postures (Giesen 1998). Displays are performed on traditional lekking locations and although some males may relocate to harvested grain fields that may be several kilometers from their lekking locations for feeding in autumn and winter (Copelin 1963, Campbell 1972, Giesen 1998), adult male lesser prairie-chickens usually are faithful throughout life to the same lekking locations where they initially established territories (Copelin 1963, Campbell 1972, Johnsgard 2002). Some lekking locations have been in the same location for ≥29 years (Copelin 1963), although locations may not be used every year. Many factors such as size of population, density of population, stability of lek, longevity of lek, reproductive success, environment, and habitat may influence whether a lek continues or fails.

Despite extensive studies of leks and lekking locations of the lesser prairie-chicken, little is known about establishment of leks or the role of attraction by conspecifics in determining number of birds attending the lek, number of territories of males that are established, number of females attracted, or duration of lekking each day and season. The objective of my study was to examine the effect of aural and visual cues from conspecifics on daily patterns of attendance on active and abandoned leks of lesser prairie-chickens during the breeding season. My study tested the hypothesis that attraction of conspecifics is responsible for enticing individuals to attend leks and stimulates lekking behavior. I also tested the hypothesis that increased aural and visual stimuli from conspecifics affect the number of birds attending a lek and duration of lekking activity.

STUDY AREA

My study was conducted in southeastern New Mexico, north of the Hagerman Cutoff (New Mexico Highway 249), south of U. S. 70, and east of the Pecos River in Chaves and Roosevelt counties; primarily on lands managed by the Bureau of Land Management (BLM). The study area primarily was in sandy-soiled, shinnery oak (*Quercus havardii*) habitat; a principal habitat of the lesser prairie-chicken (Peterson and Boyd 1998). Land was used primarily for grazing cattle, interspersed with facilities for production of oil and gas, and scattered center-pivot and dry-land agricultural farming operations.

METHODS

Methods used by Silvy and Robel (1967) and Rodgers (1992) were adapted to study behavioral responses of lesser prairie-chickens to audio playback and decoys of conspecifics and to demonstrate that attraction by conspecifics can induce attendance at abandoned locations that have been inactive for several years. Artificial leks consisted of decoys of displaying conspecifics and playback of audio recordings (Figures 1.1 and 1.2). Artificial leks were constructed on active leks, as well as on abandoned lekking locations. The experiment was conducted mid-March to mid-May during the annual lekking period for lesser prairie-chickens (Giesen 1998). Active leks and abandoned lekking locations were determined in consultation with biologists from the Bureau of Land Management and by exploration of the study area.

The audio system consisted of a modified, continuous-play, electronic, game caller, and two weatherproof speakers (Western Rivers, Inc., Lexington, Tennessee, Figure 1.1). Recordings were made on active leks of lesser prairie-chickens by Randy R. Rogers of the

Kansas Department of Wildlife and Parks. To enhance quality of the original sound track, I sent the recording to a professional editing service where it was digitized, enhanced, and transferred to compact-disc format. The enhanced format provided a reliable, high-quality playback on a game caller in the field. The recording was broadcast at a sound intensity level approximating sounds on an active lek. Recordings were played during lekking activity in the morning.

Decoys constructed were similar to those used by Rodgers (1992). Four silhouette decoys of males in two displaying postures and one decoy of a female were constructed using life-sized color photographs of lesser prairie-chickens adhered to both sides of 3.5-mm-thick PVC plastic that was cut to match the outline of the photograph (Figure 1.2). Exposed edges of PVC plastic were painted to blend with the photos. Decoys were mounted on a 1.8-mm-diameter wire pushed or hammered into the ground, which allowed the decoy to pivot. Decoys were spaced within about a 4 x 4-m area.

During 23 March-14 May 2005, I monitored 20 locations during the morning display of lekking lesser prairie-chickens. For 6 consecutive days each, 10 active leks were monitored; 3 days without audio playback and decoys followed by 3 days with audio playback and decoys. Also monitored were 10 abandoned lekking locations. Observations were made at abandoned lekking locations to determine that no displaying male was present. Abandoned lekking locations were then monitored for 3 days with audio playback and decoys. If lesser prairie-chickens were observed on any subsequent visit, activity of those individuals was assumed to be in response to addition of aural and visual stimuli. At each location, recordings of lekking lesser prairie-chickens were played continuously for 2-3 hours beginning 30 minutes before sunrise and continued for 90-150 minutes after sunrise. Locations were monitored for activity and effect of aural and visual stimuli on attendance at leks. Locations were monitored for >2-3 hours when birds remained at the lekking location. Because birds were not marked, attendance was measured as the greatest number of individuals observed at one time during the 3 days of monitoring.

Number of males and females observed, activity on the lek, and response to stimuli were recorded during each day of observation. I compared maximum number of males attending a lek, maximum number of females attending a lek, and duration of lekking behavior on leks without artificial stimuli to that on leks with audio and decoy stimuli using paired-sample *t*-tests (SPSS version 10.0, Chicago, Illinois). I also compared attendance on abandoned lekking locations prior to addition of audio playback and decoys (no lesser prairie-chicken attending) to attendance on locations with audio playback and decoys present. Statistical analyses were not used to determine the significance of the outcomes of surveys between abandoned lekking locations with and without playback and decoys. These lekking locations were specifically chosen because it was determined that lesser prairie-chickens were not using these locations for lekking. These lekking locations had zero observations of lesser prairie-chickens prior to addition of playback and decoys. Because there was no variation associated with attendance at abandoned lekking locations prior to addition of playbacks and decoys, I was unable to calculate a mean, standard deviation, or standard error needed for parametric statistics. Nor was I able to rank locations for use in non-parametric statistical methods. Therefore, I discuss results of the comparison of attendance on abandoned lekking locations prior to addition of audio playback and decoys to attendance on locations with audio playback and decoys present in biologically significant terms as opposed to statistically significant terms.

RESULTS

Ten active leks of lesser prairie-chickens monitored in absence of audio playback and decoys averaged a maximum of 16 males/lek (range 7-26) and a maximum of 3 females/lek (range 0-8; Table 1.1). The same 10 active leks subsequently monitored with audio playback and decoys averaged a maximum of 16 males/lek (range 8-22) and a maximum of 2 females/lek (range 0-6; Table 1.1). There was no significant difference in numbers of males (P = 0.836) or females (P = 0.273) between active leks monitored without audio playback and decoys and active leks monitored with audio playback and decoy stimuli. There was no apparent difference between total number of lesser prairie-chickens attending the lek with or without audio playback and decoy stimuli (P = 0.591). However, lesser prairie-chickens responding to artificial stimuli remained on locations significantly longer (P = 0.001). Birds on active leks without artificial stimuli displayed an average of >165 minutes/day (range 55 ≥ 357), whereas birds on active leks with artificial stimuli displayed an average of >231 minutes/day (range 55 ≥ 373), a 40% increase in duration of lekking. Lesser prairie-chickens responding to audio playback also exhibited increased activity such as vigorous displaying, interactions among individuals, and inquisitive behaviors such as climbing or flying to the tallest available perch, vocalizing, and searching when audio playback commenced. Some males responded to decoys by displaying among decoys, remaining among decoys when all other birds departed, attacking decoys, and attempting to copulate with decoys of females.

Presence of audio playback and decoy stimuli attracted 1-3 lesser prairie-chickens to 6 of 10 abandoned lekking locations that were monitored in 2005 (Table 1.2). Lesser prairie-chickens responding to audio playback on abandoned lekking locations were attracted to artificial leks and exhibited inquisitive behaviors such as flying by, climbing or flying to the tallest available perch, attaining a searching posture, and vocalizing. Males responded to decoys by displaying among decoys. Lesser prairie-chickens responding to audio playback also exhibited increased activity such as vigorous displaying, and inquisitive behaviors such as climbing or flying to the tallest available perch, vocalizing, and searching when aural stimuli commenced.

DISCUSSION

My study confirms the response of lesser prairie-chickens to aural and visual cues from conspecifics on both active and abandoned lekking locations. Behavioral observations and patterns of attendance from my study indicated that audio playback and decoys elicited increased activity and duration of displaying at leks, and attracted birds to abandoned lekking locations. Techniques using attraction by conspecifics are increasingly used to facilitate restoration, translocation, or establishment of populations of threatened or endangered species. Examining effectiveness of these techniques provides information on how cues from conspecifics drive selection of lekking locations, formation and growth of leks, and effective design of management protocols.

Lekking males typically respond to attendance of a female on leks by performing displays with greater intensity (Sharpe 1968). Similarly, in my study, audio playback and decoys cued males to engage in more vigorous displaying, interactions among individuals, and inquisitive searching behaviors. Silvy and Robel (1967) were able to attract greater prairie-chickens to leks about 3 hours before sunset as opposed to the usual 1.5 hour before sunset for trapping purposes, and birds returned to leks quickly and repeatedly after being disturbed by trapping efforts. In my study, vigorous displays in response to audio playback and decoys continued for 66 minutes longer on average than displays without added stimuli, a 40% increase in duration of lekking. Birds also returned to leks quickly and repeatedly after being flushed from the lek by predators or other disturbances.

Although additional aural and visual stimuli significantly increased activity and duration of daily lekking, stimulation did not significantly alter the number of birds attending active leks. Attendance at leks averaged 16 males/lek and 2-3 females/lek regardless of level of aural and visual stimulation. Jackson and DeArment (1963) and Haukos and Smith (1999) also reported that the number of males using a lek near the peak of the breeding season was relatively stable from day to day. This stability in number of birds attending leks and consequently the ability to attract birds to a location may be influenced by social, demographic, or environmental factors (Bradbury et al. 1989).

Social organization and stability in number of birds attending a lek may be influenced by compensatory changes in number of males among nearby leks, as well as size and number of territories on leks. Jamison (2000) reported that some movement by males from one lek to another occurs. Increased attendance on one lek could be the result of movements from nearby leks or attendance of non-territorial males. The number of non-territorial or satellite males in the population may influence stability in number of males attending a lek by providing a source of replacements for males, a buffer against attrition.

Establishment of territories by males on leks prior to commencement of my study might partially explain the stability in number of males attending the leks that were assessed. It is not known when or how males establish their territories, but it is likely that territories are established during lekking in autumn, prior to lekking in spring, or as lekking commences in spring (Johnsgard 2002). Stable numbers of males attending leks may indicate that males, once they have established territories for the season, will not be induced to move to other leks, even to leks with more activity. Once males attending leks have established territories, they may also prevent additional males from forming territories on the lek.

Active leks have established social organization and territories that influence locations that prospecting birds are able to select for establishing territories. Unlike active leks, no established social organization existed on abandoned lekking locations prior to initiation of attraction of conspecifics by using audio playback and decoys. Because initial responses by prospecting birds were not influenced by territorial males, birds that were attracted were able to move into open areas to investigate and display among decoys.

Lesser prairie-chickens typically form leks with 10-15 males, but occasionally form leks of ≥40 birds (Madge et al. 2002). The largest number of males reported at a single lek was 43 observed by Copelin (1963). Average number of males attending a lek in my study area was 16 (range 8-22). My study recorded attendance at leks, and then artificially increased apparent size of the lek (number of birds) by adding decoys and increasing aural stimulation. Decoys only added five individuals (four males and one female). However, aural stimulation in conjunction with sounds of displaying males attending the lek presumably mimic the sound of a much larger lek. Larger leks may be beneficial to males attempting to establish a territory by providing information about available resources such as food, cover, or access to females. Larger leks may also increase opportunities to mate with females while territorial males are occupied by maintaining territories and dominance. Conversely, young or non-territorial males may be deterred by increased aural and visual stimulation at the lek. If increased aural and visual stimulation signals not only visitation by a female but also an increase in intrasexual aggression and conflict among males on a lek, then it may be a poor choice for non-territorial males; particularly for young or inexperienced males to attempt to join the lek at that time. On an active lek, birds with established territories most likely influence locations that prospecting birds are able to select for establishing their territories by threats and aggressive interactions. Non-territorial (surplus) males may remain in areas adjacent to leks to avoid intersexual aggression. A similar hierarchy may exist among females that visit a lek. Females sometimes display agonistic behavior toward other females, using behaviors that are similar to, but less intense than, those of males (Sharpe 1968). Females, particularly subordinate females, may similarly avoid visiting a lek during periods of high intensity to avoid intrasexual and intersexual aggression, and intrasexual competition for access to the best male. More research is needed to determine how the ability to attract individuals varies with sex and age.

Demographic factors influencing variability in stability of leks may include size, density, and age structure of populations, as well as whether populations are increasing, decreasing, or stable. Local and regional fluctuations in abundance of males typically are accompanied by changes in number of leks, rather than any significant difference in average number of males per lek (Cannon and Knopf 1981, Locke 1992). Movement to satellite leks and off of leks may be facilitated by saturation of leks as increases in populations occur. Conversely, movements to permanent leks from satellite leks and dispersal from disbanding leks may increase as structure and stability of leks fail with decreasing populations of prairie grouse. Peripheral males and satellite leks may buffer increases in size of population, allowing number of males attending permanent leks to remain relatively stable. Increasing populations have a greater number of satellite leks and peripheral males than a decreasing population (Gibson and Bradbury 1986, Schroeder and Braun 1992, Haukos and Smith 1999). Constancy in individuals attending permanent leks may serve to reduce intrasexual aggression and indirectly increase reproductive efficiency of males on the lek. It is hypothesized that satellite leks, which would receive males deterred from more permanent leks, and non-territorial males, would be a potential source of males that could be attracted to unoccupied areas. Artificial leks not associated with active leks may have greater success attracting and recruiting individuals in years when a greater number of females, satellite males, or young non-territorial birds are present. Nearby leks were not monitored simultaneously and individuals were not marked, so I was unable to discern whether males attracted to abandoned locations possessed territories on other leks. However, it is probable that birds attracted to abandoned locations were either satellite or non-territorial males in the vicinity of nearby active leks or females attracted by aural and visual stimuli.

Stable number of birds attending active leks in my study may be the result of a limited number of males and females in the population, and that all available birds already were participating on a lek. Inability to recruit males to the lek may indicate that all available birds already are participating on a lek, suggesting that the population is either stable or in decline. Similarly, stable numbers of females attending leks may indicate that the number of females supported by the area may be a limiting factor to increases in size of populations. Lending further support to this hypothesis, studies have suggested that number of lesser prairie-chickens in this region may be limited or declining (New Mexico Department of Game and Fish 1999, Johnsgard 2002). Haukos and Smith (1999) reported that their study coincided with a peak in number of males attending leks in western Texas, averaging 16 males/lek in 1988 and steadily declined to 6 males/lek in 1997. Non-territorial males and satellite leks may provide a buffer of expendable individuals that if lost to predation or declines in populations, would not greatly reduce reproductive efficiency of the population. For this reason, it may not be prudent to attract non-territorial males, males occupying satellite leks, or peripheral populations away from their source population.

Seasonal timing of attraction by conspecifics may also be important. Some variation in attendance at leks naturally occurs throughout the season. Of male sage grouse, ≥90% attended leks during peak lekking and 67% (yearlings) to 100% (adults) attended leks during the peak of visitation by females (Emmons and Braun 1984). Jenni and Hartzler (1978) and Gibson and Bradbury (1986) also reported increasing attendance of yearlings on leks of sage-grouse corresponding to peak attendance by females. Number of male greater prairie-chickens attending leks in Kansas declined throughout the breeding season (Robel 1970). However, Hamerstrom and Hamerstrom (1973) and Schroeder and Braun (1992) noted that visitation to leks by greater prairie-chickens in northeastern Colorado and Wisconsin, respectively, remained relatively stable throughout March and April. It is unknown whether fluctuations in attendance are influenced by mortality during the breeding season, changes in the likelihood of birds to visit leks, or both. Seasonal variation in stability of leks, intensity of displays, breeding effort during lekking, and other factors also affect counts of lesser prairie-chickens on leks (Hamerstrom and Hamerstrom 1973, Bradbury et al. 1989). To attract males that have the potential to establish an initial or a new territory on an experimental location, I suggest timing the beginning of audio playback a few days prior to the typical first arrival date for males on the lek. This may vary with latitude and should be adjusted for the location of the study. Continuing audio playback through the breeding season is recommended because individuals may disperse or prospect within the breeding season (Schlossberg and Ward 2004). Satellite and non-territorial males may prospect for potential territories on leks throughout the breeding season, so continuing audio playback may help to attract birds to unoccupied locations or newly established leks.

Lesser prairie-chickens display in spring and autumn. To maximize the number of birds that are exposed to techniques using attraction by conspecifics and that are potential settlers to the area, I suggest use of audio playback and decoys during both spring and autumn lekking periods. In New Mexico, autumnal displaying occurs in September and October (Davis et al. 1979). Displaying in autumn may allow adult males to reaffirm territories (Bergerud and Gratson, 1988) and allow young males to learn the location of leks and the process of lekking. Adult males display on the same territories they held earlier in the year (Johnsgard 2002), while males that are yearlings wander around the lek and display sporadically. Territories in autumn are smaller, closer, and more poorly defined than territories during spring (Taylor and Guthery 1980). If males are less aggressively territorial in autumn, aural and visual cues responsible for attraction by conspecifics may recruit a greater number of males to leks. Lekking in autumn includes young-of-the-year (Copelin 1963). Use of attraction by conspecifics on unoccupied locations in areas with suitable habitat during lekking in autumn may attract yearling or non-territorial males to these locations the following year. Further research is needed to determine when male lesser prairie-chickens are assessing locations for settling. Females are believed to assess males at leks in the days just prior to mating. However, both males and females may use conspecific cues to determine location of leks during lekking in autumn or early spring.

If audio playback and decoys attract birds to a location, and they successfully establish a lek and reproduce, managers must decide whether to use attraction by conspecifics in subsequent years. Assuming that the goal is to establish leks that will persist over the long term, there are two potential courses of action. Managers may choose to discontinue use of audio playback and decoys and allow birds that were attracted in the previous year to return and assume responsibility for further attraction of conspecifics. For lesser prairie-chickens and other species of lekking grouse this could be a feasible choice because these species typically show great fidelity to lekking locations. Conversely, if attracted birds do not show fidelity to locations, the population declines, or has low reproductive success and few individuals return, this could create the need to use audio playback and decoys in subsequent years to maintain initial populations (Ward and Schlossberg 2004).

An increase in duration of attendance and displaying at leks may result in decreased survival because of a decrease in foraging time or increased risk of predation, or in benefits such as an increase in successful breeding. Vigorous vocal and visual displays bring greater attention to the male not only from females but also from predators (Johnsgard 2002). Increasing duration of daily lekking may also push lekking later in the day, where more diurnal predators are active or earlier in the morning where more nocturnal predators are active. Bradbury et al. (1989) suggested that displays of sage grouse were costly and that variations in attendance of males on leks were partly a result of conflicts between displaying and thermoregulatory expenditures. Use of techniques using attraction by conspecifics on active leks could disrupt the previously established social order, result in increased cost of survival, and decoys may impair breeding. Additional research is needed to better understand specific characteristics that attract lesser prairie-chickens to artificial leks and investigate the role of social stimulation in formation of leks and establishment of territories. Regardless, attraction by conspecifics was important to my primary goal of attracting lesser prairie-chickens to abandoned lekking locations. Audio playback and decoys may be useful in restoring leks and successful breeding of lesser prairie-chickens in rehabilitated habitats where their populations have declined.

This research investigated the role of attraction by conspecifics in formation and stability of leks established by lesser prairie-chickens and provides data to support the hypothesis that aural and visual cues have an influential role in establishment of leks and duration of daily lekking. It established methods for attracting lesser prairie-chickens to artificial leks that may be used in management of declining populations. This project provided field assessment of methods that may be used to census lesser prairie-chickens and other prairie grouse, and to attract those in diffuse populations to active and stable leks. The techniques that I tested could be used to attract lekking grouse to high-quality habitat or locations that can be managed to mitigate factors that limit survival and reproduction of a species. With additional effort, studies in spring and autumn might produce valuable data for evaluation of the use of audio playback and decoys, as well as formation, stability, and fidelity of leks.

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Table 1.1—Maximum number of lesser prairie-chickens (*Tympanuchus pallidicinctus*) observed on active leks in southeastern New Mexico, 2005.

		Absence of stimuli		Presence of stimuli	
Lek	Dates monitored	Males	Females	Males	Females
45N	23-28 March	26	4	22	4
22N	23-28 March	14	2	20	4
24N	4-9 April	23	7	21	4
2N	4-9 April	21	8	20	6
31N	18-23 April	17	1	18	1
21N	19-24 April	13	1	13	0
54N	27 April-2 May	7	0	9	0
26N	29 April-4 May	18	1	17	1
M-4	8-13 May	13	2	9	1
M-5	9-14 May	7	1	8	1

Table 1.2—Maximum number of lesser prairie-chickens (*Tympanuchus pallidicinctus*) observed on abandoned leks monitored in the presence of audio playback and decoys in southeastern New Mexico, 2005.

Lek	Dates monitored	GPS coordinates	Lesser prairie-chickens
7N	29-31 March	33°25.966'N, 103°49.188'W	0
79N	1-3 April	33°28.030'N, 103°49.077'W	2
43N	1-3 April	33°28.960'N, 103°48.650'W	1
60N	10-12 April	33°27.386'N, 103°52.587'W	1
87N	10-12 April	33°29.049'N, 103°54.595'W	1
25N	24-26 April	33°28.394'N, 103°47.763'W	0
103N	25-27 April	33°29.817'N, 103°52.637'W	2
74N	3-5 May	33°35.994'N, 103°43.262'W	0
81N	5-7 May	33°34.295'N, 103°46.761'W	0
C2-4	6-8 May	33°33.507'N, 103°32.411'W	3

Figure 1.1—Audio system consisting of a modified, continuous-play, electronic, game caller, and two weatherproof speakers.

Figure 1.2—One decoy of a female, 2 decoys of displaying males, and 1 living male lesser prairie-chickens on an active lek in east-central New Mexico.

CHAPTER 2

USE OF AUDIO PLAYBACK AND DECOYS IN MONITORING AND MANAGEMENT OF SMALL POPULATIONS OF THE LESSER PRAIRIE-CHICKEN (*TYMPANUCHUS PALLIDICINCTUS*)

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) is a species of grouse in North America that is experiencing declining populations (Bailey and Williams 2000, Johnsgard 2002). Rangewide, the number of lesser prairie-chickens has declined about 97% since the 1800s, reflecting a 92% reduction in range, including a 78% decrease in occupied range during 1963-1980 (Crawford 1980, Hagen and Giesen 2005). The lesser prairie-chicken is considered extirpated from its historical range in the northeastern portion of New Mexico, including Union, Harding, and Quay counties. Populations in New Mexico currently exist only in parts of Roosevelt, Chaves, Curry, Eddy, and Lea counties (Johnsgard 2002, Figure 2.1). K. Johnson and H. Smith (in litt.) reported that 15 years of surveys of lands administered by personnel of the Bureau of Land Management (BLM), indicated that the population had declined dramatically and was nearly extirpated in the southeastern portion of the state.

Lesser prairie-chickens have a breeding system in which males attend traditional breeding arenas called leks where they assemble and compete for breeding opportunities during spring. Females visit leks to choose a male with which to mate, and then typically build a nest within 1.2-3.4 km of the lek (Giesen 1998). These birds spend most of their life within 3-4 km of the lek (Taylor and Guthery, 1980). Although some may relocate to harvested grain fields that may be several kilometers (≤40 km) from their accustomed lekking locations for feeding in autumn and winter (Copelin 1963, Campbell 1972, Taylor and Guthery 1980, Giesen 1998), these birds primarily are philopatric, with few movements >10 km and most are <7 km (Ahlborn 1980, Giesen 1994). Individual males typically return to the same lek each year, so lekking locations are fairly permanent (Copelin 1963, Campbell 1972, Johnsgard, 2002). Therefore, lekking grouse are unlikely to move from an established territory to create leks in a new area or to reestablish in an area where leks have been extirpated.

When populations decline or become fragmented, structure and stability of leks may fail. This may result in lesser prairie-chickens occurring singly or in small groups in the vicinity of a formerly active lek. Dispersal of young from areas that retain healthy populations may also be responsible for observations of individuals or small groups (Best et al. 2003, Jamison 2000). These factors may account for occasional observations of lesser prairie-chickens in areas of southeastern New Mexico not associated with active leks or where active leks no longer occur (Best et al. 2003).

There is little information on formation or recolonization of leks by lesser prairie-chickens and many other prairie grouse. If young dispersing grouse use presence of conspecifics to determine where to settle, this behavior would have significant conservation implications. Attraction by conspecifics is the tendency for individuals of a species to settle near one another (Schlossberg and Ward 2004). Reproduction of appropriate cues could be used to attract individuals to specific, preselected locations with high-quality habitat and that can be managed to mitigate factors limiting growth of populations. Techniques to address social constraints are needed to reestablish prairie grouse in areas where the number of birds is insufficient to form socially viable leks, particularly in areas where birds have been extirpated through actions by humans, and where habitats and other environmental attributes are still adequate for supporting a population. Previous studies have attracted prairie grouse using decoys and audio playback of displaying birds for the purpose of locating and censusing (Bohl 1956, Stirling and Bendell 1966, Artmann 1970, McWilliams Chapter 1).

Silvy and Robel (1967) and Robel and Ballard (1974) played recorded vocalizations of male greater prairie-chickens (*Tympanuchus cupido*) to attract conspecifics to increase trapping success by luring birds back to leks after they had been disturbed. Hamerstrom and Hamerstrom (1960) stimulated the breeding display of male greater prairie-chickens and male sharp-tailed grouse. In a study of sharp-tailed (*Tympanuchus phasianellus*) grouse, Rodgers (1992) successfully established leks using decoys and audio recordings of displaying birds.

Previous attempts to reestablish lesser prairie-chickens into formerly occupied habitats have been unsuccessful. Lesser prairie-chickens have been transplanted in Colorado ≥10 times; however, no transplant was successful in establishing or increasing populations (Giesen 1998). Lesser prairie-chickens were introduced unsuccessfully on Ni'ihau Island, Hawaii (Fisher 1951, Giesen 1998), and in Doña Ana County, New Mexico (Snyder 1967). Transplanted birds typically return to original trapping locations (Snyder 1967); a female released in Colorado traveled nearly 300 km to the original location of capture in Kansas (Giesen 1998).

The premise of techniques using audio playback and decoys (attraction by artificial conspecifics) is to attract and hold prospecting birds among decoys using playback of calls so that the first birds arriving will remain long enough to help attract additional birds (Parker et al. 2007). As numbers of birds congregating at the location increases, the lek should become more socially stable providing an increased chance of attracting females for breeding. The objectives of my study were to assess response of lesser prairie-chickens to playback of calls (aural stimuli) and to decoys (visual stimuli). I also evaluated use of audio playback and decoys in attracting widely dispersed lesser prairie-chickens to common areas that could serve to establish socially stable leks. This is particularly important in areas where density of populations is too low to allow successful reproduction.

STUDY AREA

This study was conducted in southeastern New Mexico south of New Mexico Highway 529, north of New Mexico Highway 176, and east of New Mexico Highway 360 in Eddy and Lea counties, in an area where the population of lesser prairie-chickens is reduced to small groups or scattered individuals (Ligon 1927, Bailey and Williams 2000, Best et al. 2003, Hunt 2004). Habitat around abandoned lekking locations in the area is a sandy-soiled, short-mixed-grass prairie ecosystem dominated by shinnery oak (*Quercus havardii*), sand dropseed (*Sporobolus cryptandrus*), purple threeawn (*Aristida purpurea*), and grama (*Bouteloua*; Hunt and Best 2010).

METHODS

I conducted research during February-May to correspond to before and during the usual breeding period for lesser prairie-chickens. Thirty-two abandoned lekking locations and one active lek in southeastern New Mexico were identified in consultation with biologists from the Bureau of Land Management and by exploration. Abandoned lekking locations were believed to have been inactive for 6-20 years. These were surveyed from a vehicle for activity of lesser prairie-chickens early in the breeding season (4-7 March 2006; 28 February-3 March 2007) and again at the peak of each breeding season (10, 11, or 19 April 2006 and 14, 15, or 16 April 2007) to ensure that no active lek was present.

Life-sized decoys of four male and one female lesser prairie-chickens and an audio system to broadcast sounds of displays were used to simulate the appearance and sound of an active lek as described by McWilliams (Chapter 1). These artificial leks were constructed on abandoned lekking locations. These locations were in areas near reported sightings of lesser prairie-chickens, but where active leks were no longer known to exist. Artificial leks were monitored for 3 consecutive days with audio playback and decoy stimuli present. Recordings were played 15 minutes before sunrise and continued for 105 minutes after sunrise. Audio playback was broadcast at a volume near that of sounds naturally made by lesser prairie-chickens.

Location, date, time of monitoring, weather conditions, time of sunrise, number of males observed, number of females observed, activity at lek, evidence of predators, and response to stimuli were recorded during each day of observation. Attendance was measured as greatest number of individuals observed together during the monitoring effort for a lek. I compared attendance at abandoned lekking locations prior to artificial stimuli (no lesser prairie-chicken present) to attendance at lekking locations with audio playback and decoy stimuli present. Statistical analyses were not used to determine the significance of the outcomes of surveys between abandoned lekking locations with and without audio playback and decoys. These lekking locations were specifically chosen because they were surveyed and it was determined that lesser prairie-chickens were not using these locations for lekking. Surveys of locations with no audio playback or decoys at each site had zero observations of lesser prairie-chickens. There was no variation associated with attendance at abandoned lekking locations prior to addition of stimuli. For this reason, I was unable to calculate a mean, standard deviation, or standard error needed for parametric statistics. Nor was I able to rank locations for use in non-parametric statistical methods. Therefore, I discuss results of comparison of attendance on abandoned lekking locations prior to addition of audio playback and decoys to attendance on locations with audio playback and decoys present in biologically significant terms as opposed to statistically significant terms.

RESULTS

Of 32 abandoned lekking locations monitored for activity and effect of aural and visual stimuli on attendance at lekking locations, lesser prairie-chickens were observed on five lekking locations (Table 2.1). Observation of individuals on three of the five locations; QP-5, QP-3, and QP-26 (32°40.417'N, 103°40.183'W; 32°42.554'N, 103°40.982'W; and 32°33.844'N, 103°35.201'W; respectively), appeared to be in response to aural stimuli, whereas observations on two locations, QP-29 and QP-13 (32°34.348'N, 103°35.254'W and 32°41.856'N, 103°41.559'W; respectively), occurred in absence of audio playback and decoys. Lesser prairie-chickens responded to audio playback on abandoned lekking locations by exhibiting inquisitive behaviors such as flying by, approaching speakers, attaining a searching posture, or vocalizing. One lesser prairie-chicken flew two passes (0605 and 0658 h MST) over abandoned lekking location QP-5 in response to audio playback on 14 March 2006 and one flew past (0728 h MST) location QP-5 in response to audio playback on 15 March 2006. One female approached the speakers during audio playback at abandoned lekking location QP-3 during 0704-0713 h MST on 23 March 2006. One lesser prairie-chicken flew by location QP-3 on 25 March 2006 at 0723 h MST. One lesser prairie-chicken responded to audio playback at abandoned lekking location QP-26 at 0812 h MST on 14 March 2007 (Table 2.1).

Abandoned lekking locations were monitored for activity of lesser prairie-chickens in absence of stimuli early in the breeding season (4-7 March 2006; 28 February-3 March 2007) and again at the peak of each breeding season (10, 11, or 19 April 2006 and 14, 15, or 16 April 2007). There was no evidence of lekking at any of the 32 abandoned locations, although one male was incidentally observed at abandoned lekking location QP-29 on 16 March 2006 at 0955 h MST one day prior to monitoring with the addition of audio playback and decoys. No lesser prairie-chicken was observed or attracted during subsequent monitoring at location QP-29. At abandoned lekking location QP-13, a lesser prairie-chicken was heard calling at 0732 and 0740 h MST on 10 April 2006, 1 day after cessation of monitoring for 3 consecutive days with audio playback and decoy stimuli. I believe that this bird also was detected as a result of its attraction to the aural stimulation on previous days. However, to maintain a conservative assessment of the ability to attract lesser prairie-chickens to abandoned lekking locations using audio playback and decoys, only the maximum number of birds detected while audio playback and decoys were present was included in analyses. This action omitted detection of a bird at location QP-13 subsequent to monitoring with stimuli present. This resulted in birds being attracted to at least three of 32 locations.

One active lek, EU-NEW (32°30.385'N, 103°05.326'W), was monitored for activity of lesser prairie-chickens in absence of stimuli early in the breeding season. One lesser prairie-chicken was flushed from lek EU-NEW on the afternoon of 3 March 2006. Eleven were observed lekking there on 4 March 2006. EU-NEW was active again when monitored on 28 February 2007.

DISCUSSION

My results offer evidence that lesser prairie-chickens respond to presence of conspecifics and that they may use attraction by conspecifics to select breeding habitats. I used decoys and audio playback of displaying lesser prairie-chickens at abandoned lekking locations that I believed were uninhabited in previous years and had responses to audio playback within 3-4 days, by ≥3 individuals. The ability to quickly attract lesser prairie-chickens to artificial leks demonstrated that a diffuse, non-lekking population persisted in this region of New Mexico, and further suggested that some birds with prior experience at the abandoned lekking location had returned to the artificial lek. However, given that survival of male lesser prairie-chickens is ≤5 years in the wild (Campbell 1972) and that abandoned lekking locations that were visited in conjunction with the surrounding area had only one active lek in the previous 6 years, surviving birds with prior experience would not be expected in 2006, 12-19 years after the last known lekking activity on experimental locations (Table 2.1).

Many factors may have affected success of techniques that use attraction by conspecifics and individual responsiveness of birds in my study. As in other studies (Eng et al. 1979, McWilliams Chapter 1), sound appeared to play a prominent role in recruiting birds to artificial leks on experimental locations. Although samples were small, evidence led me to believe that lesser prairie-chickens in this area responded primarily to audio playback of displaying conspecifics as no bird was observed displaying among decoys. When male prairie grouse are not participating on a lek, they spend time in more dense vegetation. Non-lekking grouse, such as those encountered in this region, probably communicate primarily through aural cues. Visual cues may be more important in the open arena of an active lek, and decoys may be more effective for attraction of conspecifics once individuals are attracted to aural stimuli. Two individuals responding to aural stimuli were observed flying. One female was observed approaching the artificial lek by walking and this bird approached and called to speakers but was not observed among decoys.

Volume and duration of aural and visual stimulation may have influenced ability to attract lesser prairie-chickens in the study area (McWilliams Chapter 1). Broadcasting audio playback at a volume greater than that of natural displays of lekking grouse may extend the effective radius from which birds can be attracted. This may aid in recruiting conspecifics to a location, particularly in attracting widely dispersed individuals where audio playback must be broadcast over larger areas. Presumably, there is an upper limit at which volume no longer attracts lekking grouse but deters them. Further research is needed to assess the response of lekking grouse to aural stimuli.

Duration of aural and visual stimulation may also have influenced the ability to attract birds to artificial leks. Eng et al. (1979) and Rodgers (1992) monitored sage grouse and sharp-tailed grouse, respectively, and provided audio playback and decoy stimuli for longer periods than in my study. Eng et al. (1979) continued playing audio playback each day on the same experimental location for a few weeks. Rodgers (1992) monitored and provided audio playback and decoy stimuli for 2 weeks during morning and evening lekking periods before incrementally reducing aural and visual stimulation. Both Eng et al. (1979) and Rodgers (1992) were successful in establishing leks. My study showed that rapid attraction of individuals to a location is possible for detecting lesser prairie-chickens in an area. However, to establish a stable lek, efforts to attract the species should continue until enough birds gather to produce a viable social unit. Providing audio playback and decoy stimuli for longer periods with incremental reduction in stimulation is likely necessary to attract an adequate number of birds for a sufficient amount of time and induce stable lekking at experimental locations.

Populations in east-central and southeastern New Mexico occur in only 34% of the historic range of lesser prairie-chickens (New Mexico Department of Game and Fish 1999, K. Johnson and H. Smith in litt.). It is postulated that populations of lesser prairie-chickens observed in southeastern New Mexico have dispersed southward from populations in Chaves, Lea, and Roosevelt counties and into, or from, adjacent populations in western Texas (Best et al.

2003). Before 1970, only a few scattered records of lesser prairie-chickens existed in this region of southeastern New Mexico. A small population existed south of US highway 380 during the 1980s and 1990s but had nearly disappeared by 1998 (Smith et al. 1998). This population peaked at about 160 individuals in 1987 (K. Johnson and H. Smith in litt., Hunt 2004). During 1994-1996, surveyors of shinnery oak-sand dune habitats south of 33° latitude in southeastern New Mexico only observed lesser prairie-chickens near Maljamar and northeast of Eunice in Lea County (Bailey and Williams 2000). Best et al. (2003) detected no active lek during their survey of 688 locations south of US380 in Chaves, Eddy, and Lea counties during 2000. In 2001, lesser prairie-chickens were observed or active leks were detected at only 3 of 3,431 locations in sandy-soiled, shinnery-oak habitat south of US380 in Eddy and Lea counties (Best et al. 2003). Rarity of active leks and occasional encounters of this species indicate the population in this region is small. Using audio playback and decoys, I was able to attract birds to 6 of 10 abandoned lekking locations in a region north of the study area where active leks persisted (McWilliams Chapter 1). The lower rate of success (10 versus 60%) in attracting birds to abandoned locations in my study reflects scarcity of lesser prairie-chickens in this region of New Mexico.

Populations in southeastern New Mexico may fluctuate with cycles of dispersal and attrition. Censusing techniques are necessary to accurately assess and monitor populations, including scattered or peripheral populations in marginal habitats. Attendance of males at leks and density of leks have been used as indices of abundance of prairie grouse throughout their range (Copelin 1963, Hamerstrom and Hamerstrom 1973, Cannon and Knopf 1981, Martin and Knopf 1981, Best et al. 2003, Hagen et al. 2004). Only a single active lek and occasional chance encounters of individual birds have been observed in the study area for many years, yet I was able to detect birds at 5 of 32 locations (16%) during this study period. Surveys using audio playback and decoys can alleviate limitations associated with the exclusive use of surveys of leks by providing a method of detecting widely dispersed and solitary birds in areas where active leks do not occur. Although techniques using attraction by conspecifics may produce results that are comparable to other censusing techniques, this technique may have inherent dangers. Responses to audio playback and decoys may distort sex and age ratios and may vary seasonally (McNicholl 1981). It is expected that infrequent annual or bi-annual use of surveys that use audio playback will not affect lekking behavior or social structure of leks of lesser prairie-chickens, and therefore, can be conducted without harming them.

If incorporated before populations reach a critical low, attraction by conspecifics may be used to halt declines in populations of many species of lekking grouse, serve as a buffer against natural or anthropogenic catastrophes that threaten these species, and enhance growth of populations and expansion of geographic range. This strategy may also serve to facilitate reintroduction or translocation of lekking birds into areas with suitable habitat by establishing fidelity to locations in translocated birds in areas where no prior social organization exists (Rodgers 1992). Managers should not overlook the role of attraction of conspecifics in recruitment, establishment, and restoration of populations. Aural and visual cues from conspecifics may be a critical factor in attracting birds to new or restored habitats, particularly due to their slow pioneering rate (Crawford 1980). Attraction by conspecifics has enticed lesser prairie-chickens to abandoned lekking locations in areas where active leks persisted (McWilliams Chapter 1), and with lower success to abandoned lekking locations in my study area where one or no active lek persisted. Although the study area was within the historic range of the lesser prairie-chicken (Ligon 1927, Bailey and Williams 2000) and occasional observations of lesser prairie-chickens still occur, habitats surrounding locations were not assessed prior to my study to determine if sufficient resources persisted to support a breeding population. Quality and selection of habitats by lesser prairie-chickens may influence the success or failure of techniques using attraction by conspecifics. The lower success in attracting individuals in this region may be an indicator of less suitable habitat and, therefore, future studies using attraction by conspecifics perhaps should be paired with restoration of habitats. Locations selected for establishing artificial leks should be based on data on nesting, rearing of chicks, and wintering areas of the local population. Locating the artificial lek within wintering areas likely will increase success of recruiting by intercepting females and yearling males, which may not have an established territory or home range (Eng et al. 1979). Attracting birds to a new location has little conservation value unless locations are managed to ensure that attracted birds can survive and reproduce sufficiently enough to be a source population. Only if the population is productive will techniques using attraction by conspecifics be a benefit to the species (Schlossberg and Ward 2004). Techniques using attraction by conspecifics used in my study may be useful in reestablishing populations of other species of prairie grouse as well as other lekking species in decline.

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Table 2.1—Maximum number of lesser prairie-chickens (*Tympanuchus pallidicinctus*) observed on abandoned leks monitored in southeastern New Mexico, 2006 and 2007.

Lek	Dates monitored 2006	Dates monitored 2007	Last active	Lesser prairie-chickens
QP-7	25-27 April	26-28 April	1986[a]	0
QP-11	19-21 April	8-10 April	1987	0
QP-19	1-3 May	23-25 April	1987	0
QP-29	29-31 March	30 March-1 April	1987	0[b]
QP-1	28-30 April	29 April – 1 May	1988	0
QP-8	8-10 March	4-6 March	1988	0
QP-9	4-6 April	2-4 April	1988	0
QP-16	7-9 April	5-7 April	1988	0
QP-17	1-3 April	27-29 March	1988	0
QP-18	26-28 March	22-24 March	1988	0
QP-20	22-24 April	26-28 April	1988	0
QP-21	23-25 March	19-21 March	1988	0
BB-1	8-10 March	4-6 March	1989	0
QP-5	14-16 March	10-12 March	1990	1 (seen)
BB-2	14-16 March	10-12 March	1990	0
QP-2	25-27 April	8-10 April	1990	0
QP-15	20-22 March	16-18 March	1991	0
QP-3	23-25 March	19-21 March	1993	1 (seen)
QP-6	17-19 March	13-15 March	1993	0

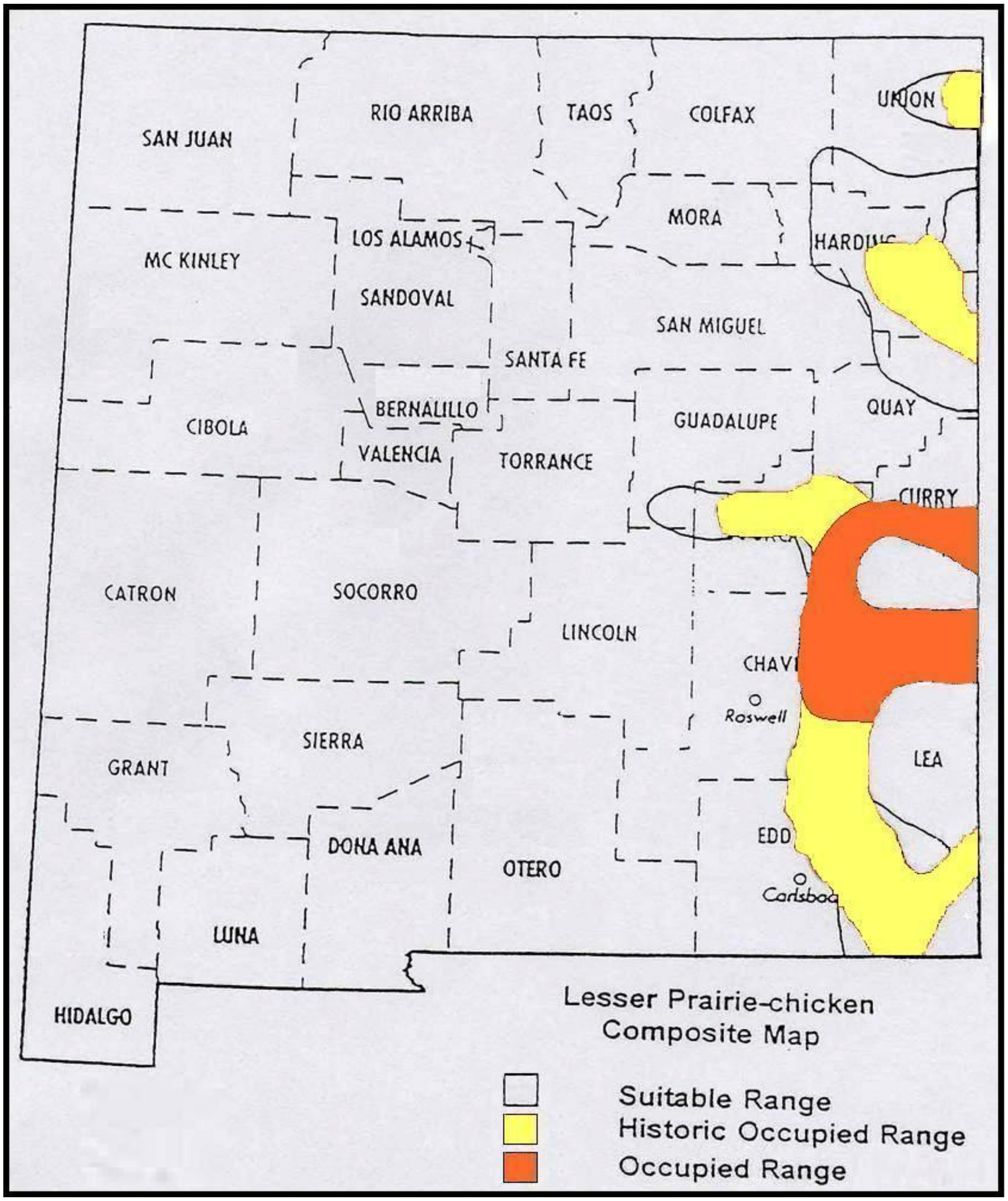
QP-10	4-6 April	5-7 April	1993	0
QP-12	29-31 March	30 March-1 April	1993	0
QP-26	17-19 March	13-15 March	1993	1 (seen)
QP-27	22-24 April	23-25 April	1993	0
QP-13	7-9 April	2-4 April	1994	0[c]
QP-4	26-28 March	22-24 March	1995	0
QP-23	1-3 April	27-29 March	1995	0
QP-28	11-13 March	7-9 March	1995	0
QP-14	19-21 April	11-13 April	1997	0
QP-24	28-30 April	11-13 April	1997	0
QP-25	20-22 March	16-18 March	1997	0
EU-23	11-13 March	7-9 March	1998	0
QP-22	1-3 May	17-19 April	2000	0

[a]Lekking location destroyed by oil-well drilling operations in 2002

[b]One lesser prairie-chicken seen on 16 March 2006

[c]One lesser prairie-chicken was heard on 10 April 2006

Figure 2.1—Suitable, current, and historic range of the lesser prairie-chicken in New Mexico (Bailey 1928, Ligon 1961, Davis et al. 2008).



CHAPTER 3

VEGETATIVE CHARACTERISTICS ASSOCIATED WITH AREAS USED BY LESSER PRAIRIE-CHICKENS IN SHINNERY OAK HABITAT IN EAST-CENTRAL AND SOUTHEASTERN NEW MEXICO

Many species of lekking birds are in decline. Loss of habitats due to drought, fragmentation, overgrazing by livestock, and conversion of habitats to agriculture have reduced populations of most prairie grouse in North America (Johnsgard 2002). Additional threats to populations of prairie grouse include continued loss of habitat due to development of wind farms and extraction of oil and gas, and may also include compounding effects of climatic change, reduced viability of small populations, and emergent diseases (Bailey and Williams 2000, Johnsgard 2002).

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) is a species of prairie grouse that has one of the smallest populations and most restricted distributions of any species of native North American grouse (Aldrich 1963, Johnsgard 1983, Giesen 1998). In 1995, the United States Fish and Wildlife Service was petitioned to list the lesser prairie-chicken as threatened or endangered under the Endangered Species Act (United States Fish and Wildlife Service 1998). This species continues to face threats posed by drought, overgrazing by livestock, predation, control of shrubs, conversion to cropland, and production of oil and gas. New threats also exist such as vulnerability and reduced viability of small populations and development for wind energy (Hoffman 1963, Jackson and DeArment 1963, Crawford 1980, Taylor and Guthery 1980, Bailey and Williams 2000). Because the lesser prairie-chicken is a species of conservation concern, characteristics of the remaining habitat that is available to this species is of special interest for conservation and management. Based on observations of lesser prairie-chickens and collections of voucher specimens in the 1970s, 1980s, and 1990s, suitable habitat for this species exists in the sandy-soiled, shinnery-oak (*Quercus havardii*) region in east-central and southeastern New Mexico (Best et al. 2003).

Historically, the Llano Estacado region of Texas and New Mexico was covered by drought-tolerant perennial grasses, such as several grama grasses (*Bouteloua*) and bluestems, especially little bluestem (*Schizachyrium scoparius*). Sand dropseed (*Sporobolus cryptandrus*), sand lovegrass (*Eragrostis trichodes*), threeawn grass (*Aristida*), and needle-and-thread grass (*Stipa comata*) also were common. Sand dropseed and sand lovegrass occurred on sandy soils. Shrubs including soapweed yucca (*Yucca glauca*) also occurred widely, and wild plum (*Prunus*) and aromatic sumac (*Rhus aromatica*) were present on more mesic, less-sandy locations. Throughout the region, sand sage (*Artemisia filifolia*) and shinnery oak share prevalence with native grasses such as sand dropseed and little bluestem (Johnsgard 2002). Habitat occupied by the lesser prairie-chicken is characterized by a combination of shinnery oak, sand sage, sand dropseed, sand bluestem (*Andropogon hallii*), little bluestem, a variety of forbs, including spectacle pod (*Dithyrea wislizenii*) and annual buckwheat (*Eriogonum annuum*), and in some cases, honey mesquite (*Prosopis glandulosa*), and broom snakeweed (*Gutierrezia sarothrae*; Taylor 1978, Davis et al. 1979, Sell 1979, Taylor and Guthery 1980, Giesen 1998, Hunt and Best 2010). All native mixed-grass prairies are not equal in terms of suitable use for lesser prairie-chickens. Areas that are dominated by tall shrubs, riparian habitats, areas that are over-used by livestock or are near developed areas are not likely to be used by lesser prairie-chickens.

Lesser prairie-chickens likely select areas to use at multiple spatial scales. A mosaic of habitats within an area provides different resources, and some patches of habitat may be more desirable than others. Most mating is believed to occur at leks, and therefore, suitable lekking locations are an important component of the habitat. Males show fidelity to leks from year to year, and consequently, lekking locations can be relatively stable over time (Copelin 1963, Campbell 1972). Females typically nest in the vicinity of leks (within 1.2-3.4 km; Giesen 1998), and lekking locations likely serve as an indicator of suitable nesting habitat at a broader landscape scale. Suitable habitat for cover, feeding, nesting, rearing of broods, and wintering in the vicinity of lekking locations are important factors in choice of habitat.

Predicting whether a habitat is suitable for a species has frequently emerged as an important topic in conservation biology and wildlife management (e.g., Kellner et al. 1992, Woodward et al. 2001). Habitat and wildlife managers are in need of methods and data that will aid in maintaining or enhancing habitats for prairie grouse. Knowledge of quality and selection of habitats by lesser-prairie chickens and other species of prairie grouse is essential for successful conservation and management (Carter et al. 2006). Prioritizing areas of critical habitat for conservation, enhancement, or protection, or all three can be a valuable tool accomplished by modeling habitat associations (De Wan et al. 2009). Lesser prairie-chickens and other lekking grouse may change their associations with landscapes in response to small-scale changes in their habitats (Woodward et al. 2001, Fuhlendorf et al. 2002). Birds may select habitats based on finer-scaled variables such as vegetative cover and composition within a landscape. Determining characteristics of habitats occupied by lesser prairie-chickens is critical to making management decisions. The primary goal of my study was to determine which characteristics of habitats were associated with areas used by lesser prairie-chicken.

STUDY AREA

The study area was in Eddy, Lea, Chaves, and Roosevelt counties in southeastern New Mexico and was characterized by gently rolling terrain, with occasional sand dunes. Depth and distribution of sandy soils and underlying calcium carbonate-rich soils determined vegetative characteristics, particularly the growth, density, and distribution of shinnery oak, the dominant shrub of habitats used by lesser prairie-chickens in New Mexico (Hagen and Giesen 2005). This area contains about 303,750 ha of shinnery oak (Peterson and Boyd 1998). The study area contains areas where lesser prairie-chickens have remained present with some fluctuation in size of populations, and other areas in which populations have disappeared (Best et al. 2003). Principal use of the area is for grazing by cattle interspersed with facilities for production of oil and gas, and scattered center-pivot and dry-land agricultural farming operations. Areas received light to moderate grazing under a variety of grazing-management schemes. Some pastures had been treated with tebuthiuron to kill shinnery oak and increase grass cover for livestock.

METHODS

Data collected by Hunt (2004) were provided for my analysis. Hunt (2004) established transects for assessments of vegetation that were 300 m from the center of an active lek or abandoned (historically active) lekking location. Cover and composition were measured using the line-point sampling method described by Bonham (1989), K. Johnson and H. Smith (in litt), and Hunt (2004). At each location, four 100-m transects were performed in four directions. Vegetation was identified to genus and recorded at 1-m intervals along each transect. Percentage cover of each genus of plant, litter, and bare ground were calculated by dividing the number of data points for each category by 400, which was the number of data points obtained at each location, then multiplying by 100. For my analysis of data collected by Hunt (2004), percentages were arcsine transformed by first dividing the percentage by 100, then taking the arcsine of the square root of the proportion to ensure normality.

Characteristics of vegetative cover from pastures containing active leks and pastures containing abandoned lekking locations were used to model use of habitats by lesser prairie-chickens using logistic regression (Anderson and Gutzwiller 2005). Because I had a large number of covariates, 17 covariates were dropped from my statistical analysis based on occurrence in ≤0.10% of sampling sites. The remaining 19 covariates were modeled together using logistic regression. Covariates were then removed one at a time based on having the lowest ratio of maximum-likelihood estimator (β) to standard error (*SE*) as described by Arnold (2010). After removing eight additional covariates the remaining 11 were modeled using logistic regression and the dredge function using Software Package MuMIn in program R (Barton 2012). This package modeled all possible combinations and subsets of the remaining 11 covariates. Models were evaluated and averaged using methods outlined in Burnham and Anderson (2002). Only models with ΔAIC-values <4.00 were averaged. Models with higher ΔAIC-values could be averaged (Burnham and Anderson 2002); however, I chose a smaller group of models to simplify results.

RESULTS

Hunt (2004) established and surveyed transects within 32 pastures containing active leks and 28 pastures containing abandoned (historically active) lekking locations in 2001, and 33 pastures containing active leks and 27 pastures containing abandoned lekking locations in 2002 and 2003. Hunt (2004) collected 400 data points for each location. This resulted in a combined total of 39,200 data points for pastures containing active leks and 32,800 data points for pastures containing abandoned lekking location.

Vegetative characteristics from surveyed locations were evaluated in >2,000 models using logistic regression. Models were evaluated using AIC (Burnham and Anderson 2002). Eleven were selected and averaged based on ΔAIC and other model parameters outlined by Burnham and Anderson (2002). *Andropogon*, *Aristida*, *Muhlenbergia*, *Prosopis*, *Quercus*, and *Senecio* occurred in all of the averaged models. Forbs occurred in 10 of 11 models that were averaged. *Artemesia* and *Eriogonum* occurred in four of 11 models that were averaged. *Panicum* and bare ground occurred in three of 11 models that were averaged. The weighted and averaged coefficients of the models of habitat characteristics for lesser prairie-chickens had a positive correlation with *Senecio* ($\beta = 0.23$), *Prosopis* ($\beta = 0.20$), *Andropogon* ($\beta = 0.15$), *Aristida* ($\beta = 0.13$), and *Quercus* ($\beta = 0.09$). The weighted and averaged coefficients of the models of habitat characteristics had a negative correlation with forbs ($\beta = -0.17$), *Muhlenbergia* ($\beta = -0.16$), *Artemesia* ($\beta = -0.01$), *Eriogonum* ($\beta = -0.01$), *Panicum* ($\beta = -0.01$), and bare ground ($\beta = -0.01$; Table 3.1). The averaged coefficients were converted to odds ratios to simplify the discussion of my results.

DISCUSSION

Hunt (2004) and Hunt and Best (2010) indicated that the most important vegetative characteristics in determining difference in cover between pastures with active leks and pastures with abandoned lekking locations were *Andropogon*, *Sporobolus*, *Muhlenbergia*, *Gutierrezia*, *Bouteloua*, and *Eriogonum*. Pastures with active leks had greater cover of *Andropogon*, *Bouteloua*, and *Gutierrezia*, and less cover of *Sporobolus*, *Muhlenbergia*, and *Eriogonum*, than did pastures with abandoned lekking locations (Hunt and Best 2010).

Suminski (1977) reported that lesser prairie-chickens in New Mexico preferred shinnery oak-bluestem habitats dominated by sand bluestem, threeawn grass, little bluestem, sand dropseed, and blue grama. Cannon and Knopf (1981) suggested that management strategies for lesser prairie-chickens in shinnery oak rangelands should emphasize species that are perennial mid- and tall-grasses. Hunt (2004) and Hunt and Best (2010) indicated that *Andropogon* was one of the most important vegetative characteristics in determining difference in cover between pastures with active leks and pastures with abandoned lekking locations. Sites in my study containing *Andropogon* were 1.16 times more likely to be used than sites without *Andropogon*. Hunt (2004) and Hunt and Best (2010) demonstrated that pastures containing lekking locations that were abandoned by lesser prairie-chickens had <20% of the *Andropogon* as those pastures with active leks. *Andropogon* grows in thick clumps that often have an open area at the center of the clump. These clumps are ideal for ground-nesting birds such as lesser prairie-chickens, which preferentially select *Andropogon* as nesting sites. Nesting success is much greater for lesser prairie-chickens that select *Andropogon* (Davis et al. 1979, Riley et al. 1992). Nesting success was correlated positively with cover of *Andropogon* and negatively correlated with level of grazing by livestock (Davis et al. 1979).

My study sites containing threeawn grass (*Aristida*) were 1.14 times more likely to be used than sites without *Aristida*. These grasses often occur in large bunches, 30-50 cm in height that provide concealment for lesser prairie-chickens and their nests. *Aristida* may also provide nesting materials and seeds for food (Holimon et al. 2012). *Aristida* is seldom grazed and may be selected for use by lesser prairie-chickens in areas where overgrazing removes other native grasses.

Hunt (2004) and Hunt and Best (2010) indicated that *Muhlenbergia* was also one of the most important vegetative characteristics in determining difference in cover between pastures with active leks and pastures with abandoned lekking locations. Sites containing *Muhlenbergia* were 0.85 times less likely to be used by lesser prairie-chickens than sites without *Muhlenbergia*. Hunt and Best (2010) similarly detected that pastures associated with active leks had lower percentage composition of *Muhlenbergia* than did pastures associated with abandoned lekking locations. This result is somewhat confounding as this grass has the potential to provide cover and seeds for granivorous, ground-dwelling birds including the lesser prairie-chicken. However, *Muhlenbergia*, as well as other grasses such as *Sporobolus,* may compete with grasses that are preferred by lesser prairie-chickens such as *Andropogon* for space and nutrients. Therefore, not all grasses are suitable as habitats of lesser prairie-chickens.

Brushy species such as shinnery oak (*Quercus havardii*) or sand sagebrush (*Artemisia filifolia*) and tall grasses such as sand bluestem (*Andropogon hallii*) are critical components of habitats of the lesser prairie-chicken (Crawford 1980). Sites containing *Quercus* were 1.09 times more likely to be used than sites without *Quercus*. Shinnery oak, however, is considered a pest plant by ranchers, it sometimes is toxic to livestock, and it is believed to compete with native grasses used as forage by livestock (Peterson and Boyd 1998). Some control of shinnery oak has occurred on the study site. As of 2000, at least 405 km^2 of shinnery oak had been treated with herbicide on BLM lands in east-central and southeastern New Mexico (Peterson and Boyd 1998, Bailey and Williams 2000). Although limited control of shinnery oak in conjunction with management of grazing by livestock may benefit lesser prairie-chickens by allowing an increase in tall grasses (Davis et al. 1979, Mote et al. 1999), it also results in loss of acorns, an important autumn and winter food, and catkins, an important component of diet in spring and summer (Jackson and DeArment 1963, Hunt 2004).

Hunt (2004) reported that abandoned lekking locations were more likely to be near honey mesquite (*Prosopis*) >60 cm in height than were active leks. However, my results indicate that sites containing *Prosopis* were 1.22 times more likely to be used than sites without *Prosopis*. A study by Clements (1920) suggested that presence of *Prosopis* may be indicative of overgrazing of pastures in New Mexico and reportedly can be spread by livestock (Heady 1975, Kramp et al. 1998, Kneuper et al. 2003). My results may indicate that the remaining habitat available to lesser prairie-chickens in New Mexico was being overgrazed. Jackson and DeArment (1963) reported that overgrazing negatively affected populations of lesser prairie-chickens, and abandoned leks in southeastern New Mexico are associated with intensive grazing (Johnson and Smith, in litt). Conversely, Bidwell (2002) and Hunt (2004) suggest that some grazing in conjunction with fire is needed to prevent species of woody plants such as *Prosopis* from encroaching on grassland habitats. Invasions of grasslands by species of woody plants such as *Prosopis* has been cited as a possible cause for declines in populations of Attwater's prairie-chicken (*Tympanuchus cupido attwateri*) and lesser prairie-chickens (New Mexico Department of Game and Fish 1999, Woodward et al. 2001). However, *Prosopis* or other tall plants may be used for shade or cover in overgrazed areas where bunch grasses may be scarce.

Sites containing broom groundsel (*Senecio*) were 1.26 times more likely to be used than sites without *Senecio*. Portions of these plants are consumed as food by lesser prairie-chickens (Hunt 2004). *Senecio* is toxic to cattle and sheep (Whitson et al. 2002) and ranchers may apply herbicides to control its growth. The positive association of *Senecio* with use by lesser prairie-chickens may also be correlated with the lack of use of herbicides and relatively low grazing pressure in pastures associated with active leks.

Sites containing unidentified forbs were 1.19 times less likely to be used by lesser prairie-chickens than sites without unidentified forbs. This result is counterintuitive in that lesser prairie-chickens use forbs for food (Pitman et al. 2005, Giesen 1998). Some forbs consumed include erect dayflower (*Commelina erecta*), fame flower (*Talinum parviflorum*), broom snakeweed (*Gutierrezia sarothrae*), and buckley penstemon (*Penstemon buckleyi*) in summer, broom groundsel (*Senecio spartioides*), dwarf dalea (*Dalea nana*), and wild buckwheat (*Eriogonum annuum*) in autumn, wild buckwheat and broom groundsel in winter, and wild buckwheat and broom snakeweed in spring (Hunt 2004). In my data, unidentified forbs was a category characterized by flowering plants that could not be identified to genera. This group comprised of unidentified forbs negatively affected use of habitats by lesser prairie-chickens in my averaged model. While forbs typically provide seeds used as food by adults and attract insects consumed by young, in my analysis, this group probably consisted of unidentified plants that are not readily used by lesser prairie-chickens and warrants additional studies.

Presence of *Artemesia*, *Eriogonum*, *Panicum*, and bare ground (odds ratios = 0.99) each had a slightly negative effect on use of sites by lesser prairie-chickens. Sites containing these characteristics are minimally less likely to be used by lesser prairie-chickens than sites without these characteristics of habitat, but the effect on the overall model is small. This small effect could be indicative of the high prevalence of these characteristics at all sites.

Knowledge of habitats occupied by a species is a basic ingredient for successful management (Carter et al. 2006). Habitat-association modeling can be a valuable tool for prioritizing conservation of biodiversity and in planning use of land (De Wan et al. 2009). Accuracy in modeling habitats of lesser prairie-chicken is difficult in a dynamic landscape where vegetation is influenced by type of soil, temperature, amount and timing of precipitation, and anthropogenic impacts such as grazing and development for exploration of energy are prevalent. While it is informative to use vegetative characteristics to model habitat associations of birds that are highly associated with grasslands, little is known about which characteristics of microhabitats within these grasslands are important to lesser prairie-chickens or how this species reacts to or overcomes pressures on their habitats from agricultural practices or development for energy. However, my analysis of habitats based on observations at active and abandoned leks provides a model, which is ultimately a statistical representation of potential habitats used by lesser prairie-chickens and the quality of those habitats. My modeling analysis should serve as a tool for managers in identifying, protecting, and improving habitats used by lesser-prairie chickens.

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Table 3.1.—Covariates of habitat, β-coefficients, model-averaged β-coefficients, and relevant AIC outputs of models of characteristics of habitats used by lesser prairie-chickens.

Model Number	1892	1896	1908	2020	1900	1912	2024	1916	2036	1904	1860	Model-averaged β-coefficients
y – Intercept	-1.408	-0.644	-0.595	-0.524	-0.421	-0.251	-0.255	-0.171	-0.228	-0.192	-0.210	-4.899
Andropogon	0.041	0.019	0.018	0.016	0.014	0.008	0.008	0.006	0.007	0.006	0.006	0.150
Aristida	0.035	0.016	0.016	0.013	0.012	0.007	0.006	0.006	0.006	0.005	0.004	0.127
Artemesia		-0.005				-0.002	-0.002			-0.002		-0.010
Bare ground					-0.002			-0.001		-0.001		-0.003
Eriogonum			-0.004			-0.001		-0.002	-0.002			-0.009
Unknown forbs	-0.051	-0.023	-0.023	-0.018	-0.018	-0.009	-0.008	-0.008	-0.008	-0.008		-0.173
Muhlenbergia	-0.044	-0.020	-0.019	-0.016	-0.016	-0.008	-0.008	-0.007	-0.007	-0.007	-0.005	-0.158
Panicum				-0.004			-0.002		-0.002			-0.008
Prosopis	0.054	0.026	0.023	0.020	0.019	0.010	0.010	0.008	0.009	0.009	0.008	0.197
Quercus	0.024	0.011	0.010	0.009	0.008	0.004	0.004	0.003	0.004	0.004	0.004	0.086
Senecio	0.063	0.031	0.029	0.023	0.022	0.013	0.012	0.011	0.011	0.010	0.006	0.230
df	8	9	9	9	9	10	10	10	10	10	7	
AICc	101.1	102.7	102.7	103.1	103.1	104.5	104.6	104.7	104.7	104.8	104.8	
delta	0	1.53	1.62	2	2.02	3.38	3.43	3.55	3.57	3.64	3.69	
weight	0.16	0.074	0.071	0.059	0.058	0.03	0.029	0.027	0.027	0.026	0.025	

CHAPTER 4

ASSESSMENT OF HABITAT EVALUATION AREAS ESTABLISHED BY THE BUREAU OF LAND MANAGEMENT IN SOUTHEASTERN NEW MEXICO FOR CONSERVATION OF THE LESSER PRAIRIE-CHICKEN

The lesser prairie-chicken (*Tympanuchus pallidicinctus*) is a species of prairie grouse that, except for the Gunnison sage-grouse (*Centrocercus minimus*), has the smallest population and most restricted distribution of any species of native North American grouse (Aldrich 1963, Johnsgard 1983, Giesen 1998). Populations in New Mexico were once sporadically distributed across about 38,000 km^2. This species has disappeared or is near extirpation across 56% of its historic range. Populations are sparse and isolated across another 23% of its historic range in New Mexico (Bailey and Williams 2000) and the lesser prairie-chicken has been extirpated in the northeastern portion of the state, including Harding, Quay, and Union counties (Figure 4.1). Although a few scattered records exist as far west as Roswell and Carlsbad Caverns National Park (Hubbard 1978), most lesser prairie-chickens in the state live within about 40 km of Texas in Roosevelt, Lea, and Chaves counties (Bailey and Williams 2000, Figure 4.1). Lesser prairie-chickens still occur in adjacent Bailey, Cochran, and Yoakum counties in western Texas, with a few leks also in Andrews and Gaines counties (Bailey and Williams 2000).

In 1995, the United States Fish and Wildlife Service was petitioned to list the lesser prairie-chicken as threatened or endangered under the Endangered Species Act (United States Fish and Wildlife Service 1998). The species was deemed warranted, but was precluded from listing by higher-priority actions and is currently a candidate species with its status reviewed annually (United States Fish and Wildlife Service 2011). During the years since the petition, the species has continued to decline throughout its range in New Mexico, Texas, Colorado, Oklahoma, and Kansas. The sparsely distributed and isolated populations that remain in New Mexico are vulnerable to extinction from genetic factors, environmental factors, or both (Bailey and Williams 2000). This species continues to face threats posed by drought, overgrazing by livestock, predation, control of shrubs, development for cropland, and production of oil and gas, in addition to new threats such as vulnerability and reduced viability of small populations and development for wind energy (Hoffman 1963, Jackson and DeArment 1963, Crawford 1980, Taylor and Guthery 1980, Bailey and Williams 2000).

Effective management of threatened or endangered species ultimately is judged by successful establishment of these species in appropriate natural or restored habitats. Lesser prairie-chickens, as well as other prairie grouse in decline, inhabit areas that have a mosaic of habitats each of which may be a key habitat for several months of the year. The lesser prairie-chicken requires different habitats and different parts of its home range during the year depending on season and changes in needs throughout its life cycle. These habitats each play an important role in the ecology of this species and, when linked together, these wintering-breeding-nesting-brooding complexes likely have considerable influence on distribution of lesser prairie-chickens. Their annual range can be 24.5-51.3 km^2 (Giesen 1998). Efforts to stabilize or increase populations require identification of remaining suitable habitats, followed by management and restoration of those habitats.

Bailey et al. (2000) reported use of lands as 85% rangeland, 12% cropland, and 4% developed for buildings, mining, or oil and gas extraction for a study area that encompassed a large portion (77%) of the historical range of lesser prairie-chickens within southeastern New Mexico. Cultivation of large tracts of land may have altered seasonal movement patterns of the lesser prairie-chicken and resulted in formation of numerous isolated populations, many of which gradually disappeared (Jackson and DeArment 1963, Crawford 1980). About 21% of historically occupied range in New Mexico is land managed by the Bureau of Land Management (BLM), 19% of historic range is owned and leased by the State Land Office, and 59% is privately owned (Bailey and Williams 2000). Reclamation and conservation efforts by the BLM focus on habitats that once were occupied, currently are occupied, or may provide suitable habitat for the lesser prairie-chicken. The BLM has selected 17 Habitat Evaluation Areas (HEAs) in southeastern New Mexico for evaluation (Appendix I). An important management objective for the BLM is to manage habitats on public lands for conservation and rehabilitation of wildlife (Bureau of Land Management 2006, New Mexico LPC/SDL Working Group in litt.). To aid the BLM, one objective of my research was to establish study areas on which I conducted evaluations of structure, cover, and composition of residual vegetation on each of the 17 HEAs during 2007-2008 and 2012. Other objectives were to compare data I obtained with those of pastures containing abandoned and active lekking locations surveyed by Hunt (2004), and, in subsequent years, to assess each of the 17 HEAs to determine if lesser prairie-chickens were present. Similarities and differences in vegetation may provide evidence for suitability of the areas as habitats for movement and reestablishment corridors, or for reintroduction of populations of lesser prairie-chicken. The primary goal of my study was to assess 17 Habitat Evaluation Areas established by the BLM as suitable or unsuitable habitat for lesser prairie-chickens using vegetative characteristics of pastures having active leks for reference. I also attempted to determine if small populations of lesser prairie-chickens existed near Habitat Evaluation Areas.

STUDY AREA

The study area contained 17 Habitat Evaluation Areas (HEAs) established by personnel of the BLM and totaling 45,751 hectares in eastern Eddy and southern Lea counties, New Mexico (Appendix 1). The study area was characterized by gently rolling terrain, with occasional sand dunes. Principal use of the area is for grazing by cattle interspersed with facilities for production of oil and gas, and scattered center-pivot and dry-land agricultural farming operations. Areas received light to moderate grazing under a variety of grazing-management schemes. Some pastures had been treated with tebuthiuron to kill shinnery oak (*Quercus havardii*) and increase grass cover for livestock.

METHODS

Assessment of Vegetative Characteristics.--Transects for assessments of vegetation were established within each of the 17 HEAs (Appendix I). Cover and composition were measured using the line-point sampling method described by Bonham (1989), K. Johnson and H. Smith (in litt), and Hunt (2004). At each HEA, four 100-m transects were performed in four directions. Vegetation was identified to genus when possible and recorded at 1-m intervals along each transect. This resulted in 400 data points for each HEA; thus, there was a total of 6,800 data points for the 17 HEAs combined. Percentage cover of each genus of plant, litter, and bare ground were calculated by dividing the number of data points for each category by 400, which was the number of data points obtained at each HEA (Tables 4.1 and 4.3). Percentages were arcsine transformed by first dividing the percentage by 100, then taking the arcsine of the square root of the proportion. Composition of vegetation was calculated by recomputing percentages by dividing number of data points for each genus by 400 minus the number of data points for litter plus bare ground (Tables 4.2 and 4.4), dividing the percentage by 100, and recomputing arcsine transformations. Data were obtained from J. L. Hunt to aid in comparisons between data I obtained for HEAs and data he provided for assessments of vegetation in 32 pastures containing active leks (active pastures) and 28 pastures containing abandoned (historically active) lekking locations (abandoned pastures) surveyed in 2001, and 33 pastures containing active leks and 27 pastures containing abandoned lekking locations surveyed in 2002 and 2003 (Hunt 2004). Data collected by Hunt (2004) also were arcsine transformed for comparison with my data. Cover and composition were compared between HEAs and locations in pastures containing active leks and between HEAs and sites in pastures containing abandoned lekking locations. Comparisons were made using discriminant-function analyses and one-way ANOVAs (SPSS version 10.0, Chicago, Illinois). Level of statistical significance ($P < 0.05$) was corrected for multiple comparisons with the sequential Bonferroni adjustment (Rice 1989). Structure matrices of discriminant-function analyses were used to evaluate relative importance of individual genera in determination of differences revealed by analyses.

Robel Visual-obstruction Method.--Using the same techniques as Hunt (2004), structure of vegetation was measured using the Robel visual-obstruction method (Robel et al. 1970). Robel-values were determined for the 17 HEAs (Table 4.5). Seven HEAs were evaluated in March 2007, 10 in January 2008, and 16 in March 2012. The Robel-value serves as an index of residual cover and often is used as a measure of intensity of grazing by livestock, with lower values indicating high usage. The technique is recommended for evaluation of habitats of lesser prairie-chickens (Mote et al. 1999). The device used to obtain Robel-values is a pole (Robel pole) marked in 2.54-cm increments with a pointed rod at one end that could be pushed into the soil. To begin each transect, 10 steps were taken from a central point. The pointed end of the Robel pole was pushed into the ground at the place where the toe of the boot was positioned on the 10th step. Four readings of the Robel pole were taken in a circle around the pole. These readings were taken from a distance of 4 m and a height of 1 m; distances were measured by a rope attached to the pole. The four readings were averaged to give a value for each point. This procedure was repeated 25 times and values were averaged to give a value for each transect. Two additional transects were conducted at 120° angles from the first, beginning from the original point of origin. The three values obtained were averaged to give an overall Robel-value for each HEA (Table 4.5). Robel visual-obstruction values were taken on 17 HEAs, with 300 data points in each, for a total of 5,100 data points. I took data that I obtained and those of Hunt (2004), listed them in Table 4.5, and compared Robel-values at HEAs, pastures with active leks, and pastures with abandoned (historically active, currently inactive) lekking locations using one-way ANOVAs (SPSS version 10.0, Chicago, Illinois).

Determining Presence of Lesser Prairie-chickens.—In previous research (McWilliams chapters 1 and 2), I adapted methods used by Rodgers (1992) and Silvy and Robel (1967) to determine whether lesser prairie-chickens were present in Habitat Evaluation Areas. Sound recordings used were made on active leks of lesser prairie-chickens and provided by Randy R. Rogers of the Kansas Department of Wildlife and Parks. To enhance quality of the original sound track, I sent the tape recording to a professional editorial service where it was digitized, enhanced, and transferred to CD format. The enhanced CD format provided a reliable format that produced high-quality playbacks on the game callers I used in the field. The audio system consisted of a continuous-play, electronic game caller (Western Rivers, Inc., Lexington, Tennessee), and two weatherproof speakers (Western Rivers, Inc., Lexington, Tennessee; Figure 1.1.

During 2 March-3 May 2008, a different location was monitored in each HEA on four occasions using the audio system (Table 4.6). At each HEA, sound recordings of lekking lesser prairie-chickens were played continuously for 2 hours beginning 15 minutes before sunrise. Thus, at each of the 17 HEAs, monitoring was conducted four times for a total of 68 2-hour assessments in 2008. With the exception of the Eunice HEA, where the ranch owner denied access, 16 HEAs were monitored 3 March-21 April 2009, 1 March-29 April 2010, and 2 March-4 May 2012 using the same procedure as in 2008 (Table 4.6). In addition, the 16 HEAs were monitored for 20-30 minutes during January of 2009 and 2010 (Table 4.6). Using the same procedure as in 2008, each of the 17 HEAs were monitored 20 March-6 May 2011 for 1-4 occasions (Table 4.6).

RESULTS

Assessment of Vegetative Characteristics.--Vegetation on HEAs consisted primarily of shinnery oak, sand dropseed (*Sporobolus cryptandrus*), and purple threeawn (*Aristida purpurea*). Together, these taxa represented 73% of vegetation on HEAs. Field sandbur (*Cenchrus incertus*), sand sage, yucca (*Yucca*), grama, prairie sunflower (*Helianthus petiolarus*), groundsel (*Senecio*), and annual bursage (*Ambrosia*) also were present and represented about 22% of vegetation. Honey mesquite (*Prosopis glandulosa*), sand bluestem (*Andropogon hallii*), broom snakeweed (*Gutierrezia sarothrae*), annual buckwheat (*Eriogonum annuum*), plains prickly pear (*Opuntia polyacantha*), croton (*Croton*), sumac (*Rhus aromatica*), sand lovegrass (*Eragrostis trichodes*), spurge (*Euphorbia*), and greasewood (*Sarcobatus*) each represented ≤1% of vegetation (Tables 4.2 and 4.4). Components occurring as ≤0.1% (percentage composition) of vegetation on sites were excluded from subsequent analyses. These components included

Amaranthus, Croton, Eragrostis, Euphorbia, *Mentzelia*, *Munroa, Opuntia, Paspalum*, *Rhus*, *Salsola*, and *Sarcobatus*. Unidentified plants also were excluded from analyses. Most HEAs included shinnery oak, sand dropseed, purple threeawn, and yucca. In addition to vegetation, cover of HEAs was on average 19% bare ground (range 6-34%) and 37% litter (range 22-60%; Tables 4.1 and 4.3).

According to structure matrices of discriminant-function analyses, cover and composition of vegetation on HEAs differed from pastures containing active leks primarily in amount of *Sporobolus*, *Cenchrus*, and *Andropogon* (Appendices II and III). *Bouteloua*, *Helianthus*, *Gutierrezia*, *Quercus*, *Yucca*, *Panicum*, litter, *Artemisia*, bare ground, *Aristida*, and *Prosopis* showed less variability among HEAs. HEAs typically had significantly more *Sporobolus* and *Cenchrus*, and less *Andropogon* than pastures containing active leks.

According to structure matrices of discriminant-function analyses, percentage cover and composition of *Sporobolus* exhibited the greatest difference from pastures associated with active leks. *Sporobolus* averaged 2% of vegetation in pastures associated with active leks, 14% in pastures associated with abandoned lekking locations, but was highest in HEAs, averaging 17% of vegetation. However, Loco Hills, Eunice, Mills, and San Simon HEAs did not differ significantly in cover or composition of *Sporobolus* (F-values < 7) from that in pastures with active leks.

Cenchrus was present in trace amounts (<0.1%) in both pastures with active leks and with pastures containing abandoned lekking locations surveyed in 2001-2003. However, it comprised a significantly greater percentage of vegetation on all HEAs than was on either active or abandoned pastures with exception of the Pearl HEA, where amount of *Cenchrus* did not differ significantly from that of abandoned pastures. Most HEAs showed an increase in percentage of *Cenchrus* from 2007 to 2012. Only Paduca, Mills, and Pearl HEAs showed a decrease (< 3.5%) in amount of *Cenchrus*.

Percentage cover and composition of *Andropogon* was lower on HEAs than on either active or abandoned pastures. It averaged 30% of vegetation in pastures associated with active leks, 5% in pastures associated with abandoned leks, and <1% (range 0-6%) of vegetation on HEAs. *Andropogon* was ≤1% of vegetation on most HEAs. Exceptions included QP-F, QP-B, QP-A, in both 2007 and 2012, and QP-C, Eunice, and Bilbry for 2007 only. All HEAs except Paduca showed a decrease in *Andropogon* from 2007 to 2012. Amount of *Andropogon* increased from 0 to 0.25% cover on the Paduca HEA from 2007 to 2012.

Robel Visual-obstruction Method.--Average vegetative cover of HEAs, as determined from Robel visual-obstruction values, was 20.85 for the 17 HEAs in 2007-2008 (range = 9.93-40.26); 20.37 for the 7 assessed in 2007, and 21.53 for the 10 assessed in 2008 (Table 4.5). Robel index decreased for each of 16 HEAs assessed in 2012 to an average Robel-value of 14.16, a 30.45% decrease on average (range 10.98-60.16%; Table 4.5). Despite the decrease in cover on HEAs in 2012, cover remained 31.61% greater ($P < 0.001$), than the average for pastures containing active leks, and 37.50% greater ($P < 0.001$) than the average for pastures containing abandoned lekking locations surveyed by Hunt (2004) in 2001-2003 (Table 4.5).

Determining Presence of Lesser Prairie-chickens.—During the 68 days of assessment in 2008, lesser prairie-chickens were observed on four of the 17 HEAs. The lek on the Eunice HEA was the only active lek in southern Lea County and the only active lek on the 17 HEAs that I evaluated. Assessment during two of five visits to the Eunice HEA verified lesser prairie-chickens in the vicinity of the active lek (6-8 were observed 22 March 2008), but the three other assessments were farther away from the active lek and yielded no observation of the lesser prairie-chicken. On HEA QP-D, one lesser prairie-chicken was attracted during the assessment on 24 March 2008. The bird flew almost directly over the observer, landed about 100 meters away and, when approached on foot, the bird flew back toward where it originated. This observation location is near where a lesser prairie-chicken was observed on this HEA in January 2008 (T. Allen and S. Bird, pers. comm.). On HEA QP-C, two lesser prairie-chickens flew to the assessment location about 25 minutes apart on 25 March 2008; one from the west and the other from the southwest. They both landed among dense vegetation and were not observed subsequently. On HEA QP-A, a lesser prairie-chicken walked onto the assessment location in shinnery oak habitat on 25 March 2008; it flew when approached on foot by the observer. During the 55 days of assessment in 2009, two lesser prairie-chickens were observed. One lesser prairie-chicken was observed on HEA QP-C on 22 January 2009. One bird was observed on the Paduca HEA on 21 March 2009. During the 57 days of assessment in 2010, one individual was observed on the Skeen HEA on 27 March. No lesser prairie-chicken was observed during the 39 days of assessment in 2011 or for the 64 days of assessment in 2012.

DISCUSSION

Assessment of Vegetative Characteristics.--Results of analyses of cover and composition of vegetation were similar. Hunt (2004) and Hunt and Best (2010) indicated that the most important vegetative characteristics in determining difference in cover between pastures with active leks and pastures with abandoned lekking locations were *Andropogon, Sporobolus, Muhlenbergia*, *Gutierrezia*, *Bouteloua*, and *Eriogonum*. Pastures with active leks had greater cover of *Andropogon*, *Bouteloua*, and *Gutierrezia*, and lower cover of *Sporobolus, Muhlenbergia*, and *Eriogonum*, than did pastures with abandoned lekking locations (Hunt and Best 2010). In my qualitative comparison of data presented by Hunt (2004) and data on composition and cover that I obtained from the 17 HEAs, I conclude that they generally are congruent (Appendices II-III). However, HEAs typically had significantly more *Sporobolus* and *Cenchrus*, and less *Andropogon*, than pastures containing active leks. Most remarkable were differences in percentage composition of *Andropogon* and *Sporobolus*.

Cannon and Knopf (1981) suggested that management strategies for lesser prairie-chickens in shinnery oak rangelands should emphasize species that are perennial mid- and tall-grasses. Hunt (2004) and Hunt and Best (2010) demonstrated that pastures containing lekking locations that were abandoned by lesser prairie-chickens had <20% of the *Andropogon* as those pastures with active leks. My study showed less *Andropogon* ($P \leq 0.044$) on most HEAs than in pastures containing active leks. HEAs had <25% as much *Andropogon* as pastures associated with active leks (Appendix II). *Andropogon* was ≤1% of vegetation on most HEAs. Exceptions included QP-F, QP-B, QP-A, in both 2007 and 2012, and QP-C, Eunice, and Bilbry for 2007 only. Perhaps not coincidentally, three of four records of lesser prairie-chickens in 2008 occurred on QP-A, QP-C, and Eunice HEAs. All HEAs, except Paduca, showed a decrease in percentage composition of *Andropogon* from 2007 to 2012, possibly as a result of drought, overgrazing, or both.

Andropogon grows in thick clumps that often have an open area at the center of the clump. These clumps are ideal for ground-nesting birds such as lesser prairie-chickens, which preferentially select *Andropogon* as nesting sites. Nesting success is much greater for lesser prairie-chickens that select *Andropogon* (Davis et al. 1979, Riley et al. 1992). *Sporobolus* grows in clumps that are not as thick as those of *Andropogon* (Powell 1994). Nests placed in *Sporobolus* would be more visible to predators than those placed in *Andropogon* (Davis et al. 1979). Davis et al. (1979) reported that nesting success in eastern New Mexico was 27% (n =

36), with 63% of failures attributed to predation. Nesting success was correlated positively with cover of *Andropogon* and negatively correlated with level of grazing by livestock (Davis et al., 1979). *Andropogon* is better forage for livestock than is *Sporobolus* (Valentine 1989); it is highly palatable, and is selected by livestock over other grasses. *Sporobolus,* although consumed by livestock, is not selected preferentially, and its value as forage declines rapidly as it matures (Stubbendieck et al. 1997). Under heavy grazing, amount of *Andropogon* decreases and *Sporobolus* increases; thus, *Sporobolus* is considered an indicator of overgrazing (Stubbendieck et al. 1997). *Andropogon* also is less well adapted to areas of poor, sandy soil, while *Sporobolus* is well adapted to such soils (Ross and Bailey 1967, Stubbendieck et al. 1997). Quality of soil at abandoned lekking locations often is poor (Ross and Bailey 1967, Chug et al. 1971, Turner et al. 1974, Lenfesty 1983).

Of the tall grasses, *Andropogon* was more common on active leks and surrounding pasture, whereas *Sporobolus* was more common on HEAs. *Sporobolus* averaged 2% of composition (1% of cover) of vegetation in pastures associated with active leks, 14% in pastures associated with abandoned lekking locations (5% of cover), but was highest in HEAs, averaging 17% of composition of vegetation (7% of cover). Relative amounts of *Andropogon* and *Sporobolus* indicate that HEAs, like pastures with abandoned leks, are more likely to be in areas of heavy grazing than are pastures containing active leks. Loco Hills, Eunice, Mills, and San Simon HEAs did not differ significantly in cover or composition of *Sporobolus* (F-values < 7) from that in pastures with active leks. Eunice, the only HEA associated with an active lek, was the only HEA that did not differ significantly in composition of either *Andropogon* or *Sporobolus* from that in pastures with active leks.

*Robel Visual-obstruction Method*s.--Analysis of vegetation by Hunt (2004) indicated that composition was not involved in choice of lekking locations, but locations likely were chosen to allow for maximum visibility of displays (Davis et al. 1979) and for proximity to suitable nesting and brood-rearing habitats (Bergerud and Gratson 1988). Height of residual grasses is important; females choose nesting and brood-rearing habitat that have good concealment both vertically and horizontally (Johnsgard 2002). For nesting and roosting sites, they select taller species of bunchgrasses that have not been grazed (Copelin 1963). Average cover on HEAs, as determined by Robel visual-obstruction values, was higher ($P < 0.001$) than the average for pastures containing active leks and for pastures containing abandoned lekking locations (Hunt 2004; Table 4.5).

Overgrazing by livestock has detrimental impacts upon rangelands by altering overall density of plants, species, and structure (Fleischner 1994, Heady and Child 1994). Hunt (2004) detected a significant correlation between overgrazing and decline in lesser prairie-chickens in southeastern New Mexico. With the possible exception of HEA QP-A, which was heavily grazed when data were obtained in 2007, Robel-values indicated adequate cover for lesser prairie-chickens in 2007-2008 (Table 4.5). While this could reflect decreased intensity of grazing in 2006-2007, a more likely explanation for presence of substantial vegetative cover when data were gathered was that data were collected following years with higher than average precipitation (Table 4.7). Significant precipitation during September 2006 and 2007 occurred within the annual growing season for New Mexico. This produced significant vegetative growth that was present as the residual vegetation we measured in early 2007 and 2008. Robel-values were lower on all HEAs measured in 2012 (Table 4.5). This may reflect lower than average precipitation during 2011.

Merchant (1982) documented population declines for lesser prairie-chickens in New Mexico during drought. Droughts in the 1930s, 1950s, and 1990s are believed to have caused range-wide declines in numbers of active leks and individuals (Merchant 1982, Giesen 1998, Bailey and Williams 2000). Population declines in 1989-1990 in New Mexico were related to drought, which reduced production, height, and density of grasses that were important nesting and brooding habitats for lesser prairie-chickens. Quality of nesting habitats is largely reliant on residual (standing dead) vegetation, particularly grasses, from the previous growing season. Excessive grazing exacerbates problems associated with drought by removing residual grasses necessary for cover prior to the nesting season (Jackson and DeArment 1963, Riley et al. 1992, Giesen 1994, Mote et al. 1999, Bailey et al. 2000, Bidwell 2002), and perhaps, by altering composition of vegetation (Bailey and Williams 2000). Merchant (1982) reported that lesser prairie-chickens relied on ungrazed or lightly grazed habitats during drought. Numbers of cattle typically are not reduced during drought but may be reduced during years following dry years (Bailey and Williams 2000). Grazing impacts on habitats could be alleviated by reduction in numbers of livestock during drought.

Hunt (2004) detected no difference between height of vegetation in pastures that contained active leks and pastures without active leks. However, these results do not indicate that height of grasses had any effect on decline of lesser prairie-chickens, but instead, might have been because some abandoned leks were inactive for years before his study began. Heights of residual grasses change from year to year due to differences in grazing schemes and patterns of precipitation. For example, precipitation in 2000 and 2001 was low across southeastern New Mexico (Table 4.7). Rainfall in late summer 2001 resulted in growth of grasses reflected in greater Robel-values in 2002 (Table 4.7). However, livestock grazing in the northern part of the study area kept Robel-values in that area low. Because amount of residual vegetation changes from year to year, use of the Robel procedure is not particularly useful in studies that attempt to explain events in previous years (Hunt 2004). The Robel procedure, however, may be useful in monitoring residual vegetation on a year-to-year basis in areas where populations of lesser prairie-chickens remain, areas that may act as dispersal corridors, or potential reintroduction locations such as the HEAs. Data gathered in my study and that of Hunt (2004) may be used as a starting point for annual monitoring of HEAs. Robel transects, or comparable methods of assessment, would be useful in evaluating HEAs annually to monitor height and composition of vegetation on HEAs. This would provide insight into potential overgrazing, effect of drought, or other conditions that might require modification of habitat-management plans. Annual monitoring also would be useful in evaluating HEAs to determine if adequate residual vegetation is present for successful reproduction by lesser prairie-chickens.

Determining Presence of Lesser Prairie-chickens.—Current populations are fragmented into small, discrete units, and the range of the lesser prairie-chicken is greatly diminished (Crawford 1980). Recent sightings of lesser prairie-chickens in areas where breeding populations no longer exist (McWilliams Chapter 2) and in HEAs that I surveyed (Table 4.6) indicate that there is some movement back into the area. Although the current population may periodically increase on managed areas such as the HEAs that I surveyed, we should not become complacent.

Currently, some HEAs may be too small to provide suitable habitat for a viable population but large enough to fill gaps between habitats and to provide potential for restoration. Small areas may not be sufficient to sustain lesser prairie-chickens long-term. Most lekking grouse are poor dispersers (Braun et al. 1994, Madge et al 2002) and lesser prairie-chickens are no exception (Copelin 1963, Jamison 2000). Dispersing individuals may contribute little to persistence of populations in fragments of disjunct habitats. Therefore, remaining large fragments of suitable habitats should be protected. Because most male lesser prairie-chickens show philopatry to leks where they first establish territories, management probably should be aimed primarily at protection and expansion of remaining habitats and secondarily at efforts to increase their connectivity by adding patches between large occupied fragments (Jamison 2000). Small, isolated populations lacking corridors to neighboring populations may experience inbreeding that can lead to decline and extinction. Usable corridors are needed to connect isolated populations to increase genetic diversity among and within populations.

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Table 4.1.—Percentage vegetative cover on 17 Habitat Evaluation Areas in southeastern New Mexico, 2007. Some columns may not total 100% due to rounding.

	Mescalero	QP-F	Loco Hills	QP-B	QP-C	Southpaw	QP-A	QP-D	Pearl	Laguna	Skeen	Eunice	Bilbry	WIPP	Mills	Paduca	San Simon
Ambrosia	0	1	0	8	2	0	0	19	0	1	0	0	0	0	0	0	0
Andropogon	1	2	0	3	1	0	2	0	0	0	0	1	1	0	0	0	1
Aristida	4	4	12	7	2	3	7	27	7	1	7	4	8	0	7	13	4
Artemisia	5	4	6	0	0	5	0	1	1	1	0	0	0	1	6	0	0
Bouteloua	4	1	9	4	2	0	2	1	1	1	2	6	4	1	2	0	3
Cenchrus	0	0	0	0	0	0	0	4	0	0	1	3	2	1	7	4	2
Croton	1	2	1	0	0	1	0	2	0	0	0	0	0	0	0	0	0
Eragrostis	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Eriogonum	1	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	1
Gutierrezia	1	0	0	0	0	1	0	1	8	0	1	0	0	0	0	0	0
Helianthus	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	4
Opuntia	0	0	0	0	1	0	1	0	0	0	0	2	0	0	0	0	2
Prosopis	0	0	0	0	0	2	0	4	1	0	0	0	0	1	4	0	0
Quercus	26	31	27	18	26	29	28	0	30	22	17	35	19	13	12	32	18
Rhus	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Senecio	0	1	0	2	2	0	0	1	0	1	0	2	2	4	1	1	23
Sporobolus	9	5	1	7	13	7	4	1	8	16	8	5	10	14	3	5	2
Yucca	2	1	1	2	0	1	2	1	1	2	0	5	1	2	1	1	0
Unidentified	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Litter	24	28	25	32	30	24	23	25	22	24	30	25	37	36	29	28	31
Bare	23	19	18	17	19	29	31	14	21	31	34	10	17	27	30	17	12

Table 4.2.—Percentage vegetative composition (bare ground and litter removed) on 17 Habitat Evaluation Areas in southeastern New Mexico, 2007. Some columns may not total 100% due to rounding.

	Mescalero	QP-F	Loco Hills	QP-B	QP-C	Southpaw	QP-A	QP-D	Pearl	Laguna	Skeen	Eunice	Bilbry	WIPP	Mills	Paduca	San Simon
Ambrosia	0	2	0	15	4	0	0	30	0	2	0	0	0	0	0	0	0
Andropogon	1	4	0	6	2	1	3	0	0	0	0	2	2	0	1	0	1
Aristida	8	8	21	13	3	5	15	44	12	2	20	6	16	0	16	24	6
Artemisia	9	8	10	0	0	11	1	2	2	1	0	0	0	2	14	0	0
Bouteloua	8	1	15	8	4	0	4	1	1	3	5	8	9	1	6	0	5
Cenchrus	0	0	0	0	0	0	0	6	0	0	2	4	3	3	16	7	3
Croton	1	3	1	0	0	1	0	4	0	0	0	0	0	1	1	0	0
Eragrostis	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Eriogonum	1	2	1	0	0	0	0	0	0	0	1	2	1	1	0	0	2
Gutierrezia	2	0	0	0	0	1	0	1	14	0	2	0	0	0	1	0	0
Helianthus	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	6
Opuntia	0	0	0	0	2	0	3	0	0	0	0	3	0	0	0	0	3
Prosopis	0	0	0	0	0	4	0	6	1	0	1	0	0	1	9	0	0
Quercus	48	59	48	35	49	62	61	0	52	50	46	53	40	34	30	58	30
Rhus	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Senecio	0	1	0	3	4	0	1	1	0	2	1	2	5	11	1	1	39
Sporobolus	17	10	1	14	25	14	9	2	14	37	23	8	21	39	6	9	3
Yucca	4	2	1	4	0	2	5	2	1	4	1	7	2	5	1	1	0
Unidentified	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0

Table 4.3.—Percentage vegetative cover on 16 Habitat Evaluation Areas in southeastern New Mexico, 2012. Some columns may not total 100% due to rounding.

	Mescalero	QP-F	Loco Hills	QP-B	QP-C	Southpaw	QP-A	QP-D	Pearl	Laguna	Skeen	Bilbry	WIPP	Mills	Paduca	San Simon
Andropogon	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Aristida	3	5	8	8	4	9	5	1	11	1	5	8	2	9	14	6
Artemisia	7	4	3	1	0	2	1	2	8	1	0	1	2	8	0	1
Bouteloua	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Cenchrus	4	1	5	2	1	3	1	12	0	2	4	2	2	4	0	4
Croton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Eriogonum	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2
Gutierrezia	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Helianthus	1	1	0	7	6	0	0	0	2	0	0	1	2	1	0	5
Opuntia	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Prosopis	1	0	0	0	0	0	0	2	1	1	0	0	0	4	0	0
Quercus	19	18	21	11	16	14	14	0	15	8	23	21	10	16	23	21
Rhus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Sporobolus	9	12	1	6	15	6	3	11	5	8	5	11	10	5	5	6
Yucca	5	2	0	0	1	1	1	4	1	3	2	1	5	0	2	0
Litter	36	40	47	52	43	52	56	56	48	60	49	49	40	31	37	41
Bare	16	17	15	13	14	13	19	13	8	17	11	6	28	22	18	12

Table 4.4.—Percentage vegetative composition (bare ground and litter removed) on 16 Habitat Evaluation Areas in southeastern New Mexico, 2012. Some columns may not total 100% due to rounding.

	Mescalero	QP-F	Loco Hills	QP-B	QP-C	Southpaw	QP-A	QP-D	Pearl	Laguna	Skeen	Bilbry	WIPP	Mills	Paduca	San Simon
Andropogon	0	1	0	2	0	0	3	0	0	0	0	1	0	1	1	1
Aristida	6	12	22	22	10	25	19	2	25	5	13	18	6	19	31	12
Artemisia	14	8	7	1	0	6	2	7	17	3	0	1	6	16	0	1
Bouteloua	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Cenchrus	7	3	13	6	3	7	3	37	0	7	11	5	7	7	1	8
Croton	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1
Eriogonum	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	5
Euphorbia	0	0	0	0	0	0	0	0	0	0	0		0	1	0	0
Gutierrezia	3	0	0	0	0	0	0	1	3	0	0	0	0	1	0	0
Helianthus	1	3	1	20	15	0	1	1	5	1	1	2	6	2	0	11
Opuntia	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0
Prosopis	1	0	0	0	0	1	0	6	2	4	0	0	0	9	1	0
Quercus	39	42	55	30	36	39	54	0	33	33	57	46	30	35	51	45
Rhus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Sarcobatus	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
Senecio	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1
Sporobolus	19	27	3	17	34	17	11	34	12	36	13	24	30	10	11	12
Yucca	10	4	0	1	1	4	5	12	2	11	5	3	14	0	3	1
Unidentified	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

Table 4.5.—Robel-values for Habitat Evaluation Areas, active leks, and abandoned lekking locations in southeastern New Mexico.

Habitat Evaluation Areas				Active leks				Abandoned lekking locations			
Site	2007	2008	2012	Site	2001	2002	2003	Site	2001	2002	2003
Mescalero		24.04	17.44	EU-23		6.42	11.66	BB-1	2.86	5.24	14.55
QP-F		18.01	15.76	C1-4	11.03	11.24	11.01	BB-2	10.50	8.07	15.00
Loco Hills		14.97	10.24	C2-1	11.46	12.51	8.94	E-23	7.70	7.15	13.28
QP-B		21.07	13.52	GW1-2	6.96	10.63	7.40	QP-1	4.66	9.22	11.28
QP-C	26.19		21.03	GW6-1	9.70	9.70	7.98	QP-12	6.75	8.74	16.78
Southpaw	20.99		17.04	M-5	12.72	14.90	10.51	QP-15	6.28	14.47	14.03
QP-A	9.93		7.95	M-4	14.98	15.45	13.02	QP-7	13.40		
QP-D		15.43	9.59	M-8	7.85	10.48	7.28	QP-9	7.18		
Pearl		23.74	16.79	MA-1	8.51	7.91	7.10	QP-22	9.92	13.49	15.04
Laguna		21.58	10.57	NB-1	12.62	15.55	11.46	QP-23	10.94	19.65	24.52
Skeen	21.60		13.81	10N	14.27	9.20	9.11	QP-27	10.67	10.95	11.48
Eunice		15.82		13N	9.40		7.52	12N	9.40		8.00
Bilbry	40.26		16.04	13E	10.00		9.60	32S	9.60	5.57	4.90
WIPP	14.73		12.55	2N	10.15	4.90	5.20	60N	6.10	4.80	5.01
Mills	17.03		15.16	21N	8.50	7.00	8.43	7N	9.03	5.03	5.60
Paduca		22.32	13.57	22N	9.00	4.95	5.70				
San Simon		26.74	15.5	24N	12.30	4.67	14.10				
				39N	12.45	7.24	6.62				
				4N	14.75	10.25	9.69				
				47N	13.05	6.90	9.90				
				48N	9.84	7.02	6.56				
				54N	13.70	9.23	7.65				
				74N	10.50	5.44	7.07				
Average	20.37	21.53	14.16		11.08	9.12	8.85		8.33	9.37	8.85

Table 4.6.—Locations of monitoring sites, dates assessed in 2008-2012, and lesser prairie-chickens (LPC) observed on 17 Habitat Evaluation Areas (HEA) in southeastern New Mexico.

HEA	Location	Date assessed	LPC
Mescalero Sands			
	32º55.711’N, 103º57.430’W	18 March 2008	none
	32º54.299’N, 103º55.650’W	28 March 2008	none
	32º55.300’N, 103º55.921’W	8 April 2008	none
	32º55.401’N, 103º58.508’W	23 April 2008	none
	32º55.173’N, 103º57.228’W	23 January 2009	none
	32º55.233’N, 103º57.188’W	19 March 2009	none
	32º52.288’N, 103º53.626’W	30 March 2009	none
	32º55.405’N, 103º58.496’W	7 April 2009	none
	32º56.214’N, 103º57.155’W	18 April 2009	none
	32º54.735’N, 103º58.258’W	24 January 2010	none
	32º54.749’N, 103º55.377’W	16 March 2010	none
	32º54.279’N, 103º55.630’W	24 March 2010	none
	32º55.290’N, 103º57.228’W	2 April 2010	none
	32º55.404’N, 103º58.501’W	18 April 2010	none
	32º55.403’N, 103º58.495’W	3 April 2011	none
	32º54.916’N, 103º55.328’W	17 April 2011	none
	32º55.514’N, 103º57.451’W	6 May 2011	none
	32º55.611’N, 103º57.649’W	17 March 2012	none
	32º56.237’N, 103º54.731’W	2 April 2012	none
	32º54.910’N, 103º55.337’W	18 April 2012	none
	32º54.485’N, 103º58.313’W	4 May 2012	none
QP-F			
	32º47.375’N, 103º50.304’W	17 March 2008	none
	32º47.258’N, 103º51.738’W	27 March 2008	none
	32º48.012’N, 103º52.185’W	7 April 2008	none
	32º47.888’N, 103º51.172’W	3 May 2008	none
	32º47.376’N, 103º50.309’W	21 January 2009	none
	32º47.378’N, 103º50.307’W	18 March 2009	none
	32º47.967’N, 103º52.169’W	29 March 2009	none
	32º48.018’N, 103º51.066’W	4 April 2009	none
	32º47.116’N, 103º51.570’W	21 April 2009	none
	32º48.040’N, 103º52.188’W	21 January 2010	none
	32º47.126’N, 103º51.567’W	15 March 2010	none
	32º47.339’N, 103º52.218’W	24 March 2010	none
	32º47.935’N, 103º52.193’W	1 April 2010	none
	32º48.020’N, 103º51.070’W	17 April 2010	none
	32º47.119’N, 103º51.574’W	31 March 2011	none
	32º47.340’N, 103º52.213’W	15 April 2011	none
	32º47.966’N, 103º52.187’W	4 May 2011	none
	32º47.289’N, 103º50.711’W	15 March 2012	none
	32º47.974’N, 103º52.184’W	31 March 2012	none
	32º47.116’N, 103º51.574’W	16 April 2012	none
	32º47.338’N, 103º52.215’W	2 May 2012	none

Table 4.6.—Continued.

HEA	Location	Date Assessed	LPCs
Loco Hills			
	32º44.829'N, 103º57.053'N	16 March 2008	none
	32º44.668'N, 103º58.414'W	27 March 2008	none
	32º45.884'N, 103º57.007'W	6 April 2008	none
	32º45.669'N, 103º59.422'W	2 May 2 008	none
	32º44.526'N, 103º55.369'W	23 January 2009	none
	32º44.959'N, 103º55.827'W	17 March 2009	none
	32º44.670'N, 103º58.416'W	29 March 2009	none
	32º44.849'N, 103º57.966'W	6 April 2009	none
	32º46.000'N, 103º56.685'W	20 April 2009	none
	32º44.989'N, 103º56.065'W	24 January 2010	none
	32º45.997'N, 103º56.735'W	14 March 2010	none
	32º44.664'N, 103º58.413'W	23 March 2010	none
	32º44.836'N, 103º57.052'W	31 March 2010	none
	32º44.994'N, 103º56.060'W	16 April 2010	none
	32º45.999'N, 103º56.743'W	2 April 2011	none
	32º44.833'N, 103º57.049'W	16 April 2011	none
	32º44.987'N, 103º56.066'W	5 May 2011	none
	32º45.086'N, 103º57.165'W	16 March 2012	none
	32º45.975'N, 103º56.857'W	1 April 2012	none
	32º44.082'N, 103º58.530'W	17 April 2012	none
	32º44.984'N, 103º56.069'W	3 May 2012	none
QP-B			
	32º44.179'N, 103º42.282'W	15 March 2008	none
	32º43.791'N, 103º42.122'W	26 March 2008	none
	32º43.888'N, 103º41.059'W	5 April 2008	none
	32º44.306'N, 103º41.222'W	1 May 2008	none
	32º43.924'N, 103º42.174'W	22 January 2009	none
	32º44.239'N, 103º42.236'W	10 March 2009	none
	32º43.909'N, 103º41.077'W	28 March 2009	none
	32º44.370'N, 103º41.124'W	6 April 2009	none
	32º43.878'N, 103º42.094'W	19 April 2009	none
	32º44.081'N, 103º41.000'W	22 January 2010	none
	32º43.918'N, 103º42.158'W	8 March 2010	none
	32º43.905'N, 103º41.042'W	23 March 2010	none
	32º44.304'N, 103º41.059'W	31 March 2010	none
	32º44.192'N, 103º42.282'W	15 April 2010	none
	32º44.186'N, 103º42.456'W	1 April 2011	none
	32º43.912'N, 103º41.040'W	13 April 2011	none
	32º43.982'N, 103º42.206'W	3 May 2011	none
	32º44.167'N, 103º41.964'W	14 March 2012	none
	32º43.972'N, 103º41.081'W	30 March 2012	none
	32º44.073'N, 103º40.856'W	15 April 2012	none
	32º43.858'N, 103º42.125'W	1 May 2012	none

Table 4.6.—Continued.

HEA	Location	Date Assessed	LPCs
QP-C			
	32º42.551'N, 103º44.795'W	12 March 2008	none
	32º42.543'N, 103º43.592'W	25 March 2008	YES
	32º42.965'N, 103º43.572'W	3 April 2008	none
	32º42.238'N, 103º42.117'W	28 April 2008	none
	32º42.546'N, 103º43.591'W	22 January 2009	YES
	32º42.543'N, 103º43.593'W	11 March 2009	none
	32º40.546'N, 103º47.496'W	27 March 2009	none
	32º42.318'N, 103º41.976'W	5 April 2009	none
	32º43.050'N, 103º44.100'W	16 April 2009	none
	32º42.547'N, 103º43.082'W	22 January 2010	none
	32º42.561'N, 103º44.661'W	9 March 2010	none
	32º43.069'N, 103º43.654'W	22 March 2010	none
	32º42.344'N, 103º41.981'W	30 March 2010	none
	32º42.543'N, 103º43.595'W	20 April 2010	none
	32º42.554'N, 103º44.653'W	30 March 2011	none
	32º42.548'N, 103º43.594'W	12 April 2011	none
	32º42.574'N, 103º44.514'W	13 March 2012	none
	32º41.972'N, 103º44.589'W	29 March 2012	none
	32º42.542'N, 103º43.593'W	14 April 2012	none
	32º42.964'N, 103º42.991'W	30 April 2012	none
Southpaw			
	32º42.605'N, 103º49.133'W	14 March 2008	none
	32º42.789'N, 103º48.746'W	26 March 2008	none
	32º41.511'N, 103º48.613'W	4 April 2008	none
	32º42.468'N, 103º49.509'W	30 April 2008	none
	32º42.904'N, 103º48.553'W	21 January 2009	none
	32º42.553'N, 103º49.145'W	14 March 2009	none
	32º43.284'N, 103º48.702'W	28 March 2009	none
	32º41.373'N, 103º48.809'W	5 April 2009	none
	32º43.116'N, 103º47.875'W	17 April 2009	none
	32º43.050'N, 103º48.446'W	23 January 2010	none
	32º43.288'N, 103º48.707'W	22 March 2010	none
	32º41.090'N, 103º49.249'W	30 March 2010	none
	32º42.374'N, 103º49.303'W	14 April 2010	none
	32º43.188'N, 103º47.878'W	21 April 2010	none
	32º43.565'N, 103º49.118'W	29 March 2011	none
	32º43.217'N, 103º47.885'W	14 April 2011	none
	32º41.804'N, 103º49.048'W	1 May 2011	none
	32º42.416'N, 103º48.925'W	12 March 2012	none
	32º43.427'N, 103º48.800'W	28 March 2012	none
	32º41.056'N, 103º49.234'W	13 April 2012	none
	32º43.188'N, 103º47.885'W	29 April 2012	none

Table 4.6.—Continued.

HEA	Location	Date Assessed	LPCs
QP-A			
	32º41.467'N, 103º36.944'W	13 March 2008	none
	32º40.688'N, 103º39.232'W	25 March 2008	YES
	32º42.061'N, 103º39.605'W	2 April 2008	none
	32º40.566'N, 103º40.034'W	29 April 2008	none
	32º41.255'N, 103º37.358'W	22 January 2009	none
	32º41.511'N, 103º36.956'W	13 March 2009	none
	32º40.590'N, 103º36.210'W	27 March 2009	none
	32º41.996'N, 103º37.893'W	3 April 2009	none
	32º41.976'N, 103º39.998'W	15 April 2009	none
	32º41.256'N, 103º37.357'W	22 January 2010	none
	32º42.002'N, 103º37.929'W	29 March 2010	none
	32º40.687'N, 103º39.225'W	12 April 2010	none
	32º41.454'N, 103º36.987'W	19 April 2010	none
	32º41.284'N, 103º37.355'W	29 April 2010	none
	32º41.990'N, 103º37.911'W	27 March 2011	none
	32º40.682'N, 103º39.229'W	11 April 2011	none
	32º41.252'N, 103º37.357'W	30 April 2011	none
	32º42.970'N, 103º42.993'W	2 May 2011	none
	32º41.484'N, 103º37.006'W	11 March 2012	none
	32º42.385'N, 103º39.192'W	27 March 2012	none
	32º40.681'N, 103º39.230'W	12 April 2012	none
	32º40.252'N, 103º37.358'W	28 April 2012	none
QP-D			
	32º40.590'N, 103º46.481'W	11 March 2008	none
	32º41.258'N, 103º47.216'W	24 March 2008	YES
	32º40.326'N, 103º47.493'W	2 April 2008	none
	32º41.294'N, 103º46.521'W	27 April 2008	none
	32º41.154'N, 103º47.533'W	21 January 2009	none
	32º41.253'N, 103º47.219'W	15 March 2009	none
	32º40.546'N, 103º47.496'W	26 March 2009	none
	32º40.302'N, 103º47.450'W	3 April 2009	none
	32º40.241'N, 103º46.093'W	14 April 2009	none
	32º40.631'N, 103º47.700'W	23 January 2010	none
	32º40.520'N, 103º47.509'W	13 March 2010	none
	32º40.827'N, 103º46.460'W	21 March 2010	none
	32º40.306'N, 103º47.486'W	29 March 2010	none
	32º41.257'N, 103º47.212'W	11 April 2010	none
	32º41.315'N, 103º46.834'W	25 March 2011	none
	32º40.668'N, 103º46.555'W	10 March 2012	none
	32º40.523'N, 103º47.489'W	26 March 2012	none
	32º41.266'N, 103º46.401'W	11 April 2012	none
	32º40,858'N, 103º46.934'W	27 April 2012	none

Table 4.6.—Continued.

HEA	Location	Date Assessed	LPCs
Pearl			
	32º38.617’N, 103º32.720’W	10 March 2008	none
	32º38.848’N, 103º32.002’W	24 March 2008	none
	32º39.475’N, 103º33.260’W	1 April 2008	none
	32º37.843’N, 103º33.186’W	26 April 2008	none
	32º38.622’N, 103º32.733’W	20 January 2009	none
	32º38.620’N, 103º32.724’W	12 March 2009	none
	32º38.826’N, 103º31.590’W	26 March 2009	none
	32º39.447’N, 103º33.258’W	4 April 2009	none
	32º37.808’N, 103º33.189’W	13 April 2009	none
	32º38.344’N, 103º32.305’W	21 January 2010	none
	32º38.625’N, 103º32.734’W	10 March 2010	none
	32º37.831’N, 103º33.171’W	28 March 2010	none
	32º39.477’N, 103º33.257’W	10 April 2010	none
	32º38.871’N, 103º31.988’W	27 April 2010	none
	32º38.822’N, 103º33.444’W	26 March 2011	none
	32º37.867’N, 103º33.384’W	28 April 2011	none
	32º38.574’N, 103º33.193’W	8 March 2012	none
	32º39.042’N, 103º33.539’W	25 March 2012	none
	32º38.049’N, 103º32.205’W	10 April 2012	none
	32º37.826’N, 103º33.277’W	26 April 2012	none
Laguna			
	32º36.105’N, 103º48.382’W	9 March 2008	none
	32º36.265’N, 103º46.616’W	23 March 2008	none
	32º36.601’N, 103º45.798’W	1 April 2008	none
	32º36.467’N, 103º47.629’W	25 April 2008	none
	32º35.921’N, 103º48.034’W	20 January 2009	none
	32º35.922’N, 103º48.034’W	9 March 2009	none
	32º36.259’N, 103º48.607’W	25 March 2009	none
	32º36.582’N, 103º45.786’W	2 April 2009	none
	32º36.261’N, 103º48.748’W	12 April 2009	none
	32º36.450’N, 103º47.165’W	21 January 2010	none
	32º36.268’N, 103º46.610’W	7 March 2010	none
	32º36.197’N, 103º48.615’W	20 March 2010	none
	32º36.597’N, 103º45.794’W	28 March 2010	none
	32º35.920’N, 103º48.029’W	8 April 2010	none
	32º36.279’N, 103º48.718’W	10 April 2011	none
	32º36.266’N, 103º46.603’W	9 March 2012	none
	32º35.263’N, 103º42.641’W	24 March 2012	none
	32º36.599’N, 103º45.790’W	9 April 2012	none
	32º36.313’N, 103º48.423’W	25 April 2012	none

Table 4.6.—Continued.

HEA	Location	Date Assessed	LPCs
Skeen			
	32º34.309'N, 103º35.259'W	8 March 2008	none
	32º35.130'N, 103º35.070'W	23 March 2008	none
	32º35.121'N, 103º33.815'W	31 March 2008	none
	32º34.701'N, 103º32.695'W	24 April 2008	none
	32º34.304'N, 103º35.276'W	20 January 2009	none
	32º34.306'N, 103º35.257'W	8 March 2009	none
	32º35.112'N, 103º33.780'W	25 March 2009	none
	32º35.131'N, 103º35.073'W	2 April 2009	none
	32º34.136'N, 103º33.715'W	11 April 2009	none
	32º34.310'N, 103º35.257'W	21 January 2010	none
	32º34.109'N, 103º34.153'W	6 March 2010	none
	32º35.135'N, 103º35.066'W	27 March 2010	YES
	32º35.126'N, 103º33.788'W	3 April 2010	none
	32º34.309'N, 103º35.262'W	28 April 2010	none
	32º34.305'N, 103º35.274'W	28 March 2011	none
	32º35.116'N, 103º33.791'W	8 April 2011	none
	32º35.138'N, 103º35.061'W	27 April 2011	none
	32º34.806'N, 103º35.193'W	7 March 2012	none
	32º35.122'N, 103º33.799'W	23 March 2012	none
	32º35.538'N, 103º34.350'W	8 April 2012	none
	32º34.300'N, 103º35.276'W	24 April 2012	none
Eunice			
	32º30.946'N, 103º03.979'W	7 March 2008	YES
	32º29.935'N, 103º05.056'W	22 March 2008	YES
	32º28.835'N, 103º05.825'W	31 March 2008	none
	32º31.379'N, 103º05.622'W	17 April 2008	none
	32º31.325'N, 103º05.596'W	22 March 2011	none
Bilbry			
	32º27.944'N, 103º39.804'W	6 March 2008	none
	32º28.290'N, 103º40.266'W	22 March 2008	none
	32º28.666'N, 103º40.568'W	30 March 2008	none
	32º27.347'N, 103º38.478'W	22 April 2008	none
	32º27.816'N, 103º40.267'W	19 January 2009	none
	32º27.818'N, 103º40.265'W	7 March 2009	none
	32º27.388'N, 103º38.431'W	24 March 2009	none
	32º28.296'N, 103º40.272'W	1 April 2009	none
	32º28.671'N, 103º40.567'W	10 April 2009	none
	32º28.151'N, 103º40.568'W	19 January 2010	none
	32º27.817'N, 103º40.266'W	5 March 2010	none
	32º27.277'N, 103º38.641'W	19 March 2010	none
	32º28.296'N, 103º40.272'W	27 March 2010	none
	32º28.667'N, 103º40.569'W	7 April 2010	none
	32º27.814'N, 103º40.258'W	23 March 2011	none
	32º27.242'N, 103º38.455'W	7 April 2011	none
	32º28.671'N, 103º40.567'W	29 April 2011	none
	32º28.001'N, 103º39.731'W	6 March 2012	none
	32º27.253'N, 103º38.495'W	22 March 2012	none
	32º28.921'N, 103º39.550'W	7 April 2012	none
	32º27.818'N, 103º40.260'W	23 April 2012	none

Table 4.6.—Continued.

HEA	Location	Date Assessed	LPCs
WIPP			
	32º23.961’N, 103º47.298’W	5 March 2008	none
	32º27.439’N, 103º47.524’W	21 March 2008	none
	32º21.354’N, 103º46.208’W	30 March 2008	none
	32º23.725’N, 103º45.475’W	21 April 2008	none
	32º23.731’N, 103º45.457’W	19 January 2009	none
	32º23.730’N, 103º45.474’W	6 March 2009	none
	32º27.416’N, 103º48.457’W	23 March 2009	none
	32º23.761’N, 103º47.117’W	1 April 2009	none
	32º24.673’N, 103º48.527’W	9 April 2009	none
	32º24.022’N, 103º44.748’W	19 January 2010	none
	32º23.732’N, 103º45.475’W	4 March 2010	none
	32º24.645’N, 103º48.443’W	26 March 2010	none
	32º21.354’N, 103º46.209’W	2 April 2010	none
	32º27.415’N, 103º48.459’W	6 April 2010	none
	32º27.420’N, 103º48.468’W	24 March 2011	none
	32º24.548’N, 103º48.529’W	6 April 2011	none
	32º23.735’N, 103º45.475’W	19 April 2011	none
	32º23.729’N, 103º45.473’W	5 March 2012	none
	32º23.980’N, 103º47.209’W	21 March 2012	none
	32º24.610’N, 103º48.522’W	6 April 2012	none
	32º27.423’N, 103º48.462’W	22 April 2012	none
Mills			
	32º21.606’N, 103º41.961’W	4 March 2008	none
	32º22.005’N, 103º42.375’W	20 March 2008	none
	32º22.693’N, 103º41.808’W	29 March 2008	none
	32º22.117’N, 103º40.989’W	19 April 2008	none
	32º21.438’N, 103º42.152’W	19 January 2009	none
	32º21.582’N, 103º41.923’W	5 March 2009	none
	32º21.321’N, 103º41.811’W	22 March 2009	none
	32º22.722’N, 103º41.706’W	31 March 2009	none
	32º21.448’N, 103º42.800’W	8 April 2009	none
	32º21.567’N, 103º42.154’W	19 January 2010	none
	32º21.381’N, 103º42.815’W	3 March 2010	none
	32º21.965’N, 103º42.260’W	25 March 2010	none
	32º22.719’N, 103º41.692’W	1 April 2010	none
	32º21.494’N, 103º41.830’W	4 April 2010	none
	32º21.582’N, 103º42.032’W	9 April 2011	none
	32º21.771’N, 103º42.017’W	4 March 2012	none
	32º22.164’N, 103º42.781’W	20 March 2012	none
	32º21.309’N, 103º42.794’W	5 April 2012	none
	32º22.723’N, 103º41.706’W	21 April 2012	none

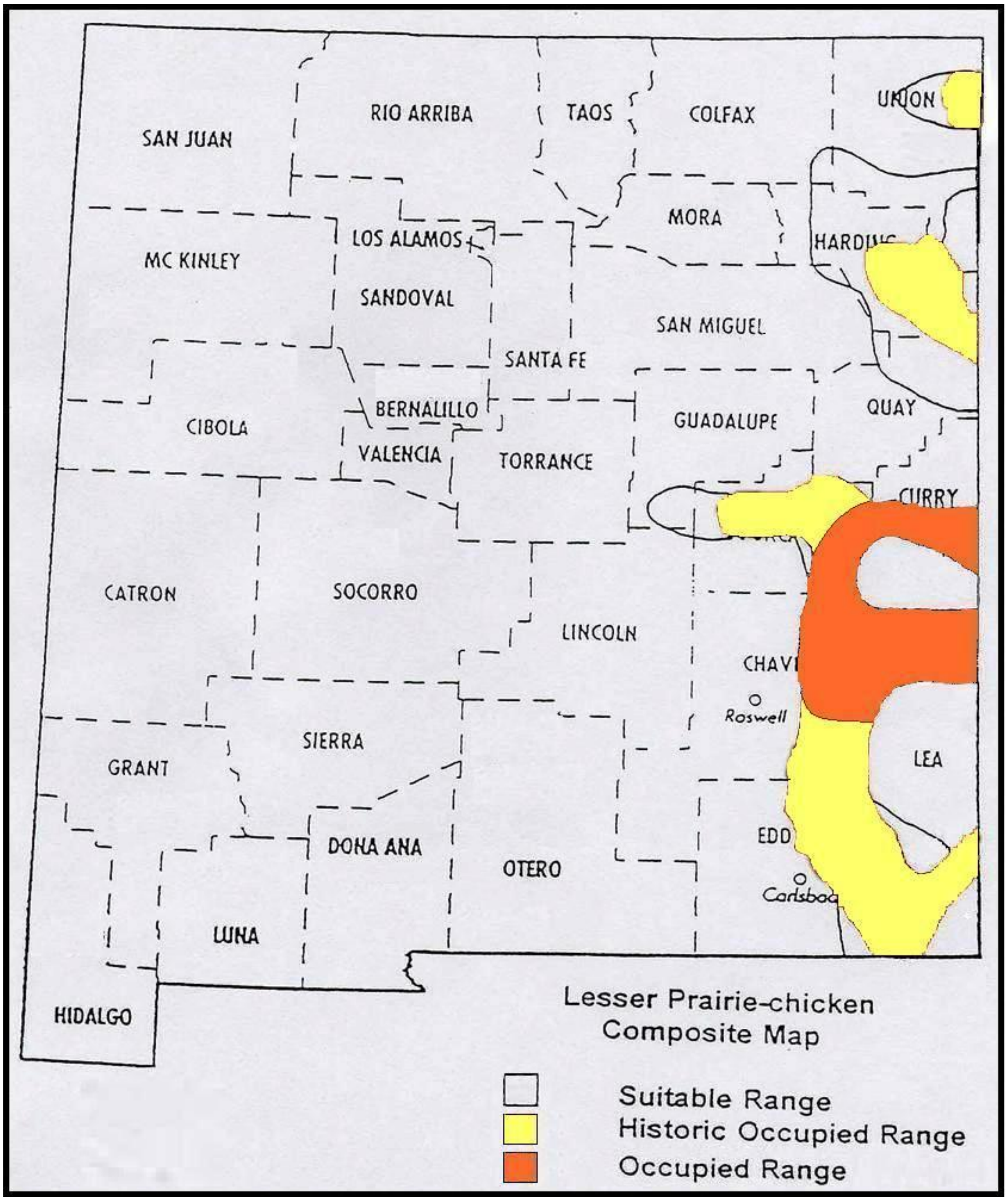
Table 4.6.—Continued.

HEA	Location	Date Assessed	LPCs
Paduca			
	32º21.518'N, 103º31.919'W	3 March 2008	none
	32º21.138'N, 103º34.086'W	21 March 2008	none
	32º22.464'N, 103º33.496'W	29 March 2008	none
	32º22.499'N, 103º31.475'W	20 April 2008	none
	32º22.703'N, 103º30.710'W	19 January 2009	none
	32º21.463'N, 103º32.004'W	4 March 2009	none
	32º22.549'N, 103º33.461'W	21 March 2009	YES
	32º22.696'N, 103º30.710'W	31 March 2009	none
	32º21.216'N, 103º34.008'W	8 April 2009	none
	32º22.717'N, 103º30.713'W	20 January 2010	none
	32º21.461'N, 103º31.903'W	2 March 2010	none
	32º22.449'N, 103º33.634'W	18 March 2010	none
	32º21.218'N, 103º34.009'W	26 March 2010	none
	32º22.695'N, 103º30.710'W	5 April 2010	none
	32º24.051'N, 103º34.062'W	21 March 2011	none
	32º22.716'N, 103º30.717'W	5 April 2011	none
	32º21.357'N, 103º32.134'W	20 April 2011	none
	32º21.543'N, 103º32.061'W	3 March 2012	none
	32º22.700'N, 103º30.711'W	19 March 2012	none
	32º22.555'N, 103º33.520'W	4 April 2012	none
	32º22.502'N, 103º31.522'W	20 April 2012	none
San Simon			
	32º17.348'N, 103º19.429'W	2 March 2008	none
	32º19.902'N, 103º20.400'W	20 March 2008	none
	32º17.484'N, 103º18.125'W	28 March 2008	none
	32º17.912'N, 103º17.924'W	18 April 2008	none
	32º17.399'N, 103º19.472'W	25 January 2009	none
	32º17.437'N, 103º19.523'W	3 March 2009	none
	32º17.839'N, 103º18.230'W	20 March 2009	none
	32º17.689'N, 103º19.340'W	30 March 2009	none
	32º19.902'N, 103º20.406'W	7 April 2009	none
	32º17.956'N, 103º18.529'W	20 January 2010	none
	32º17.487'N, 103º18.124'W	1 March 2010	none
	32º17.843'N, 103º18.286'W	17 March 2010	none
	32º19.905'N, 103º20.403'W	25 March 2010	none
	32º17.514'N, 103º19.389'W	3 April 2010	none
	32º17.484'N, 103º18.124'W	20 March 2011	none
	32º17.840'N, 103º18.377'W	4 April 2011	none
	32º17.510'N, 103º19.388'W	18 April 2011	none
	32º17.580'N, 103º19.567'W	2 March 2012	none
	32º17.487'N, 103º18.124'W	18 March 2012	none
	32º19.899'N, 103º20.433'W	3 April 2012	none
	32º17.517'N, 103º19.386'W	19 April 2012	none

Table 4.7.—Total monthly precipitation (mm) at Carlsbad, 32º35'N, 104º22'W, elevation 951 m, Eddy Co., New Mexico, 2000-2012. (http://cdo.ncdc.noaa.gov).

	Month												
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
2000	1.5	1.3	6.6	3.6	0	96.3	2.5	9.9	0	59.7	106.7	9.9	297.9
2001	22.8	12.2	22.4	12.4	13.5	31.0	11.4	13.2	24.4	2.8	31.5	5.1	202.7
2002	4.3	16.0	54.6	0	0	6.6	63.2	52.8	24.6	50.5	14.5	12.7	300.0
2003	0	25.1	8.9	0	30.2	12.7	14.2	7.9	5.3	31.2	12.2	0	147.8
2004	6.3	24.1	43.4	105.9	8.9	42.4	72.4	52.1	104.6	19.6	116.3	20.8	617.0
2005	11.4	42.4	17.0	4.6	38.4	3.0	14.5	61.2	6.6	26.7	0	0	225.8
2006	0	7.9	30.5	2.5	4.1	45.7	13.7	48.3	109.2	19.3	2.3	8.4	291.8
2007	41.9	12.2	67.1	15.0	87.6	25.7	33.0	37.3	129.8	0	10.4	23.4	483.4
2008	0.3	1.0	5.8	0	21.8	15.7	64.3	48.0	59.2	18.8	1.0	3.3	239.3
2009	0	3.8	3.6	0	10.2	45.2	155.7	16.0	6.6	25.9	2.5	38.1	307.6
2010	24.9	34.0	10.4	15.5	21.8	31.5	186.9	25.4	86.6	2.5	0	0.3	439.9
2011	0	10.9	0	0	0	1.0	15.5	12.7	42.4	6.9	1.3	37.8	128.5
2012	6.1	1.8	1.5	3.6	76.5	0	64.8	14.0	47.2	0	5.3	3.3	224.0

Figure 4.1—Suitable, current, and historic range of the lesser prairie-chicken as it coincides with sandy-soiled, shinnery oak (*Quercus havardii*) habitat in New Mexico (Bailey 1928, Ligon 1961, Davis et al. 2008).



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APPENDIX I.—DESCRIPTIONS OF HABITAT EVALUATION AREAS (HEAS) ESTABLISHED BY PERSONNEL OF THE BUREAU OF LAND MANAGEMENT.

<u>HEA: Bilbry</u>.

Hectares: 2,156

Vegetation Transect. Location: 32°27.997'N, 103°39.730'W. T21S, R32E. Elevation: 1,141 m. Dates assessed: 20 March 2007, 5 March 2012.

Robel Transect. Location: 32°28.001'N, 103°39.539'W. T21S, R32E. Elevation: 1,154 m. Dates assessed: 20 Mach 2007, 5 March 2012.

Lekking locations within the HEA: BB-1, BB-2.

<u>HEA: Eunice</u>.

Hectares: 3,100

Vegetation Transect. Location: 32°30.681'N, 103°04.421'W. T20-21S, R38-39E. Elevation: 1,086 m. Date assessed: 23 March 2007.

Robel Transect. Location: 32°30.684'N, 103°04.293'W. T20-21S, R38-39E. Elevation: 1,087 m. Date assessed: 20 January 2008.

Lekking locations within the HEA: EU-2, EU-23, EU-NEW

<u>HEA: Laguna</u>.

Hectares: 1,331

Vegetation Transect. Location: 32°36.146'N, 103°48.311'W. T19-20S, R31-32E. Elevation: 1,064 m. Dates assessed: 24 March 2007, 9 March 2012.

Robel Transect. Location: 32°36.145'N, 103°48.183'W. T19-20S, R31-32E. Elevation: 1,066 m. Dates assessed: 19 January 2008, 9 March 2012.

Lekking locations within the HEA: None

HEA: Loco Hills.

Hectares: 3,577

Vegetation Transect. Location: 32°45.082'N, 103°57.166'W. T18S, R30E. Elevation: 1,056 m. Dates assessed: 27 March 2007, 16 March 2012.

Robel Transect. Location: 32°45.082'N, 103°57.038'W. T18S, R30E. Elevation: 1,054 m. Dates assessed: 25 January 2008, 16 March 2012.

Lekking locations within the HEA: None

HEA: Mescalero Sands.

Hectares: 3,783

Vegetation Transect. Location: 32°55.611'N, 103°57.649'W. T16S, R30-31E. Elevation: 1,167 m. Dates assessed: 28 March 2007, 16 March 2012.

Robel Transect. Location: 32°55.611'N, 103°57.520'W. T16S, R30-31E. Elevation: 1,164 m. Dates assessed: 25 January 2008. 16-17 March 2012.

Lekking locations within the HEA: None

HEA: Mills.

Hectares: 1,046

Vegetation Transect. Location: 32°21.770'N, 103°42.018'W. T22S, R32E. Elevation: 1,089 m. Dates assessed: 22 March 2007, 3 March 2012.

Robel Transect. Location: 32°21.758'N, 103°41.891'W. T22S, R32E. Elevation: 1,087 m. Dates assessed: 22 March 2007, 3 March 2012.

Lekking locations within the HEA: None

HEA: Paduca.

Hectares: 6,138

Vegetation Transect. Location: 32°21.543'N, 103°32.060'W. T22-23S, R33-34E. Elevation: 1,051 m. Dates assessed: 23 March 2007, 2 March 2012.

Robel Transect. Location: 32°21.542'N, 103°31.931'W. T22-23S, R33-34E. Elevation: 1,052 m. Dates assessed: 21 January 2008, 2-3 March 2012.

Lekking locations within the HEA: None

HEA: Pearl.

Hectares: 1,309

Vegetation Transect. Location: 32°38.572'N, 103°33.193'W. T19S, R34E. Elevation: 1,139 m. Dates assessed: 24 March 2007, 7 March 2012.

Robel Transect. Location: 32°38.571'N, 103°33.065'W. T19S, R34E. Elevation: 1,141 m. Dates assessed: 22 January 2008, 7 March 2012.

Lekking locations within the HEA: None

HEA: QP-A.

Hectares: 3,074

Vegetation Transect. Location: 32°41.483'N, 103°37.004'W. T18-19S, R33-34E. Elevation: 1,155 m. Dates assessed: 24 March 2007, 11 March 2012.

Robel Transect. Location: 32°41.483'N, 103°37.136'W. T18-19S, R33-34E. Elevation: 1,154 m. Dates assessed: 29 March 2007, 11 March 2012.

Lekking locations within the HEA: QP-2, QP-3, QP-19, QP-18, QP-14, QP-5.

HEA: QP-B.

Hectares: 242

Vegetation Transect. Location: 32°44.167'N, 103°41.963'W. T18S, R33E. Elevation: 1,166 m. Dates assessed: 27 March 2007, 14 March 2012.

Robel Transect. Location: 32°44.167'N, 103°41.835'W. T18S, R33E. Elevation: 1,166 m. Dates assessed: 19 January 2008, 14 March 2012.

Lekking locations within the HEA: None

<u>HEA: QP-C</u>.

Hectares: 1,253

Vegetation Transect. Location: 32°42.574'N, 103°44.514'W. T18S, R32-33E. Elevation: 1,131 m. Dates assessed: 27 March 2007, 19 March 2012.

Robel Transect. Location: 32°42.575'N, 103°44.385'W. T18S, R32-33E. Elevation: 1,134 m. Dates assessed: 29 March 2007, 19 March 2012.

Lekking locations within the HEA: QP-12

<u>HEA: QP-D</u>.

Hectares: 798

Vegetation Transect. Location: 32°40.673'N, 103°46.558'W. T19S, R32E. Elevation: 1,111m. Dates assessed: 24 March 2007, 10 March 2012.

Robel Transect. Location: 32°40.673'N, 103°46.431'W. T19S, R32E. Elevation: 1,106 m. Dates assessed: 20 January 2008, 10 March 2012.

Lekking locations within the HEA: None

<u>HEA: QP-F</u>.

Hectares: 1,177

Vegetation Transect. Location: 32°47.287'N, 103°50.708'W. T17-18S, R31E. Elevation: 1,154 m. Dates assessed: 17 March 2007, 15 March 2012.

Robel Transect. Location: 32°47.287'N, 103°50.580'W. T17-18S, R31E. Elevation: 1,153 m. Dates assessed: 24 January 2008, 15 March 2012.

Lekking locations within the HEA: None

<u>HEA: San Simon</u>.

Hectares: 4,331

Vegetation Transect. Location: 32°17.446'N, 103°19.609'W. T23S, R35-36E. Elevation: 1,063 m. Dates assessed: 23 March 2007, 1-2 March 2012.

Robel Transect. Location: 32°17.447'N, 103°19.482'W. T23S, R35-36E. Elevation: 1,057 m. Dates assessed: 21 January 2008, 2 March 2012.

Lekking locations within the HEA: None

<u>HEA: Skeen</u>.

Hectares: 1,190

Vegetation Transect. Location: 32°34.288'N, 103°35.142'W. T20S, R34E. Elevation: 1,106 m. Dates assessed: 18 March 2007, 6 March 2012.

Robel Transect. Location: 32°34.281'N, 103°35.014'W. T20S, R34E. Elevation: 1,108 m. Dates assessed: 18 March 2007, 6 March 2012.

Lekking locations within the HEA: QP-21, QP-29.

<u>HEA: Southpaw</u>.

Hectares: 1,236

Vegetation Transect. Location: 32°42.416'N, 103°49.052'W. T18-19S, R31-32E. Elevation: 1,115 m. Dates assessed: 24 March 2007, 12 March 2012.

Robel Transect. Location: 32°42.416'N, 103°48.924'W. T18-19S, R31-32E. Elevation: 1,114 m. Dates assessed: 28 March 2007, 12 March 2012.

Lekking locations located within the HEA: QP-22

HEA: WIPP.

Hectares: 10,011

Vegetation Transect. Location: 32°23.980'N, 103°47.207'W. T21-22S, R30-31E. Elevation: 1,041 m. Dates assessed: 20 March 2007, 21 March 2012.

Robel Transect. Location: 32°23.982'N, 103°47.038'W. T21-22S, R30-31E. Elevation: 1,045 m. Dates assessed: 20 March 2007, 21 March 2012.

Lekking locations within the HEA: None.

APPENDIX II.— Percentage vegetative cover of Habitat Evaluation Areas (HEAs), pastures with active leks of lesser prairie-chickens (*Tympanuchus pallidicinctus*), and pastures with abandoned lekking locations in southeastern New Mexico, spring 2001–2003, 2007, and 2012. ANOVA with Bonferroni adjustment for multiple comparisons revealed significant difference between HEAs and pasture locations at $P < 0.008$.

				Active		Abandoned	
Plant	Site	Year	Percentage	*F*	*P*	*F*	*P*
Ambrosia							
	Pastures with active leks						
		2001	0				
		2002	0				
		2003	0				
	Pastures with abandoned lekking locations						
		2001	0				
		2002	0				
		2003	0				
	Mescalero Sands						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	QP-F						
		2007	1.00	3.4E+33	<0.001	4.9E+33	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	Loco Hills						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	QP-B						
		2007	7.50	2.7E+34	<0.001	3.9E+34	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	QP-C						

		2007	2.25	7.9E+33	<0.001	1.1E+34	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	Southpaw						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	QP-A						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	QP-D						
		2007	18.50	7.1E+34	<0.001	1.0E+35	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	Pearl						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	Laguna						
		2007	0.75	2.5E+33	<0.001	3.6E+33	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	Skeen						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	Eunice						
		2007	0	0.346	0.558	4.469	0.038
		2012	NA				
	Bilbry						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	WIPP						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	Mills						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	Paduca						
		2007	0	0.346	0.558	4.469	0.038

		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	San Simon						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
Andropogon							
	Pastures with active leks						
		2001	17.16				
		2002	14.78				
		2003	13.03				
	Pastures with abandoned lekking locations						
		2001	2.36				
		2002	2.43				
		2003	1.81				
	Mescalero Sands						
		2007	0.50	3.357	0.070	0.023	0.880
		2012	0	5.053	0.027	0.482	0.489
		Combined		8.318	0.005	0.358	0.552
	QP-F						
		2007	2.25	1.800	0.183	0.238	0.627
		2012	0.50	3.357	0.070	0.023	0.880
		Combined		5.032	0.027	0.056	0.813
	Loco Hills						
		2007	0	5.053	0.027	0.482	0.489
		2012	0	5.053	0.027	0.482	0.489
		Combined		10.107	0.002	0.965	0.329
	QP-B						
		2007	3.25	1.330	0.252	0.540	0.465
		2012	0.75	3.008	0.086	0.001	0.981
		Combined		4.162	0.044	0.252	0.617
	QP-C						
		2007	1.00	2.728	0.102	0.007	0.933
		2012	0	5.053	0.027	0.482	0.489
		Combined		7.590	0.007	0.186	0.668
	Southpaw						
		2007	0.25	3.841	0.053	0.101	0.751

		2012	0	5.053	0.027	0.482	0.489
		Combined		8.850	0.004	0.513	0.476
	QP-A						
		2007	1.50	2.288	0.134	0.070	0.791
		2012	0.75	3.008	0.086	0.001	0.981
		Combined		5.271	0.024	0.029	0.865
	QP-D						
		2007	0	5.053	0.027	0.482	0.489
		2012	0	5.053	0.027	0.482	0.489
		Combined		10.107	0.002	0.965	0.329
	Pearl						
		2007	0	5.053	0.027	0.482	0.489
		2012	0	5.053	0.027	0.482	0.489
		Combined		10.107	0.002	0.965	0.329
	LAGUNA						
		2007	0	5.053	0.027	0.482	0.489
		2012	0	5.053	0.027	0.482	0.489
		Combined		10.107	0.002	0.965	0.329
	Skeen						
		2007	0	5.053	0.027	0.482	0.489
		2012	0	5.053	0.027	0.482	0.489
		Combined		10.107	0.002	0.965	0.329
	Eunice						
		2007	1.25	2.492	0.118	0.032	0.858
		2012	NA				
	Bilbry						
		2007	1.00	2.728	0.102	0.007	0.933
		2012	0.25	3.841	0.053	0.101	0.751
		Combined		6.519	0.012	0.027	0.869
	WIPP						
		2007	0	5.053	0.027	0.482	0.489
		2012	0	5.053	0.027	0.482	0.489
		Combined		10.107	0.002	0.965	0.329
	Mills						
		2007	0.25	3.841	0.053	0.101	0.751
		2012	0.25	3.841	0.053	0.101	0.751
		Combined		7.683	0.007	0.203	0.654
	Paduca						
		2007	0	5.053	0.027	0.482	0.489
		2012	0.25	3.841	0.053	0.101	0.751
		Combined		8.850	0.004	0.513	0.476
	San Simon						
		2007	0.50	3.357	0.070	0.023	0880

		2012	0.25	3.841	0.053	0.101	0751
		Combined		7.191	0.009	0.111	0.740
Aristda							
	Pastures with active leks						
		2001	6.63				
		2002	5.78				
		2003	4.23				
	Pastures with abandoned lekking locations						
		2001	5.18				
		2002	5.10				
		2003	5.19				
	Mescalero Sands						
		2007	4.25	0.008	0.927	0.001	0.972
		2012	3.00	0.175	0.676	0.152	0.698
		Combined		0.130	0.719	0.090	0.765
	QP-F						
		2007	4.00	0.024	0.878	0.010	0.919
		2012	5.25	0.019	0.891	0.046	0.831
		Combined		<0.001	0.991	0.006	0.937
	Loco Hills						
		2007	12.00	1.768	0.187	2.274	0.135
		2012	8.25	0.522	0.572	0.720	0.399
		Combined		2.101	0.150	2.770	0.100
	QP-B						
		2007	6.50	0.157	0.693	0.245	0.622
		2012	7.75	0.400	0.529	0.565	0.455
		Combined		0.529	0.469	0.776	0.381
	QP-C						
		2007	1.75	0.675	0.413	0.684	0.411
		2012	4.25	0.008	0.927	0.001	0.972
		Combined		0.417	0.520	0.370	0.545
	Southpaw						
		2007	2.50	0.322	0.572	0.304	0.583
		2012	8.75	0.655	0.420	0.890	0.348
		Combined		0.029	0.865	0.076	0.784
	QP-A						
		2007	6.75	0.198	0.657	0.300	0.585

		2012	4.75	0.001	0.980	0.009	0.927
		Combined		0.110	0.740	0.205	0.652
	QP-D						
		2007	27.00	10.268	0.002	12.549	0.001
		2012	11.00	2.028	0.158	2.192	0.143
		Combined		1.426	0.235	1.837	0.179
	Pearl						
		2007	7.00	0.243	0.623	0.360	0.550
		2012	11.00	1.385	0.242	1.802	0.183
		Combined		1.391	0.241	1.880	0.174
	Laguna						
		2007	0.75	1.610	0.207	1.722	0.193
		2012	1.25	1.046	0.309	1.091	0.299
		Combined		2.625	0.106	2.777	0.099
	Skeen						
		2007	7.25	0.292	0.590	0.424	0.517
		2012	5.25	0.019	0.891	0.046	0.831
		Combined		0.229	0.633	0.374	0.543
	Eunice						
		2007	4.25	0.008	0.927	0.001	0.972
		2012	NA				
	Bilbry						
		2007	7.75	0.400	0.529	0.565	0.455
		2012	8.25	0.522	0.472	0.720	0.399
		Combined		0.918	0.340	1.281	0.261
	WIPP						
		2007	0	4.335	0.040	4.816	0.031
		2012	2.00	0.536	0.466	0.532	0.468
		Combined		3.923	0.050	4.219	0.043
	Mills						
		2007	6.50	0.157	0.693	0.245	0.622
		2012	8.75	0.655	0.420	0.890	0.348
		Combined		0.726	0.396	1.033	0.312
	Paduca						
		2007	13.00	2.181	0.143	2.781	0.099
		2012	14.25	2.736	0.101	3.460	0.067
		Combined		4.901	0.029	6.222	0.015
	San Simon						
		2007	3.75	0.047	0.829	0.029	0.866
		2012	6.00	0.087	0.768	0.149	0.701
		Combined		0.003	0.956	0.023	0.879
Artemisia							
	Pastures with						

	active leks						
		2001	0.70				
		2002	0.68				
		2003	0.74				
	Pastures with abandoned lekking locations						
		2001	0.91				
		2002	1.19				
		2003	0.98				
	Mescalero Sands						
		2007	4.75	6.353	0.013	3.770	0.056
		2012	6.75	10.107	0.002	6.165	0.015
		Combined		16.210	<0.001	9.774	0.002
	QP-F						
		2007	4.25	5.458	0.022	3.205	0.077
		2012	3.50	4.158	0.044	2.391	0.126
		Combined		9.570	0.003	5.566	0.021
	Loco Hills						
		2007	5.50	7.731	0.007	4.646	0.034
		2012	2.50	2.528	0.115	1.385	0.243
		Combined		9.482	0.003	5.521	0.021
	QP-B						
		2007	0	0.619	0.433	0.603	0.440
		2012	0.50	0.060	0.807	0.005	0.943
		Combined		0.146	0.703	0.247	0.621
	QP-C						
		2007	0	0.619	0.433	0.603	0.440
		2012	0	0.619	0.433	0.603	0.440
		Combined		1.239	0.268	1.206	0.275
	Southpaw						
		2007	5.25	7.268	0.008	4.350	0.040
		2012	2.25	2.145	0.146	1.153	0.286
		Combined		8.588	0.004	4.962	0.029
	QP-A						
		2007	0.25	0.005	0.943	0.035	0.851
		2012	0.50	0.060	0.807	0.005	0.943
		Combined		0.015	0.902	0.007	0.935
	QP-D						
		2007	1.00	0.483	0.489	0.195	0.660
		2012	2.25	2.145	0.146	1.153	0.286

		Combined		2.324	0.131	1.145	0.288
	Pearl						
		2007	1.00	0.483	0.489	0.195	0.660
		2012	7.50	11.573	0.001	7.107	0.009
		Combined		8.084	0.005	4.684	0.033
	Laguna						
		2007	0.50	0.060	0.807	0.005	0.943
		2012	0.75	0.239	0.626	0.074	0.786
		Combined		0.270	0.605	0.059	0.808
	Skeen						
		2007	1.00	0.483	0.489	0.195	0.660
		2012	0	0.619	0.433	0.603	0.440
		Combined		0.004	0.948	0.056	0.814
	Eunice						
		2007	0	0.619	0.433	0.603	0.440
		2012	NA				
	Bilbry						
		2007	0	0.619	0.433	0.603	0.440
		2012	0.50	0.060	0.807	0.005	0.943
		Combined		0.146	0.703	0.247	0.621
	WIPP						
		2007	0.75	0.239	0.626	0.074	0.786
		2012	2.00	1.774	0.186	0.931	0.337
		Combined		1.653	0.202	0.764	0.385
	Mills						
		2007	0	7.731	0.007	4.646	0.034
		2012	7.75	11.573	0.001	7.107	0.009
		Combined		19.076	<0.001	1.033	0.312
	Paduca						
		2007	0	0.619	0.433	0.603	0.440
		2012	0	0.619	0.433	0.603	0.440
		Combined		1.239	0.268	1.206	0.275
	San Simon						
		2007	0	0.619	0.433	0.603	0.440
		2012	0.50	0.060	0.807	0.005	0.943
		Combined		0.146	0.703	0.247	0.621
Bouteloua							
	Pastures with active leks						
		2001	9.09				
		2002	5.55				
		2003	4.42				
	Pastures						

	with abandoned lekking locations						
		2001	4.96				
		2002	3.37				
		2003	3.56				
	Mescalero Sands						
		2007	4.25	0.021	0.884	0.211	0.647
		2012	0	3.202	0.077	0.591	0.444
		Combined		1.848	0.177	0.048	0.828
	QP-F						
		2007	0.50	1.553	0.216	0.132	0.718
		2012	0	3.202	0.077	0.591	0.444
		Combined		4.602	0.034	0.640	0.426
	Loco Hills						
		2007	8.50	0.317	0.575	0.978	0.326
		2012	0	3.202	0.077	0.591	0.444
		Combined		0.732	0.394	0.024	0.878
	QP-B						
		2007	4.25	0.021	0.884	0.211	0.647
		2012	0	3.202	0.077	0.591	0.444
		Combined		1.848	0.177	0.048	0.828
	QP-C						
		2007	2.00	0.455	0.502	0.004	0.949
		2012	0	3.202	0.077	0.591	0.444
		Combined		3.017	0.086	0.247	0.620
	Southpaw						
		2007	0	3.202	0.077	0.591	0.444
		2012	0.50	1.553	0.216	0.132	0.718
		Combined		4.602	0.034	0.640	0.426
	QP-A						
		2007	1.75	0.560	0.456	<0.001	0.993
		2012	0	3.202	0.077	0.591	0.444
		Combined		3.204	0.077	0.288	0.593
	QP-D						
		2007	0.75	1.250	0.266	0.071	0.790
		2012	0	3.202	0.077	0.591	0.444
		Combined		4.218	0.043	0.536	0.466
	Pearl						
		2007	0.75	1.250	0.266	0.071	0.790
		2012	0	3.202	0.077	0.591	0.444
		Combined		4.218	0.043	0.536	0.466

	Laguna						
		2007	1.25	0.836	0.363	0.013	0.909
		2012	0	3.202	0.077	0.591	0.444
		Combined		3.642	0.059	0.390	0.534
	Skeen						
		2007	1.75	0.560	0.456	<0.001	0.993
		2012	0	3.202	0.077	0.591	0.444
		Combined		3.204	0.077	0.288	0.593
	Eunice						
		2007	5.50	0.008	0.930	0.402	0.528
		2012	NA				
	Bilbry						
		2007	4.25	0.021	0.884	0.211	0.647
		2012	0	3.202	0.077	0.591	0.444
		Combined		1.848	0.177	0.048	0.828
	WIPP						
		2007	0.50	1.553	0.216	0.132	0.718
		2012	0	3.202	0.077	0.591	0.444
		Combined		4.602	0.034	0.640	0.426
	Mills						
		2007	2.25	0.366	0.547	0.014	0.908
		2012	0	3.202	0.077	0.591	0.444
		Combined		2.846	0.095	0.212	0.646
	Paduca						
		2007	0.25	1.996	0.161	0.238	0.627
		2012	0	3.202	0.077	0.591	0.444
		Combined		5.125	0.026	0.789	0.377
	San Simon						
		2007	3.00	0.173	0.678	0.066	0.797
		2012	1.00	1.020	0.315	0.035	0.853
		Combined		1.015	0.316	0.003	0.960
Cenchrus							
	Pastures with active leks						
		2001	0				
		2002	0.01				
		2003	0				
	Pastures with abandoned lekking locations						
		2001	0				

		2002	0.02				
		2003	0				
	Mescalero Sands						
		2007	0.25	95.040	<0.001	37.559	<0.001
		2012	3.50	1504.780	<0.001	601.400	<0.001
		Combined		218.525	<0.001	150.894	<0.001
	QP-F						
		2007	0	0.010	0.920	0.012	0.913
		2012	1.25	519.129	<0.001	206.927	<0.001
		Combined		69.043	<0.001	44.070	<0.001
	Loco Hills						
		2007	0	0.010	0.920	0.012	0.913
		2012	4.75	2062.620	<0.001	824.798	<0.001
		Combined		87.118	<0.001	66.104	<0.001
	QP-B						
		2007	0.25	95.040	<0.001	37.559	<0.001
		2012	2.25	953.777	<0.001	380.819	<0.001
		Combined		248.252	<0.001	155.165	<0.001
	QP-C						
		2007	0	0.010	0.920	0.012	0.913
		2012	1.25	519.129	<0.001	206.927	<0.001
		Combined		69.043	<0.001	44.070	<0.001
	Southpaw						
		2007	0	0.010	0.920	0.012	0.913
		2012	2.50	1063.372	<0.001	424.684	<0.001
		Combined		80.428	<0.001	57.077	<0.001
	QP-A						
		2007	0	0.010	0.920	0.012	0.913
		2012	0.75	304.884	<0.001	121.291	<0.001
		Combined		57.839	<0.001	33.536	<0.001
	QP-D						
		2007	3.50	1504.780	<0.001	601.400	<0.001
		2012	11.75	5296.463	<0.001	2120.500	<0.001
		Combined		887.468	<0.001	639.522	<0.001
	Pearl						
		2007	0.25	95.040	<0.001	37.559	<0.001
		2012	0	0.010	0.920	0.012	0.913
		Combined		30.930	<0.001	14.574	<0.001
	Laguna						
		2007	0	0.010	0.920	0.012	0.913
		2012	1.50	627.149	<0.001	250.129	<0.001
		Combined		72.490	<0.001	47.733	<0.001
	Skeen						

		2007	0.75	304.884	<0.001	121.291	<0.001
		2012	4.25	1838.718	<0.001	735.125	<0.001
		Combined		417.197	<0.001	277.536	<0.001
	Eunice						
		2007	2.50	1063.372	<0.001	424.684	<0.001
		2012	NA				
	Bilbry						
		2007	1.50	627.149	<0.001	250.129	<0.001
		2012	2.25	953.777	<0.001	380.819	<0.001
		Combined		1328.272	<0.001	575.119	<0.001
	WIPP						
		2007	1.00	411.658	<0.001	163.959	<0.001
		2012	2.25	953.777	<0.001	380.819	<0.001
		Combined		826.544	<0.001	407.724	<0.001
	Mills						
		2007	6.50	2853.918	<0.001	1141.770	<0.001
		2012	3.50	1504.780	<0.001	601.400	<0.001
		Combined		2011.014	<0.001	1106.867	<0.001
	Paduca						
		2007	3.75	1615.831	<0.001	645.867	<0.001
		2012	0.25	95.040	<0.001	37.559	<0.001
		Combined		214.076	<0.001	149.710	<0.001
	San Simon						
		2007	1.75	735.632	<0.001	293.527	<0.001
		2012	3.75	1615.831	<0.001	645.867	<0.001
		Combined		1199.064	<0.001	633.794	<0.001
Eriogonum							
	Pastures with active leks						
		2001	0.48				
		2002	1.48				
		2003	0.10				
	Pastures with abandoned lekking locations						
		2001	0.53				
		2002	1.90				
		2003	3.69				
	Mescalero Sands						
		2007	0.50	0.040	0.842	0.132	0.718

		2012	0	0.870	0.353	1.100	0.297
		Combined		0.267	0.607	0.994	0.322
	QP-F						
		2007	1.00	0.480	0.490	0.004	0.948
		2012	0	0.870	0.353	1.100	0.297
		Combined		0.028	0.867	0.616	0.435
	Loco Hills						
		2007	0.50	0.040	0.842	0.132	0.718
		2012	0	0.870	0.353	1.100	0.297
		Combined		0.267	0.607	0.994	0.322
	QP-B						
		2007	0	0.870	0.353	1.100	0.297
		2012	0	0.870	0.353	1.100	0.297
		Combined		1.741	7.190	2.200	0.142
	QP-C						
		2007	0	0.870	0.353	1.100	0.297
		2012	0	0.870	0.353	1.100	0.297
		Combined		1.741	0.190	2.200	0.142
	Southpaw						
		2007	0	0.870	0.353	1.100	0.297
		2012	0	0.870	0.353	1.100	0.297
		Combined		1.741	0.190	2.200	0.142
	QP-A						
		2007	0	0.870	0.353	1.100	0.297
		2012	0	0.870	0.353	1.100	0.297
		Combined		1.741	0.190	2.200	0.142
	QP-D						
		2007	0.25	0.022	0.883	0.329	0.568
		2012	0	0.870	0.353	1.100	0.297
		Combined		0.582	0.447	1.314	0.255
	Pearl						
		2007	0	0.870	0.353	1.100	0.297
		2012	0	0.870	0.353	1.100	0.297
		Combined		1.741	0.190	2.200	0.142
	Laguna						
		2007	0	0.870	0.353	1.100	0.297
		2012	0	0.870	0.353	1.100	0.297
		Combined		1.741	0.190	2.200	0.142
	Skeen						
		2007	0.25	0.022	0.883	0.329	0.568
		2012	0.50	0.040	0.842	0.132	0.718
		Combined		0.001	0.970	0.438	0.510
	Eunice						
		2007	1.50	1.150	0.286	0.027	0.870

		2012	NA				
	Bilbry						
		2007	0.25	0.022	0.883	0.329	0.568
		2012	0	0.870	0.353	1.100	0.297
		Combined		0.582	0.447	1.314	0.255
	WIPP						
		2007	0.25	0.022	0.883	0.329	0.568
		2012	0	0.870	0.353	1.100	0.297
		Combined		0.582	0.447	1.314	0.255
	Mills						
		2007	0	0.870	0.353	1.100	0.297
		2012	0.25	0.022	0.883	0.329	0.568
		Combined		0.582	0.447	1.314	0.255
	Paduca						
		2007	0.25	0.022	0.883	0.329	0.568
		2012	0.50	0.040	0.842	0.132	0.718
		Combined		0.001	0.970	0.438	0.510
	San Simon						
		2007	1.00	0.480	0.490	0.004	0.948
		2012	2.25	2.366	0.127	0.199	0.657
		Combined		2.480	0.118	0.073	0.788
Gutierrezia							
	Pastures with active leks						
		2001	2.73				
		2002	3.52				
		2003	2.94				
	Pastures with abandoned lekking locations						
		2001	0.38				
		2002	0.58				
		2003	0.48				
	Mescalero Sands						
		2007	1.25	0.075	0.784	1.567	0.214
		2012	1.25	0.075	0.784	1.567	0.214
		Combined		0.151	0.698	3.136	0.080
	QP-F						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529

		Combined		3.316	0.072	0.801	0.374
	Loco Hills						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374
	QP-B						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374
	QP-C						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374
	Southpaw						
		2007	0.50	0.434	0.512	0.289	0.592
		2012	0	1.658	0.201	0.400	0.529
		Combined		1.890	0.172	0.004	0.947
	QP-A						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374
	QP-D						
		2007	0.75	0.260	0.611	0.662	0.418
		2012	0.25	0.725	0.396	0.032	0.859
		Combined		0.927	0.338	0.491	0.485
	Pearl						
		2007	8.25	1.941	0.167	18.970	<0.001
		2012	1.25	0.075	0.784	1.567	0.214
		Combined		0.616	0.434	14.833	<0.001
	Laguna						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374
	Skeen						
		2007	0.75	0.260	0.611	0.662	0.418
		2012	0	1.658	0.201	0.400	0.529
		Combined		1.612	0.207	0.016	0.899
	Eunice						
		2007	0	1.658	0.201	0.400	0.529
		2012	NA				
	Bilbry						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374

	WIPP						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374
	Mills						
		2007	0.25	0.725	0.396	0.032	0.859
		2012	0.50	0.434	0.512	0.032	0.859
		Combined		1.141	0.288	0.256	0.614
	Paduca						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374
	San Simon						
		2007	0	1.658	0.201	0.400	0.529
		2012	0	1.658	0.201	0.400	0.529
		Combined		3.316	0.072	0.801	0.374
Helianthus							
	Pastures with active leks						
		2001	0.05				
		2002	0.13				
		2003	0.03				
	Pastures with abandoned lekking locations						
		2001	0.05				
		2002	0.06				
		2003	0.10				
	Mescalero Sands						
		2007	0	0.119	0.731	0.115	0.735
		2012	0.50	6.066	0.016	5.909	0.017
		Combined		2.154	0.145	2.087	0.152
	QP-F						
		2007	0	0.119	0.731	0.115	0.735
		2012	1.25	17.448	<0.001	16.991	<0.001
		Combined		6.636	0.011	6.364	0.014
	Loco Hills						
		2007	0	0.119	0.731	0.115	0.735
		2012	0.25	2.563	0.113	2.498	0.119
		Combined		0.773	0.381	0.753	0.388

	QP-B						
		2007	0	0.119	0.731	0.115	0.735
		2012	7.00	113.328	<0.001	110.326	<0.001
		Combined		32.570	<0.001	29.787	<0.001
	QP-C						
		2007	2.75	41.519	<0.001	40.424	<0.001
		2012	6.25	100.381	<0.001	97.724	<0.001
		Combined		127.076	<0.001	122.445	<0.001
	Southpaw						
		2007	0	0.119	0.731	0.115	0.735
		2012	0	0.119	0.731	0.115	0.735
		Combined		0.239	0.626	0.231	0.632
	QP-A						
		2007	0	0.119	0.731	0.115	0.735
		2012	0.25	2.563	0.113	2.498	0.118
		Combined		0.773	0.381	0.753	0.388
	QP-D						
		2007	0	0.119	0.731	0.115	0.735
		2012	0.25	2.563	0.113	2.498	0.118
		Combined		0.773	0.381	0.753	0.388
	Pearl						
		2007	0	0.119	0.731	0.115	0.735
		2012	2.25	33.380	<0.001	32.502	<0.001
		Combined		12.347	0.001	11.707	0.001
	Laguna						
		2007	0	0.119	0.731	0.115	0.735
		2012	0.25	2.563	0.113	2.498	0.118
		Combined		0.773	0.381	0.753	0.388
	Skeen						
		2007	0	0.119	0.731	0.115	0.735
		2012	0.25	2.563	0.113	2.498	0.118
		Combined		0.773	0.381	0.753	0.388
	Eunice						
		2007	0	0.119	0.731	0.115	0.735
		2012	NA				
	Bilbry						
		2007	0	0.119	0.731	0.115	0.735
		2012	1.00	13.572	<0.001	13.218	<0.001
		Combined		5.140	0.026	4.945	0.029
	WIPP						
		2007	0	0.119	0.731	0.115	0.735
		2012	2.00	29.348	<0.001	28.576	<0.001
		Combined		10.969	0.001	10.428	0.002
	Mills						

		2007	0	0.119	0.731	0.115	0.735
		2012	1.00	13.572	<0.001	13.218	<0.001
		Combined		5.140	0.026	4.945	0.029
	Paduca						
		2007	0	0.119	0.731	0.115	0.735
		2012	0	0.119	0.731	0.115	0.735
		Combined		0.239	0.626	0.231	0.632
	San Simon						
		2007	3.75	58.036	<0.001	56.504	<0.001
		2012	5.25	83.285	<0.001	81.082	<0.001
		Combined		138.573	<0.001	134.658	<0.001
Muhlenbergia							
	Pastures with active leks						
		2001	0.02				
		2002	0.04				
		2003	0.37				
	Pastures with abandoned lekking locations						
		2001	4.46				
		2002	3.48				
		2003	3.79				
	Mescalero Sands						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	QP-F						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	Loco Hills						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	QP-B						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	QP-C						

		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	Southpaw						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	QP-A						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	QP-D						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	Pearl						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	Laguna						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	Skeen						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	Eunice						
		2007	0	0.062	0.804	1.513	0.222
		2012	NA				
	Bilbry						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	WIPP						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	Mills						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	Paduca						
		2007	0	0.062	0.804	1.513	0.222

		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
	San Simon						
		2007	0	0.062	0.804	1.513	0.222
		2012	0	0.062	0.804	1.513	0.222
		Combined		0.124	0.725	3.028	0.086
Panicum							
	Pastures with active leks						
		2001	0.62				
		2002	0.33				
		2003	0.10				
	Pastures with abandoned lekking locations						
		2001	0.20				
		2002	0.03				
		2003	0.05				
	Mescalero Sands						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	QP-F						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	Loco Hills						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	QP-B						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	QP-C						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	Southpaw						
		2007	0	0.483	0.489	0.111	0.740

		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	QP-A						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	QP-D						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	Pearl						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	Laguna						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	Skeen						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	Eunice						
		2007	0	0.483	0.489	0.111	0.740
		2012	NA				
	Bilbry						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	WIPP						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	Mills						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	Paduca						
		2007	0	0.483	0.489	0.111	0.740
		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
	San Simon						
		2007	0	0.483	0.489	0.111	0.740

		2012	0	0.483	0.489	0.111	0.740
		Combined		0.966	0.328	0.222	0.639
Prosopis							
	Pastures with active leks						
		2001	0.74				
		2002	0.78				
		2003	0.78				
	Pastures with abandoned lekking locations						
		2001	0.42				
		2002	0.53				
		2003	0.54				
	Mescalero Sands						
		2007	0	0.182	0.671	0.264	0.609
		2012	0.50	0.165	0.685	0.328	0.568
		Combined		<0.001	0.989	0.002	0.967
	QP-F						
		2007	0	0.182	0.671	0.264	0.609
		2012	0	0.182	0.671	0.264	0.609
		Combined		0.364	0.548	0.528	0.470
	Loco Hills						
		2007	0	0.182	0.671	0.264	0.609
		2012	0	0.182	0.671	0.264	0.609
		Combined		0.364	0.548	0.528	0.470
	QP-B						
		2007	0.25	0.023	0.880	0.057	0.811
		2012	0	0.182	0.671	0.264	0.609
		Combined		0.038	0.846	0.038	0.847
	QP-C						
		2007	0	0.182	0.671	0.264	0.609
		2012	0	0.182	0.671	0.264	0.609
		Combined		0.364	0.548	0.528	0.470
	Southpaw						
		2007	1.75	1.368	0.245	2.457	0.121
		2012	0.25	0.023	0.880	0.057	0.811
		Combined		0.868	0.354	1.615	0.207
	QP-A						
		2007	0	0.182	0.671	0.264	0.609

		2012	0	0.182	0.671	0.264	0.609
		Combined		0.364	0.548	0.528	0.470
	QP-D						
		2007	3.75	3.749	0.056	6.590	0.012
		2012	2.00	1.647	0.202	2.943	0.090
		Combined		5.173	0.025	9.132	0.003
	Pearl						
		2007	0.75	0.364	0.548	0.687	0.410
		2012	0.75	0.364	0.548	0.687	0.410
		Combined		0.728	0.396	1.375	0.244
	Laguna						
		2007	0	0.182	0.671	0.264	0.609
		2012	1.00	0.591	0.444	1.092	0.299
		Combined		0.058	0.810	0.139	0.710
	Skeen						
		2007	0.25	0.023	0.880	0.057	0.811
		2012	0	0.182	0.671	0.264	0.609
		Combined		0.038	0.846	0.038	0.847
	Eunice						
		2007	0	0.182	0.671	0.264	0.609
		2012	NA				
	Bilbry						
		2007	0	0.182	0.671	0.264	0.609
		2012	0	0.182	0.671	0.264	0.609
		Combined		0.364	0.548	0.528	0.470
	WIPP						
		2007	0.50	0.165	0.685	0.328	0.568
		2012	0	0.182	0.671	0.264	0.609
		Combined		<0.001	0.989	0.002	0.967
	Mills						
		2007	0	0.182	0.671	0.264	0.609
		2012	4.25	4.383	0.039	7.685	0.007
		Combined		1.345	0.249	2.390	0.126
	Paduca						
		2007	0	0.182	0.671	0.264	0.609
		2012	0.25	0.023	0.880	0.057	0.811
		Combined		0.038	0.846	0.038	0.847
	San Simon						
		2007	0	0.182	0.671	0.264	0.609
		2012	0	0.182	0.671	0.264	0.609
		Combined		0.364	0.548	0.528	0.470
Quercus							
	Pastures with						

	active leks						
		2001	10.18				
		2002	10.96				
		2003	11.77				
	Pastures with abandoned lekking locations						
		2001	8.02				
		2002	8.79				
		2003	8.11				
	Mescalero Sands						
		2007	25.50	3.152	0.079	5.918	0.017
		2012	18.75	1.179	0.280	2.734	0.101
		Combined		4.084	0.046	8.319	0.005
	QP-F						
		2007	30.75	5.151	0.025	8.947	0.004
		2012	18.00	1.008	0.318	2.437	0.122
		Combined		5.315	0.023	10.233	0.002
	Loco Hills						
		2007	27.25	3.776	0.055	6.877	0.010
		2012	20.75	1.686	0.197	3.586	0.062
		Combined		5.244	0.024	10.167	0.002
	QP-B						
		2007	18.00	1.008	0.318	2.437	0.122
		2012	10.75	0.015	0.902	0.320	0.573
		Combined		0.633	0.428	2.249	0.138
	QP-C						
		2007	25.50	3.152	0.079	5.918	0.017
		2012	15.50	0.519	0.473	1.540	0.218
		Combined		3.098	0.082	6.690	0.011
	Southpaw						
		2007	29.25	4.542	0.036	8.036	0.006
		2012	13.75	0.261	0.610	1.008	0.318
		Combined		3.444	0.066	7.219	0.009
	QP-A						
		2007	28.00	4.057	0.047	7.304	0.008
		2012	13.75	0.261	0.610	1.008	0.318
		Combined		3.152	0.079	6.750	0.011
	QP-D						
		2007	0	7.156	0.009	6.741	0.011
		2012	0	7.156	0.009	6.741	0.011

		Combined		14.315	<0.001	13.487	<0.001
	Pearl						
		2007	29.50	4.641	0.034	8.185	0.005
		2012	14.50	0.363	0.548	1.225	0.272
		Combined		3.753	0.056	7.726	0.007
	Laguna						
		2007	22.25	2.111	0.150	4.277	0.042
		2012	7.50	0.126	0.723	0.001	0.980
		Combined		0.592	0.444	2.135	0.148
	Skeen						
		2007	16.50	0.699	0.405	1.880	0.174
		2012	22.50	2.185	0.143	4.397	0.039
		Combined		2.672	0.105	5.996	0.016
	Eunice						
		2007	34.75	6.918	0.010	11.551	0.001
		2012	NA				
	Bilbry						
		2007	18.75	1.179	0.280	2.734	0.102
		2012	20.75	1.686	0.197	3.586	0.062
		Combined		2.842	0.095	6.291	0.014
	WIPP						
		2007	12.75	0.149	0.700	0.745	0.391
		2012	9.50	0.003	0.959	0.135	0.714
		Combined		0.056	0.814	0.757	0.387
	Mills						
		2007	12.00	0.084	0.772	0.569	0.453
		2012	16.25	0.652	0.421	1.793	0.184
		Combined		0.601	0.440	2.187	0.143
	Paduca						
		2007	32.00	5.681	0.019	9.734	0.003
		2012	23.25	2.414	0.124	4.762	0.032
		Combined		7.725	0.007	13.983	<0.001
	San Simon						
		2007	17.50	0.900	0.345	2.245	0.138
		2012	21.25	1.823	0.180	3.812	0.154
		Combined		2.641	0.107	5.948	0.017
Senecio							
	Pastures with active leks						
		2001	0.10				
		2002	0.55				
		2003	0.11				
	Pastures						

	with abandoned lekking locations						
		2001	0.08				
		2002	0.54				
		2003	0.63				
	Mescalero Sands						
		2007	0	0.134	0.715	0.305	0.582
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.268	0.606	0.611	0.437
	QP-F						
		2007	0.50	1.129	0.291	0.440	0.509
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.240	0.625	0.006	0.938
	Loco Hills						
		2007	0	0.134	0.715	0.305	0.582
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.268	0.606	0.611	0.437
	QP-B						
		2007	1.75	5.622	0.020	3.156	0.079
		2012	0.25	0.389	0.534	0.084	0.773
		Combined		4.416	0.038	2.106	0.150
	QP-C						
		2007	2.00	6.584	0.012	3.772	0.056
		2012	0	0.134	0.715	0.305	0.582
		Combined		2.316	0.131	0.930	0.338
	Southpaw						
		2007	0	0.134	0.715	0.305	0.582
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.268	0.606	0.611	0.437
	QP-A						
		2007	0.25	0.389	0.534	0.084	0.773
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.033	0.856	0.034	0.853
	QP-D						
		2007	0.75	1.959	0.165	0.902	0.345
		2012	0.25	0.389	0.534	0.084	0.773
		Combined		2.042	0.156	0.767	0.384
	Pearl						
		2007	0.25	0.389	0.534	0.084	0.773
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.033	0.856	0.034	0.853

	Laguna						
		2007	0.75	1.959	0.165	0.902	0.345
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.525	0.470	0.078	0.781
	Skeen						
		2007	0.25	0.389	0.534	0.084	0.773
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.033	0.856	0.034	0.853
	Eunice						
		2007	1.50	4.674	0.033	2.555	0.114
		2012	NA				
	Bilbry						
		2007	2.25	7.558	0.007	4.402	0.039
		2012	0	0.134	0.715	0.305	0.582
		Combined		2.703	0.103	1.144	0.288
	WIPP						
		2007	4.25	15.645	<0.001	9.763	0.002
		2012	0	0.134	0.715	0.305	0.582
		Combined		5.871	0.017	3.050	0.084
	Mills						
		2007	0.50	1.129	0.291	0.440	0.509
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.240	0.625	0.006	0.938
	Paduca						
		2007	0.50	1.129	0.291	0.440	0.509
		2012	0	0.134	0.715	0.305	0.582
		Combined		0.240	0.625	0.006	0.938
	San Simon						
		2007	22.75	101.509	<0.001	69.417	<0.001
		2012	0.25	0.389	0.534	0.084	0.773
		Combined		39.074	<0.001	26.479	<0.001
Sporobolus							
	Pastures with active leks						
		2001	0.04				
		2002	1.16				
		2003	1.65				
	Pastures with abandoned lekking locations						
		2001	3.32				

		2002	5.80				
		2003	5.88				
	Mescalero Sands						
		2007	9.00	10.613	0.002	0.837	0.363
		2012	9.00	10.613	0.002	0.837	0.363
		Combined		21.231	<0.001	1.675	0.199
	QP-F						
		2007	5.25	5.064	0.027	0.107	0.744
		2012	11.75	15.032	<0.001	1.629	0.206
		Combined		18.521	<0.001	1.279	0.261
	Loco Hills						
		2007	0.50	0.003	0.959	0.910	0.343
		2012	1.00	0.207	0.650	0.517	0.474
		Combined		0.128	0.721	1.400	0.240
	QP-B						
		2007	7.00	7.572	0.007	0.384	0.537
		2012	6.00	6.118	0.015	0.210	0.648
		Combined		13.648	<0.001	0.581	0.448
	QP-C						
		2007	13.00	17.117	<0.001	2.039	0.157
		2012	14.75	20.110	<0.001	2.658	0.107
		Combined		37.151	<0.001	4.676	0.034
	Southpaw						
		2007	6.50	6.839	0.010	0.292	0.590
		2012	6.00	6.118	0.015	0.210	0.648
		Combined		12.948	0.001	0.498	0.482
	QP-A						
		2007	4.25	3.716	0.057	0.019	0.889
		2012	2.75	1.864	0.175	0.035	0.851
		Combined		5.414	0.022	0.001	0.973
	QP-D						
		2007	1.00	0.207	0.650	0.517	0.474
		2012	10.75	13.397	<0.001	1.322	0.254
		Combined		8.038	0.006	0.019	0.764
	Pearl						
		2007	8.00	9.072	0.003	0.596	0.443
		2012	5.25	5.064	0.027	0.107	0.744
		Combined		13.807	0.00	0.604	0.439
	Laguna						
		2007	16.25	22.739	<0.001	3.225	0.076
		2012	8.25	9.454	0.003	0.653	0.421
		Combined		30.311	<0.001	3.371	0.070
	Skeen						

		2007	7.25	7.943	0.006	0.434	0.512
		2012	5.00	4.720	0.032	0.080	0.778
		Combined		12.430	0.001	0.443	0.508
	Eunice						
		2007	5.00	4.720	0.032	0.080	0.778
		2012	NA				
	Bilbry						
		2007	9.75	11.794	0.001	1.036	0.312
		2012	11.00	13.803	<0.001	1.397	0.241
		Combined		25.552	<0.001	2.420	0.124
	WIPP						
		2007	14.00	18.817	<0.001	2.386	0.126
		2012	9.50	11.398	0.001	0.968	0.328
		Combined		29.616	<0.001	3.192	0.078
	Mills						
		2007	2.50	1.583	0.211	0.063	0.803
		2012	4.50	4.046	0.047	0.036	0.851
		Combined		5.330	0.023	0.002	0.965
	Paduca						
		2007	4.75	4.381	0.039	0.056	0.814
		2012	5.00	4.720	0.032	0.080	0.778
		Combined		9.099	0.003	0.134	0.715
	San Simon						
		2007	2.00	1.054	0.307	0.149	0.701
		2012	5.50	5.412	0.022	0.138	0.711
		Combined		5.573	0.020	<0.001	0.992
Yucca							
	Pastures with active leks						
		2001	3.40				
		2002	3.54				
		2003	3.70				
	Pastures with abandoned lekking locations						
		2001	2.09				
		2002	2.04				
		2003	1.79				
	Mescalero Sands						
		2007	2.25	0.075	0.785	0.148	0.701

		2012	4.75	0.340	0.561	1.991	0.162
		Combined		0.048	0.828	1.602	0.209
	QP-F						
		2007	1.25	0.563	0.455	0.035	0.852
		2012	1.75	0.245	0.622	0.014	0.905
		Combined		0.776	0.381	0.002	0.962
	Loco Hills						
		2007	0.50	1.592	0.210	0.639	0.427
		2012	0	4.406	0.038	3.249	0.075
		Combined		5.628	0.020	3.364	0.070
	QP-B						
		2007	2.00	0.145	0.704	0.066	0.798
		2012	0.25	2.306	0.132	1.226	0.272
		Combined		1.792	0.184	0.358	0.551
	QP-C						
		2007	0	4.406	0.038	3.249	0.075
		2012	0.50	1.592	0.210	0.639	0.427
		Combined		5.628	0.020	3.364	0.070
	Southpaw						
		2007	1.00	0.806	0.372	0.132	0.718
		2012	1.25	0.563	0.455	0.035	0.852
		Combined		1.359	0.247	0.151	0.698
	QP-A						
		2007	2.25	0.075	0.785	0.148	0.701
		2012	1.25	0.563	0.455	0.035	0.852
		Combined		0.524	0.471	0.020	0.889
	QP-D						
		2007	1.25	0.563	0.455	0.035	0.852
		2012	3.75	0.076	0.784	1.087	0.300
		Combined		0.112	0.738	0.363	0.549
	Pearl						
		2007	0.75	1.133	0.290	0.317	0.575
		2012	0.75	1.133	0.290	0.317	0.575
		Combined		2.266	0.135	0.633	0.428
	Laguna						
		2007	2.00	0.145	0.704	0.066	0.798
		2012	2.50	0.029	0.864	0.257	0.614
		Combined		0.153	0.697	0.291	0.591
	Skeen						
		2007	0.25	2.306	0.132	1.226	0.272
		2012	2.00	0.145	0.704	0.066	0.798
		Combined		1.792	0.184	0.358	0.551
	Eunice						
		2007	4.75	0.340	0.561	1.991	0.162

		2012	NA				
	Bilbry						
		2007	0.75	1.133	0.290	0.317	0.575
		2012	1.25	0.563	0.455	0.035	0.852
		Combined		1.646	0.202	0.281	0.598
	WIPP						
		2007	2.00	0.145	0.704	0.066	0.798
		2012	4.50	0.259	0.612	1.749	0.190
		Combined		0.008	0.928	1.238	0.269
	Mills						
		2007	0.50	1.592	0.210	0.639	0.427
		2012	0	4.406	0.038	3.249	0.075
		Combined		5.628	0.020	3.364	0.070
	Paduca						
		2007	0.75	1.133	0.290	0.317	0.575
		2012	1.50	0.381	0.538	0.001	0.978
		Combined		1.413	0.237	0.174	0.678
	San Simon						
		2007	0.25	2.306	0.132	1.226	0.272
		2012	0.25	2.306	0.132	1.226	0.272
		Combined		4.614	0.034	2.452	0.121
Unidentified Forb							
	Pastures with active leks						
		2001	0.64				
		2002	0.08				
		2003	0.01				
	Pastures with abandoned lekking locations						
		2001	0.45				
		2002	0.81				
		2003	0.19				
	Mescalero Sands						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	QP-F						
		2007	0	0.422	0.518	0.375	0.542

		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	Loco Hills						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	QP-B						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	QP-C						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	Southpaw						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	QP-A						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	QP-D						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	Pearl						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	Laguna						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	Skeen						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	Eunice						
		2007	0	0.422	0.518	0.375	0.542
		2012	NA				
	Bilbry						
		2007	0.25	0.273	0.602	0.036	0.850
		2012	0	0.422	0.518	0.375	0.542

		Combined		0.008	0.929	0.089	0.766
	WIPP						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	Mills						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	Paduca						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
	San Simon						
		2007	0	0.422	0.518	0.375	0.542
		2012	0	0.422	0.518	0.375	0.542
		Combined		0.844	0.361	0.751	0.389
Bare							
	Pastures with active leks						
		2001	22.30				
		2002	16.82				
		2003	25.93				
	Pastures with abandoned lekking locations						
		2001	42.66				
		2002	31.31				
		2003	32.67				
	Mescalero Sands						
		2007	23.00	0.050	0.823	1.013	0.317
		2012	16.50	0.319	0.574	2.617	0.118
		Combined		0.058	0.810	3.436	0.067
	QP-F						
		2007	19.25	0.048	0.827	1.822	0.181
		2012	17.00	0.250	0.618	2.458	0.121
		Combined		0.258	0.612	4.255	0.042
	Loco Hills						
		2007	17.75	0.164	0.686	2.231	0.139
		2012	15.25	0.532	0.468	3.046	0.085

		Combined		0.643	0.425	5.245	0.025
	QP-B						
		2007	17.00	0.250	0.618	2.458	0.121
		2012	12.75	1.159	0.284	4.057	0.047
		Combined		1.241	0.268	6.409	0.013
	QP-C						
		2007	18.50	0.097	0.756	2.020	0.159
		2012	14.25	0.748	0.389	3.424	0.068
		Combined		0.691	0.408	5.347	0.023
	Southpaw						
		2007	29.00	0.780	0.379	0.270	0.605
		2012	12.50	1.238	0.269	4.171	0.044
		Combined		0.026	0.873	3.174	0.079
	QP-A						
		2007	31.00	1.196	0.277	0.111	0.740
		2012	18.75	0.079	0.780	1.952	0.166
		Combined		0.328	0.568	1.486	0.226
	QP-D						
		2007	14.00	0.809	0.371	3.524	0.064
		2012	12.75	1.159	0.284	4.057	0.047
		Combined		1.953	0.165	7.574	0.007
	Pearl						
		2007	21.00	<0.001	0.993	1.408	0.239
		2012	8.00	3.353	0.070	6.755	0.011
		Combined		1.664	0.200	7.080	0.009
	Laguna						
		2007	31.25	1.253	0.266	0.098	0.755
		2012	16.75	0.283	0.596	2.536	0.115
		Combined		0.170	0.681	1.797	0.184
	Skeen						
		2007	33.75	1.894	0.172	0.013	0.910
		2012	11.25	1.687	0.197	4.781	0.032
		Combined		0.003	0.957	2.576	0.112
	Eunice						
		2007	9.75	2.355	0.128	5.613	0.020
		2012	NA				
	Bilbry						
		2007	16.50	0.319	0.574	2.617	0.110
		2012	6.25	4.662	0.033	8.142	0.005
		Combined		3.662	.059	9.903	0.002
	WIPP						
		2007	26.75	0.412	0.523	0.466	0.497
		2012	28.25	0.645	0.424	0.311	0.579
		Combined		1.044	0.309	0.769	0.383

	Mills						
		2007	30.25	1.030	0.313	0.155	0.695
		2012	22.25	0.019	0.891	1.152	0.286
		Combined		0.662	0.418	1.073	0.303
	Paduca						
		2007	16.50	0.319	0.574	2.617	0.110
		2012	18.00	0.139	0.710	2.159	0.146
		Combined		0.440	0.509	4.766	0.032
	San Simon						
		2007	11.50	1.590	0.210	4.654	0.034
		2012	12.00	1.407	0.238	4.407	0.039
		Combined		2.994	0.087	9.061	0.003
Litter							
	Pastures with active leks						
		2001	24.82				
		2002	33.61				
		2003	29.78				
	Pastures with abandoned lekking locations						
		2001	23.38				
		2002	31.70				
		2003	30.04				
	Mescalero Sands						
		2007	24.00	0.392	0.533	0.210	0.648
		2012	35.50	0.564	0.454	0.728	0.396
		Combined		0.008	0.930	0.077	0.782
	QP-F						
		2007	28.25	0.010	0.922	0.002	0.965
		2012	39.75	1.512	0.222	1.713	0.194
		Combined		0.634	0.428	0.906	0.344
	Loco Hills						
		2007	25.00	0.249	0.619	0.114	0.736
		2012	47.25	4.223	0.043	4.389	0.039
		Combined		1.171	0.282	1.489	0.226
	QP-B						
		2007	32.00	0.121	0.729	0.220	0.641
		2012	51.50	6.343	0.013	6.433	0.013
		Combined		4.010	0.048	4.399	0.039

	QP-C						
		2007	29.75	0.007	0.935	0.047	0.830
		2012	42.75	2.439	0.122	2.641	0.108
		Combined		1.336	0.251	1.674	0.199
	Southpaw						
		2007	23.50	0.476	0.492	0.270	0.605
		2012	52.00	6.620	0.012	6.699	0.011
		Combined		1.680	0.198	2.019	0.159
	QP-A						
		2007	22.75	0.619	0.433	0.374	0.542
		2012	56.00	9.064	0.003	9.030	0.004
		Combined		2.300	0.133	2.648	0.108
	QP-D						
		2007	25.25	0.219	0.641	0.095	0.759
		2012	55.50	8.736	0.004	8.719	0.004
		Combined		2.918	0.191	3.281	0.074
	Pearl						
		2007	22.00	0.783	0.378	0.497	0.483
		2012	55.50	4.450	0.037	4.609	0.035
		Combined		0.717	0.399	0.989	0.323
	Laguna						
		2007	24.25	0.353	0.554	0.183	0.670
		2012	60.25	12.113	0.001	11.919	0.001
		Combined		3.835	0.053	4.181	0.044
	Skeen						
		2007	30.00	0.013	0.911	0.060	0.808
		2012	48.50	5.044	0.027	5.183	0.025
		Combined		2.716	0.103	3.098	0.082
	Eunice						
		2007	24.75	0.282	0.597	0.135	0.714
		2012	NA				
	Bilbry						
		2007	36.50	0.748	0.389	0.924	0.339
		2012	48.50	4.802	0.031	4.950	0.029
		Combined		4.628	0.034	5.027	0.028
	WIPP						
		2007	36.25	0.700	0.405	0.873	0.353
		2012	40.00	1.581	0.212	1.783	0.186
		Combined		2.190	0.142	2.573	0.113
	Mills						
		2007	29.25	<0.001	0.982	0.025	0.874
		2012	30.75	0.040	0.841	0.108	0.743
		Combined		0.025	0.875	0.119	0.731
	Paduca						

		2007	28.25	0.010	0.922	0.002	0.965
		2012	36.50	0.748	0.389	0.924	0.339
		Combined		0.292	0.590	0.503	0.480
	San Simon						
		2007	30.50	0.029	0.864	0.090	0.764
		2012	41.25	1.949	0.166	2.153	0.146
		Combined		1.219	0.272	1.550	0.217
Other[ab]							
	Pastures with active leks						
		2001	0.30				
		2002	0.21				
		2003	0.32				
	Pastures with abandoned lekking locations						
		2001	0.57				
		2002	0.35				
		2003	0.53				
	Mescalero Sands						
		2007	0.50				
		2012	0				
		Combined					
	QP-F						
		2007	1.75				
		2012	0				
		Combined					
	Loco Hills						
		2007	2.50				
		2012	0				
		Combined					
	QP-B						
		2007	0.25				
		2012	0.25				
		Combined					
	QP-C						
		2007	1.50				
		2012	0.50				
		Combined					
	Southpaw						

		2007	0.50				
		2012	0.25				
		Combined					
	QP-A						
		2007	1.25				
		2012	0.50				
		Combined					
	QP-D						
		2007	2.25				
		2012	0				
		Combined					
	Pearl						
		2007	0.50				
		2012	1.00				
		Combined					
	Laguna						
		2007	0				
		2012	0				
		Combined					
	Skeen						
		2007	0				
		2012	0				
		Combined					
	Eunice						
		2007	4.50				
		2012	NA				
	Bilbry						
		2007	0.50				
		2012	0				
		Combined					
	WIPP						
		2007	1.00				
		2012	0				
		Combined					
	Mills						
		2007	0.25				
		2012	0.25				
		Combined					
	Paduca						
		2007	0.00				
		2012	0.25				
		Combined					
	San Simon						
		2007	1.75				

		2012	0.50				
		Combined					

[a] Not included in analyses.
[b]Includes *Amaranthus, Croton, Eragrostis, Euphorbia, Mentzelia, Munroa, Opuntia, Paspalum, Rhus, Salsola, Sarcobatus* and unidentified plants.

APPENDIX III.— Percentage vegetative composition (bare ground and litter removed) of Habitat Evaluation Areas (HEAs), pastures with active leks of lesser prairie-chickens (*Tympanuchus pallidicinctus*), and pastures with abandoned lekking locations in southeastern New Mexico, spring 2001–2003, 2007, and 2012. ANOVA with Bonferroni adjustment for multiple comparisons revealed significant difference between HEAs and pasture locations at $P < 0.008$.

				Active		Abandoned	
Plant	Site	Year	Percentage	*F*	*P*	*F*	*P*
Ambrosia							
	Pastures with active leks						
		2001	0				
		2002	0				
		2003	0				
	Pastures with abandoned lekking locations						
		2001	0				
		2002	0				
		2003	0				
	Mescalero Sands						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	QP-F						
		2007	1.90	6.7E+33	<0.001	9.6E+33	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	Loco Hills						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	QP-B						
		2007	14.71	5.6E+34	<0.001	8.0E+34	<0.001
		2012	0	0.346	0.558	4.469	0.038

		Combined		96.040	<0.001	80.048	<0.001
	QP-C						
		2007	4.35	1.6E+34	<0.001	2.2E+34	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	Southpaw						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	QP-A						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	QP-D						
		2007	30.45	1.2E+35	<0.001	1.8E+35	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	Pearl						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	Laguna						
		2007	1.69	5.9E+33	<0.001	8.4E+33	<0.001
		2012	0	0.346	0.558	4.469	0.038
		Combined		96.040	<0.001	80.048	<0.001
	Skeen						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	Eunice						
		2007	0	0.346	0.558	4.469	0.038
		2012	NA				
	Bilbry						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	WIPP						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	Mills						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014

	Paduca						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
	San Simon						
		2007	0	0.346	0.558	4.469	0.038
		2012	0	0.346	0.558	4.469	0.038
		Combined		<0.001	1.000	6.283	0.014
Andropogon							
	Pastures with active leks						
		2001	32.74				
		2002	29.22				
		2003	28.38				
	Pastures with abandoned lekking locations						
		2001	5.50				
		2002	5.95				
		2003	4.85				
	Mescalero Sands						
		2007	0.94	3.636	0.060	0.063	0.802
		2012	0	5.307	0.023	0.513	0.476
		Combined		8.859	0.004	0.467	0.496
	QP-F						
		2007	4.29	2.066	0.154	0.089	0.766
		2012	1.16	3.469	0.066	0.040	0.842
		Combined		5.441	0.022	0.005	0.945
	Loco Hills						
		2007	0	5.307	0.023	0.513	0.476
		2012	0	5.307	0.023	0.513	0.476
		Combined		10.617	0.002	1.025	0.314
	QP-B						
		2007	6.37	1.539	0.218	0.279	0.598
		2012	2.10	2.903	0.092	<0.001	0.989
		Combined		4.331	0.040	0.132	0.717
	QP-C						
		2007	1.93	2.989	0.087	0.002	0.966
		2012	0	5.307	0.023	0.513	0.476
		Combined		8.118	0.005	0.287	0.594

	Southpaw						
		2007	0.53	4.043	0.047	0.139	0.710
		2012	0	5.307	0.023	0.513	0.476
		Combined		9.306	0.003	0.593	0.444
	QP-A						
		2007	3.24	2.412	0.124	0.026	0.871
		2012	2.97	2.517	0.116	0.015	0.902
		Combined		4.929	0.029	0.041	0.840
	QP-D						
		2007	0	5.307	0.023	0.513	0.476
		2012	0	5.307	0.023	0.513	0.476
		Combined		10.617	0.002	1.025	0.314
	Pearl						
		2007	0	5.307	0.023	0.513	0.476
		2012	0	5.307	0.023	0.513	0.476
		Combined		10.617	0.002	1.025	0.314
	Laguna						
		2007	0	5.307	0.023	0.513	0.476
		2012	0	5.307	0.023	0.513	0.476
		Combined		10.617	0.002	1.025	0.314
	Skeen						
		2007	0	5.307	0.023	0.513	0.476
		2012	0	5.307	0.023	0.513	0.476
		Combined		10.617	0.002	1.025	0.314
	Eunice						
		2007	1.91	3.001	0.086	0.002	0.962
		2012	NA				
	Bilbry						
		2007	2.13	2.888	0.092	<0.001	0.993
		2012	0.55	4.013	0.048	0.133	0.717
		Combined		6.853	0.010	0.069	0.793
	WIPP						
		2007	0	5.307	0.023	0.513	0.476
		2012	0	5.307	0.023	0.513	0.476
		Combined		10.617	0.002	1.025	0.314
	Mills						
		2007	0.62	3.942	0.050	0.118	0.732
		2012	0.53	4.037	0.047	0.138	0.712
		Combined		7.980	0.006	0.255	0.615
	Paduca						
		2007	0	5.307	0.023	0.513	0.476
		2012	0.55	4.017	0.048	0.133	0.716
		Combined		9.277	0.003	0.584	0.447
	San						

	Simon						
		2007	0.86	3.705	0.057	0.074	0.786
		2012	0.53	4.033	0.047	0.137	0.712
		Combined		7.736	0.006	0.206	0.651
Aristda							
	Pastures with active leks						
		2001	12.06				
		2002	11.69				
		2003	9.44				
	Pastures with abandoned lekking locations						
		2001	14.67				
		2002	13.52				
		2003	13.36				
	Mescalero Sands						
		2007	8.02	0.038	0.845	0.245	0.622
		2012	6.25	0.193	0.661	0.532	0.468
		Combined		0.202	0.654	0.750	0.389
	QP-F						
		2007	7.61	0.062	0.804	0.298	0.587
		2012	12.14	0.085	0.772	0.001	0.978
		Combined		0.001	0.976	0.164	0.686
	Loco Hills						
		2007	20.96	1.296	0.258	0.618	0.434
		2012	22.00	1.508	0.222	0.761	0.386
		Combined		2.800	0.097	1.375	0.244
	QP-B						
		2007	12.75	0.127	0.723	0.001	0.972
		2012	21.68	1.441	0.223	0.715	0.400
		Combined		1.207	0.275	0.386	0.536
	QP-C						
		2007	3.38	0.845	0.360	1.416	0.237
		2012	9.88	0.001	0.972	0.075	0.786
		Combined		0.389	0.535	1.065	0.305
	Southpaw						
		2007	5.26	0.348	0.557	0.763	0.385
		2012	24.65	2.101	0.150	1.178	0.281
		Combined		0.362	0.549	0.022	0.883
	QP-A						

		2007	14.59	0.299	0.586	0.047	0.828
		2012	18.81	0.898	0.346	0.364	0.548
		Combined		1.116	0.293	0.337	0.563
	QP-D						
		2007	44.44	8.631	0.004	6.323	0.014
		2012	1.57	1.790	0.184	2.535	0.115
		Combined		1.169	0.282	0.385	0.537
	Pearl						
		2007	12.28	0.094	0.760	<0.001	0.990
		2012	24.86	2.152	0.146	1.214	0.274
		Combined		1.567	0.214	0.588	0.445
	Laguna						
		2007	1.69	1.708	0.194	2.441	0.122
		2012	5.43	0.317	0.575	0.719	0.399
		Combined		1.743	0.190	2.896	0.093
	Skeen						
		2007	20.00	1.111	0.295	0.497	0.483
		2012	13.21	0.164	0.687	0.007	0.935
		Combined		1.062	0.305	0.309	0.580
	Eunice						
		2007	6.49	0.164	0.686	0.485	0.488
		2012	NA				
	Bilbry						
		2007	16.49	0.536	0.466	0.157	0.693
		2012	18.23	0.801	0.373	0.305	0.582
		Combined		1.323	0.253	0.449	0.504
	WIPP						
		2007	0	4.867	0.030	5.887	0.017
		2012	6.30	0.187	0.666	0.522	0.472
		Combined		3.426	0.067	4.871	0.030
	Mills						
		2007	16.05	0.476	0.492	0.126	0.723
		2012	18.62	0.865	0.355	0.343	0.559
		Combined		1.311	0.255	0.443	0.508
	Paduca						
		2007	23.53	1.841	0.178	0.992	0.322
		2012	31.32	3.906	0.051	2.532	0.115
		Combined		5.546	0.021	3.341	0.071
	San Simon						
		2007	6.47	0.167	0.684	0.489	0.486
		2012	12.83	0.134	0.716	0.002	0.965
		Combined		0.001	0.976	0.214	0.645
Artemisia							

	Pastures with active leks						
		2001	1.26				
		2002	1.23				
		2003	1.52				
	Pastures with abandoned lekking locations						
		2001	1.36				
		2002	3.63				
		2003	2.78				
	Mescalero Sands						
		2007	8.96	6.452	0.013	1.603	0.209
		2012	14.06	11.826	0.001	3.244	0.075
		Combined		17.803	<0.001	4.696	0.033
	QP-F						
		2007	8.10	5.600	0.020	1.352	0.248
		2012	8.09	5.597	0.020	1.351	0.249
		Combined		11.199	0.001	2.704	0.104
	Loco Hills						
		2007	9.61	7.099	0.009	1.796	0.184
		2012	6.67	4.246	0.042	0.962	0.330
		Combined		11.143	0.001	2.691	0.105
	QP-B						
		2007	0	0.681	0.411	0.543	0.463
		2012	1.40	0.217	0.643	0.001	0.975
		Combined		0.064	0.801	0.248	0.620
	QP-C						
		2007	0	0.681	0.411	0.543	0.463
		2012	0	0.681	0.411	0.543	0.463
		Combined		1.362	0.246	1.087	0.300
	Southpaw						
		2007	11.05	8.586	0.004	2.245	0.138
		2012	6.34	3.944	0.050	0.876	0.352
		Combined		12.031	0.001	2.958	0.089
	QP-A						
		2007	0.54	0.001	0.970	0.072	0.789
		2012	1.98	0.516	0.474	0.033	0.856
		Combined		0.231	0.632	0.004	0.951
	QP-D						

		2007	1.65	0.335	0.564	0.010	0.922
		2012	7.09	4.637	0.034	1.073	0.303
		Combined		3.685	0.058	0.640	0.426
	Pearl						
		2007	1.75	0.391	0.533	0.016	0.900
		2012	16.95	15.096	<0.001	4.272	0.042
		Combined		9.642	0.002	2.350	0.129
	Laguna						
		2007	1.12	0.107	0.744	0.003	0.959
		2012	3.26	1.370	0.245	0.203	0.653
		Combined		1.118	0.293	0.080	0.778
	Skeen						
		2007	0	0.681	0.411	0.543	0.463
		2012	0	0.681	0.411	0.543	0.463
		Combined		1.362	0.246	1.087	0.300
	Eunice						
		2007	0	0.681	0.411	0.543	0.463
		2012	NA				
	Bilbry						
		2007	0	0.681	0.411	0.543	0.463
		2012	1.10	0.101	0.752	0.003	0.955
		Combined		0.128	0.721	0.314	0.576
	WIPP						
		2007	2.03	0.544	0.463	0.037	0.847
		2012	6.30	3.909	0.051	0.867	0.355
		Combined		3.656	0.059	0.630	0.430
	Mills						
		2007	13.58	11.295	0.001	3.078	0.083
		2012	15.96	13.956	<0.001	3.911	0.051
		Combined		25.167	<0.001	6.965	0.010
	Paduca						
		2007	0	0.681	0.411	0.543	0.463
		2012	0	0.681	0.411	0.543	0.463
		Combined		1.362	0.246	1.087	0.300
	San Simon						
		2007	0	0.681	0.411	0.543	0.463
		2012	1.07	0.089	0.766	0.005	0.946
		Combined		0.138	0.711	0.324	0.571
Bouteloua							
	Pastures with active leks						
		2001	15.97				
		2002	10.37				

		2003	9.68				
	Pastures with abandoned lekking locations						
		2001	10.16				
		2002	7.07				
		2003	10.06				
	Mescalero Sands						
		2007	8.02	0.044	0.835	0.065	0.799
		2012	0	3.748	0.056	0.610	0.437
		Combined		2.266	0.135	0.137	0.712
	QP-F						
		2007	0.95	1.852	0.177	0.190	0.664
		2012	0	3.748	0.056	0.610	0.437
		Combined		5.426	0.022	0.740	0.392
	Loco Hills						
		2007	14.85	0.203	0.653	0.424	0.517
		2012	0	3.748	0.056	0.610	0.437
		Combined		1.072	0.303	0.008	0.928
	QP-B						
		2007	8.33	0.030	0.862	0.076	0.783
		2012	0	3.748	0.056	0.610	0.437
		Combined		2.191	0.142	0.126	0.723
	QP-C						
		2007	3.86	0.565	0.454	0.005	0.944
		2012	0	3.748	0.056	0.610	0.437
		Combined		3.586	0.061	0.361	0.550
	Southpaw						
		2007	0	3.748	0.056	0.610	0.437
		2012	1.41	1.517	0.221	0.128	0.721
		Combined		5.005	0.028	0.648	0.423
	QP-A						
		2007	3.78	0.585	0.446	0.006	0.938
		2012	0	3.748	0.056	0.610	0.437
		Combined		3.621	0.060	0.368	0.546
	QP-D						
		2007	1.23	1.633	0.204	0.149	0.700
		2012	0	3.748	0.056	0.610	0.437
		Combined		5.154	0.025	0.680	0.412
	Pearl						
		2007	1.32	1.578	0.212	0.139	0.710

		2012	0	3.748	0.056	0.610	0.437
		Combined		5.083	0.026	0.665	0.417
	Laguna						
		2007	2.81	0.867	0.354	0.032	0.859
		2012	0	3.748	0.056	0.610	0.437
		Combined		4.089	0.046	0.459	0.500
	Skeen						
		2007	4.83	0.370	0.545	<0.001	0.987
		2012	0	3.748	0.056	0.610	0.437
		Combined		3.207	0.076	0.291	0.591
	Eunice						
		2007	8.40	0.028	0.868	0.079	0.780
		2012	NA				
	Bilbry						
		2007	9.04	0.010	0.923	0.104	0.748
		2012	0	3.748	0.056	0.610	0.437
		Combined		2.032	0.157	0.104	0.748
	WIPP						
		2007	1.35	1.554	0.216	0.135	0.714
		2012	0	3.748	0.056	0.610	0.437
		Combined		5.053	0.027	0.658	0.419
	Mills						
		2007	5.56	0.258	0.613	0.006	0.940
		2012	0	3.748	0.056	0.610	0.437
		Combined		2.956	0.089	0.247	0.620
	Paduca						
		2007	0.45	2.389	0.125	0.299	0.586
		2012	0	3.748	0.056	0.610	0.437
		Combined		6.058	0.016	0.881	0.351
	San Simon						
		2007	5.17	0.313	0.577	0.002	0.964
		2012	2.14	1.129	0.291	0.066	0.798
		Combined		1.314	0.254	0.022	0.881
Cenchrus							
	Pastures with active leks						
		2001	0				
		2002	0.03				
		2003	0				
	Pastures with abandoned lekking						

	locations						
		2001	0				
		2002	0.09				
		2003	0				
	Mescalero Sands						
		2007	0.47	53.010	<0.001	14.283	<0.001
		2012	7.29	919.439	<0.001	253.419	<0.001
		Combined		187.841	<0.001	101.034	<0.001
	QP-F						
		2007	0	0.010	0.920	0.012	0.913
		2012	2.89	352.461	<0.001	96.720	<0.001
		Combined		61.079	<0.001	29.236	<0.001
	Loco Hills						
		2007	0	0.010	0.920	0.012	0.913
		2012	12.67	1640.614	<0.001	453.003	<0.001
		Combined		85.171	<0.001	58.097	<0.001
	QP-B						
		2007	0.49	55.224	<0.001	14.888	<0.001
		2012	6.29	788.965	<0.001	217.334	<0.001
		Combined		195.825	<0.001	99.444	<0.001
	QP-C						
		2007	0	0.010	0.920	0.012	0.913
		2012	2.91	354.581	<0.001	97.306	<0.001
		Combined		61.211	<0.001	29.348	<0.001
	Southpaw						
		2007	0	0.010	0.920	0.012	0.913
		2012	7.04	886.730	<0.001	244.371	<0.001
		Combined		77.978	<0.001	47.289	<0.001
	QP-A						
		2007	0	0.010	0.920	0.012	0.913
		2012	2.97	362.573	<0.001	99.511	<0.001
		Combined		61.697	<0.001	29.765	<0.001
	QP-D						
		2007	5.76	719.805	<0.001	198.211	<0.001
		2012	37.01	5352.241	<0.001	1481.374	<0.001
		Combined		410.595	<0.001	292.632	<0.001
	Pearl						
		2007	0.44	49.055	<0.001	13.201	<0.001
		2012	0	0.010	0.920	0.012	0.913
		Combined		18.873	<0.001	5.710	0.019
	Laguna						
		2007	0	0.010	0.920	0.012	0.913
		2012	6.52	818.683	<0.001	225.552	<0.001

		Combined		76.809	<0.001	45.748	<0.001
	Skeen						
		2007	2.07	249.370	<0.001	68.282	<0.001
		2012	10.69	1372.021	<0.001	378.651	<0.001
		Combined		416.535	<0.001	215.557	<0.001
	Eunice						
		2007	3.82	469.924	<0.001	129.154	<0.001
		2012	NA				
	Bilbry						
		2007	3.19	390.533	<0.001	107.230	<0.001
		2012	4.97	617.897	<0.001	170.040	<0.001
		Combined		877.067	<0.001	261.949	<0.001
	WIPP						
		2007	2.70	328.837	<0.001	90.201	<0.001
		2012	7.09	892.542	<0.001	245.979	<0.001
		Combined		670.987	<0.001	255.939	<0.001
	Mills						
		2007	16.05	2110.726	<0.001	583.178	<0.001
		2012	7.45	939.819	<0.001	259.056	<0.001
		Combined		1323.697	<0.001	576.425	<0.001
	Paduca						
		2007	6.79	853.367	<0.001	235.144	<0.001
		2012	0.55	62.335	<0.001	16.834	<0.001
		Combined		204.567	<0.001	105.673	<0.001
	San Simon						
		2007	3.02	368.501	<0.001	101.148	<0.001
		2012	8.02	1015.524	<0.001	279.999	<0.001
		Combined		710.238	<0.001	280.780	<0.001
Eriogonum							
	Pastures with active leks						
		2001	0.88				
		2002	3.09				
		2003	0.22				
	Pastures with abandoned lekking locations						
		2001	1.72				
		2002	5.36				
		2003	9.01				
	Mescalero						

	Sands						
		2007	0.94	0.027	0.870	0.266	0.608
		2012	0	0.852	0.358	1.221	0.272
		Combined		0.286	0.594	1.311	0.256
	QP-F						
		2007	1.90	0.409	0.524	0.066	0.797
		2012	0	0.852	0.358	1.221	0.272
		Combined		0.040	0.843	0.925	0.339
	Loco Hills						
		2007	0.87	0.015	0.904	0.290	0.592
		2012	0	0.852	0.358	1.221	0.272
		Combined		0.320	0.573	1.349	0.249
	QP-B						
		2007	0	0.852	0.358	1.221	0.272
		2012	0	0.852	0.358	1.221	0.272
		Combined		1.704	0.195	2.444	0.122
	QP-C						
		2007	0	0.852	0.358	1.221	0.272
		2012	0	0.852	0.358	1.221	0.272
		Combined		1.704	0.195	2.444	0.122
	Southpaw						
		2007	0	0.852	0.358	1.221	0.272
		2012	0	0.852	0.358	1.221	0.272
		Combined		1.704	0.195	2.444	0.122
	QP-A						
		2007	0	0.852	0.358	1.221	0.272
		2012	0	0.852	0.358	1.221	0.272
		Combined		1.704	0.195	2.444	0.122
	QP-D						
		2007	0.41	0.048	0.828	0.523	0.472
		2012	0	0.852	0.358	1.221	0.272
		Combined		0.650	0.422	1.670	0.200
	Pearl						
		2007	0	0.852	0.358	1.221	0.272
		2012	0	0.852	0.358	1.221	0.272
		Combined		1.704	0.195	2.444	0.122
	Laguna						
		2007	0	0.852	0.358	1.221	0.272
		2012	0	0.852	0.358	1.221	0.272
		Combined		1.704	0.195	2.444	0.122
	Skeen						
		2007	0.69	<0.001	0.999	0.365	0.547
		2012	1.26	0.115	0.736	0.177	0.675
		Combined		0.058	0.811	0.525	0.471

	Eunice						
		2007	2.29	0.632	0.429	0.030	0.863
		2012	NA				
	Bilbry						
		2007	0.53	0.014	0.908	0.446	0.506
		2012	0	0.852	0.358	1.221	0.272
		Combined		0.539	0.465	1.570	0.214
	WIPP						
		2007	0.68	<0.001	0.993	0.371	0.544
		2012	0	0.852	0.358	1.221	0.272
		Combined		0.433	0.512	1.468	0.229
	Mills						
		2007	0	0.852	0.358	1.221	0.272
		2012	0.53	0.014	0.908	0.446	0.506
		Combined		0.539	0.465	1.570	0.214
	Paduca						
		2007	0.45	0.033	0.856	0.495	0.484
		2012	1.10	0.064	0.800	0.218	0.642
		Combined		0.003	0.960	0.685	0.410
	San Simon						
		2007	1.72	0.315	0.576	0.090	0.765
		2012	4.81	2.544	0.114	0.068	0.795
		Combined		2.313	0.132	0.001	0.978
Gutierrezia							
	Pastures with active leks						
		2001	5.05				
		2002	7.08				
		2003	6.95				
	Pastures with abandoned lekking locations						
		2001	0.95				
		2002	1.39				
		2003	1.43				
	Mescalero Sands						
		2007	2.36	0.103	0.749	0.916	0.341
		2012	2.60	0.074	0.787	1.083	0.301
		Combined		0.175	0.676	1.996	0.161
	QP-F						

		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	Loco Hills						
		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	QP-B						
		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	QP-C						
		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	Southpaw						
		2007	1.05	0.415	0.521	0.173	0.679
		2012	0	1.612	0.207	0.403	0.527
		Combined		1.827	0.180	0.024	0.877
	QP-A						
		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	QP-D						
		2007	1.23	0.348	0.557	0.256	0.614
		2012	0.79	0.535	0.466	0.072	0.789
		Combined		0.873	0.352	0.300	0.586
	Pearl						
		2007	14.47	1.351	0.248	11.877	0.001
		2012	2.82	0.052	0.820	1.237	0.269
		Combined		0.432	0.513	10.051	0.002
	Laguna						
		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	Skeen						
		2007	2.07	0.146	0.703	0.728	0.396
		2012	0	1.612	0.207	0.403	0.527
		Combined		1.360	0.246	0.024	0.878
	Eunice						
		2007	0	1.612	0.207	0.403	0.527
		2012	NA				
	Bilbry						
		2007	0	1.612	0.207	0.403	0.527

		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	WIPP						
		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	Mills						
		2007	0.62	0.633	0.428	0.026	0.873
		2012	1.06	0.410	0.523	0.177	0.675
		Combined		1.031	0.312	0.169	0.682
	Paduca						
		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
	San Simon						
		2007	0	1.612	0.207	0.403	0.527
		2012	0	1.612	0.207	0.403	0.527
		Combined		3.225	0.076	0.806	0.372
Helianthus							
	Pastures with active leks						
		2001	0.09				
		2002	0.25				
		2003	0.07				
	Pastures with abandoned lekking locations						
		2001	0.16				
		2002	0.15				
		2003	0.29				
	Mescalero Sands						
		2007	0	0.117	0.733	0.115	0.735
		2012	1.04	6.487	0.012	4.192	0.044
		Combined		2.330	0.130	1.409	0.239
	QP-F						
		2007	0	0.117	0.733	0.115	0.735
		2012	2.89	20.674	<0.001	13.686	<0.001
		Combined		7.864	0.006	5.126	0.026
	Loco Hills						
		2007	0	0.117	0.733	0.115	0.735

		2012	0.67	3.799	0.054	2.414	0.124
		Combined		1.258	0.265	0.722	0.398
	QP-B						
		2007	0	0.117	0.733	0.115	0.735
		2012	19.58	167.203	<0.001	112.898	<0.001
		Combined		41.337	<0.001	30.220	<0.001
	QP-C						
		2007	5.31	40.298	<0.001	26.910	<0.001
		2012	14.53	120.347	<0.001	81.106	<0.001
		Combined		134.978	<0.001	92.343	<0.001
	Southpaw						
		2007	0	0.117	0.733	0.115	0.735
		2012	0	0.117	0.733	0.115	0.735
		Combined		0.234	0.630	0.230	0.633
	QP-A						
		2007	0	0.117	0.733	0.115	0.735
		2012	0.99	6.110	0.015	3.942	0.050
		Combined		2.179	0.143	1.311	0.255
	QP-D						
		2007	0	0.117	0.733	0.115	0.735
		2012	0.79	4.651	0.034	2.975	0.088
		Combined		1.595	0.210	0.936	0.336
	Pearl						
		2007	0	0.117	0.733	0.115	0.735
		2012	5.08	38.410	<0.001	25.635	<0.001
		Combined		14.025	<0.001	9.440	0.003
	Laguna						
		2007	0	0.117	0.733	0.115	0.735
		2012	1.09	6.819	0.010	4.412	0.039
		Combined		2.464	0.120	1.496	0.225
	Skeen						
		2007	0	0.117	0.733	0.115	0.735
		2012	0.63	3.357	0.063	2.241	0.138
		Combined		1.154	0.285	0.657	0.420
	Eunice						
		2007	0	0.117	0.733	0.115	0.735
		2012	NA				
	Bilbry						
		2007	0	0.117	0.733	0.115	0.735
		2012	2.21	15.338	<0.001	10.104	0.002
		Combined		5.839	0.018	3.744	0.056
	WIPP						
		2007	0	0.117	0.733	0.115	0.735
		2012	6.30	48.480	<0.001	32.436	<0.001

		Combined		17.156	<0.001	11.689	0.001
	Mills						
		2007	0	0.117	0.733	0.115	0.735
		2012	2.13	14.700	<0.001	9.676	0.003
		Combined		5.591	0.020	3.576	0.062
	Paduca						
		2007	0	0.117	0.733	0.115	0.735
		2012	0	0.117	0.733	0.115	0.735
		Combined		0.234	0.630	0.230	0.633
	San Simon						
		2007	6.47	49.871	<0.001	33.376	<0.001
		2012	11.23	90.808	<0.001	61.082	<0.001
		Combined		133.434	<0.001	90.070	<0.001
Muhlenbergia							
	Pastures with active leks						
		2001	0.04				
		2002	0.11				
		2003	0.80				
	Pastures with abandoned lekking locations						
		2001	13.88				
		2002	9.27				
		2003	9.81				
	Mescalero Sands						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	QP-F						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0126	0.723	3.287	0.073
	Loco Hills						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	QP-B						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204

		Combined		0.126	0.723	3.287	0.073
	QP-C						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	Southpaw						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	QP-A						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	QP-D						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	Pearl						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	Laguna						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	Skeen						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	Eunice						
		2007	0	0.063	0.802	1.643	0.204
		2012	NA				
	Bilbry						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	WIPP						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	Mills						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073

	Paduca						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
	San Simon						
		2007	0	0.063	0.802	1.643	0.204
		2012	0	0.063	0.802	1.643	0.204
		Combined		0.126	0.723	3.287	0.073
Panicum							
	Pastures with active leks						
		2001	1.21				
		2002	0.62				
		2003	0.21				
	Pastures with abandoned lekking locations						
		2001	0.45				
		2002	0.06				
		2003	0.13				
	Mescalero Sands						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	QP-F						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	Loco Hills						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	QP-B						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	QP-C						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628

	Southpaw						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	QP-A						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	QP-D						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	Pearl						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	Laguna						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	Skeen						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	Eunice						
		2007	0	0.489	0.486	0.118	0.732
		2012	NA				
	Bilbry						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	WIPP						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	Mills						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	Paduca						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
	San						

	Simon						
		2007	0	0.489	0.486	0.118	0.732
		2012	0	0.489	0.486	0.118	0.732
		Combined		0.978	0.325	0.237	0.628
Prosopis							
	Pastures with active leks						
		2001	1.15				
		2002	1.46				
		2003	1.85				
	Pastures with abandoned lekking locations						
		2001	1.71				
		2002	1.70				
		2003	1.61				
	Mescalero Sands						
		2007	0	0.181	0.671	0.236	0.628
		2012	1.04	0.191	0.663	0.117	0.733
		Combined		<0.001	0.994	0.010	0.919
	QP-F						
		2007	0	0.181	0.671	0.236	0.628
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.363	0.548	0.473	0.494
	Loco Hills						
		2007	0	0.181	0.671	0.236	0.628
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.363	0.548	0.473	0.494
	QP-B						
		2007	0.49	0.025	0.876	0.005	0.942
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.036	0.850	0.085	0.771
	QP-C						
		2007	0	0.181	0.671	0.236	0.628
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.363	0.548	0.473	0.494
	Southpaw						
		2007	3.68	1.510	0.222	1.214	0.274
		2012	0.70	0.077	0.781	0.036	0.850
		Combined		1.131	0.290	0.830	0.365
	QP-A						

		2007	0	0.181	0.671	0.236	0.628
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.363	0.548	0.473	0.494
	QP-D						
		2007	6.17	3.006	0.086	2.515	0.117
		2012	6.30	3.085	0.082	2.585	0.112
		Combined		6.092	0.015	5.102	0.027
	Pearl						
		2007	1.32	0.300	0.585	0.201	0.655
		2012	1.69	0.468	0.496	0.335	0.564
		Combined		0.759	0.386	0.527	0.470
	Laguna						
		2007	0	0.181	0.671	0.236	0.628
		2012	4.35	1.894	0.172	1.545	0.217
		Combined		0.444	0.507	0.281	0.597
	Skeen						
		2007	0.69	0.073	0.787	0.033	0.856
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.012	0.913	0.046	0.831
	Eunice						
		2007	0	0.181	0.671	0.236	0.628
		2012	NA				
	Bilbry						
		2007	0	0.181	0.671	0.236	0.628
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.363	0.548	0.473	0.494
	WIPP						
		2007	1.35	0.315	0.576	0.213	0.646
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.009	0.924	<0.001	0.986
	Mills						
		2007	8.64	4.604	0.034	3.926	0.051
		2012	9.04	4.872	0.030	4.163	0.045
		Combined		9.476	0.003	8.089	0.006
	Paduca						
		2007	0	0.181	0.671	0.236	0.628
		2012	0.55	0.037	0.848	0.012	0.915
		Combined		0.027	0.869	0.072	0.790
	San Simon						
		2007	0	0.181	0.671	0.236	0.628
		2012	0	0.181	0.671	0.236	0.628
		Combined		0.363	0.548	0.473	0.494
Quercus							

	Pastures with active leks						
		2001	21.18				
		2002	23.51				
		2003	27.94				
	Pastures with abandoned lekking locations						
		2001	25.79				
		2002	25.18				
		2003	22.16				
	Mescalero Sands						
		2007	48.11	1.801	0.183	2.001	0.161
		2012	39.06	0.816	0.369	0.898	0.346
		Combined		2.518	0.116	2.787	0.099
	QP-F						
		2007	58.57	3.408	0.068	3.805	0.055
		2012	41.62	1.057	0.306	1.168	0.283
		Combined		4.117	0.045	4.574	0.035
	Loco Hills						
		2007	47.60	1.735	0.191	1.927	0.169
		2012	55.33	2.853	0.094	3.181	0.078
		Combined		4.516	0.036	5.026	0.028
	QP-B						
		2007	35.29	0.513	0.476	0.560	0.456
		2012	30.07	0.201	0.655	0.215	0.644
		Combined		0.678	0.412	0.735	0.394
	QP-C						
		2007	49.28	1.954	0.165	2.172	0.144
		2012	36.05	0.568	0.453	0.622	0.433
		Combined		2.310	0.132	2.553	0.114
	Southpaw						
		2007	61.58	3.974	0.049	4.441	0.038
		2012	38.73	0.787	0.377	0.866	0.355
		Combined		4.123	0.045	4.576	0.035
	QP-A						
		2007	60.54	3.772	0.055	4.215	0.043
		2012	54.46	2.711	0.103	3.023	0.086
		Combined		6.438	0.013	7.186	0.009
	QP-D						
		2007	0	5.393	0.022	6.166	0.015

		2012	0	5.393	0.022	6.166	0.015
		Combined		10.788	0.001	12.337	0.001
	Pearl						
		2007	51.75	2.300	0.133	2.561	0.113
		2012	32.77	0.346	0.558	0.375	0.542
		Combined		2.206	0.141	2.434	0.123
	Laguna						
		2007	50.00	2.052	0.155	2.282	0.135
		2012	32.61	0.336	0.563	0.365	0.548
		Combined		2.018	0.159	2.225	0.140
	Skeen						
		2007	45.52	1.481	0.227	1.642	0.204
		2012	56.60	3.064	0.083	3.419	0.068
		Combined		4.397	0.039	4.892	0.030
	Eunice						
		2007	53.05	2.494	0.118	2.778	0.099
		2012	NA				
	Bilbry						
		2007	39.89	0.891	0.348	0.982	0.325
		2012	45.86	1.521	0.220	1.687	0.198
		Combined		2.370	0.127	2.622	0.109
	WIPP						
		2007	34.46	0.454	0.502	0.495	0.484
		2012	29.92	0.194	0.660	0.208	0.650
		Combined		0.621	0.433	0.672	0.415
	Mills						
		2007	29.63	0.181	0.671	0.193	0.661
		2012	34.57	0.462	0.498	0.504	0.480
		Combined		0.611	0.436	0.661	0.419
	Paduca						
		2007	57.92	3.291	0.073	3.674	0.059
		2012	51.10	2.206	0.141	2.455	0.121
		Combined		5.441	0.022	6.065	0.016
	San Simon						
		2007	30.17	0.206	0.651	0.221	0.640
		2012	45.45	1.474	0.228	1.634	0.205
		Combined		1.387	0.242	1.522	0.221
Senecio							
	Pastures with active leks						
		2001	0.21				
		2002	1.16				

		2003	0.25				
	Pastures with abandoned lekking locations						
		2001	0.21				
		2002	1.38				
		2003	1.83				
	Mescalero Sands						
		2007	0	0.133	0.716	0.315	0.576
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.266	0.607	0.631	0.429
	QP-F						
		2007	0.95	0.932	0.337	0.204	0.653
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.179	0.673	0.006	0.938
	Loco Hills						
		2007	0	0.168	0.683	0.355	0.553
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.300	0.585	0.670	0.416
	QP-B						
		2007	3.43	4.888	0.029	1.962	0.165
		2012	0.70	0.590	0.444	0.091	0.764
		Combined		4.390	0.039	1.438	0.234
	QP-C						
		2007	3.86	5.634	0.020	2.324	0.131
		2012	0	0.133	0.716	0.315	0.576
		Combined		1.942	0.167	0.451	0.504
	Southpaw						
		2007	0	0.133	0.716	0.315	0.576
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.266	0.607	0.631	0.429
	QP-A						
		2007	0.54	0.391	0.533	0.037	0.848
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.034	0.855	0.068	0.795
	QP-D						
		2007	1.23	1.337	0.250	0.357	0.552
		2012	0.79	0.706	0.403	0.127	0.722
		Combined		1.993	0.161	0.455	0.502
	Pearl						
		2007	0.44	0.273	0.602	0.013	0.909
		2012	0	0.133	0.716	0.315	0.576

		Combined		0.012	0.912	0.100	0.753
	Laguna						
		2007	1.69	2.021	0.158	0.639	0.426
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.549	0.460	0.028	0.868
	Skeen						
		2007	0.69	0.577	0.449	0.087	0.769
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.078	0.781	0.035	0.851
	Eunice						
		2007	2.29	2.983	0.087	1.065	0.305
		2012	NA				
	Bilbry						
		2007	4.79	7.251	0.008	3.125	0.081
		2012	0	0.133	0.716	0.315	0.576
		Combined		2.584	0.111	0.704	0.404
	WIPP						
		2007	11.49	19.832	<0.001	9.665	0.003
		2012	0	0.133	0.716	0.315	0.576
		Combined		7.458	0.007	2.993	0.087
	Mills						
		2007	1.23	1.337	0.250	0.357	0.552
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.310	0.579	0.001	0.980
	Paduca						
		2007	0.90	0.866	0.354	0.181	0.672
		2012	0	0.133	0.716	0.315	0.576
		Combined		0.159	0.691	0.009	0.924
	San Simon						
		2007	39.22	82.968	<0.001	44.293	<0.001
		2012	0.53	0.384	0.537	0.036	0.851
		Combined		34.419	<0.001	18.574	<0.001
Sporobolus							
	Pastures with active leks						
		2001	0.07				
		2002	2.33				
		2003	3.36				
	Pastures with abandoned lekking						

	locations						
		2001	11.41				
		2002	16.00				
		2003	15.75				
	Mescalero Sands						
		2007	16.98	9.959	0.002	0.173	0.679
		2012	18.75	11.405	0.001	0.274	0.602
		Combined		21.338	<0.001	0.442	0.508
	QP-F						
		2007	10.00	4.702	0.033	0.004	0.948
		2012	27.17	18.836	<0.001	0.986	0.324
		Combined		20.677	<0.001	0.428	0.515
	Loco Hills						
		2007	0.87	<0.001	0.985	1.278	0.262
		2012	2.67	0.431	0.513	0.642	0.425
		Combined		0.203	0.653	1.865	0.176
	QP-B						
		2007	13.73	7.411	0.008	0.042	0.838
		2012	16.78	9.799	0.002	0.163	0.688
		Combined		17.116	<0.001	0.185	0.668
	QP-C						
		2007	25.12	16.948	<0.001	0.782	0.379
		2012	34.30	25.830	<0.001	1.834	0.179
		Combined		42.115	<0.001	2.503	0.118
	Southpaw						
		2007	13.68	7.380	0.008	0.041	0.840
		2012	16.90	9.894	0.002	0.169	0.682
		Combined		17.169	<0.001	0.188	0.666
	QP-A						
		2007	9.19	4.147	0.044	0.017	0.897
		2012	10.89	5.328	0.023	<0.001	0.998
		Combined		9.437	0.003	0.008	0.929
	QP-D						
		2007	1.65	0.101	0.752	0.934	0.337
		2012	33.86	25.375	<0.001	1.776	0.186
		Combined		12.850	0.001	0.065	0.800
	Pearl						
		2007	14.04	7.647	0.007	0.051	0.822
		2012	11.86	6.028	0.016	0.006	0.941
		Combined		13.622	<0.001	0.045	0.832
	Laguna						
		2007	36.52	28.135	<0.001	2.139	0.147
		2012	35.87	27.454	<0.001	2.048	0.156
		Combined		55.598	<0.001	4.188	0.044

	Skeen						
		2007	22.76	14.833	<0.001	0.570	0.453
		2012	12.58	6.552	0.012	0.016	0.900
		Combined		20.378	<0.001	0.387	0.536
	Eunice						
		2007	7.63	3.125	0.080	0.068	0.795
		2012	NA				
	Bilbry						
		2007	20.74	13.085	<0.001	0.411	0.523
		2012	24.31	16.213	<0.001	0.706	0.403
		Combined		29.195	<0.001	1.097	0.298
	WIPP						
		2007	38.51	30.271	<0.001	2.430	0.123
		2012	29.92	21.459	<0.001	1.289	0.260
		Combined		51.161	<0.001	3.626	0.060
	Mills						
		2007	6.17	2.223	0.139	0.156	0.694
		2012	9.57	4.409	0.038	0.010	0.922
		Combined		6.436	0.013	0.122	0.728
	Paduca						
		2007	8.60	3.751	0.056	0.032	0.859
		2012	10.99	5.397	0.022	<0.001	0.992
		Combined		9.069	0.003	0.014	0.906
	San Simon						
		2007	3.45	0.765	0.384	0.483	0.489
		2012	11.76	5.955	0.016	0.005	0.946
		Combined		5.247	0.022	0.196	0.659
Yucca							
	Pastures with active leks						
		2001	6.39				
		2002	7.27				
		2003	8.63				
	Pastures with abandoned lekking locations						
		2001	7.01				
		2002	5.67				
		2003	4.91				
	Mescalero						

	Sands						
		2007	4.25	0.131	0.718	0.006	0.939
		2012	9.90	0.314	0.576	0.744	0.391
		Combined		0.020	0.889	0.307	0.581
	QP-F						
		2007	2.38	0.629	0.430	0.267	0.607
		2012	4.05	0.162	0.688	0.014	0.906
		Combined		0.715	0.400	0.202	0.654
	Loco Hills						
		2007	0.87	1.680	0.198	1.059	0.306
		2012	0	4.152	0.044	3.185	0.078
		Combined		5.543	0.021	3.946	0.050
	QP-B						
		2007	3.92	0.184	0.669	0.021	0.885
		2012	0.70	1.897	0.172	1.236	0.270
		Combined		1.624	0.206	0.786	0.378
	QP-C						
		2007	0	4.152	0.044	3.185	0.078
		2012	1.16	1.387	0.242	0.825	0.366
		Combined		5.151	0.025	3.610	0.061
	Southpaw						
		2007	2.11	0.756	0.387	0.353	0.554
		2012	3.52	0.266	0.607	0.055	0.816
		Combined		0.959	0.330	0.343	0.560
	QP-A						
		2007	4.86	0.058	0.811	0.002	0.963
		2012	4.95	0.050	0.823	0.004	0.949
		Combined		0.108	0.744	0.006	0.938
	QP-D						
		2007	2.06	0.780	0.379	0.370	0.545
		2012	11.81	0.661	0.418	1.254	0.266
		Combined		0.002	0.961	0.128	0.721
	Pearl						
		2007	1.32	1.257	0.265	0.724	0.397
		2012	1.69	0.986	0.323	0.519	0.473
		Combined		2.235	0.138	1.234	0.270
	Laguna						
		2007	4.49	0.097	0.756	0.001	0.979
		2012	10.87	0.478	0.491	0.992	0.322
		Combined		0.072	0.790	0.467	0.496
	Skeen						
		2007	0.69	1.910	0.170	1.246	0.268
		2012	5.03	0.043	0.835	0.006	0.937
		Combined		1.256	0.265	0.533	0.467
	Eunice						

		2007	7.25	0.030	0.864	0.218	0.642
		2012	NA				
	Bilbry						
		2007	1.60	1.051	0.308	0.567	0.454
		2012	2.76	0.482	0.489	0.173	0.679
		Combined		1.478	0.227	0.683	0.411
	WIPP						
		2007	5.41	0.019	0.889	0.022	0.882
		2012	14.17	1.213	0.273	1.999	0.161
		Combined		0.459	0.500	1.210	0.275
	Mills						
		2007	1.23	1.324	0.253	0.776	0.381
		2012	0	4.152	0.044	3.185	0.078
		Combined		5.063	0.027	3.535	0.064
	Paduca						
		2007	1.36	1.223	0.271	0.698	0.406
		2012	3.30	0.321	0.572	0.082	0.776
		Combined		1.397	0.240	0.627	0.431
	San Simon						
		2007	0.43	2.325	0.131	1.593	0.211
		2012	0.53	2.142	0.147	1.439	0.234
		Combined		4.466	0.037	3.031	0.085
Unidentified Forb							
	Pastures with active leks						
		2001	1.20				
		2002	0.16				
		2003	0.02				
	Pastures with abandoned lekking locations						
		2001	1.21				
		2002	2.51				
		2003	0.56				
	Mescalero Sands						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405

	QP-F						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	Loco Hills						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	QP-B						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	QP-C						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	Southpaw						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	QP-A						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	QP-D						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	Pearl						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	Laguna						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	Skeen						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	Eunice						
		2007	0				
		2012	NA				
	Bilbry						

		2007	0.53	0.370	0.545	0.006	0.937
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.001	0.976	0.131	0.719
	WIPP						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	Mills						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	Paduca						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
	San Simon						
		2007	0	0.423	0.517	0.350	0.556
		2012	0	0.423	0.517	0.350	0.556
		Combined		0.847	0.360	0.700	0.405
Other[ab]							
	Pastures with active leks						
		2001	0.50				
		2002	0.46				
		2003	0.67				
	Pastures with abandoned lekking locations						
		2001	1.84				
		2002	1.08				
		2003	1.43				
	Mescalero Sands						
		2007	0.94				
		2012	0				
		Combined					
	QP-F						
		2007	3.33				
		2012	0				
		Combined					
	Loco Hills						

		2007	4.37				
		2012	0				
		Combined					
	QP-B						
		2007	0.49				
		2012	0.70				
		Combined					
	QP-C						
		2007	2.90				
		2012	1.16				
		Combined					
	Southpaw						
		2007	1.05				
		2012	0.70				
		Combined					
	QP-A						
		2007	2.70				
		2012	1.98				
		Combined					
	QP-D						
		2007	3.70				
		2012	0				
		Combined					
	Pearl						
		2007	0.88				
		2012	2.26				
		Combined					
	Laguna						
		2007	0				
		2012	0				
		Combined					
	Skeen						
		2007	0				
		2012	0				
		Combined					
	Eunice						
		2007	6.87				
		2012					
	Bilbry						
		2007	1.06				
		2012	0				
		Combined					
	WIPP						
		2007	2.03				
		2012	0				

		Combined					
	Mills						
		2007	0.62				
		2012	0.53				
		Combined					
	Paduca						
		2007	0				
		2012	0.55				
		Combined					
	San Simon						
		2007	3.02				
		2012	1.07				
		Combined					

[a] Not included in analyses.
[b]Includes *Amaranthus, Croton*, *Eragrostis, Euphorbia*, *Mentzelia*, *Munroa*, *Opuntia*, *Paspalum*, *Rhus*, *Salsola*, *Sarcobatus*, and unidentified plants.