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Response of a Sage Grouse Breeding Population to Fire in Southeastern Idaho

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Abstract Prescribed burning is a common method to eliminate sagebrush (*Artemisia* spp.) and has been suggested as a tool to enhance the habitat of sage grouse (*Centrocercus urophasianus*). Effects of this practice on sage grouse have not been evaluated rigorously. We studied effects of prescribed fire on lek (traditional breeding display areas) attendance by male sage grouse occupying low-precipitation (<26 cm) sagebrush habitats in southeastern Idaho from 1986 through 1994. During the preburn period (1986–89), average declines for male attendance were 48% and 46% for treatment and control leks, respectively. Lek counts were similar for treatment and control leks during the preburn years (*G*-test, $0.25>P>0.10$). During the postburn period (1990–94), male attendance at treatment leks declined 90% and control leks declined 63%. Although declines were similar between treatment and control leks during the preburn period, postburn declines were greater for treatment than control leks ($0.05<P<0.10$). We rejected the null hypothesis that for the 2 largest leks in both the treatment and control areas, counts were independent of years for preburn ($0.05<P<0.10$) and postburn ($P\lesssim0.05$) periods and concluded that breeding population declines became more severe in years following fire. Prescribed burning negatively affected sage grouse in southeastern Idaho and should not be used in low-precipitation sagebrush habitats occupied by breeding sage grouse.

Key words *Artemisia, Centrocercus urophasianus,* fire, habitat, lek, sagebrush, sage grouse

Prescribed burning of sagebrush (*Artemisia* spp.) communities is a common method to eliminate sagebrush on public lands (Braun 1987) due to its low cost and reduced environmental constraints. Fire has been suggested as a tool to enhance the habitat of sage grouse (*Centrocercus urophasianus*) (Klebenow 1972, Gates 1983, Sime 1991), but effects of the practice on this species have not been evaluated rigorously. Although much is known about the effects of chemical control of sagebrush on sage grouse populations (Enyeart 1956, Peterson 1970, Wallestad 1975), less is known about effects of fire (Fischer 1994). Moreover, no long-term studies (i.e., >5 years duration) have been conducted on effects of fire in sagebrush habitats on sage grouse.

We summarize results of a 9-year study on effects of prescribed fire on a breeding population of sage grouse in southeastern Idaho. We hypothesized that

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removing ≤60% of the sagebrush cover in a mosaic pattern by prescribed fire would have no effect on number of sage grouse leks or lek attendance and that changes in the breeding population in the burned area would be similar to those in a control area.

Study area

We conducted the study in the Big Desert on the upper Snake River Plain, approximately 60 km west of Blackfoot, Idaho. Topography was flat to gently rolling with frequent lava outcrops typical of the Columbia Plateau Province (Atwood 1970) and included an area of nearly 200,000 ha (United States Department of Interior 1981:37). Climate and vegetation were characteristic of the northern cold desert shrub biome (Atwood 1970). Temperatures at the Idaho National Engineering Laboratory, approximately 24 km north of the study area, ranged from -41° to 38°C, with a mean of 6°C. January was the coldest month, with temperatures averaging -9°C. Winter precipitation averaged 2.2 cm in December and decreased to an average of 1.5 cm in March. Annual precipitation averaged 23 cm, with 40% of the precipitation occurring in April through June (Yanskey et al. 1966). Elevation ranged from 1,536 m to 1,640 m, with adjacent mountains reaching 2,304 m.

Soils were derived primarily from silicic volcanic material and Paleozoic rocks (McBride et al. 1978). The surface soil was a light-colored silt loam over a weakly developed B horizon, which overlaid a strongly calcareous C horizon (Hironaka et al. 1983).

The area was a Wyoming big sagebrush (*A. tridentata wyomingensis*)-bluebunch wheatgrass (*Agropyron spicatum*) habitat type (Hironaka et al. 1983). Dominant shrubs included Wyoming big sagebrush and three-tip sagebrush (*A. tripartita*). Rabbitbrush (*Chrysothamnus* spp.) and gray horsebrush (*Tetradymia canescens*) also were common. The understory was mainly bluebunch wheatgrass with Sandberg bluegrass (*Poa sandbergii*), needle and thread grass (*Stipa comata*), and squirreltail (*Sitanion hystrix*). Within the north-central portion of the Big Desert, we selected a study area (containing treatment [area to be burned] and control sites) for intensive field work. The treatment and control sites were each about 5,000 ha and separated by 6 km. Sage grouse used these areas for winter, breeding, and early brood-rearing habitats, but migrated >15 km to summer range during late spring (Connelly et al. 1994, Fischer 1994).

Before the fire, the entire study area was dominated by Wyoming big sagebrush and three-tip sagebrush. Bluebunch wheatgrass and needle and thread grass were common (Connelly et al. 1994).

Methods

During spring (Mar-Apr), we conducted 5 lek routes within the study area and we censused 31 leks along these routes from 1986 through 1994. We surveyed routes at least 3 times each spring using established methods (Jenni and Hartzler 1978, Emmons and Braun 1984). We monitored lek use and attendance in treatment and control areas for 4 years prior to the burn (1986-89) and 5 years postburn (1990-94). The treatment area was burned in late summer 1989. The fire prescription specified removal of 60% of the sagebrush cover in an irregular pattern. Postburn measurements indicated that 57% of the sagebrush was removed (Connelly et al. 1994), providing a mosaic of sagebrush and grass cover types.

We identified 12 leks from 1986 through 1994 within and immediately adjacent to the treatment area and 21 leks in the control area. We classified leks as major (≥50 males attended at some point during the study), minor (11-49 males), and satellite (<11 males or the lek was active ≤3 years of the study). Before the fire (1986-89), the treatment area supported 12 active leks (2 major, 6 minor, 4 satellite), whereas the control area had 17 active leks (5 major, 10 minor, 2 satellite).

We conducted 2 lek routes in and immediately adjacent to the treatment area and 3 in the control area (Table 1). Each route contained 4-7 leks; however, we discarded data from 1 route in the control

Table 1. Maximum counts of male sage grouse on lek routes in the Big Desert of southeastern Idaho, 1986–94.

	Treatment		Control		
Year	Route 1	Route 2	Route 3[a]	Route 4[a]	Route 5
1986	155	105	NA	NA	237
1987	185	275	155	74	237
1988	137	129	166	40	249
1989	61	52	75	24	84
1990	92	54	96	15	100
1991	31	31	84	13	137
1992	47	11	66	6	57
1993	31	6	43	5	42
1994	22	29	53	1	45

[a] Not applicable; route initiated in 1987.

area (route 4) for the postburn period because grouse were harvested by Native Americans on at least 5 leks on this route during 1990-92.

We used a *G*-test (Sokal and Rohlf 1981) to examine effects of fire on numbers of males attending leks. We analyzed changes in lek attendance with a Kruskal-Wallis test (Sokal and Rohlf 1981) and evaluated the effect of fire on mean number of males/lek with a Mann-Whitney test (Zar 1984). Because of inherent variation in lek counts (Beck and Braun 1980), we considered differences significant if $P<0.10$.

Results

During the postburn period (1990-94), number of leks active for at least 2 of 5 years in the treatment area declined 58% to 5 leks. Number of control leks declined 35% to 11 leks during this period, including 4 new leks.

Sage grouse lek attendance declined on all lek routes during the study. Peak attendance in the treatment area occurred in 1987 and lows occurred in 1993 for route 2 and in 1994 for route 1 (Table 1). Declines during this period were 88% and 98% for treatment area routes 1 and 2, respectively. Peak attendance in the control area occurred in 1988 with lows in 1993 (Table 1). Declines during this period were 74% and 83% for control area routes 3 and 5, respectively.

Table 2. Changes in mean lek attendance for major leks in treatment and control areas in the Big Desert of southeastern Idaho, 1986–94[a].

Area	Preburn (1986–89)[b]	Postburn(1990–94)[c]
Treatment		
Big Lake	−0.40	−0.92
Quaking Aspen	−0.55	−0.87
Overall $\bar{x}$	−0.48	−0.90
Control		
Antelope Lake	−0.43	−0.47
Lava Bluff	−0.46	NC[d]
Osborne	−0.62	NC[d]
Prairie	−0.40	−0.63
Sunset Lake	−0.42	−0.79
Overall $\bar{x}$	−0.46	−0.63

[a] Values were calculated by examining change from the base (first year counted during each period) to the year with the least mean count during each period.

[b] No difference between areas.

[c] Changes differ between areas ($0.05<P<0.10$).

[d] Not calculated because of hunting by Native Americans.

Total counts of males along lek routes were influenced by attendance at major leks in treatment and control areas. Four of these leks had >100 males attending during at least 1 year. Therefore, we examined changes in mean lek attendance at major leks during preburn and postburn periods (Table 2). Average declines were 48% and 46% for the treatment and control leks, respectively, during the preburn period. During the postburn period, treatment leks declined 90% and control leks 63%. Declines were similar between treatment and control leks during the preburn period, but postburn declines were greater for treatment than control leks ($H=3.00$, 1 df, $0.05<P<0.10$). We also compared mean counts of males attending the 2 largest of these leks in each area for preburn and postburn years. Average annual attendance at treatment leks during 1987-89 was 67 males (SE = 18, Range = 31-86); attendance averaged 59 males (SE=8, Range = 43-70) for this same period in the control area (Table 3). We rejected the null hypothesis that lek counts were independent of years during the preburn period ($G=4.80$, 2 df, $0.05<P<0.10$). Average annual attendance at treatment leks from 1990 through 1994 was 22 males (SE=7, Range=8-48); attendance averaged 36 males (SE = 4, Range = 22-50) for this period in the control area. We again rejected the null hypothesis that during the postburn years counts were independent of years ($G=8.20$, 4 df, $P\leq 0.05$) and concluded that breeding population declines increased in severity following fire.

Table 3. Mean counts of males at the 2 largest leks occurring in the treatment and control areas in the Big Desert of southeastern Idaho, 1987-94.

	Treatment (range, SE)	Control (range, SE)
Preburn years[a]		
1987	85 (11–224,21)	70 (9–130,15)
1988	86 (27–127,11)	65 (4–126,14)
1989	31 (21–48,4)	43 (30–63,5)
$\bar{x}$	67 (11–224,12)	59 (4–130,11)
Postburn years[b]		
1990	48 (29–69,4)	50 (28–101,9)
1991	23 (0–42,6)	38 (22–62,7)
1992	18 (7–31,4)	35 (24–43,3)
1993	8 (0–12,2)	22 (15–26,1)
1994	15 (4–29,4)	34 (22–47,4)
$\bar{x}$	22 (0–69,4)	36 (15–101,5)

[a] Mean counts differ between areas ($0.05<P<0.10$).

[b] Mean counts differ between areas ($P<0.05$).

Male sage grouse captured on lek.

During the preburn period, mean number of grouse/lek (including all leks identified in the study area) ranged from 9 to 41 birds ($\chi^2=26$, SE=7, $n=12$) in the treatment area and from 18 to 46 birds ($\chi^2=36$, SE=9, $n=17$) in the control area. Number of grouse/lek during the preburn period did not differ among years in treatment and control areas ($U=9.00, P>0.10$). For the postburn period, mean number of grouse/lek ranged from 2 to 12 birds in the treatment area ($\chi^2=6$, SE=2, $n=5$) and 9 to 29 birds in the control area ($\chi^2=17$, SE=4, $n=11$). Mean number of grouse/lek varied ($U=23.00$, $P=0.05$) among years during the postburn period.

Discussion

Lek counts reflected a decline in number of sage grouse within the study area throughout the study, coinciding with a range-wide sage grouse population decline (Connelly and Braun 1997). The overall decrease in the Big Desert population was most likely attributable to drought (Fischer 1994, Connelly and Braun 1997) and may have somewhat masked the effects of fire on sage grouse. During our study, we commonly observed sage grouse leks that were disturbed by predators, people other than research personnel, and hunting by Native Americans. Because grouse on leks may be disturbed easily, there is a relatively great variability associated with lek counts (Beck and Braun 1980). Consequently, analyses of lek data may be confounded by numerous variables that increase difficulty of measuring the effect of an environmental perturbation on the breeding population. Neither Martin (1990) nor Bensen et al. (1991) detected a fire effect on lek attendance by male sage grouse. Similarly, Fischer (1994) could not detect a difference in lek attendance patterns attributable to fire during his study. However, an additional year of data on lek attendance within Fischer's (1994) study area and further analysis of lek data indicated fire influenced negatively the breeding population in the treatment area.

The negative effects of fire on the sage grouse breeding population in the treatment area are supported by 4 findings. First, the treatment area had a greater loss of leks (-58%) than the control area (-35%). Second, changes in attendance at major leks by males were similar in the treatment and control areas during the preburn period, but the treatment area had a greater decline in attendance (-90%) than the control area (-63%) during the postburn period. Third, average lek attendance at the 2 largest leks in both areas was greater in the treatment (67 males) than the control (59 males) area during the preburn period. However, the situation reversed during the postburn period and average attendance at the 2 treatment leks (22 males) was less than average attendance at the control leks (36 males). Finally, mean number of male sage grouse/lek was similar in treatment and control areas during the preburn period, but less in the treatment (6 males) than the control area (17 males) during the postburn period.

Connelly et al. (1981) indicated that sage grouse on the Big Desert will readily use disturbed sites for leks. The prescribed burn created numerous openings in the sagebrush, but no new leks formed, likely because of low breeding populations. The only indication we had that breeding birds would use burned areas for leks was the shifting of some males from a lek on a landing strip to a burned area about 200 m east of the landing strip.

We collected our data under a pseudoreplicated design (1 treatment, 1 control). True replication was not possible for this study because we investigated

Grouse on lek, Big Desert, Idaho.

a migratory sage grouse population that ranged annually over several thousand square kilometers (Connelly et al. 1994, Fischer et al. 1997). Additional prescribed burns would have occurred in different precipitation zones, habitats, or sage grouse breeding populations. Thus, our findings should be viewed with caution. Although true replication was not possible for our field study, data on fire and sage grouse populations have been compiled on a landscape basis for portions of the upper Snake River Plain north and east of our study area and support our findings (Crowley and Connelly 1996). In these other areas, incidence of fire has increased by >2,000% between 1959 and 1989 and sage grouse breeding populations have declined substantially (Crowley and Connelly 1996).

Prescribed fire, Big Desert, Idaho, 1989.

Our findings are applicable to habitats dominated by Wyoming big sagebrush in low-precipitation zones. However, effects of fire on sage grouse populations using more mesic areas or different species or subspecies of sagebrush may be different than those we documented.

Management implications

Although some investigators did not document a negative response by breeding sage grouse to fire (Martin 1990, Benson et al. 1991, Fischer 1994), research has documented clearly the adverse consequences of chemical and mechanical sagebrush removal on breeding sage grouse. Higby (1969), Peterson (1970), and Wallestad (1975) indicated that applying herbicide to sagebrush stands adjacent to leks caused declines in male lek attendance. Similarly, Swensen et al. (1987) reported a 73% decline in overall lek attendance by male sage grouse in an area where sagebrush surrounding leks was removed by plowing.

Sage grouse breeding habitat in southeastern Idaho that burned in August 1989.

Regardless of the method used to eliminate or reduce sagebrush cover in sage grouse breeding habitat, these actions have the potential to reduce breeding populations of grouse. Moreover, sagebrush reduction programs may exacerbate the negative effects of natural phenomena such as drought, causing extreme declines in sage grouse populations.

The ecological condition of many western sagebrush rangelands has been degraded for several reasons (Drut 1994), and many of these areas no longer provide suitable breeding habitat for sage grouse. In some instances, especially where the herbaceous understory is depleted badly or junipers (*Juniperus* spp.) have invaded, fire may be used to improve ecological condition of a site. If fire is used in this manner, the treatment should be designed to preserve sage grouse winter habitat and allow rapid recolonization of the burned area by sagebrush.

Our work does not support using fire to improve rangelands that provide satisfactory sage grouse habitat. Burning this habitat likely has a detrimental effect on sage grouse populations and areas affected by prescribed burns may burn again because of wildfire. During late summer 1996, a wildfire of about 80,000 ha burned the entire control area and part of the treatment area within our study site (J.W. Connelly, unpublished data). Hence, we urge natural resource managers to refrain from burning in low precipitation (<26 cm) sagebrush habitats that are used by breeding sage grouse.

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