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United States
Department of
Agriculture

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**Rocky Mountain
Forest and Range
Experiment Station**

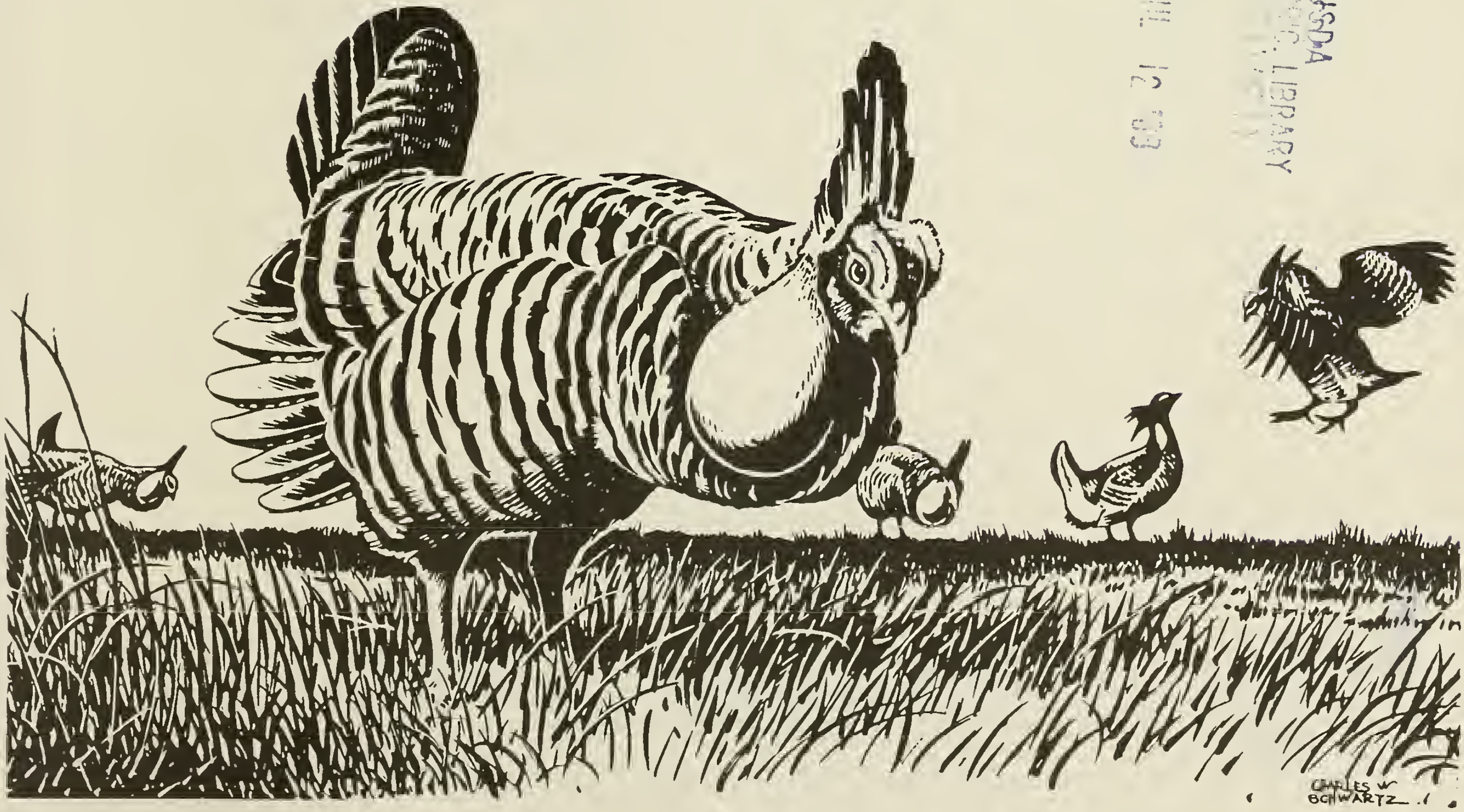
Fort Collins,
Colorado 80526

**General Technical
Report RM-159**

[1988]

Prairie Chickens on the Sheyenne National Grasslands

**September 18, 1987
Crookston, Minnesota**



Foreword

The greater prairie chicken (Tympanuchus cupido pinnatus), also known as the pinnated grouse, is a naturalized immigrant in the Dakotas. This species moved west in the 1880's from the east-central United States, when the Dakotas were under homestead settlement and grain was commonly planted adjacent to vast expanses of prairie.

The prairie chicken moved west as far as northwestern South Dakota, but is now absent from many parts of its newly adopted range. Populations have declined in 11 of 12 States, and completely disappeared in 6 States. However, populations have remained in areas of the Dakotas. These have become noteworthy in south-central South Dakota and southeastern North Dakota.

The prairie chicken population in southeastern North Dakota has centralized on the delta of the glacial river of the Sheyenne River, which drained into glacial Lake Agassiz. This delta was formed when the Sheyenne River carried overflow from glacial Lake Souris in north-central North Dakota to glacial Lake Agassiz. These events took place near the end of the Wisconsin Glacial Period some 10,000 to 12,000 years ago. This seemingly ideal habitat for the prairie chicken--sandy grassland with interspersed grain cropland--has perpetuated the immigrant and provided a subject for considerable research.

Research data on the prairie chickens of the Sheyenne Delta have never before been assembled in one place. The 17th Prairie Grouse Technical Conference was proposed as the setting to conduct the symposium on the "Prairie Chickens on the Sheyenne National Grasslands".

More than 100 people attended the 17th Prairie Grouse Technical Conference and "Prairie Chickens on the Sheyenne National Grasslands" Symposium, held September 15-19, 1987 on the campus of the University of Minnesota, Crookston. The conference and the symposium brought together researchers, educators, students, managers, and field technicians. The conference included a general session on all species of grouse, while the symposium centered on the "Prairie Chickens on the Sheyenne National Grasslands". These published proceedings document the symposium.

The proceedings of this symposium will serve as valuable reference for continued improvement in the management of the habitat of the prairie chicken. They will also provide further incentive for the Great Plains Agricultural Council to continue its promotion of similar symposia.

Ardell J. Bjugstad, Chairman
Dan Svedarsky, Co-Chairman
Tom Nichols, Co-Chairman

ABSTRACT

Bjugstad, Ardell J., tech. coord. 1988. Prairie chickens on the Sheyenne National Grasslands [symposium proceedings]. 1987 Sept. 18; Crookston, MN. Gen. Tech. Rep. RM-159. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 73 p.

These proceedings contain eight papers and two abstracts of papers presented at a special symposium arranged as a part of the 17th Prairie Grouse Technical Conference. The papers document and synthesize information gained over the past several years on prairie chicken ecology, habitats, and diets, and effects of cattle grazing.

USDA Forest Service
General Technical Report RM-159

June, 1988

Prairie Chickens on the Sheyenne National Grasslands

September 18, 1987
Crookston, Minnesota

Ardell J. Bjugstad
Technical Coordinator

Co-sponsors:

Great Plains Agricultural Council
Prairie Grouse Technical Council
Minnesota Prairie Chicken Society
University of Minnesota
USDA Forest Service

Rocky Mountain Forest and Range Experiment Station
Fort Collins, Colorado

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Prairie Chicken Populations of the Sheyenne Delta in North Dakota, 1961-1987[1]

Jerry D. Kobriger, David P. Vollink, Michael E. McNeill, and Kenneth F. Higgins[2]

Abstract.--Prairie chickens (*Tympanuchus cupido pinnatus*) were first censused on the Sheyenne Grasslands in 1961. The population was extremely low in the 1960's, gradually increased in the 1970's, and reached a peak of 410 in 1980. Sufficient evidence exists to link the increase in numbers of prairie chickens on the grasslands from 1961 through 1987 to changes in land management, primarily the introduction of rotational grazing practices and prescribed burning of meadows.

INTRODUCTION

The Sheyenne National Grasslands, under administration of the United States Forest Service (USFS), is located in southeastern North Dakota about 30 miles from both Minnesota and South Dakota. There are 70,180 acres under Federal administration but 64,609 acres of private land are also included within the grassland boundary. These public lands were obtained by purchase in the 1930's under the Bankhead-Jones Farm Tenant Act.

The senior author first became aware of grouse on the Sheyenne Grasslands in September, 1963, at the Prairie Grouse Technical Council meeting in Nevada, Missouri when John Mathison presented a paper entitled "Prairie Grouse Habitat and Plans for Management on the Sheyenne National Grasslands". In 1963, when Mathison gave his report, 9 male prairie chickens had been counted on the Sheyenne Grasslands. The particulars of the paper are hard to recall, but in John's abstract he states: "Direct wildlife improvements and coordination with other resource management *is being considered* for wildlife". It sounds like up to this point in time that wildlife considerations were nil. He also stated that "all of the publicly owned land is in prairie which is grazed by livestock under special USFS permit. The native tall grass prairie has been largely replaced by intermediate and introduced species". The improvements that Mathison mentioned that would aid prairie grouse were: fencing to protect woody cover; planting of shrubs; and good grazing practices. Perhaps by the conclusion of this session today we will learn, after 24 years, if these were good recommendations and if they were actually carried out.

PRAIRIE CHICKEN CENSUS DATA

The first prairie chicken census actually occurred in 1961: 6 booming grounds were located; 2 were censused; and 5 males were counted. Lloyd Oldenburg, biologist for the North Dakota Game and Fish Department, filed a report on 13 April 1961 which stated: "on 12 April, 46 miles of transect were covered on which stops were located to effectively census 88 square miles". Oldenburg calculated a prairie chicken density of 0.5 birds per square mile, a low population but with potential for rapid increase, should habitat conditions become suitable. In his memo, Oldenburg noted that all grouse were observed within 1/4 mile of areas excluded from grazing and farming. He recommended fencing 40 acres per section to benefit all wildlife. It is interesting to note that Richard Flory, Wildlife Staff Assistant, USFS, who aided in the survey that year, recommended fencing only 10 acres per section for wildlife.

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[1] Paper presented at the Prairie Chickens on the Sheyenne National Grasslands Symposium, September 18, 1987, at the University of Minnesota, Crookston.

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Table 1. Prairie chicken census, Sheyenne Grasslands, North Dakota, 1961-70.

Ground Number	Year of Census							
	1961	1962	1963	1965	1966	1968	1969	1970
1	*	0	*			*	7	
2	*	*	*					
3	*	0						
4	1	1						
5	4	6	9	4	3	0	0	2
6	*	0	*		0	0		1
7		2						
8		*	*					
Total Males	5	9	9	4	3	0	7	3

* Booming ground was heard and plotted but not censused.

No counts were made in 1964 or 1967.

Census attempts were made in 1962, 63, 65, 66, 68, and 1969. During this period the highest counts were in 1962 and 1963 when 9 males were seen each year; none were seen in 1968 (Table 1). In 1970, 5 personnel helped conduct surveys on all or parts of 3 different mornings. Despite ideal conditions on 2 of the mornings, only 2 male prairie chickens were recorded; however, 1970 must have been a good production year because 1971 was the turning

Table 2. Prairie chicken census, Sheyenne Grasslands, North Dakota, 1971-80.

	Year of Census									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Grounds Visited	6	15	20	17	25	29	33	31	48	49
Active Grounds Counted	5	12	14	14	23	20	24	22	36	39
Total Males	20	68	89	78	139	139	188	195	338	410
Males/ Active Ground	4.0	5.7	6.4	5.6	6.0	7.0	7.8	8.9	9.4	10.8

Table 3. Prairie chicken census, Sheyenne Grasslands, North Dakota, 1981-87.

	Year of Census						
	1981	1982	1983	1984	1985	1986	1987
Grounds Visited	29	37	40	28	43	22	39
Active Grounds Counted	17	28	34	26	27	22	24
Total Males	137	223	396	313	262	173	220
Males/ Active Ground	8.1	8.0	11.6	12.0	9.7	7.9	9.2

point in the spring male counts (Table 2). Three personnel worked the area in 1971, located 5 active grounds and 20 males. In 1972, 6 biologists counted 68 males on 12 grounds. The prairie chicken population continued to increase, reaching a peak in 1980 when 410 males were counted on 39 booming grounds.

The census effort has remained fairly constant since 1979 except for 1981. The prairie chicken population (males) has fluctuated between 410 and 173 (excluding 1981) (Table 3).

It is difficult to assess the true population numbers over the long term due to

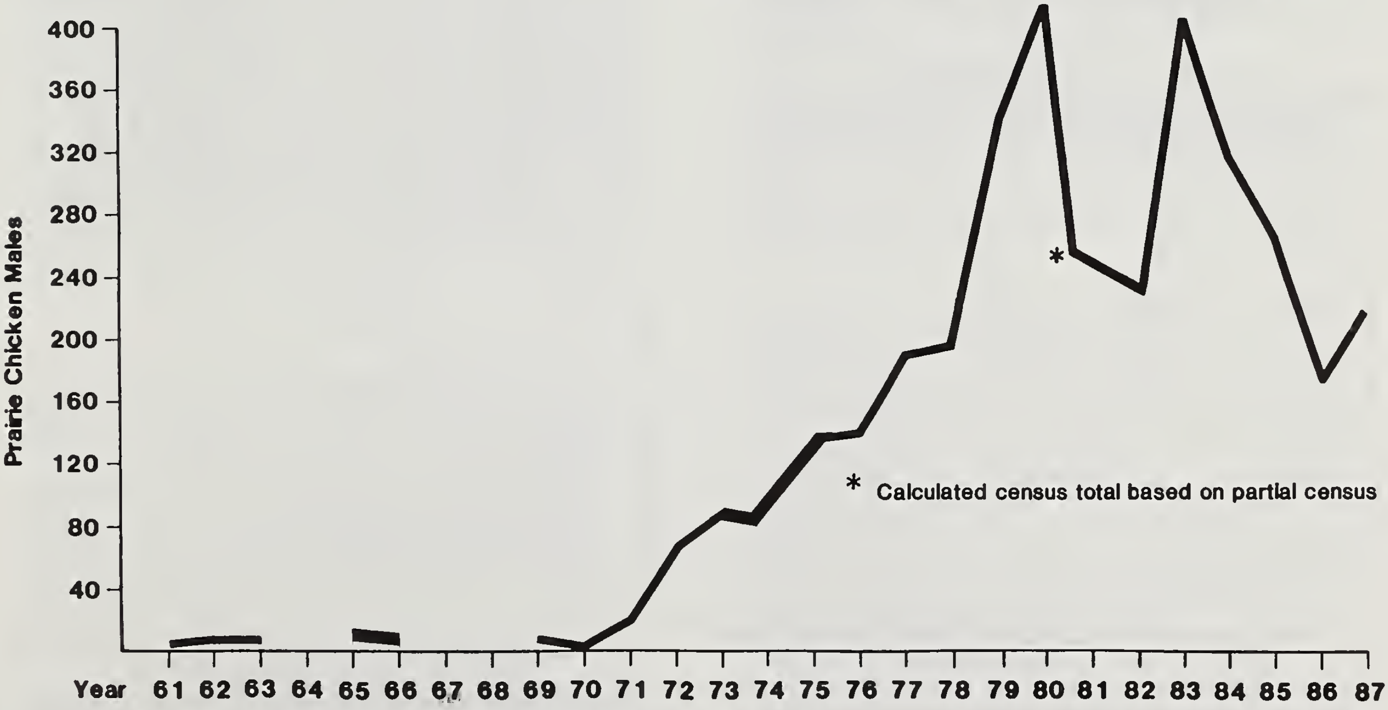

Figure 1. Male prairie chickens counted, Sheyenne Grasslands, North Dakota, 1961-1987.

incomplete census work, particularly during the early years. However, there is no doubt the population increased from 1961 through 1987 (Fig. 1). A significant positive relationship exists between males counted per year and year of census (Fig. 2).

At this point in time, it would do little good to dwell on the accuracy of population figures for the early years, it is sufficient to know that the population was very low. But, with better census effort and data from 1979 through 1987 (Fig. 3), the population trend has been downward, but not significantly so (Fig. 4). We do not think the downward population trend is cause for immediate alarm, but it is of concern. The population, compared to earlier census years, is still in good shape.

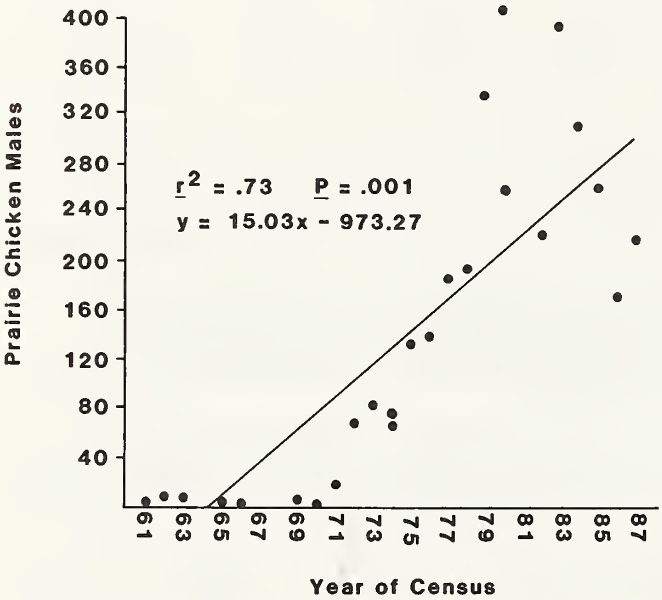

Figure 2. Linear relationship between total prairie chicken males counted and year of census, Sheyenne Grasslands in North Dakota, 1961-1987.

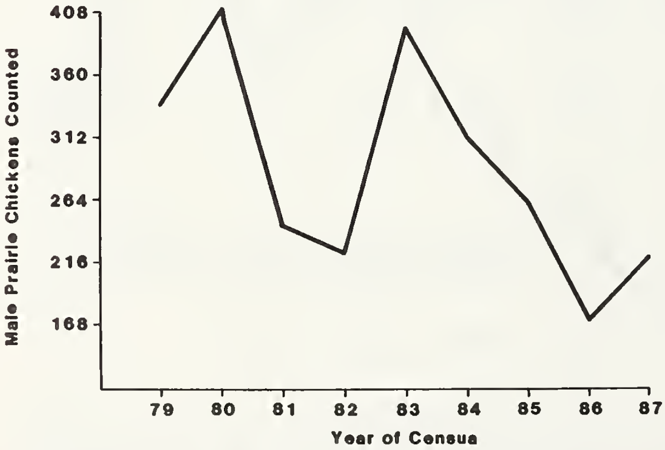

Figure 3. Male prairie chickens counted on the Sheyenne Grasslands, North Dakota, 1979-1987.

With this prairie chicken population, and with the interest shown in the area, as demonstrated by this symposium today, this trend can be reversed. The prairie chicken population in the Sheyenne grasslands is the only viable one left in North Dakota and the species is listed as threatened on the state list.

Manske and Barker (1981) estimated that approximately 100 square miles of potential prairie chicken habitat occurs in the Sheyenne National Grasslands. Densities of prairie chicken males in this area have ranged from 0.2 per square mile in 1961 to 6.2 per square mile in 1980 for potential habitat. We and many other biologists believe that the peak number of males (410) that was counted in 1980, was not the potential peak population that could be attained on the Sheyenne grasslands area. Westemier (1983) has stated that 100 prairie chicken males per square mile of nesting cover are realistic goals in Illinois. In North Dakota, sharp-tailed grouse (Kobriger and Oldenburg 1965) densities have reached about 18 males per square mile of total habitat. Thus, we believe a realistic goal for the Sheyenne Delta grasslands area would be 16 male prairie chickens per square mile of potential cover or double the estimated 8.2 males per square mile of occupied habitat in 1980.

LAND MANAGEMENT-PRAIRIE CHICKEN RELATIONSHIPS

A very apparent relationship existed between the number of male prairie chickens and the predominant type of land management being practiced on the Sheyenne Delta grassland area. The increase in the prairie chicken population between 1961 and 1987 is almost entirely attributable to changes in land management, primarily grazing practices (Fig. 5), because during the same period it was illegal to hunt prairie chickens and systematic predator control measures were not in practice. Thus, very little, if any, of the expansion in prairie chicken numbers was due to curtailment

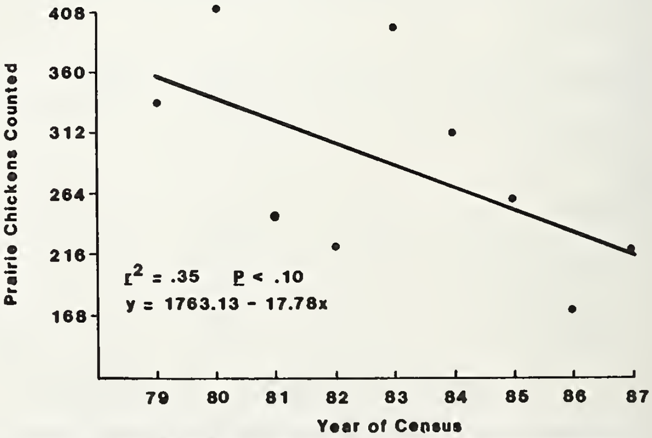

Figure 4. Linear relationship between total male prairie chickens counted and year of census, Sheyenne Grasslands, North Dakota, 1979-1987.

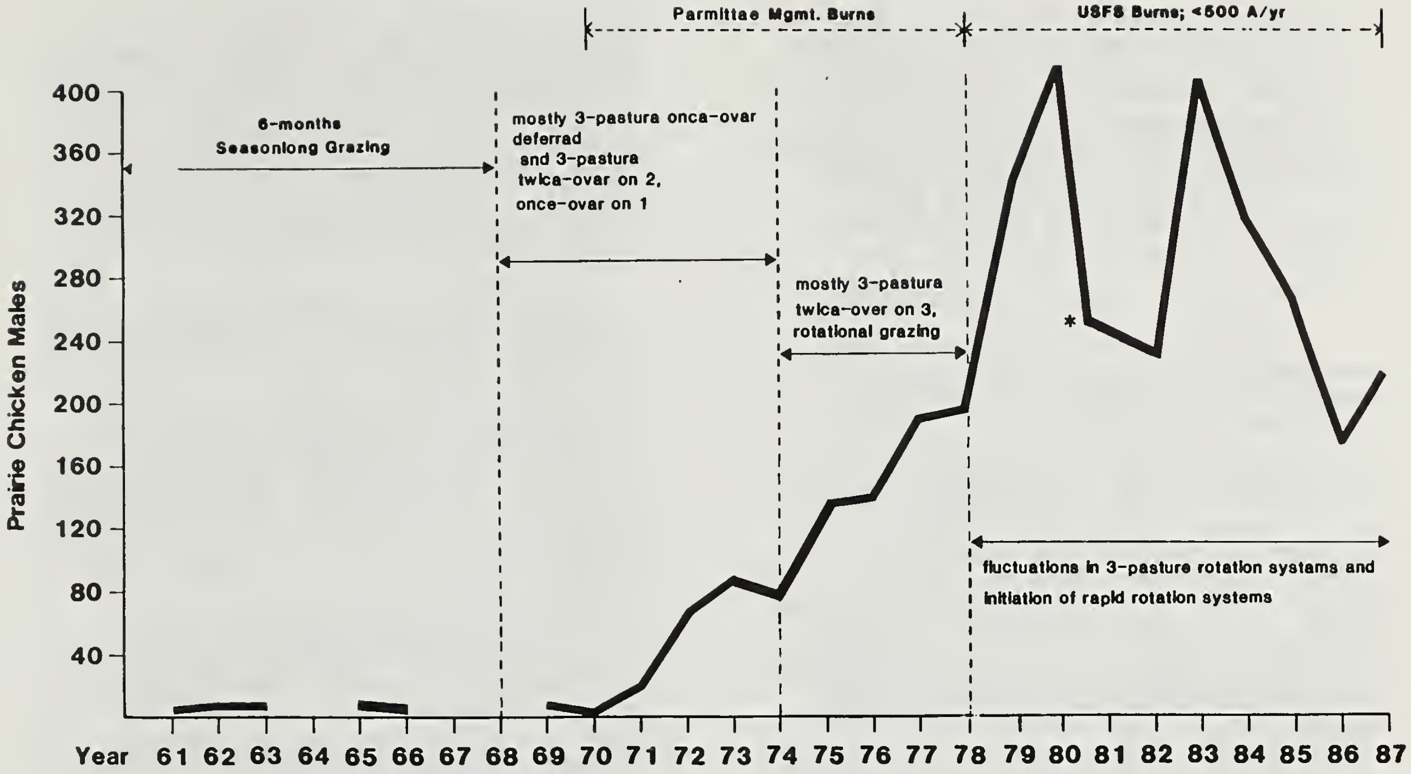

Figure 5. Land management relationships to prairie chicken males counted in spring during 1961-1987, Sheyenne grasslands, ND.

* 1981 count was estimated on the basis of partial survey

No burns in 1975 or 1980

of harvest or the elimination or control of predators by professional predator control agents. During 1961-1987, the amount of winter food supply in terms of corn and sunflower seeds increased but we have no direct evidence to indicate whether or not food was a limiting factor. However, the N.D. Crop and Livestock Reporting Service records for Ranson and Richland Counties indicate significant increases in sunflower and corn acreages from 1969 through 1986 and these acreages appeared to correlate with grouse numbers .

Seasonlong Grazing

The 56 allotments on the Sheyenne grasslands were managed with a "seasonlong grazing treatment" for 8 months duration during 1940-1954 and 6 months duration from 1955-1967. In 1967, cross-fencing was established on some allotments. When the Sheyenne grasslands were managed with seasonlong grazing, the prairie chicken population was apparently kept at the threshold of extinction ($\leq$ 10 males in total per year) (Fig.5).

3-Pasture Once-Over Deferred Rotation

Starting in 1968, some type of rotational herd management was initiated on several allotments and by 1974 approximately 63% of the allotments or 84% of the total land area was being managed with rotational grazing, primarily a "3-pasture once-over deferred rotation system". With this system, one herd was rotated once among the 3 pastures after approximately 45-60 days of grazing per pasture. Essentially, 2 of the 3 pastures were overgrazed with this system of herd rotation but 1 pasture retained some residual cover for the next spring.

The first noticeable increase of prairie chickens in early spring occurred in 1971 or during the 1968-1974 period (Fig. 5). The delay in prairie chicken response following the substantial reduction in seasonlong grazing in 1967 may have been due to the residual effect of seasonlong grazing on the habitat causing a delay in plant community response during 1968 and possibly even into 1969. Furthermore, the winter of 1968-1969 was one of extremely heavy snow cover and it may have affected food availability and subsequently the post-winter reproductive condition of female grouse. Thus, we believe there is good justifiable cause to imply that grouse production may have been delayed until the 1970 nesting season and these birds were subsequently censused in spring 1971.

However, the increase of prairie chickens during 1968-1974 cannot be singly attributable to the change in grazing practices, because in 1970 prescribed burning was also introduced as a grassland management practice on the same area (Fig. 5). The objective of the prescribed burning was mainly to reduce willows (Salix spp.) in the meadows and to induce better grazing utilization of the meadows (Barker 1983).

3-Pasture Twice-Over Rotation Systems

There are two types of 3-pasture twice over systems: 3-pasture twice over on 2-pastures, once on 1-pasture; and 3-pasture twice over on 3 pastures.

Between approximately 1971-1974, and again during 1979-1985, the primary grazing system was a "3-pasture twice-over on 2-pastures, once-over on 1-pasture deferred rotation system". This system increased the herd rotation on two of the pastures from a previous history of once-over to twice-over. Between 1971-1974 this system was used on about 28% of the area and between 1978 and 1979 it went from 5% to 36% and averaged about 41% of the area between 1979-1984.

Starting in approximately 1974, some of the grazing allotments were managed with a "3-pasture twice-over on 3 pastures". This system increased the herd rotation to every 28 days instead of the 45-60 days in the 3-pasture once-over rotation system. In this system, the herds are rotated twice over on 3-pastures. This system was increased in use on the grasslands from 1974 until 1978 when 54% of the area was managed with it.

Simultaneously in the same period, permittee burning and mowing of meadows had increased in practice, and as many as 5,000 acres were spring burned annually between 1 April and 20 May, except in 1975. There was no burning in 1975 because of a record high rain fall. With the implementation of the 3-pasture twice-over rotation systems in combination with meadow burning, the prairie chicken population continued to increase (Fig. 5).

Land Management Changes 1979-1987

Some significant changes in grazing systems practices and prescribed burning occurred between 1979 and 1987. In 1979 prescribed burning by permittees was curtailed and 3-pasture twice-over on 3-pastures rotational grazing was reduced from 40% to 10% of the area and this was replaced primarily by an increase in 3-pasture twice-over on 2-pastures, once-over on one-pasture, deferred rotational systems and smaller total acreages ($\leq$ 500 acres) being managed with prescribed burns by USFS.

About 1982, a type of "short-duration rotational system" was implemented on one allotment and by 1986 this system of grazing practice was being used on 4 allotments. With this system, cattle are moved every 12 days among 3 pastures. The grazing period varies from as few as 7 days to a maximum of 15 days. In some other allotments, a few seasonlong pastures were converted to either a 2 pasture twice-over rotation or to a 3-pasture twice-over deferred rotational system.

In addition to individual pasture capacities, two aspects of plant physiology are utilized in selection of a grazing duration. One is that the plant should not be stressed a second time after being grazed while it is trying to regrow. The second aspect is that the plant should be afforded ample time to regrow. On the Sheyenne National Grassland, the optimal time frames for these two aspects are thought to be 7-14 days of grazing followed with at least 25-30 days rest between grazing periods.

Along with erratic changes in land management practices from 1979-1987, there were also erratic fluctuations in the number of prairie chickens (Fig. 5). The prairie chicken population on the grasslands continued to increase until a peak of 410 displaying males in 1980 even though large management burns and the area being managed with 3-pasture twice-over rotational grazing systems were greatly reduced in 1979. Very probably, the continuance in prairie chicken population increases during 1979 and 1980 were still in response to the residual positive vegetation response from the former management practices. A large population decline in 1981 (39%) corresponds with the large change in grazing from the 3-pasture twice-over on 3-pasture rotation systems (40% to 10%) to the 3-pasture twice-over on 2-pastures, once-over on 1-pasture deferred rotation system (5% to 36%) and little change in the seasonlong grazing. After 1980, the erratic fluctuations in the prairie chicken population are unexplainable. The population fluctuations may have been natural, they may have been due to periodic changes in grazing management systems or to winter food availability, e.g. greater acreages of sunflowers and corn , or a combination of these. We would also like to point out that these changes occurred with minimal burning of meadows after 1978.

SUMMARY AND MANAGEMENT IMPLEMENTATION

The prairie chicken population on the Sheyenne grasslands was near extinction in the early 1960's at the same time seasonlong grazing was practiced on the whole area. The population dramatically increased in size following changes in grazing practices and the addition of prescribed burning of meadows. Since the burning of large acreages of meadows by permittees was curtailed and several changes in grazing systems, including the addition of short duration rapid-rotation systems in some allotments during 1982-1987, the relationship between land management practices and the numbers of male prairie chickens during spring counts is confounded and largely unexplainable when the grasslands are evaluated in total. By the very fact that all males on several "booming grounds" disappeared during 1981-1987 instead of a reduction of a few grouse from all or most of the booming grounds suggests that the contributing effect may be on an allotment basis rather than an overall natural cause affecting the entire population or grasslands area.

This prairie chicken population is the only remaining viable population in North Dakota. Because of the importance of this population, we offer the following recommendations:

1) Censuses should be made of displaying prairie chicken and sharp-tailed grouse (Tympanuchus phasianellus) males and all booming and dancing grounds should be mapped accurately within allotments on an annual basis.

2) Annual records should be accurately maintained on the amount, season, type, and intensity of land management practices and the kind and age structure of animals within grazing herds.

3) Prescribed burning practices of meadows should be brought back, at least to the amounts that were being done in the mid-1970's including permittee burning efforts (approx. 5,000 acres per year).

4) We propose that strong consideration be given to an evaluation of the effects and differences between 3-pasture, twice-over on 2-pastures and once-over on 1-pasture rotational systems and 3-pasture, twice-over on all 3-pastures deferred systems on greater prairie chicken populations and habitats.

5) We recommend further evaluation of the prairie chicken population in relation to land management practices, including past records as well as in the future, particularly on an allotment and pasture basis. Annual records should also be kept on acreages of corn, sunflowers and other potential winter food crops in and adjacent to the Sheyenne grasslands.

6) And lastly, we recommend a deferment of implementation of "short duration" grazing systems on additional areas or allotments until proper evaluation has been made of their effects on native prairie vegetation and wildlife.

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Habitat Usage by Prairie Grouse on the Sheyenne National Grasslands[1]

Llewellyn L. Manske and William T. Barker[2]

Abstract.--Prairie grouse habitat usage was observed for six years. Spring and summer habitat usage was primarily in the upland and midland grassland habitat types. Habitat usage shifted during the fall and winter to cropland and associated tree shelterbelts. The switchgrass plant community was the primary concealment cover for nesting and roosting. Cropland and associated tree shelterbelts was the primary habitat during winter.

Habitat management for Greater Prairie Chicken (Tympanuchus cupido pinnatus) and Sharp-tailed Grouse (Pedioecetes phasianellus) requires knowledge of the relative habitat usage by the grouse during different seasonal periods and major activities. The purpose of this study was to determine, in relative terms, which habitat types were being used by prairie chicken and sharp-tailed grouse during spring, summer, fall and winter and for spring courtship, nesting, brooding and day and night roosting.

STUDY AREA

The north unit of the Sheyenne National Grasslands is between 46°21' and 46°40' north latitude and 97°10' and 97°30' west longitude in Ransom and Richland counties of southeastern North Dakota. The boundaries include 67,320 acres of federal land and 63,240 acres of privately owned land. The federal land is administered by the United States Department of Agriculture, Forest Service and managed in cooperation with the Sheyenne Valley Grazing Association. The federal land is managed under the multiple-use concept. The primary uses are grazing by beef cattle, wildlife, and dispersed recreation. The private land is managed for grazing by beef cattle, hay production, and suitable areas are farmed for livestock feed or cash sale of harvested commodities.

The region has a continental climate with cold winters and hot summers. Data from the McLeod Weather Substation (U.S. Dept. Com. 1973) show that the long term mean annual temperature is 41.9°F. January is the coldest month with a mean temperature of 7.7°F. July and August are the warmest months with mean temperatures of 70.9°F and 69.9°F, respectively. The long term mean annual precipitation is 19.6 inches with 79% occurring during the growing season, April through September. The frost free period averages 130 days beginning in mid May. Soil thaw is usually completed in the spring by 1 May (Jensen 1972).

The Sheyenne National Grasslands is located on a geologic formation known as the Glacial Sheyenne Delta. The delta was formed near the end of the Wisconsin Glaciation where glacial meltwater of the glacial Sheyenne River emptied into Glacial Lake Agassiz and deposited sands, clays and gravels. A layer of nearly impervious lake sediments is below the delta formation. This layer is responsible for the relatively high water table of the area.

The vegetation on the Sheyenne National Grasslands consists of native forest, woodland and grassland communities and non-native (cropland) replacement communities with associated cultivated and introduced plant species. The native plant communities have quantitatively been described by Nelson 1964, Hanson 1976, and Manske 1980.

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[1] Paper presented at the 17th Prairie Grouse Technical Conference and Prairie Chickens on the Sheyenne National Grasslands Symposium University of Minnesota-Crookston, Crookston, September 15-19, 1987.

[2] Llewellyn L. Manske is Assistant Professor of Range Science and William T. Barker is Professor of Range Science, North Dakota State University, Fargo, N.D.

METHODS

Field observations of prairie grouse habitat use were made from foot survey routes with trained bird dogs and listening and visual survey routes with a vehicle. This study of habitat usage by prairie grouse was conducted from March 1975 through February 1981. Foot survey routes were made by walking or riding on horse back along selected routes accompanied by a pointing dog. The length of each survey walked or ridden and the acreage covered by the dogs were recorded. Vehicle survey routes conducted similarly to standard spring census listening survey routes (Grange 1948 and Kirsch 1956) were made by driving a vehicle along all passable roads and trails and stopping at ¼, ½ or 1 mile intervals and scanning surrounding areas for grouse with the aid of binoculars and spotting scope. Concentrated efforts to locate nests, broods and day and night roosts were made at appropriate times. Cable-chain drag method as described by Higgins, Kirsch and Ball (1969) and Higgins et al. (1977) was also used to locate nest sites. Habitat use data were collected during the spring census. Distance from center of spring display grounds to livestock watering facilities was measured each year. The habitat use survey routes were conducted in all available habitat types during each seasonal period of each year. All time periods of the day were sampled except from 11:00 p.m. to 3:00 a.m. All prairie grouse observations were recorded in field notes by species and by sex, if it could be determined. Number and estimated age of chicks were recorded for each brood. The data included in each observation was: location (cadastral and/or allotment and pasture), land use, habitat type, dominant plant species, date, time of day, weather conditions, and behavioral activity of the bird. The habitat use data was separated into four seasonal periods, Spring (1 April - 15 June), Summer (16 June - 31 August), Fall (1 September - 15 November), and Winter (16 November - 31 March). Visual obstruction of vegetation was sampled by the height-density method developed by Robel et al. (1970a) and modified by Kirsch (1974). Visual obstruction measurements (VOM) were presented in decimeters. One decimeter equals 3.9 inches.

A map of the habitat associations was constructed using a combined mapping technique to include the vegetation, soil and topographic characteristics. A general vegetation map was constructed by visual interpretation of homogeneous reflectance from two sets of Landsat-2 images taken on 6 May 1976 and 22 August 1976 and one set of Skylab photographs taken 12 June 1973. A general soil map was constructed from the General Soils Maps of Ransom and Richland Counties (1963) using homogeneous regions of similar soil textural class and general topographic relief. Soil characteristics for the soil series were taken from Thompson and Joos (1975). A general topographic map was constructed from the nine U.S. Geological Survey Topographic Quadrangle Maps (1960) of the area by combining homogeneous physiographic regions. These three general maps, vegetation, soil and topography, were field checked and combined to form one Habitat Association Map.

All vegetation within the boundary of the Sheyenne National Grasslands north unit were classified into eleven habitat types according to vegetative composition, soil characteristics and topography. These habitat types were grouped into four habitat associations. Plant species composition, soil and topographic characteristcs were quantitatively described by Manske (1980) and Manske and Barker (1981) for each habitat type and habitat association. Acreages of each habitat type and habitat association were determined by electronic planimeter (3 replications) and dot grid (2 replications) on aerial photographs taken in 1970 (Manske and Barker, 1981).

Prairie grouse habitat use index as developed by Robel et al. (1970b) (% of bird locations/% of study area) was used to indicate relative habitat use by prairie grouse. A habitat use index value greater than 1.0 indicated that prairie grouse selection for that habitat was greater than expected if the grouse exhibited no preference. A value less than 1.0 indicated habitat use at a level less than expected. A value of zero indicated avoidance of that habitat type.

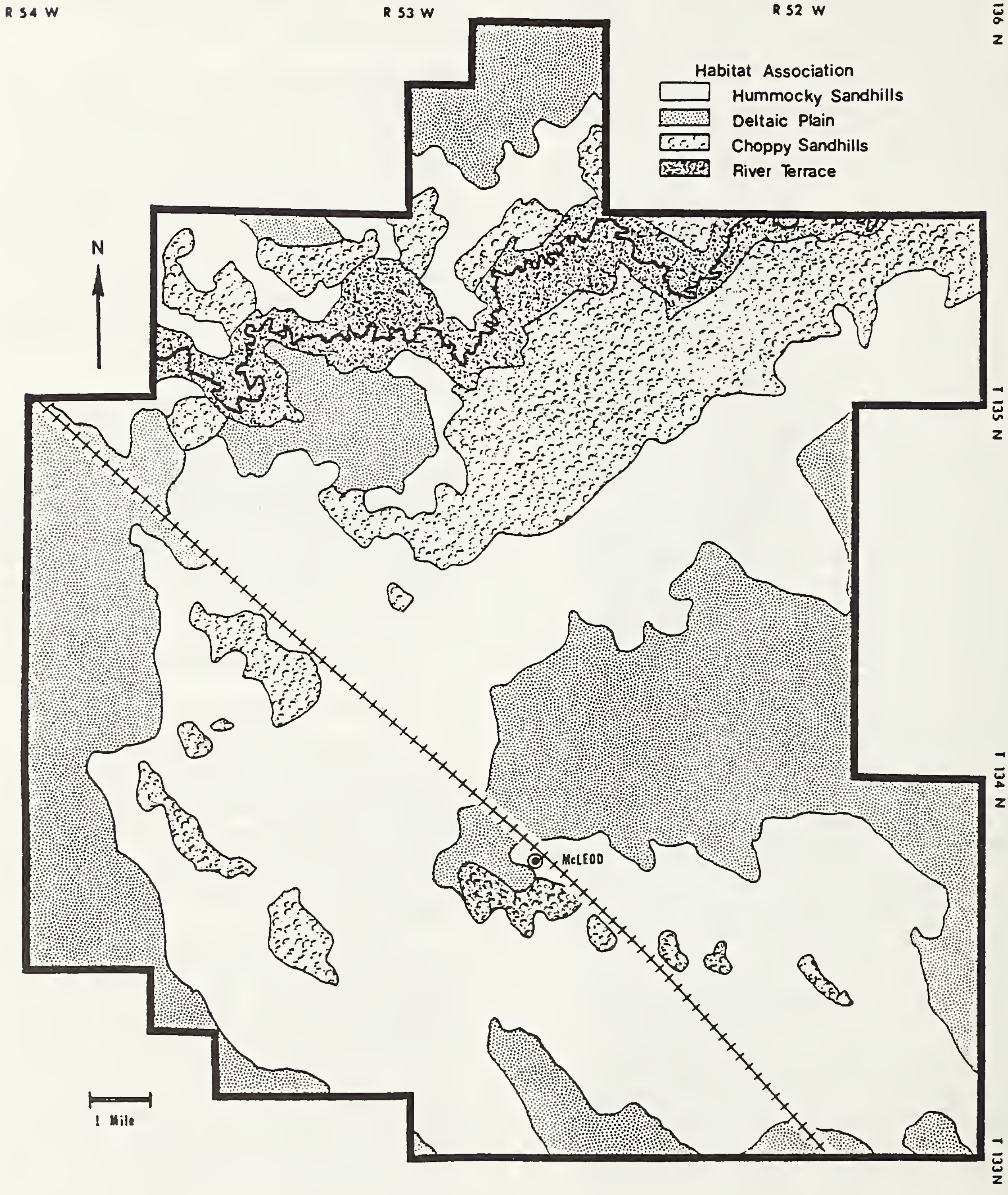
RESULTS AND DISCUSSION

Habitat Associations and Habitat Types

The vegetation on the Sheyenne National Grasslands was divided into eleven habitat types on the basis of similar plant species composition, soil type and topography. Eight habitat types consisted of native vegetation and three of replacement (cropland) vegetation. The habitat types of closely related characteristics and distribution were grouped into four habitat associations (fig. 1).

The Hummocky Sandhills Habitat Association consists of 65,494 acres, 50.16% of the Sheyenne National Grasslands. The topography is gently rolling and undulating hummocks (small hills) with relief usually 5 to 10 feet and slope 5 to 10%. The soils are primarily loamy fine sand with low available soil water. This habitat association is divided into four habitat types. The Upland Grassland Habitat Type exists on the summit and shoulder slopes of each hummock. The combined area is 34,389 acres (26.34%). The soils are loamy fine sand which are low in available soil water. The vegetation is the *Bouteloua gracilis - Stipa comata - Carex heliophila* mixed grass prairie community. The Midland Grassland Habitat Type exists on the back and foot slopes of each hummock with a combined

FIGURE 1. HABITAT ASSOCIATIONS ON THE SHEYENNE NATIONAL GRASSLANDS



area of 16,558 acres (12.68%). The soils are loamy fine sand with low to moderate available soil water. The vegetation is the Andropogon gerardi - Andropogon scoparius - Panicum virgatum tall grass prairie community. The Lowland Grassland Habitat Type exists on the foot and toe slopes and has an area of 12,737 acres (9.76%). The soils are fine sandy loam with moderate to low available soil moisture but with high soil moisture because of a high water table. The vegetation is the Carex lanuginosa - Calamagrostis inexpansa - Juncus balticus sedge meadow community. The Cropland Habitat Type exists on areas with generally low relief with characteristics of the midland habitat type. The combined area is small with 1,810 acres (1.39%). The soils are primarily loamy fine sand with low to moderate available soil water. The vegetation is primarily Zea mays and Medicago sativa. Associated with the cultivated land is 37 acres (0.03%) of planted tree shelterbelts.

The Deltaic Plain Habitat Association consists of 38,761 acres, 29.69% of the Sheyenne National Grasslands. The topography is nearly level with relief usually 1 to 2 feet and small areas of relief of 1 to 5 feet and slopes mostly less than 2%. The soils are primarily loam with high to moderate available soil moisture. The entire association has a high water table. This habitat association is divided into three habitat types. The Midland Grassland Habitat Type exists on areas that are slightly elevated with a total area of 14,476 acres (11.09%). The soils are loam to fine sandy loam and are high to moderate in available soil moisture. The vegetation is the Andropogon gerardi - Andropogon scoparius - Sorghastrum nutans tall grass prairie community. A very small area of less than 15 acres (0.01%) of Bouteloua gracilis - Stipa comata mixed grass prairie community exists within this midland habitat type on areas of slightly higher relief. The Lowland Habitat Type is located in the slight depressions in the landscape. The combined area is 5,387 acres (4.13%). The soils are loam with moderate to low available soil moisture. The vegetation is the Carex lanuginosa - Calamagrostis inexpansa - Carex spp. sedge meadow community. The Cropland Habitat Type is a large portion of this association because of the nearly level topography and good fertile soil. The combined area is 18,898 acres (14.47%). The soils are loam to fine sandy loam with high to low available soil moisture. The vegetation is primarily Zea mays, Medicago sativa and Helianthus annuus. Associated with the cultivated land is 402 acres (3.08%) of planted tree shelterbelts.

The Choppy Sandhills Habitat Association consists of 19,170 acres, 14.68% of the Sheyenne National Grasslands. The topography is very rough and choppy with relief usually 5 to 50 feet and slopes 10 to 20%. The soils are fine sand with very low available soil moisture. This habitat association is divided into two habitat types. The Upland Woodland Habitat Type exists on the slopes and depressions of the choppy topography and has a combined area of 12,269 acres (9.40%). The soil is fine sand with low available soil moisture. The vegetation is the Quercus macrocarpa - Populus tremuloides - Fraxinus pennsylvanica woodland community with a thin understory of grass, forbs and shrubs. The tree population varies from dense groves to scattered individual trees. The Open Grassland Habitat Type exists between the areas of dense groves and has a combined area of 6,901 acres (5.29%). The topography is rough and highly variable. The soil is fine sand with very low available soil moisture. The vegetation is the Bouteloua gracilis - Carex heliophila - Sporobolus cryptandrus mixed grass prairie community.

The River Terrace Habitat Association exists along the Sheyenne River and its spring fed tributaries. It consists of 7,135 acres, 5.46% of the Sheyenne National Grasslands. The topography is very level on the various alluvial terraces with a slope of 0.3%. The river channel has steep banks. The edge of the river valley has a very steep escarpment of 25 to 30 feet with a slope greater than 20%. The soils are silt loam with high available soil moisture. This association is divided into two habitat types. The Riparian Forest Habitat Type exists throughout the river terrace and river valley escarpment except for oxbow areas and areas cleared for farming. The area is 5,710 acres (4.37%). The soils are silt loam to silty clay with high available soil moisture. The vegetation is the Tilia americana - Ulmus americana - Fraximus pennsylvania forest community. Very small areas of sedge-cattail-willow wetland communities exist in the oxbows and along the river channel. The Cropland Habitat Type exists in areas that have been cleared of forest vegetation. The combined area is 1,425 acres (1.09%). The soils are silt loam with high available soil moisture. The vegetation is primarily Zea mays, Helianthus annuus and Medicago sativa.

Transportation Routes with associated right of ways have been constructed across the Sheyenne National Grasslands. Three categories of transportation routes were separated. The Railroad Transportation Route has 17.5 miles of track with 106 acres of right of way which is 0.08% of the Sheyenne National Grasslands. The Gravel Road Transportation Routes have 112 miles of road with 679 acres of right of way (0.52%). The Asphalt Road Transportation Route has 13 miles of road with 79 acres of right of way (0.06%).

Habitat Association Use

Prairie grouse habitat use for the four seasonal periods was primarily in two Habitat Associations, the Hummocky Sandhills and the Deltaic Plain (table 1). No prairie grouse habitat use was observed in the River Terrace

Table 1.--Habitat use index for prairie grouse during four seasonal periods of the habitat associations on the Sheyenne National Grasslands (SNG).

		Spring 1 Apr - 15 Jun			Summer 16 Jun - 31 Aug		Fall 1 Sep - 15 Nov		Winter 16 Nov - 31 Mar	
Habitat Association	% of SNG	Prairie Chicken	Sharp-tailed Grouse	Hybrid	Prairie Chicken	Sharp-tailed Grouse	Prairie Chicken	Sharp-tailed Grouse	Prairie Chicken	Sharp-tailed Grouse
Hummocky Sandhills	50.17	1.89	1.98	1.99	1.78	1.79	0.73	1.62	0.36	0.34
Deltaic Plain	29.70	0.17	0.0	0.0	0.35	0.08	1.81	0.53	2.58	2.16
Choppy Sandhills	14.69	0.0	0.06	0.0	0.0	0.53	0.0	0.06	0.0	0.39
River Terrace	5.46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation Routes	0.66	0.0	0.0	0.0	0.0	0.0	14.57	2.89	8.00	19.55
(N) =		3642	958	117	638	350	780	210	3524	1248

Table 2.--Habitat use index for prairie grouse during four seasonal periods of the habitat types on the Sheyenne National Grasslands (SNG).

		Spring 1 Apr - 15 Jun			Summer 16 Jun - 31 Aug		Fall 1 Sep - 15 Nov		Winter 16 Nov - 31 Mar	
Habitat Association Habitat Type	% of SNG	Prairie Chicken	Sharp-tailed Grouse	Hybrid	Prairie Chicken	Sharp-tailed Grouse	Prairie Chicken	Sharp-tailed Grouse	Prairie Chicken	Sharp-tailed Grouse
Hummocky Sandhills										
Upland Grasslands	26.34	1.64	2.48	1.95	1.18	1.36	0.55	0.76	0.14	0.31
Midland Grasslands	12.68	3.38	2.33	3.77	3.34	2.57	0.42	4.62	0.34	0.03
Lowland Grasslands	9.76	0.76	0.34	0.09	1.27	1.96	0.17	0.20	0.01	0.08
Cropland	1.36	0.97	0.61	0.0	2.65	1.89	11.12	0.70	6.11	5.07
Shelterbelts	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.81	32.05
Deltaic Plain										
Upland Grasslands	0.01	5.49	0.0	0.0	0.0	0.0	1897.44	190.48	295.12	0.0
Midland Grasslands	11.09	0.40	0.0	0.0	0.34	0.03	0.94	0.09	0.99	0.42
Lowland Grasslands	4.13	0.14	0.0	0.0	0.49	0.48	5.90	3.11	0.89	0.0
Cropland	11.39	0.96	0.0	0.0	0.41	0.0	0.0	0.0	3.68	4.28
Shelterbelts	3.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.56	3.51
Choppy Sandhills										
Upland Woodland	9.40	0.0	0.09	0.0	0.0	0.82	0.0	0.0	0.0	0.03
Open Grasslands	5.29	0.0	0.0	0.0	0.0	0.0	0.0	0.18	0.0	1.01
River Terrace										
Riparian Forest	4.37	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cropland	1.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transportation Routes										
Railroad	0.08	0.0	0.0	0.0	0.0	0.0	68.91	0.0	59.24	161.26
Gravel roads	0.52	0.0	0.0	0.0	0.0	0.0	7.89	3.66	1.04	0.0
Asphalt roads	0.06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(N) =		3642	958	117	638	350	780	210	3524	1248

Habitat Association. Prairie chickens did not use the Choppy Sandhills Habitat Association but sharp-tailed grouse did have some use in that Habitat Association during all four seasons. Generally, there was very little difference between the relative seasonal habitat use indeces of prairie chicken and sharp-tailed grouse.

Most of the prairie grouse activity was in the Hummocky Sandhills Habitat Association during spring and summer. Activity shifted to the Deltaic Plain Habitat Association during fall and winter. Sharp-tailed grouse shifted their activities from the Hummocky Sandhills Habitat Association to the Deltaic Plain Habitat Association later in the fall than prairie chicken and they shifted their activities back to the Hummocky Sandhills Habitat Association earlier in the spring than prairie chicken.

Habitat Type Use

Prairie grouse used a wide diversity of habitat types in each seasonal period and their relative habitat usage varied with the activity and seasonal period (table 2). Habitat usage during spring was primarily the Upland and Midland Habitat Types of the Hummocky Sandhills Habitat Association. Birds active in spring courtship rituals used areas of short native vegetation primarily on Upland and Midland Habitat Types with areas of taller vegetation adjacent or near. Birds not actively displaying during courtship used areas with taller vegetation primarily the Midland Habitat Type. Prairie chickens continued to feed on agricultural residue in the Cropland Habitat Types of the Deltaic Plain and Hummocky Sandhills Habitat Associations during early spring. Sharp-tailed grouse fed in the Cropland Habitat Type of the Hummocky Sandhills Habitat Association but did not use the Cropland Habitat Type of the Deltaic Plain Habitat Association during spring.

Summer habitat use was principally in the Hummocky Sandhills Habitat Association with all available habitat types selected. Prairie grouse disbanded into small groups or singles after spring courtship. Several male grouse continued to stay near display ground areas for a large portion of the summer. Hens were very mobile and used a wide variety of habitat types. Shrubs on the Midland and Lowland Habitat Types were used for cover and shade during the hot portions of summer. Areas with alfalfa (Medicago sativa) cropland were used for feed and cover.

Fall was a period with several changes. Hens left their broods which broke up and dispersed. Small flocks of adult and juvenile birds would gather on or near fall display grounds. These small flocks were very mobile and would travel several miles during a day. Habitat use shifted from primarily grassland vegetation to cropland. This shift in habitat usage was earlier for prairie chicken than sharp-tailed grouse.

Winter was a stressful period for prairie grouse. During severe weather, small flocks joined together and formed packs (flocks larger than 60 birds). Activities of these large flocks centered around cropland and adjacent shelterbelts, primarily in the Deltaic Plain Habitat Association. A very small amount of winter activity was conducted on grassland habitats of the Deltaic Plain and Hummocky Sandhills Habitat Associations. Spilled grain along transportation routes and in cropland and crop residue from harvested cropland were the primary sources for high energy winter food. Spilled wheat along the railroad right of way was used by most large flocks for food during late fall and winter. Trees in shelterbelts were used for cover and their buds, fruit and samaras used for food. Standing corn (Zea mays) and sunflowers (Helianthus annuus) were used for food when snow covered the spilled grain and other crop residue.

Display Ground Habitat

Prairie grouse spring courtship display grounds were primarily located on Upland and Midland Habitat Types on the Hummocky Sandhills Habitat Association (fig. 2 and table 3). A few prairie chicken display grounds were located on the Deltaic Plain Habitat Association. No sharp-tailed grouse display grounds were on the Deltaic Plain Habitat Association. No prairie chicken or sharp-tailed grouse display grounds were located on the Choppy Sandhills or River Terrace Habitat Associations.

Livestock tended to graze vegetation near some watering facilities to a shorter height than vegetation away from water. Distance from center of display ground to nearest livestock watering facility was measured for 176 prairie chicken and 87 sharp-tailed grouse display grounds. One hundred eighteen (67.1%) prairie chicken and 48 (55.2%) sharp-tailed grouse display grounds were less than 1500 feet from livestock water. Mean distance was 601 feet for prairie chicken and 569 feet for sharp-tailed grouse. Fifty-eight (33.0%) of the prairie chicken grounds were further than 1500 feet from livestock water. Twenty of these grounds had been mowed the previous year. Thirty-six had not been mowed of which 31 were restricted to the Upland Habitat Type. Only five (2.8%) of the prairie chicken display grounds had member male birds displaying on the Midland Habitat Type that had not been mowed the previous year and was greater than 1500 feet from livestock water. No prairie chicken males displayed on unmowed Lowland Habitat Types that were greater than 1500 feet from water.

Thirty-nine (44.8%) of the sharp-tailed grouse display grounds were further than 1500 feet from livestock water. Eleven of these grounds had been mowed the previous year.

FIGURE 2. PRAIRIE GROUSE DISPLAY GROUNDS ON THE SHEYENNE NATIONAL GRASSLANDS-1980

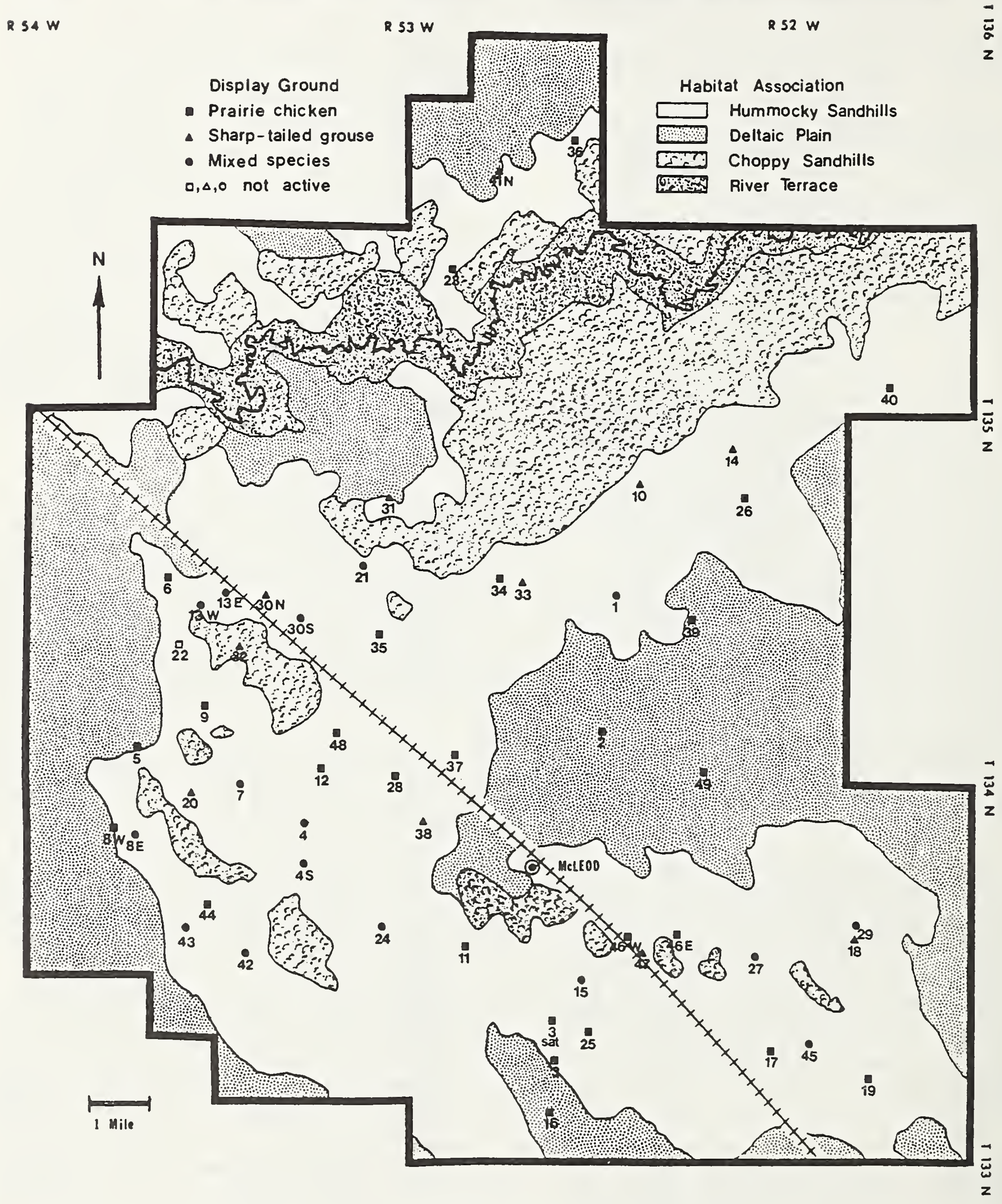


Table 3.--Habitat use index for spring courtship display grounds used by prairie grouse on the Sheyenne National Crasslands (SNG).

Habitat Association Habitat Type	% of SNG	Prairie Chicken	Sharptailed Grouse	Hybrid
Hummocky Sandhills				
Upland Grasslands	26.34	1.90	2.76	1.93
Midland Grasslands	12.68	2.56	2.15	3.72
Lowland Grasslands	9.76	0.99	0.0	0.0
Cropland	1.36	0.0	0.0	0.0
Shelterbelts	0.03	0.0	0.0	0.0
Deltaic Plain				
Upland Grasslands	0.01	131.58	0.0	0.0
Midland Grasslands	11.09	0.40	0.0	0.17
Lowland Grasslands	4.13	0.32	0.0	0.0
Cropland	11.39	0.08	0.0	0.0
Shelterbelts	3.08	0.0	0.0	0.0
Choppy Sandhills				
Upland Woodlands	9.40	0.0	0.0	0.0
Open Grasslands	5.29	0.0	0.0	0.0
River Terrace				
Riparian Forest	4.37	0.0	0.0	0.0
Cropland	1.09	0.0	0.0	0.0
(N) =		228	88	53

Twenty-eight had not been mowed of which 23 were restricted to the Upland Habitat Type. Five (5.75%) of the sharp-tailed grouse display grounds had member male birds displaying on the Midland Habitat Type that had not been mowed and was greater than 1500 feet from livestock water. No male sharp-tailed grouse displayed on the Lowland Habitat Type.

Vegetation for prairie grouse courtship display needed to be short. The plants that were present on the Upland Habitat Type were of short stature and acceptable to prairie grouse for courtship display activity with or without mowing and grazing management. Vegetation on the Midland and Lowland Habitat Types was generally too tall and unacceptable for courtship display activity unless it had been mowed the previous year or grazed short which occurred near some livestock watering facilities.

Concealment cover adjacent or near spring display grounds was considered to be important and 181 prairie chicken and 87 sharp-tailed grouse display grounds were evaluated for availability of concealment cover. Good concealment cover was considered to be vegetation with mean 100% VOM of greater than 1.5 decimeters (Manske and Barker, 1981 and Higgins and Barker, 1982). Respectively, 72.9% and 80.5% of the spring display grounds with prairie chickens and sharp-tailed grouse had very good concealment cover adjacent or very near. Courtship display areas with less than good concealment cover were 14.9% and 12.6% for the prairie chicken and sharp-tailed grouse, respectively. The remaining courtship display areas, 12.2% and 6.9% with prairie chickens and sharp-tailed grouse, respectively, had very poor or no concealment cover near the grounds. Most of the display grounds, 87.9% of the prairie chicken and 93.1% of the sharp-tailed grouse, had some concealment cover adjacent or near. Spring courtship display ground habitat appears to be a combination of short vegetation for display purposes and adjacent or very near areas with good cover for concealment.

Nest Habitat

Nineteen prairie grouse nest sites were located during this study. Eleven were prairie chicken and eight were sharp-tailed grouse nests. Six prairie chicken and six sharp-tailed grouse nests had completed clutches. Five prairie chicken and two sharp-tailed grouse nests had only partially completed clutches. Two prairie chicken nest scrapes were located with the hens present. Nine prairie chicken and eight sharp-tailed grouse nests were found in native grassland vegetation. All seventeen of these nests were in the Midland Grassland Habitat Type of the Hummocky Sandhills Habitat Association (table 4). Switchgrass (Panicum virgatum) was the dominant species at all of the nest sites in

Table 4.--Habitat use index for nest site locations used by prairie grouse on the Sheyenne National Grasslands (SNG).

Habitat Association Habitat Type	% of SNG	Prairie Chicken Full Clutch	 Partial Clutch	 Nest Scrape	Sharptailed Grouse Full Clutch	 Partial Clutch	 Nest Scrape
Hummocky Sandhills							
Upland Grasslands	26.34	0.0	0.0	0.0	0.0	0.0	0.0
Midland Grasslands	12.68	3.58	1.43	1.43	5.91	1.97	0.0
Lowland Grasslands	9.76	0.0	0.0	0.0	0.0	0.0	0.0
Cropland	1.36	0.0	0.0	0.0	0.0	0.0	0.0
Shelterbelts	0.03	0.0	0.0	0.0	0.0	0.0	0.0
Deltaic Plain							
Upland Grasslands	0.01	0.0	0.0	0.0	0.0	0.0	0.0
Midland Grasslands	11.09	0.0	0.0	0.0	0.0	0.0	0.0
Lowland Grasslands	4.13	0.0	0.0	0.0	0.0	0.0	0.0
Cropland	11.39	0.80	0.80	0.0	0.0	0.0	0.0
Shelterbelts	3.08	0.0	0.0	0.0	0.0	0.0	0.0
Choppy Sandhills							
Upland Woodlands	9.40	0.0	0.0	0.0	0.0	0.0	0.0
Open Grasslands	5.29	0.0	0.0	0.0	0.0	0.0	0.0
River Terrace							
Riparian Forest	4.37	0.0	0.0	0.0	0.0	0.0	0.0
Cropland	1.09	0.0	0.0	0.0	0.0	0.0	0.0
(N) =		6	3	2	6	2	0

native vegetation except for one sharp-tailed grouse nest where spiraea (Spiraea alba) and Kentucky bluegrass (Poa pratensis) were dominant species and switchgrass was subdominant. Two prairie chicken nests were found in alfalfa (Medicago sativa) of the Cropland Habitat Type. No sharp-tailed grouse nests were found in cropland. No prairie grouse nest sites were located in the Choppy Sandhills or River Terrace Habitat Associations.

Nest sites were characteristically completely covered by vegetation. Sides and top concealment at nests had very dense residual and growing vegetation. The mean 100% visual obstruction measurements (VOM) from six prairie chicken and eight sharp-tailed grouse nests at nest center was 2.9 ± 1.2 decimeters for prairie chicken nests and 2.6 ± 0.9 decimeters for sharp-tailed grouse nests. Some nest sites had a pathway through the vegetation where the hen passed in or out. The mean height-density at the 100% VOM of nest habitat within four meters of the nest site was 2.5 ± 1.0 decimeters for prairie chicken and 2.4 ± 0.6 decimeters for sharp-tailed grouse. There was no difference between prairie chicken and sharp-tailed grouse nesting habitat ($P>0.05$). The range in measurements for the 100% VOM for nest habitat was 1.5 to 3.5 decimeters. The 1.5 decimeter level at the 100% visual obstruction measurement (VOM) was considered from these data to be the minimum level for good nest habitat for both prairie chicken and sharp-tailed grouse. Prairie chicken and sharp-tailed grouse nest habitat was the switchgrass portion of the Midland Habitat Type of the Hummocky Sandhills Habitat Association with mean 100% VOM of 1.5 decimeters or greater. Prairie chicken also nested in alfalfa cropland.

Brood Habitat

Fifty-four prairie chicken and twenty-eight sharp-tailed grouse broods were located. Prairie grouse broods were very mobile and traveled over a considerable amount of area. Prairie chicken used all the available grassland habitat types and alfalfa cropland of the Hummocky Sandhills and Deltaic Plain Habitat Associations (table 5). Sharp-tailed grouse broods used the grassland habitat types of the Hummocky Sandhills Habitat Association and the Lowland Habitat Type of the Deltaic Plain Habitat Association. Sharp-tailed grouse broods also used the Upland Woodland Habitat Type of the Choppy Sandhills Habitat Association. These sharp-tailed grouse broods used the areas of shrubs and young trees on the edge of groves. No broods were located within the groves of mature trees. Prairie chicken broods did not use the Habitat Types in the Choppy Sandhills Habitat Association. Prairie chicken and sharp-tailed grouse broods did not use the Habitat Types of the River Terrace Habitat Association.

Table 5.--Habitat use index for prairie grouse broods on the Sheyenne National Grasslands (SNG).

Habitat Association Habitat Type	% of SNG	Prairie Chicken	Sharptailed Grouse
Hummocky Sandhills			
Upland Grasslands	26.34	1.27	1.56
Midland Grasslands	12.68	3.12	2.34
Lowland Grasslands	9.76	1.12	1.58
Cropland	1.36	1.41	0.0
Shelterbelts	0.03	0.0	0.0
Deltaic Plain			
Upland Grasslands	0.01	0.0	0.0
Midland Grasslands	11.09	0.46	0.0
Lowland Grasslands	4.13	0.62	0.69
Cropland	11.39	0.56	0.0
Shelterbelts	3.08	0.0	0.0
Choppy Sandhills			
Upland Woodlands	9.40	0.0	1.17
Open Grasslands	5.29	0.0	0.0
River Terrace			
Riparian Forest	4.37	0.0	0.0
Cropland	1.09	0.0	0.0
(N) =		54	28

Areas of short vegetation that had been mowed and grazed with adjacent areas of dense residual and growing vegetation were used considerably as feeding areas. The dense cover was used mainly for escape cover and loafing but very little for feeding. Broods usually used areas that had relatively high amounts of forbs and shrubs. These areas usually provided good canopy cover and relatively open understory. The percentage of broods observed in woody vegetation consisting of short shrubs was 47.3% of the prairie chicken and 51.7% of the sharp-tailed grouse broods. Most of the broods observed in the Upland Habitat Type, 93.7% of the prairie chicken and 81.8% of the sharp-tailed grouse broods, were in woody vegetation. The mean 100% VOM for Upland, Midland and Lowland Habitat Types used for brood cover was 1.6, 2.2, and 1.9 decimeters, respectively. The mean 0% VOM for the three habitat types was 3.6, 6.3, and 5.7 decimeters, respectively.

Prairie grouse brood habitat was a wide diversity of plant communities and height-densities. Generally broods were associated with vegetation with relatively larger amounts of forbs and short shrubs that provided good canopy cover and relatively open understories.

Night and Day Roost Habitat

Prairie grouse spent a considerable amount of time on ground roosts. They were on night roosts from dusk to dawn and on day roosts for a large portion of the day between morning and evening feeding periods. Roosting activity occupied the greatest amount of time in the life of a prairie grouse.

Prairie grouse night roost sites with the birds present were primarily in the Midland and Lowland Habitat Types of the Hummocky Sandhills Habitat Association during spring, summer and fall (table 6). The switchgrass portion of the midland grassland community was more important for night roosting than the upper portion. Night roost habitat shifted to Cropland and adjacent shelterbelts during winter. Some night roosting activity was continued in the midland grassland community with switchgrass in the winter. Tree shelterbelts were very important for night roosting in winter. This shelterbelt habitat included the rows of planted trees on the edge of cropland and also small areas of volunteer willow (Salix spp.), cottonwood (Populus deltoides) and/or aspen (Populus tremuloides) that were located in or near cropland. Trees provided some protection from the winter weather and deeper snow drifts developed in or near trees. Prairie grouse often burrowed into these snow drifts to roost at night. Most snow burrows were found in snow that

Table 6.--Habitat use index for prairie grouse night roost sites on the Sheyenne National Grasslands (SNG).

Habitat Association Habitat Type	% of SNG	Spring 1 Apr - 15 Jun	Summer 16 Jun - 31 Aug	Fall 1 Sep - 15 Nov	Winter 16 Nov - 31 Mar
Hummocky Sandhills					
Upland Grasslands	26.34	0.20	0.0	0.0	0.07
Midland Grasslands without switchgrass	12.68	0.10	0.0	1.17	0.14
Midland Grasslands with switchgrass	12.68	4.57	6.12	5.70	1.94
Lowland Grasslands	9.76	3.64	2.30	1.33	0.0
Deltaic Plain and Hummocky Sandhills					
Cropland	12.75	0.0	0.0	0.0	2.61
Shelterbelt	3.11	0.0	0.0	0.0	12.41
(N) =		76	49	54	57

was 12 inches or greater in depth. Snow drifts also tended to accumulate on the back and foot slopes on the lee side of hummocks in the grassland habitats. Prairie grouse also used these snow drifts to make burrows for night roosting.

The mean 100% visual obstruction measurements (VOM) for night roost sites was 1.9 ± 0.4 decimeters with a range from 1.5 to 2.2 decimeters. From these data, it was considered that 1.5 decimeters was the minimum level for good night roost habitat. This was the same as the minimum level determined for prairie grouse nesting habitat.

Prairie grouse day roost sites with the birds present were primarily in the Midland Grassland with switchgrass Habitat Type of the Hummocky Sandhills Habitat Association during spring and fall and primarily in the Upland and Lowland Habitat Types during summer (table 7). In summer, day roosts were associated with shrubs. Summer day roosts were mainly in lead plant (Amorpha canescens) in the upland and willow (Salix spp.) in the lowlands. Shrubs provided shade from the hot sun and good canopy cover in the summer. No day roost sites were found in the winter.

The mean 100% visual obstruction measurements (VOM) for day roost sites was 1.5 ± 0.4 decimeters with a range from 1.1 to 1.9 decimeters. The 100% VOM values were lower for day roosts than night roosts. Day roost sites characteristically had one of the four sides with very low vegetation. The birds head was at the side with low vegetation and the pile of feces developed at the opposite side. Mean 100% VOM for the three high sides of day roost sites was 1.9 decimeters.

Night roosting habitat was primarily the switchgrass portion of the Midland Habitat Type of the Hummocky Sandhills Habitat Association with mean 100% VOM of 1.5 decimeters or greater. During winter, night roosts were primarily in snow burrows. These snow burrows were located in areas where snow accumulated to 12 inches or greater in depth. Day roosting habitat was primarily the switchgrass portion of the Midland Habitat Type of the Hummocky Sandhills Habitat Association with mean 100% VOM of 1.1 decimeters or greater. Shrubs on the Upland and Lowland Habitat Types of the Hummocky Sandhills Habitat Association were used during the summer.

SUMMARY

The Hummocky Sandhills Habitat Association was the primary spring and summer prairie grouse habitat and the Deltaic Plain Habitat Association was the primary winter habitat. All of the grassland and cropland habitat types of the Hummocky Sandhills and Deltaic Plain Habitat Associations were used by prairie chicken and sharp-tailed grouse during some seasonal period of the year and should be considered as valuable prairie grouse habitat. The switchgrass portion of the Midland Habitat Type of the Hummocky Sandhills Habitat Association was by far the primary grassland habitat used by prairie chicken and sharp-tailed grouse on the Sheyenne National Grasslands. It was used for concealment cover during spring courtship. It was the only native grassland habitat selected for nesting. It was one of the major brood habitats. It was the primary night roosting habitat and an important day roosting habitat. The Cropland and associated tree shelterbelt Habitat Type was the primary prairie grouse habitat used in winter. The Cropland Habitat Type was used by prairie grouse for the source of high energy food from spilled grain, crop residue and unharvested

Table 7.--Habitat use index for prairie grouse day roost sites on the Sheyenne National Grasslands (SNG).

Habitat Association Habitat Type	% of SNG	Spring 1 Apr - 15 Jun	Summer 16 Jun - 31 Aug	Fall 1 Sep - 15 Nov	Winter 16 Nov - 31 Mar
Hummocky Sandhills					
Upland Grasslands	26.34	0.23	3.16	0.0	0.0
Midland Grasslands without switchgrass	12.68	0.0	0.0	0.0	0.0
Midland Grasslands with switchgrass	12.68	7.10	0.0	7.89	0.0
Lowland Grasslands	9.76	0.0	1.71	0.0	0.0
Deltaic Plain and Hummocky Sandhills					
Cropland	12.75	0.0	0.0	0.0	0.0
Shelterbelt	3.11	0.0	0.0	0.0	0.0
(N) =		10	6	23	0

standing row crops that they needed during the winter.

Management for prairie chicken and sharp-tailed grouse habitat should consider all available Habitat Types of the Hummocky Sandhills and Deltaic Plain Habitat Associations as important. Habitat types of the Choppy Sandhills and River Terrace Habitat Associations were not selectively used by prairie grouse and should be managed for purposes other than for prairie grouse. Two habitat types were more important to the prairie grouse than the other habitat types. These two habitat types were the switchgrass portion of the Midland Habitat Type of the Hummocky Sandhills Habitat Association and the Cropland and associated tree shelterbelts Habitat Type. The Midland Habitat Type should be manipulated by mowing or burning on a 5 or 6 year cycle to maintain high quality habitat. Portions of the Lowland Habitat Type should be manipulated by mowing and burning annually to draw grazing pressure away from the Midland Habitat Type. A conscious effort should be made by state and federal agencies to provide unharvested high energy food on the Cropland Habitat Types for use by prairie grouse during winter.

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A Method for Trapping Prairie Grouse Hens on Display Grounds[1,2]

John E. Toepfer,[3] Jay A. Newell,[3] and John Monarch[4]

Abstract: This paper describes a method for trapping prairie grouse hens on display grounds. The basic principle of the trap is a drift fence which funnels visiting hens into traps. The trap has been used successfully in at least 6 states and 2 provinces and on 4 species of prairie grouse. This method is less expensive and less disruptive than rocket or cannon nets.

INTRODUCTION

One of the most difficult and time consuming aspects of studying prairie grouse is capturing hens for marking and radio-tagging. Rocket and cannon nets placed on the display grounds have been used but they are cumbersome, and if used too often may disrupt normal breeding activities. This paper details a simple, inexpensive method for trapping hens on display grounds and if used properly creates only a minor disturbance to the displaying cocks.

The basic principle of this trap is that of a drift fence placed on the display ground. It's basic concept is not new since similar traps have been used to capture a wide variety of birds (Wilbur 1967 and McClure 1984). The "cloverleaf" trap (Dorney and Mattison 1956) used the same principle to capture ruffed grouse hens and their broods. Mussehl (1960) and Tomlinson (1963) used drift fences and funnel traps to capture blue grouse on the breeding grounds.

METHODS

This trapping system consists of a series of traps and wire leads placed to intercept hens as they walk across the display grounds. Two systems of deploying the leads were used: (1) a circle and (2) a "W" (Figs. 1 and 2). The circle was initially developed by John Monarch and associates to capture Columbian sharptail hens (*Tympanuchus phasianellus columbianus*). The circle system consisted of a series of 5 chicken wire leads and traps placed around the dominant cock, thereby intercepting and trapping hens as they visited the display ground for breeding (Fig. 1). One or more of the traps in this system should have a funnel opening facing the center to capture hens as they leave because some hens will jump the wire to get near the dominant cock. Placement of the leads is critical in the circle system because if it does not encircle the dominant cock, hens will walk by or around the leads.

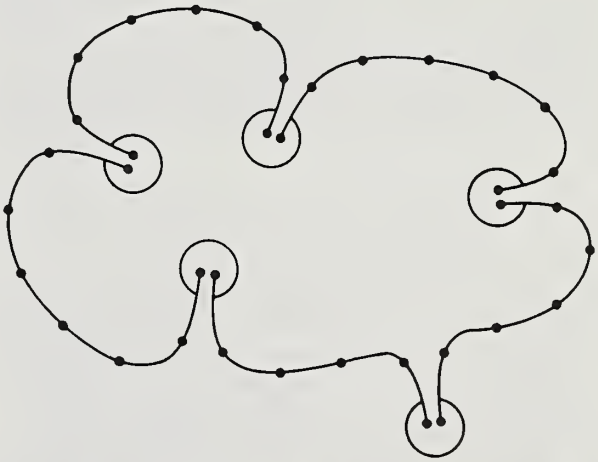

Figure 1.--Circle system of deploying traps and wire leads to capture sharptail hens.

Greater prairie chicken (*Tympanuchus cupido pinnatus*) cocks on booming grounds are more widely spaced than sharptails. Consequently the circle method does not cover enough of the booming ground to intercept hens. The circle system, also requires knowing the location of the dominant cock, which will limit trapping early in the

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[2] Contribution No. 2144 from Montana Agric. Exp. Stn.

[3] Fish and Wildlife Program, Department of Biology, Montana State University, Bozeman.

[4] Pittsburg and Midway Coal Company, Denver.

booming season. In order to cover more of the booming ground and trap earlier in the season Toepfer and Newell developed the "W" method of deployment (Fig. 2).

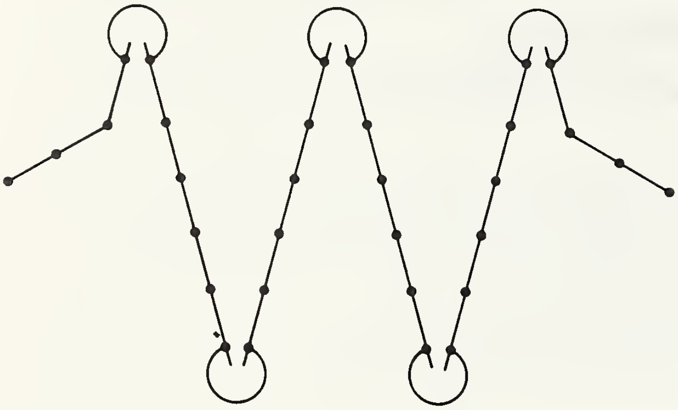

Figure 2.--"W" system of deploying traps and wire leads to capture prairie grouse hens.

The "W" consisted of 5 or more chicken wire leads oriented perpendicular to the path of visiting hens with funnel traps at the ends (Fig. 3). Trapping success was enhanced when the general movement patterns of hens were observed before placing the trap. Movement of hens varied between booming ground and often changed from day to day necessitating some adjustments in the positioning of the leads. Frequently the best location for the "W" was across the center of the display ground. The avantages of the "W" are that it covers more of the display ground and it can be effective when placed across the center of the display ground prior to observing the movement of hens.

Wire leads and traps were the same for both methods of deployment, and consisted of 18-24 inch, 1 inch mesh chicken wire. The number and length of the leads in the "W" system varied with the size of the booming ground. Five leads, 50-75 feet long, were usually used. The chicken wire leads were supported with metal or wooden stakes, although metal rods woven through the wire were the best. Early in the season a hammer was necessary to pound stakes into the frozen ground and a vice grips pliers was necessary to remove the stakes. Rigid chicken wire (1 inch mesh, 16-18 gauge) was used for leads so the cocks did not bend them over when using them for perches.

Catch traps were made of separate 8-10 foot long by 2 feet wide lengths of 2 x 2 inch or smaller mesh welded wire turned into a horseshoe-shaped coil with the two ends forming an entrance approximately 6 inches wide (Fig. 3). Larger traps can be used, but removing trapped birds becomes more difficult. Wire leads were fastened to the trap entrances so the leads went partway into the trap (Fig. 3). The leads were held in place by two 2-3 ft. rods woven through the end of the chicken wire leads and sides of the entrance to form a "V" into the trap.

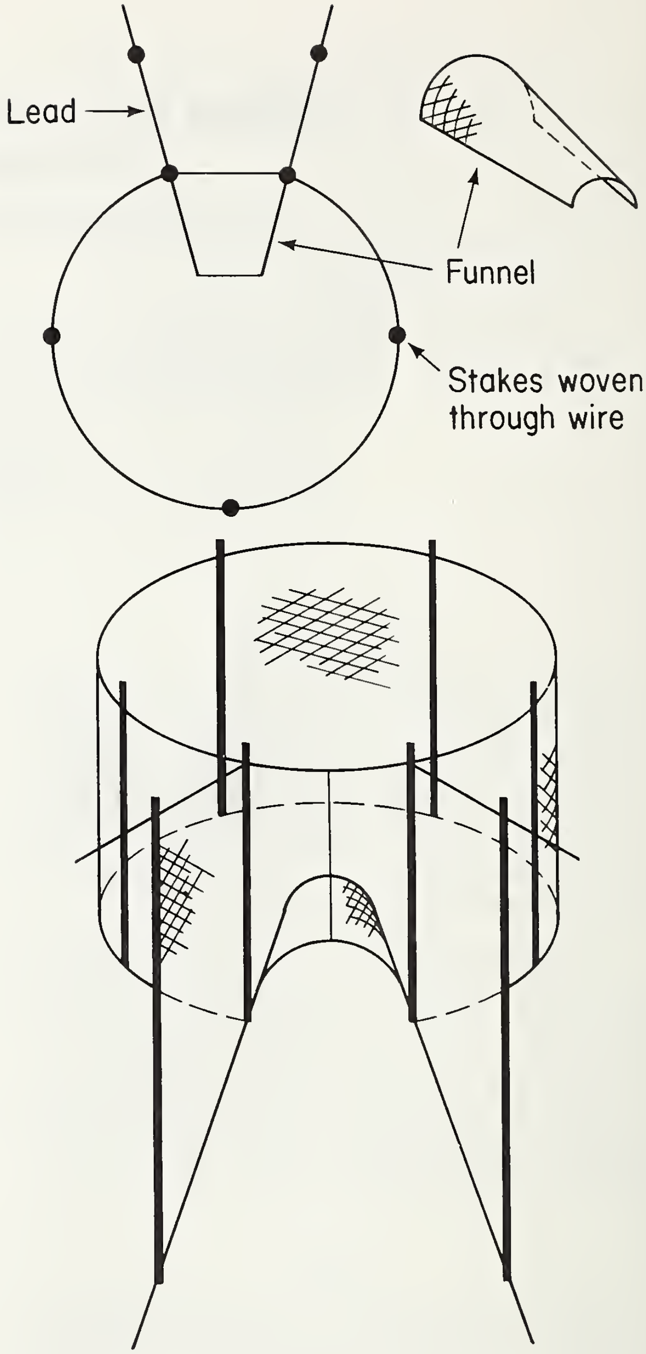

Figure 3.--Traps, wire leads and funnel.

The trap was secured at ground level with 2-3 metal stakes pounded into the ground. Metal or plastic tent stakes worked to secure the traps, but are expensive. The top of the trap was covered with soft fish netting which overlapped the sides. The netting was held in place with open hog rings used as hooks to hold the netting down along the sides of the trap. The mesh of the netting should be small enough so the bird cannot get their wings or head through it. The tops should not be covered with wire as the birds will scrape their heads and wings when trying to escape.

A funnel at the entrance into the trap is essential to prevent trapped birds from finding their way out (Fig. 3). Funnels were made of chicken wire and extended approximately 8 inches into the trap. The opening into the funnel should be 6-8 inches high and drop down to 4 inches.

Hens were captured in both baited and unbaited traps. Some hens were attacted to the bait while others showed no interest. The use of bait can create problems as it will attract cocks to the traps.

Traps set on the booming ground for the first time will capture some cocks. The number of cocks captured can be reduced by leaving the traps closed for at least a day while the cocks learn to avoid the closed entrances. However, some cocks will still be captured usually when they move onto the grounds in the early morning. Cocks should be removed from the traps as soon as possible because their behavior will discourage hens from entering a trap. Hens will go into traps with other hens, but will hesitate to enter a trap with a cock present. We have left cocks and hens in traps up to 45 minutes with no problems. However, if 2 cocks or a hen and a cock became caught in the same trap they should be removed immediately to avoid injury.

To avoid injury and prevent birds from being captured inadvertently the traps should not be left unattended or opened before the cocks go to roost at night. It is best to open the traps in the morning before the cocks begin to display or at least 1 hour after the cocks have gone to roost.

Walk-in traps have been set on the same booming ground from 1 April-10 May. Cocks appeared to adjust to the wire leads and traps usually within a day. For morning trapping it was best to set the trap the day before and let the cocks adjust to the traps and leads during the evening display period. Some cocks that were captured several times were known to shift their territories away from traps and leads. All cocks were banded and none were known to abandon the booming ground.

During the 1983 and 1984 breeding seasons we trapped 46 prairie grouse hens in 60 days using the "W" walk-in traps on 4 booming grounds in North Dakota. The earliest a hen was captured was on 2 April and the latest on 3 May. Most hens (70%) were captured from 17-25 April. In addition to walk-in traps 3 hens were captured with rocket nets and 4 with bownets in 1983.

A comparison of the 3 trapping methods showed that the walk-in traps were approximately 3 times more efficient (0.29 hens/hour) than the rocket nets (0.10 hens/hour) and 6 times more efficient that bownets baited with corn (0.05 hens/hour). The walk-in trap also captured a higher percentage of the hens present on the booming ground than rocket nets (16.7% vs 4.7%). In an earlier study in Minnesota in 1977, it took 4 men, 122 hours to capture 20 hens on booming grounds using rocket nets (0.16 hens/hour and 14.2% of the hens) (Toepfer unpubl. data).

Only 1 of 65 birds captured in walk-in traps died. This mortality was due to 2 cocks getting in the same trap and being harassed by a redtail hawk (Buteo jamaicensis) before the observer could get to the trap. One of these 2 birds suffered a broken wing in the encounter and was collected. By contrast the mortality rate for rocket nets was 3%.

The traps without leads were also used to capture individual prairie chicken cocks by placing a trap baited with corn in a cock's territory. The "W" system with traps baited with corn was also used to trap cocks and hens in winter feeding areas. However, because of the behavior of birds once inside the traps usually only 1, or at most 2 birds were captured at a time. The traps with leads should be effective on the display ground during fall and in intercepting and capturing a few birds in fall feeding areas when food is not limited. Ligon (1946) also felt that wire leads could be used to intercept and trap prairie chickens as they moved to and from feeding areas.

The "W" system has also been used to capture lesser prairie chickens (Tympanuchus pallidicinctus)and sage grouse (Centrocercus urophasianus) hens. No cost figures are available, but several walk-in traps can be purchased for the price of a single rocket net setup.

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Summary Brood-Rearing Ecology of the Greater Prairie Chicken on the Sheyenne National Grasslands[1,2]

Jay A. Newell,[3,4] John E. Toepfer,[3] and Mark A. Rumble[5]

Abstract--Twenty-two radio-tagged hens hatched 265 chicks, of which all but 4 left the nest. Mortality of chicks was high, especially in the first 24 days, with only 28.4% surviving to the end of summer. Brood ranges varied from 22 to 2248 ha with an average of 488.6 ha for 15 broods that had at least one chick alive on 10 August. Several factors influenced the size of the range, including timing of the nest, age of the hen, and loss or potential loss of young due to predation, mowing or grazing. Small areas within the total range were used more intensively. These areas averaged 40.4 ha. Broods were relocated in native vegetation 70.1% of the time. When in native vegetation they were found in lowlands, midlands and uplands 45.5, 26.9 and 23.2% of the time, respectively. Broods seldom night roosted in upland vegetation, the community most heavily grazed by cattle. Broods were seldom relocated in pastures with cattle (26.8%) and usually left areas once they were mowed. Deferred pastures contained the greatest number of intensive use areas, 10, while prairie hay and alfalfa had 8 and 5 respectively. Population declines in recent years might be due in part to the poor brood survival.

INTRODUCTION

Quantity of grassland vegetation appears to be directly related to pairie chicken (Tympanachus cupido) population levels (Schwartz 1945, Baker 1953, Hamerstrom et al. 1957). However, quality of the grassland vegetation is also important (Christisen and Krohn (1980).

Lack of quality grassland most often affects the availability of nesting and brood-rearing habitat, considered to be the most important factor influencing prairie chicken population levels (Hamerstrom et al. 1957, Kirsch 1974, Westemeir 1980). Although spring and summer ecology of hens and broods is important, it is probably the least understood period in the life cycle of the prairie chicken (Hamerstrom and Hamerstrom 1973). Radio telemetry studies have povided some information on habitat use and movements during the brood rearing period (Silvy 1968, Bowman and Robel 1977, Svedarsky 1979) but more information is needed.

This study was initiated in the spring of 1983 to:
(1) determine the brood-rearing habitat requirements of the greater prairie chicken,
(2) evaluate grazing management practices and their effects on prairie chicken habitat, and
(3) develop compatible management recommendations for prairie chickens and livestock.

Field work was conducted from March through August in 1983 and 1984 on the north unit of the Sheyenne National Grasslands, North Dakota.

This study was funded by the USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Rapid City, SD. The assistance of Robert Riddle, William Fortune, and Mike McNeal of the Sheyenne National Grasslands District, Custer National Forest, and the members of the Sheyenne Valley Grazing Association is gratefully acknowledged. R. L. Eng is acknowledged for his constant support, shared experience, and guidance throughout the project.

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[1] Paper presented at Prairie Chickens on the Sheyenne National Grassland Symposium, September 18, Crookston, MN.

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STUDY AREA

The north unit of the Sheyenne National Grasslands District of the Custer National Forest (SNG) is located approximately 36 km southwest of Fargo, North Dakota. It encompasses approximately 27,150 ha of USFS land interspersed with 25,338 ha of private land. The primary economic use of the SNG was cattle grazing. The private land was used for pasture, alfalfa hay (Medicago spp.), prairie hay, or cash crops.

Grazing on public lands usually began 15-20 May and ended 15-20 November. Management of pastures varied on a yearly basis and between allotments depending upon pasture size, stocking rates, and weather conditions. The most common grazing systems were the 3-pasture deferred, 2-pasture rotation and continuous system. Lessees were encouraged to mow "rank" vegetation in lowlands of the deferred pastures and first pasture grazed of the 2-pasture systems between 15 July and 15 August. Lessees were occasionally allowed to mow lowland vegetation in the continuous systems and in other pastures besides those previously mentioned.

METHODS

Forty-six prairie chicken hens were captured using paired rocket nets, bownets (Anderson and Hamerstrom 1967), and walk-in traps. Captured birds were aged by outer primary wear (Petrides 1942, Wright and Hiatt 1943, Ammann 1944). Hens entering their first breeding season were considered juveniles throughout the summer while all others were adults. Radio transmitters mounted on a bib (Amstrup 1980) were placed on captured birds then they were released on or near the display ground of capture. Two types of solar-powered radio transmitters were used with mean weights of 16.8 and 22.0 grams.

Most relocations were made using a single eight-element 3.8 m antenna mounted on a vehicle. Bird locations were determined by triangulating from two or three recognizable points on 1:660 air photos. Ground to ground range was between 0.8 and 1.6 km. Estimated accuracy using similar equipment was 41 m at distances from 305 to 537 m (Toepfer 1976). A fixed-wing airplane with a two-element yagi mounted on each strut was used occasionally to relocate birds. Hand held yagis were used to pinpoint hens on nests and to periodically flush hens. An attempt was made to locate broods at least once every other day through August.

Night roosts of hens were periodically marked by approaching hens in the dark and flagging nearby vegetation. The roost was found the next day by searching the area with a dog. Height-density of vegetation at the center of the roost was estimated using a Robel pole (Robel et. al. 1970).

Radio locations were digitized into an X-Y coordinate system using the Universal Transverse Mercator Grid (UTM) (Avery and Berlin 1977) and were entered into a computer program TELDAY (Lonner and Burkhalter 1983) to determine home range area. Home range was defined as the area enclosed by connecting the outer perimeter of points (Hayne 1949). Only ranges of hens with at least one chick alive on 10 August were used to calculate mean brood ranges. Within the total brood range, hens spent a greater portion of time in small areas called intensive use areas (IUAs). IUAs were areas where all relocations for at least five consecutive days fell within a small area relative to the total brood range. The assumption was made that hens remained within the IUA between successive locations. Distances were measured between IUAs as an indicator of brood mobility.

The vegetation surrounding booming grounds on which birds were captured was cover-typed in early May and late August of each year. Vegetation was classified into the following height classes: Class I (0-8 cm); Class II (9-25 cm); Class III (26-50 cm); Class IV (over 51 cm). Each location of a prairie chicken was assigned to one of the above height classes and a community type. Community types included upland, midland, lowland (Manske 1980), grass/shrub, lowland II (dominated by prairie cordgrass (Spartina pectinata)), alfalfa, or planted prairie hay. Community types were: determined from SCS air photos superimposed over radio relocations; or recorded at night roosts, nest sites, or sites where birds were flushed.

Each relocation was assigned a land disturbance type based on past and present land use, pasture type, cattle presence, private land use, and ownership. Analyses of use of disturbance types by prairie chickens were based on whether the areas selected were grazed or mowed and whether the disturbance type selected after hatching was more disturbed, less disturbed, or as disturbed as the type the nest was in. Even though an IUA may have consisted of more than one disturbance type, it was assigned assigned the disturbance type from which the most relocations were recorded. The total number of days broods spent in each disturbance types was then calculated.

In cases where a relocation was within 41 m of another community or disturbance type, those relocations were originally assigned a code for edge. However, there were relatively few edge relocations for disturbance type so edge codes were not incorporated in disturbance type analysis.

Vegetation in four communities -- upland, midland, lowland, and planted prairie hay -- was monitored for changes in height and density along 21 photo-plot transects throughout the summer (Newell 1987).

To compare early and late brood mortality, the summer was divided into two time periods, from hatching until the first time the brood was flushed and from the first flush until the end of the summer. If a hen was killed during the brood period it was assummed that the chicks also died.

RESULTS

Movements and Home Range

Brood hens utilized IUAs for periods ranging from 7 to 57 days (mean=24.8 days SD=14.9). Twenty hens had 40 IUAs identified during the course of this study. Four hens who lost their broods or were killed early in brood-rearing were not included in calculations of mean IUAs (Table 1).

Table 1. Average size of intensive use areas of broods on the SNG, 1

Age	Mean (ha)	SD	No. area
Adult	40.5	47.7	19
Juvenile	40.2	50.3	17
Total	40.4	48.2	36
After Renest	21.6	11.7	11
After Initial	48.6	55.7	25

Mean distance from the nest to the first IUA was 0.47 km (SD=0.56) with little difference exhibited between adults and juveniles (Table 2). Mean distances to the second and third IUAs were over two times greater for juveniles than adults. The furthest distance moved by an adult with a brood between IUAs was 2.3 km, while 3 of 10 juveniles moved from 2.4 to 10.5 km with broods 12 to 34 days old.

Mean brood range sizes were largest for juvenile hens that hatched initial nests (Table 3). The smallest brood range for any juvenile that hatched an initial nest and had chicks at the end of the summer was 229 ha which was larger than all adult brood ranges except one. Individual brood rearing ranges varied greatly from 22 - 2248 ha, and averaged 488.6 ha (SD=709.5, n=15).

Table 3. Mean brood range size of adult and juvenile prairie chicken hens.

Age	Nest Type[1]	x-(ha)	SD	N
Adult	I	255.8	99.8	4
Juvenile	I	1178.8	915.5	5
Combined	I	768.6	812.1	9
Adult	R	77.5	42.3	4
Juvenile	R	51.0	35.4	2
Combined	R	68.7	38.9	6
Adult	R&I	166.6	118.8	8
Juvenile	R&I	856.6	928.4	7
All Combined	R&I	488.6	709.5	15

[1] I = Initial nest, R= Renest.

Habitat Utilization

Community type locations were recorded for 921 hen relocations during the brood rearing period. Most of the use associated with agricultural communities was in alfalfa and planted prairie hay. Of all brood locations in agricultural communities, 87.3% were in planted prairie hay (37.9%), alfalfa (41.0%), or in associated edge communities (8.4%). Hens decreased use of agricultural community types by 23% in August. Three broods used alfalfa almost exclusively. Following the mowing of alfalfa, brood hens remained near the fields but used the edge of windbreaks, ditches, and adjacent prairie hay for cover. Twenty-nine (12.7%) of all brood locations in non-native communities were recorded in cash crops or their associated edge, most of which were those of one brood.

Brood hens were relocated in native vegetation (public and private land) 70.1% of the time. Structurally, the vegetation in midlands and lowlands was similar, and differentfrom uplands. Upland vegetation was heavily grazed by cattle throughout the summer. Most brood relocations were in the lowlands with the highest use occurring in June when lowland vegetation was much taller and denser than upland or midland vegetation (Table 4).

Table 2. Mean distance (km) moved by brood hens from nest site to first intensive use area, and mean distances between subsequent intensive use areas.

Age	km from nest			km to second			km to third			km to fourth		
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Adult	0.57	0.66	9	1.01	0.36	6	1.03	0.28	4	1.12	-	1
Juvenile	0.39	0.47	11	2.83	3.94	6	2.86	1.19	3	-	-	0
Total	0.47	0.56	20	1.92	2.83	12	1.82	1.21	7	1.12	-	1

Table 4. Percent use of native communities, combined with their respective edges, by broods.

Community type	June		July		August	
	%	N	%	N	%	N
Upland	22.5	41	26.0	66	20.5	43
Midland	25.8	47	25.5	65	29.5	62
Lowland	48.3	88	44.1	112	44.8	94
Grass/shrub	3.3	6	4.3	11	5.2	11

Mean Robel pole reading from 43 night roosts of brood hens averaged 1.04 (SD=.68). Thirty-seven (86.0%) were located in Class III or taller vegetation while none were recorded in Class I vegetation; only 18.6% of all brood night roosts were found in the upland community.

Fifty-six percent of all brood locations were on public land (Table 5). Although in July broods spent more time on private land . Brood hens often used areas that had been mowed the previous year, with 30.4% and 45.9% of the relocations in prairie hay or alfalfa, respectively, in June and July. Alfalfa and prairie hay use by broods declined to 24.8 % in August due to the mowing of those community types. Hens with out broods left mowed prairie hay fields, whereas those with broods sometimes remained in or near mowed alfalfa fields.

In June, July, and August 64.9, 49.5 and 60.8% of all brood locations, respectively, were in pastures. Three-pasture deferred systems were used most by broods in all months (Table 5). Within 3-pasture systems, 53.9% of the locations were in the deferred pasture. Pastures deferred one and two years prior had 30.7 and 15.4% of the locations, respectively. Hens tended to avoid pastures with cattle and pastures that had been grazed earlier that year. Seventy-three percent of all brood locations were in disturbance types without cattle.

After hatching, hens often moved their broods from the disturbance type in which they nested, to a different disturbance type. Of 19 hens that made a selection of disturbance type following hatching, 6 moved their broods from areas with cattle to areas without cattle and 9 stayed in disturbance types that were undisturbed (unmowed or ungrazed) in the current year. Of the 4 that remained in grazed pastures, one lost her brood within 6 days, two stayed in the more disturbed area for 7 and 11 days, and one remained in a relatively undisturbed portion of a grazed pasture throughout brood rearing.

Table 6. Disturbance types that were the major components of intensive use areas (IUAs) and the number of brood days spent in each.

Disturbance type	No. IUAs	No. Days	N[1]
4-pasture	2	25	2
3-pasture[2]	1	10	1
3-pasture[3]	6	154	4
3-pasture[4]	10	243	7
2-pasture[2]	3	59	7
2-pasture[3]	1	10	1
1-pasture	2	38	2
Prairie hay	8	197	7
Alfalfa	5	143	4
Barley	1	23	1
Private pasture	1	20	1
Total	40	922	32

[1] Number of different broods.
[2] First pasture grazed.
[3] Second pasture grazed
[4] Deferred pasture.

Table 5. Number and percent of relocations in disturbance types for brood hens June-August, 1983-1984.

Disturbance type	June		July		August		Total	
	No.	%	No.	%	No.	%	No.	%
Public[1]								
4-pasture	11	4.1	5	1.3	3	1.1	19	2.1
3-pasture	95	35.2	130	33.9	119	44.1	344	37.3
2-pasture	11	4.1	30	7.8	7	2.6	48	5.2
1-pasture	58	21.5	25	6.5	35	13.0	118	12.8
Private								
Prairie hay	11	15.2	131	34.2	43	15.9	215	23.3
Alfalfa	41	15.2	45	11.7	24	8.9	110	11.9
Crops	3	1.1	10	2.6	13	4.8	26	2.8
Misc.[2]	10	3.7	7	1.8	26	9.6	43	4.7
Total	270	100.0	383	99.8	270	100.0	923	100.0

[1] Includes nine locations in grazed pastures, private land
[2] Includes road ditches and undisturbed areas.

Forty-three percent of all locations of hens with broods were in deferred pastures and prairie hay. Analysis of IUAs suggested that hens selected those areas because of the lack of disturbance. Eighteen of 40 IUAs consisted mainly of prairie hay or deferred pastures, while 47.7% of all brood days were spent in those types (Table 6). Two other disturbance types

Table 7. Range of heights (HT) and densities (EHT) (cm) of vegetation along photo-plot transects.

Vegetation	Upland			Midland			Lowland		
	June	July	Aug.	June	July	Aug.	June	July	Aug.
EHT[1]	3-6	7-12	8-12	8-12	17-20	20-21	8-18	25-30	6-1
HT[1]	11-21	22-31	31-33	22-30	35-40	40-48	20-36	22-50	17-22
EHT[2]	3-4	3-6	3-5	8-10	10-11	9-11	7-10	9-14	11-14
HT[2]	12-13	9-11	7-11	27-28	22-27	24-25	16-23	20-31	25-31
EHT[3]	5-6	9-11	5-11	7-10	12-14	12-14	10-14	18-22	18-22
HT[3]	15-17	20-28	16-28	19-25	24-28	24-29	25-33	46-59	46-59
EHT[4]				3-13	17-21	2			
HT[4]				9-23	34-42	6			
EHT[5]							16-29	35-39	35-39
HT[5]							31-51	61-72	69-72

[1] 3-pasture, deferred pasture.
[2] 3-pasture, deferred 1 year prior.
[3] 3-pasture, deferred 2 years prior.
[4] prairie hay.
[5] continuous system. Lowland II community.

contained significant numbers of IUAs, the second pasture grazed of 3-pasture systems and alfalfa. In all but one case, hens utilized the second pasture grazed when cattle were not present, and the undisturbed edges of alfalfa fields when they were mowed.

Prairie hay and deferred pastures represented a small portion of the area available to a hen. Height and density of vegetation was superior in all communities in the deferred pasture (ungrazed) in June and July (Table 7). Height and density of vegetation was similar to the deferred pasture in the undisturbed prairie hay in July. Lowland and prairie hay vegetation was mowed in August which accounts for the tremendous reduction in height and density in that month. Lowland vegetation that received the most use was the tallest and densest in most disturbance types during the summer. Even though hens nested in and broods were relocated close to the lowland II community, they were seldom observed in it. The lowland II community may have contained vegetation too tall and dense for easy brood movement.

Brood hens selected Class III (26-50 cm) or taller vegetation 81.8% of the time throughout the summer. Hens appeared to avoid Class II or shorter vegetation, especially as the growing season progressed and taller vegetation became more available (Table 8).

Table 8. Height class of vegetation used by brood hens on the Sheyenne National Grasslands, 1983-84.

Height Class (cm)	June No.	June %	July No.	July %	August No.	August %
I (0-8)	15	5.7	6	1.6	5	1.9
II (9-25)	23	8.7	12	3.2	24	9.0
III (26-50)	150	56.8	202	53.2	116	43.4
IV (> 51)	38	14.4	135	35.5	94	35.2
edge[1]	38	14.4	55	24.7	28	10.5

[1] Locations within 41m of two height classes.

Brood Mortality

Twenty-two radio-tagged prairie chickens produced 265 chicks, all but 4 of which left the nests. Mortality of broods was high, especially during the first 2.5 weeks of brood rearing. Three hens made 3, 11, and 9 km moves 1, 5, and 10 days, respectively, after hatching. Periodic marking of roosts, and flushing, indicated they had each lost their entire brood prior to these moves. In addition, five hens were killed during the brood rearing period, three within 17 days after hatching and two after 45 and 53 days.

Brood hens were first flushed an average of 24 (SD 13.1) days after leaving the nest. Mortality during this early period averaged 0.31 chick per day per hen, resulting in a loss of 62.8% of the chicks. The average number of days to the end of the summer was 32.9 (SD 12.48) days. Mortality during this later period was 0.04 chick per day per hen, resulting in a loss of 8.9% of the chicks.

Of 261 chicks that left the nest, only 28.4% (74) survived to the end of the summer. Average brood size for 13 hens that had chicks at the end of the summer was 5.7 (SD = 3.75). In two years, 45 prairie chicken hens had only 74 chicks survive until 31 August. Of the 22 radio-tagged prairie chicken hens that produced chicks, only 13 had one or more chicks at the end of the summer.

DISCUSSION

Brood Movements and Home Range

Earlier studies indicated that hens with broods remained in the area of the nest following hatching (Schwartz 1945, Hamerstrom and Hamerstrom 1949). With the advent of radio telemetry, investigators found that broods were capable of making extensive moves within the first week of hatching (Viers 1967, Silvy 1968, Svedarsky 1979). Our data agree, and show that hens with broods were very mobile with five hens moving 2.0 to 10.5 km within 34 days of hatching.

Brood ranges in this study showed great varability, from 22 - 2248 ha, but are greater than previously reported in other areas. The smallest range for a hen which hatched an initial nest and had chicks at the end of the summer was 197 ha.

Several factors appeared to influence the size of the brood home range. All broods hatching from renests had smaller ranges than broods from initial nests. Successful renesting hens generally had much more restricted movements compared to hens having successful initial nests. Vegetation development, food availibility, and greater energy outlay for renesting hens might have influenced hen movements following hatching. Others have found that prairie chickens tend to become less mobile as summer progresses (Svedarsky 1979, Robel et. al. 1970).

Age of the hen seemed to influence brood range size. Females in their first breeding season had much larger ranges than adults. The largest move made between intensive use areas by any adult was 2.3 km, while four of six juveniles hatching initial nests made at least one move over 2 km.

Early long moves and subsequent larger home ranges of brood hens may have resulted from hens searching for suitable brood-rearing habitat (Svedarsky 1979). Suitable brood habitats have been described as areas that had been mowed, burned, or grazed the previous summer, and without tall, rank vegetation (Svedarsky 1979, Skinner 1977, Toepfer 1973,). Most of the SNG and associated land is disturbed annually by mowing, grazing, or cultivation with relatively small tracts of land going undisturbed for a period of time in any given year. Hens in this study appeared to avoid areas disturbed in the current year and utilize areas that were undisturbed or had minimal disturbance in the current year. The large brood ranges in this study might have been partially in response to disturbances such as mowing and grazing and/or brood predation.

Five hens remained in undisturbed IUAs that ranged in size from 9 to 83 ha. Two of the IUAs were in prairie hay and one each in alfalfa, the deferred pasture of a 3-pasture system and the first pasture grazed of a 2-pasture system. The average number of days spent in those IUAs was 31 (SD=19.7) and ranged from 11 to 57 days. Within three days of mowing, hens moved an average of 1.2 km, which may have resulted in increased mortality to chicks. One hen with 12-day-old chicks moved 1.5 km after the alfalfa she was in was mowed. Another hen which remained near a mowed alfalfa field was killed by a predator shortly after the second cutting.

Cattle appeared have to caused at least one hen to move from the area. Hen 1270 had spent 32 days in a 35-ha IUA in the deferred pasture of a 3-pasture system. Three days after cattle were introduced she moved from the pasture. Although only one hen was observed to shift immediately upon cattle entry into the pasture, only 27% of all brood relocations were in pastures with cattle, and hens appeared to avoid establishing IUAs in areas with cattle.

Attempted brood predation appeared to prompt moves. Sharp-tailed grouse (T. phasianellus) broods made long moves after the female was captured, and those moves may have been precipitated by the capture (Artmann 1970). Svedarsky (1979) hypothesized that it may be advantageous for a hen to move out of an area following a predator encounter, and that researcher approaches may be viewed as predator encounters. Some support for this hypothesis was noted in this study. A hen and brood moved 4.2 km following a flushing during which one of her chicks was accidently killed. This was the only instance where a brood hen moved immediately after being flushed. Five other shifts may have been caused by predator avoidance. A hen with a brood of 8 was oftened observed in close proximity to a perching Swainsons hawk (Buteo swainsoni). The hawk was observed on the ground near the hen and brood on 8 July. Subsequently, the hawk was flushed but no dead chicks were observed. However, the following day the hen moved her brood 10.5 km from the site. Another hen moved from her nest into a pasture with a fox den with six pups. After spending seven days in this pasture, the hen abruptly moved 1.5 km west of the area. Although 13 eggs had hatched only 2 chicks remained following the move. Moves of 3.2, 11.1 and 9.7 km were noted for hens that lost entire broods.

In summary, it appeared that the size of individual brood ranges was influenced by the timing of nest, age of the hen and loss or potential loss of chicks due to predation or habitat alteration.

Habitat Use

It appeared that disturbance types with suitable cover were selected for brood IUAs. Brood IUAs averaged 40.4 ha and might be considered a suitable management unit. Vegetation in lowlands and midlands of deferred pastures and prairie hay had superior height and density compared to grazed pastures. After mowing in late July or early August this was no longer true. Night roosts were in vegetation that provided complete visual obstruction over 1 dm with heights over 2.5 dm. Broods used lowlands and midlands more than uplands both day and night because of the superior cover provided, avoiding areas of sparse vegetation (Horak 1985). Rice and Carter (1984) reported that brooding hens selected the best available habitat with ample vegetation. Hens with broods in this study utilized vegetation which provided visual screening in excess of 2.5 dm in all summer months. Hens also avoided areas with sparse vegetation resulting from heavy grazing of uplands and mowing of prairie hay fields and lowlands. Hens appeared to avoid pastures with cattle present or areas with very tall and dense vegetation.

Although data were not collected on species composition at brood rearing sites, hens may have selected IUAs with concentrations of high-energy forbs such as alfalfa or sweet clover (Melilotus spp.). Five IUAs were located in alfalfa and 8 in prairie hay that was adjacent to or contained alfalfa. Diet analysis from fecal samples (Rumble et al., this proceedings) showed a high composition of alfalfa/sweet clover in the diets of brood hens. Svedarsky (1979) found that broods showed a preference for alfalfa fields.

Brood hens avoided cash crops, especially row crops during the summer and selected lowlands over midlands and midlands over uplands. Three percent of all brood relocations were in cash crops. Arthaud (1968) and Svedarsky (1979) also reported that prairie chickens spent little time in cultivated crops. Thus, with the exception of use made of mowed alfalfa, brood hens chose the areas on the SNG with relatively undisturbed vegetation.

Mortality

Mortality of chicks in this study was very high, with only 28.4% of the chicks surviving to the end of the summer. Chick mortality during the first 24 days appeared to be much higher than later periods. Mortality of hens was also high; 21 of 44 hens died during the spring and summer months (April - August). Most of the adult mortality was the result of predation, but the causes of chick mortality could not be determined. Populations of prairie chickens on the SNG have declined from 391 males in 1983 to 202 males in 1986, and these declines may be in part due to poor brood survival. There is a need to provide more areas 40 ha or greater with undisturbed vegetation that provides visual screening to 2.5 dm in height during the brood-rearing months on the SNG.

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Winter Ecology of the Greater Prairie Chicken on the Sheyenne National Grasslands, North Dakota[1,2]

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Abstract.--Twenty radio-tagged prairie-chickens (6 cocks, 14 hens) were followed during the winter of 1984-85 on the Sheyenne National Grasslands in North Dakota. A total of 3,945 (2,879 day and 1,066 night) locations were obtained from 9 December to 15 March. Winter survival was high at 58.8%. Mean winter home range size was 8.4 km^2 and slightly larger for hens than cocks (8.8 km^2 vs 7.7 km^2). Mean winter to spring movements were 4.4 km for cocks and 6.4 km for hens. All locations were within 6700 m of a known booming ground; 64% were within 2400 m with a mean of 2078 ± 980 m. Cocks remained closer to boomimg grounds than hens (Mean = 1797 ± 709 vs 2327 ± 1178 m). Mean movements from day areas to night roosts were 1085 ± 778 and were greater for cocks than hens (1358 vs 1035 m). Mean within day movements were less at 992 m for cocks and 899 for hens. When possible, radioed birds did not use the same roosting area on successive nights as the mean distance between successive night locations was 922 m. Agriculture and grass made up 71.3% of all the winter habitat types used by radioed birds (Agriculture 41.7%, Grass 29.6%). Picked corn made up 70.8% of the agricultural use. Habitat used at night was dramatically different from that used during the day; 66.7% of the night locations were in grassland habitat and 11.8% in shrubs, primarily snowberry. Lowland grass and sedges accounted for 64% of the night use. A breakdown by vegetation height classes showed that 78% of all locations were associated with 9 cm or taller vegetation; 59% with 25-50 cm cover. Over 75% of the night use was in 25 cm or greater vegetation and 77.9% in cover undisturbed within the past 8 months. Within these undisturbed areas night roosting prairie-chickens selected the taller available cover.

INTRODUCTION

Since the 1960's, winter ecology of the greater prairie chicken (Tympanuchus cupido pinnatus) has been largely ignored. Past studies that dealt with winter were limited with regard to movements and habitat use (Schmidt 1936, Grange 1948, Hamerstrom and Hamerstrom 1949, Baker 1953, Ammann 1957, Hamerstrom et al. 1957, Robel et al. 1970a and Horak 1985).

This study was initiated to examine the winter ecology of the greater prairie chicken on the Sheyenne National Grasslands (SNG) and to explore the effects of grazing practices on winter habitat of this bird. Radioed hens were monitored from mid-December 1984 until incubation which provided movement patterns from winter to spring.

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[2] Contribution No. 2146 from Montana Agric. Exp. Stn.

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STUDY AREA

The Sheyenne National Grasslands (SNG) is located 36 kilometers (km) south of Fargo, North Dakota. The north unit of the SNG contains 52,488 ha of which 48.4% is private and 51.6% is public land managed by the U.S. Forest Service in association with the Sheyenne Valley Grazing Association.

The terrain varied from level to rolling hills referred to locally as sandhills. The area is relatively open, but dotted with scattered solitary trees and small clumps of cottonwood (*Populus deltoidies*), aspen (*Populus* spp.) and Oak (*Quercus* spp). The grassland areas vary from level to rolling with grass-covered sand dunes 1.5-3 meters (m) above the level lowlands, which vermiculate between and through the higher uplands.

Manske (1980) divided the grasslands into 3 major communities: Upland (mixed grass prairie dominated by blue gramma (*Boutelous gracillis*) and Kentucky bluegrass (*Poa pratensis*); Midland (tall grass prairie) dominated by big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Kentucky bluegrass and switchgrass (*Panicum virgatum*); Lowland (sedge meadow) dominated by sedge (*Carex* spp. and *Carex lanuginosa*), blue grass, reed grass (*Calamogrostis* spp.) and switch grasses (*Panicum* spp.).

The SNG was managed using a multiple pasture system (1,2,3 or 4 pastures), primarily 3 pasture units. All 2,3 or 4 pastures were grazed at least once during the period May - November. One of the 3 or 4 pastures was usually deferred during the peak of the growing season. Most level lowlands were mowed once every 3 years to stimulate growth and encourage cattle to graze the lowlands.

METHODS

Trapping

Prairie chickens were captured in traps constructed of lengths of welded wire (approximately 0.7 X 3 m) with 2.5 cm mesh. The wire was staked to the ground in a circle forming a funnel on one side and covered with fish netting. Three to 5 traps were placed in known feeding areas and baited with cobbed corn. Age, adult or immature, was determined by primary feather molt and wear (Petrides 1942, Wright and Hiatt 1943, and Ammann 1944) and by depth of the bursa (Gower 1939, and Kirkpatrick 1944).

Movements

Radio transmitters (SM1 Type, 12-16 g. and SB2, 19-22 g AVM Instrument Company, Dublin, California) were in the 150-151MHz frequency range. Transmitters were powered by solar panels connected to a NiCad battery that stored power. The units were attached to the bird using a bib system similar to that used by Amstrup (1980). The larger units had a reduced antenna (16 cm) to prevent them from slapping the bird's wings inflight. The smaller units had full length antennas (25 cm) held forward at a 45 degree angle by a spring to avoid wing slapping. Two birds were radioed with back pack units (Dumke and Pils, 1973).

Radioed birds were located by triangulation with an AVM, LA12 receiver connected to a single 3.4 m high, 8 - element yagi antenna mounted on a vehicle. Ground to ground range of the system was respectively. Average accuracy using signal nulls for known transmitter locations (night roosting birds) with angles of intersection of between 60 and 120 degrees was $27.8 \pm 15.4_m$(n = 78) from 262-1016 m (Mean = 479.8 ± 189.2). At night, birds were located by approaching with a vehicle to within 5-20 m, marking the line and locating the roosts the next day for detailed analysis.

Each location was recorded as to date, time (CST), straight line distance to the last location, distance to the nearest booming ground, home or regular booming ground, nearest sharptail dancing ground, type of movement, habitat, disturbance type, vegetation height class and activity. The distances between locations were stratified into 2 types of daily movements: (1) the distances between a daytime and a subsequent night location (daylight to night move) and (2) distance between consecutive night locations. The distance to the nest was measured to the first known nest. The home booming ground for cocks was the one on which they displayed and for hens the one nearest their first nest. Home range is that defined by Burt (1943) and its area calculated by enclosing the outer perimeter (Hayne 1949).

Habitat Use

Habitat types were classified using cover type maps of the areas drawn from aerial photographs. Ocular percentage estimates were used to place cover into 7 general categories: Grass, Forbs, Agricultural, Shrubs, Wetland, Trees, and Other. Paired combinations of these categories i.e. Grass 80-100% equaled Grass, whereas a mixture of 50-75% Grass and 25-50% Forbs equaled Grass/Forbs. A shift in composition favoring Forbs (greater than 50%) was classified as Forbs/Grass habitat. These general categories were then visually classified according to the dominant plant specie(s). Disturbances were classified as to the type of disturbance within the last 8 months (undisturbed, agricultural, grazed, mowed). Vegetation height classes were established relative to the height of a standing prairie chicken. Class I up to the belly of a bird (0-8 cm), Class II up to the eye of a bird (9-25 cm), Class III above the birds head (26-50 cm), Class IV (51-100 cm) Class V (1-2 m) and Class VI (over 2 m). In addition to the major categories, habitat, disturbances and height were classified as an edge type when a location was within 55 m of a different habitat or disturbance. This compensated for the limitations in the accuracy of the radio locations and reduced the possibility of placing the location in the wrong habitat type.

Night Roost Analysis

The following data were collected at each roost: Robel pole (Robel et al. 1970b), snow depth, last disturbance, height class, distance nearest roost, maximum distance between roosts, depth of roost in snow, distance to nearest edge, type and disturbance of edge, and distance to feeding area. Random measurements were taken at points one meter apart along a line parallel to where the birds roosted.

Other

Maximum and minimum temperatures and depth of snow were recorded daily. Official precipitation records were obtained from the U. S. Weather station 2 miles east of McLeod. Winter was that period when 7 cm of snow had accumulated covering most ground level foods (15 December - 17 February) and early spring the period after the snow was gone (18 February - 15 March). In addition to the winter period, data were stratified into weekly periods.

The day was divided into two periods, daylight and dark. Daylight hours were stratified into 3 equal periods (AM, MIDDAY, PM) begining 1 hour before sunrise and ending 1 hour after sunset.

We emphasize that statistical or mathematical differences may or may not be biologically significant and that they are largely guides to possible differences. Our personal observations of prairie grouse suggest that they exist within ranges limited by their biological and physiological capabilities, individual experiences, and conditions at a given point in time. Therefore we have chosen to primarily identify common trends and patterns from which management decisions can be made. Means and ranges are presented in parentheses and the ± symbol represents 1 standard deviation.

RESULTS AND DISCUSSION

Weather

The winter of 1984-85 on the SNG can best be described as having average temperatures, below normal snowfall and an early spring. Mean temperature for winter was 3.9F (SD ± 12.3) and ranged from 29-33. At times the wind chill factor reached 40 to 50 below, 80 below on 19 January. Snow remained on the ground 64 days from 15 December to 17 February. Snowfall during the study period was 18 cm (7 in) during winter and 22.9 cm (9 in) in early spring. Average annual snowfall is 91.4 cm (36 inches) and average snow on the ground during winter ranges from 13-18 cm (5-7 in) for 80 days (DTP Background Report, 1979).

The regular presence of strong winds (1-60 mph) caused snow to drift. Some habitat types (lowlands, brush, windrows and fencelines) accumulated drifted snow, while ridges and parts of agricultural fields were often blown free of snow.

Radio-tagging

Eight cock and 15 hen prairie chickens were radio-tagged, 14 of which (4 cocks and 10 hens) received the larger, more powerful SB2 transmitters. In addition 3 hens radio-tagged the spring of 1984 were followed through the winter 1984-85.

Radio Locations

Twenty radioed prairie chickens (14 hens and 6 cocks) yielded 2879 day and 1066 night locations. The distribution of the radio locations were evenly distributed throughout the day (AM, Midday, PM, Night) (ChiSq. P = 0.47, df 3).

Flocking

On the SNG in winter and early spring 89% of 335 prairie chicken observations were of groups of 2 or more. Mean flock sizes for radioed and non-radioed prairie chickens were comparable (Mean = 7.9 ± 9.3, n = 154 vs Mean = 6.1 ± 8.0, n = 151). In the winter, mean flock size during the day was 13.8 ± 12.5, (n = 250), while at night only 5.5 ± 5.5, (n = 91) based on roost counts. The same pattern was observed in the spring, 5.8 ± 5.0 (n = 60) during the day versus 3.9 ± 2.6, (n = 15) at night. This difference in flock sizes between day and night is thought to be the result of small flocks coming together in common feeding areas during the day. The largest number of birds found roosting together in winter was 19.

The degree of integrity of smaller night groups is not clear. There was some shifting between groups as radioed individuals roosted together for several nights, but were apart on others. If social grouping existed it likely occurred in the smaller roosting flocks; however our data suggested that winter flocks appeared to be loosely bound.

Survival

Survival of prairie chicken cocks and hens was 66.6 (4 of 6) and 54.5% (6 of 11) respectively. Only individuals radioed as of 7 January were used to calculate winter survival. Of the 7 radioed prairie chickens found dead, 6 were fed upon by predators (5 by raptors and 1 by a mammal).

Home Range

Home ranges were calculated for all birds, but means only for those followed from the first week of January to 17 February. The mean winter home range for radioed prairie chickens was 8.4 km^2 (3.2 mi^2). Hens had slightly larger ranges than cocks and the ranges of immatures were larger than adults (Table 1).

Table 1. Mean home range sizes (sq km) for radio-tagged prairie chickens during winter, 15 December—17 February, Sheyenne National Grasslands, 1984-85.

Adult Hens	n= 7	8.7+4.6
Immature Hens	n= 2	9.3+3.2
Total Hens	n= 9	8.8+4.0
Adult Cocks	n= 4	7.2+3.2
Immature Cocks	n= 1	9.8+ -
Total Cocks	n= 5	7.7+4.1
TOTAL	n=14	8.4+3.6

Agriculture (private) and grassland (public) were represented in all home ranges. The ratio of grassland to agriculture was variable and ranged from 20:80 to 80:20. A mean of these ratios would be meaningless since each home range was a function of the distance between night roosting sites in grassland and feeding sites in agriculture. This distance varied for many individuals during the winter as snow conditions altered the availablity of food. Thus the proximity of available food to roosting areas controlled sizes of winter home ranges for prairie chickens on the SNG.

Individual birds moved most extensively in late December with the first snowfall, apparently searching for food sources. Once available food was located, birds established a regular pattern of use within the total winter home range. However, when new snow covered current source(s) of food, a shift in use pattern occurred. Some birds fed in only 1 or 2 fields all winter, but roosted in several areas.

MOVEMENTS

Winter to Spring

The mean maximum distance that radioed prairie chickens moved from winter to spring ranges (cocks to home booming ground hens to nest) was 4.4 km for cocks and 6.4 km for hens (Table 2). That cocks remained closer than hens to their home ground was also shown by the mean minimum distances moved (0.2 km for cocks and 3.2 for hens). Adult cocks, required no long seasonal movements as all remained within 5.0 km of their home booming ground.

Table 2. Mean distance moved (km) by radio-tagged prairie chickens from winter range (hens to nest and cocks to home booming ground), Sheyenne National Grasslands, 1984-85.

		Maximum	Minimum
Adult Hens	n=12	6.4+2.4	3.2+2.5
Immature Hens	n= 3	6.1+2.3	3.2+2.2
Total Hens	n=15	6.3+2.4	3.2+2.3
Adult Cocks	n= 4	4.0+0.3	0.2+0.1
Immature Cocks	n= 1	0.6+ -	0.3+ -
Total Cocks	n= 5	3.3+0.9	0.2+0.2
TOTAL	n=20	5.6+3.1	2.5+2.4

One immature cock moved 6.9 km (4.3 mi) from his eventual home booming ground, while covering a large area between three booming grounds in early March. He was known to have visited all three grounds, apparently in an effort to establish a territory. However, his home booming ground was only .6 km from his winter range.

Hens exhibited two general movement patterns in shifting from winter to spring range. Several hens wintered within 0.8 to 1.6 km of their spring ranges, while other hens moved considerable distances to eventual nest sites. Those which wintered close to spring ranges were in winter areas with more agriculture than grassland. Those which moved greater distances had spring areas characterized by large amounts of grass with little agriculture. It was felt the more extensive movements were related to winter food, with birds either returning to traditional food sources or moving until they found an adequate food source. More extensive moves made by adult hens suggested homing to the previous years nesting area. Two hens, followed during two springs, nested within 100 m of their previous years nests. Four other hens had nests which were found 2 years in a row (1 three) and all but one returned to nest near the same booming ground.

Movements made from winter to spring by adult hens were made quickly (1-2 days), were directional with no wandering, and each hen localized very soon near their eventual nest site. Three immature hens followed to nests showed no rapid movements that suggested homing. They also localized later and more slowly than adult hens.

Relationship to Booming Grounds

Winter distribution of prairie chickens on the SNG coincided closely with that of the booming grounds; for the most part, all birds remained within 3 km of a display ground. No radio-tagged prairie chickens were known to have left the SNG during the winter of 1984-85. All non-booming ground radio locations (n = 2444) and observations (n = 1985) of prairie chickens were within 6500 m (4 miles) of a known booming ground. The mean distance from radioed bird locations to nearest booming ground was 2007 ± 980 m in winter with 64.8% within 2400 m. The mean for non-radioed birds was 1921 ± 1001 m, with 68.1% within 2400 m. Radioed cocks in the winter were closer to booming grounds than hens (Table 3, Fig. 1),reflecting a strong association to their home ground. Evidence indicated that cocks attempted to stay as close to home ground as winter conditions and surrounding habitats permit. Hamerstrom et al. (1957) and Hamerstrom and Hamerstrom (1973) reported similar findings. Schwartz (1945) felt there was a "sphere of influence around each booming ground".

Hens showed much less association to a particular booming ground in winter than cocks, as only 49.5% of their locations were within 4000 m (2.5 miles) of their home booming ground (Mean = 4072 m, Table 3). Hens as a group showed little affinity for their nest sites during the winter, with only 54.9% of the observations within 4000 m (2.5 mi). The mean distance to home booming ground decreased in early spring with cocks being closer than hens (1302 m vs 2004 m, Table 3). Both adult cocks and hens were closer than their immature counterparts (Table 3). No relationship was demonstrated between prairie chickens and the nearest sharptail dancing ground (Fig. 2).

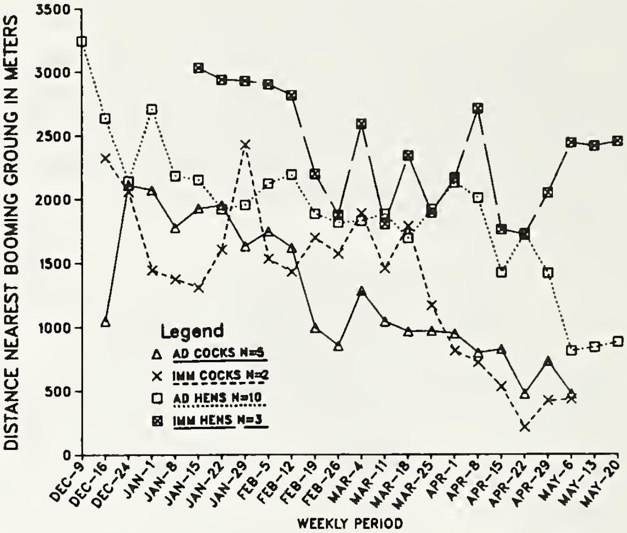

Figure 1.--Weekly mean distances to the nearest booming ground for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-20 May, 1984-85.

The cocks returned to booming grounds in February, 1 radioed cock was observed on 5

Table 3.--Mean distance to nearest and home booming ground and nest for radio-tagged prairie chickens, Sheyenne National Grasslands, 1984-85. Number of locations in parentheses.

	Cocks			Hens		
	Adult N=4	Immature N=2	Total	Total	Adult N=12	Immature N=3
Distance Nearest Booming Ground						
Winter	1845± 713(582)	1661± 679(203)	1797± 709(785)	2327±1178(1659)	2140±1150(1251)	2900± 586(408)
Early Spring	1102± 689(185)	1631± 579(112)	1302± 697(297)	2004± 898(1116)	1886± 930(789)	2287± 745(327)
Distance Home Booming Ground						
Winter	2755±1127(582)	2030±1322(203)	2568±1222(785)	4072±1975(1373)	4282±2125(965)	3575± 967(408)
Early Spring	1424±1124(185)	1941±1078(112)	1619±1133(297)	3662±1974(1104)	3889±2140(777)	3122±1373(327)
Distance Nest						
Winter				4299±2144(1283)	4426±2383(875)	4026±2001(408)
Spring				3932±1960 (986)	4075±2374(659)	3643±1546(327)

February and 2 others on 10 February. Hens returned to home booming ground and nest areas in late March, and early April. Adult hens moved towards nests earlier and remained closer than immatures (Fig. 3).

A strong tendency existed for prairie chickens to remain in areas near a booming ground. During winter hens were nearer a booming ground than their nests (2327 m vs 4299 m). This suggests that the area within 3.2 km of any given booming ground is the key to prairie chicken habitat management. This area could serve as an effective management unit or a group of grounds as a complex in which management could focus its activities.

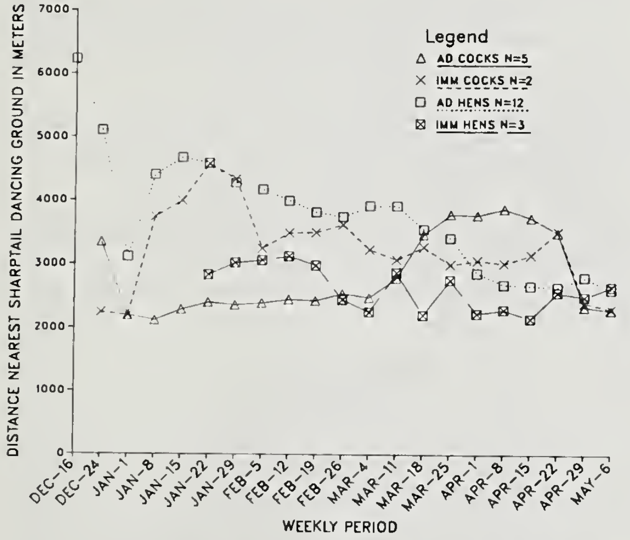

Figure 2.--Weekly mean distances to the nearest sharptail dancing ground for radio-tagged prairie chickens, Sheyenne National Grasslands, 16 December- 6 May, 1984-85.

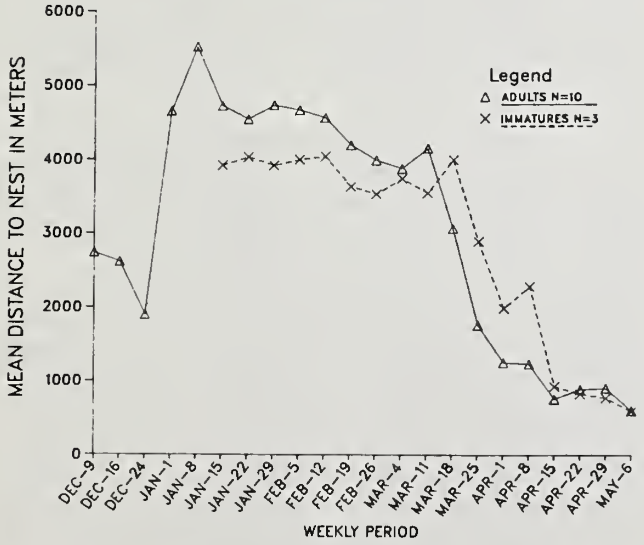

Figure 3.--Weekly mean distances to nest for radio-tagged prairie chicken hens, Sheyenne National Grasslands, 9 December-20 May, 1984-85.

Daily Movements

An index to daily movements was calculated by measuring the distance between day to night locations (DN), and the distance between consecutive night locations (NN). The DN distances, were close approximations of the distances moved between feeding and roosting areas and NN distances showed relative fidelity to the previous night's location.

DN Distance in winter were 1085 ± 778 m, (n = 852) and were greater for cocks than hens (1358 ± 909 m, n = 132 vs 1035 ± 855, n = 720). The greater DN movements for cocks is a result of morning visits to their booming grounds in the late winter. Conversely, hens centered their movements near feeding areas and showed no interest in booming grounds or nest sites during winter and early spring. The maximum distance moved from day to night in winter was 4 km (2.5 mi) for a cock and 4.4 km (2.7 mi) for a hen. Although DN movements were basically a measure of distances between feeding and roosting areas, not all birds used either the nearest available feeding area or the nearest roost.

After snow melted in early spring the DN movements for both cocks (1074 ± 938 m, n = 74) and hens (709 ± 584 m, n = 121) declined as food and cover became more available (Fig. 4). These early spring mean distances were 21% less for cocks and 32% less for hens than their respective winter means. The greater movements of cocks in early spring were due to their twice daily visits to booming grounds, plus flights to the agricultural areas to feed. Hamerstrom and Hamerstrom (1949) and Ammann (1957) also indicated that prairie chickens were most mobile during winter.

In early spring hens were not yet associated with a particular booming ground or their eventual nest areas and their movements were localized near their feeding areas. All radioed hens spent the first 4 weeks after snow melt moving only from roosting areas to feeding areas (less than 600 m) (Fig. 4). This reduction in movements may have allowed hens to recover lost weight.

Mean NN distances were 922 ± 770 (n = 445) in winter for hens and 949 ± 816 (n = 174) for cocks. With one exception, prairie chickens did not use the same roosting area on successive nights, the closest being 60 m. The exception involved 2 radioed birds which used the same roost area 3-4 nights in a row. These 2 birds spent most of the winter on private land and had only 3 undisturbed roost sites near their feeding areas. Their patterns were irregular, but they too shifted between 3 available roosting areas. This tendency to use several roost areas in the winter points out the need for a good distribution of roosting cover.

Once snow melted, individuals began to use the same areas on successive nights (Fig. 5). Use of the same roost area on successive nights in spring may be due to an increase in security due to more available cover. Some of the same roosting areas used only once in the winter were used regularly on successive nights in the early spring.

Distances (NN) became less for cocks and hens as their activities become concentrated near their booming ground and nests in early April. The greatest NN distance for hens occurred during the last week in March when they moved from winter to spring areas (Fig. 5).

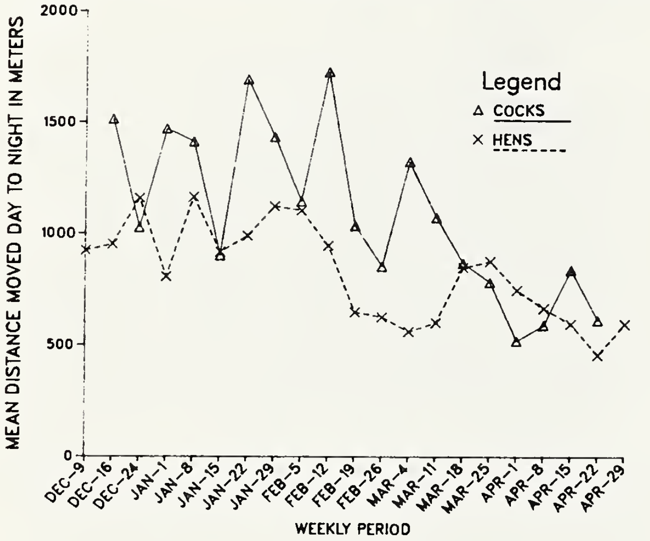

Figure 4.--Weekly mean distances moved from day to night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-5 May, 1984-85.

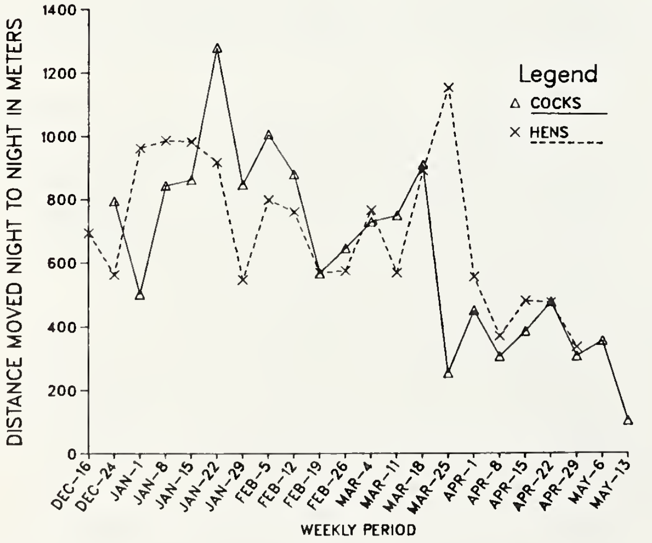

Figure 5.--Weekly mean distances between successive night locations for radio-tagged prairie chickens, Sheyenne National Grasslands, 16 December-13 May, 1984-85.

Cold and snow had the greatest influence on the daily movement patterns of prairie chickens. Fresh snow caused individuals to increase their within day movements when normal food sources were covered. Snow also caused abandonment of roost areas as new snow altered cover.

Prairie chickens responded to long periods of sub-zero temperatures by reducing activity. They remained in their roosts longer in the AM, fed in the agriculture later or during midday, flew to their roosts earlier than normal, (as early as 1400 hours) and remained in roost areas until the following day (15-17 hrs.). Visual documentation was obtained of individuals in snow burrows several hours before they would have gone to roost in milder weather or at other times of the year. Reduced activity during cold temperatures was thought to be an energy conservation mechanism. Hamerstrom and Hamerstrom (1949) observed similar behavior in prairie chickens during very cold or stormy weather in Wisconsin.

Habitat Use

Four major habitat components appear to determine the quality of prairie chicken habitat: type, height (form), disturbance and space (open treeless areas). All 4 are closely related to one another and most are more closely associated with cover structure than species composition. Height or form appeared to be the critical component as it creates the structure that prairie chickens actually use. This is not new, but is based on the life form concept as applied to prairie chickens by Hamerstrom et al. (1957) and Jones (1963). From a management perspective, disturbance is the key factor as it determines height, and influences the amount and distribution of cover.

A total of 3674 radio locations of prairie chickens from 15 December - 15 March were used in habitat analyses. Booming ground observations and unknown habitat types were excluded. Tree(s) were not included in the analysis of height and disturbances. No effort was made to analyze habitat use relative to the amount available in the study area. Observations in the field showed that the total amount of a habitat type available did not determine use and was not a valid index to what prairie chickens preferred. These indicies or importance values relate only to conditions under which they were collected and do not take into account the habitat needs of animals during other critical times (nesting, brood rearing). To be effective management must relate winter use to the habitat used at other times of the year.

Overall, the agriculture and grass habitat types totaled 71.3% of the habitat used by radio-tagged prairie chickens in the winter of 1984-85, on the SNG. Other studies indicated similar habitat use patterns (Schwartz 1945, Grange 1948, Hamerstrom and Hamerstrom 1949, Baker 1953, Ammann 1957, Hamerstrom et al 1957, Mohler 1963, Robel et al. 1970a, and Horak, 1985). A breakdown by habitat type showed that agriculture made up 41.7% of the total use, grass 29.6%, followed by trees and shrubs at 9.0 and 7.6%. (Table 4).

Corn (picked and silage) made up 70.8% of the agricultural types followed by oats and sunflowers at 8.6 and 8.0%. These difference are misleading as not all birds had all of the agricultural types available within or near their ranges. Some individuals used corn all winter, while others used corn and/or sunflowers.

Habitat use varied with time of day (Fig. 6). Use of agriculture by prairie chickens occurred primarily during the AM and PM and was associated with feeding and loafing. Habitat used for night roosting was dramatically different from daytime use as there was a complete shift away from the agricultural habitat types. Night roosting occasionally occurred in agriculture, but was not common. The majority of night locations occurred in grassland followed by shrubs, and wetlands (Table 4). The lowlands received the greatest use, followed by reed canary (Phalaris arundinacea), midland grasses, primarily little bluestem, and quackgrass (Andropyron repens). All of these grasses are tall in form, and stand up well against winter conditions. Almost all of the

Table 4.--Habitat type use by time of day (%) for radio-tagged prairie chickens, winter (9 December-17 February) and early spring (18 February-15 March), Sheyenne Grasslands, 1984-85. Number of locations in parentheses.

Habitat Type	Winter					Early Spring				
	Time of Day						Time of day			
	AM	Midday	PM	Night	Total	Total	AM	Midday	PM	Night
Agriculture	78.9(491)	31.0(215)	50.8(229)	3.8 (20)	41.7 (955)	43.6 (603)	78.1(250)	23.8 (88)	70.4(236)	8.1 (29)
Picked corn	47.4(234)	67.9(146)	57.2(131)	60.0 (12)	54.8 (523)	47.9 (289)	48.0(120)	37.5 (33)	55.1(130)	20.7 (6)
Silage corn	16.7 (82)	13.5 (29)	18.3 (42)	0	16.0 (153)	11.8 (71)	15.2 (38)	6.8 (6)	11.4 (27)	0
Oats	10.2 (50)	4.7 (10)	7.9 (18)	20.0 (4)	8.6 (82)	1.7 (10)	2.0 (5)	1.1 (1)	1.7 (4)	0
Sunflowers	10.0 (49)	3.3 (7)	8.7 (20)	0	8.0 (76)	18.2 (110)	24.4 (61)	17.0 (15)	14.4 (34)	0
Soybeans	9.0 (44)	0.9 (2)	5.7 (13)	0	6.2 (59)	0.3 (2)	0.4 (1)	0	0.4 (1)	0
Alfalfa	3.5 (18)	5.1 (11)	1.3 (3)	20.0 (4)	3.6 (36)	20.1 (121)	10.0 (25)	37.5 (33)	16.9 (40)	79.3 (23)
Haystack	2.9 (14)	4.7 (10)	0.9 (2)	0	2.7 (26)	0	0	0	0	0
Grass	9.3 (58)	25.5(177)	21.1 (95)	66.7(350)	29.6 (680)	37.6 (520)	12.2 (39)	37.8(140)	18.2 (61)	78.4 (280)
Lowland	39.7 (23)	35.6 (63)	45.3 (43)	64.0(224)	51.9 (353)	52.1 (271)	38.4 (15)	25.0 (35)	31.1 (19)	72.1 (202)
Grass Forbs	13.8 (8)	17.5 (31)	10.5 (10)	6.6 (23)	10.6 (72)	13.5 (70)	0	22.9 (32)	18.0 (11)	9.6 (27)
Reed Canary	17.2 (10)	23.7 (42)	15.8 (15)	13.7 (48)	16.9 (115)	9.2 (48)	5.1 (2)	8.6 (12)	4.9 (3)	11.1 (31)
Midland	6.9 (4)	8.5 (15)	5.3 (5)	7.4 (26)	7.4 (50)	13.8 (72)	35.9 (14)	30.9 (43)	16.4 (10)	1.8 (5)
Upland	8.6 (5)	6.2 (11)	18.9 (18)	1.2 (4)	5.6 (38)	4.0 (21)	12.8 (5)	2.9 (4)	19.7 (12)	0
Prairie Hay	3.4 (2)	2.8 (5)	3.2 (3)	0	1.5 (10)	2.9 (16)	7.7 (3)	5.7 (8)	8.2 (5)	0
Quackgrass	10.3 (6)	5.6 (10)	1.1 (1)	7.1 (25)	6.2 (42)	4.2 (22)	0	4.3 (6)	1.6 (1)	5.4 (15)
Edge type	2.6 (16)	14.6(101)	6.9 (31)	1.0 (5)	6.8 (153)	6.6 (91)	3.4 (11)	15.1 (56)	4.5 (15)	2.5 (9)
Fencelines	81.3 (13)	72.3 (73)	61.3 (19)	80.0 (4)	71.3 (109)	57.8 (52)	36.4 (4)	69.6 (39)	46.7 (7)	22.2 (2)
Railroad	6.3 (1)	16.8 (17)	16.1 (5)	20.0 (1)	17.0 (24)	31.9 (29)	54.5 (6)	23.2 (13)	53.3 (8)	22.2 (2)
Upland Shrub	12.5 (2)	10.9 (11)	22.5 (7)	0	9.2 (20)	11.0 (10)	9.1 (1)	7.1 (4)	0	55.6 (5)
Trees & edges	6.1 (38)	15.7(109)	10.6 (48)	2.3 (12)	9.0 (207)	7.8 (108)	4.3 (14)	17.0 (63)	5.7 (19)	3.4 (12)
Shelterbelts	18.4 (7)	28.4 (31)	12.5 (6)	0	43.5 (44)	75.9 (82)	64.3 (9)	85.7 (54)	63.2 (12)	58.3 (7)
Sandhills	47.4 (18)	17.4 (19)	50.0 (24)	100.0 (12)	35.3 (73)	14.8 (16)	28.6 (4)	6.3 (4)	21.1 (4)	33.3 (4)
Tree(s)	34.2 (13)	54.1 (59)	37.5 (18)	0	43.5 (90)	9.3 (10)	7.1 (1)	7.9 (5)	15.8 (3)	8.3 (1)
Shrubs	1.9 (12)	10.2 (71)	6.7 (30)	11.8 (62)	7.6 (175)	2.7 (37)	1.6 (5)	4.1 (15)	0.3 (1)	4.5 (16)
Snowberry	58.3 (7)	39.4 (28)	86.7 (26)	95.2 (59)	68.6 (120)	59.5 (22)	0	40.0 (6)	0	100.0 (16)
Misc Shrubs	41.7 (5)	42.6 (30)	13.4 (4)	3.2 (2)	23.4 (41)	16.2 (6)	20.0 (1)	26.7 (4)	100.0 (1)	0
Shrub Grass	0	18.3 (13)	0	1.6 (1)	8.0 (14)	24.3 (9)	80.0 (4)	33.4 (5)	0	0
Forbs	0.5 (3)	1.2 (8)	0.7 (3)	7.6 (40)	2.4 (54)	0.1 (1)	0	0.3 (1)	0	0
Misc Forbs	100.0 (3)	87.5 (7)	33.3 (1)	27.5 (11)	40.7 (22)	0	0	0	0	0
Sweet Clover	0	12.5 (1)	66.6 (2)	72.5 (29)	59.3 (32)	100.0 (1)	0	100.0 (1)	0	0
Wetland	3.3 (2)	0.9 (6)	1.6 (7)	6.7 (35)	2.2 (50)	0.9 (12)	0.3 (1)	0.8 (3)	0.3 (1)	2.0 (7)
Other	0.3 (2)	1.0 (7)	1.8 (8)	0.2 (1)	0.8 (18)	0.7 (10)	0	1.1 (4)	0.6 (2)	1.1 (4)
Total	100.0(622)	100.0(694)	100.0(451)	100.0(525)	100.0(2292)	100.0(1382)	100.0(320)	100.0(370)	100.0(335)	100.0(357)

shrub use occurred in snowberry (Symphoricarpos occidentalis).

Manske and Barker (1981) reported budding by prairie chickens in shelter belts on the SNG in 1980. In this study budding was rarely observed and the primary use of trees appeared to be for loafing before the birds moved into or after they left the agricultural fields. The main food source on the SNG for prairie chickens in winter was provided by agriculture on private land. There was no agricultural land on the SNG public land.

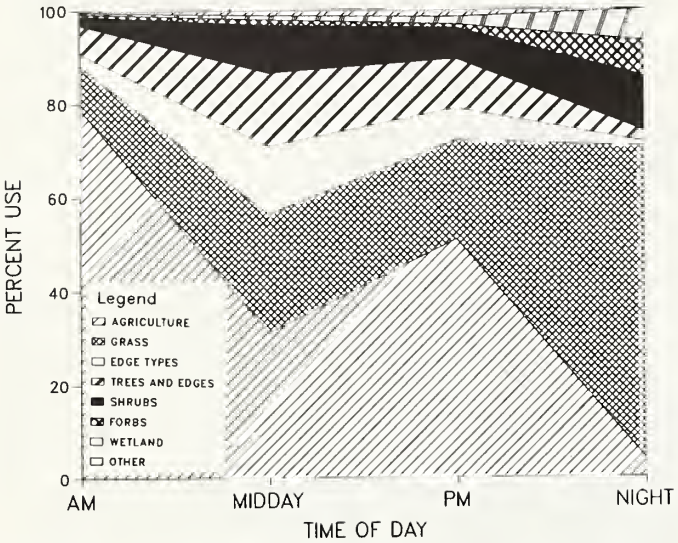

Figure 6.--Use of habitat types by time of day for radio-tagged prairie chickens during winter, 15 December-17 February, Sheyenne National Grasslands, 1984-85.

Height

Of all the radio locations in winter, 78% were associated with Class II or taller vegetation. Class III vegetation (25-50 cm) dominated the usage at 60%. The pattern of use, like that for habitat type, varied between the periods of the day (Fig. 7). The shorter forms, Class I and II were used primarily during the AM (51.4%) with slightly lower use during the PM (47.2%). The taller Classes (III and IV) were used for day roosting during the midday period (59.6%). Robel et al. (1970a) indicated that density (visual obstruction) was not a "significant factor in habitat usage in prairie chickens". However, their density data were collected from vegetation transects and not from the specific sites used by prairie chickens. Most other researchers have pointed out, the importance of taller undisturbed cover (Hamerstrom and Hamerstrom 1949, Baker 1953, Ammann 1957, Hamerstrom et al. 1957, Horak, 1985).

The edge habitats between shorter and taller vegetation classes were used equally through the day. This edge type was important and probably used more than our data indicates as it provided simultaneous access to 2 vegetation forms. This occurred along the borders of agricultural fields, and edges between lowland and upland and upland and midland grasses. Feeding was observed most in the lower height classes, particularly Class I (81.8%). Day roosting was primarily associated with Classes III and IV (greater than 25 cm), with most occurring in Class III (63.0%). The high use of the lower classes reflected the bias that activity must be observed to be documented and birds were more easily seen in the shorter vegetation types. However, telemetry data showed the same general pattern of use and indicated that birds were most active, primarily feeding in the AM and PM. The day roosting observations were based on birds flushed or examination of sign after birds moved and was thought to accurately represent day roosting habitat and height use. The increased use of the taller classes during the PM period coincides with observations of prairie chickens going to roost early during periods of cold weather.

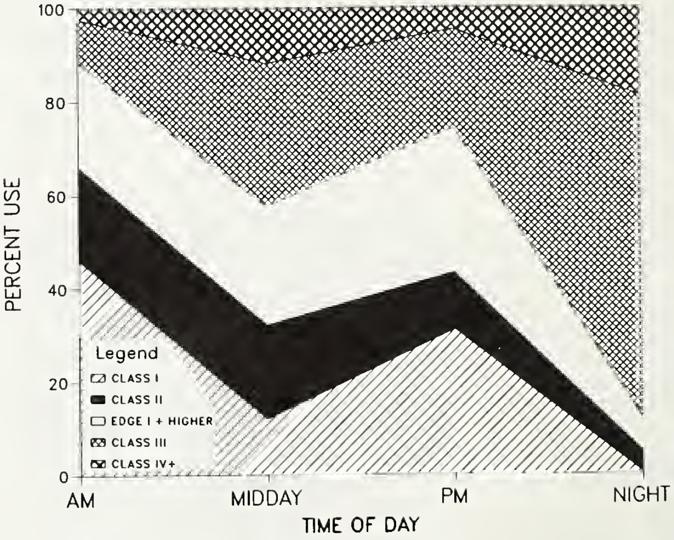

Figure 7.--Use of cover by height classes (I=0-8 cm, II=9-25 cm, III=26-50 cm, IV+ greater than 50 cm) by time of day for radio-tagged prairie chickens during winter, 15 December-17 February, Sheyenne National Grasslands, 1984-85.

Disturbance

Disturbance has its greatest influence on vegetation height. The taller height classes were used most by prairie chickens, yet shorter forms were used for feeding. A mixture of tall and short, or undisturbed and disturbed, is an important aspect of prairie chicken habitat. The amount and distribution of each will strongly influence the number of prairie chickens in a given area. Large amounts of disturbed short vegetation will reduce the amounts available for roosting and nesting. The most difficult component of prairie chicken habitat to maintain is the undisturbed open grassland, since this is the type of habitat most commonly converted to cropland or pastureland.

Use by prairie chickens of disturbed or undisturbed habitat also varied during the day and showed a strong similarity in pattern of use to type and height data. Disturbed agricultural areas were used most during the AM (82%) and less during PM (58.5%) (Fig. 8). This high use of agricultural habitats with their shorter height classes reflected a concentration of available food. Open low vegetation provided easier access to food on the ground and agricultural activities increased both the distribution and amount present. This use of disturbed areas has also been reported by (Yeatter 1943, Ammann 1957, and Drobney and Sparrowe 1977).

Use of undisturbed cover was highest at night (77.9%, Fig. 8). Unmowed lowlands (38.7%) and lightly grazed lowlands were used most often at night for roosting. Hamerstrom et al. (1957) suggested that prairie chickens when night roosting have a preference for grass and sedges over woody cover. Snowberry was used 11.2% and classified as undisturbed even though areas between stems were heavily grazed. The stucture and height created by snowberry was similar to undisturbed grassland but was used only for snow roosting when it trapped enough snow to permit burrowing.

All of the unmowed lowlands were at least lightly grazed since cattle were in all pastures at sometime during the grazing season. These lowlands were also classified as undisturbed as use by cattle on the SNG rarely reduced structure. By contrast mowing of lowlands in the summer eliminated all structural cover from these areas until the following June.

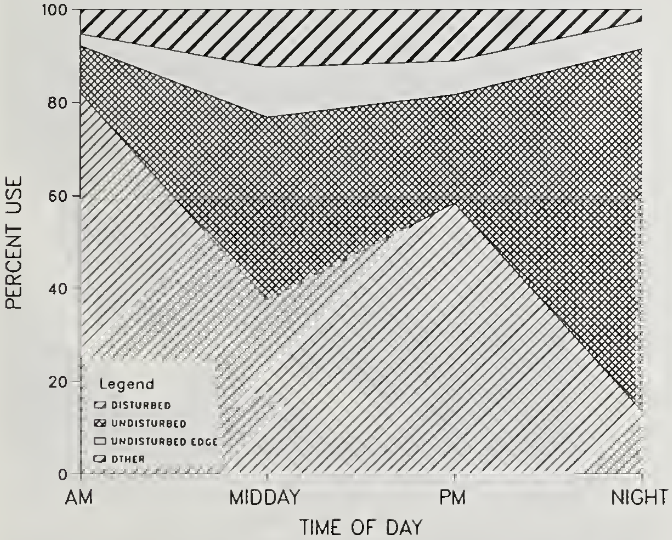

Figure 8.--Use of habitat by disturbance types by time of day for radio-tagged prairie chickens during winter, 15 December-17 February, Sheyenne National Grasslands, 1984-85.

Land Ownership

Habitat use based on land ownership showed that 76.4% of all radio locations occurred on private land, due primarily to high use (52.9%) of agriculture during the day. Night roosting favored public land (56.2% vs 43.8%). The use of private and public land emphasized the importance of both to winter survival of prairie chickens on the SNG. The recorded use of private land for roosting was the result of 2 radioed prairie chickens that used private lands for both feeding and roosting. These roosting areas, like those on the SNG, were lowland pasture areas that were undisturbed, Class III and IV vegetation, a habitat not common on private land. The typical pattern of 17 of 20 radioed birds was to feed on private agricultural land and roost at night on public land.

Early Spring

Habitat use relative to type, height and disturbance patterns in early spring were only slightly different from those observed during winter. The use of grass increased from 29.6% in winter to 37.6% in early spring. The use of edge types remained the same and the use of shrubs declined (Table 4). Changes in the daily pattern of habitat use occurred in the PM period, where the incidence of agriculture increased from 50.8% in the winter to 70.4% in the spring. The use of the lower height classes in the PM also increased in early spring (63.1% vs 81.7%) as did the use of disturbed habitat (58.5% vs 77.3%). These changes were the result of longer warmer days and prairie chickens spent more time feeding in the PM.

Use of night roosting habitat in spring was similar to winter, as the lowlands and Class III vegetation still dominated (71% vs 66%). Overall use by land ownership remained the same except for a reduction in use of public land in the PM, a reflection of the longer feeding periods in agriculture in the PM.

Within the agricultural types, the use of alfalfa and sunflowers increased from winter to spring from 3.6-20.1% and from 8-18.2% respectively. The disappearance of snow made food in these 2 types available. Prairie chickens showed a preference for sunflowers when both corn and sunflowers were in the same feeding field. In winter, harvested sunflowers were only available where snow was blown clear.

Alfalfa was used for both feeding and roosting in spring. The alfalfa fields used for roosting (both day and night) were fields where only 2 crops were taken and regrowth in late summer produced cover of 8-15 cm. Short-cropped alfalfa was used for feeding as the growing green vegetation was apparently attractive to prairie chickens, particularly hens.

Winter and early spring habitat data presented here should not be taken out of context. The high use of agriculture was important to the survival of the prairie chicken on the SNG, but it must be related to the bird's year-long needs. Management must provide a combination of agriculture and grass that will provide the necessary year-long requirements. The grass component must be of the right height and type for nesting and roosting, and occur in proximity to winter food. From early spring on there is a decided decrease in the use of agricultural types and a corresponding increase in the use of grassland. Over 70% of all nests and over 90% of all booming grounds were located on the public grasslands. Although this phase of the study was concerned primarily with winter habitat, a decided change in use was noted between winter and late spring. Habitat use by type, height class disturbance and landownership on a weekly basis, by day and night, are presented in Figures 9-16. After the first week of April, a day time shift in habitat use was recorded, from agriculture to grassland. Night roosting continued to be centered in the undisturbed lowlands.

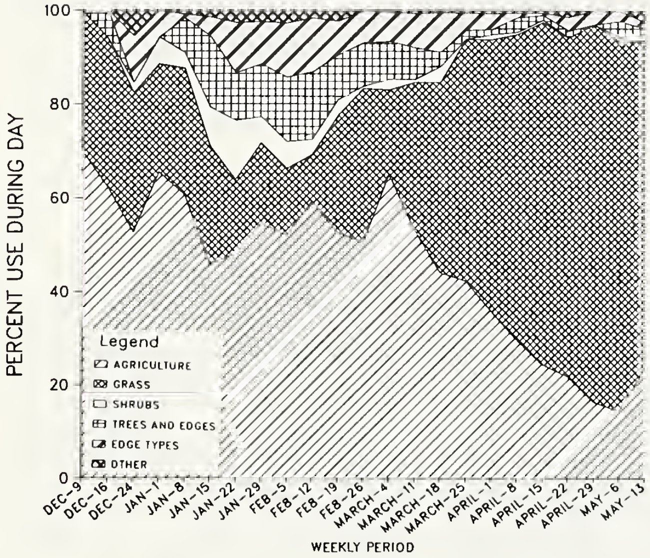

Figure 9.--Weekly use of habitat types during the daytime for radio-tagged prairie chickens Sheyenne National Grasslands, 9 December-19 May, 1984-85.

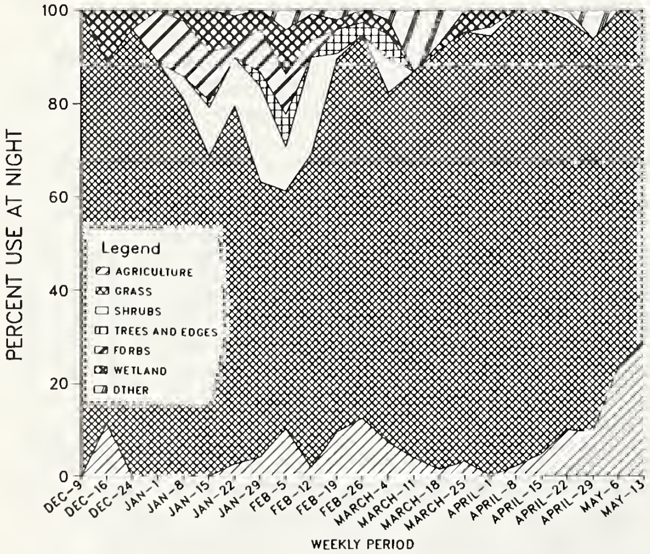

Figure 10.--Weekly use of habitat types at night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-19 May, 1984-85.

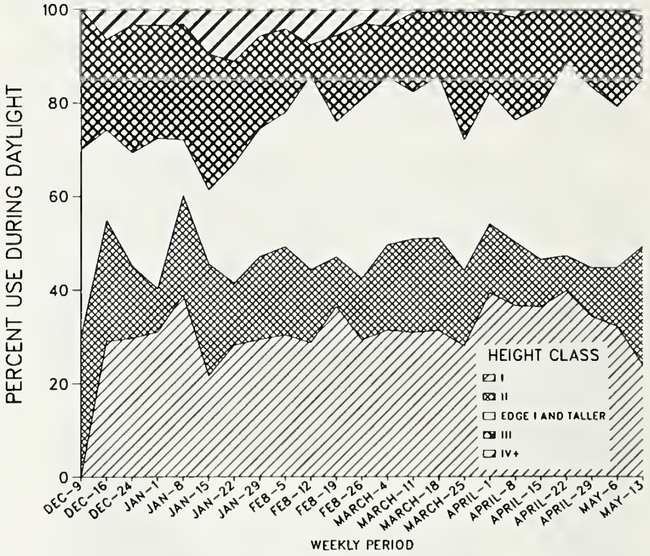

Figure 11.--Weekly use of cover by height classes (I=0-8 cm, II=9-25 cm, III=26=50 cm, IV+= greater than 50 cm) during the daytime for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-19 May, 1984-85.

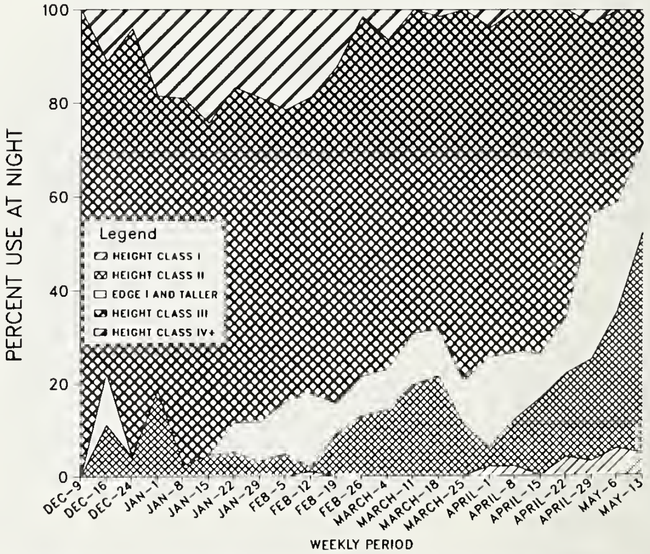

Figure 12.--Weekly use of cover by height classes (I=0-8 cm, II=9-25 cm, III=26=50 cm, IV+= greater than 50 cm) at night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-19 May, 1984-85.

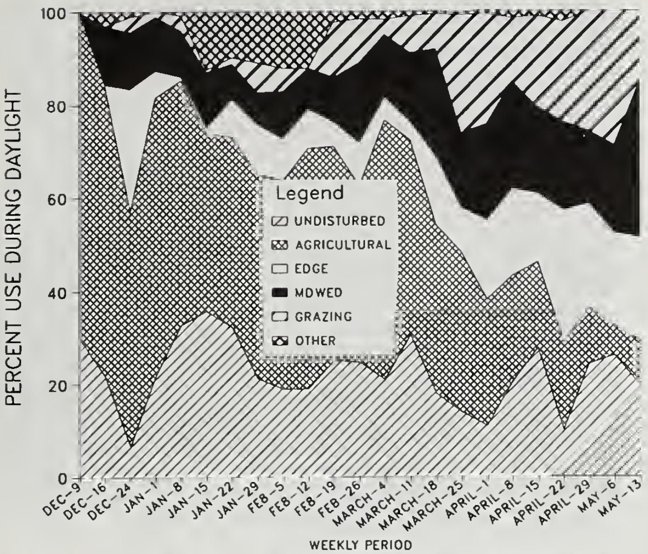

Figure 13.--Weekly use of habitat by disturbance types during the daytime for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-19 May, 1984-85.

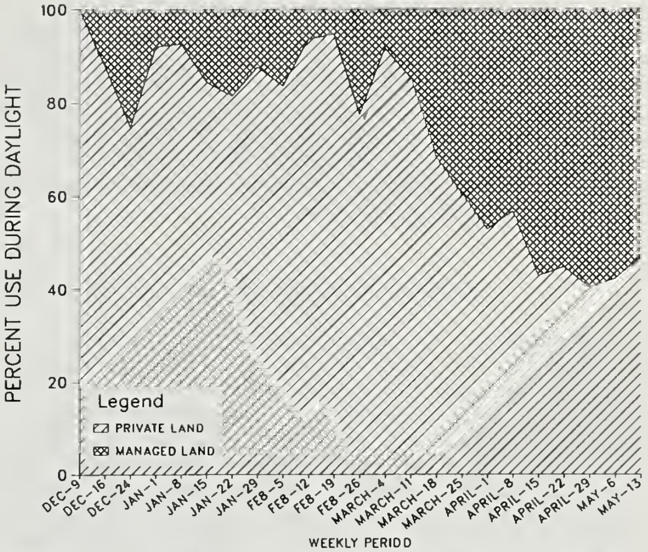

Figure 15.--Weekly use of land types during the daytime for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-19 May, 1984-85.

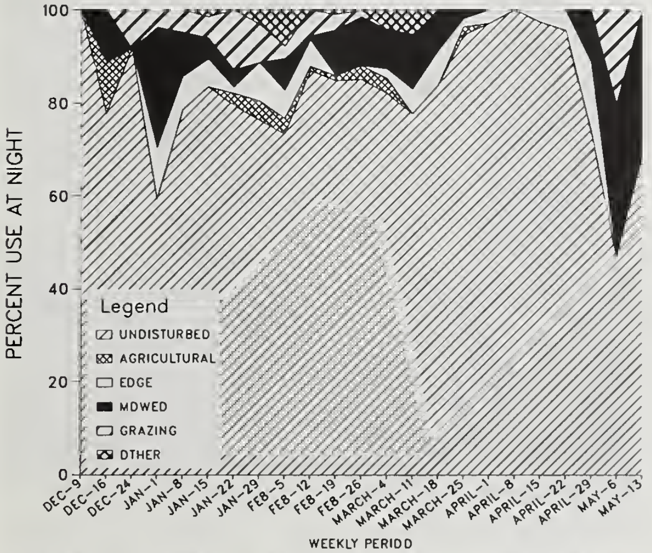

Figure 14.--Weekly use of habitat by disturbance types at night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-19 May, 1984-85.

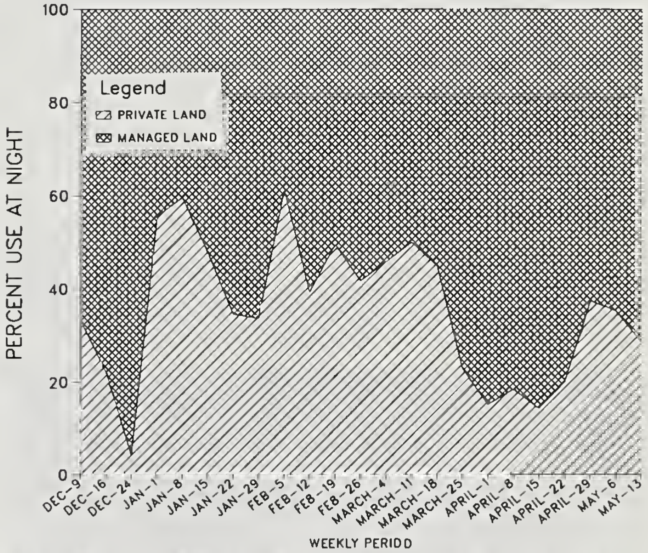

Figure 16.--Weekly use of land types at night for radio-tagged prairie chickens, Sheyenne National Grasslands, 9 December-19 May, 1984-85.

Summary Daily Pattern

The daily tracking of radioed individuals, along with observations in the field, yielded the following general pattern for winter daily movements and habitat use by prairie chickens on the SNG. Prairie chickens left the roost area in small flocks, after sunrise, flew 0.8-1.6 km to agricultural fields where they fed and loafed in low form (Class I or II, 0-25 cm) disturbed vegetation, primarily corn. They walked or flew 0.8-1.6 km to taller, (Class III, 26-50 cm) undisturbed vegetation, where they loafed or day roosted during midday. They returned to short form, disturbed vegetation in the PM, fed and flew to taller (Class III or IV) undisturbed lowlands or snowberry to night roost. Prairie chickens typically made 4 major flights of over 0.4 km (.25 mile) per day, 1 from roosting to feeding, 1 to day roost areas, 1 back to the feeding area and a final flight to a roosting area. Flights to feeding and roosting areas were often made in 2 segments, 1 long and 1 short, making 6 flights a day. Changes in the daily pattern usually occurred only when new snow covered regular feeding areas, or when sub-zero temperatures caused them to spend more time in the roost. This pattern changed for the cocks in late winter as they initiated visits to their booming grounds early in the morning before they fed. Hens reduced their movements and localized near a food source. As spring progressed cocks visited booming grounds in the morning and evening, and eventually abandoned agriculture and began to feed in the grasslands near their booming grounds.

Individual Night Roosts

A total of 372 winter and 52 early spring prairie chicken night roosts were examined and analyzed between 12 January and 15 March in 1985. Four types were documented: a vegetation roost, where vegetation was the only source of cover; a snow depression, where the bird made a bowl in the snow and snow was the main source of cover (Fig. 17); a snow vegetation-roost where both vegetation and snow provided cover; and the snow burrow where the bird made a tunnel and enclosed cavity into soft snow (Fig. 18).

Both the accumlation or the movement of snow by wind created situations that influenced roost site selection. With the exception of several snow burrows in the sandhills where the birds burrowed into snow that had accumulated in drifts of up to 2 meters, all observed roosts were associated with some type of vegetation. The vegetation either served as cover or caused snow to accumulate in a snow fence effect. Terrain served a similar function as blown snow accumulated in the lee of ridges.

Evaluating the cover at individual roost sites was difficult when snow was present, as the birds used both snow and vegetation. Because of the role snow played in providing roost cover, the Robel pole was used to evaluate total coverage and coverage by vegetation. Total coverage included snow and vegetation in reading obstruction on the Robel pole, while coverage by vegetation included vegetation only. Each roost had 4 Robel pole readings, but because of snow, some had from none to 4 for vegetation.

Dominant Cover

No detailed species composition was collected at individual roost sites, as only the dominant species or genus was visually estimated for each roost (Table 5). Grasses and sedges were dominant at 74% of the roosts in winter. Panicum vergatum and Carex lanuginosa and Panicum sp. and Carex sp. either alone or in combination, were dominant at 43.6% of the observed roosts. Snow burrows were associated with the taller species that trapped and accumulated enough snow to permit the birds to burrow. Snowberry, sweet clover, quackgrass, Panicum spp. and Spartina gracilis, all tall, sturdy species dominated at snow burrows.

Figure 17.--Snow depression used for night roosting by prairie chicken, Sheyenne National Grasslands, 1984-85.

Figure 18.--Snow burrow used for night roosting by prairie chicken, Sheyenne National Grassland, 1984-85.

Dense cover was not used for roosting or burrowing as the density of stems prevented entry into the vegetation. Space between stems is necessary to permit burrowing, but height and structure are also necessary to hold or accumulate snow. Snowberry and sweetclover (Melilotus spp.) were not important dominants in any other roost types as they provided little cover in the absence of deep snow.

To snow burrow the birds actively sought areas where snow had accumlated to the necessary depth. Birds commonly attempted to snow burrow only to have it collapse. Snow burrows were often

Table 5.--Percent occurrence of dominant plant species at prairie chicken night roosts, winter (9 December-17 February) and early spring (18 February-15 March), Sheyenne National Grasslands, 1984-85. Number of roosts in parentheses.

	Winter					Early Spring
	Type of Roost					Type of Roost
Species	Vegetation	Vegetation and Snow	Snow Burrow	Snow Depression	Total	Vegetation
Panicum vergatum	7.7 (3)	9.2(10)	2.6 (4)	5.5 (7)	5.6 (24)	9.5 (6)
Panicum spp.	12.8 (5)	2.8 (3)	13.6(21)	15.7(20)	11.4 (49)	
Carex lanuginosa	12.8 (5)	3.7 (4)	3.8 (6)	3.1 (4)	4.4 (19)	30.2 (19)
Carex spp.		36.7(40)		13.3(17)	13.3 (57)	9.5 (6)
Panicum/Carex spp.	7.7 (3)	29.4(32)	2.6 (4)	3.9 (5)	10.2 (44)	9.5 (6)
Agropyron repens		3.7 (4)	7.1(11)	10.2(13)	6.5 (28)	7.9 (5)
Phalaris arundinacea	51.3(20)	1.8 (2)		2.4 (3)	5.8 (25)	
Calamagrostis inexpansa	2.6 (1)	3.7 (4)			0.9 (5)	1.6 (1)
Brommus inermis			0.6 (1)	1.6 (2)	0.7 (3)	
Andropogon gerardi						9.5 (6)
Spartina gracilis		6.4 (7)		1.6 (2)	2.1 (9)	
Andropogon scoparius			11.0(17)	5.5 (7)	5.6 (24)	
Melilotus spp.			14.9(23)	7.1 (9)	7.5 (32)	
Symphoricarpos occidentalis			19.5(30)	13.4(17)	11.0 (47)	
Salix spp.	2.6 (1)		4.5 (7)		1.9 (8)	1.6 (1)
Aster sp.			5.8 (9)	1.6 (2)	2.6 (11)	
Solidago spp.			2.6 (4)	1.6 (2)	1.4 (6)	1.6 (1)
Typha sp.				0.8 (1)	0.2 (1)	
Poa sp.	0.6 (1)				0.5 (2)	
Sorghastrum nutans			5.8 (9)	2.4 (3)	2.8 (12)	
Corn		2.8 (3)	1.9 (3)	.8 (1)	1.6 (7)	
Alfalfa				9.5(12)	2.8 (12)	19.0 (12)
Open snow					3.2 (5)	
Total	39	109	150	134	437	63

unsuccessful either because the snow was too shallow or too soft to support a roof (Fig 19).

All successful burrows during the winter 1984-85 were in areas where snow had accumulated due to vegetation or terrain. When a bird failed in its attempt to burrow, it usually walked a short distance and formed a snow depression near some vegetation above the snow. At times both snow burrows and snow depressions were found in the same group of roosting birds.

Unused snow depressions were often found in the tracks leading to eventual night roosts. These depressions contained 1-2 or no droppings and appeared to be temporary or possibly even unsatisfactory roosts as birds left them and moved to a burrow or another depression farther away. At times some birds must have flown to different sites because no tracks were found leading from the unused depression. These depressions may have been loafing forms occupied only until the bird went to roost for the night, although, at times the bird remained for the night in their first and only depression. Back tracking from night roosts has revealed as many as three depressions on the way to the final night roost. The mean distance walked in snow to night roosts was 104±84 m (n = 101).

No evidence was found that prairie chickens ever dove from flight into snow burrows. The usual pattern (based on tracks) was to land in open areas along the edge of vegetation, walk (0.1-20 m) into cover and select a roost site. In the morning birds either flew directly from their roosts or walked a short distance and flew. Tracks indicated that birds did little feeding in roost areas in the morning, although some feeding occurred in the evening prior to roosting.

Figure 19.--Unsuccessful attempt at snow burrowing by prairie chicken, Sheyenne National Grasslands, 1984-85. (E=entrance, P= snow plug sealing entrance).

Fox and coyote tracks were often observed in roost areas and at times they passed within 10 m of roosting birds during the night. Of the 372 winter roosts observed, there was no evidence that any birds were killed or flushed at night.

Effective Cover

The use of snow as cover appears to serve primarily as wind shelter and/or insulation. Mean coverage by vegetation ranged from 1.1-3.8 and total coverage (including snow) varied between the types of night roosts (Table 6). Total coverage and vegetation coverage were higher in the winter than early spring. Analysis of 368 random points in the same habitat as the roosts suggested that roosting prairie chickens selected sites in winter with greater total and vegetation coverage and deeper snow. The selection of taller cover continued into the early spring (Table 7).

Height Class

Class III (25 to 50 cm) or taller residual vegetation was associated with 94.1% of all roost types (Table 7). Comparisons with random height classifications, indicated that prairie chickens selected the taller classes within the areas they used (CSq, P = 0.001, df = 3). A breakdown by disturbance types, shows that 78% of observed roosts were in undisturbed habitat, and 68% of these were in unmowed lowlands. Uplands or mowed lowlands were not used in winter or early spring.

Night roosts were usually located in the open, away from tree(s). Mean distance to the nearest single tree in winter was 320±221 (n = 485) and to nearest trees (woodlot or clump) 353±241 (n = 485). The birds roosted farther from trees in spring than winter. (503±354 m, n = 33 vs 353±241, n = 485). They roosted near the edge of cover in both winter (18.1±20.5 m (n = 405) and spring (14.7± 10.4 m, n = 50). The nearest edge in both spring and winter was typically a lower height Class (91%) and 83% of the edge types were heavily grazed or mowed. Roosting flocks confined themselves to a small portion of a roost area as average maximum distance between roosting birds was 27.9±15.8 (n = 94) in the winter and 11.5± 27.4 m, (n = 24) in the spring. The average distance to nearest bird showed the same pattern as birds roosted closer to each other in spring 1.7±1.3 (n = 36) than in the winter, 3.3±5.6 (n = 261). The greater distances from the edge and between birds in winter was thought to be due to less cover above the snow, causing the birds to spread out over a larger area to find suitable cover or snow.

Size

Even though prairie chickens clustered when night roosting and remained near the edge, they

Table 6.--Mean Robel pole readings by total and vegetation coverage for individual prairie chicken night roosts and random points, during winter (9 December-17 February), and early spring (18 February-15 March), Sheyenne National Grasslands, 1984-85.

	Mean Robel pole reading			
	Total Coverage*	Total Coverage	Coverage by Vegetation	Coverage by Vegetation
Roost Type	Roosts	Random Points	Roosts	Random Point
Vegetation				
Spring	1.6±1.0 (40)	1.2±1.2 (97)	1.6±1.0 (40)	1.2±1.2(97)
Winter	2.1±1.0 (32)	1.5±1.4 (46)	2.1±1.0 (32)	1.5±1.4(46)
Vegetation and snow				
Winter	2.8±1.4(115)	1.7±0.6 (56)	1.1±0.4 (90)	1.5±0.4(38)
Spring	1.9±0.5 (12)	1.3±0.5 (44)	1.9±0.5 (12)	1.3±0.5(44)
Snow Depression	2.1±0.8(120)	1.8±1.1(104)	3.2±0.9 (38)	2.4±1.1(12)
Unused Snow Depression	2.3±0.4 (76)		0 (76)	
Snow Burrow	2.6±0.8(145)	2.4±0.8 (162)	3.8±0.4 (2)	2.8±1.0 (7)
Unsuccessful Snow Burrow	2.2±0.6 (39)		0 (39)	

* Snow or vegetation or a combination of both.

roosted in relatively large undisturbed areas. The size of roost areas as determined by measurements from aerial photographs and in the field, showed that the mean size for 26 winter roost areas was 1.3 ha with a range of .04-5.5 ha; 76% were greater than 0.4 ha (1 acre) in size. Average length was 174±105 m and width 88±38 m. The larger areas were associated with private land or rough areas in the SNG that were not or could not be mowed. The size of the areas used in spring were smaller with a mean of 0.4±.28, (n = 7) (1 acre). Mean length and width were 82±39 m and 45.7±33 m).

Table 7.--Use of vegetation height classes (%) for observed prairie chicken roosts and random points during winter (9 December-17 February), and early spring (18 February-15 March), Sheyenne National Grasslands, 1984-85.

	Vegetation Height Class			
	I	II	III	IV+
Roost Type	0-8 cm	9-25 cm	26-50 cm	>50 cm
Vegetation				
Winter	0	8.8 (3)	76.5 (26)	14.7 (3)
Spring	2.1 (1)	29.2(14)	66.7 (32)	2.1 (1)
Vegetation and snow				
Winter	0	4.7 (5)	77.4 (82)	17.9(19)
Spring	0	0	100.0 (6)	
Snow Depression	.9 (9)	.9 (1)	79.1 (91)	19.1(22)
Unused Snow Depression	1.3 (1)	0	82.5 (66)	16.3(13)
Snow Burrow	2.3 (3)	.8 (1)	73.1 (95)	23.8(31)
Unsuccessful Snow Burrow	0	2.2 (1)	62.2 (28)	35.6(16)
Total winter	3.3(13)	2.6(10)	75.0(294)	19.1(75)
Total spring	3.9 (2)	13.7(17)	80.4 (41)	2.0 (1)
Random Points				
Winter	7.9(12)	23.7(36)	47.4 (72)	21.1(32)
Spring	32.3(32)	26.3(26)	37.4 (37)	4.0 (4)

It is believed that larger areas were selected for winter night roosting because of the greater security provided in the form of cover above the snow. In early spring there is more coverage available in a smaller area. These roost areas were similar in type, height class and species composition to areas used by radioed prairie chicken hens for nesting. At least 9 of the areas used by prairie chickens for winter night roosting either were or had been used by radioed hens for nesting.

Thus the undisturbed lowland community on the SNG is the critical component for winter night roosting sites and nesting habitat for prairie chickens. These are the 2 places where an individual spends more than a few hours in one spot. The amount and distribution of this lowland cover on the SNG is determined by lowland mowing practices, the pattern of which will be a key factor in maintaining or improving habitat for prairie chickens on the SNG. Nesting and roosting cover along with winter food should serve as focal points for any future management plans for the prairie chickens on the Sheyenne National Grasslands.

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Diets of Greater Prairie Chickens on the Sheyenne National Grasslands[1,2]

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Abstract.-- Diets of greater prairie chickens on the Sheyenne National Grassland of North Dakota were examined. During the winter months agricultural crops (primarily corn) were the predominant food items. Green vegetation was consumed in greater quantities as spring progressed. Dandelion flowers and alfalfa/sweetclover were the major vegetative food items through the summer. Both juvenile and adults selected diets high in digestible protein obtained through consumption of arthropods and some plants.

INTRODUCTION

Initially, the development of agriculture on the prairies was credited with increasing the population and range of the greater prairie chicken (<u>Tympanuchus cupido</u>) (Hamerstrom et al. 1957). Further development however, of agriculture, primarily "clean farming", contributed to their decline (Yeatter 1963, Westemier 1980). Prairie chicken populations are highest in areas where agriculture is interspersed with grasslands in approximately a 1:2 ratio (Evans 1968). The quality of the grassland habitats is also important, however (Christisen and Krohn 1980).

Greater prairie chickens are primarily herbivorous, as are other grouse except during the juvenile stage (Evans 1968). Prairie chicken broods generally select areas of high herbaceous cover with forbs where they forage for insects. Winter is a critical period, during which prairie chickens depend on agricultural crops. Corn is generally thought to be the staple food of prairie chickens (Trippensee 1948, Hamerstrom et al. 1957) but other agricultural crops may be selected (Evans 1968).

The Sheyenne National Grassland is an island of suitable prairie chicken habitat in eastern North Dakota. Because the population of prairie chickens on the Sheyenne National Grassland increased during the period 1974-1980 (Manske and Barker 1981), the possibility of an annual harvest arose. Yet, the reasons for this population increase were not clear. As a result, this study was initiated by the Rocky Mountain Forest and Range Experiment Station, in cooperation with Montana State University to determine food habits of greater prairie chickens on the Sheyenne National Grassland.

This food habits study was designed to be part of a larger effort to gain a better understanding of the ecology of prairie chickens. Habitat selection patterns are reported elsewhere in this symposium.

METHODS

This study was conducted on the Sheyenne National Grassland, Custer National Forest, in southeast North Dakota. This area represents an island of tall- and mixed-grass prairie surrounded by farmland. Vegetative descriptions of seral stages and habitat types are provided by Manske and Barker (1981), and Barker and Manske (this proceedings).

Prairie chicken fecal samples were collected from marked night and day roost locations of radio marked birds, booming grounds, and incidental flushes. Eighty-seven percent of all samples were obtained from radio marked birds. Samples were collected between April and August of 1983-1984 (spring-summer samples) and December to February 1984-1985 (winter samples). Winter samples were collected only during periods when at least 3 cm of snow was present. Samples were air-dried and analyzed separately (Sparks and Malachek 1968) by the Diet Composition Laboratory at Colorado State University. Diet composition (percent dry weight) was estimated from one slide

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(containing 20 fields). Estimates of summer diets were based on 321 samples; winter diet were based on 119 samples.

Data from both periods were separately subjected to a divisive cluster analysis program (Ball and Hall 1967) to search for natural grouping of samples. There were few trends toward natural biological groupings such as sex, age, or monthly differences. Within the summer period however, brood samples tended to be different from adult samples. Therefore, data from adult diets are presented as monthly averages for winter and spring-summer; data from brood diets are presented separately.

The food item categories listed often represent combinations of similar food items. For example, corn includes small amounts of the corn plant (less than .02%); sunflower includes plant material and seeds from other species of the composit family and soybean includes other legume seeds which could not be discerned from soybeans. The food category forb seeds represents seeds from unidentified forbs. Other forbs, shrubs, and grass refers primarily to plant material other than seeds.

RESULTS

Winter Diets

A total of 34 different food items were found in winter samples. These were condensed into 9 categories (Table 1). Waste from agriculture crops comprised over 60% of diets during all winter months. Corn alone made up about 50% of the diets during each month, but sunflowers and soybeans made up over 50% of some individual samples. The frequency of occurrence of corn in prairie chicken diets was 83% compared to 39% for sunflower and 24% for soybeans. Grass seeds comprised a large portion of the December diets but were somewhat less important during January and February. Consumption of a variety of unidentified forb seeds was not apparent until January. During the latter two months of the winter, forb seeds were relatively important food items. Fringed sage (Artemesia frigida) in the prairie chicken diets increased from zero in December to 11% by February. A number of forbs of various species comprised about 9% of the diets during December, then declined during January followed by a slight increase in February. Shrubs were an unimportant food category during this study; Russian olive (Elaeagnus angustifolia) was taken most frequently. Vegetative material from grasses were also relatively unimportant. Kentucky bluegrass (Poa pratensis) was the predominant food item in this category.

Spring-Summer Diets

A total of 59 food items or categories were identified in the diets of adult prairie chickens between April and August. Of these only four were consistently important over the spring-summer period (Table 2). These four food categories over two-thirds of the prairie chicken diets.

During the prenesting through incubation period (April-May), dandelion (Taraxacum officinale) flowers, alfalfa/sweetclover and waste corn dominated the diets. Fringed sage continued to contribute a relatively constant portion of the diet from the winter months. During this period, corn declined while dandelion flowers and alfalfa/sweetclover increased . An unidentified composite comprised 13% of the diet in April but only about 2% in May.

Arthropods increased in importance as a food to adult prairie chickens in June and continued to increased throughout the summer. By August nearly 60% of the diet of adult prairie chickens was composed of arthropods. Consumption of dandelions declined in June and comprised about 10% of the diet throughout the summer. Alfalfa/sweetclover in prairie chickens diets increased throughout the spring to 42% in June, then declined to 15% by August.

Arthropods were the single most important food category of juvenile prairie chickens (Table 3),

Table 1. Percent composition of greater prairie chicken diets during winter (Dec.-Feb.) on the Sheyenne National Grasslands, North Dakota.

Species	December (N=7)	January (N=49)	February (N=63)
	$\bar{x}$ ± se	$\bar{x}$ ± se	$\bar{x}$ ± se
Corn	49.3 ± 17.6	52.1 ± 5.9	50.8 ± 5.0
Sunflower	18.6 ± 12.6	3.0 ± 0.8	4.8 ± 1.3
Soybean	4.1 ± 2.7	6.3 ± 2.3	6.6 ± 2.7
Grass seeds	16.6 ± 9.2	7.7 ± 2.1	9.4 ± 2.1
Forb seeds	0	21.8 ± 4.4	8.5 ± 2.8
Artemesia frigida	0	4.0 ± 1.9	10.7 ± 2.7
Other forbs[1]	9.3 ± 3.5	2.9 ± 1.8	4.8 ± 1.4
Other shrubs[1]	0.2 ± 0.2	0.9 ± 0.3	2.7 ± 1.5
Other grasses[1]	1.8 ± 1.3	1.1 ± 0.5	1.6 ± 0.3

[1] Includes both identified and unidentified species.

Table 2. Percent composition of greater prairie chicken brood diets on the Sheyenne National Grasslands, North Dakota.

Species	June (N=15)	July (N=30)	August (N=30)
	$\bar{x}$ ± se	$\bar{x}$ ± se	$\bar{x}$ ± se
Arthropod parts	80.1 ± 6.9	87.3 ± 3.5	86.3 ± 3.5
Taraxacum officinale	0	3.5 ± 2.4	1.5 ± 0.7
Medicago/melilotus spp.	7.4 ± 6.5	2.9 ± 1.4	4.5 ± 1.3
Artemesia frigida	0.1 ± 0.1	0.2 ± 0.1	0.1 ± 0.1
Flower parts	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Unidentified composite	0	0.6 ± 0.4	1.8 ± 1.3
Poa pratensis	0.7 ± 0.4	0.6 ± 0.2	0.4 ± 0.2
Forb seeds	0	0.1 ± 0.1	0.2 ± 0.2
Carex spp.	5.6 ± 1.9	2.0 ± 0.5	0.3 ± 0.1
Grass seeds	0.3 ± 0.2	0.1 ± 0.1	0.1 ± 0.1
Equisetum spp.	0.6 ± 0.5	0.3 ± 0.1	0
Eleocharis spp.	3.3 ± 1.5	0.7 ± 0.5	0
Andropogon spp.	0	0.2 ± 0.1	0.1 ± 0.1
Ambrosia spp.	0	0.1 ± 0.1	0.2 ± 0.1
Agropyron spp.	0.1 ± 0.1	0.1 ± 0.1	0.2 ± 0.1
Other forbs[1]	0.1 ± 0.1	0.3 ± 0.1	0
Other grasses[1]	1.3 ± 0.6	0.9 ± 0.2	0.7 ± 0.2
Other shrubs[1]	0.1 ± 0.1	0.1 ± 0.1	0.2 ± 0.1

[1] Includes both identified and unidentified species.

Table 3. Percent composition of greater prairie chicken diets during spring-summer (April-August) on the Sheyenne National Grasslands, North Dakota.

	Month				
Species	April (N=45)	May (N=88)	June (N=39)	July (N=44)	August (N=27)
	x ± $\bar{se}$	x ± $\bar{se}$	x ± $\bar{se}$	x ± $\bar{se}$	x ± $\bar{se}$
Arthropod parts	8.0 ± 2.1	6.4 ± 1.2	26.3 ± 4.2	39.0 ± 5.3	59.8 ± 6.3
Taraxacum officinale flower	14.6 ± 4.6	26.5 ± 3.8	9.0 ± 3.5	10.7 ± 4.1	8.1 ± 3.8
Medicago/Melilotus spp.	20.6 ± 4.5	30.7 ± 3.8	42.7 ± 5.6	30.7 ± 5.4	14.8 ± 4.2
Corn kernel	22.5 ± 3.8	13.8 ± 2.1	1.9 ± 1.2	1.9 ± 1.9	2.8 ± 1.4
Artemesia frigida	7.9 ± 2.4	8.7 ± 2.2	0.9 ± 0.4	0.3 ± 0.3	0.3 ± 0.1
Flower parts	1.4 ± 1.1	1.6 ± 0.8	7.5 ± 2.7	3.5 ± 2.4	1.2 ± 0.1
Unidentified composite	13.4 ± 4.2	1.6 ± 0.8	2.3 ± 1.5	1.2 ± 0.5	5.9 ± 3.7
Antennaria/Cirsium spp.	1.3 ± 0.6	2.8 ± 1.5	0.2 ± 0.1	0.1 ± 0.1	0
Poa pratensis	1.1 ± 0.3	0.6 ± 0.2	0.2 ± 0.1	0.2 ± 0.1	0.4 ± 0.2
Forb seeds	2.1 ± 1.9	0.2 ± 0.1	1.9 ± 0.6	1.2 ± 0.5	0.2 ± 0.2
Carex spp.	0.3 ± 0.1	0.7 ± 0.3	0.7 ± 0.6	1.2 ± 0.4	2.8 ± 2.2
Rosa spp.	0.1 ± 0.1	0.4 ± 0.2	2.1 ± 2.1	0.3 ± 0.2	0.1 ± 0.1
Grass seeds	1.3 ± 0.7	0.2 ± 0.1	0.1 ± 0.1	0.2 ± 0.2	0.6 ± 0.4
Equisetum spp.	0.4 ± 0.3	0.3 ± 0.1	0	0.2 ± 0.1	0
Eleocharis spp.	0.3 ± 0.2	0.2 ± 0.1	0.3 ± 0.2	0.1 ± 0.1	0.1 ± 0.1
Andropogon spp.	0	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.4 ± 0.4
Ambrosia spp.	0.6 ± 0.4	0.5 ± 0.2	0.8 ± 0.7	2.5 ± 1.3	1.3 ± 0.9
Agropyron spp.	0	0.2 ± 0.1	0.1 ± 0.1	0	0
Other Forbs[1]	1.0 ± 0.4	0.9 ± 0.3	1.6 ± 0.7	1.4 ± 0.6	0.5 ± 0.3
Other Grasses[1]	0.6 ± 0.2	0.5 ± 0.2	0.2 ± 0.1	0.5 ± 0.2	0.7 ± 0.3
Other Shrubs[1]	0.1 ± 0.1	0.9 ± 0.9	0	0.1 ± 0.1	0.1 ± 0.1

[1] Includes identified and unidentified species.

comprising over 80% of the diet between June and August. Alfalfa/sweetclover was the only other food item consumed by juveniles in notable quantities throughout the summer. Prairie chicken chicks consumed some dandelion flowers later in the summer, and some shoots of sedges (Carex spp.) and rushes (Eleocharis spp.) during June. Other food categories recorded comprised less than 1% of the diets.

DISCUSSION

Waste corn was the most important single food item consumed during the winter months. Corn averaged of 90% of the diet in about 50% of the samples. However, for some individual birds, other food items were equally important. Both soybeans and sunflowers made up over 50% of some individual samples. Forb seeds were probably the next most important food category. High composition of forb seeds (over 30%) was found almost exclusively in samples from prairie chickens observed feeding in soybean fields the previous day. Soybean fields tend to contain many weeds due to the susceptibility of soybeans to herbicides. Forb seeds comprised over 50% (and up to 98%) of some individual samples. Prairie chickens on occasion were noted flying past corn fields on occasion to feed in soybean fields. Thus, most feeding during the winter by prairie chickens in this study was related to agriculture. Various agronomic crops were noted in prairie chicken diets in other regions (Korschgen 1962, Toney 1980, Horak 1985). However, selection of agronomic crops may reflect a preference rather than requirement at southern latitudes (Horak 1985).

Prairie chickens were first recorded in North Dalota in the 1880s following the spread of agriculture (Evans 1968). Whether prairie chickens were native to this region or not may be debated (eg. Kirsch and Kruse 1973), but prairie chicken numbers increased dramatically with the agricultural invasion on the prairie (Hamerstrom et al. 1957). It is our opinion that agriculture is now a necessary habitat component for prairie chickens in this area.

Prairie chickens often fed in fields during the mornings then moved to the edges of fields for day loafing. During December, grass seeds were probably consumed during day loafing while some grass seeds were still attached to stalks.

Of notable significance was the lack of "budding" by prairie chickens during the winter in this study. Prairie chickens used tree habitats on 5.5% of the observations but were observed budding only 1.1% of the time. The lack of shrub or tree buds in the diet may have been due to the lack of snow accumulation during a relatively mild winter. Thus, prairie chickens in this study were not forced to select shrubs as major food items.

Fringed sage appeared in the diets during January and increased in February. Fringed sage tends to retain green leaves during mild winters and may provide a source of green material as the birds get closer to the breeding season. Vitamin A, from green plant materials, was found to stimulate breeding in Gambel's quail (Callipepta gambelii) (Hungerford 1965). Fringed sage continued to make up about 10% of the diets through the prenesting and incubation periods.

During the prenesting and incubating periods, prairie chickens appeared to be selecting food items that were high in digestible energy and protein. Waste corn is obviously a high-energy food. The other dominant food items during this period were arthropods, which are high in protein, and dandelion flowers, alfalfa/sweetclover, and fringed sage. Forbs generally tend to be higher in digestible protein than grasses (Cook 1972). Increased protein intake during egg laying can result in less weight loss to laying hens (Beckerton and Middleton 1983). Hens loose 15-20% of their body weight during incubation and a hen's ability to successfully raise a brood may depend on her condition after incubation.

Dandelions were also the most important forb in gray partridge diets when available (Weigand 1980), and were highly selected for by sage grouse (Peterson 1970). Individual fecal samples contained up to 96% dandelion flowers during the spring (April-May), indicating that prairie chickens also appear to prefer dandelion flowers when available.

Waste corn was still being selected by the prairie chickens during early spring but consumption of corn declined as the breeding season progressed. Reduced consumption of corn corresponded to decreased use of agricultural habitats and increased use of grasslands, and coincided with spring greenup and field preparations for spring planting of new crops. Consumption of agricultural crops by prairie chickens in this study showed similar patterns to those in Missouri (Korschgen 1962, Toney 1980). During early spring, birds would typically visit display grounds during the morning and evening and feed in the fields during the day.

During the summer months adult prairie chickens continued to select for high-protein and high-energy food items. The level of protein in prairie chicken diets through consumption of arthropods increased from June through August, and probably reflected the increased availability of arthropods. Trends in the diets indicated that alfalfa/sweetclover were being traded for arthropods through the summer, which would indicate a trade off of plant protein for possibly more preferred animal protein. Insects were the dominant food item of lesser prairie chickens (T. pallidicintus) in Texas except during periods of low availability, during which acorns (Quercus harvardii) were selected (Doerr and Guthey 1983).

Prairie chicken hens attending broods occasionally selected diets similar in content to the juveniles. Some samples from hens attending broods contained over 80% arthropods. However, high quantities of arthropods were not being selected consistently by hens with broods. The reasons for the occasional selection of high quantities of arthropods by hens are unclear, the data did not result from misidentified brood samples, however. Brood samples were easily identified from adult samples on the basis of size.

The high composition of arthropods in the diets of juveniles was expected. The diets of most young gallinaceous birds are dominated by arthropods during their first 8-12 weeks (Kobridger 1965, Petersen 1970, Doerr and Guthery 1983, Whitmore et al. 1986). The importance of arthropods in the diets of young birds has been related to protein demands of the growing young (Cross 1966, Potts 1980, Hurst and Poe 1985). Experiments with sage grouse (Centrocercus urophasianus) chicks fed diets of varying amounts of insects showed that developmental deficiencies were apparent for birds whose diets contained restricted amounts of insects (Johnson 1987). Despite the importance of insects in diets, habitat selection patterns in sharp-tailed grouse in Nebrasks were not determined by the abundance of insects, however (Kobridger 1965).

Juvenile prairie chickens consumed small amounts of some vegetation throughout the summer. Sedges and rushes were found in the diets in notable quantities only when these plants were producing new shoots. Whether the sedges and rushes selected were from mesic or xeric species was not known; broods used habitats where both occurred (Newell 1987). Sedges and rushes declined in the diets following periods of initial rapid growth. Alfalfa/sweet clover was consumed by juvenile prairie chickens throughout the summer in low quantities. We suspect that these amounts of may have been related to availability of arthropods and succulence of the vegetation. Alfalfa produces new growth throughout the summer following cutting of fields for hay, and appeared in the diets throughout the summer. Alfalfa/sweetclover also tend to be higher than other forbs and grasses in digestible protein and energy (Church 1972, White and Wright 1984). Clover (Trifolium spp.), also a leguminous forb, was the most important plant food item for immature sharp-tailed grouse in Nebraska (Kobridger 1965). All of these plant foods items decreased in the diets as arthropods increased through the summer.

Low amounts of the several other species of vegetation which appeared in the diets of both adults and juveniles may have been from incidental intake from the guts of herbivorous arthropods (Hansen 1975).

CONCLUSIONS AND IMPLICATIONS

Agricultural crops interspersed with grassland habitats provide an important source of winter food for prairie chickens in this area. The importance of these high energy foods to sustaining prairie chicken populations may increase in regions with cold temperatures and snow accumulations. Although prairie chickens fed in both soybean and sunflower fields, corn appeared to be the most important single food item during the winter. Establishment of corn food plots could be a viable management objective if winter food were determined to be limiting this population of prairie chickens.

Agricultural crops declined in importance with a corresponding increase in consumption of green vegetative materials and arthropods during the spring. This diet shift coincided with breeding activities and spring field preparation. Forbs and arthropods were the dominant food items through the summer. These food items indicated that adult prairie chickens were selecting for food high in digestibility and protein. Prairie chicken chicks consumed diets high in animal protein as expected, but included some plants through August.

Whereas there are few management alternatives for enhancing food availability on the grasslands during the spring-summer, other management actions could be detrimental. Pest management that impacts nontarget insects could have detrimental impacts on brood survival and growth due to the dependence of the juvenile prairie chickens on arthropods. Direct manipulation of vegetation to enhance native clover or dandelions is not recommended. However, inclusion of leguminous forbs in rangeland seeding mixes is recommended.

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Management of Livestock to Improve and Maintain Prairie Chicken Habitat on the Sheyenne National Grasslands[1,2]

Robert L. Eng, John E. Toepfer, and Jay A. Newell[3]

Abstract-- Cover requirements of prairie grouse are primarily related to vegetative structure, whereas food needs are species related. Seasonal distribution and intensity of grazing initially alter the structure and ultimately can alter species composition. Initial successful nests were found in areas of more and higher residual cover than unsuccessful nests. Nesting areas were similar in type and height class to areas used by prairie chickens for winter and spring roosting. Success of renesting hens was higher than initial nests which was probably a function of additional cover provided by current year's growth. A key factor influencing prairie grouse numbers lies in the amount and distribution of residual grass cover (15-50 cm, ht) within 1.6 km of a display ground. On the Sheyenne Grasslands, this cover was almost entirely found in the lowlands and midlands. Grazing and haying management of these two communities will have the greatest impact on prairie chickens.

One need only look at published reports of cover requirements for a widely distributed gallinaceous species to see that the common denominator for secure cover lies in structure rather than plant species composition. Hammerstrom et al. (1957) discussed this aspect of cover for prairie chickens in Wisconsin. Jones (1963), in comparing habitats of the greater and lesser prairie chicken (Tympanuchus cupido and T. pallidicinctus), generally found the greater using tall grasses for cover, while the lesser in shortgrass habitat used shrubs. Likewise, Nielsen and Yde (1981) found sharptails (Tympanuchus phasianellus) using shrubs for cover in the absence of grass of adequate height. Perhaps an extreme in seeking the structural cover requirements, was the heavy use of man-made objects (largely farm machinery) by scaled quail (Calipepla squamata) reported by Schemnitz (1961). In this symposium, Newell et.al. reported on the heavy dependence by prairie chickens on cover height during the reproductive season as did Toepfer and Eng for the winter season. This paper summarizes some of these data and relates them to livestock management on the Sheyenne National Grasslands (SNG).

Reproductive Season

Seventy-six prairie grouse nests were located, just under 80% of which were located on USFS grasslands (Newell 1987). Only 9% were found on private grasslands and of these 7 nests, only 1 was successful. Just over 80% of the nests located on public lands were located in lowlands (56%) and midlands (25%), while only 3% were located in the most heavily grazed uplands. Structural cover was measurably greater at successful nests than at unsuccessful nests (Newell 1987).

Renesting attempts were more successful (68%) than initial efforts (48%), probably a reflection of the greater amount of cover as a result of current seasons growth. Nesting cover for first nests was invariably provided by residual grasses and sedges, the quality of which was dependent upon the degree of disturbance the previous year. Leopold (1933: 309)) pointed out that waterfowl and gallinaceous birds tend to intitiate nesting efforts prior to new green growth. A decided tendency was shown for nesting chickens to avoid pastures in which cattle were present when 11 of 13 renesting hens which had an option, selected pastures without cattle. The 2 which nested in pastures being grazed, selected the site prior to cattle being moved in.

Hens with and without broods showed a preference for native stands of vegetation over agriculture and made extensive use of lowland habitats. Also, brood and broodless hens tended to seek areas which had little or no disturbance

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[2] Contribution No. 2145 from Montana Agric. Exp. Stn.

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(grazing or mowing) during the current year. Roosts by hens during the brood season were primarily found in Class III (26-50 cm) or taller vegetation.

Winter Season

Although prairie chickens on the SNG spent considerable time in disturbed types during the winter while feeding, undisturbed grassland played a key role in their habitat use, with 78% of observed roosts in this type of habitat. From a structural standpoint, 94 % of all roost types were in association with Class III or taller vegetation. Height Classes I and II (0-25 cm) which include areas disturbed by agriculture or grazing, were used primarily during the day for feeding (Figs. 1 and 2). Conversely, the undisturbed lowland community found on the SNG provided the taller Class III and IV (26+ cm) cover used extensively for night roosting (Figs. 3 and 4).

Taller height classes of vegetation played a dual role in providing cover for winter roosting prairie chickens. Birds used the vegetation itself in the absence of snow of adequate depth for burrowing. Taller vegetation also acted to accumulate drifting snow providing sufficient depths for snow burrows or depressions (Fig. 5). At no time during the winter of study, did snow accumulate on the level to a minimum depth required for snow burrowing (23+ cm).

Grazing Management Recommendations

The importance of the lowland and midland communities to prairie chickens on the SNG cannot be denied. These two communities recieved most of the winter and spring use by all hens and in summer by brood hens. None of the nests were located in an upland grass community or in a mowed lowland. Renests were more successful than initial nests, indicating a deficit in residual cover prior to current years growth. Thus, modifications in the management of the lowland and midland communities could have the greatest positive impact on prairie chickens.

Mowing of lowland vegetation was carried out primarily to remove rank vegetation and encourage cattle to graze on these areas thereby reducing pressure on the uplands. Mowing was done on a block basis with all the lowlands in a single pasture removed. A major benefit to prairie chickens could be derived from an adjustment in the mowing pattern to provide a wider distribution of unmowed lowlands. Secondly, efforts should be made to increase the total amount of undisturbed lowland and midland for nesting and winter roosting. One possibility to insure both a more even distribution and an increase acreage of residual grasses would be to mow one third of each pasture in a 3-pasture allotment on a three year rotational basis. A second alternative would be to evaluate individural allotments relative to grouse numbers. Using bird numbers as a habitat index, mowing and grazing practices would remain the same within a 1.6 km radius of booming grounds with high numbers of birds while adjustments could be made around booming grounds with low or unstable numbers. The latter alternative would necessitate a reliable monitoring of population numbers and distribution.

Adjustments in the timing of mowing could be advantageous. By delaying mowing of lowlands until 10 August, most nesting activities would be complete and broods mature enough to avoid mowers. Renesting activities were quite significant toward production in this study, with 6 radio-tagged hens bringing off broods after 10 July. Field observations have shown that chicks less than 21 days old sit rather than fly when threatened. A delayed mowing date would make these chicks less vulnerable.

Adjustments in turn-in dates for cattle provides another alternative for a positive impact on prairie chickens. Delaying the introduction of cattle into pastures until June 1 or 15, or distributing the cattle evenly between pastures for the first 2 weeks, would increase the amount of early vegetational cover for early hatching broods.

Recommendations thus far have dealt almost entirely with vegetation structure. Although sharptails used habitat types, height classes and disturbance types on the SNG in a manner comparable to prairie chickens, they used the shrub habitat at a rate 3 times greater. It appears that sharptails are the more aggressive of the 2 species. In this study, while sharing feeding areas, sharptails dominated prairie chickens in 87 of 94 aggression encounters. In 5 of 6 locations in 3 states that we are aware of where both species inhabited the same area, only sharptails remain. Thus, changes in the distribution and relative abundance of shrub species on the SNG could influence the current balance between the two grouse species. Spring inventory should be maintained at a level sufficient to detect changes in the composition and distribution of the two grouse species and shrub control could be implemented if needed and desired to favor prairie chickens.

Although winter food from agricultural crop is usually available, deep and/or crusted snow can eliminate this food source. Recorded shifts in daily ranges clearly indicates the instability of winter food sources, a condition which at times could contribute to reduced survival and production. A more dependable food source could be provided in the form of standing corn or sunflowers, strategically located with respect to known wintering areas booming grounds.

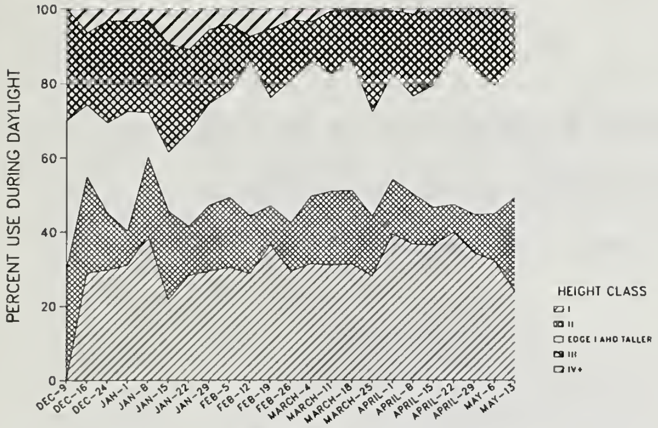

Fig. 1. Weekly use of vegetation height classes (I=0-8 cm, II=9-25 cm, III=26-50 cm, IV=50+ cm) during the daytime by radio-tagged prairie chickens, on the SNG, 1984-85.

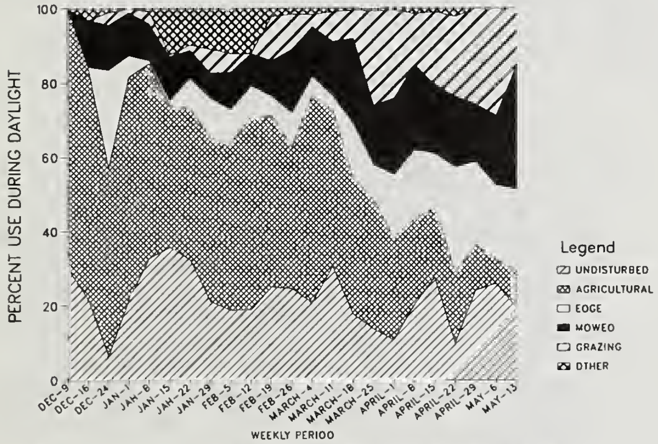

Fig. 2. Weekly use of disturbance types during the daytime for radio-tagged prairie chickens, SNG, 1984-85.

Fig. 5. The accumulation of snow by vegetation, SNG 1984-85.

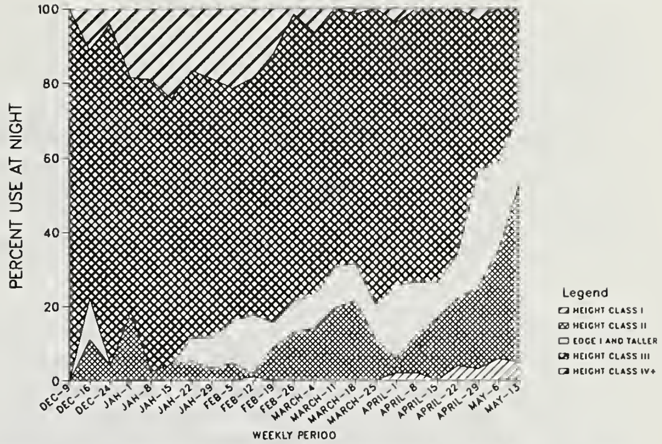

Fig. 3. Weekly use of disturbance types at night for radio-tagged prairie chickens, SNG, 1984-85.

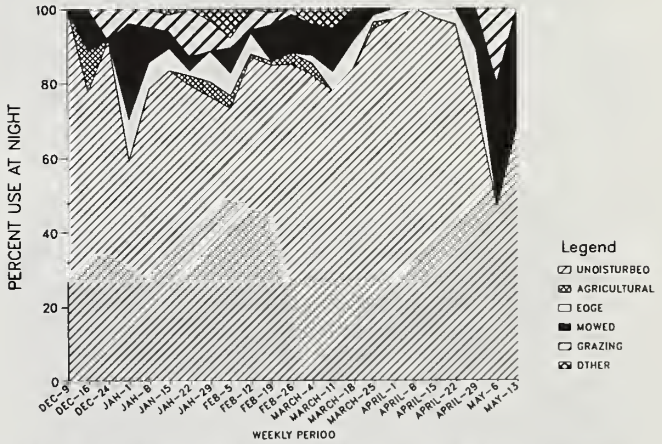

Fig. 4. Weekly use of vegetation height classes (I=0-8 cm, II=9-25 cm, III=26-50 cm, IV=50+ cm) at night by radio-tagged prairie chickens on the SNG, 1984-KD85.

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Effects of Grazing Management Treatment on Grassland Plant Communities and Prairie Grouse Habitat[1]

Llewellyn L. Manske, William T. Barker, and Mario E. Biondini[2]

Abstract.--Seasonlong grazing treatments show no benefit to grass basal cover and visual obstruction is not adequate. Pastures with one grazing period in mid season show no positive change in grass basal cover but have better visual obstruction than seasonlong. Deferred grazing decreases basal cover of warm season grasses and visual obstruction reduced to inadequate levels the first growing season after treatment. Pastures with two grazing periods show increase in basal cover and have adequate visual obstruction. Prairie grouse select against use in seasonlong, one period mid season and deferred grazing treatments but select for pastures grazed two periods for display ground and nest locations.

The effects of grazing by domestic livestock on grassland plant communities depend on season of use, intensity of grazing and duration of grazed and ungrazed periods. Differential responses of the vegetation to grazing management treatments affects the prairie grouse populations that depend on grassland plants for habitat. The different affects on the plant communities and prairie grouse habitat by the various types of grazing management treatments were not well understood. The purpose of this project was to determine the effects of selected grazing management treatments on the grassland plant communities and prairie grouse habitat and evaluate prairie grouse use of the different grazing treatments.

STUDY AREA

This study was conducted on the Sheyenne National Grasslands located in southeastern North Dakota in Ransom and Richland Counties on a geologic formation known as the Glacial Sheyenne Delta. The north unit consists of 67,320 acres of federal land and 63,240 acres of private land. Average annual precipitation was 19.6 inches with 79% of this occurring April through September (Jensen 1972). The frost-free period averages 130 days beginning in mid May. Mean monthly temperatures were highest in July and August (70.9° and 69.9°F, respectively) and lowest in January (7.7°F) (Jensen 1972). The vegetation consists of native grassland and woodland and non-native replacement communities (cropland). These were described by Manske and Barker (1981).

The federally owned land on the Sheyenne National Grasslands was purchased as submarginal farm land from private ownership from 1937 to 1939 after the Congress passed the Bankhead-Jones Farm Tenant Act. The administration of these lands was assigned to the Soil Conservation Service in 1940. The federal land was divided into 10 common grazing blocks which were grazed seasonlong. The grazing season was 8 months from 1940 to 1954. In 1954, the administration was transferred to the U.S. Forest Service. The grazing season was changed to 6 months in 1955 and the common grazing blocks were divided into 56 grazing allotments. These allotments were managed by a seasonlong grazing system. Cross fencing of the allotments began in 1967. Twenty-two allotments were managed by rotation grazing systems with one grazing period per pasture in 1968. In 1974, rotational grazing systems were used on 63% of the allotments (84% of the federal land). Twice over rotation systems (two grazing periods per pasture) were started by District Ranger Robert Storch in eleven allotments in 1974 upon the recommendation of Dr. William T. Barker. The number of allotments that had pastures with twice over rotation grazing periods increased

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until 1978 when 54% of the federal land was managed with twice over systems. In 1979, this management trend was reversed with a change in District Rangers and 70% of the federal land was managed with once over and deferred grazing systems and only 20% with twice over rotation systems. Less than 10% of the federal land was managed with a seasonlong grazing system in 1980. Most of the allotments were grazed by one herd managed as a unit.

METHODS

Records from the Sheyenne Valley Grazing Association of grazing management plans for each grazing allotment from 1974 through 1980 were reviewed and each allotment was classified to type of grazing management treatment for each year. The types of management were categorized by the number of pastures in each system, the number of grazing periods for the pasture with the least number of periods and the season when the grazing periods occurred. The grazing treatments consisted of 1, 2, 3 and 4 pastures. The number of grazing periods varied from 1 to 4 periods. Two 5 pasture systems were designed but these were primarily managed as 2 and 3 pasture systems with 2 herds where some exchange of herds between systems occurred.

The one pasture treatments were grazed one period seasonlong for 183 days. Examples of this type were used as the control treatment. The two pasture systems had examples of 1, 2, 3 and 4 grazing periods. Each pasture was grazed for a total of about 90 days. Only the pastures with 3 and 4 grazing periods (switchback system) were included in this study.

The three pasture treatments were primarily grazed 1, 2 or 3 periods (once, twice or thrice over systems, respectively). Most 3 pasture systems had two pastures grazed twice over and the third pasture grazed once over. The pasture with one grazing period was grazed during the mid season period of June to early September or they were deferred until after grass seed development in late August and grazed only during the late season period of September to mid November. These deferred pastures were not grazed from August of the previous year until late August or September of the year of deferment. These pastures were ungrazed for 11 to 13 months prior to the deferred grazing period. This one year period of ungrazing was included in this study as a treatment. The pastures with two grazing periods were grazed during three season of use categories; early season (May - mid June), mid season (June - early September) or late season (September - mid November). Two grazing periods in three season of use categories resulted in four possible combinations; early - late, early - mid, mid - mid and mid - late. Each pasture was grazed for a total of about 60 days.

Four pasture grazing management treatments were used in 6 allotments which was about 20% of the federal land. These were generally managed as 3 pasture systems with the fourth pasture used for herd splitting for breeding or other purposes or to maintain separation between old cows and heifers. None of these 4 pasture treatments were true one herd 4 pasture rotation systems and were not evaluated as such in this study.

Basal cover was determined in August, 1976 - 1978, by sampling along permanent transect segments on identical slope position in the upland, midland and lowland plant communities with the inclined ten-pin point frame (Levy and Madden 1933, Tinney, Aamodt and Ahlgren 1937, Heady and Rader 1958, and Smith 1959). Fifteen hundred points were read for each plant community per sample stand. Relative changes in basal cover between pretreatment and post treatment were estimated in each pasture for both grazed and ungrazed paired plots. The effects of the different grazing treatments on these relative changes were analyzed with a standard paired plot t test (Mosteller and Rourke 1973).

Visual obstruction was sampled by the height-density method developed by Robel et al. (1970a), and modified by Kirsch (1974). The ability of the grassland vegetation to obstruct vision was considered to be a very important factor in the evaluation of prairie grouse habitat (Hamerstrom et al. 1957, and Robel et al. 1970b). Mean 100% visual obstruction measurements of 1.5 decimeters was considered to be the minimum level for good nesting success and roost cover for prairie grouse Manske and Barker (1981) and Higgins and Barker (1982). The <u>Panicum virgatum</u> (switchgrass) portion of the midland grassland community located on the foot slope was the primary prairie grouse concealment cover on the Sheyenne National Grasslands (Manske and Barker 1981). This switchgrass area was selected as the key vegetation to evaluate the effects of different grazing treatments on prairie grouse habitat. Readings to the nearest 0.5 decimeters (2 inches) were made for the 0% and 100% visual obstruction measurements (VOM) of the height-density pole at four major compass directions. Twenty-five pole sets with an interval of 12 paces were made in homogenous vegetation along a transect of about 270 meters (900 feet). Permanent transects were established in 17 pastures with 5 different grazing treatments. These permanent transects were read spring and fall of 1979 and 1980. Nonpermanent transects were sampled during the spring of 1979 or 1980 in 40 pastures with 8 grazing treatments. Fall data from nonpermanent transects collected on deferred pastures prior to the grazing period were also included. The data collected on the permanent and non-permanent transects were treated separately and analysed using an unbalanced AOV (Mosteller and Rourke 1973).

Location of spring display grounds (Manske and Barker 1981) were classified according to the type of grazing treatment the pasture received the previous year. Use index (% of display location/% of study area) as described by Robel et al. (1970b) was used to evaluate display ground-management interactions. An index value greater than 1.0 indicates selection for that grazing treatment, a value less than 1.0 indicates use less than would be expected if the grouse exhibited no preference. A value of zero indicates avoidance of that treatment category.

Prairie chicken and sharp-tailed grouse nest locations (Manske and Barker 1981) were classified according to the type of grazing treatment the pasture received the previous year. Statistical analysis was not done on the nest location data.

RESULTS AND DISCUSSION

Seasonlong grazing treatments were used on the Sheyenne National Grasslands from 1940 through 1967. The prairie grouse population was very low (less than 25 males) during this period and did not show any increase. In 1968, rotation grazing treatments were started. By 1973, 75% of the federal land was managed by some type of multiple pasture rotation system with one grazing period per pasture. Eighteen pastures in 15 allotments had two grazing periods in 1971. Prior to this, pastures were grazed for one period. There was a large increase in prairie grouse population between 1971 and 1972. During the period of 1968 to 1974 the population of prairie chicken and sharptailed grouse increased appreciably. Management with two grazing periods on multiple pastures within an allotment started in 1974. There was a very large increase in the prairie grouse population in the spring census of 1975. Management with twice over grazing periods increased from 10% of the federal land in 1974 to 54% in 1978. The prairie grouse population increased substantially during this 5 year period. The increasing trend for management with multiple grazing periods on pastures was changed to single grazing periods and deferred type grazing management in 1979. Seventy and seventy-one percent of the federal land was managed by treatments with single grazing periods in mid season or deferred until late season in 1979 and 1980, respectively. The prairie grouse population responded negatively to these changes in management and greatly declined in the spring census of 1981.

Acreages and percentages of federal land managed with 1, 2, 3, and 4 pasture treatments from 1974 through 1980 are shown in table 1. Mean annual acreage for 1, 2, 3 and 4 pasture treatments was 7,369 (11.0%), 11,518 (17.2%), 34,759 (52.0%) and 13,224 (19.8%) acres, respectively. Mean stocking rate of all allotments was 0.88 AUM's/acre. Mean stocking rate for one, two, three (once over) and three (twice over) pasture treatments were 0.75, 1.08, 1.17, 1.07 AUM's/acre, respectively (Table 2). The one pasture seasonlong treatments were stocked below ($P<0.05$) the two and three pasture treatments. The stocking rates for the two pasture, switchback; three pasture, once over; and three pasture, twice over treatments were not significantly different ($P>0.05$).

Basal cover data of individual species were grouped as warm season, cool season and sedges (Tables 3, 4 and 5, respectively). The major species of each plant community were evaluated individually. Data for Panicum virgatum (switchgrass) and Poa pratensis (Kentucky bluegrass) were reported in Table 6.

Basal cover of the warm season grasses (Fig. 1) was significantly reduced by the deferred grazing treatment (#4) in the midland plant community ($P<0.05$). Warm season basal cover (Fig. 1) was reduced ($P<0.05$) in the lowland plant community of the two pasture, thrice over grazing treatment (#2). Changes in basal cover for the warm season grasses in the upland plant communities for the ten treatments were not significant ($P>0.05$). Basal cover of the warm season grasses on the lowland community decreased significantly ($P<0.05$) on the two pasture, thrice over treatment (#2) compared to the seasonlong treatment (#1).

Basal cover for the cool season grasses (Fig. 2) did not change significantly ($P>0.05$) in the upland, midland and lowland plant communities for the ten grazing treatments.

Basal cover for the sedges (Fig. 3) in the lowland community were significantly ($P<0.1$) increased on the three pasture, twice over grazed early and late season treatment (#7). Sedges did not change ($P>0.05$) in the upland and midland communities for the ten grazing treatments. Basal cover of the sedges on the lowland community increased significantly ($P<0.05$) on the three pasture, twice over grazed early and late season treatment (#7) compared to the seasonlong treatment (#1).

Basal cover for Panicum virgatum (Fig. 4) was significantly reduced in the midland ($P<0.05$) and lowland ($P<0.1$) plant communities of the deferred grazing treatment (#4). The three pasture, twice over, grazed early and late treatment (#7) reduced the basal cover of Panicum virgatum (Fig. 4) in the lowland plant community ($P<0.05$). The two pasture thrice over treatment (#2) reduced the basal cover of Panicum virgatum ($P<0.05$) and increased the basal cover of Poa pratensis ($P<0.05$) in the lowland plant community (Fig. 4). Basal cover of Panicum virgatum in the midland community decreased significantly ($P<0.05$) on the three pasture, once over deferred treatment (#4) compared to the seasonlong treatment (#1). Panicum virgatum

Table 1. Annual acreage and percentage of federal land managed with 1, 2, 3 and 4 pasture treatments.

		Year						
Treatment		1974	1975	1976	1977	1978	1979	1980
One Pasture								
Seasonlong	acres	10,977	6,867	6,867	6,926	6,926	6,566	6,457
	%	16.4	10.3	10.3	10.4	10.4	9.8	9.7
Two Pasture								
Once Over, Mid Season	acres	4,658	6,595	5,273	3,404	3,404	5,766	6,450
	%	7.0	9.9	7.9	5.1	5.1	8.6	9.7
Switchback	acres	4,466	4,147	5,469	9,336	9,336	6,974	5,348
	%	6.7	6.2	8.2	14.0	14.0	10.4	8.0
Three Pasture								
Deferred, Late Season	acres	4,384	11,021	5,572	3,072	3,512	21,360	17,041
	%	6.6	16.5	8.3	4.6	5.3	31.9	25.5
Once Over, Mid Season	acres	26,698	18,679	18,569	13,416	11,887	7,133	12,557
	%	39.9	27.9	27.8	20.1	17.8	10.7	18.8
Twice Over, Early, Mid, Late	acres	2,248	5,596	12,623	18,219	19,308	5,236	5,182
	%	3.4	8.4	18.9	27.3	28.9	7.8	7.8
Four Pasture								
Deferred, Late Season	acres	0	0	0	0	0	2,572	3,456
	%	-	-	-	-	-	3.9	5.2
Once Over, Mid Season	acres	13,439	12,720	11,252	5,090	5,090	10,018	7,900
	%	20.1	19.0	16.8	7.6	7.6	15.0	11.8
Twice Over, Early, Mid, Late	acres	0	1,245	1,245	7,407	7,407	1,245	2,479
	%	-	1.9	1.9	11.1	11.1	1.9	3.7

Table 2. Total number of days grazed per pasture and stocking rate for 1, 2 and 3 pasture grazing treatments. Means of same column followed by the same letter are not significantly different ($P<0.05$).

	Total number days grazed	Stocking rate AUM/acre
1 Pasture, Control		
Seasonlong	183.7 ± 0.5	0.75 ± 0.01a
2 Pasture, Switchback		
3 Grazing Periods	87.3 ± 4.5	1.08 ± 0.01b
4 Grazing Periods	92.5 ± 4.3	1.08 ± 0.01b
3 Pasture, Once Over		
Deferred, Late	58.2 ± 5.3	1.15 ± 0.09b
Ungrazed	11-13 months (Sep-Sep)	1.17 ± 0.09b
Mid Season	60.3 ± 6.7	1.18 ± 0.0b
3 Pasture, Twice Over		
Early - Late	59.7 ± 0.5	1.10 ± 0.06b
Early - Mid	57.9 ± 2.8	1.10 ± 0.10b
Mid - Mid	59.7 ± 2.6	1.04 ± 0.04b
Mid - Late	59.8 ± 3.2	1.03 ± 0.03b

Table 3. Basal cover of warm season grasses pretreatment and post treatment for ten grazing treatments.

			Upland		Midland		Lowland	
Treatment	Treatment number	Grazing status	Pre treatment	Post treatment	Pre treatment	Post treatment	Pre treatment	Post treatment
One Pasture, Control								
Seasonlong	1	Grazed	20.1	14.8	11.3	9.1	0.3	0.4
n = 2		Ungrazed	30.2	28.3	16.0	16.0	0.3	0.3
Two Pasture, Switchback								
3 Grazing Periods	2	Grazed	26.7	22.5	17.6	14.3	1.5	0.2
n = 2		Ungrazed	32.8	27.7	20.7	15.6	0.1	0.6
4 Grazing Periods	3	Grazed	28.5	20.7	19.7	13.7	0.5	1.6
n = 2		Ungrazed	28.0	23.5	25.1	14.7	0.8	0.6
Three Pasture, Once Over								
Deferred	4	Grazed	9.6	11.2	18.9	14.0	4.0	9.4
n = 4		Ungrazed	25.4	13.7	12.4	20.0	2.1	7.2
Ungrazed	5	Grazed	11.8	0.4	31.9	21.1	10.9	7.7
n = 3		Ungrazed	14.8	2.4	25.5	18.4	4.7	4.3
Mid Season	6	Grazed	29.2	39.6	13.8	18.6	1.0	9.4
n = 1		Ungrazed	29.8	38.0	17.8	20.0	1.4	5.6
Three Pasture, Twice Over								
Early - Late	7	Grazed	27.6	31.9	17.5	24.3	2.8	4.8
n = 3		Ungrazed	24.9	28.5	19.9	23.1	1.3	5.8
Early - Mid	8	Grazed	35.5	25.0	27.1	22.3	7.9	6.3
n = 6		Ungrazed	35.8	20.6	31.9	22.2	6.1	3.0
Mid - Mid	9	Grazed	24.6	23.7	16.2	16.6	3.0	4.8
n = 5		Ungrazed	22.7	18.9	20.8	18.5	1.8	2.6
Mid - Late	10	Grazed	20.5	17.8	28.1	16.5	3.8	3.5
n = 5		Ungrazed	21.2	17.2	29.4	18.4	4.8	2.9

Table 4. Basal cover of cool season grasses pretreatment and post treatment for ten grazing treatments.

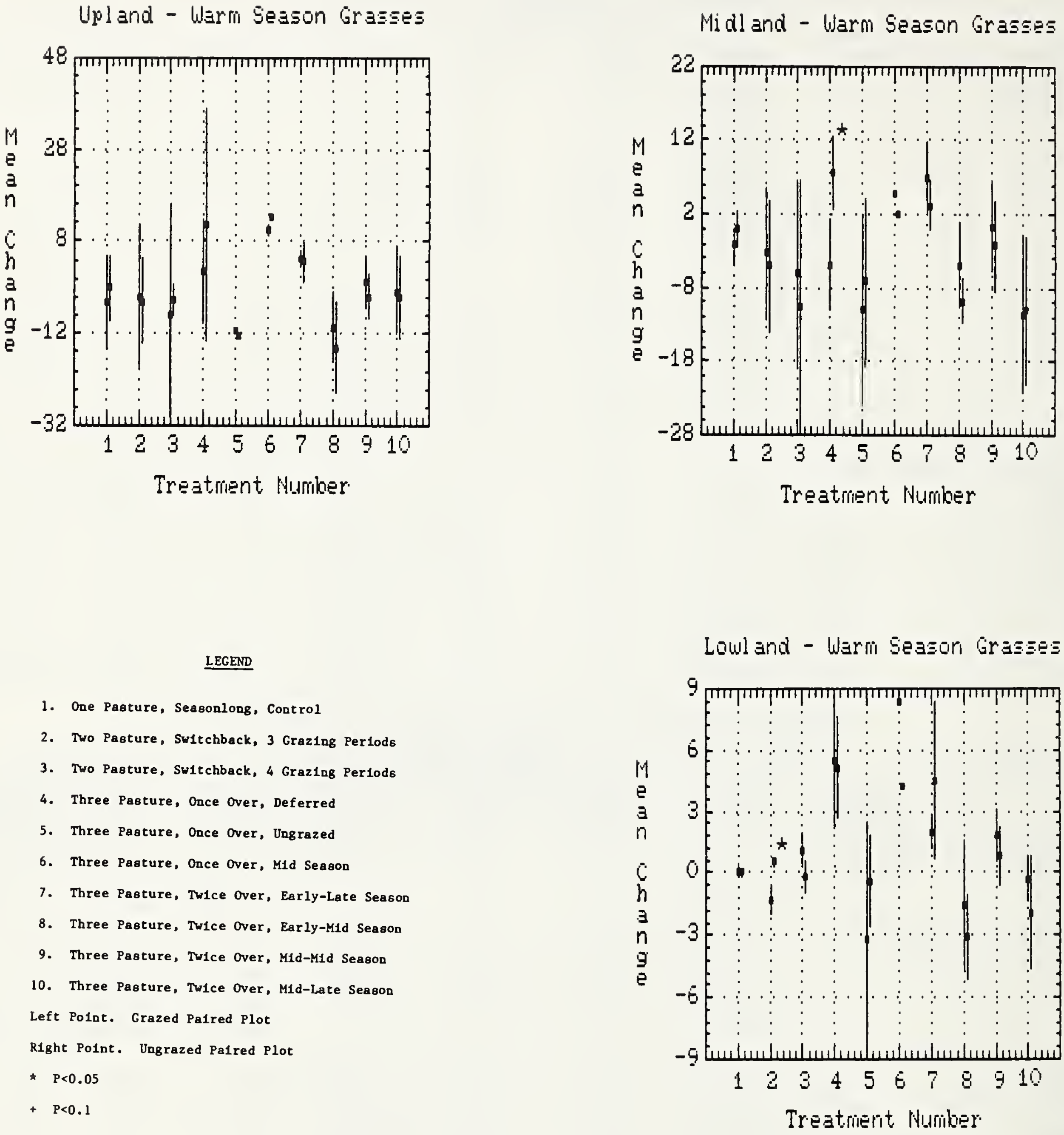
			Upland		Midland		Lowland	
Treatment	Treatment number	Grazing status	Pre treatment	Post treatment	Pre treatment	Post treatment	Pre treatment	Post treatment
One Pasture, Control								
Seasonlong	1	Grazed	13.3	11.9	18.1	13.3	4.1	9.4
n = 2		Ungrazed	15.2	5.4	13.5	9.9	6.2	10.7
Two Pasture, Switchback								
3 Grazing Periods	2	Grazed	14.9	5.8	15.4	13.7	1.9	6.6
n = 2		Ungrazed	10.0	4.5	18.0	11.2	1.6	5.8
4 Grazing Periods	3	Grazed	7.6	6.5	16.7	11.9	4.2	8.0
n = 2		Ungrazed	8.9	7.0	15.5	12.1	1.5	7.3
Three Pasture, Once Over								
Deferred	4	Grazed	18.7	11.9	17.1	13.2	3.5	11.9
n = 4		Ungrazed	9.5	7.7	17.0	12.7	5.4	12.2
Ungrazed	5	Grazed	34.2	10.2	11.1	8.3	6.2	9.1
n = 3		Ungrazed	32.4	9.6	15.1	9.3	6.3	11.1
Mid Season	6	Grazed	3.0	7.2	6.6	15.2	10.2	21.6
n = 1		Ungrazed	8.2	8.2	7.8	17.6	6.4	10.6
Three Pasture, Twice Over								
Early - Late	7	Grazed	2.7	4.9	8.0	8.9	6.9	14.3
n = 3		Ungrazed	3.3	6.7	9.7	11.2	3.7	10.3
Early - Mid	8	Grazed	17.7	2.8	15.9	7.6	7.1	9.7
n = 6		Ungrazed	15.1	4.5	11.8	8.4	6.6	7.4
Mid - Mid	9	Grazed	7.7	8.7	14.8	14.6	10.1	15.6
n = 5		Ungrazed	9.9	11.2	11.2	14.9	7.2	15.2
Mid - Late	10	Grazed	19.6	9.8	15.4	15.7	11.2	13.2
n = 5		Ungrazed	22.0	11.6	15.6	11.9	11.7	14.8

Table 5. Basal cover of sedges pretreatment and post treatment for ten grazing treatments.

			Upland		Midland		Lowland	
Treatment	Treatment number	Grazing status	Pre treatment	Post treatment	Pre treatment	Post treatment	Pre treatment	Post treatment
One Pasture, Gontrol								
Seasonlong	1	Grazed	8.4	3.6	14.7	6.1	24.0	18.1
n = 2		Ungrazed	3.6	3.6	14.4	6.8	25.6	20.7
Two Pasture, Switchback								
3 Grazing Periods	2	Grazed	6.2	4.6	20.4	7.2	35.7	16.2
n = 2		Ungrazed	6.8	3.3	15.1	7.0	27.5	14.4
4 Grazing Periods	3	Grazed	7.1	4.4	17.3	7.8	23.3	16.1
n = 2		Ungrazed	7.3	4.6	15.2	7.6	22.7	20.0
Three Pasture, Once Over								
Deferred	4	Grazed	12.6	6.9	10.7	5.6	23.0	12.9
n = 4		Ungrazed	11.3	8.4	13.2	8.3	23.9	14.2
Ungrazed	5	Grazed	5.2	6.4	10.0	5.1	24.7	10.8
n = 3		Ungrazed	20.8	8.0	12.1	6.7	24.9	12.6
Mid Season	6	Grazed	1.6	2.0	5.0	9.6	13.8	13.2
n = 1		Ungrazed	1.0	1.2	3.0	10.8	19.0	25.4
Three Pasture, Twice Over								
Early - Late	7	Grazed	2.8	3.4	4.9	5.1	10.8	17.1
n = 3		Ungrazed	3.5	3.7	6.3	6.5	14.3	17.5
Early - Mid	8	Grazed	5.4	3.7	11.6	4.4	27.7	12.7
n = 6		Ungrazed	3.8	3.4	8.6	6.1	28.4	16.6
Mid - Mid	9	Grazed	2.8	3.5	6.6	5.5	15.1	15.1
n = 5		Ungrazed	4.5	5.6	5.1	4.6	16.0	13.2
Mid - Late	10	Grazed	5.5	3.3	6.1	5.3	23.4	13.4
n = 5		Ungrazed	8.8	4.3	6.4	4.8	19.2	13.6

Table 6. Basal cover of Panicum virgatum and Poa pratensis pretreatment and post treatment for ten grazing treatments.

			Panicum virgatum				Poa pratensis	
			Midland		Lowland		Lowland	
Treatment	Treatment number	Grazing status	Pre treatment	Post treatment	Pre treatment	Post treatment	Pre treatment	Post treatment
One Pasture, Gontrol								
Seasonlong	1	Grazed	1.1	1.1	0.0	0.1	0.2	0.2
n = 2		Ungrazed	2.2	2.4	0.0	0.0	0.0	0.0
Two Pasture, Switchback								
3 Grazing Periods	2	Grazed	0.5	3.2	0.2	0.1	0.3	1.4
n = 2		Ungrazed	0.6	2.2	0.1	0.6	0.2	0.2
4 Grazing Periods	3	Grazed	2.1	1.1	0.4	0.2	0.7	3.2
n = 2		Ungrazed	1.1	1.2	0.7	0.4	0.1	3.0
Three Pasture, Once Over								
Deferred	4	Grazed	6.4	2.1	2.0	1.6	2.2	7.1
n = 4		Ungrazed	3.3	3.9	0.4	2.1	2.8	5.8
Ungrazed	5	Grazed	5.5	2.7	7.9	2.9	2.1	5.7
n = 3		Ungrazed	2.7	2.5	3.7	1.7	2.1	3.7
Mid Season	6	Grazed	1.2	1.6	0.4	7.4	5.8	11.4
n = 1		Ungrazed	1.8	0.4	0.0	0.0	1.0	0.4
Three Pasture, Twice Over								
Early - Late	7	Grazed	0.9	0.9	0.5	2.6	6.2	12.5
n = 3		Ungrazed	2.1	2.7	0.7	4.3	1.1	4.8
Early - Mid	8	Grazed	2.0	1.2	2.7	2.7	4.2	5.6
n = 6		Ungrazed	4.2	3.0	2.5	1.8	2.4	1.4
Mid - Mid	9	Grazed	0.9	1.2	1.4	2.5	7.2	10.3
n = 5		Ungrazed	1.6	1.1	0.8	1.3	2.8	6.9
Mid - Late	10	Grazed	1.4	1.4	2.0	1.9	6.2	9.0
n = 5		Ungrazed	1.7	1.3	2.1	1.6	4.8	4.8



LEGEND

1. One Pasture, Seasonlong, Control
2. Two Pasture, Switchback, 3 Grazing Periods
3. Two Pasture, Switchback, 4 Grazing Periods
4. Three Pasture, Once Over, Deferred
5. Three Pasture, Once Over, Ungrazed
6. Three Pasture, Once Over, Mid Season
7. Three Pasture, Twice Over, Early-Late Season
8. Three Pasture, Twice Over, Early-Mid Season
9. Three Pasture, Twice Over, Mid-Mid Season
10. Three Pasture, Twice Over, Mid-Late Season

Left Point. Grazed Paired Plot

Right Point. Ungrazed Paired Plot

* $P<0.05$

\+ $P<0.1$

Fig. 1 Mean changes for warm season grasses in absolute basal cover between pretreatment and post treatment for ten grazing management treatments comparing grazed (point on left) and ungrazed (point on right) paired plots.

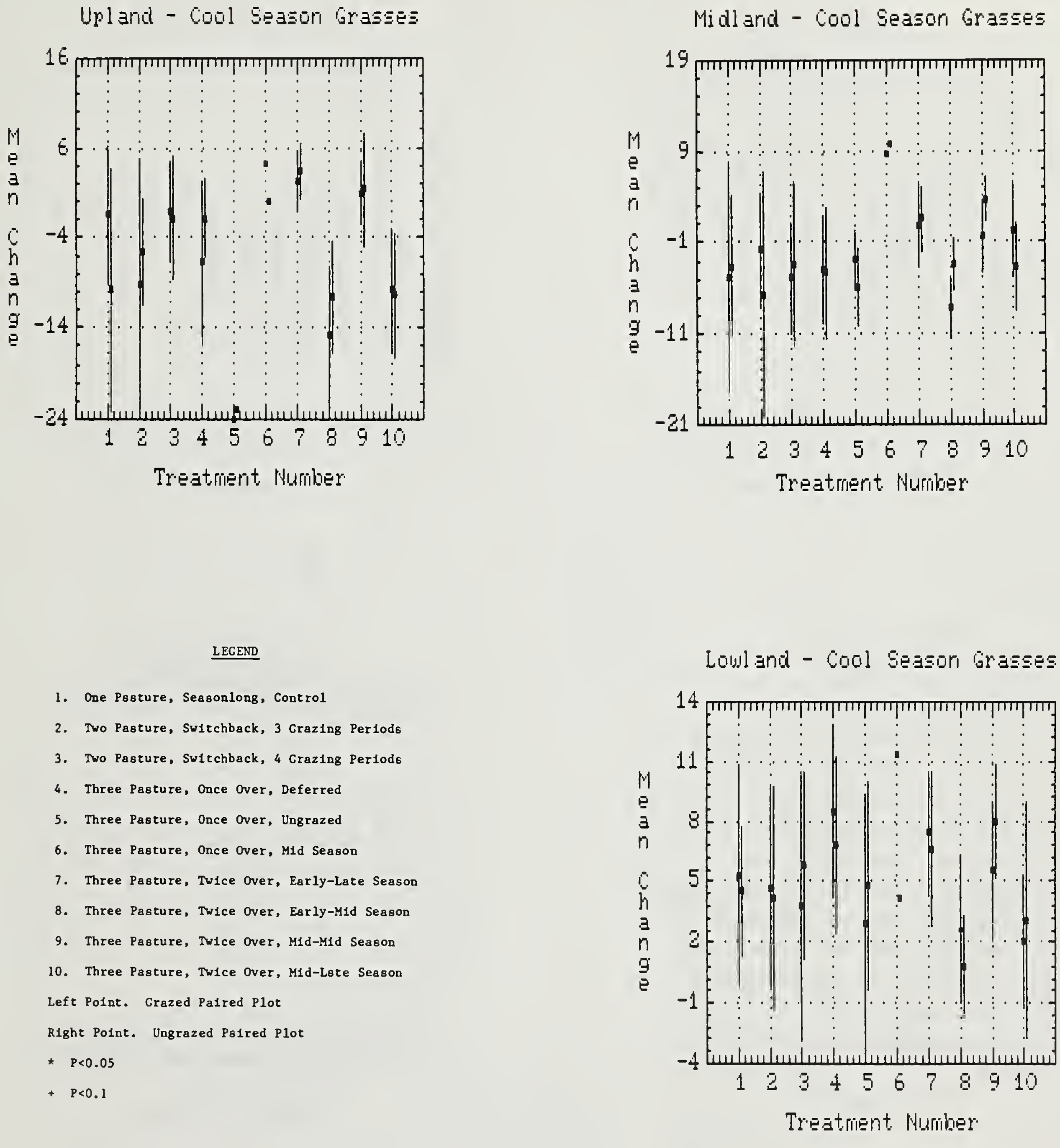
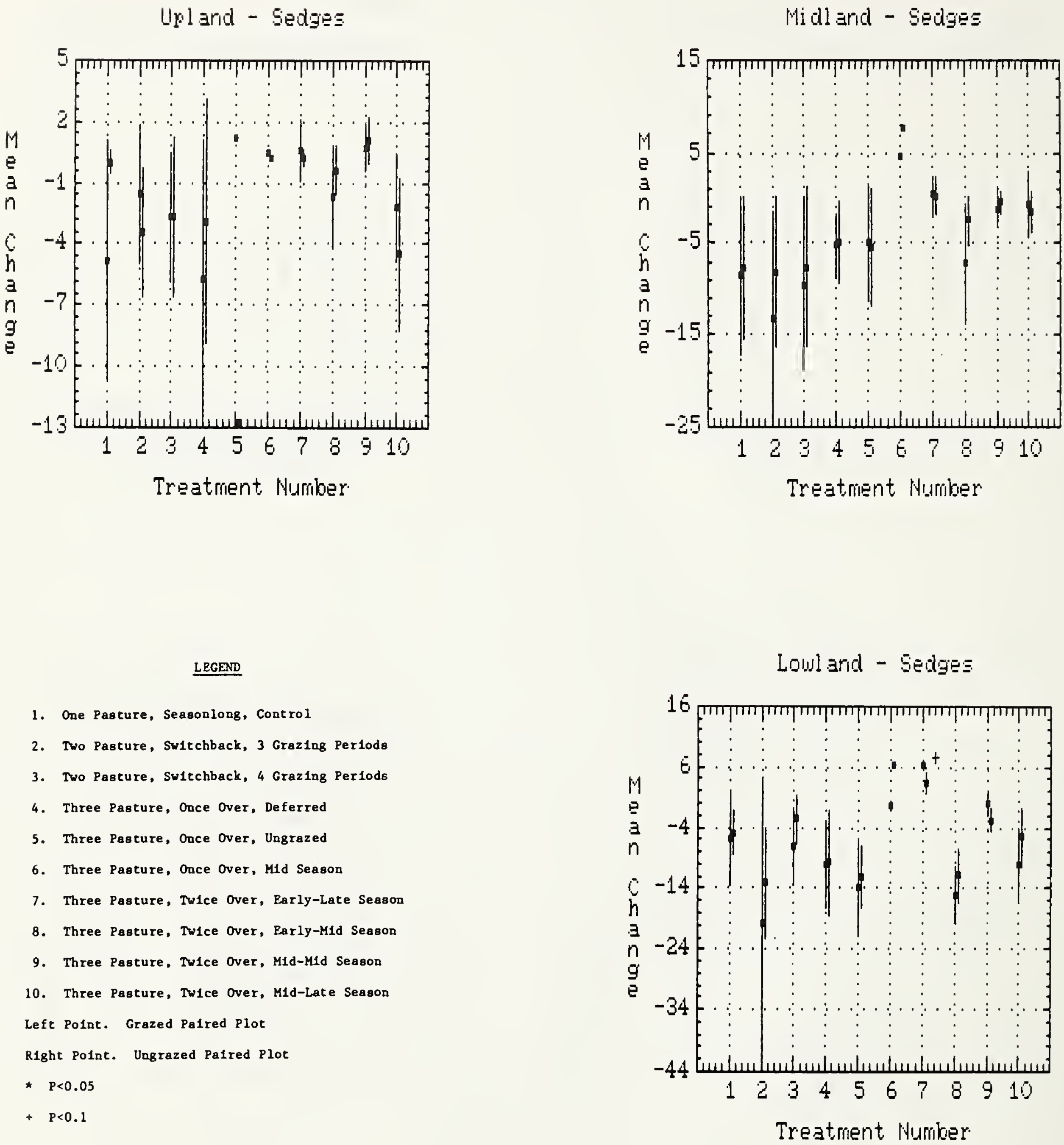


Fig. 2 Mean changes for cool season grasses in absolute basal cover between pretreatment and post treatment for ten grazing management treatments comparing grazed (point on left) and ungrazed (point on right) paired plots.



LEGEND

1. One Pasture, Seasonlong, Control
2. Two Pasture, Switchback, 3 Grazing Periods
3. Two Pasture, Switchback, 4 Grazing Periods
4. Three Pasture, Once Over, Deferred
5. Three Pasture, Once Over, Ungrazed
6. Three Pasture, Once Over, Mid Season
7. Three Pasture, Twice Over, Early-Late Season
8. Three Pasture, Twice Over, Early-Mid Season
9. Three Pasture, Twice Over, Mid-Mid Season
10. Three Pasture, Twice Over, Mid-Late Season

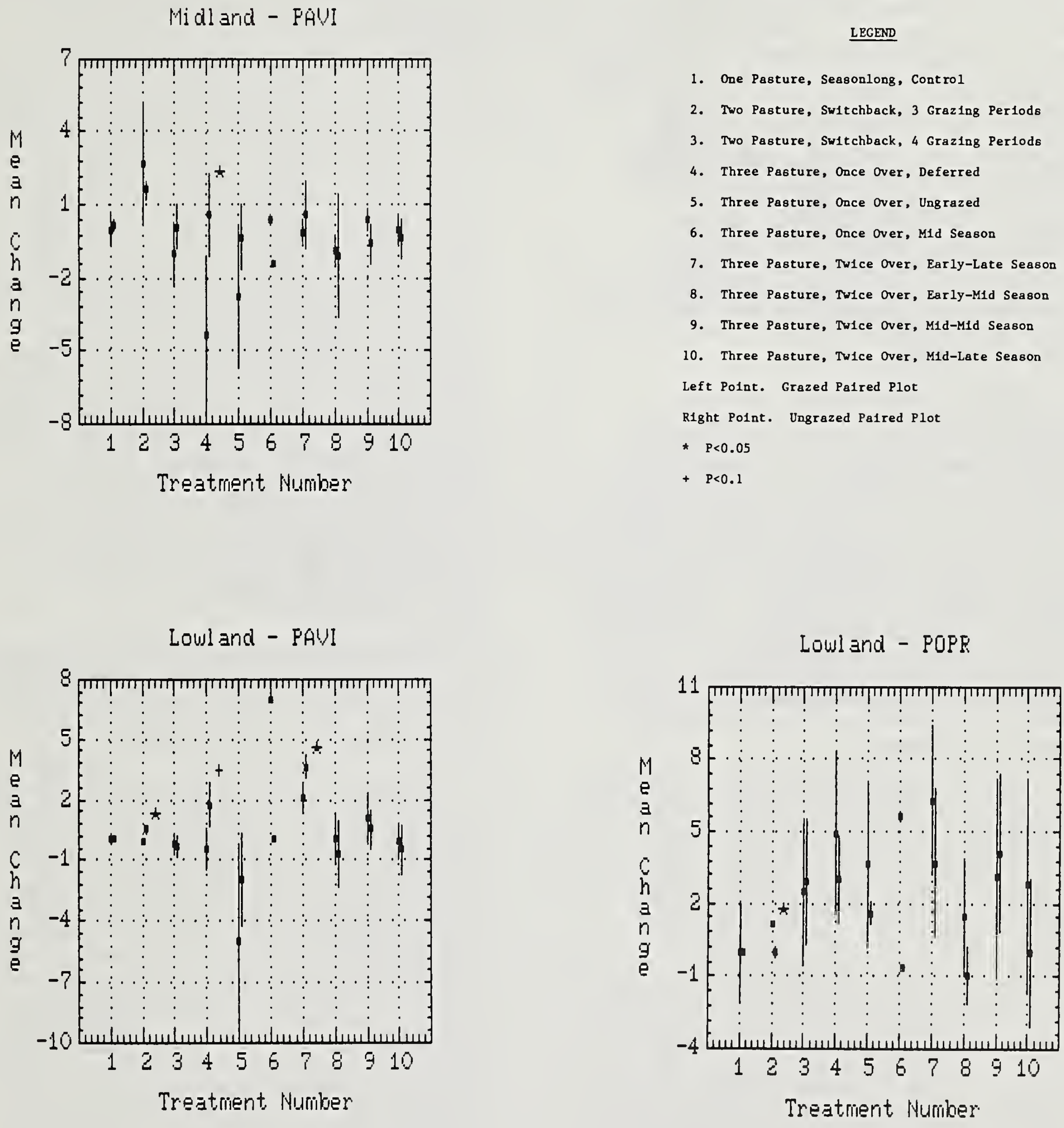
Left Point. Grazed Paired Plot

Right Point. Ungrazed Paired Plot

* P<0.05

\+ P<0.1

Fig. 3 Mean changes for sedges in absolute basal cover between pretreatment and post treatment for ten grazing management treatments comparing grazed (point on left) and ungrazed (point on right) paired plots.



LEGEND

1. One Pasture, Seasonlong, Control
2. Two Pasture, Switchback, 3 Grazing Periods
3. Two Pasture, Switchback, 4 Grazing Periods
4. Three Pasture, Once Over, Deferred
5. Three Pasture, Once Over, Ungrazed
6. Three Pasture, Once Over, Mid Season
7. Three Pasture, Twice Over, Early-Late Season
8. Three Pasture, Twice Over, Early-Mid Season
9. Three Pasture, Twice Over, Mid-Mid Season
10. Three Pasture, Twice Over, Mid-Late Season

Left Point. Grazed Paired Plot

Right Point. Ungrazed Paired Plot

* $P<0.05$

\+ $P<0.1$

Fig. 4 Mean changes for *Panicum virgatum* (PAVI) and *Poa pratensis* (POPR) in absolute basal cover between pretreatment and post treatment for ten grazing management treatments comparing grazed (point on left) and ungrazed (point on right) paired plots.

basal cover in the lowland community decreased significantly (P<0.05) on the two pasture, thrice over treatment (#2) compared to the seasonlong treatment (#1). Basal cover of Panicum virgatum was significantly (P<0.05) increased in the lowland community on the three pasture, twice over grazed early and late season treatment (#7) compared to the seasonlong treatment (#1). Basal cover of Andropogon gerardi (Big bluestem), Andropogon scoparius (Little bluestem), Bouteloua gracilis (Blue grama), Calamagrostis inexpansa (Northern reedgrass), Koeleria pyramidata (Prairie junegrass), Stipa comata (Needleandthread), Stipa spartea (Porcupine grass), Carex heliophila (Sun sedge), Carex lanuginosa (Woolly sedge) and Juncus balticus (Baltic rush) did not change significantly (P>0.05) for the ten grazing treatments.

Relative changes in basal cover on management treatments comparing grazed and ungrazed paired plots showed no significant changes in vegetation after one year of treatment on the seasonlong treatments (#1) at significantly (P<0.05) lower stocking rates; or on two pasture, four times over (#3); three pasture, ungrazed (#5); three pasture, twice over grazed early-mid (#8); mid-mid (#9); and mid-late (#10) season treatments. Significantly negative effects on basal cover were shown by two pasture, thrice over (#2) and three pasture, once over, deferred (#4) treatments. Significantly positive effects on basal cover after one year of treatment was shown by the three pasture, twice over grazed early-late season (#7) treatments.

Visual obstruction measurements (VOM) were read spring and fall for 2 years along permanent transects in 17 pastures with 5 grazing treatments (table 7). The grazing management of the previous year (1978) for these pastures were the same as 1979 and 1980 for each treatment except one replication of the three pasture, once over grazed mid season treatment. It was grazed for two periods in 1978. The replications in the 3 pasture, deferred category were deferred until September only in 1979. In 1978, each pasture was grazed for two periods with the second period ending in early or mid September. These pastures were ungrazed from September 1978 until September 1979. The one period of deferred grazing occurred during the late season from September to mid November 1979. In 1980, these pastures were again grazed two periods.

The general trend for the visual obstruction measurements (table 7) was for the readings of spring 1979 to be the starting value with an increase due to growth for the fall of 1979. The readings of spring 1980 were below fall 1979 readings primarily because of fall grazing after the readings were taken and snow pack. The fall 1980 readings again increased above spring readings due to plant growth.

The readings on the permanent transects (table 7) of the one pasture, seasonlong treatments were generally below the other treatments. The 100% VOM of the one pasture treatments were significantly (P<0.05) below the two pasture, switchback; three pasture, mid season; and three pasture, twice over in spring 1979, the three pasture, deferred in fall 1979, and the three pasture, deferred; three pasture, mid season; and three pasture, twice over in spring 1980. The one pasture, seasonlong treatment was significantly (P<0.05) above the three pasture, deferred in fall 1980. The 100% VOM of the one pasture, seasonlong treatments were below the minimum of 1.5 decimeters in both spring 1979 and 1980. The 100% VOM of the three pasture, deferred treatment was not significantly different (P>0.05) from the other rotation treatments in spring and fall 1979 and spring 1980. The 100% VOM for the deferred treatment was significantly below (P<0.05) the one pasture, seasonlong; three pasture, mid season; and three pasture, twice over treatments in fall 1980. The 100% VOM fall 1980 for the three pasture, deferred treatment was below the minimum of 1.5 decimeters. The 100% VOM for the two pasture, switchback; three pasture, once over mid season; and three pasture, twice over were not significantly different (P>0.05) for spring and fall 1979 and 1980.

The 0% VOM (table 7) for the three pasture, deferred treatment was significantly greater (P<0.05) than the other treatments in fall 1979 and spring 1980. The 0% VOM were very similar (P>0.05) for all other treatments.

Visual obstruction measurements from the permanent transects of the seasonlong treatments had 100% readings significantly below other treatments during the spring and below the minimum of 1.5 decimeters required to provide adequate concealment cover. The three pasture, once over deferred treatments had vegetation that was significantly taller but not significantly denser in the fall prior to the deferred grazing period than the rotation treatments that had been grazed. In the spring after the deferred grazing, the 0% VOM was still significantly taller and the 100% VOM was not significantly different than the rotation treatments. At the end of the first growing season after deferred grazing, the 0% VOM was not significantly different and the 100% VOM was significantly below the readings from the rotation grazing treatments and below the minimum 1.5 decimeters. The visual obstruction readings for the two pasture, switchback, three pasture, once over mid season and three pasture, twice over treatments were not significantly different and the 100% VOM's were above the minimum 1.5 decimeter level. The seasonlong grazing treatment and the three pasture, deferred treatment did not satisfactorily provide adequate concealment cover for prairie grouse.

Table 7. Visual obstruction measurements in decimeters from permanent transects read spring and fall of 1979 and 1980 for 1, 2 and 3 pasture grazing treatments. Means of same column followed by the same letter are not significantly different (P<0.05).

Treatment	Percent visual obstruction	1979		1980	
		Spring	Fall	Spring	Fall
1 Pasture, Control					
Seasonlong	0%	3.45 ± 0.15z	5.20 ± 0.10z	4.30 ± 0.0z	4.95 ± 0.25z
n = 2	100%	1.15 ± 0.15a	1.65 ± 0.25a	1.30 ± 0.0a	2.00 ± 0.10a
2 Pasture,					
Switchback	0%	5.10 ± 0.44y	5.63 ± 1.22z	4.90 ± 1.39zy	4.55 ± 1.06z
n = 4	100%	1.75 ± 0.23b	1.85 ± 0.56ab	1.45 ± 0.21ab	1.48 ± 0.47ab
3 Pasture, Once Over					
Deferred, Late	0%	4.97 ± 0.26y	7.93 ± 0.12y	5.83 ± 0.72x	4.08 ± 0.87z
n = 4	100%	1.50 ± 0.29ab	2.17 ± 0.17b	1.65 ± 0.11b	1.20 ± 0.25b
Mid Season	0%	5.05 ± 0.15y		4.97 ± 0.80zy	4.90 ± 0.88z
n = 3	100%	1.80 ± 0.40b		1.80 ± 0.43b	1.80 ± 0.29a
3 Pasture, Twice Over					
Early-Mid-Late	0%	4.57 ± 0.83y	5.28 ± 0.82z	4.68 ± 0.36y	4.95 ± 0.65z
n = 4	100%	1.53 ± 0.05b	1.83 ± 0.18ab	1.73 ± 0.22b	1.85 ± 0.30a

Table 8. Visual obstruction measurements in decimeters from nonpermanent transects read spring of 1979 or 1980 for 1, 2, and 3 pasture grazing treatments. Means of same column followed by the same letter are not significantly different (P<0.05).

Treatment	0% Visual Obstruction	100% Visual Obstruction
1 Pasture, Control		
Seasonlong	3.87 ± 0.43z	1.20 ± 0.12a
n = 4		
2 Pasture,		
Switchback	5.00 ± 1.03zy	1.60 ± 0.26b
n = 8		
3 Pasture, Once Over		
Deferred, Late	5.58 ± 0.71yx	1.64 ± 0.10b
n = 5		
Ungrazed (Fall)	7.10 ± 1.03x	2.12 ± 0.17c
n = 5		
Mid Season	4.73 ± 0.53zy	1.62 ± 0.23b
n = 6		
3 Pasture, Twice Over		
Early - Late	4.80 ± 0.50y	1.55 ± 0.05b
n = 2		
Early - Mid	4.88 ± 0.56y	1.44 ± 0.33b
n = 5		
Mid - Mid	5.00 ± 0.70y	1.70 ± 0.16b
n = 6		
Mid - Late	4.10 ± 0.42zy	1.68 ± 0.15b
n = 4		

The 0% and 100% VOM from the nonpermanent transects (table 8) were read in the spring of 1979 or 1980 in 40 pastures with 8 treatments. The nonpermanent transects in the deferred treatment were also read in the fall after one year of ungrazed treatment prior to the deferred grazing period in mid September. The 100% VOM for the one pasture, seasonlong treatment was significantly below (P<0.05) all other treatments. It was the only nonpermanent transect reading below the minimum of 1.5 decimeters. The fall 100% VOM for the three pasture, ungrazed was significantly greater (P<0.05) than all other treatments. The spring readings on the deferred treatments were significantly reduced (P<0.05) from the fall readings on the same transects in the ungrazed treatment. The spring 100% VOM of the three pasture, deferred treatment were not significantly different (P>0.05) than the other rotation grazing treatments. The 100% VOM spring readings for the two pasture, switchback; three pasture, once over, midseason; three pasture, twice over, grazed early-late; early-mid; mid-mid; and mid-late season were not significantly different (P>0.05).

The 0% VOM for the three pasture, ungrazed treatment was significantly taller (P<0.05) than all other treatments in the fall. It did not retain this height in the following spring after fall grazing. The three pasture, deferred treatment was not significantly different (P>0.05) from the other rotation grazing treatments (table 8).

Visual obstruction measurements from the nonpermanent transects showed that the seasonlong treatment did not provide adequate prairie grouse concealment cover. The visual obstruction for the three pasture, once over deferred treatment appeared impressive before the grazing period began but was no different than the rotation treatments the following spring after the deferred grazing treatment.

There were 30 active prairie grouse display grounds in the spring of 1975 and 54 in 1980 (Manske and Barker 1981). Twenty-seven grounds were active for the entire six year study period. The location of these grounds changed from the previous year on the average 2.6 ± 1.4 times in six years. Only two display grounds remained on the same 10 acre area for the duration of the study. These two grounds moved within that area. All 54 display grounds observed during this study changed locations from the previous year 62% of the time.

This high rate of changing locations of display grounds was different from the traditional concept of permanent locations for prairie grouse display grounds. The reasons that the display grounds on the Sheyenne National Grasslands changed locations frequently was primarily due to a relatively young population that was increasing and expanding and had not developed long term traditional locations and location changes as a response to the various grazing management treatments.

Twenty-six (48%) of the display grounds active in 1980 were new after 1974. Thirty-four (63%) were new after 1972 and forty-four (81%) were new after 1968 when rotation type grazing management was started on the Sheyenne National Grasslands. Most of the prairie grouse population increase and expansion occurred after 1968. Large increases in the population occurred between 1968 and 1972, 1973 and 1975, and 1978 and 1979. Large expansions into previously unoccupied habitat occurred between 1973 and 1974, and 1978 and 1979. A large increase in density of males per square mile of occupied habitat occurred between 1978 and 1979.

Use index (Robel et al. 1970b) by display grounds of various grazing management treatments (table 9) indicates that display grounds have preferably moved into pastures of 2, 3 and 4 pasture systems that had been grazed 2, 3 or 4 periods the previous year. Pastures of 3 and 4 pasture systems that had been grazed for only one period in mid season or deferred until September were not preferably used by prairie grouse for courtship display. The one pasture, seasonlong treatment was also not preferably selected for courtship display.

Six prairie chicken and eight sharp-tailed grouse nests (table 9) were found on federal land during this study. Five prairie chicken and six sharp-tailed grouse nests were located in pastures of 3 and 4 pasture systems that had been grazed for 2 or 3 periods the previous year. Three of these prairie chicken and 3 sharp-tailed grouse nests were successfully hatched and 2 prairie chicken and 3 sharp-tailed grouse nests were not successful. One prairie chicken and one sharp-tailed grouse nests were located in pastures that had been deferred from grazing until September the previous year. The sharp-tailed grouse nest was successful but the prairie chicken nest was not hatched. One sharp-tailed grouse nest was located in a one pasture, seasonlong treatment. It was not successfully hatched. The majority (79%) of the prairie grouse nests found during this study were located in pastures that had been grazed for 2 or 3 periods the previous year.

SUMMARY

Grazing by domestic livestock on grasslands effects the plant communities differentially depending on season of use, intensity of grazing and duration of grazed and ungrazed periods. Prairie grouse depend on grassland plant communities to provide for their various habitat requirements. Prairie grouse populations respond to the differential changes in grassland vegetation resulting from various grazing management treatments.

Table 9. Use index for display ground locations and number of nest locations for 1, 2, 3 and 4 pasture grazing treatments.

Treatment	Use Index Display Grounds 1975 - 1980	Number of Nests	
		Prairie Chicken	Sharp-tailed Grouse
1 Pasture, Control Seasonlong	0.72 ± 0.47	0	1
2 Pasture			
1 Over	1.05 ± 0.30	0	0
2, 3, & 4 Over	1.64 ± 0.17	0	0
3 Pasture			
Deferred, Late	0.53 ± 0.45	1	1
1 Over	0.84 ± 0.16	0	0
2 & 3 Over	1.06 ± 0.14	3	6
4 Pasture			
Deferred, Late	0.54 ± 0.54	0	0
1 Over	0.56 ± 0.06	0	0
2 & 3 Over	1.33 ± 0.29	2	0

Seasonlong grazing treatments showed no benefit to grass basal cover even at low stocking rates. Spring 100% visual obstruction measurements (VOM) were below rotation grazing treatments. These readings were below the minimum 1.5 decimeter level and did not provide adequate prairie grouse concealment cover for nesting or roosting. Prairie grouse select against seasonlong grazing treatments for spring courtship display ground and nest locations.

Two pasture systems with three grazing periods showed reduction in basal cover of warm season grasses and switchgrass on the lowland plant community. These decreases were greater on the two pasture, thrice over treatments than on the seasonlong treatments. Basal cover of vegetation on the two pasture, four times over was not significantly changed. Pastures in two pasture treatments should be managed with no less than four grazing periods. Spring 100% VOM readings were greater on two pasture treatments than one pasture, seasonlong treatments and were not different than readings from three pasture rotation treatments for permanent and non-permanent transects. Prairie grouse selected pastures managed with two pasture grazing treatments for courtship display locations but not for nest site locations.

Pastures grazed for one period during mid season, June to September, showed no positive response in grass basal cover but did show significantly greater 100% VOM readings compared to seasonlong grazing treatments. Prairie grouse did not select for pastures managed with one mid season grazing period for display ground and nest locations.

Three pasture, once over deferred grazing treatments had 11 to 13 months of ungrazing prior to the deferred grazing treatment. No changes in basal cover of the vegetation occurred during this one year ungrazed period. The vegetation height did visually appear to be impressive as prairie grouse habitat after one year of ungrazing. The 0% VOM was significantly taller than grazed treatments but the 100% VOM was not different than rotation grazed treatments. After 60 days of grazing during the late season, the 0% VOM was reduced but still taller than the other treatments and the 100% VOM was greatly reduced but not different than rotation treatments in the spring. The deferred grazing treatment was intended to delay grazing pressure on one pasture in a system until after grass seed development which occurrs by late August or early September for the purpose of improving grass plant density but deferred grazing decreases basal cover of warm season grasses and reduces basal cover of switchgrass on the midland and lowland plant communities. The 100% VOM was significantly decreased during the first growing season after deferred treatments and the level fell below the minimum of 1.5 decimeters. Prairie grouse select against pastures managed with deferred grazing the previous year for spring display ground locations. Deferred grazing is not a desirable grazing treatment for grassland vegetation and prairie grouse.

Three pasture, twice over treatments were grazed early-late, early-mid, mid-mid, and mid-late season of use. Warm season grasses and switchgrass on the midland and lowland communities and sedges on the lowland communities increased in basal cover on pastures managed with two grazing periods compared to pastures managed with one pasture, seasonlong treatments. The 100% VOM on pastures with two grazing periods was significantly greater than on pastures grazed seasonlong. Prairie grouse select for pastures with two or three grazing periods for display ground and nest locations. Management treatments with the pastures grazed for two periods showed benefit to grassland vegetation, prairie grouse habitat and prairie grouse populations. Treatments with twice over grazing on each pasture should be used to manage the allotments on the Sheyenne National Grasslands.

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Abstracts

GRASSLAND HABITAT TYPES OF THE SHEYENNE DELTA - Bill Barker, Mario Biondini, Lee Manske and Tim Nelson, North Dakota State University

The grassland vegetation of the Sheyenne Delta in southeastern North Dakota was characterized according to habitat type based on concepts and methods developed by Daubenmire. Detrended Correspondence Analysis (DCA) was used to summarize the species composition and identify the habitat types. The number of significant ordination axis was determined with the use of the Fisher's proportion test. The habitat types identified through DCA were tested for statistical significance with the use of the Kruskal-Wallis statistics. Five grasslands habitats were described: 1) *Stipa comata* - *Carex heliophila* h.t., 2) *Andropogen hallii* - *Calamovilfa longifolia* h.t., 3) *Bouteloua gracilis* - *Stipa comata* h.t., 4) *Andropogon gerardi* - *Andropogon scoparius* h.t., and 5) *Carex lanuginosa* - *Calamagrotis stricta* h.t.

MANIPULATION OF HABITAT BY FIRE AND MOWING - Bill Barker and Lee Manske, North Dakota State University; and Ken Higgins, South Dakota State University

The effects of spring burning (1 May) and 3 mowing treatments (1 June mow, 1 July mow and 1 August mow) on the floristic composition and utilization by livestock of the *Carex lanuginosa* - *Calamagrostis stricta* habitat type were studied. Repeated spring burning eliminates woody species from this habitat type but increases livestock utilization from about 10% to 60%. Repeated mowing eliminates woody species but does not increase utilization by livestock as much as spring burning. July 1 is probably the best time to mow to gain increased livestock utilization and obtain high quality hay. We recommend a change from grazing the 3 pasture deferred rotation grazing systems once-over to grazing 2 pastures twice-over and 1 pasture once-over. Spring burning and mowing are effective in getting better livestock utilization.

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