Microhabitat Characteristics Relative to Lek Abandonment by Greater Sage Grouse in the Dakotas

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Abstract

We compared peripheral microhabitat characteristics to identify possible reasons for greater sage grouse (*Centrocercus urophasianus*) lek abandonment in North Dakota and South Dakota. Comparisons of active leks in the Dakotas were made with active leks in eastern Montana. We systematically selected 12 sample sites at equidistant points from each other within 1.5 km of the lek center. Only non-tilled areas were sampled, but tillage generally comprised < 5 percent of sample sites and was evaluated in a separate landscape-level study. We detected no differences ($P > 0.10$) between sagebrush (*Artemisia spp.*) cover or density around active leks compared to the same attributes around historically active but now inactive leks in North and South Dakota. However, big sagebrush (*A. tridentata*) height, forb cover, and bare ground were greater ($P < 0.10$) around active leks compared to inactive leks in North Dakota. The area within 1.5 km of active leks in eastern Montana had much greater ($P < 0.10$) cover and density of sagebrush than active leks in either North or South Dakota. Sagebrush characteristics, i.e., coverage, density, and height, peripheral to active leks in the western Dakotas appeared desirable for sage grouse nesting sites compared to nesting habitat described in other areas of more classic habitat in Montana or Idaho. The substantial forb and grass cover association with marginal sagebrush coverage in the Dakotas apparently provides adequate nesting and brood rearing habitat.

Key words: *Artemisia spp.*, *Centrocercus urophasianus*, greater sage grouse, lek, Montana, North Dakota, sagebrush, South Dakota

Introduction

Total numbers of males among greater sage grouse (*Centrocercus urophasianus*) and males/lek have steadily declined in the past 50 years with many leks on the eastern edge of the species' range in the Dakotas becoming inactive (Smith et al. 2004). Our knowledge of sage grouse habitat in the Dakotas is limited, particularly that relative to habitat characteristics that may lead to lek abandonment by males or factors contributing to population declines. Researchers have attributed declining populations of sage grouse during the 1900s to the decrease of sagebrush (*Artemisia spp.*) due in part to conversion to tillage agriculture, overgrazing, fire, and/or drought (Patterson 1952, Rogers 1964, Gregg et al. 1994, Connelly and Braun 1997, Connelly et al. 2000). Distribution of sage grouse in the western Dakotas lies along an eastward extension of sagebrush steppe, including both big sagebrush (*A. tridentata*) and silver sagebrush (*A. cana*) (Schroeder et al. 1999). Laycock (1967) and Frischknecht and Harris (1973) reported that overgrazing by sheep negatively affected sagebrush, and in South Dakota, domestic sheep grazing

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reduced sagebrush production by 40 percent in 2 years (Bever 1951). Sage grouse rely on sagebrush for food, shelter, water, and escape cover (Swenson et al. 1987, Fischer et al. 1996, Paige and Ritter 1999, Schroeder et al. 1999). Connelly et al. (1991), Gregg et al. (1994), and Crawford (1997) have shown that along with sagebrush habitat herbaceous cover is important to sage grouse—a complex critical for nesting and early brood rearing (Connelly et al. 2000). Since male sage grouse also tend to establish display grounds (leks) in areas occupied by prenesting females (Gibson 1996), good habitat in proximity to leks likely improves chances of male sage grouse attracting females.

Our objectives were to 1) determine if differences occur in microhabitat characteristics, e.g., percent sagebrush canopy cover, big sagebrush height, silver sagebrush height, herbaceous cover of grass and forbs, etc., between active and inactive leks that may be related to abandonment, and 2) discern how microhabitat around leks on the eastern edge of the sage grouse range compares to microhabitat characteristics around leks more central to the sage grouse range in Montana. A separate landscape level study (Smith et al. 2005) evaluated macro-habitat influences that included influences of tilled ground.

Study Area

The study area (Fig. 1) was located in extreme western South Dakota in Fall River, Butte, and Harding counties, southwestern North Dakota in Bowman, Slope, and Golden Valley counties, and southeastern Montana in Garfield, Rosebud, Custer, and Powder River counties. Elevation in the South Dakota study area ranges from 525 to1050 m above sea level; unglaciated rolling prairie with occasional buttes and intermittent streams characterize topography of the area (Johnson 1976, Kalvels 1982, Johnson 1988). Annual precipitation ranges from 37.4 to 41.8 cm with ~ 80 percent falling from April to September (Johnson 1976, Kalvels 1982, Johnson 1988). Seasonal temperatures range from 14.3 to 31.1 °C during summer and from -14.6 to -1.4 °C during winter (Johnson 1976, Kalvels 1982, Johnson 1988).

Elevation in the North Dakota study area ranges from 660 to 1970 m above sea level; general topography resembles the South Dakota study area but with pinnacles, domes, canyons, gorges, ravines, and gullies associated with the Little Missouri Badlands (Opdahl et al. 1975, Thompson 1978, Aziz 1989). Annual precipitation ranges from 35.6 cm to 40.6 cm with ~ 80 percent falling from April to September (Opdahl et al. 1975, Thompson 1978, Aziz 1989). Summer temperatures range from 9.9 to 27.5° C and -15.6—0.2° C during winter (Opdahl et al. 1975, Thompson 1978, Aziz 1989).

Elevation in the Montana study area ranges from 575 to 2480 m above sea level; rolling to eroded sedimentary terraces dominate the landscape (Nunns 1943, Parker 1971, USDA Natural Resources Conservation Service 1996, Drummond 2003). Annual precipitation ranges from 25.5 cm to 35.6 cm with ~ 80 percent falling during April-September (Nunns 1943, Parker 1971, USDA Natural Resources Conservation Service 1996, Drummond 2003). Summer temperatures range from 13.8 to 22.6° C and from -9.3 to 0.7° C during winter (Nunns 1943, Parker 1971, USDA Natural Resources Conservation Service 1996, Drummond 2003).

Our study areas fall within the big sagebrush-wheatgrass plains vegetation type (Johnson and Larson 1999). Vegetation communities consist of a mixture of shrubs that include big sagebrush, silver sagebrush, and greasewood (*Sarcobatus vermiculatus*). We did not identify big sagebrush to subspecies at our study sites although Wyoming big sagebrush (*A .t. wyomingensis*) is ubiquitous across this region, and basin big sagebrush (*A. t. tridentata*) also overlapped this range. Perennial grasses include Kentucky bluegrass (*Poa pratensis*), western wheatgrass (*Agropyron smithii*), and Japanese brome (*Bromus japonicus*), and forbs include common dandelion

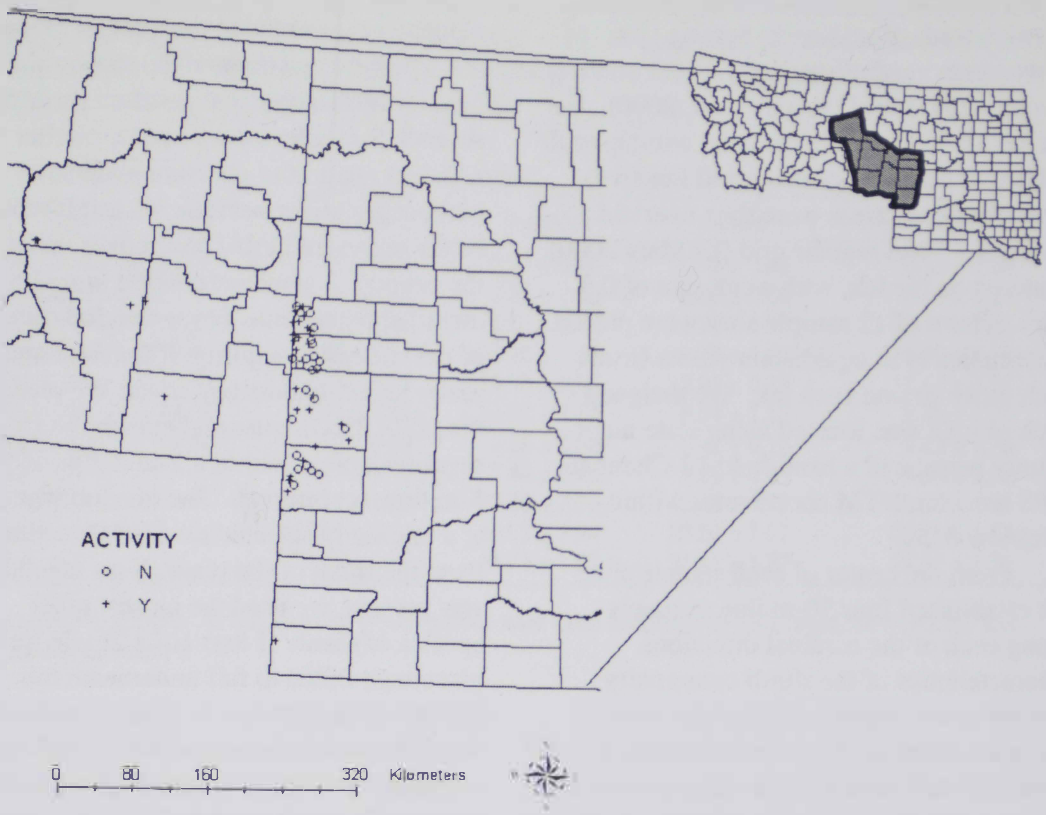

Figure 1. Approximate active and inactive lek locations used for microhabitat comparisons.

(*Taraxacum officinale*), common yarrow (*Achillea millefolium*) and cudweed sagewort (*Artemisia ludoviciana*). Agricultural lands included cash crops (corn, wheat, and alfalfa), tilled land, and open grassland.

Methods

Collecting microhabitat data

We sampled microhabitats during 14 May–27 June of 2001 and 2002 near sage grouse leks in North Dakota (n = 27), South Dakota (n = 22), and Montana (n = 5). Data were gathered from both active and inactive lek sites (Fig. 1). Connelly et al. (2000) defined an active lek as having >2 male sage grouse in >2 of the previous 5 years. We considered a lek inactive when it did not meet criteria for an active lek. An inactive lek may have at one time been active but was inactive at the time of the study (Smith et al. 2004). We received legal descriptions of lek locations, i.e., township, range, section, quarter-section, from North Dakota Game and Fish Department (NDGF), South Dakota Department of Game, Fish an d Parks (SDGFP), Montana Fish, Wildlife and Parks, and USDA Forest Service (USFS). Visits to each lek were made in the spring of 2001 and 2002 to assist NDGF, SDGFP, and USFS in determining activity and to get Universal Transverse Mercator (UTM) coordinates of the lek centers. Centers of the quarter sections were used as the proximal inactive lek centers. We then entered coordinates into a computer, referenced, and overlaid onto a map of western South Dakota, southwestern North Dakota, eastern Montana using the geographic information system (GIS) ArcView 3.2a (Environmental Systems Research Institute [ESRI], Inc. 1999). We buffered the center each lek using an area with a radius of 1.5 km to use as an indicator of habitat quality for microhabitat analysis. Aldridge (2000) found an average lek-to-nest distance of 4.7 km in Alberta. Wakkinen et al. (1992) found that 92 percent of nests in Idaho occurred <3 km from leks where females bred. Breeding to nesting site movements generally range 1.1–6.2 km but can be >20.0 km (Connelly et al. 2000). We used a 1.5-km buffer to prevent overlap with buffers of other leks (active and inactive). These buffered areas were then overlaid with a 3 x 3-km regular grid (DeMars 2000) centered on the lek, with a cell size of 0.5 km^2. A total of 12 sample sites were placed systematically at equidistant points from each other around each lek. We assigned each sample site, located using state maps, county maps, and a hand-held 12-Channel GPS receiver, UTM coordinates within ArcView 3.2a.

From the center of each sample site, we established four 50-m line transects along each of the cardinal directions. Characteristics of the shrub community canopy cover, density, and height, were recorded along each transect (Ellis et al. 1989). Total live and dead shrub cover was measured using the line-intercept method (Canfield 1941, Connelly et al. 1991, Higgins et al. 1996). We determined densities of sagebrush shrubs by species by walking along all transects with a 1-m stick centered horizontally and perpendicular to the tape, counting the numbers of individuals that had >50 percent of their canopy or the entire area of the trunk within the area covered by the meter stick and then calculating density/ m^2 for each species (Higgins et al. 1996). Height (cm) of shrubs by species and maximum effective height of grass were measured at 5-m intervals along each transect to obtain mean values (Connelly et al. 1991, Musil et al. 1994, Nelle et al. 2000). We measured grass height at 5-m intervals and the height of the closest each shrub of each species within a 2-m radius of the tape to prevent bias of measuring the tallest or shortest of each species.

Herbaceous cover was measured within a 20- x 50-cm quadrat (Daubenmire 1959, Higgins et al. 1996) along each transect at 5-m intervals. We placed the 20- x 50-cm quadrat with the 50-cm side perpendicular to the edge of the right side of the tape relative to the starting point. If a shrub obstructed placement , we placed the quadrat along the tape between the two closest shrubs next to the 5-m interval point on the tape. At each 5-m interval we used a smaller 10 x 25-cm quadrat to measure understory herbaceous cover because we felt it would better represent herbaceous cover under the canopy. A standard quadrat would have included herbaceous cover that fell outside of the canopy a majority of the time and not really reflect understory cover. We placed the 10- x 25-cm quadrat beneath the closest sagebrush plant within a 2-m radius of the 5-m transect interval. The quadrat was laid at a randomly selected cardinal direction from the trunk of the plant. If no sagebrush was present, we used the closest other species of shrub. If first 10- x 25-cm quadrat placement failed to fall underneath the canopy of the shrub or if quadrat placement was obstructed, the next counterclockwise cardinal direction was used to place the quadrat. For each quadrat (20- x 50-cm and 10- x 25-cm) we assigned the following variables to one of six cover classes based on ocular estimates (Daubenmire 1959): total grass cover, total forb cover, total bare ground, and total litter (dead vegetation that was disconnected or not standing, dead insects, and animal feces) were recorded for both understory and herbaceous cover (Nelle et al. 2000, J.W. Connelly, IDGF, pers. comm.). Average cover estimates of the 20- x 50-cm quadrats and 10- x 25-cm quadrats for each sample site were used in the analysis. Percent visual obstruction was measured using the staff-ball method (Collins and Becker 2001) in each quadrant defined by the intersection of transects. We measured visual obstruction readings 10 m from the intersection point and at a 45° angle. Percent visual obstruction was measured at heights of 0.10 m, 0.25 m, and 0.50 m.

Microhabitat characteristics related to lek activity

A multiple t-test with a Bonferroni correction was performed to compare habitat variables (SAS Institute 1999). We used the

Table 1. Habitat variables ($x \pm SE$) variables used for comparison between active and inactive sage grouse leks [Active - North Dakota: leks = 15, sample sites (n) = 180; South Dakota: leks = 12, sample sites (n) = 144] [Inactive - North Dakota: leks = 12, sample sites (n) = 144; South Dakota: leks = 10, sample sites (n) = 120].

Variable[a]	North Dakota		South Dakota	
	Active	Inactive	Active	Inactive
Sagebrush canopy cover (%)	2.99 ± 0.26	2.24 ± 0.24	3.02 ± 0.28	3.53 ± 0.36
Sagebrush density (/m²)	0.41 ± 0.03	0.35 ± 0.03	0.62 ± 0.06	0.66 ± 0.07
Big sagebrush height (cm)	20.95 ± 1.16	15.50 ± 1.29	21.26 ± 0.90	18.10 ± 1.21
Silver sagebrush height (cm)	23.00 ± 1.41	22.26 ± 1.58	8.60 ± 1.29	10.83 ± 1.59
Grass height (cm)	10.21 ± 0.38	10.70 ± 0.57	12.22 ± 0.33	12.47 ± 0.34
Visual obstruction 0.25 m (%)	8.93 ± 1.02	12.12 ± 1.62	8.94 ± 1.12	8.46 ± 1.21
Visual obstruction 0.50 m (%)	1.72 ± 0.34	2.23 ± 0.52	0.42 ± 0.15	0.63 ± 0.28
Forb cover (%)	7.96 ± 0.42	5.44 ± 0.48	7.26 ± 0.41	7.54 ± 0.45
Grass cover (%)	41.10 ± 1.80	44.90 ± 2.06	46.48 ± 1.62	53.25 ± 1.78
Bare ground cover (%)	24.93 ± 1.70	16.53 ± 1.94	23.89 ± 1.67	20.74 ± 1.83
Litter cover (%)	26.07 ± 1.60	25.71 ± 1.82	31.41 ± 1.37	29.82 ± 1.50

[a] Average cover reading for 40 Daubenmire (1959) frames were used to categorize forb, grass, bare ground, and litter cover for each sample site.

Bonferroni correction to correct for type I error by using a P-value adjustment for all main effect means that takes into account the raw P-value and number of comparisons. North and South Dakota were analyzed separately due to differing landscape features around lek sites and may include different breeding populations because the closest active leks were >20 km apart (Connelly et al. 2000). Comparisons were also made between moderately large leks, i.e., >40 males, in Montana and active leks in North Dakota and South Dakota that were smaller. Variables compared were deemed to be important to sage grouse lek occurrence and activity. We set statistical significance at $\alpha = 0.10$.

Results

Microhabitat characteristics related to lek activity

Microhabitat comparisons in relation to lek activity in North Dakota were performed using data from 180 sample sites around 15 active and 144 sample sites around 12 inactive leks. We performed microhabitat comparisons relative to lek activity in South Dakota using data from 144 sample sites around 12 active and 120 sample sites around 10 inactive sage grouse leks.

We calculated descriptive statistics for variables considered in lek activity analyses; sagebrush cover and sagebrush density were analyzed as a combination of both big and silver sagebrush (Table 1). We found greater big sagebrush height ($P < 0.05$) and greater forb cover and bare ground ($P < 0.01$) around active leks than around inactive leks in North Dakota (Table 2).

South Dakota comparisons showed that grass cover was higher ($P < 0.10$) around inactive leks (Table 2). None of the other variables differed ($P > 0.10$) between areas around active and inactive leks (Table 2).

Montana leks compared to leks in the Dakotas

We found greater sagebrush canopy cover and density, visual obstruction at 0.25-m height, and bare ground ($P < 0.0001$) around Montana active leks than around North Dakota active leks (Table 3). Height of silver sagebrush was considerably shorter ($P < 0.0001$) around Montana active leks than around North Dakota active leks (Table 3); however, forb cover and bare ground were greater ($P < 0.05$) around active leks in North Dakota. We found sagebrush greater canopy cover and density, visual obstruction at 0.25 m, and visual obstruction at 0.25 m and 0.50 m ($P < 0.10$) and greater height of

Table 2. Microhabitat comparisons of sample sites within 1.5 km of active versus inactive sage grouse leks. [North Dakota - active: leks = 15, sample sites (*n*) = 180; inactive: leks = 12, sample sites (*n*) = 144] [South Dakota - active: leks = 12, sample sites (*n*) = 144; inactive: leks = 10, sample sites (*n*) = 120].

	North Dakota				South Dakota			
Variables	Active	Inactive	Raw-P[a]	Bon[b]	Active	Inactive	Raw-P	Bon
Sagebrush canopy cover (%)	2.99	2.24	0.0398	0.4378	3.02	3.53	0.2574	1.0000
Sagebrush density (%)	0.41	0.35	0.1873	1.0000	0.62	0.66	0.6392	1.0000
Big sagebrush ht. (cm)	20.95	15.50	0.0019	0.0209	21.26	18.10	0.0248	0.2728
Silver sagebrush ht. (cm)	23.00	22.26	0.7247	1.0000	8.60	10.82	0.2734	1.0000
Grass ht. (cm)	10.21	10.70	0.4611	1.0000	12.22	12.47	0.5904	1.0000
Visual obstruction 0.25 m (%)	8.93	12.11	0.0856	0.9416	8.94	8.46	0.7704	1.0000
Visual obstruction 0.50 m (%)	1.72	2.23	0.3973	1.0000	0.42	0.63	0.4962	1.0000
Forb cover (%)	7.96	5.44	0.0001	0.0011	7.26	7.54	0.6476	1.0000
Grass cover (%)	41.10	44.09	0.1660	1.0000	46.48	53.25	0.0053	0.0583
Bare ground cover (%)	24.93	16.53	0.0013	0.0143	23.89	20.74	0.2050	1.0000
Litter cover (%)	26.07	25.71	0.8849	1.0000	31.41	29.82	0.4334	1.0000

[a] *P*-value not adjusted for number of comparisons.

[b] Bonferroni Correction *P*-value adjustment for all main effect means that takes into account the raw *P*-value and number of comparisons.

Table 3. Microhabitat comparisons of sample sites within 1.5 km of active sage grouse leks with >40 males in eastern Montana and active sage grouse leks in North Dakota. [Montana - leks = 5, sample sites (*n*) = 60; North Dakota - leks = 15, sample sites (*n*) = 180]

	Montana		North Dakota			
Variables	x	SE	x	SE	Raw-P[a]	Bon[b]
Sagebrush canopy cover (%)	9.25	1.10	2.99	0.26	<0.0001	<0.0001
Sagebrush density (%)	1.03	0.11	0.41	0.03	<0.0001	<0.0001
Big sagebrush ht. (cm)	25.93	1.17	20.95	1.16	0.0201	0.1324
Silver sagebrush ht. (cm)	7.13	1.82	23.00	1.41	<0.0001	<0.0001
Grass ht. (cm)	9.04	0.36	10.21	0.38	0.0934	0.4968
Visual obstruction 0.25 m (%)	24.04	3.14	8.93	1.02	<0.0001	<0.0001
Visual obstruction 0.50 m (%)	1.75	0.72	1.72	0.34	0.9693	1.0000
Forb cover (%)	5.48	0.34	7.96	0.44	0.0020	0.0220
Grass cover (%)	30.35	1.88	41.10	1.62	0.0003	0.0033
Bare ground cover (%)	59.12	2.45	24.93	1.76	<0.0001	<0.0001
Litter cover (%)	7.14	0.74	26.07	1.60	<0.0001	<0.0001

[a] *P*-value not adjusted for number of comparisons.

[b] Bonferroni Correction *P*-value adjustment for all main effect means that takes into account the raw *P*-value and number of comparisons.

big sagebrush ($P < 0.05$) around active leks in Montana than around active leks in South Dakota (Table 4). Grass height was less ($P < 0.0001$) around Montana active leks than around South Dakota active leks (Table 4). We found greater grass cover and litter cover ($P = <0.0001$) and less bare ground ($P = <0.0001$) around active leks in South Dakota around active leks in Montana.

Discussion

Leks provide key activity areas for sage grouse within spring and early summer habitat complexes. Other research has shown that sagebrush reduction adjacent to leks resulted in a decreased numbers of strutting males or caused complete abandonment of the lek (Enyeart 1956, Peterson 1970, Wallestad and Schladweiler 1974, Smith et al. 2005). Potential lek

Table 4. Microhabitat comparisons of sample sites within 1.5 km of active sage grouse leks with >40 males in eastern Montana and active sage grouse leks in South Dakota. [Montana - leks = 5, sample sites (n) = 60; South Dakota - leks = 12, sample sites (n) = 144]

Variables	Montana		South Dakota			
	x	SE	x	SE	Raw-P[a]	Bon[b]
Sagebrush canopy cover (%)	9.25	1.10	3.02	0.28	<0.0001	<0.0001
Sagebrush density (%)	1.03	0.11	0.62	0.06	0.0009	0.0060
Big sagebrush ht. (cm)	25.93	1.17	21.26	0.90	0.0037	0.0259
Silver sagebrush ht. (cm)	7.13	1.82	8.60	1.29	0.5263	0.9946
Grass ht. (cm)	9.04	0.36	12.22	0.33	<0.0001	<0.0001
Visual obstruction 0.25 m (%)	24.04	3.14	8.94	1.12	<0.0001	<0.0001
Visual obstruction 0.50 m (%)	1.75	0.72	0.42	0.15	0.0111	0.0753
Forb cover (%)	5.48	0.34	7.26	0.42	0.0302	0.3322
Grass cover (%)	30.35	1.88	46.48	1.51	<0.0001	<0.0001
Bare ground cover (%)	59.12	2.45	23.89	1.77	<0.0001	<0.0001
Litter Cover (%)	7.14	0.74	31.41	1.40	<0.0001	<0.0001

[a]*P*-value not adjusted for number of comparisons.

[b]Bonferroni Correction *P*-value adjustment for all main effect means that takes into account the raw *P*-value and number of comparisons.

habitat may not be limiting (Schroeder et al. 1999), and vegetation on active sites may not likely change rapidly or dramatically, except with tillage of the area, so as to exclude sage grouse from actual strutting areas or other alternate sites nearby. Therefore, abandonment of leks by male sage grouse may be related to female migration from these areas to areas with more desirable nesting habitat or to an increase in human disturbance in the proximate area of the lek site, e.g., installation of oil and natural gas near leks in North Dakota, or to an inadequate food supply within 1.5 km of the lek (Tate et al. 1979, Call and Maser 1985, Braun 1998). Presence of good nesting habitat around leks is important in order to attract females to the display ground. Fidelity of male sage grouse to leks is related to the previous years' territory establishment and reproductive success (Dunn and Braun 1985, Gibson 1992). In our study, sagebrush canopy cover did not differ around active and inactive leks within our 1.5-km buffers in South or North Dakota, which suggested that factors other than sagebrush canopy led to lek abandonment. Big sagebrush was taller around active leks than around inactive leks in North Dakota, which might suggest that areas around active leks provided better quality nesting sites (Connelly et al. 1991, Wallestad and Pyrah 1974, Aldridge and Brigham 2002), hence attracting females to these areas. The larger active leks in Montana also had taller and denser sagebrush than the Dakotas, which may result in more females in the area, increased male breeding success, and thus, larger male numbers on the lek. Retention or attraction of females would help keep males in the area and maintain active leks (Gibson 1992). Connelly et al. (1991) found higher nest success (53%) for sage grouse nesting under sagebrush than those that nested under other species of shrubs (22%). Conversely, Sveum et al. (1998) found no difference between nest success under sagebrush versus nest success under other species of shrubs, indicating that if adequate overall cover is present the species comprising the cover may be of minor importance as suggested by Aldridge and Brigham (2002).

We found no relationship between sagebrush cover and density, big sagebrush height, silver sagebrush height, grass height, visual obstruction 0.25 and 0.50 m and abandonment of leks in South Dakota, which indicated that other factors may be involved. Comparisons of forb, grass, bare ground, and litter cover in North Dakota revealed that forb cover was greater around active leks and may thereby have provided greater food availability for females or broods. The presence of forbs may nutritionally enhance female reproductive output and also increase densities of insects, a food source for newly hatched chicks (Barnett and Crawford 1994, Drut et al. 1994). Bare ground was greater around active leks in North Dakota, and bare ground was greater around the large Montana lek than around leks in both North and South Dakota; this may be related to greater shrub cover in these areas since shrubs may shade out grasses or compete for water (Peterson 1995). Sage grouse nesting sites in Washington were associated with high percentages of bare ground cover (Sveum et al. 1998).

Sagebrush canopy cover, density, and visual obstruction (0.25 m) were greater in Montana and might be important to support large, active leks. Sage grouse in the Dakotas seemingly rely upon taller and denser grass or forb cover to supplement canopy of the shorter and smaller sagebrush (Aldridge and Brigham 2002), and other shrub species such as silver sagebrush might play more of a role in survival. We would expect greater forb cover in North Dakota and greater grass cover in both South and North Dakota because the area lies at the eastern edge of the sagebrush distribution and functions as an ecotone between sagebrush and prairie. Sagebrush communities in the Dakotas also offer more mesic habitat compared to Montana. Herbaceous cover located within the 1.5-km buffer around active leks in the Dakotas apparently provided adequate nesting sites (Connelly et al. 2000) and daily use areas for female sage grouse (Musil et al. 1994); mean forb coverage ranged from 5 to 25 percent in North Dakota and South Dakota and mean grass coverage ranged from 26-50 percent in North Dakota and South Dakota.

Sagebrush cover (>28%) and height (>40 cm) in proximity to the lek are important to male sage grouse lek fidelity in the Great Basin area of the Western U. S. (Ellis et al. 1989). Successful nest areas located within big sagebrush/bunchgrass in south-central Washington during 1992-1993 had sagebrush cover of 19-23 percent, sagebrush height of 23-27 cm, and bare ground of 35-44 percent (Sveum et al. 1998). Other studies (Connelly et al. 2000) across the country have shown that sage grouse nest sites have mean sagebrush heights of 29-80 cm, mean sagebrush canopy coverages of 15-38 percent, mean grass heights of 14-30 cm, and mean grass coverages ~ 3-51 percent. Our study showed that in the big sagebrush-wheatgrass plains of the western Dakotas (Johnson and Larson 1999), sagebrush cover and density likely limit sage grouse success. When compared to larger active leks in Montana the Dakotas have significantly less sagebrush cover, and the cover that was present was not as dense. Mean sagebrush canopy coverage peripheral to active lek sites was 3.0 percent in North and South Dakota; mean big sagebrush height was 21.0 cm in North Dakota and 21.3 cm in South Dakota; and mean silver sagebrush height was 23.0 cm in North Dakota and 8.6 cm in South Dakota. These values were lower than those observed at successful nesting sites (Connelly et al. 2000) and daily use areas (Musil et al. 1994) in more central portions of the sage grouse range. However, preferred habitat may exist outside of this buffered area, or the sage grouse in the Dakotas have adapted to marginal sagebrush habitats with less than preferred cover as nesting sites. The adequate forb and grass cover in the Dakotas may provide means for greater reproductive success (Crawford 1977) and allow for sage grouse populations to exist in these marginal habitats.

Average movements of female sage grouse from breeding to nesting sites range from 1.1 to 6.2 km, and patchy distribution of sagebrush habitat in the Dakotas means it is probably not distributed uniformly in relation to the leks. This might suggest managing areas ≤5 km from all active leks (Connelly et al. 2000). Given the extensive movements and not knowing whether the population is migratory, evaluation of nesting in radio-marked female sage grouse in the Dakotas could provide valuable information on their movements from breeding areas, selection of nest site and brood rearing areas, and nesting and brood rearing success in this marginal sagebrush habitat. Possible use of silver sagebrush or other shrubs by sage grouse would also be of interest in regard to potential nest site resources in the Dakotas.

ACKNOWLEDGEMENTS

We thank the North Dakota Game and Fish Department, the South Dakota Department of Game, Fish and Parks, Montana Fish, Wildlife and Parks, and the USDA Forest Service for providing lek locations. We also appreciate the many landowners that provided access to their land. We would like to thank K. C. Jensen and G. E. Larson for reviewing our manuscript. We would also like to thank J. W. Connelly for visiting our study area and making suggestions on vegetation measurements. Funding for this project was provided by the SDGFP, Fish and Parks, Federal Aid to Wildlife Restoration Fund (Project W-107-R, Amendment #14, No. 1012); NDGF, Federal Aid to Wildlife Restoration Fund (Project W-67-R-40, No. B-V-4); USFS Agreement No. 00-CS-1102; and Bureau of Land Management Contract Agreement ESA000013 Task Order 1.

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Received 31 October 2005
Accepted 29 June 2006