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Jennifer H. Boisvert
University of Idaho, Moscow, Idaho

Richard W. Hoffman
Colorado Division of Wildlife, Fort Collins, Colorado

Kerry P. Reese
University of Idaho, Moscow, Idaho

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HOME RANGE AND SEASONAL MOVEMENTS OF COLUMBIAN SHARP-TAILED GROUSE ASSOCIATED WITH CONSERVATION RESERVE PROGRAM AND MINE RECLAMATION

Jennifer H. Boisvert[1,3], Richard W. Hoffman[2,4], and Kerry P. Reese[1]

ABSTRACT.—During 1999 and 2000 we trapped and radio-marked 156 Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*) on leks in Conservation Reserve Program (CRP, $n = 73$) and mine reclamation (MR, $n = 83$) lands in northwestern Colorado. Median spring–fall home range sizes using the 95% fixed kernal and minimum convex polygon estimators for 54 grouse were 86 ha and 61 ha, respectively. Median fixed kernal home range size did not differ between males (79 ha) and females (87 ha). Home ranges of grouse associated with CRP (112 ha) were larger than those of grouse in MR (75 ha). Directional orientation of movements from leks of capture to wintering areas was nonrandom, and there was a positive elevation gain (median = 102 m) associated with these movements. Movements did not differ between grouse captured in CRP and MR for any season but did differ between genders for the spring–fall period. Males exhibited stronger fidelity and less variation in their movements than females; 96% of males compared with only 77% of females remained within 2.0 km of their lek of capture from spring through fall. Ninety percent of females nested within 2.5 km of their lek of capture. During winter all grouse were found farther (median = 21.5 km) from lek sites than in any other season. Males remained on the breeding range longer in the fall and returned earlier in the spring than females even though they wintered similar distances away (median males = 21.5 km, median females = 21.4 km). Our findings support the 2.0-km radius used in the Habitat Suitability Index model for Columbian Sharp-tailed Grouse to assess nest and brood-rearing cover around leks, but not the 6.5-km radius used to evaluate winter cover.

Key words: Columbian Sharp-tailed Grouse, home range, seasonal movements, Conservation Reserve Program, mine reclamation, Tympanuchus phasianellus columbianus, *Colorado.*

Columbian Sharp-tailed Grouse inhabit seasonally distinct vegetation types, using grassland and shrub-steppe communities during spring, summer, and fall, and tall deciduous riparian and mountain shrub cover types during winter (Giesen and Connelly 1993). Movements within and between seasonally occupied habitats vary depending on the quality and juxtaposition of these habitats (Meints et al. 1992). Available information suggests that most grouse remain within 2.0 km of the lek where they were captured from spring through fall and within 6.5 km of the lek during winter (Marks and Marks 1987, Meints 1991, Ulliman 1995, Giesen 1997, Apa 1998, McDonald 1998). Meints et al. (1992) used these figures as the basis for developing the Habitat Suitability Index (HSI) model for Columbian Sharp-tailed Grouse.

More recently, Columbian Sharp-tailed Grouse have been documented using nonnative habitats, such as Conservaton Reserve Program (CRP) and mine reclamation (MR) lands, for breeding, nesting, and brood-rearing (Meints 1991, Sirotnak et al. 1991, Apa 1998, McDonald 1998, Boisvert 2002). In northwestern Colorado, 44% of 133 active leks surveyed between 1997 and 2000 were located on CRP (26%) or MR (18%) lands (Hoffman 2001). While others have attempted to document movements of Sharp-tailed Grouse in relation to leks located in CRP (Meints 1991, Apa 1998, McDonald 1998), their results were based on small samples of radio-marked grouse that were often biased toward one sex. There have been no published studies of seasonal movements of Sharp-tailed Grouse attending leks in MR lands. This information is necessary for describing habitat use patterns, implementing meaningful management practices, and evaluating the impacts of land use changes around these nontraditional lek sites. It is also important to

[1]Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83844-1136.
[2]Colorado Division of Wildlife, 317 West Prospect Road, Fort Collins, CO 80526.
[3]Present address: ABR, Inc., Box 240268, Anchorage, AK 99524.
[4]Corresponding author.

know whether the distances used to develop the HSI model apply to leks in CRP and MR lands.

We monitored seasonal movements of Columbian Sharp-tailed Grouse associated with CRP and MR lands in northwestern Colorado during 1999 and 2000 in conjunction with investigations of habitat use, productivity, and survival (Boisvert 2002). Here we report spring–fall home range sizes, distances traveled in relation to leks of capture, and elevation changes and directional orientation of movements from breeding to wintering areas. We tested the hypotheses that home range and distances traveled did not differ between genders or between grouse captured in CRP and those captured in MR. We also address timing of movements, fidelity to lek sites, and gender segregation. In addition, we define appropriate buffer sizes around lek sites that can be used for assessing habitat use and suitability, and for directing management of Columbian Sharp-tailed Grouse populations using nonnative habitats such as CRP and MR.

STUDY AREA

Our study was conducted in Routt and Moffat Counties in northwestern Colorado (40°22′N, 107°05′W) within the Upper Yampa River watershed. Boundaries of the 276,602-ha study area were delineated based on maximum movements of grouse from their leks of capture. However, trapping and most fieldwork during the spring–fall period were confined to a 20,215-ha region known as Twentymile Park, located 28 km southwest of Steamboat Springs in Routt County. The Twentymile Park area is a mosaic of shrub-steppe, upland shrub, and well-established CRP (627 ha) and MR (2513 ha) lands in close proximity to each other (Boisvert 2002).

Average annual precipitation ranges from <26 cm near Craig in Moffat County to >127 cm at Steamboat Springs in Routt County. During this study mean annual precipitation was 51 cm and mean monthly temperature was 5°C (range = –8° to +20°C); snow depth was ≥3 cm for over 100 days during winter and averaged 53 cm.

The area is topographically diverse with elevations and slopes ranging from 2000 m to 2600 m and 0° to 60°, respectively. Vegetation types in the area are equally diverse due to variations in topography, soils, moisture conditions, elevation, and aspect. The natural transition is from big sagebrush (*Artemisia tridentata*) at the lower elevations to shrub-steppe, upland shrub, quaking aspen (*Populus tremuloides*), mixed conifer/aspen, and finally to conifer at the highest elevations. The extensive deciduous shrub component dominated by Saskatoon serviceberry (*Amelanchier alnifolia*) interspersed with sagebrush, native grasslands, CRP, MR, aspen, and agricultural lands provides optimal habitat for Columbian Sharp-tailed Grouse. Land ownership is mostly (>70%) private. Livestock grazing and coal mining are the primary land uses, with some irrigated hay, alfalfa (*Medicago sativa*), and dryland wheat (*Triticum* spp.) farming.

METHODS

Grouse were captured using walk-in funnel traps placed on the leks (Schroeder and Braun 1991). During 1999 we trapped and radio-marked 50 grouse (23 females, 27 males) on 8 leks in MR and 35 grouse (22 females, 13 males) on 4 leks in CRP. During 2000 our numbers were 34 grouse (22 females, 12 males) on 7 leks in MR and 37 grouse (25 females, 12 males) on 5 leks in CRP. The radio-transmitters weighed <15 g and were attached with an elastic necklace. Captured birds were banded with a serially numbered aluminum leg band (size 12), classified to gender using crown and tail feather characteristics (Henderson et al. 1967), and aged based on the shape and wear of the 2 distal primaries (Ammann 1944). Two age classes were recognized for analyses: subadults (≤12 months) and adults (>12 months). Eighteen subadult females and only 2 subadult males were captured over the 2-year period. Thus, comparisons between age classes were based only on females. Trapping and handling protocols used in this study were conducted under the approval of the Colorado Division of Wildlife and University of Idaho Animal Care and Use Committees.

Monitoring began 7–10 days post-capture at which time we flushed each bird to ensure they were still alive and had adjusted to the transmitter. All radio-marked grouse were subsequently located twice per week during spring and summer, once every 2 weeks during fall, and at least once per month during winter. All grouse were located from the ground using the loudest signal method (Springer 1979). Aerial searches were used on 5 occasions to find missing grouse, which were subsequently located from the ground. The grouse were approached and circled within 20 m to avoid flushing them and to minimize location error. We obtained approximate Universal Transverse Mercator (UTM) coordinates of grouse locations by triangulating 3–4 GPS readings using a handheld GPS unit as we circled each bird. The GPS unit was also used to determine the elevation where the grouse was located and the direction and distance to its lek of capture. Most locations (68%) were obtained between 0930 and 1700 hours, whereas 21% of the locations were collected before 0930 and 11% after 1700.

Nest sites were found by monitoring females 2–3 times per week until they initiated incubation. When 2 subsequent observations of a female were made at the same location, we assumed she was nesting. We then circled the suspected nest site at a radius of 5–10 m to obtain an accurate location without flushing the female. We recorded the UTM coordinates, distance, and compass direction to the nest from an inconspicuously flagged location 7–10 m from the nest. We continued to monitor the site until the eggs hatched or the signal indicated the female was no longer present on the nest. At this time we obtained the exact UTM coordinates for the nest site and determined the distance to the lek of capture using the GPS unit.

We defined 5 seasons of use: breeding, nesting, brood-rearing, summer–fall, and winter. Seasons of use were defined based on changes in weather conditions and changes in behavior, movements, and habitat use patterns for each individual grouse. Thus, seasons of use differed between years because of variations in weather conditions from one year to the next and overlapped within years because of behavioral differences among individual grouse. The breeding season ranged from 24 April (earliest location of radio-marked grouse) to 29 May 1999, and from 22 March to 31 May 2000, and included all locations of males and females during the lekking period until they no longer consistently attended the lek (males) or initiated incubation (females). The nesting season ranged from 19 May to 8 July 1999, and from 7 May to 14 July 2000, and encompassed the period when females were incubating eggs. The brood-rearing season extended from 16 June to 1 September 1999, and from 8 June to 2 September 2000, and included all locations of successful females (hatched ≥1 egg) from the time they left the nest until brood breakup. There were no distinct changes in behavior, movements, or habitat use patterns of grouse between summer and fall seasons. Consequently, these seasons were combined into a single period (summer–fall) that ranged from 2 June to 19 November 1999, and from 16 May to 9 November 2000. This period included all locations of males after they stopped attending leks until they departed the breeding range. It also included all locations of females that hatched no eggs or lost their brood from the time they abandoned the nest or were no longer accompanied by chicks until they departed the breeding range. These females are hereafter referred to as unsuccessful females. The winter period extended from 20 November 1999 to 4 April 2000, and from 10 November 2000 until the study ended on 31 January 2001. The onset of this period was marked by obvious movements of grouse away from the CRP, MR, grassland, and shrub-steppe communities on the breeding range to upland shrub cover types on the winter range and concluded with initiation of movements back to breeding areas.

We estimated home range sizes with a 95% fixed-kernal (FK) estimator (Worton 1989), using least squares cross-validation to choose kernal band widths. We also estimated home range sizes using the Minimum Convex Polygon method (MCP; Mohr 1947) for comparison with other studies. All home ranges were calculated using the Spatial Animal Movement extension (Hooge and Eichenlaub 1997) in ArcView 3.2 (ESRI 1999). We included all grouse with a minimum of 19 locations (range 19–57) during the spring–fall period in the estimation and analysis of home ranges. Winter locations were not included in the home range estimate because the grouse used distinctly different areas and cover types during winter (Boisvert 2002). Although we monitored the grouse during winter, we did not collect enough locations to delineate their winter home range due to difficulties in regularly accessing the birds in remote areas. Likewise, we did not collect enough locations to separately delineate home ranges for breeding, brood-rearing, and summer–fall periods. We compared

TABLE 1. Spring–fall home range estimates (ha) of Columbian Sharp-tailed Grouse associated with Conservation Reserve Program (CRP) and mine reclamation (MR) lands in northwestern Colorado, 1999–2000. Estimates are based on ≥19 locations per grouse.

		95% fixed-kernal			Minimum convex polygon		
Category	*n*	Median	Mean	Range	Median	Mean	Range
Male	18	79	120	39–642	61	81	28–438
Female	36	87	170	37–777	60	108	19–581
CRP	20	112	186	39–642	64	98	19–304
MR	34	75	134	37–777	59	91	20–581
All Grouse	54	86	153	37–777	61	99	19–581

home range sizes based on age (females only), gender, and breeding habitat (CRP or MR).

Multiple locations within seasons were used to calculate movements of individual grouse from their lek of capture during breeding, summer–fall, and winter seasons, and from their nest site to brood-rearing areas. Only 1 location corresponding to the nest site was used to calculate the distance from the lek of capture for the nesting season. We first calculated mean and median movements for individual grouse for each season, excluding the nesting season. We then derived overall mean and median movements for each season from mean and median movements of the individual grouse. For the nesting season, mean and median movements were calculated from a single estimate for each female that nested. Movements were categorized by (1) gender, breeding habitat (CRP and MR), gender within breeding habitat, and age (females only) for the breeding and summer–fall periods; (2) breeding habitat and age for the nesting and brood-rearing periods; and (3) gender and breeding habitat for the winter period.

We made all statistical comparisons with multiresponse permutation procedures (MRPP; Mielke and Berry 2001) conducted in the program BLOSSOM (Cade and Richards 2000). We report the standardized test statistic as *T*. We compared elevation change between breeding and wintering areas and differences between FK and MCP home range estimators by using the MRPP test for matched pairs. The permutation version of Rao's spacing test (Rao 1976) was used to test for nonrandom directional orientation of movements from leks of capture to wintering areas. For comparisons of movements and home range sizes by gender, age, and breeding habitat, we used the MRPP version of the median test. Significance for all tests was set at 0.05.

RESULTS

Home range size did not differ between year, gender, or age class ($P = 0.382–0.784$); thus, data were pooled by gender and age for both years. The 95% median FK spring–fall home range size estimated for 54 grouse was 86 ha (Table 1). Median home range size of grouse captured in CRP (112 ha) was larger than for grouse captured in MR (75 ha), but the difference was not statistically significant ($T = -1.407$, $P = 0.085$). Although some home range estimates were extremely large (range = 37–777 ha), most grouse (72%) occupied home ranges that were <75 ha. The MCP home range estimate was 61 ha, which was smaller ($T = -18.913$, $P < 0.001$) than the 95% FK estimate for the same 54 grouse (Table 1).

Columbian Sharp-tailed Grouse occupied 2 distinct ranges corresponding to the spring–fall and winter periods. Analysis of 1775 telemetry locations collected during the spring–fall period indicated 85% were within 2.0 km of the lek of capture (Fig. 1). In comparison, all ($n = 100$) winter locations were >3.0 km from the lek of capture (Fig. 1). Directional orientation of movements from lek of capture to wintering areas was nonrandom ($T = 3.757$, $P < 0.001$), with 16 of 30 (53%) grouse moving WSW (254°) to WNW (299°). There was a significant positive elevation gain ($T = -17.415$, $P < 0.001$) associated with all movements to wintering areas. The median elevation change between spring–fall (2076–2280 m) and wintering (2202–2593 m) areas was 102 m (range 5–383 m).

Within breeding habitat types, movements of grouse from their leks of capture did not

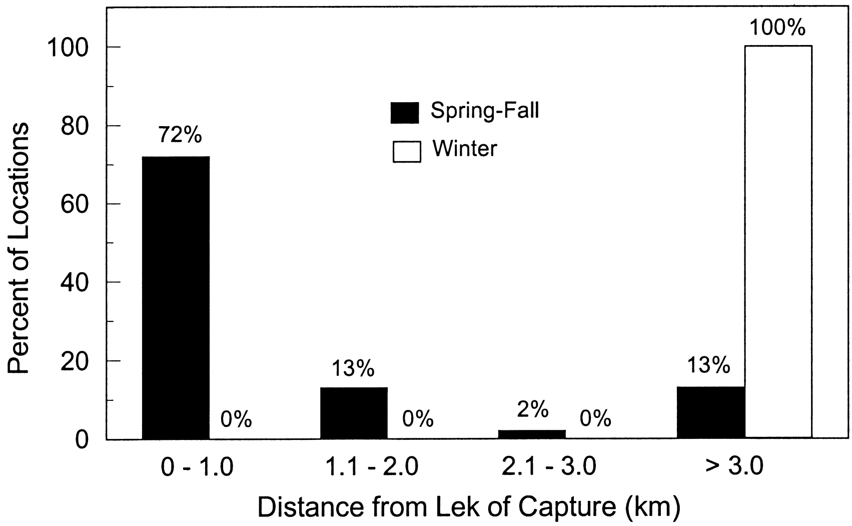

Fig. 1. Distribution of Columbian Sharp-tailed Grouse telemetry locations from leks of capture for the spring–fall (n = 1775 locations) and winter (n = 100 locations) periods, northwestern Colorado, 1999–2000.

differ between years within seasons for either gender or any age category (P = 0.071–1.000). Therefore, data were pooled by gender and age for both years within seasons.

During the breeding season, males and females captured in CRP moved similar distances compared with their counterparts captured in MR (males: T = 0.444, P = 0.545; females: T = 0.673, P = 0.805; Table 2). Although both sexes remained relatively close to their lek of capture during the breeding season, males moved significantly shorter distances (T = –11.958, P < 0.001) and exhibited less variation in their movements than females (Table 2). No males ventured >1.3 km from their lek of capture during the breeding season. In comparison, 78% of the females remained within 1.3 km of their lek of capture during the breeding season, and 85% remained within 2.5 km. We found no difference (T = 0.655, P = 0.734) in movements of adult and subadult females during the breeding season (Table 2).

Fifty (86%) of 58 females located on nests were found within 2.0 km of their lek of capture and 52 (90%) nested within 2.5 km. We detected no differences in movements to nest sites between adult and subadult females (T = 0.689, P = 0.766) or between CRP and MR females (T = 0.617, P = 0.709). The median distance moved to nest sites for all females was 0.63 km (Table 2).

Most females (96%) raised their broods within 1.4 km of where they nested. The single exception was a subadult female that moved her brood 2.28 km from the nest during brood-rearing. Despite this longer movement, adult and subadult females raised their broods within similar (T = 0.739, P = 0.807) distances of their nest sites (Table 2). Again, there was no difference (T = –1.082, P = 0.122) in movements between CRP and MR females during the brood-rearing season. The median distance that females moved from their nest during the brood-rearing season was 0.40 km (Table 2).

Males continued to show fidelity to their lek site throughout the summer–fall period with 91% found within 1.5 km and 96% within 2.0 km of their lek of capture. This applied to both CRP and MR males, with no difference (T = 0.689, P = 0.800) detected in their summer–fall movements (Table 2). The only male found >2.0 km from its lek during the summer–fall period ventured 4.28 km during midsummer, but returned to within 500 m of the lek in the fall.

Unsuccessful females moved significantly farther (T = –6.504, P < 0.001) from their lek of capture than males during the summer–fall period (Table 2). However, 77% still remained within 2.0 km of their lek. There was no difference in movements between age classes (T = 0.579, P = 0.655) or between unsuccessful

TABLE 2. Seasonal movements (km) of Columbian Sharp-tailed Grouse from leks of capture in Conservation Reserve Program (CRP) and mine reclamation (MR) lands to breeding, nesting, summer–fall, and winter use areas, and from nest sites to brood-rearing areas in northwestern Colorado, 1999–2000.

Category	*n*	Median	Mean	Range
BREEDING AREA				
CRP Male	18	0.32	0.38	0.07–1.23
CRP Female	36	0.60	1.21	0.21–7.68
MR Male	24	0.36	0.44	0.08–1.27
MR Female	36	0.64	1.47	0.13–10.10
Adult Female	61	0.63	1.18	0.13–7.68
Subadult Female	11	0.56	2.20	0.20–10.10
All Males	42	0.32	0.41	0.07–1.27
All Females	72	0.63	1.34	0.13–10.10
NEST SITE				
CRP Female	22	0.65	1.46	0.09–8.17
MR Female	36	0.62	1.21	0.12–11.30
Adult Female	49	0.63	1.15	0.09–8.17
Subadult Female	9	0.47	2.16	0.12–11.30
All Females	58	0.63	1.30	0.09–11.30
BROOD-REARING AREA				
CRP Female	5	0.48	0.53	0.30–0.81
MR Female	20	0.38	0.53	0.10–2.28
Adult Female	19	0.40	0.44	0.10–1.19
Subadult Female	6	0.55	0.81	0.28–2.28
All Females	25	0.40	0.53	0.10–2.28
SUMMER–FALL AREA				
CRP Male	11	0.40	0.77	0.21–4.28
CRP Female	13	0.85	2.29	0.22–7.50
MR Male	12	0.38	0.52	0.27–1.53
MR Female	28	0.82	1.41	0.25–10.27
Adult Female	34	0.82	1.39	0.22–7.50
Subadult Female	7	0.89	3.18	0.25–10.27
All Males	23	0.40	0.64	0.21–4.28
All Females	41	0.84	1.69	0.22–10.27
WINTER AREA				
All Males	13	21.50	20.01	4.18–36.50
All Females	17	21.40	22.14	3.14–41.50
CRP Grouse	5	21.50	23.65	3.14–36.50
MR Grouse	25	21.40	20.73	4.18–41.50
All Grouse	30	21.50	21.30	3.14–41.50

females from CRP and MR ($T = 0.586$, $P = 0.668$) during the summer–fall period (Table 2).

Males and females were found farther from lek sites during winter than during any other season of the year (Table 2). The closest any grouse was located to its lek of capture during winter was 3.14 km; 87% of the radio-marked grouse wintered >10.0 km (median = 21.50 km) from where they were trapped. Although movements to wintering areas were highly variable (Table 2), there were no differences between males and females ($T = 0.718$, $P = 0.868$) or between grouse from CRP and those from MR ($T = 0.675$, $P = 0.727$). We did not test for differences between age classes of females due to small sample sizes of subadult females ($n = 3$).

In 1999 all grouse remained on the breeding range until 14 November but moved to wintering areas by 28 December. During fall 2000, movements away from the breeding range were documented as early as 25 October, and most birds (84%) moved to wintering areas by mid-November. In both years females left the breeding range before males. Grouse remained on the winter range through mid- to late March. No radio-marked grouse were observed in the same flock during winter, but in 6 instances 2 or more grouse were found wintering in the same general area <1 km apart. Males returned to the breeding range 22–28 March, whereas the females returned 11–17 April. Although few grouse (6 males, 10 females) trapped on leks in the spring survived the entire study period, those that did were all relocated on or near the leks where they were captured. In addition, 4 grouse monitored both winters used the same wintering area, and 6 females monitored through 2 consecutive nesting seasons nested within 250 m of their previous year's nests.

DISCUSSION

We found no published studies that report home range sizes for Sharp-tailed Grouse associated with CRP or MR lands. Our spring–fall home range estimates, however, were smaller than estimates reported for Columbian Sharp-tailed Grouse occupying native habitats. Using the MCP method, Marks and Marks (1987) and Giesen (1997) calculated mean spring–fall home range sizes of 110 ha and 187 ha, respectively, for Columbian Sharp-tailed Grouse occupying native habitats in northwestern Colorado and western Idaho.

Our results compare favorably with other descriptions of seasonal movements of Columbian Sharp-tailed Grouse in native and nonnative habitats (Marks and Marks 1987, Meints 1991, Giesen 1997, McDonald 1998). Median spring–fall movements from leks of capture for all grouse in our study were ≤1.6 km. Seasonal movements did not differ between grouse from CRP and those from MR but did differ between gender. Approximately 85% of the grouse monitored in this study remained within 2.0 km of their lek of capture throughout the spring–fall period; however, males clearly displayed a stronger fidelity to lek sites than females.

Most females (86%) in our study were able to find suitable nest sites within 2.0 km of their lek of capture whether they were trapped on CRP or MR leks. Successful females subsequently raised their broods in close proximity (<1.4 km) to where they nested, suggesting they selected nest sites within or near suitable brood-rearing habitat. Giesen (1997) reported that 92% of the females he monitored in native habitats nested within 2.0 km (median = 1.4 km) of their lek of capture. Similarly, Meints (1991), Apa (1998), and McDonald (1998) all reported average movements to nests of <2.0 km.

Despite similarities between our findings and those of other studies, we documented some atypical movements. Previously, the longest movement to a nest site reported in the literature was 7.04 km (McDonald 1998). Nine females in our study moved >7.0 km from their lek of capture to nest. We excluded the movements of 2 of these females because we had evidence they were nonresident females trapped while moving through the area from winter ranges. One female moved 23.1 km and the other moved 9.5 km from where they were trapped. Both females were adults trapped early in the breeding season, and both localized their movements and nested within 1.0 km of other known leks. Neither female returned the following year to the CRP lek where it was captured; instead, both returned to the vicinity of the leks where they nested the previous year. Four of the remaining 7 females moving >7 km were adults. We are uncertain if they also were nonresident females because we were unable to monitor them through 2 consecutive breeding seasons to confirm their status. Therefore, they were included in the analyses.

Giesen and Connelly (1993:327) stated, "Columbian Sharp-tailed Grouse seem to move farther to wintering habitats in regions lacking a broad distribution of winter food resources." Results from other studies (Ulliman 1995, McDonald 1998), including ours, contradict this statement. Northwestern Colorado has not suffered from the large-scale habitat conversions that have taken place in many other regions within the range of Columbian Sharp-tailed Grouse (McDonald and Reese 1998, Schroeder et al. 2000, Hoffman 2001). Consequently, the landscapes, particularly the upland shrub and aspen cover types used for winter habitat (Boisvert 2002), have remained intact, comprising >25% of available cover types in this region (Hoffman 2001). Additionally, these cover types occur in abundance within 2 km of all leks trapped in this study, and we frequently observed unmarked grouse using these areas during winter. Yet, the closest any grouse wintered to its lek of capture was 3.14 km, the median distance being 21.50 km, and the longest movement 41.50 km. Before our study the longest movement documented to a wintering area was approximately 20 km (Meints 1991).

Our findings do not support the hypothesis proposed by Ulliman (1995:92) that the reason grouse do not use the closest suitable winter habitat is that females move farther to avoid harassment and competition for food with males on winter habitats near leks. Not only did males and females move similar distances in our study, but they also were found in similar geographic locations. The only difference we noted in their movement patterns was the timing. Males remained on the breeding range longer and returned earlier than females. Other investigators, in addition to Ulliman (1995), have reported longer movements by females to wintering areas (Giesen 1997, McDonald 1998). However, results of these studies were based on small samples of grouse trapped from few leks.

One reason grouse may disperse throughout the available winter range is to reduce their vulnerability to predators. During winter grouse feed in the upper branches of deciduous shrubs, such as serviceberry, where they are exposed and possibly more susceptible to avian predation. Large concentrations of grouse in this situation may attract predators and increase their mortality rates. Conversely, if they are dispersed over a broad range of suitable habitats, their chances of survival are greater. However, for this to be true, the survival advantage gained by this behavior must outweigh the increased risk of moving long distances. According to Hamerstrom and Hamerstrom (1951), large-scale movements were historically common for Plains (*T. p. jamesi*) and Prairie (*T. p. campestris*) Sharp-tailed Grouse under pristine conditions. Thus, longer movements should not be interpreted as indicative of areas having low suitability for Sharp-tailed Grouse.

Another reason for longer movements may be the lack of quality breeding, nesting, and brood-rearing areas in northwestern Colorado. The introduction of CRP and MR lands into the northwestern Colorado landscape may be partially compensating for degradation and loss of native grassland and shrub-steppe cover types used for breeding, nesting, and brood-rearing. However, CRP and MR lands account for only about 4% of available cover types within the occupied range of Columbian Sharp-tailed Grouse in northwestern Colorado (Hoffman 2001). Sharp-tailed Grouse apparently will move longer distances to use this limited resource. Columbian Sharp-tailed Grouse breeding in shrub-steppe habitats in Colorado (Giesen 1997) and Idaho (Marks and Marks 1987) moved shorter distances to wintering areas than what we documented for grouse breeding in CRP and MR.

MANAGEMENT IMPLICATIONS

Our findings suggest that the 2.0-km radius used in the Columbian Sharp-tailed Grouse HSI model (Meints et al. 1992) for assessing nest/brood cover around leks is biologically relevant when applied to grouse breeding in MR and CRP. However, the 6.5-km radius used for assessing winter cover (i.e., shrub-dominated cover types) may be less relevant for grouse in Colorado. This does not mean that shrub-dominated cover types near leks in MR and CRP are not important, because they are (Boisvert 2002), but their value as winter habitat may not be as critical as the model implies. Where cover types used during winter are abundant, but not necessarily in close proximity to quality breeding, nesting, and brood-rearing areas, the radius could be increased to 10 km or even 15 km.

Our findings also have implications in evaluating and selecting sites for the translocation of Columbian Sharp-tailed Grouse. In the past the availability of suitable winter cover within 6.5 km was an important factor in the selection of release sites. However, Gardner (1997) found that by moving the release site farther from aspen and tall shrub-dominated cover types that support higher densities of nesting raptors, the post-release survival of transplanted birds was enhanced. Ideally, releases should be made within 6.5 km of suitable winter habitat; however, we believe successful releases into quality nesting and brood-rearing habitats can be made 10–20 km from abundant winter cover.

In searching for grouse during winter, we discovered that large expanses of the upland shrub and aspen cover types were not inhabited by grouse. We consistently found grouse in the same areas each winter. Topographically, areas used by grouse during winter tended to be on north slopes with deep, soft snow. These slopes were near or along ridge tops rather than on side slopes or in draws. The few grouse that we monitored both winters returned to the sites they used the previous winter. Also, grouse captured in 2000 moved to the same general wintering areas as grouse captured in 1999. Finally, although suitable winter habitat occurred in all directions from the breeding range, the majority of grouse moved WSW to

WNW. These observations suggest that grouse may use traditional wintering areas. Thus, additional studies are needed to ascertain why grouse used these specific areas during winter when other areas closer to the leks appeared equally suitable. Meanwhile, efforts should be made to identify and protect areas where Columbian Sharp-tailed Grouse are known to winter.

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