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SAGE GROUSE ON THE IDAHO NATIONAL ENVIRONMENTAL
RESEARCH PARK

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ABSTRACT

A comprehensive study of sage grouse (Centrocercus urophasianus) ecology was conducted on the Idaho National Engineering Laboratory (INEL) site between June 1977 and May 1981. Sage grouse used lawns surrounding INEL facilities for feeding and loafing throughout the summer. Mean summer home range was 406 ha for adult female sage grouse and 94 ha for juveniles. Radionuclide concentrations in grouse summering near a liquid radioactive waste disposal area (N=29) were significantly higher than those in grouse summering near a solid radioactive waste disposal area (N=14) or control areas (N=20).

Sage grouse moved from 2 to 83 km during seasonal migration. Fall movements from INEL facilities to winter range were slow and meandering. Spring movements of females from leks to summer range were also slow and meandering but male movements appeared rapid and direct.

Sage grouse remained in segregated flocks during early summer but the number of mixed sex flocks increased in late summer. Sage grouse occurred in segregated flocks throughout the winter. Both flock type and habitat influenced winter sage grouse flock size. Mean flock size remained relatively constant as winter weather became more severe. Agricultural areas were an important component of sage grouse summer range and were preferred by all sage grouse sex and age classes. Sage grouse winter range was generally characterized by sagebrush stands with 11 to 30% canopy coverage.

INTRODUCTION

Sage grouse dependence on sagebrush (Artemisia spp.) has been well documented (Patterson, 1952; Klebenow, 1969, 1970; Eng and Schladweiler, 1972; Wallestad, 1975; Beck, 1977). Unfortunately, over 2 million ha of western rangeland have experienced some form of sagebrush control during the past 40 years (Braun et al., 1977). To fully understand the impact of habitat loss on sage grouse, it is necessary to first understand sage grouse seasonal habitat use and movements.

The Idaho National Engineering Laboratory (INEL) is located in southeastern Idaho and was designated a National Environmental Research Park in 1975. Because of relatively unaltered habitat in most areas of the INEL, and its inaccessibility to the general public, a unique opportunity is available to study sage grouse in a relatively natural environment and in areas altered by man. The purposes of this paper are to present a summary of: 1) movements and radionuclide concentrations of sage grouse summering near INEL nuclear facilities; and 2) sage grouse seasonal movements, flocking characteristics and habitat use. Additional information on this study has been published (Connelly, 1982; Connelly et al., 1981; Connelly and Markham, 1983) or will be published later.

STUDY AREA AND METHODS

Radionuclide Concentrations

During summers, sage grouse were studied near 3 INEL facilities and in 2 off-site areas. The Central Facilities Area (CFA) and the Test Reactor Area/Idaho Chemical Processing Plant Complex (TRA/ICPP) are located in the south-central portion of the INEL site along the Big Lost River. TRA and ICPP were grouped because grouse moved between these facilities. Both areas contain irrigated lawns, abundant forbs, and sources of free water. Additionally, TRA contains a leaching pond complex that has been used for the disposal of low-level, liquid radioactive waste since 1952 (Halford and Markham 1978). TRA is an advanced nuclear materials testing complex, and the ICPP recovers uranium from spent nuclear fuels and processes radioactive liquid waste into noncorrosive solid form. CFA contains various support services for the INEL and is not a nuclear facility. The Radioactive Waste Management Complex (RWMC) is located in the southern portion of the INEL and has been used since 1952 to store transuranic contaminated waste and to dispose of waste contaminated with activation and fission radionuclides. This facility has many disturbed sites containing a variety of forbs and free water is often available. An agricultural area at the mouth of the Little Lost River (Howe area) and a big sagebrush (*A. tridentata*)/low sagebrush (*A. arbuscula*) habitat in lower Birch Creek were used as control areas.

During summers, 1977 through 1980, 43 sage grouse were collected near nuclear facilities and 21 grouse were collected in control areas. A 70 g muscle sample and the gastrointestinal (G.I.) tract from each grouse were analyzed for gamma emitting radionuclides using a 65 cm³ lithium-drifted germanium crystal coupled to a computerized multi-channel analyzer. All tissues were gamma-scanned as fresh or frozen material with uniform dimensions and volumes. The minimum detection limit for all nuclides detected ranged from 0.14 to 2.20 pCi/g for muscle samples and from 0.04 to 1.78 pCi/g for G.I. tract samples. Sample results were corrected for radioactive decay.

All data were coded and log-transformed prior to statistical analyses (Steel and Torrie, 1980). Analysis of variance (ANOVA) and Student's t-test were used to make statistical comparisons. The 1st test for unequal sample sizes (Steel and Torrie, 1980:114) was used to compare means when ANOVA indicated a significant difference between groups ($P < 0.05$).

Average and maximum potential whole-body dose commitments to a person consuming sage grouse muscle were calculated using a method suggested by Hoenes and Soldat (1977). Calculations were based on the assumption that the entire muscle mass of one sage grouse was consumed on the same day the bird left the nuclear facility.

Movements, Flocking Characteristics and Habitat Use

Sage grouse were captured and marked during summers on lawns at CFA and TRA using drive traps (Gill, 1965) and mist nets. Sage grouse were captured by night-lighting (Labisky, 1968) on and near leks during March

and April. All captured birds were marked with numbered aluminum leg bands. Additionally, females were color-marked with numbered ponchos (Pyrah, 1970) or were radio-marked with a poncho harness (Amstrup, 1980) or back-pack harness. Males were color-marked with numbered patagial tags or were radio-marked with a backpack harness. Ponchos and patagial tags were color-coded to allow immediate identification of the capture site. Movement data were obtained from radio locations, band returns, and reobservations of marked grouse.

The size, sex, and age composition of flocks were recorded throughout the year. If a single sex appeared to comprise at least 3/4 of a flock, the flock was classified as that sex, otherwise it was recorded as a mixed sex flock. All flocks were flushed to ensure an accurate count and classification.

Analyses of seasonal habitat use were based on data collected while conducting monthly census routes. During summers, flock location, cover type, and the flock's proximity to water were recorded. Flock location, cover type, snow depth, and mean daily temperature were recorded during winter. A circular plot technique (Lyon, 1968; Peek et al., 1978) was used to quantify the winter habitat at locations of flocks numbering 3 or more birds. At each site, sagebrush canopy coverage, height, and density were estimated. Sagebrush habitat that was not used as sage grouse winter range was analyzed in a similar fashion for comparative purposes.

RESULTS

Radionuclide Concentrations

Seventeen radionuclides were detected in TRA/ICPP sage grouse and 2 in RWMC grouse (Table 1). Seven radionuclides were detected in control grouse. Radionuclide concentrations in muscle samples of TRA/ICPP grouse ($\bar{X} = 0.29$ pCi/g, $N=29$) were significantly higher than those of control grouse ($\bar{X} = 0.13$ pCi/g, $N=20$) (ANOVA, $P<0.05$). No difference could be demonstrated in muscle concentrations between TRA/ICPP and RWMC samples ($\bar{X} = 0.14$ pCi/g, $N=14$) or between RWMC and control samples ($P>0.05$). G.I. tract radionuclide concentrations in TRA/ICPP sage grouse ($\bar{X} = 0.80$ pCi/g, $N=29$) were significantly higher than those of RWMC ($\bar{X} = 0.05$ pCi/g, $N=14$) or control birds ($\bar{X} = 0.11$ pCi/g, $N=19$) ($P<0.01$). No significant difference existed between G.I. tract radionuclide concentrations in RWMC and control samples ($P>0.05$).

The average and maximum potential dose commitments to a person consuming the entire muscle mass of a sage grouse were greater for TRA/ICPP birds than for either RWMC or control grouse. The highest estimated potential dose commitment was 2.37 mrem and would have resulted from consuming an adult male sage grouse that summered near TRA/ICPP. In contrast, the highest estimated potential dose commitments from grouse using the RWMC and control areas were 0.02 mrem and 0.04 mrem, respectively.

Table 1. Frequency of occurrence (%) and maximum and mean^a radionuclide concentrations (pCi/g fresh weight) in tissue samples from sage grouse collected during summer and fall, 1977 through 1979, at the Test Reactor Area/Idaho Chemical Processing Plant (TRA/ICPP) complex, the Radioactive Waste Management Complex (RWMC), and control areas.

Nuclide	TRA/ICPP						RWMC						Control Areas					
	G.I. Tract (N=29)			Muscle (N=29)			G.I. Tract (N=14)			Muscle (N=14)			G.I. Tract (N=19)			Muscle (N=20)		
	Freq.	Max.	$\bar{X}$	Freq.	Max.	$\bar{X}$	Freq.	Max.	$\bar{X}$	Freq.	Max.	$\bar{X}$	Freq.	Max.	$\bar{X}$	Freq.	Max.	$\bar{X}$
Cr-51	38	539.0	60.3		ND ^b			ND			ND			ND			ND	
Cs-137	93	107.0	6.2	86	30.1	1.8	100	0.2	0.1	100	0.4	0.3	89	0.2	0.1	90	0.4	0.3
Co-60	31	25.2	2.0	24	1.9			ND			ND			ND			ND	
Ce-144	7	7.1			ND			ND			ND		5	1.5			ND	
Cs-134	28	26.8	1.3	14	5.8			ND			ND			ND			ND	
Nb-95	24	1.8		3	0.2			ND			ND		16	0.7			ND	
Zr-95	10	1.1			ND			ND			ND		11	0.7			ND	
Ce-141	3	2.2			ND			ND			ND		11	0.8			ND	
Ru-103	7	0.9		3	0.4			ND		7	0.6		11	0.6		5	0.3	
La-140	7	0.6			ND			ND			ND			ND			ND	
Se-75	17	4.5		3	1.4			ND			ND			ND			ND	
Na-24		ND		3	3.8 ^c			ND			ND			ND			ND	
Ru-106		ND			ND			ND			ND			ND		11	1.5	
Co-58	3	0.1			ND			ND			ND			ND			ND	
Hg-203	7	0.6		7	0.5			ND			ND			ND			ND	
Ba-140		ND		3	2.7			ND			ND			ND			ND	
Mn-54	14	0.7		3	0.3			ND			ND			ND			ND	
Zn-65	34	12.7	0.9	7	1.5			ND			ND			ND			ND	

^a Means only given for those radionuclides occurring in at least 25% of the samples, and 0 was used in computing means when nuclides were below detection limits.

^b ND = Not detected.

^c pCi/g, see Connelly (1982) for explanation.

Movements, Flocking Characteristics and Habitat Use

Movements. Two hundred and forty five sage grouse were marked at CFA and TRA during the study, and movement data were obtained on 29 grouse, 14 of which were radio-marked. We determined summer ranges for 5 adult females, 2 juvenile males, and 1 juvenile female. All adults were marked at CFA and 4 had broods when captured. Females with broods remained at CFA for an average of 47 days and had a mean summer range of 406 ha. The female without a brood remained at CFA for 25 days and occupied a summer range of 174 ha. The 3 juveniles were marked at TRA, remained at this facility for an average of 35 days, and had a mean summer range of 94 ha.

From 1 July to 7 September, 72% of all radio-locations (N=131) were made within 1 km of the facilities and 95% were within 2 km. The last 3 weeks of September appeared to be a transition period in which relatively few locations were made within 1 km of summer feeding sites at the facilities. During October and November, 82% of the radio-locations (N=22) were over 2 km from the facilities and ranged from 2 to 32 km. The average 1-way movements to winter range from CFA and TRA were 19.9 and 15.5 km, respectively, and ranged from 0.2 to 81.0 km (Fig. 1).

A total of 195 sage grouse were marked on 4 leks in the mountain valley area and 178 grouse were marked on 9 leks in the plains area of the INEL. Of 26 summer reobservations, radio-locations, and band returns of mountain valley birds, 23 occurred in the Birch Creek valley. Male sage grouse from the mountain valley population left their leks in late April and May. Their movements to summer range were more rapid and direct than those of females. Three radio-marked males moved an average of 0.9 km per day during spring migration. Four radio-marked females from the mountain valley area moved an average of 0.3 km per day during spring.

Sage grouse males from the plains population usually moved in a southwesterly direction to summer range while females moved north. Limited data on males from this population suggested that they also moved directly to summer range after leaving their leks in late April and May. Females made relatively extensive movements during spring. Three radio-marked females moved an average of 0.6 km per day during spring.

Flocking. During summer, 635 sage grouse flocks were recorded. Grouse occurred in segregated flocks in June and July; mixed sex flocks accounted for less than 10% of the total flocks observed during this period. The frequency of mixed sex flocks increased in late summer and comprised 36% of the total number of flocks observed during September.

During winter, 469 sage grouse flocks were recorded. Most grouse remained in segregated flocks throughout the winter. Mixed sex flocks never comprised more than 16% of all flocks recorded in any month from November through March. In all areas mixed sex flocks were largest and male flocks smallest.

During winter 1978-79, more snow fell and mean daily temperatures were lower than in the following winters of 1979-80 and 1980-81 (Connelly 1982). However, no single environmental variable (i.e. snow depth, temperature, sagebrush height, or sagebrush canopy coverage) had a strong influence on sage grouse flock size.

Habitat Use. Summer habitat was classified into 4 cover types: sagebrush, agriculture/sagebrush, disturbed areas, and crested wheatgrass (*Agropyron cristatum*). During summers, 289 sage grouse flocks totaling 1,930 birds were recorded along 5 census routes. Of all grouse observed along these routes, 79.0% were in agricultural areas. Sage grouse were never observed in crested wheatgrass plantings during the summer. Differences in habitat use were significant for all flock types (chi-square analysis, $P < 0.01$) (Connelly 1982).

Winter habitats in both the mountain valley and plains areas were characterized according to the 3 most abundant plant species. Four cover types were recognized in the mountain valley area and 6 in the plains area. During winters, 103 flocks totaling 1,993 sage grouse were recorded in the mountain valley area. Habitat use by these birds varied significantly from the expected (chi-square analysis, $P < 0.01$) (Connelly 1982).

In the plains area, 127 flocks totaling 1,229 sage grouse were recorded during winters. Habitat use by these grouse also differed significantly from the expected (chi-square analysis, $P < 0.01$) (Connelly 1982). Sage grouse were never observed in crested wheatgrass plantings or in the agricultural area during winter.

DISCUSSION

Lawns surrounding INEL facilities provide a unique substitute for natural meadows, as do the alfalfa fields near the Howe study area. Both provide a predictable source of forbs, insects, and free water during summer and early fall. Also, because they are irrigated, neither type of summering area is as seriously affected by drought as are natural meadows.

The highest radionuclide concentrations in sage grouse occurred in samples from TRA/ICPP. However, the number and concentration of radionuclides in grouse muscle and G.I. tract samples from this area were generally lower than those reported for waterfowl (Halford et al., 1981) and mourning doves (*Zenaida macroura*) (Markham and Halford, 1982) in the same area. ^{137}Cs concentrations reported for dove muscle were approximately 3 times greater than ^{137}Cs concentrations in sage grouse muscle. ^{137}Cs concentrations reported for waterfowl muscle were over 400 times greater than those in sage grouse. The higher concentrations in doves and waterfowl were probably due to their greater use of the TRA ponds. The relatively large summer range of INEL sage grouse also reduced their exposure to these contaminated areas. The difference in radionuclide concentrations between TRA/ICPP and RWMC grouse suggests that the transfer of radioactivity from liquid waste systems is greater than the transfer from solid waste systems.

The maximum potential whole-body dose commitment to a person eating a sage grouse shortly after it left the vicinity of an INEL facility was estimated at 2.37 mrem (Connelly and Markham 1983). The recommended maximum permissible whole-body dose commitment to an individual in the general public is 500 mrem per year (International Commission on Radiological Protection, 1959) or 208 times the maximum dose commitment from a grouse summering near an INEL facility. To exceed the 500 mrem per year maximum recommended dose, a person would have to eat approximately 422 kg of sage grouse meat or about 211 sage grouse containing maximum concentrations in 1 year (Connelly and Markham 1983). Therefore, based on current guidelines, the potential dose commitment to a person consuming a sage grouse shortly after it left an INEL facility does not constitute a radiation health hazard.

Summer home ranges averaged 260 ha (Connelly, 1982) and were generally smaller than spring and fall ranges (Connelly 1982). These seasonal ranges are relatively large and support the contentions that grouse need vast expanses of suitable habitat (Eng and Schladweiler, 1972; Wallestad, 1975) and that the protection of sagebrush within a 3.2 km radius of leks is not sufficient (Beck, 1977).

Some adult sage grouse summering on the INEL moved more than 60 km to winter range and juveniles dispersed over 80 km, even though radio-telemetry data indicated suitable winter range occurred much closer to summer range. Because grouse winter range occurs in close proximity to leks on the INEL (Connelly 1982), adult movements to winter range represent their return to traditional breeding areas. Fall movements of juvenile grouse suggest that these birds are dispersing in random directions (Connelly 1982).

Spring movements of female sage grouse were slow and meandering when compared to the rapid and direct movements of males. Many grouse moved relatively long distances from leks to summer range, even though there was suitable summer habitat much closer (Connelly 1982). These movements are probably the result of traditional migratory patterns established before agricultural developments created suitable summer range closer to breeding areas.

Patterson (1952) indicated that sage grouse remained in segregated flocks throughout the summer. During this study, grouse occurred in segregated flocks during early summer but the number of mixed sex flocks increased in August and September. Past research has also suggested that flock size increased during late summer (Dalke et al., 1963). However, the size of male and female/juvenile flocks on the INEL did not increase in late summer.

Wallestad (1971) indicated that sage grouse spent a large portion of the summer in sagebrush habitats. In this study, less than 15% of all grouse observed during summers were in sagebrush habitats. Sage grouse showed a strong preference for agricultural and disturbed areas and both of these habitats were vital components of grouse summer range at low

elevations. Patterson (1952) reported that sage grouse do not need free water but will use it when available. Similarly, INEL grouse that summered in sagebrush habitats were not closely associated with water.

Both Ihli et al. (1973) and Beck (1977) reported little use of crested wheatgrass plantings by sage grouse. The crested wheatgrass plantings used as leks on the INEL contained small, scattered stands of sagebrush. In spite of this, grouse were never observed in these areas at any other time of the year, suggesting that these plantings are totally unsuitable as winter or summer range. During this study, 53% of sage grouse observed on winter range occurred in areas with more than 20% canopy coverage and 89% of the observations occurred in areas with more than 10% canopy coverage (Connelly 1982). Montana sage grouse preferred winter range with sagebrush canopy coverage greater than 20% (Eng and Schladweiler, 1972).

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