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SAGE GROUSE FLOCK CHARACTERISTICS AND HABITAT SELECTION IN WINTER¹

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Abstract: Sage grouse (Centrocercus urophasianus) were studied in North Park, Colorado, during the winters of 1973–74 and 1974–75. Distribution was plotted from sightings of 199 flocks and 17 single birds, totaling 5,080 grouse. Only 50 percent of the 1,252 km² of lands dominated by sagebrush (Artemisia spp.) sustained winter use by grouse because of snow depth, steepness of slope, and sagebrush disturbance. Nearly 80 percent of the use occurred in 7 areas comprising less than 7 percent of the total area. Sexes segregated; males formed more unisexual flocks. Flocks were the dominant social unit and contained less than 50 individuals in 88 percent of all observations. Flocks containing more than 50 percent females were larger than male flocks and used denser sagebrush stands for feeding and loafing. Roosting and feeding sites had similar vegetal and physical characteristics. Sixty-six percent of flocks were on slopes less than 5 percent, and only 13 percent were on slopes greater than 10 percent. Sixty-two percent of 2,350 grouse in 1973–74 and 61 percent of 1,984 grouse in 1974–75 were females.

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Sage grouse inhabit semiarid Western ranges dominated by sagebrush and subdominant grass types with interspersed native and cultivated hay meadows. As a result of agricultural demands, livestock grazing, and encroachment of man-related developments, there has been a continued destruction of sage grouse habitat since early settlement. During the 1960's sagebrush removal by use of herbicides progressed at a rate that was alarming to most state wildlife agencies.

In 1963 the Colorado Division of Wildlife, in cooperation with the U.S. Bureau of Land Management, initiated a long-term study in North Park, Colorado, to document the effects of 2,4-D spraying of sagebrush on sage grouse abundance and distribution. Even though changes in sage grouse abundance and distribution due to habitat changes are likely to occur during a time of limited habitat, i.e., winter, little scientific effort has been directed toward winter ecology of sage grouse. Sage grouse are totally dependent upon sagebrush for food and cover during the winter months (Griner 1939, Patterson 1952:203, Wallestad et al. 1975), a dependence that places stress on grouse populations in areas where large blocks of sagebrush have been disturbed. Eng and Schladweiler (1972) studied radiomarked females in central Montana and noted short movements and the use of dense stands of sagebrush on level terrain. Ihli et al. (1973), in a descriptive study of sage grouse flocks wintering in central Idaho, reported strong sex segregation with feeding concentrated on windblown ridges and in dense stands of sagebrush on broad plains. Other references to sage grouse in winter have been general observations concerning movements and flock composition (Bailey 1925, Griner 1939, Patterson 1952, Dalke et al. 1963). As part of the long-term investigation, this study of the winter ecology of sage grouse was conducted during the winters of 1973-74 and 1974-75.

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STUDY AREA

North Park, the northernmost of Colorado's four large intermontane parks, is entirely within Jackson County. Elevation of most of the sagebrush is between 2,400 and 2,585 m with surrounding mountain ranges rising steeply to 3,850 m. Geology of the park has been described in detail (Beekly 1915, Finch 1957). The many streams meandering through the park are the headwaters of the North Platte River. Over 1,870 km² of sage grouse habitat lie within North Park, of which 1,252 km² are dominated by sagebrush with the remainder being irrigated meadows of native sedges and grasses. Meadows border all major streams on low alluvial flood plains up to 1 km wide. Five species of sagebrush dominate, with Artemisia tridentata vaseyana dominating 90 percent of the sagebrush lands within the park. Artemisia longiloba, A. cana, A. argilosa, and A. nova are dominant on selected areas (Smith 1966:57). Other important shrubs are greasewood (Sarcobatus vermiculatus), rabbitbrush (Chrysothamnus spp.), willow (Salix spp.), and bitterbrush (Purshia tridentata). Herbaceous vegetation consists primarily of cespitose perennial forbs and bunchgrasses.

The climate is characterized by low precipitation and low temperatures. Weather data from Walden (north-central Jackson County, elevation 2,492 m) indicate mean annual precipitation of 23.2 cm, mean annual daily temperature of 3.2 C, and mean annual frost-free period of 46 days (Smith 1966:41). Climatic conditions during winter (December–February) vary considerably north and south of Owl and Peterson Ridges, which rise 62–154 m above the surrounding terrain. Winter precipitation north of these ridges is normally 45 percent of that in the south. Winter precipitation usually accounts for 15 and 23 percent of the yearly precipitation in the north and south areas, respectively. Most of the north area is usually snow-free by mid-March except following frequent snowstorms during March, April, and May.

METHODS

Winter observations were conducted from 8 January to 8 March 1974 and from 24 December 1974 to 1 March 1975. Distribution of grouse was investigated by searching all probable use areas equally. Areas were considered potentially usable if any sagebrush was visible. Four-wheel drive trucks, snowmobiles, and snowshoes were utilized in searching the sagebrush lands.

Once grouse were located, they were first observed through 7×50 binoculars to obtain a total count and sex composition (after Patterson 1952:7) of the flock. Attempts to observe colored leg bands were made with 15-60 power telescopes. Records were kept of both sight observations and grouse sign (tracks, droppings, roosts). A flock was any group of two or more birds in close proximity to each other. Individuals were often scattered from 10-200 m apart, so flock integrity was decided by the observer rather than by assigning specific association distances. Flocks comprised of greater than 50 percent of one sex were referred to as female or male flocks, depending upon which sex predominated.

Physical and vegetal characteristics recorded at each site where birds were observed were aspect, slope, snow depth and condition, sagebrush density, crown breadth, and height of sagebrush above snow. All site data were obtained after the flock had left the site of its own volition. Slope and aspect were measured with an Abney level and compass. Snow condition

was rated as crusted, powder, or melting. Sagebrush density was measured as number of plants protruding above snow per circular 0.004 ha plot. Crown breadth was calculated as the mean of 10 representative shrubs in the plot. Height of sagebrush above snow was calculated as the mean of three selected representative shrubs. Weather conditions were recorded during all observations.

Movement data were obtained from observations of birds banded with colored bandettes coded to capture locations. The map distance from capture site to observation site was determined, thus all movements are an index to minimum distance traveled. Banding was conducted during the springs of 1973, 1974, and 1975 as part of a long-term study following procedures described by Gill (1965:25-40). The maximum possible number of banded birds present in the winter of 1973-74 was 268 (166 males, 102 females), and in 1974-75, 289 (186 males, 103 females). These figures represent the number of birds banded in preceding years less natural mortality, assumed to be 50 percent, and hunting losses. Statistical comparisons were made with the Mann-Whitney U test and the *t*-test.

RESULTS

Winter Distribution

During the 1973–74 winter field period, 129 flocks and 10 single birds totaling 2,753 grouse were observed, whereas 2,327 birds, consisting of 70 flocks and 7 single birds, were sighted in the same period in 1974–75. Plotting of flock locations indicated three major areas where no flocks were observed, seven areas of high use, and scattered observations in the remaining sagebrush areas.

One-half (50.1%) of the sagebrush dominated lands in North Park were not utilized by sage grouse during the two winters of this study. The largest area of no observed use was that portion of the park south of Owl and Peterson Ridges amounting to 36.0 percent (446 km²) of the sagebrush lands. During the 2-year period only 1 flock observation was made in this area, probably as a result of extensive snow cover and little exposed sagebrush. The Canadian River area in the northeast corner of the park encompassed 9.1 percent (114 km²) of the sagebrush lands, and although ample sagebrush was available no grouse were observed. The remaining area of no observed use was the broken ridges south of Independence Mountain along the north boundary of the park, encompassing 5.0 percent (63 km^2) of the sagebrush lands. Extensive stands of tall, dense sagebrush on relatively steep slopes were common in this area.

The 7 areas of high use comprised 6.8 percent (85 km^2) of the sagebrush lands in North Park. These locations were not searched more frequently than less productive sites, thus eliminating the bias of implied heavy use due to high frequency of search time. Nearly 80 percent of all grouse observed in 1973-74 and slightly over 50 percent of those observed in 1974-75 were located within the 7 major use areas (Table 1). Flocks of grouse were mobile and could not be located consistently at the same site. On 14 occasions, flocks that were flushed flew 13 km or more until out of view. Size of flocks located in successive days at the same site varied considerably indicating that either particular flocks did not have stable membership or several flocks were using the same areas sporadically. Eng and Schladweiler (1972) reported that flocks with marked birds exhibited marked fluctuations in size. Daily patterns of feeding activity were not apparent and feeding occurred during all weather conditions, even blizzards. Grouse generally flew to roost sites after complete

		No. flocks	observed	Total no. birds observed		
Area	(km ²)	1973-74	1974-75	1973-74	1974-75	
1	7.8	14	0	114	0	
2	16.9	16	1	214	60	
3	7.8	19	1	223	11	
4	14.3	8	10	179	448	
5	26.6	19	8	866	521	
6	9.1	13	6	371	152	
7	2.6	7	0	213	0	
Totals	85.1	96	26	2,180	1,192	
% of all	observations	5 74.4	37.1	79.2	51.2	

Table 1. Areas utilized by wintering sage grouse, North Park, Colorado 1973-74 and 1974-75.

darkness. Of 26 flocks observed until complete darkness, 18 did not roost within 250 m of their last observed position.

Only 4 flocks were observed in areas where sagebrush was noticeably altered, although at least 32.0 percent (401 km²) of the sagebrush lands in North Park had been disturbed by 2,4-D spraying, plowing and seeding, and burning since 1957. Three male flocks were observed in a crested wheatgrass (Agropyron cristatum) field planted in 1962. Snow depth was less than 2 cm and exposed young sagebrush plants were common. The other flock comprised of 2 males and 1 female was also in a crested wheatgrass field but snow depth was 15 cm and the nearest visible sagebrush was 40 m distant.

Flock Composition and Size

Approximately 85 percent of all grouse observed in each winter were classified as

Table 3. Number of sage grouse observed as singles and flocks, North Park, Colorado, 1973-74 and 1974-75.

	No. of birds in unit					
	1	2-25	26-50	51-100	>100	
No. encounters % total encounters	17 7.9	$\begin{array}{c} 153 \\ 70.8 \end{array}$	21 9.7	16 7.4	9 4.2	
observed	0 .3	32.5	14.5	22.0	30.7	

to sex (2,350 birds [85.4%] in 1973–74 and 1,984 [84.3%] in 1974–75). Sex ratios were 62 females:38 males (1973–74) and 61 females:39 males (1974–75).

Strong segregation by sex was evident (Table 2). Seventy-two percent of all flocks dominated by males contained no females, but only 40 percent of the female flocks contained no males. Only one flock, containing six birds, had equal numbers of males and females.

The flock was the prevalent social unit of sage grouse in North Park (Table 3). Most flocks (88%) contained 50 or fewer individuals; average flock sizes were 12.2 (s.e. =1.5) and 21.2 (s.e.=4.2) for males and 29.2 (s.e.=7.0) and 48.1 (s.e.=10.5) for females in 1973–74 and 1974–75, respectively. Differences between average flock size for males and females were significant in each winter (t-test, $P \leq 0.05$). Increase in size between years (1973–74 vs. 1974–75) was significant (t-test, $P \leq 0.05$) for male but not for female flocks. Means do not describe the distribution of flock size accu-

Table 2. Sex composition of winter flocks of sage grouse, North Park, Colorado, 1973-74 and 1974-75.ª

	% dominant sex in flock							
	Female				Male			
Flock size	100	90-99	70-89	51-69	100	90-99	70-89	51-69
2-29	29	6	12	8	65	6	12	4
30-49	2	4	2	2				1
50-74		2	2		2	2		2
75–99		1	2		1			
>100	1	2	5	1				
Total	32	15	23	11	68	8	12	7
% of all flocks	18.2	8.5	13.1	6.2	38.6	4.5	6.8	4.0

^a Excluding 1 flock of 50:50 males and females.





Fig. 1. Aspect and percent slope of sites utilized by flocks of male sage grouse in winter. Each concentric circle represents 5 percent slope with the center representing zero slope.

Fig. 2. Aspect and percent slope of sites utilized by flocks of female sage grouse in winter. Each concentric circle represents 5 percent slope with the center representing zero slope.

rately, because females had a greater tendency to form large flocks (>100) than did males (Table 2). Median size for male flocks was 10.0 in 1973-74 and 15.5 in 1974-75; corresponding values for females were 15.0 and 20.5, indicating more similarity in flock size than was evident from comparisons of mean values. Based on ranking tests, females were significantly more likely (U test, $P \leq 0.05$) to be found in larger flocks than males during both winters. Both males and females were significantly more likely (*U* test, $P \leq 0.05$) to be found in larger flocks in 1974-75 than in 1973-74. Overall, females consistently formed larger flocks than males, often of great size (>100). No patterns in flock size variation and frequency of sighting were detected within either winter.

Characteristics of Winter Use Sites

Flocks were typically located on south- to west-facing slopes of less than 5 percent gradient (Figs. 1, 2). The mean gradient for areas used by 74 female flocks was 4.9 and for 82 male flocks was 6.0. Sixty-six percent of the use sites were on slopes less than 5 percent, whereas only 13 percent were on slopes greater than 10 percent. On areas with slopes greater than 5 percent, 66.7 percent of female and 93.1 percent of male flocks were observed on west-, southwest-, south-, or southeast-facing slopes. The use of southwest exposures was likely a reflection of the impact of drifting snow on available sagebrush. The predominantly southwest wind served to drift snow onto northeast exposures covering much, if not all, of the sagebrush. Wind action kept many ridgetops and southwest exposures free of snow, thus providing suitable foraging areas even when height of the sagebrush was less than 10 cm.

Mean sagebrush density, mean height of sagebrush above snow, mean crown

	19	73–74	1974-75		
	Male	Female	Male	Female	
Sample size	58	42	22	29	
Sagebrush density (plants/0.004 ha)	46.0(3.7) ^b	$68.2^{\circ}(6.1)$	63.7(8.0)	77.5(5.5)	
Height of sagebrush above snow (cm)	19.9(1.3)	23.9(1.9)	29.6(3.5)	35.6(3.4)	
Crown breadth (cm)	37.6(2.2)	43.9(2.6)	40.8(3.0)	44.4(2.7)	
Cover index (ht. × density)	991(114.3)	1,700° (219.4)	2,048(338.1)	2,906(345.8)	

Table 4. Vegetal characteristics of sage grouse winter use sites, North Park, Colorado, 1973-74 and 1974-75.

^a Significant difference between sexes during a year, t-test, $P \leq 0.05$.

^b Standard deviation of mean in parentheses.

breadth, and mean cover index (height \times density) were used in comparing sites utilized by male and female flocks (Table 4). Females were significantly more likely (U test, $P \leq 0.05$) to use denser stands of sagebrush than males during both winters. Both male and female flocks were significantly more likely (U test, P=0.05) to use denser stands of sagebrush in 1974-75 than the preceding winter. This was likely a reflection of less snow in the northern portion of North Park in the latter year (2.7 vs. 4.5 cm). Many shrubs that normally would have been snow covered were exposed in the mild winter of 1974-75, thus density and height increases between years were a reflection of weather conditions rather than bird selectivity. No significant differences $(P \ge 0.05)$ were detected between vegetal characteristics of the seven high use areas and other sites used.

Twenty-six of the 199 flock locations were used as roosting sites, the remainder being feeding-loafing sites. No significant differences ($P \ge 0.05$) were detected in vegetation or physical parameters between roosting and feeding-loafing sites. Eng and Schladweiler (1972) similarly reported that canopy coverage was similar for feeding and roosting sites in Montana. Roosting depressions in the snow occurred at 13 of the 26 sites. Depressions to depths of 30 cm were observed, although most were 5–15 cm deep. Occurrence of depressions was not related to snow condition or temperature. On only one occasion did all birds in a flock (13 males) roost in depressions. Roost sites were difficult to locate.

Movements

Average distance traveled from spring banding sites by males was 10.8 km (N =51) in 1973–74 and 5.3 km (N = 17) in 1974–75. Corresponding values for females were 19.2 km (N = 5) and 15.8 km (N =5). Shorter distances traveled in 1974-75 probably resulted from the milder winter (Table 5). Direction of movement corresponded strongly with directions of the main winter use areas from banding sites, primarily leks in the northwest quarter of the park. Analysis of observations of banded males indicated that males banded on a particular lek did not associate with males only from that lek. Of 23 observed flocks with 2 or more banded males, 19 had males from different leks. Two flocks of 13 and 20 males each had 6 banded males representing 5 different leks. These data support the concept that sage grouse in North Park should be managed as one population.

Predation

Only 1 predator attack was witnessed during 838 hours of observations during

the 2 winters. The attack by a golden eagle (Aquila chrysaetos) on a female grouse in flight was unsuccessful. Three golden eagles were observed feeding on a fresh carcass of an immature male grouse, but cause of death was not known. No other grouse carcasses or remains were found. Golden eagles, coyotes (Canis latrans), and red foxes (*Vulpes vulpes*) were common on the study area. On 5 occasions sage grouse were observed feeding within 150 m of a perched eagle. The grouse were typically aware of the eagles but did not appear to be alarmed. In these five situations, grouse stopped feeding and looked toward the eagle but did not flush when it flew.

DISCUSSION

Distribution of sage grouse in North Park during winter was primarily a reflection of availability of sagebrush above snow, slope, and aspect. Snowfall was sufficient to cover nearly all sagebrush on level and moderate slopes in the southern portion of the park, even during the mild winter of 1974–75. Although sage grouse are capable of scratching into crusted snow to depths of 30 cm, areas without protruding sagebrush offered little cover and no indication of a food supply.

In the northern portion of the park sagebrush was completely snow covered in 1973–74 more than during the mild winter of 1974–75. Foraging areas were larger and grouse were less concentrated than in the preceding winter. In 1973–74 snowfall was 26 percent greater than the 30-year average, consequently the high use areas probably contained the last remaining suitable habitat. Snowfall in 1974–75 was 26 percent below the 30-year average, and only 3 of the 7 high use localities in 1973–74 received similar use. It would appear that winter use areas were determined by amount of snow rather than affinity for a particular site.

Although snow cover was a major factor in determining areas used, slope and aspect further restricted amount of suitable habitat for sage grouse. In North Park, grouse selected sagebrush on southwest exposures and flat to gentle slopes. Sagebrush on slopes greater than 15 percent was rarely used although such areas were present, especially along the northern boundary of the park and along Owl and Peterson Ridges. Eng and Schladweiler (1972) also reported avoidance of steep slopes in winter by sage grouse in central Montana. Avoidance of steep slopes may be an adaptation against avian predation, because golden eagles commonly were seen hunting along ridge crests, then plummeting down the slope in apparent attempts to flush and capture prey. The adaptive force of golden eagles on sage grouse during spring mating activities was deemed of major significance by Hartzler (1974).

The strong sexual segregation observed in sage grouse in winter was as great or greater than that reported for other grouse species (Koskimies 1957, Seiskari 1962, Weeden 1964, Braun and Schmidt 1971). Complete segregation was greater in male than female flocks. Although mechanisms of segregation are not understood completely, mixed flocks of predominantly females may result from immature males flocking with sibling groups and successful nesting hens in fall. Most unisexual male flocks probably form during the immediate post-strutting period, while hens are nesting.

Sex segregation in capercaillie (*Tetrao* urogallus) and black grouse (*Lyrurus te*trix) was accompanied by differential habitat utilization but not large spatial separation (Koskimies 1957, Seiskari 1962). Both spatial and habitat separation were reported for the sexually segregated white-tailed ptarmigan (*Lagopus leucurus*) (Braun and Schmidt 1971), rock ptarmigan (*L. mu*-

Year		Distance traveled (km)								
	0–5	5.1-10	10.1–15	15.1-20	20.1-30	>30	Mean	Standard error		
1973-74	13	10	20	9	4	1	11.6	1.4		
1974–75	10	6	3	1	2	0	7.9	1.5		

Table 5. Distribution of minimum distances traveled from spring to winter by sage grouse banded in North Park, Colorado, 1973-74 and 1974-75.

tus), and willow ptarmigan (L. lagopus) (Weeden 1964). Spatial separation was not observed in sage grouse; the only observed habitat difference was sagebrush density, and females used denser stands. Sage grouse winter flocking behavior, as well as breeding behavior, more closely resembles those characteristics of the capercaillie and black grouse than of ptarmigan.

Increases in flock size of both sexes between 1973-74 and 1974-75 probably were due to excellent production in the summer of 1974 (Braun and Beck 1975, unpub. rep., Colorado Div. Wildl.) and the mild winter of 1974-75 that resulted in more available sagebrush. Although fewer flocks were seen in 1974-75, nearly as many birds were seen suggesting that birds may respond to severe winter conditions by grouping into smaller flocks. Koskimies (1957) suggested that capercaillie and black grouse formed smaller flocks during short periods of severe winter weather and then formed large flocks again as milder conditions ensued. A similar situation appears to exist with sage grouse in North Park. The rationale is that with more snow, sagebrush stands are smaller in area and thus more suitable for small flocks than large ones.

Sage grouse researchers long have noted a disparity in harvest sex ratios favoring females and have expressed great concern over the assumed over-harvest of females (Pyrah 1963, P-R Job Compl. Rep., Proj. W-125-R, Idaho Dept. Fish & Game). The pooled harvest sex ratio for adults (including yearlings) in North Park for the years 1955–74 was 64 females:36 males, quite similar to the 62:38 and 61:39 ratios observed during the winters of 1973–74 and 1974–75. This suggests that harvest ratios favoring females are merely reflective of population ratios and that females have a higher survival rate than males.

Understanding of seasonal ranges is critical for proper management of sage grouse. Great emphasis has been placed on locating leks and protecting surrounding areas from sagebrush control practices. Protection of the sagebrush surrounding a lek for a 3.2km distance (Wallestad and Pyrah 1974) would have had little benefit for wintering sage grouse in North Park, for only 40 and 34 percent of all winter observations in 1973–74 and 1974–75 were within this area. Movements away from leks were greater in the more severe winter of 1973-74 (Table 5), and no more than 28 percent of the marked birds observed were within 3.2 km of the lek upon which they were banded. Additionally, nearly 10 percent were observed within 3.2 km of a lek other than the site of capture. Protection of sagebrush around leks alone would not satisfy seasonal needs of sage grouse in North Park. Sagebrush control historically has been directed toward dense stands on flat to gentle slopes. Such areas provide the core of sage grouse winter habitat in North Park and probably other localities in western North America. Regeneration of disturbed sagebrush ranges is slow, and the lack of observations of sage grouse in such areas in North Park indicates that grouse select against such sites during

the winter. It is obvious that perpetuation and enhancement of sage grouse populations entail the identification, protection, and possibly improvement of all seasonal habitats necessary for the life processes of this unique grouse. Disturbances of sage grouse habitat in identified winter use areas should be avoided or kept to a minimum.

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