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The Relationship of Cattle Grazing to Sage Grouse Use of Meadow Habitat on the Sheldon National Wildlife Refuge

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Renewable Natural Resources.

by

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ABSTRACT

In Nevada, sage grouse (*Centrocercus urophasianus*) are dependent upon succulent forbs provided by meadows during the summer months. To evaluate the effects of cattle grazing on meadow habitat, numbers of sage grouse, forb abundance, and forb phenology were compared between grazed and ungrazed meadows on the Sheldon National Wildlife Refuge in 1982. Sage grouse use of grazed meadows was significantly greater than use of ungrazed meadows in late July and thoughout August. Although grouse were initially attracted to abundance of common dandelion (*Taraxacum officinale*), phenological stage of food forbs was most important in explaining the attraction to grazed meadows as the summer progressed. Forb regrowth, stimulated by grazing prior to the cessation of plant growth, was available to sage grouse on grazed meadows throughout most of the summer, while forbs on ungrazed meadows became mature and unpalatable by late July.

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INTRODUCTION

Since the onset of settlement in the west, the sage grouse (Centrocercus urophasianus) has undergone serious declines in population levels over most of its native range. In pioneer times this large grouse was the number 1 game bird in 9 western states (Patterson 1952), while today it is hunted only under limited seasons and restricted bags.

The story of sage grouse in Nevada is no exception, population levels have generally declined from previous levels of abundance. While the degree and time of the decline is difficult to document, scattered references in the literature and first hand accounts by old time residents indicate sage grouse were at one time much more common in Nevada than they are today. Many Nevada ranchers feel that the birds have declined substantially since their childhood years (I. Sara, rancher, Eureka, Nevada; J. Berry, rancher, Adel, Oregon; pers. comm., 1982). Residents of White Pine County described sage grouse in the 1920's as being so numerous that they "got up in waves" and "blotted out the sun" (Nevada Fish and Game Commission 1964-65). Changes in harvest regulations may also reflect declines, as 5 to 8 bird bag limits were common in the years prior to the early sixties, in comparison to the restrictive 2 to 3 bird limits established since 1964 (Donoho and Robertson 1982). But even the early 1900's, while described as periods of abundance, were also beset by years of alarming lows. Sportsmen and the Nevada Department

of Wildlife felt the birds were on their way to extinction around 1912, 1913, 1927, and 1936 (Nevada Fish and Game Commission 1964-65).

It is felt that loss of habitat or changes in habitat have been largely responsible for sage grouse declines. Patterson (1952) noted that with the settlement of the west and the resulting intensification of agriculture, grazing, and hunting activities, sage grouse populations have diminished. Although many factors acting together have caused changes in Nevada's rangeland habitat, livestock grazing over the years has been a powerful force in influencing vegetative changes (Robertson and Kennedy 1954, Hazeltine et al. 1961, Nevada Fish and Game Commission 1964-65). Near the turn of the century, Nevada's lands supported an estimated 700,000 cattle and over a million sheep (Nevada Fish and Game Commission 1964-65). It is difficult to document actual grazing related changes in sage grouse habitat since few detailed descriptions of pristine conditions on Nevada rangelands exist; however, reports in the literature indicate there has been a general loss of forbs and grass, and an increase in big sagebrush (*Artemisia tridentata*) and rabbitbrush (*Chrysothamnus* sp.). Hazeltine et al. (1961) described an abundance of palatable grasses and weeds growing under and between the shrubs on northern Nevada ranges. Sagebrush was reported to occur only in scattered stands which were seldom dense. Robertson, in Robertson and Kennedy (1954), compared his own observations with those made in 1902 by P.B. Kennedy

and determined that meadow conditions in general have deteriorated over the past 50 years.

That grazing related changes have taken place on Nevada rangelands is apparent, but the degree of change and its effect on sage grouse is not clearly understood. Changes that involve meadow vegetation would seem especially important to sage grouse, particularly in the more arid portions of their range. In Nevada, meadow habitat is critical for sage grouse broods, while it is also important for nonbreeding adults (Savage 1968, Oakleaf 1971). Meadows often provide the only sources of succulent forbs available to sage grouse as the surrounding sagebrush habitat desiccates. Oakleaf (1971) viewed the relationship of upland meadows to sage grouse in Nevada as the concentration of annual production into a small but important component of the sage grouse habitat.

The importance of forbs in the diets of sage grouse is well documented. Diets of juvenile sage grouse are composed primarily of insects and forbs, insects being most important during the first few weeks of life, while forbs form the major component of the diet through the late spring and summer growth periods. Savage (1968) found that crops from 4 to 8 week old sage grouse collected in Nevada, contained over 72 percent forbs, the remainder of the diet consisting primarily of sagebrush and insects. Forbs averaged 75 percent of the diets of 127 juveniles through 12 weeks of age in Montana (Peterson 1969). In an Idaho study, Klebenow and

Gray (1968) found that while insects comprised 52 percent of the total diet of chicks during the first week of life, forbs were the major food item in diets of chicks 2 to 10 weeks old.

While many studies show a preponderance of sagebrush in the diets of adult sage grouse (Girard 1937, Patterson 1952, Nelson 1955, Wallestad et al. 1975), adult birds will readily consume forbs when they are available. Almost 34 percent of the summer diet of adult grouse in Wyoming was found to be forbs (Patterson 1952). Savage (1968) found that diets of hens with broods contained over 53 percent forbs, while forbs formed almost 45 percent of the diets of hens without broods. Diets of adult males collected during the same period contained almost 11 percent forbs. In California, stomach analysis of hunter killed birds showed that fall sagebrush diets were supplemented with significant amounts of common dandelion (Taraxacum officinale) and members of the Fabaceae family (Leach and Hensley 1954).

Although specific effects of grazing on sage grouse food forbs have not been determined, several studies have evaluated livestock grazing in relation to sage grouse habitat in northwestern Nevada. These studies seem to indicate that at least some degree of grazing may be compatible with or even desirable for grouse. Neel (1980) found that rest rotation grazing management was generally beneficial. A period of rest tended to allow for recovery of food forb species, and grazing in dense stands of vegetation increased the avail-

ability of these species for grouse. Klebenow (1982) found that birds tended to avoid meadow areas of dense rank vegetation but would use these areas once they were "opened up" by grazing. Oakleaf (1971) reported that heavily grazed meadows containing a mixture of forbs and grass-like species were utilized by sage grouse, while succulent areas of ungrazed meadows dominated by heavy stands of sedge (Carex sp.) and rush (Juncus sp.) were not used as feeding areas. After cattle grazed and left a meadow, sage grouse were observed to concentrate there in greater numbers than before the grazing treatment (DeRocher 1980). Savage (1968) found that meadow use by sage grouse did not depend on meadow condition but rather the presence of adequate food, cover, and water. Overgrazed meadows in poor condition were utilized if these requirements were met. These studies indicate some level of grazing may act to improve the availability or quality of the food forb resource for sage grouse.

There is a need to further examine the relationship of cattle grazing to sage grouse use of meadows. On the Sheldon National Wildlife Refuge in northwestern Nevada, cattle grazing is used as a "tool" for managing wildlife habitat. More information is needed on the relationship of different grazing treatments to changes in meadow habitat and to meadow use by grouse before specific recommendations can be made.

This study attempted to refine some of the sage grouse/cattle interrelationships alluded to in previous studies for the purpose of defining grazing management for the

benefit of these important game birds. The overall objective was to determine how cattle grazing affected sage grouse use of meadows. Specific objectives included:

1) Determine the importance of the following factors in influencing sage grouse use of meadows:

   a) abundance of sage grouse food forbs.

   b) growth stage of sage grouse food forbs.

   Observations were also made on how the availability of water and presence of cattle influenced sage grouse use of meadows.

2) Determine how cattle grazing effects the quality and quantity of the forb resource for sage grouse.

3) Compare sage grouse use of grazed and ungrazed meadows.

STUDY AREAS

The Sheldon National Wildlife Refuge is located in extreme northwestern Nevada (Fig. 1). Total area of the Refuge is 232,794 ha. Large expanses of big sagebrush habitat characterize the bottomlands, while low sagebrush (Artemisia arbuscula) communities dominate the broad rimrock tables which are common in the area. Springs and stringer meadows are scattered throughout the valleys. Average annual precipitation ranges from 33 cm in the western part of the Refuge to less than 15 cm in the eastern portion. The elevation averages 1829 m.

A large portion of the Sheldon National Wildlife Refuge includes what was once referred to as the Sheldon Antelope Range. Both the original Refuge and the former Range were

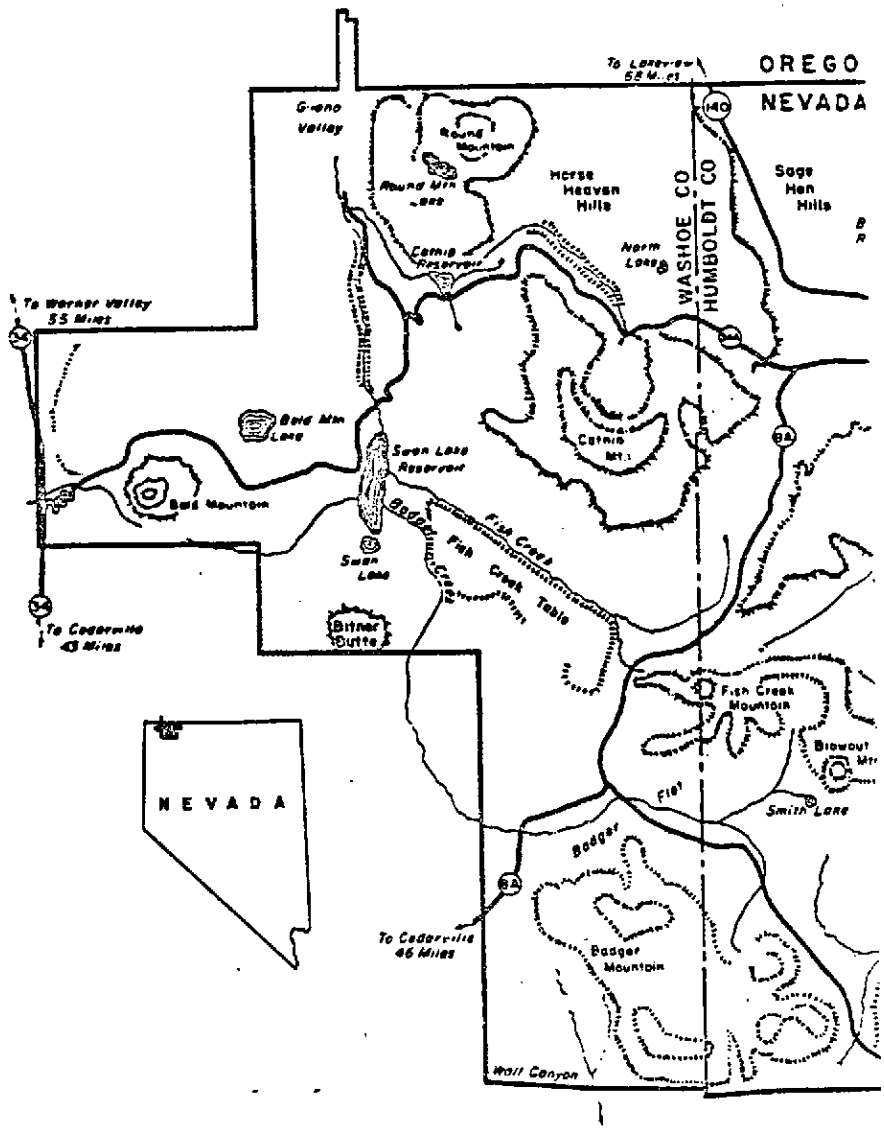
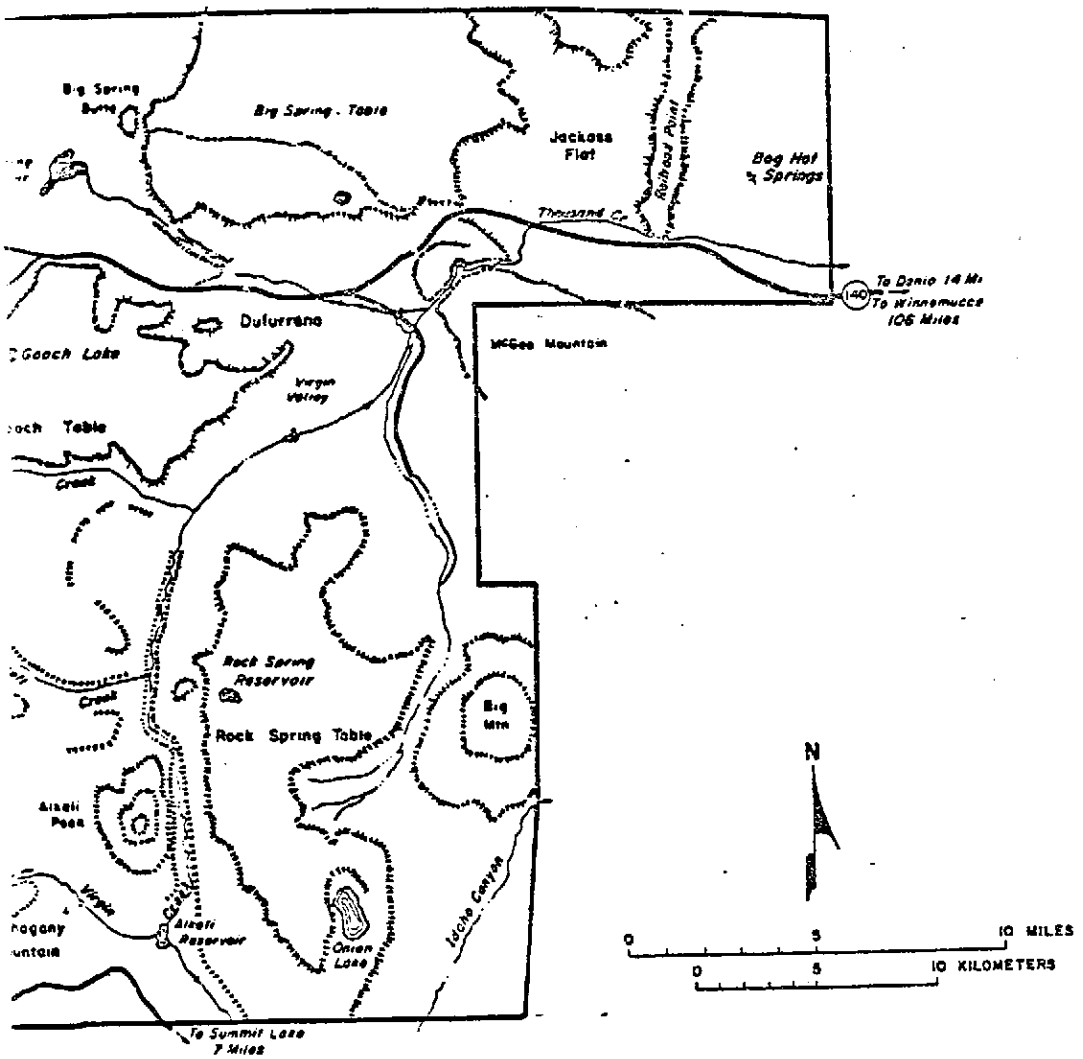


Fig. 1. Location of the Sheldon National Wildlife Refug


Big Spring Butte
Big Spring - Table
Jackass Flat
Railroad Point
Bog Hot Springs
Thousand Cr
To Denio 14 Mi
To Winnemucca 106 Miles
140
Dufurrena
McGee Mountain
Gooch Lake
Virgin Valley
Creek
Rock Spring Reservoir
Rock Spring Table
Big Mtn
Alkali Peak
Virgin
Alkali Reservoir
Onion Lake
Idaho Canyon
To Summit Lake 7 Miles
N
0
5
10 MILES
0
5
10 KILOMETERS

set aside in the 1930's primarily for the conservation of antelope (Antilocapra americana) and other species of wildlife. Originally the Range was under joint administration of the U.S. Fish and Wildlife Service and the U.S. Bureau of Land Management, but in 1976 sole jurisdiction was transferred to the Fish and Wildlife Service. Many years of different grazing management policies have resulted in contrasts between vegetative condition on the Refuge and the former Range. The majority of the Refuge is in good to excellent condition, while areas of the Range have suffered from past overuse. Traditionally, the Refuge has been grazed under a deferred rotation system, while grazing on the Range was season-long up until 1980. In 1980, a rest-rotation grazing management program was initiated on the Range. Although the Range is now technically referred to as the Refuge, it will be continued to be identified as the Range for the purpose of this thesis.

The rangeland habitat of the Sheldon is interspersed with upland meadows ranging in size from small spring-associated or stringer meadows to expansive meadow bottomlands. These meadows are bordered by sagebrush and contain a mixture of grass and grass-like species, and a wide diversity of forbs. Some support flowing water throughout the meadow, while water is absent or present only in emphemeral spring sources in others. These meadows also represent a wide range of vegetative conditions. Those which were subject to past periods of overgrazing, and which occur in the lower more

arid elevations of the Sheldon, typically support invasions of big sagebrush and rabbitbrush, and a loss of riparian vegetation. Many of the meadows on the Range can be included in this description, although their condition may be improving under recent changes in the grazing program. Most of the Refuge meadows are in good to excellent condition.

Thirteen meadows were selected for intensive vegetative and sage grouse surveys in 1982. Nine of the meadows are located on the Range, while 4 are on the Refuge (Figs. 2,3,4). Although the study meadows differed in size and condition, all are major meadows in areas of key sage grouse habitat. Elevations of most of the meadows average between about 1760 m and 1860 m, with the exception of West Rock Springs Exclosure at an elevation of 1975m, and the Bald Mountain Creek meadows with an average elevation of 1737 m. The areas of all meadows that were surveyed along with their estimated range condition are shown in Table 1.

METHODS

Strutting Ground Counts

Several known active strutting grounds were counted, while attempts were made to locate other grounds. The location of unmapped grounds was pinpointed by listening for the sound made by males during their courtship displays. On cold still mornings, this sound could be heard approximately 3 km away.

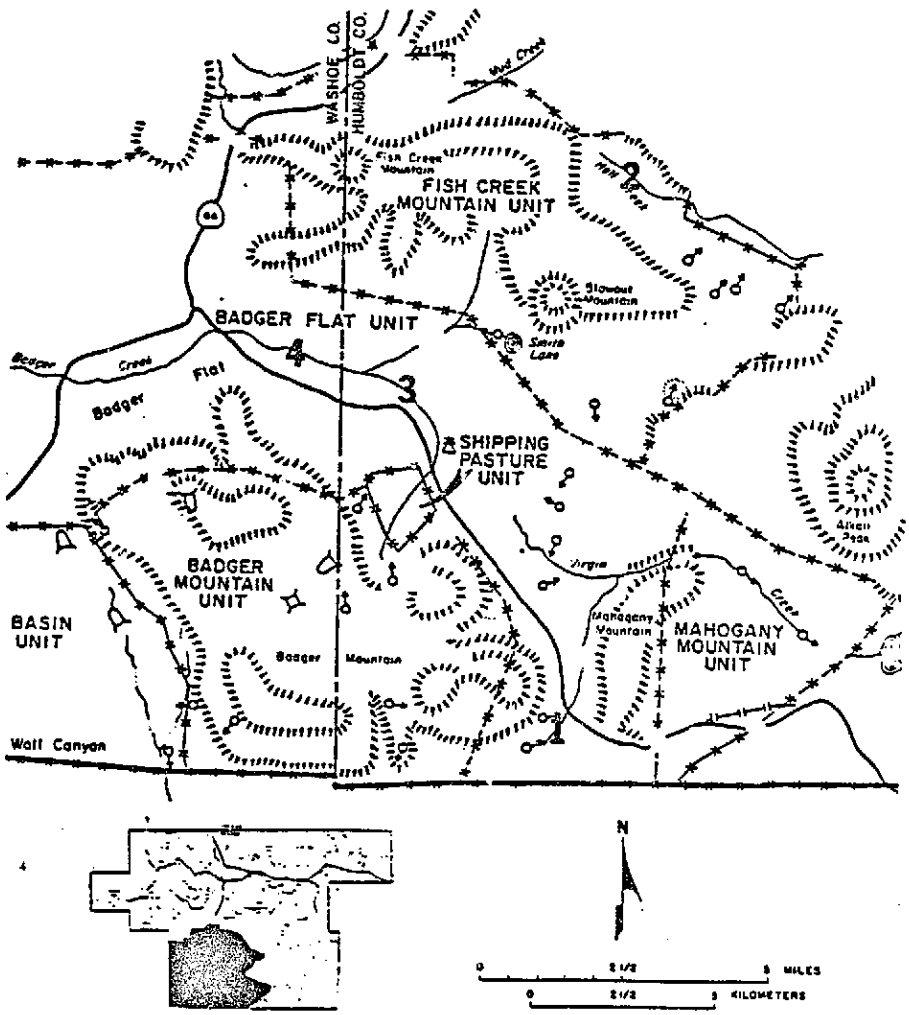


Fig. 2. Location of 1982 study meadows. 1=Bateman, 2=Hell Creek, 3=Badger Shearing Pen, 4=Badger Creek.

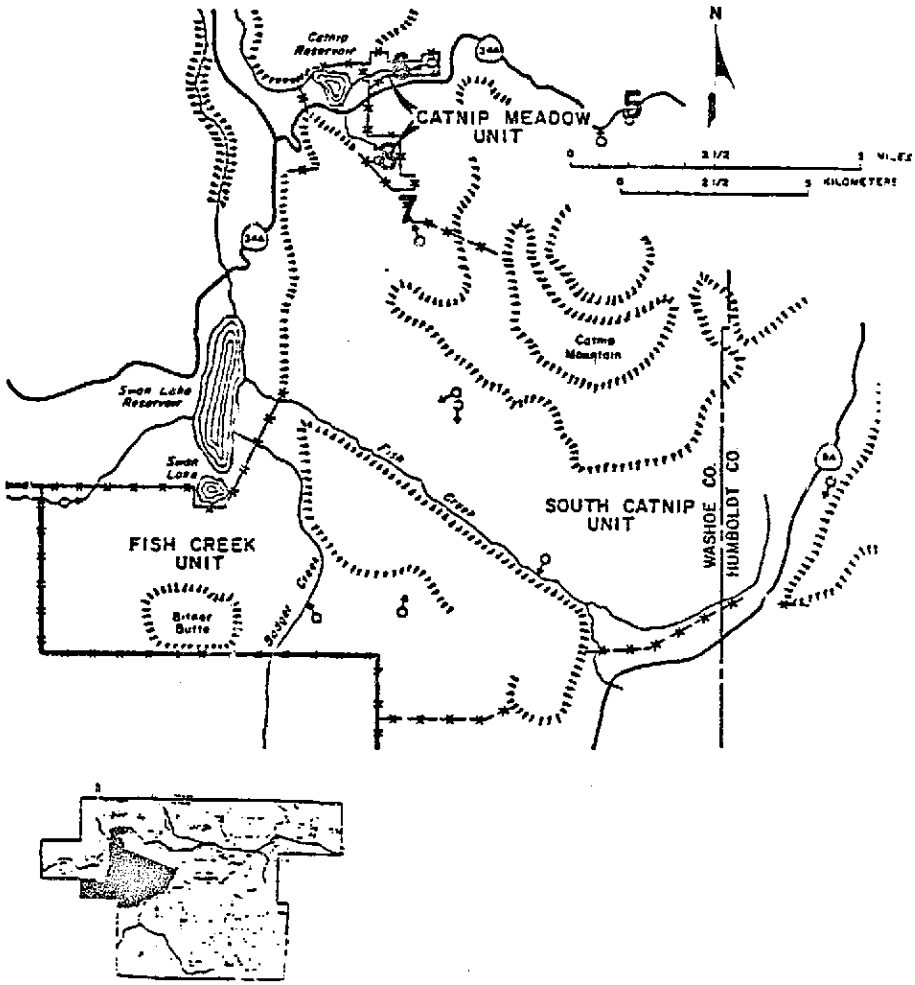


Fig. 3. Location of 1982 study meadows. 5=West Rock Springs Exclosure, 6=North Catnip Creek, 7=Little Catnip Springs, 8=South Catnip Creek.

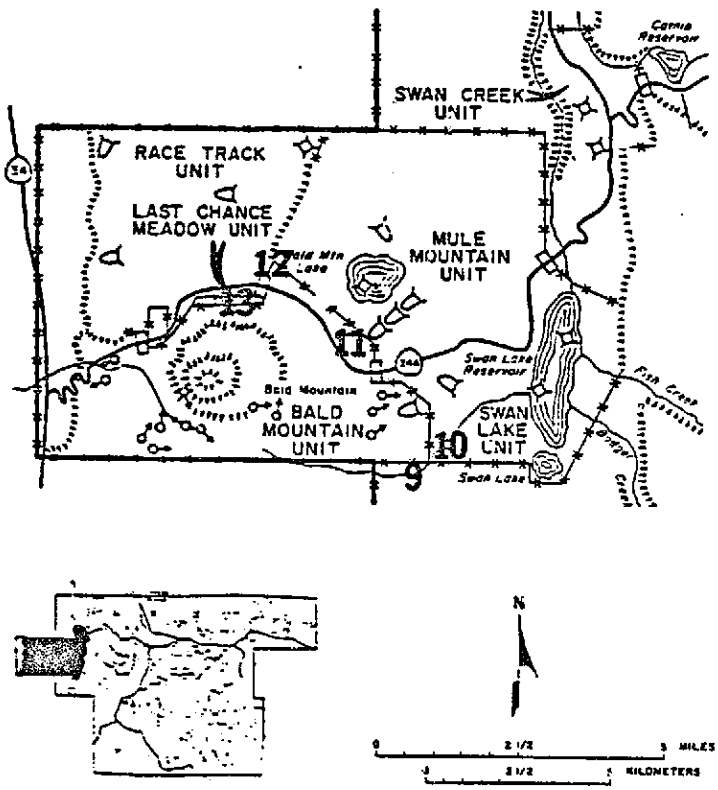


Fig. 4. Location of 1982 study meadows. 9=Bald Mountain Creek-Range, 10=Bald Mountain Creek-Refuge, 11=Hobble Springs, 12=Lower Last Chance, 13=Upper Last Chance.

Table 1. Areas of meadows surveyed and meadow condition ratings of meadows selected for vegetative and sage grouse surveys on the Sheldon National Refuge and Range in 1982.

Meadow	Meadow area survyed (ha)	Estimated range condition[a]
Range Meadows		
Bateman	8.14	Poor-fair
Hell Creek	2.70	Poor
Badger Shearing Pen	7.05	Good
Badger Creek	2.23	Poor
West Rock Springs Exclosure	0.74	Excellent
North Catnip Creek	6.84	Excellent
Little Catnip Springs	2.14	Poor
South Catnip Creek	7.49	Excellent
Bald Mountain Creek-Range	2.92	Poor
Refuge Meadows		
Bald Mountain Creek-Refuge	0.49	Good
Upper Hobble Springs	5.75	Good
Upper Last Chance	20.92	Excellent
Lower Last Chance	10.31	Excellent

[a]From Klebenow and Burkhardt (1982) and from observations in 1981.

Strutting grounds were visited between late March and early May. Counts were made between 0530 and 0630. Total numbers of males and females recorded are shown in Appendix I.

Food Habits

Crops were collected from 4 to 12 week old sage grouse observed feeding on or near a meadow in 1981. All crop material was separated into identifiable constituents, which were then air dried and weighed to the nearest 0.01 gram. Age of the chicks was determined by primary feather length

(Beck et al. 1975).

Meadow Surveys

All observations of sage grouse on both upland and meadow habitat in 1981 and 1982 were recorded as adult males, adult females, or juveniles. Although intensive meadow surveys were conducted only in 1982, data on numbers of sage grouse flushed, presence or absence of cattle, forb phenology, and distribution of water were collected on meadow habitat in 1981. This information, along with late spring-/early summer observations of sage grouse in both 1981 and 1982 is included in Appendix II.

In 1982, the following 5 factors were evaluated on the 13 selected study meadows over the summer:

Sage grouse meadow use

Forb abundance and phenology

Cover

Water availability

Presence of cattle

Since sage grouse response to some of these factors could be expected to change over the summer, each meadow was surveyed 4 times, beginning with the initial appearance of the grouse on meadows in July and ending in late August. The range of dates for the 4 periods included; 12 July - 22 July (mid-July), 26 July - 5 August (late July - early August), 9

August - 16 August (mid-August), and 20 August - 28 August (late August).

Because upland meadows represent mosaics of plant communities rather than homogeneous stands of vegetation, information on the 5 factors could only be collected accurately by stratifying each meadow into similar areas or "types" (Appendix III). It was believed sage grouse use of meadows might be better explained by recognizing variation within a meadow. Types were defined on the basis of similarities in plant species composition, as well as similarities in physical appearance, or structure of the vegetation. For example, Hell Creek supported similar vegetation throughout its length, but it was divided into 3 types, ranging from a very narrow riparian area in its upper reaches, to a broader open meadow area at its base. Portions of a meadow which included sagebrush cover were also separated from those areas supporting entirely herbaceous vegetation. Types were mapped on aerial photographs and their areas in hectares were determined.

Sage grouse meadow use was determined by censusing the 13 meadows on foot or horseback with the aid of a bird dog. Each meadow was censused twice a day, 1 day every 2 weeks for a total of 4 counts. Sage grouse were counted from 1/2 hour before sunrise to 2 hours after sunrise in the morning and from 2 hours before sunset to sunset in the evening. Morning and evening counts were summed to represent total daily use for each meadow for each day. Sex and age classes of all

birds flushed or observed were recorded on a per hectare basis for each count. Number of flushes occurring in each type were also recorded. A flush was considered to have occurred whenever a single bird or a group of birds got up together from the same area. No attempt was made to survey meadows during inclement weather.

All terrestrial forbs found in each type on each study meadow were rated for abundance and phenology (Appendix IV). Phenology ratings were assigned during each of the 4 meadow surveys. An abundance rating system developed by Poulton (1962) was modified to include numerical ratings. The more plentiful a forb, the more importance it was assumed to have for sage grouse:

4	Abundant	Species that are easily found throughout the meadow and which occur in dense stands to the exclusion of other species.
3	Common	Species that can easily be seen by looking casually around any part of the meadow.
2	Occasional	Species which can easily be seen in some parts of the meadow, but which require careful searching before being found through the meadow.
1	Rare	Species which can be seen only by carefully searching the entire meadow.

A numerical rating system for phenology was also developed based on the forb growth stages described by Robertson and Torrell (1958). The rating which a particular forb species received at one point in time represented the stage in which a majority of the individuals of that species belonged to at the time of sampling. Since younger, therefore more succulent, plant tissue was assumed to be more desirable for sage grouse, the earlier the growth or phenological stage, the higher the corresponding numerical rating:

8	Early leaf
7	Pre-bloom
6	Bloom
4	Dough (soft seed)
3	Mature
2	Dry seed cast
5	Green seed cast
1	Weathered

The green seed cast category (rating 5) was created primarily for common dandelion since it, unlike many other forbs, tends to retain its succulence long after seed cast. The 5 rating was not always limited to common dandelion, occasionally other forbs growing in moist areas tended to remain green late into the summer. All forb names are from Rogers and Tiehm (1978).

Although all forbs found on study meadows were classified for abundance and phenology, only some were assumed to

represent food items for sage grouse. These potential food forbs were identified from the literature and the food habits portion of this study (Table 2). Savage (1968) found that on the Sheldon, common dandelion was the most highly utilized forb on all the meadows he studied, and that western aster (Aster occidentalis) and yarrow (Achillea lanulosa) were important food items on several major meadows. These 3 forbs were also found to be by far the most important component of the diets of young grouse collected on meadows in 1981. Consequently, these species were referred to as the 3 main grouse food forbs in the study area, and emphasis in 1982 was

Table 2. Forb species which occur on the Sheldon meadows and which have been identified as being potential food forbs for grouse from the literature and from the food habits portion of this study. Species reported to have occurred only in trace amounts in grouse diets are not included.[a]

Yarrow
False dandelion (Agoseris glauca)
Agoseris (Agoseris sp.)
Louisiana sagebrush (Artemisia Ludoviciana)
Western aster
Milkvetch (Astragalus sp.)*
Rockcress (Arabis sp.)
Tapertip hawksbeard (Crepis acuminta)
Flixweed tansymustard (Descurainia Sophia)
Small woolly eriophyllum (Eriophyllum lanatum)
Pepperweed (Lepidium sp.)*
Slender false phlox (Microsteris gracilis) (seeds)
Nuttall monolepis (Monolepis Nuttalliana)
Common dandelion
Yellow salsify (Tragopogon dubius)
Clover (Trifolium sp.)*

[a]Literature sources: Patterson 1952, Leach and Hensley 1954, Nelson 1955, Klebenow and Gray 1968, Savage 1968, Peterson 1969, Neel 1980.

*Several species of this genus or the genus by itself has been reported as being important.

placed on evaluating how grazing affected these species for grouse.

A cover rating to evaluate the effectiveness of meadow vegetation as hiding cover was developed from the method described by Jenkins (1961). Ten 38 cm triangular shaped fiber board models were placed at 4 m intervals along a 40 m out at an angle of 45° in both directions from each end of a transect established in a representative area of the meadow type. The visibility of the models was recorded from 10 m the transect line for a total of 4 readings. If 75 percent or more of the model could be seen clearly, it received a rating of 1.0, if 25 percent or more of the model was obscured by vegetation, it received a rating of 0.5. The total number of visible and partly visible models were summed to arrive at a single index to represent the type. An index of 40.0 represented the situation where cover was lacking entirely, while an index of 0.0 represented a situation where cover was extremely tall or dense.

The availability of water in each meadow type was recorded during each survey. Water considered to be available for sage grouse included free water in perennial creeks, intermittent channels, seeps, springs, and puddles created from overflow of livestock watering troughs.

During each census of sage grouse on meadows, proximity of birds to cows was recorded by the following categories:

No cattle in vicinity	0

Cattle in vicinity, but not on meadow	1
Cattle on meadow	2
Cattle over 50 m from grouse	A
Cattle 25 - 50 m from grouse	B
Cattle less than 25 m from grouse	C

Effects of Grazing on Forbs

Short and long term effects of grazing on herbaceous vegetation was evaluated by comparing differences in percent cover inside and outside temporary and permanent livestock exclosures. Two temporary exclosures, one at West Rock Springs and another at South Catnip Creek, were constructed just prior to grazing in 1982. Permanent exclosures included the uppermost fenced spring source at Hobble Springs, the Hell Creek bighorn sheep pen, Bateman springs, and the Refuge portion of Bald Mountain Creek. Past grazing histories of these areas indicate they have received little or no use by livestock in recent years (Franzen, range conservationist, U.S. Fish and Wildlife Service, pers. comm., 1982). Vegetation around the Hobble spring source has been protected from any grazing since the 1950's or 1960's. No cattle have been allowed in the bighorn sheep pen since it was built in 1968 or on Bateman since it was fenced in 1977. The south boundary of the Refuge fence, which separates Bald Mountain Creek-Range from Bald Mountain Creek-Refuge, was constructed in the 1940's. Traditionally, grazing pressure has been very light on the Refuge side of the fence, especially in comparison to

the heavy use experienced on the Range side.

Percent canopy cover of herbaceous vegetation and percent bareground was estimated in plots systematically placed along transects established in similar vegetation types inside and outside the exclosures. To incorporate differences in the distribution and abundance of the more important forb species, 5 quadrat sizes of the following dimensions were used; 0.2 x 0.1 m, 0.5 x 0.2 m, 1.0 x 0.5 m, 1.0 x 1.0 m, and 1.0 x 2.0 m. Different quadrat sizes were selected for each species based on its occurence. Percent cover and bareground were estimated from the scale developed by Daubenmire (1959) and modified by Bailey and Poulton (1968):

Cover class	Range of cover (%)	Midpoint
1	0-1	0.5
2	1-5	3.0
3	5-25	15.0
4	23-50	37.5
5	50-75	62.5
6	75-95	85.0
7	95-100	97.5

Effects of grazing on regrowth of the 3 most important sage grouse food forbs (common dandelion, western aster, yarrow) and cinquefoil (Potentilla gracilis) (it was a major component of the South Catnip Creek meadow) were evaluated by comparing percent succulent leaves of grazed and ungrazed plants at the South Catnip Creek and West Rock Springs Exclo-

sures. Succulent leaves were defined as those which were green, had the appearance of being new, and were free from blemishes or damage due to weathering. Number of leaves in 2 categories, succulent or mature and/or weathered, were counted for all individuals of selected forb species found in 0.5 x 0.2 m plots systematically placed along transects established inside and outside the exclosures. To determine percentage of succulent leaves of each species, number of succulent leaves were divided by total number of leaves counted in each plot.

Differences in percent Kjeldahl crude protein and crude fiber were also compared for the 3 main food forbs (A.O.A.C. 1965). Leaves were collected from plots (0.5 x 0.2 m plots were used for western aster and yarrow, a 1.0 x 1.0 m plot was used for common dandelion) systematically placed along transects established inside and outside the ungrazed temporary exclosure at West Rock Springs. All nutritional analyses were completed by the Animal Science Nutrition Laboratory, University of Nevada, Reno.

Grazing Treatments

Specific grazing treatments were applied only on West Rock Springs Exclosure and South Catnip Creek. These meadows were grazed experimentally prior to the cessation of plant growth in 1982. The small West Rock Springs Exclosure was grazed from 14 June to 25 June by 44 head of cattle including a mixture of cows and calves, and 1 bull. At South Catnip

Creek (which was considerably larger in size), approximately 20 cows entered the meadow on 14 June, and by 28 June the introduction of additional cows and yearling heifers increased the total number of head to 56. These animals remained on the meadow until the third week of July.

In addition to West Rock Springs Exclosure and South Catnip Creek, 4 other meadows including Hell Creek, Badger Creek, Little Catnip Springs, and Bald Mountain Creek-Range, were classified as grazed in 1982. While early to mid-summer use was scheduled on some of these meadows, others received use only from trespass grazing. In both cases, grazing occurred before the cessation of plant growth and was sufficient to cause regrowth of meadow vegetation. On Hell Creek and Little Catnip Springs, only a few cows were present on the meadow in July, but in these areas of limited riparian vegetation, the effects of grazing were readily apparent. While the small number of apparently trespass cattle present on Badger Creek were not observed until August, the meadow was utilized fairly consistently by a herd of wild horses in July. Regrowth of grazed forbs was evident in moist areas of the meadow during the first survey. From 10 to 30 cows were observed on Bald Mountain Creek-Range between mid-July and the end of August. None of the ungrazed meadows received any grazing in 1982 with the exception of Batenan. One calf was occasionally observed on the meadow in August, but the effects were considered to be insignificant.

Data Analysis

An index to compare the frequency and the proportion of use a meadow received by grouse in relation to other meadows was developed from the method described by Joyner (1980). An index of meadow use was developed for each study meadow as follows:

$$\text{Use Index} = \frac{\text{Total number grouse/ha on meadow Y}}{\text{Total number grouse/ha on all meadows}} \times \text{Number of counts in which meadow Y supported grouse}$$

In addition to the use index described above, sage grouse use of meadows was also evaluated on a per hectare basis. In order to relate sage grouse per hectare for the whole meadow to the forb data which was collected by meadow type, it was necessary to expand the abundance and phenology values to represent the meadow as a whole. An overall meadow index for abundance or phenology of a particular forb was developed by averaging ratings weighted by the size of the type. For example, the phenology index for western aster on Bateman meadow during the second survey was calculated as follows:

Type number	Phenology rating		Type size (ha)		
1	6	x	0.12	=	0.72
2	6	x	2.27	=	13.62
3	4	x	5.75	=	23.00
			8.14		37.34

Overall phenology index = 37.34/8.14 = 4.59

In the case where 2 phenology ratings were assigned to a forb species at one point in time, the average of the 2 ratings was multiplied by the size of the type. A forb could receive 2 ratings during the same survey if the majority of individuals within a type did not belong to a particular phenology class, but rather approximately 1/2 were in one phenology class and 1/2 were in another. All forb abundance and phenology indices are included in Appendix V.

Simple linear correlation and multiple linear regression were used to test for relationships between sage grouse use of meadows and the abundance and phenology of the 3 main food forbs(Steel and Torrie 1980). Two-way analysis of variance (ANOVA, least squares method) was used to evaluate the relationship of sage grouse meadow use to food forb phenology over time and to evaluate the effects of grazing over time on food forb phenology (Steel and Torrie 1980). Chi-square analysis of availability-utilization data (Nue et al. 1974) was used to test for sage grouse selection of grazed and ungrazed meadows and selection of sites within a meadow on the basis of cover and food forb abundance and phenology. T-tests were used to evaluate differences in percent cover inside and outside exclosures and in percent succulent leaves of grazed and ungrazed plants (Steel and Torrie 1980). A test statistic was considered to be significant at the 0.05 level of probability for all analyses.

RESULTS

Food Habits

Juvenile sage grouse crops contained over 22 plant and animal food items, but less than half of these formed substantial components of the diet (Table 3). Species which comprised almost 94 percent of the diet by weight included; in order, low sagebrush, big sagebrush, little green rabbitbrush (*Chrysothamnus viscidiflorus*), yarrow, common dandelion, western aster, and Louisiana sagebrush. Food items which occurred most frequently in the diet included; in order, yarrow, common dandelion, ants (Formicidae), little green rabbitbrush, big sagebrush, western aster, and low sagebrush. Other food items which were also important in terms of frequency or composition but were used in lesser amounts included clover, milkvetch species, and false dandelion. Most of the plant species were consumed as young growing leaves, although developing flowerheads and even seeds of slender false phlox and common dandelion, were sometimes used.

Three species, yarrow, common dandelion, and western aster, stood out as being by far the most important of the forbs. Although over 12 species were used, these 3 formed over 82 percent of the forb component of the diet in terms of composition by weight, and were used the most frequently. In most cases, with the exception of flowerheads of yarrow and the seeds of common dandelion, only young succulent leaves of

Table 3. Percent composition and frequency of food items found in crops of 27 juvenile sage grouse aged 4-12 weeks old. Not included is an unidentified species of forb which occurred in crops in trace amounts.

Food item	% Compostion (g)	Frequency
Shrubs		
Low sagebrush-leaves	24.2	5
Low sagebrush flower-buds	3.6	2
Big sagebrush-leaves	16.4	7
Little green rabbitbrush-leaves	13.3	10
Silver sage (*Artemisia cana*) leaves	t[a]	2
Total	57.5	26
Forbs		
Yarrow-leaves	12.8	11
Yarrow flower-buds	3.9	2
Common dandelion-leaves	11.1	10
Common dandelion-seeds	0.1	1
Western aster-leaves	6.2	6
Louisiana sagebrush-leaves	2.0	4
Slender false phlox-seeds	1.3	2
Slender false phlox-leaves	0.7	1
Milkvetch sp.-leaves	0.7	4
False dandelion-leaves	0.2	4
Clover sp.-leaves	0.1	3
Thistle (*Cirsium* sp.)-leaves	t	1
Total	41.4	50
Invertebrates		
Ants (Formicidae)	0.3	9
Beetles (Coleoptera)	0.4	2
Spiders (Arachnida)	0.1	1
Flies (Diptera)	t	1
Grasshoppers (Acrididae)	t	1
Total	0.8	14
Other		
Little green rabbitbrush-galls	0.5	1
Bluegrass (*Poa* sp.)-leaves	t	1
Mat muhley (*Mulhenbergia richarsonii*)-leaves	t	2
Total	0.5	4

[a]t=trace (less than 0.1%).

these species were found in the crops. Particularly with yarrow, crops were usually packed with tiny new leaf tips.

Sage Grouse Use of Meadows

A total of 995 sage grouse observations were made on the 13 study meadows between 12 July and 28 August, 1982. Number of sage grouse recorded on meadows and use of meadows by different sex and age classes varied over the 4 survey periods (Fig. 5). Meadow attendance increased steadily from mid-July to mid-August, but decreased by the end of August. Adult males made up over 66 percent of all sage grouse observations on the first survey, but formed less than 37 percent of all observations on the following 3 surveys.[1] Hens and juveniles made up 60 percent or more of the observations in survey periods 2 and 3, but formed only 30.8 percent of the sample in mid-July, and 40.5 percent of the sample in late August. Excluding the late August survey period, unclassified birds formed only a small percentage of all observations. In the last time period the composition of 1 large flock could not be accurately determined. Additionally, 32 of what appeared to be barren hens are included in the observations of hens and juveniles.

Sage grouse were flushed more often from meadows during the morning counts than during the evening counts (Table 4). Over 63 percent of all observations of all sex and age groups

1. The percentage of males utilizing meadows in late August is probably underestimated as some of the birds recorded as unclassified at that time were believed to be males.

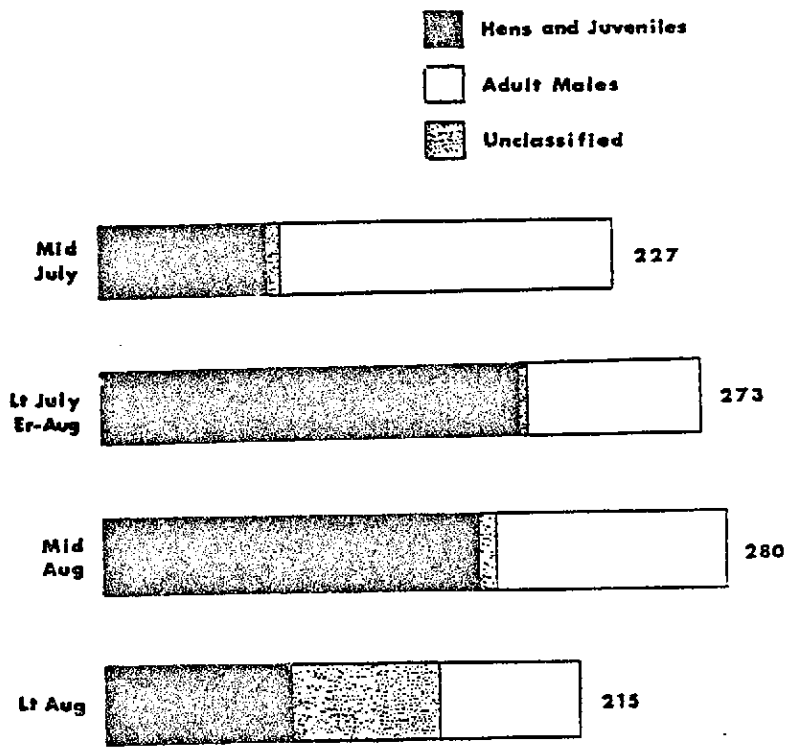


Fig. 5. Sex and age composition of sage grouse observations for each of the 4 survey periods in 1982. Numbers to the right of the bars represent sample size for each survey period.

Table 4. Total number of sage grouse by sex and age class recorded during morning (AM) and evening (PM) counts of the 13 study meadows over the 4 time periods in 1982. Percent of total AM and PM surveys for each sex/age class are shown in parentheses.

Sex/age group	No. sage grouse	
	AM surveys	PM surveys
Hens and juveniles	288 (56.6)	221 (43.4)
Males	277 (69.9)	119 (30.1)
Unclassified	70 (77.8)	20 (22.2)
Totals	635 (63.8)	360 (36.2)

were recorded on the morning counts. Additionally, adult males, more than hens and juveniles, seemed to utilize meadows more consistently in the morning than in the evening. Almost 70 percent of all observations of adult male sage grouse were recorded on the morning counts in comparison to the 56.6 percent recorded for hens and juveniles during the same period.

Meadow use, represented by all sex and age classes of sage grouse per hectare of surveyed meadows, varied for the 13 meadows over the 4 survey periods (Table 5). Sage grouse were flushed at least once during the summer on all 13 meadows. When meadow use by hens and juveniles only was considered, certain meadows did not support use during some periods (Table 6).

Patterns of meadow use, recorded as sage grouse per hectare, were different for grazed and ungrazed meadows over

Table 5. Sage grouse per hectare of surveyed meadows recorded for each of the 13 study meadows over the 4 survey periods. AM and PM counts are combined for each survey period and actual numbers of sage grouse counted are in parentheses.

Meadow	Mid-July	Late July-Early Aug.	Mid-Aug.	Late Aug.
Bateman	4.3 (35)	2.0 (16)	0.0	1.4 (11)
Hell Creek	8.1 (22)	5.2 (14)	6.3 (17)	0.0
Badger Shearing Pen	1.6 (11)	0.0	1.1 (8)	0.0
Badger Creek	5.8 (13)	10.3 (23)	5.4 (12)	6.7 (15)
West Rock Springs Exclosure	0.0	0.0	17.6 (13)	9.5 (7)
North Catnip Creek	0.1 (1)	4.4 (30)	1.6 (11)	0.6 (4)
Little Catnip Springs	1.9 (4)	1.9 (4)	8.9 (19)	3.3 (7)
South Catnip Creek	0.0	5.1 (38)	9.4 (73)	6.0 (45)
Bald Mtn. Creek-Range	3.4 (10)	18.2 (53)	4.8 (14)	20.0 (58)
Bald Mtn. Creek-Refuge	0.0	0.0	0.0 (20)[a]	0.0
Hobble Springs	6.1 (35)	3.1 (18)	7.0 (40)	3.0 (17)
Lower Last Chance	5.8 (60)	4.5 (46)	1.8 (19)	3.2 (33)
Upper Last Chance	1.7 (36)	1.5 (31)	1.6 (34)	0.9 (18)

[a]Although no sage grouse flushes were recorded on Bald Mountain Creek-Refuge during the mid-August survey, a group of 20 males was observed near the meadow.

Table 6. Hen and juvenile sage grouse per hectare of surveyed meadows recorded for each of the 13 study meadows over the 4 survey periods. AM and PM counts are combined for each survey period and actual numbers of sage grouse counted are in parentheses.

Meadow	Mid-July	Late July Early Aug.	Mid-Aug.	Late Aug.
Bateman	0.9 (7)	1.5 (12)	0.0	1.4 (11)
Hell Creek	4.1 (10)	5.2 (14)	6.3 (17)	0.0
Badger Shearing Pen	1.6 (11)	0.0	1.1 (8)	0.0
Badger Creek	1.8 (4)	10.3 (23)	4.5 (10)	3.6 (8)
West Rock Springs Exclosure	0.0	0.0	17.6 (13)	9.5 (7)
North Catnip Creek	0.0	2.5 (17)	0.9 (6)	0.1 (1)
Little Catnip Springs	0.0	0.9 (2)	8.9 (19)	2.3 (5)
South Catnip Creek	0.0	3.1 (23)	4.1 (31)	2.7 (20)
Bald Mtn. Creek-Range	3.4 (10)	18.2 (53)	4.8 (14)	2.7 (8)[a]
Bald Mtn. Creek-Refuge	0.0	0.0	0.0	0.0
Hobble Springs	1.2 (7)	0.7 (4)	1.7 (10)	1.0 (6)
Lower Last Chance	1.3 (13)	1.2 (12)	1.6 (17)	0.7 (7)
Upper Last Chance	0.4 (9)	1.1 (24)	1.5 (32)	0.7 (14)

[a]Not included is a group of 50 unclassified sage grouse flushed from Bald Mountain Creek-Range during the late August survey. While many of the birds were believed to be males, hens and juveniles per hectare may be underestimated.

the 4 time periods (Fig. 6). Sage grouse utilized grazed meadows in increasing numbers from mid-July to mid-August while attendance on ungrazed meadows declined after mid-July. By late August, use of grazed meadows also began to decrease as sage grouse shifted from summer to fall habitat.

In a 2-way ANOVA, a highly significant portion of the total variation in meadow use by sage grouse was explained by the grazing treatment, while the amount of variation explained by time and the interaction of time with grazing was not significant (Table 7). This indicates that the time during the summer that the meadow was surveyed (mid-July, late July-early August, mid-August, or late August) was not as important as whether or not the meadow had been grazed that year.

A chi-square test showed statistically significant selection for grazed meadows as the summer progressed (Table 8). Sage grouse used grazed and ungrazed meadows in proportion to their availability during the mid-July survey, but not during the late July-early August, mid-August, and late August surveys. During the last 3 surveys, observed use of grazed meadows was significantly higher than expected.

Use patterns of individual meadows over the 4 time periods showed variability and fluctuation, but in general, sage grouse per hectare values were higher for most grazed than ungrazed meadows from late July to the end of August (Fig. 7). For ungrazed meadows, there was a general decline in sage grouse per hectare after mid-July. Hobble Springs was

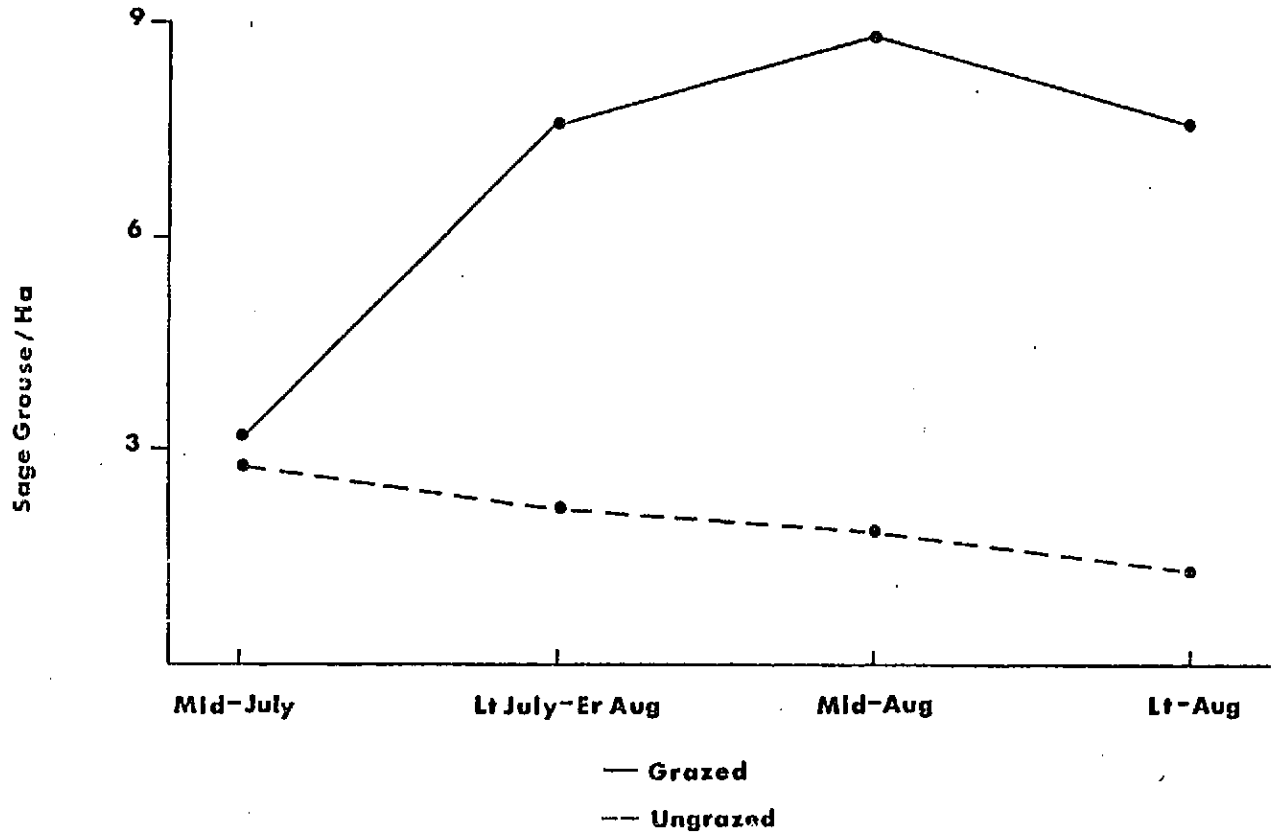


Fig. 6. All sexes and age classes of sage grouse per hectare observed on grazed and ungrazed meadows over the 4 survey periods in 1982.

Table 7. Two-way analysis of variance of the effects of grazing treatment and time on sage grouse per hectare on the 13 study meadows over the 4 survey periods in 1982.

Source	DF	SS	MS	F Test
Grazing treatment[a]	1	237.165	237.165	14.043**
Time[b]	3	52.230	17.410	1.031
Interaction[c]	3	70.179	23.393	1.385
Error	44	743.094	16.889	
Total	51	1102.668		

[a]Grazing treatment means either ungrazed in 1982, or grazed during the growing season in 1982.
[b]Time includes the 4 survey periods; mid-July, late July-early August, mid-August, and late August.
[c]Interaction represents the effects of time with grazing treatment.
** Significant at 0.01 level of probability.

Table 8. Observed and expected use of grazed and ungrazed meadows by sage grouse in 1982.

Survey period	Meadow treatment	No. sage grouse observed	No. sage grouse expected[a]	(X^2)
Mid-July	Grazed	49	52	
	Ungrazed	178	175	0.23
		227		
Late July-early August	Grazed	132	62	
	Ungrazed	141	211	102.26**
		273		
Mid-August	Grazed	148	64	
	Ungrazed	132	216	142.92**
		280		
Late August	Grazed	132	49	
	Ungrazed	83	166	182.23**
		215		

[a]Calculated by multiplying percent of total hectares represented by each category of meadow treatment by total number of sage grouse observed for that survey period (Nue et al. 1974).

**Significant at 0.01 level of probability.

an exception and its sage grouse per hectare values were in the range shown for grazed meadows during the late July-early August survey.

Indices of sage grouse meadow use were generally higher for grazed meadows than for ungrazed meadows (Table 9). Exceptions were Hobble Springs and Lower Last Chance, which had use index values in the range reported for grazed meadows. Use indices for grazed meadows ranged from 1.46 to 0.35, with an average of 0.68, while indices for ungrazed

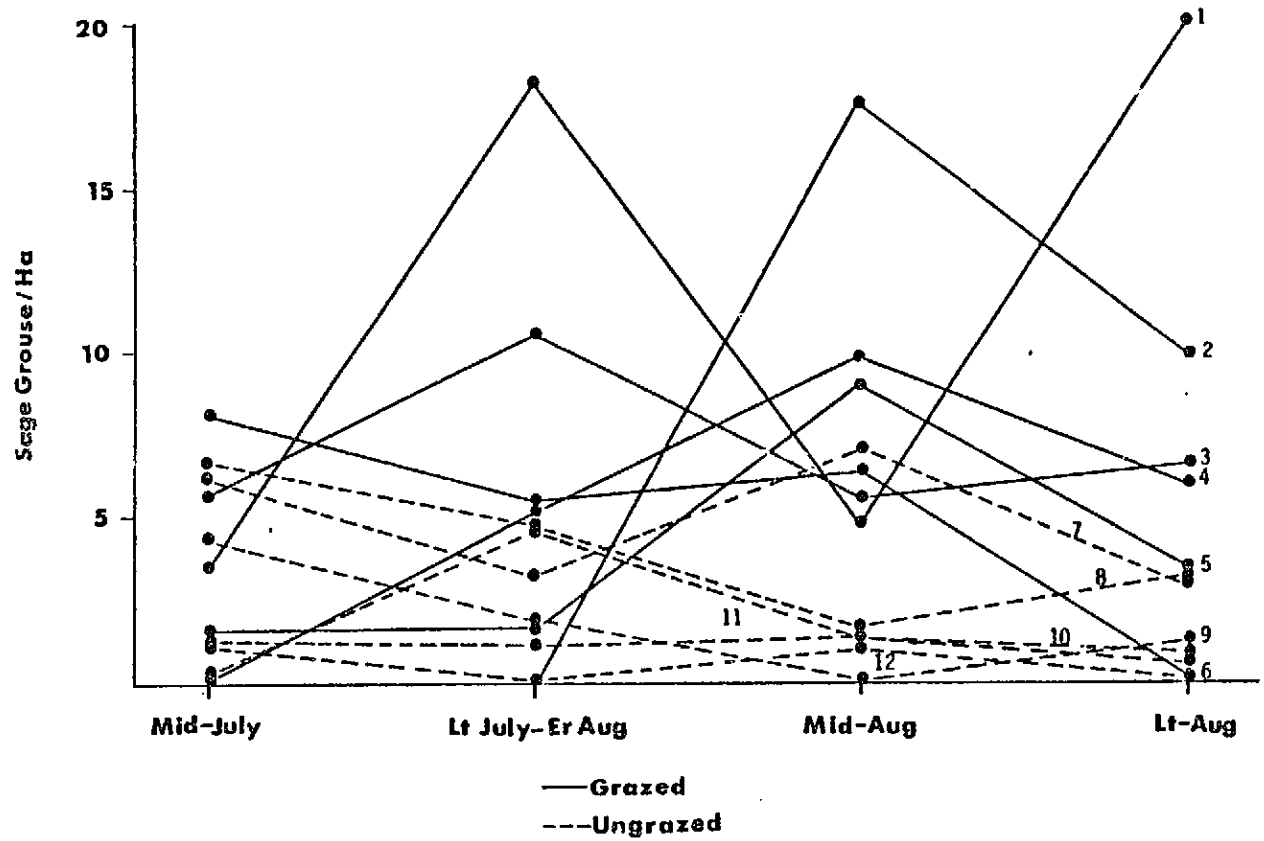


Fig. 7. All sexes and age classes of sage grouse per hectare observed on the 13 study meadows over the 4 survey periods in 1982. For grazed meadows; 1=Bald Mountain Creek-Range, 2=West Rock Springs Exclosure, 3=Badger Creek, 4=South Catnip Creek, 5=Little Catnip Springs, 6=Hell Creek. For ungrazed meadows; 7=Hooble Springs, 8=Lower Last Chance, 9=Bateman, 10=Upper Last Chance, 11= North Catnip Creek, 12=Badger Shearing Pen. Bald Mountain Creek-Refuge is not shown since all values equal 0.

meadows ranged from 0.69 to 0.03, with an average of 0.26.

Selection for meadows which had been grazed was consistently higher for hens and juveniles (Table 10). Index values ranged from 1.29 to 0.43, with an average of 0.68, while values for ungrazed meadows ranged from 0.22 to 0.0, with an average of 0.14.

Table 9. Indices of meadow use by sage grouse on grazed and ungrazed meadows in 1982.

	Use index[a]
Grazed meadows	
Bald Mountain Creek-Range	1.46
Badger Creek	0.89
South Catnip Creek	0.56
Little Catnip Springs	0.43
West Rock Springs Exclosure	0.37
Hell Creek	0.35
Average	0.68
Ungrazed Meadows	
Hobble Springs	0.69
Lower Last Chance	0.48
Upper Last Chance	0.20
North Catnip Creek	0.18
Bateman	0.17
Badger Shearing Pen	0.04
Bald Mountain Creek-Refuge	0.00
Average	0.25

[a] Use Index = $\frac{\text{Total number grouse/ha on meadow Y}}{\text{Total number grouse/ha on all meadows}} \times$ Number of counts in which meadow Y supported grouse

Table 10. Indices of meadow use by adult hen and juvenile sage grouse on grazed and ungrazed meadows in 1982.

	Use index[a]
Grazed meadows	
Bald Mountain Creek-Range	1.27
Badger Creek	0.88
West Rock Springs Exclosure	0.59
Hell Creek	0.46
Little Catnip Springs	0.44
South Catnip Creek	0.43
Average	0.68
Ungrazed meadows	
Upper Last Chance	0.22
Lower Last Chance	0.21
Hobble Springs	0.20
Bateman	0.14
North Catnip Creek	0.13
Badger Shearing Pen	0.06
Bald Mountain Creek-Refuge	0.00
Average	0.14

[a]Use Index = (Total number grouse/ha on mdw Y / Total number grouse/ha on all mdws) X (Number of counts in which meadow Y supported grouse)

Use Areas Within Meadows by Sage Grouse

Sage grouse use of areas within meadows was influenced by the distribution of common dandelion. Of the 3 food forbs, it was the most important. Sage grouse were flushed more often from meadow types where dandelion was rated as common or abundant than would be expected if no selection for those areas were occurring (X^2=9.57, $P \leq 0.01$, Table 11). Similarly, number of sage grouse flushes recorded in types where dandelion was rated as occasional, rare, or absent were

Table 11. Comparison of observed and expected use of areas within a meadow by sage grouse in relation to the abundance of the 3 main food forbs.

Food forb abundance	Total hectares[a]	Proportion of total hectares	No. sage grouse flushes observed	No. sage grouse flushes expected[b]	(k^2)
Yarrow					
Common	36.97	0.4757	62	70	
Occasional-rare-absent	40.75	0.5243	85	77	1.75
	77.72		147		
Western Aster					
Common	26.58	0.3420	59	50	
Occasional-rare-absent	51.14	0.6580	88	97	2.30
	77.72		147		
Common dandelion					
Abundant-common[c]	33.02	0.4249	81	62	
Occasional-rare-absent	44.70	0.5751	66	85	10.07**
	77.72		147		

[a]Total hectares for abundant-common and occasional-rare-absent designations were calculated by summing areas of meadow types by appropiate abundance ratings of forbs within those types.
[b]Calculated by multiplying percent of total hectares by total number of sage grouse flushes observed. (Hue et al. 1974).
[c]Of the 3 food forbs, only common dandelion ever received a rating of abundant.
**Significant at the 0.01 level of probability.

less than expected, indicating birds were not seeking these areas. No selection or avoidance of areas based on the distribution of yarrow and western aster could be shown.

The amount or thickness of vegetative cover present on certain areas may have influenced sage grouse distribution on meadows. The difference between the number of sage grouse flushes expected and the number observed within a range of cover ratings for meadow types was significant (X^2=12.79, $P \leq 0.05$, Table 12). While sage grouse did not appear to select or avoid areas of open to moderately dense cover, significantly fewer ($P \leq 0.10$) sage grouse flushes were observed in very dense areas (with ratings of 0.0 - 1.5), than would be expected if no avoidance of those areas was occurring.

Although all 13 study meadows contained water summer-long, sage grouse use of areas within meadows was influenced to some extent by the distribution of water. On some meadows, areas which supported both water and sage grouse on the first and second surveys later became dry and subsequently supported few observations of birds. On Lower Last Chance, for example, type 4 received the most use by grouse of all types on the meadow in mid-July and late July-early August, but when the area became dry in mid-August, sage grouse were no longer observed there. The lower ends of Bateman and Badger Creek also supported observations of sage grouse during the first or second surveys when water was available, but as the areas became dry, sage grouse were then flushed only from the types where water was present.

Table 12. Comparison of observed and expected use of areas within a meadow by sage grouse in relation to cover ratings. (All statistics are from Nue et al. 1974).

Range of cover ratings[a]	Total hectares	Proportion of sage grouse expected[b]	No. sage grouse flushes observed	No. sage grouse flushes expected	Proportion of sage grouse observed	90% confidence interval on proportion of observations[e] (p_i)
27.0 - 38.0 (most visibility)	9.42	0.121	21	18[c]	0.143[d]	$0.074 \leq p1 \leq 0.212$
18.0 - 26.0	12.73	0.164	28	24	0.190	$0.113 \leq p2 \leq 0.267$
9.5 - 14.0	17.89	0.230	32	34	0.218	$0.136 \leq p3 \leq 0.230$
6.0 - 9.0	4.90	0.063	17	9	0.116	$0.053 \leq p4 \leq 0.179$
2.0 - 5.5	15.46	0.199	28	29	0.190	$0.113 \leq p5 \leq 0.267$
0.0 - 1.5 (least visibility)	17.32	0.223	21	33	0.143	$0.074 \leq p6 \leq 0.212$[f]
	77.72		147	147		

$X2=12.79$, $P \leq 0.05$.

[a]The range of cover ratings shown for each category was determined by dividing the total number of ratings recorded for all meadow types (48) into 6 groups. While 4 groups received 8 ratings each, one group has 9 ratings while another has only 7. This is because dividing each group into 8 would have put the same rating into 2 different classes.

[b]Proportion of sage grouse expected is the same as proportion of total hectares in each class if sage grouse selected areas at random.

[c]Calculated by multiplying proportion of total hectares by total number of sage grouse flushes observed, i.e., 0.121x147=18.

[d]Calculated by dividing number of sage grouse flushes observed within a range of cover ratings by total number of flushes observed, i.e., 21-147=0.143.

[e]The confidence intervals on the proportion of flushes observed within a range of cover ratings is compared to the proportion of flushes expected to determine if the hypothesis of proportional use is accepted or rejected, i.e., 0.143=0.121. (90%, rather than 95% confidence intervals were used since the 95% test was not sensitive enough to pick up the factor(s) creating the significance in the overall chi-square value, $X2 = 12.79$ which is significant at the 0.05 level of probability).

[f]The proportion of sage grouse flushes expected (0.223) lies outside of the range of flushes observed, indicating sage grouse were flushed significantly fewer times from meadow areas with cover ratings of 0.0-1.5 than would be expected if no avoidance of those areas was occurring.

In general, sage grouse seemed to use meadows where cattle were present or in the vicinity, but appeared to avoid close contact. When cattle were observed in the vicinity but not actually on meadows, sage grouse were found on meadows 14 times, while birds were absent from meadows only 8 times. Of 21 observations of cattle actually on meadows, birds were absent only 4 times[1]. However, in 13 of 17 times grouse were found on meadows where cattle were present, the birds were over 50 m away. Grouse were observed within 25-50 m of cattle only 3 times, and were less than 25 m away only once. On 1 occasion, however, (although it was not part of a regular meadow survey), a group of mostly juveniles was seen watering within several meters of cattle in the creek channel below the West Rock Springs Exclosure. The birds could have crossed under the fence and drank from the spring source in the protected area, but did not do so.

Relationship of Food Forb Abundance and Phenology to Sage Grouse Use of Meadows

Initially, abundance of common dandelion on study meadows appeared to be important to sage grouse but as the summer progressed, birds appeared to select for succulence in food forbs (Table 13). Sage grouse per hectare were significantly positively correlated with the abundance of common dandelion in the mid-July and late July-early August surveys. By the mid-August survey, number of sage grouse per hectare was

1. Two of the 4 times were at South Catnip Creek where 56 head of cattle were present on the meadow.

Table 13. Simple correlation of sage grouse per hectare with average abundance and phenology indices for the 3 main food forbs over the 4 survey periods.

	Simple correlation coefficient (r)[a]			
Food Forb	Mid-July	Late-July early Aug.	Mid-Aug.	Late Aug.
Abundance indices				
Yarrow	0.22	-0.166	0.049	-0.062
Western aster	0.03	-0.403	-0.090	-0.289
Common dandelion	0.705**	0.563*	0.415	-0.224
Phenology indices				
Yarrow	-0.004	-0.142	0.762**	0.122
Western aster	-0.008	-0.481	0.633**	-0.078
Common dandelion	-0.228	0.116	0.774**	0.132

[a]Degrees of freedom = N-2 = 11.
*Significant at 0.05 level of probability.
**Significant at 0.01 level of probability.

significantly positively correlated with the phenological stage of all 3 food forbs. No linear relationship between food forb abundance or phenology was evident during the last survey in late August.

To further explain the relationship of food forb abundance and phenology to sage grouse use of meadows, multiple correlation coefficients, using forb index values as the independent variables and sage grouse per hectare as the dependent variable, were calculated for the 4 survey periods (Table 14). In late July-early August survey, 59 percent of the variation in meadow use by sage grouse was explained by

the abundance of the 3 main food forbs ($R=0.766$, $R^2=0.586$, $P \leq 0.05$). Abundance was not important in any other summer period. The relationship between meadow use and phenology of the 3 main food forbs was highly significant in mid-August, but not during the other survey periods. Approximately 72 percent of the variation in sage use of meadows ($R=0.846$, $R^2=0.716$, $P \leq 0.01$) was explained by the phenology of yarrow, western aster, and common dandelion.

Multiple correlation of food forb abundance and phenology to use of meadows by hens and juveniles only, failed to reveal a significant linear relationship. Coefficients,

Table 14. Multiple correlation of sage grouse per hectare with indices of abundance and phenology of the 3 main food forbs. The dependent variable in each case is number of sage grouse per hectare. Number of observations for each analysis is 13.

	Multiple correlation coefficient (R)			
Food Forb	Mid-July	Late July-early Aug.	Mid-Aug.	Late Aug.
Independent variables				
Abundance indices of yarrow, western aster, and common dandelion	0.715	0.766*	0.399	0.499
Phenology indices of yarrow, western aster, and common dandelion	0.263	0.632	0.846**	0.295

*Significant at 0.05 level of probability.
**Significant at 0.01 level of probability.

however, were similar in magnitude to those obtained when adult males were included in the analysis.

Effects of Grazing on Forbs

Short Term Effects of Grazing

There was no significant difference between abundance indices for the 3 food forbs on grazed and ungrazed meadows. Abundance indices for grazed meadows ranged from 0.29 to 3.00, while indices for ungrazed meadows ranged from 0.16 to 2.99.

Average phenology indices for the 3 food forbs decreased on all meadows over time, but indices for forbs on grazed meadows were generally higher and declined at a slower rate than indices for forbs on ungrazed meadows (Fig. 8). In a 2-way analysis of variance where the effects of time and grazing on phenology (N=52 for each analysis) were considered, the effects of grazing treatment on phenology were highly significant for common dandelion ($F=9.039$) and significant for yarrow and western aster ($F=4.155$, $P \leq 0.05$, $F=4.405$, $P \leq 0.05$, respectively). The effects of time on phenology were highly significant for yarrow and western aster ($F=10.913$, $F=8.257$, respectively), but not for dandelion. Common dandelion, unlike many other forbs, retained its succulence long after maturation.

Forbs with phenology index values of 2.00 or less were dry or weathered. A comparison of the percent of all forb

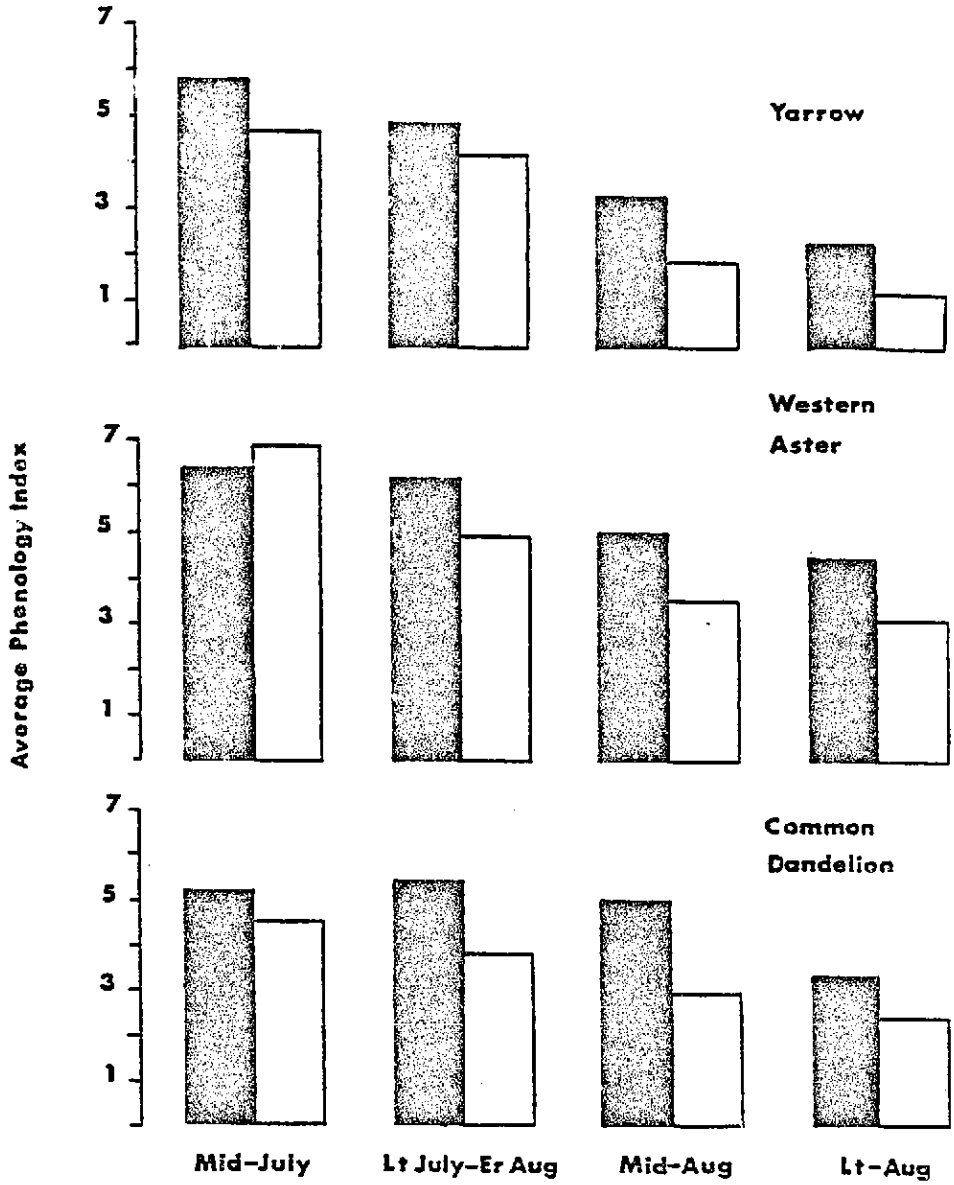


Fig. 8. Average phenology indicies for grazed and ungrazed food forbs over the 4 survey periods in 1982. Solid bars represent grazed forbs, open bars represent ungrazed forbs.

species with index values of 2.00 or less for each meadow over the 4 time periods shows differences in the extent of desiccation that occurred on grazed and ungrazed meadows (Fig. 9). While the slope of the curve for desiccation was similar for both types of meadows, percentages of weathered forbs were considerably higher for most ungrazed meadows than for grazed meadows over the 4 survey periods. Bald Mountain Creek-Range and Bald Mountain Creek-Refuge presented exceptions to the observed patterns for grazed and ungrazed meadows. Bald Mountain Creek-Range supported a high percentage of weathered forbs throughout the summer, while Bald Mountain Creek-Refuge had the lowest percent of weathered forbs on all 4 survey periods recorded for any of the meadows.

Results of Early Summer Grazing on the West Rock Springs Exclosure

Cold spring temperatures in 1982 delayed initiation of plant growth, and the majority of forbs in the West Rock Springs Exclosure were still in the early leaf stage when the meadow was first grazed (Table 15). A few forbs, including blue-eyed Mary (Collinsia parviflora) and common dandelion had progressed beyond the bloom stage by mid-June. While the early growing dandelion had long since cast its seeds by the time of the grazing treatment, it remained green and succulent well into the summer wherever it occurred.

The short duration, high intensity grazing treatment of

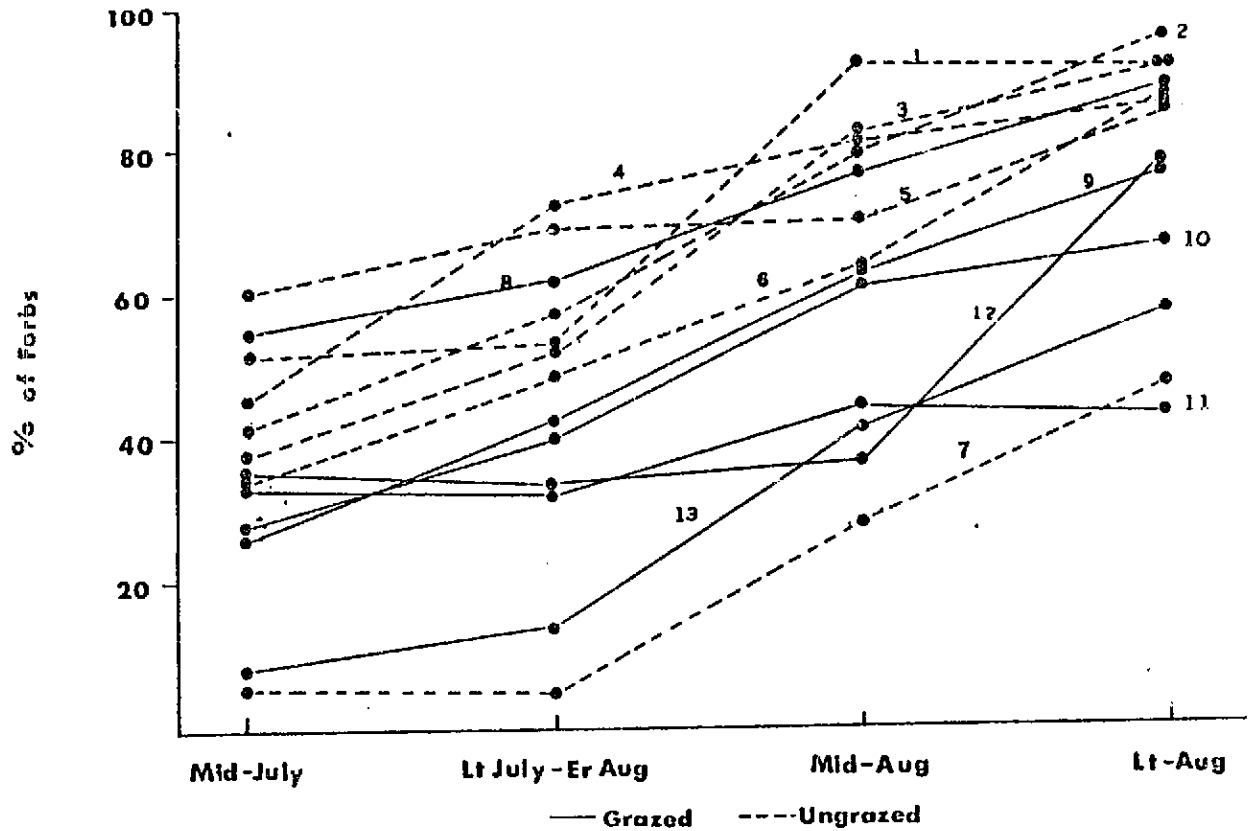


Fig. 9. Percent of forbs on the 13 study meadows with phenology indices of 2.00 or less during the 4 survey periods in 1982. For ungrazed meadows; 1=Badger Shearing Pen, 2=Upper Last Chance, 3=Hobble Springs, 4=North Catnip Creek, 5=Bateman, 6=Lower Last Chance, 7=Bald Mountain Creek-Refuge. For grazed meadows; 8=Bald Mountain Creek-Range, 9=Badger Creek, 10=Bell Creek, 11=South Catnip Creek, 12=Little Catnip Springs, 13=West Rock Springs Exclosure.

the meadow was unintentionally severe. Ranch plans for moving the cattle were delayed, and hungry animals were forced to remain on the meadow several days after it had been depleted of forage. Nine days of grazing by 44 cattle on such a small area resulted in almost complete removal of the herbaceous vegetation. The extent of forage removal that occurred is evident in a comparison of the meadow as it appeared in July of 1981 with the way it appeared following grazing in June of 1982 (Figs. 10 and 11). Additionally, comparison of vegetation in the grazed portion of the meadow with vegetation inside the small temporary corner exclosure showed that almost every forb, most of the grass cover, and even some of the old litter cover had been consumed (Figs. 12, 13, and 14).

Differences in the percent of forbs, grasses, grass-likes, litter and percent bareground inside and outside the temporary corner exclosure were significant when measured 3 weeks after the grazing treatment (Table 16). With almost a 40 percent reduction in percent cover of grasses, grass-likes and litter, a major consequence of the grazing treatment was a dramatic increase in percent bareground.

Frequent thunderstorms during June and early July, coupled with the moisture naturally present in the meadow, resulted in the rapid regrowth of the grazed vegetation (Fig. 15; a, b). By 17 July, 22 days following removal of the cattle, sedge and baltic rush (Juncus balticus) had grown as much as 10 to 20 cm, while new leaves of western aster and

yarrow formed carpets of succulent regrowth (Figs. 16, 17).

Table 15. Phenological stages of some of the more common forbs in West Rock Springs Exclosure at the time of the grazing treatment (14 June to 25 June, 1982).

Forb species	Phenological stage[a]
Arnica (*Arnica* sp.)	Bloom
Autumn willow-weed (*Epilobium paniculatum*)	Early leaf
Common dandelion	Green seed cast
Cinquefoil	Early leaf
Blue-eyed Mary	Dough-soft seed
Longstalk Starwort (*Stellaria longipes*)	Bloom
Oregon checker-mallow (*Sidalcea oregana*)	Early leaf
Rydberg penstemon (*Penstemon Rydbergii*)	Early leaf
Thistle	Early leaf
Western Aster	Early lead
(*Barbarea orthocaeras*)[b]	Early leaf

[a]The phenological stage shown represents the stage in which the majority of the individuals of a species belonged at the time of grazing. Not all members of a species are necessarily in the same phenological stage at any given point in time.
[b]Common name not known.

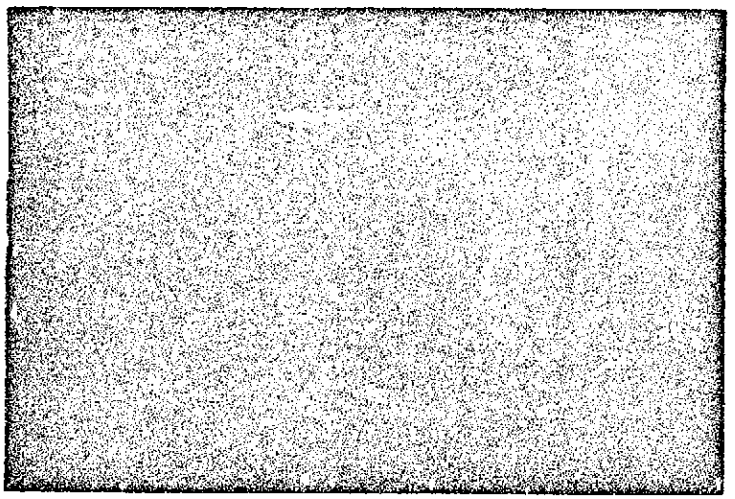


Fig. 10. West Rock Springs Exclosure as it appeared in July of 1981. The meadow had been grazed only incidentally within the last 20 years. Herbaceous vegetation had become dense and old litter accumulation was heavy.

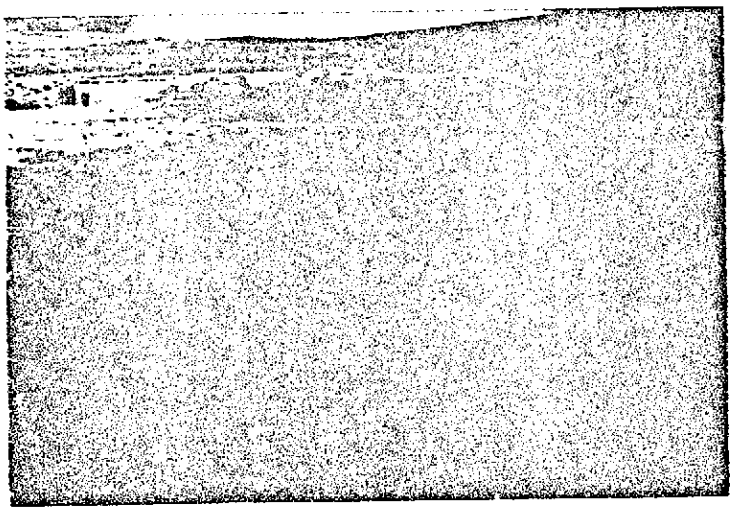


Fig. 11. West Rock Springs Exclosure as it appeared near the conclusion of 9 days of grazing by 44 head of cattle in June of 1982. Photo by J. Wayne Burkhardt.

Fig. 12. Comparison of grazed portion of West Rock Springs Exclosure as it appeared near the end of June 1982 with the protected portion of the meadow in the temporary corner exclosure. Photo by J. Wayne Burkhardt.

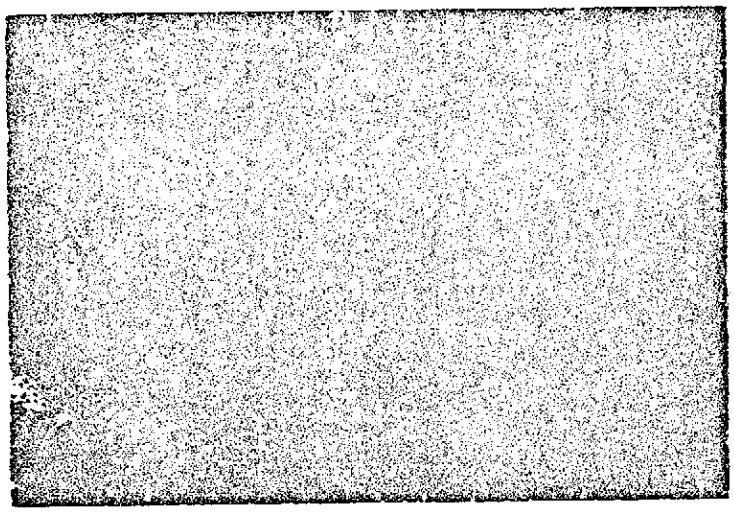


Fig. 13. Close up of the grazed portion of the West Rock Springs Exclosure shows almost all of the living herbaceous vegetation and even much of the old litter cover had been consumed. Photo by J. Wayne Burkhardt.

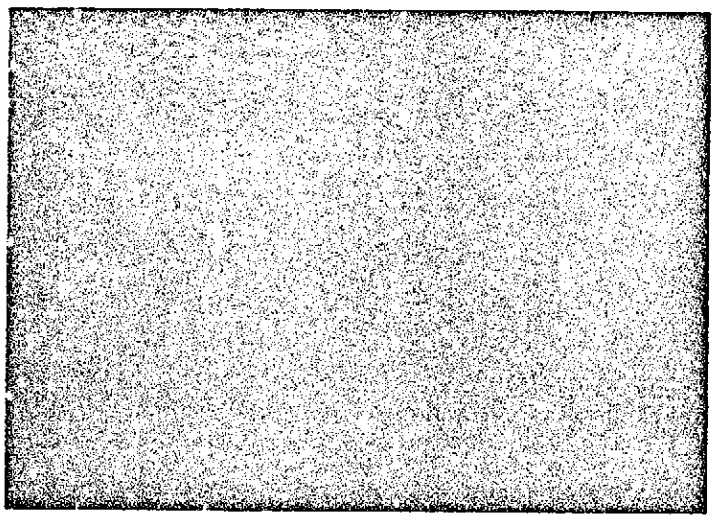


Fig. 14. A close up of the protected vegetation inside the temporary corner exclosure at West Rock Springs shows the amount of litter and herbaceous vegetation present on the meadow prior to grazing.

Table 16. Comparison of percent cover of litter, forbs, grasses, and grass-likes, and percent bareground inside and outside the temporary exclosure at West Rock Springs Exclosure on 17 July (3 weeks after the grazing treatment).

	% Cover		
	Grazed	Ungrazed	Significance
	$\bar{X}$ CL[a]	$\bar{X}$ CL	of difference
Litter	22.6 ± 2.6	30.5 ± 2.5	**
Grass/grass-likes	17.0 ± 1.7	42.1 ± 2.6	**
Forbs	8.9 ± 1.3	13.8 ± 1.7	**
Bareground	23.3 ± 3.0	1.4 ± 0.5	**

[a]95% confidence limits.
**Significant at 0.01 level of probability (t-test).

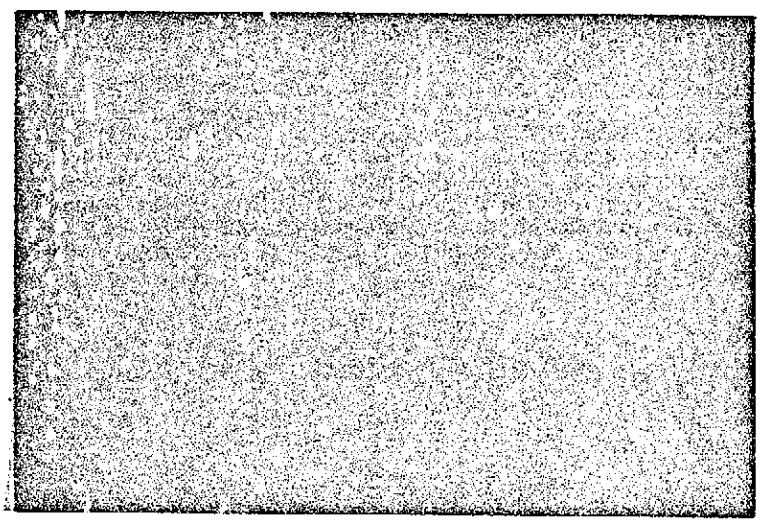


Fig. 15; a, b. Regrowth of the grazed vegetation at West Rock Springs Exclosure began almost immediately once the cattle were moved. A comparison of the grazed vegetation in the meadow with the protected vegetation inside the corner exclosure shows the extent of regrowth that took place within several weeks after the grazing treatment.

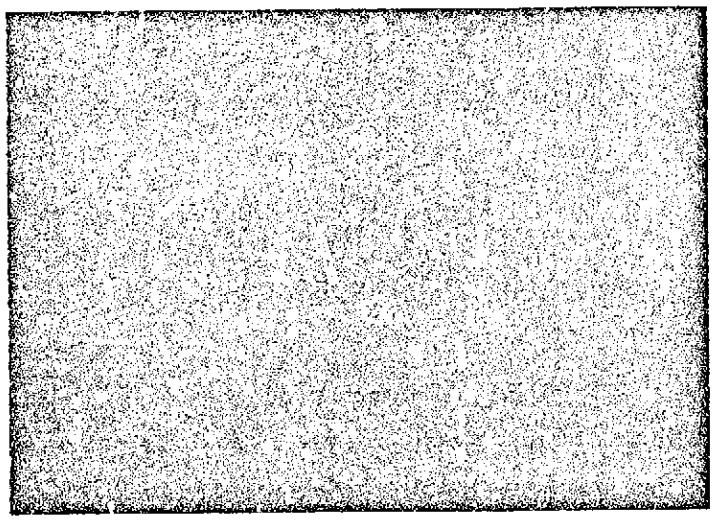


Fig. 16. Regrowth of western aster at West Rock Springs Exclosure on 17 July, 1982, 3 weeks after heavy grazing. Grazed western aster appeared as a carpet of succulent new growth throughout moist areas of the meadow.

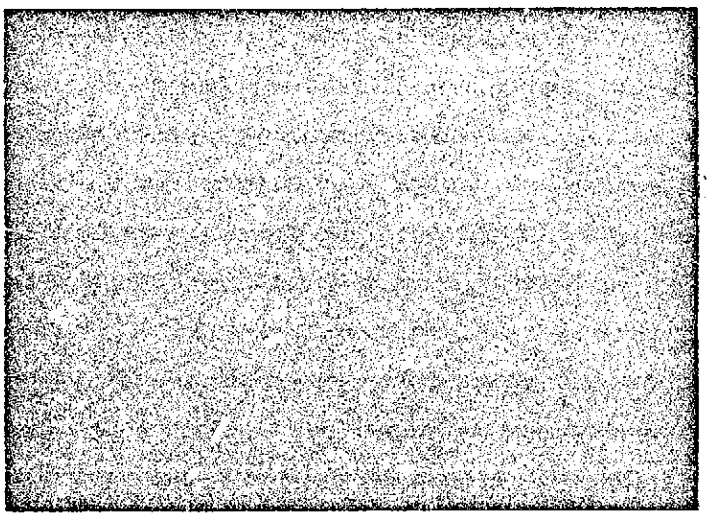


Fig. 17. Regrowth of yarrow at West Rock Springs Exclosure on 17 July, 1982, 3 weeks after heavy grazing. Tender, new leaves were produced by grazed plants.

Scattered, new common dandelion plants appeared in the wetter parts of the meadow and centers of mature grazed plants produced new leaves. Inside the temporary corner exclosure, western aster and yarrow were still in the early leaf stage or were just beginning to bloom, but leaves were large and coarse. Similarly, most leaves of protected common dandelion plants were much larger and appeared to be coarser in comparison to new leaves produced by grazed plants.

As the summer progressed, ungrazed forbs inside the temporary exclosure began to mature and dry. Grazed forbs were still green and succulent by 8 August. In the grazed meadow, over 90 percent of the leaves of western aster, common dandelion, and yarrow were still green and succulent 6 weeks after the grazing treatment (Table 17). Inside the ungrazed exclosure, less than 4 percent of the leaves of yarrow and less than 15 percent of the leaves of western aster were still

Table 17. Differences in the percent succulent leaves of grazed and ungrazed sage grouse food forbs at West Rock Springs Exclosure on 8 August, 1982 , 6 weeks after grazing was concluded.

Forb	% Succulent leaves		
	Grazed	Ungrazed	Significance
	$\bar{X}$ CL[a]	$\bar{X}$ CL	of difference
Western aster	92.5 ± 2.7	3.8 ± 5.4	**
Yarrow	94.9 ± 2.2	14.9 ± 36.4	**
Common dandelion	92.6 ± 4.1	23.7 ± 36.4	**

[a]95% confidence limits.
**Significant at 0.01 level of probability (t-test).

succulent. Approximately 23 percent of the leaves of ungrazed common dandelion plants were still green by the mid to late summer period.

Grazed sage grouse food forbs were higher in crude protein and lower in crude fiber when compared in July and August (Table 18). On 20 July, crude protein of grazed western aster and yarrow was 21.2 percent and 19.5 percent respectively, while crude protein of the same forbs inside the ungrazed exclosure was only 13.2 percent and 12.0 percent, respectively. Crude protein levels in grazed western aster and yarrow decreased as the summer progressed, but were still higher in comparison to levels present in protected plants. The protein content of grazed common dandelion was also higher than the crude protein content of ungrazed dandelion 7 weeks after grazing. While differences in crude

Table 18. Comparison of percent crude protein and crude fiber levels for grazed and ungrazed sage grouse food forbs collected at West Rock Springs Exclosure in July and August, 1982.[a]

Forb	Date Collected	% Crude protein		% Crude fiber	
		Grazed	Ungrazed	Grazed	Ungrazed
Yarrow	7/20/82	19.5	12.0	18.4	22.0
	8/13/82	15.7	11.6		
Western aster	7/20/82	21.1	13.2	13.1	14.6
	8/13/82	18.7	11.6		
Common dandelion	8/13/82	16.9	14.0	12.0	13.7

[a]Grazing period was 14-25 June.

fiber content of grazed and ungrazed forbs were less dramatic than differences in crude protein, the crude fiber levels were consistently lower than where they were not grazed.

Grazed plant regrowth present on the meadow appeared as a carpet of green on 13 August in comparison to the yellow color of cured vegetation inside the temporary corner exclosure (Fig. 18). Although most plants had ceased growing by the end of August, moist areas in the meadow supported some green growing vegetation into the first week of September (Fig. 19).

Results of Early Summer Grazing on South Catnip Creek

The second grazing experiment at South Catnip Creek was much less severe than it had been at West Rock Springs Exclosure. Although cattle remained on the meadow 3 weeks longer, the intensity was considerably less as grazing was dispersed over a much larger area. Only light removal of herbaceous vegetation occurred during the first week, but by mid-July most of the sedge cover and some of the forb cover had been grazed. When cattle were removed from South Catnip Creek, grazing pressure was fairly uniform throughout the meadow. Although forbs were grazed later into the growing season at Catnip than at West Rock Springs, many were still in the early leaf stage 12 days after initial introduction of cattle (Table 19).

Five weeks of moderate grazing at Catnip Meadow resulted in selective grazing of the more palatable vegetation. Per-

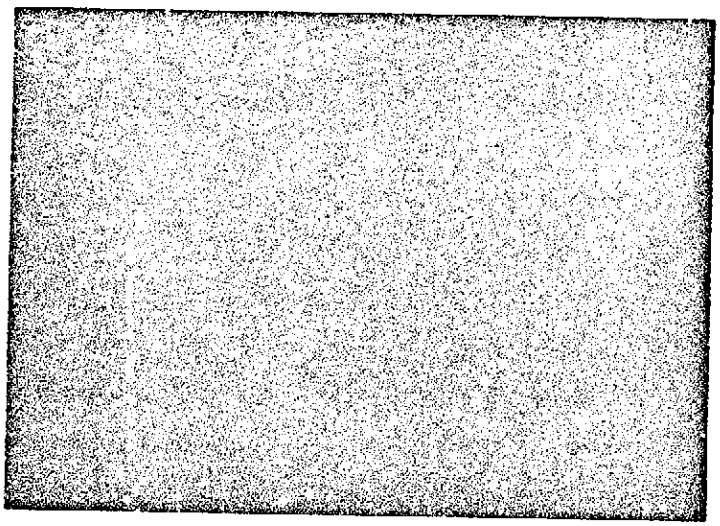


Fig. 18. By 13 August, 1982, regrowth at West Rock Springs Exclosure appears as a carpet of green in comparison to the cured vegetation inside in the corner exclosure. The availability of succulent vegetation in the rangeland environment is limited in mid to late summer, and regrowth is probably most attractive to sage grouse at this time.

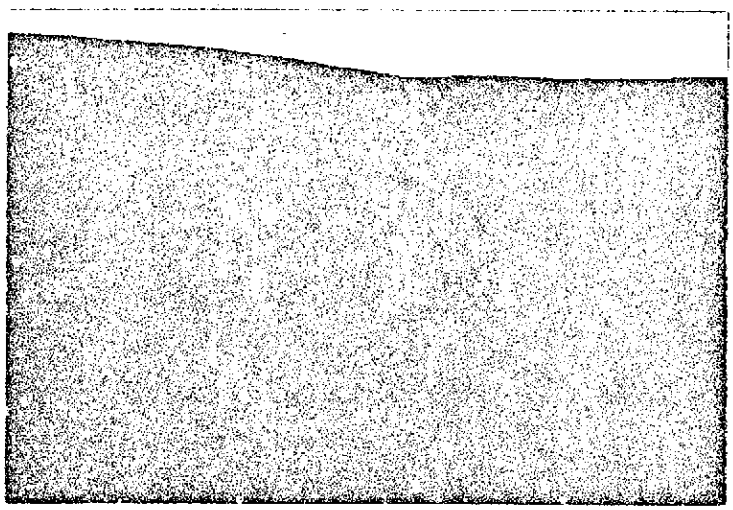


Fig. 19. The grazed portion of West Rock Springs Exclosure still contains some succulent vegetation in the first week of September, 1982. Protected vegetation in the temporary corner exclosure became mature and dry much earlier in the summer.

Table 19. Phenological stages of some of the more common forbs at South Catnip Creek on 26 June, 1982 (12 days after the introduction of cattle).

Forb Species	Phenological stage[a]
Autumn willow-weed	Early leaf
Cinquefoil	Early leaf - bloom
Common dandelion	Green seed cast
False dandelion	Seed cast
Wild iris (*Iris missouriensis*)	Bloom
Blue-eyed Mary	Weathered
Longstalk starwort	Bloom
Oregon checker-mallow	Early leaf
Penstemon (*Penstemon* sp.)	Bloom
Thistle	Early leaf
Western aster	Early leaf
Yarrow	Early leaf - bloom

[a]Phenological stage shown represents stage in which the majority of the individuals of a species belonged to at the time of grazing.

cent forb cover was significantly lower on the grazed portion of the meadow compared to the ungrazed portion inside the exclosure ($P \leq 0.01$, Table 20). There was no significant change in the percent cover of litter, bareground, shrubs, grasses, and grass-likes, between the grazed and protected areas.

Although South Catnip Creek was drier than the meadow at West Rock Springs, and grazing had been lighter and had been

applied later in the growing season, regrowth of forbs still occurred. A comparison of grazed vegetation in the meadow with the protected vegetation inside the temporary exclosure on 14 August showed that the grazing treatment was effective in stimulating regrowth (Fig. 20).

Tender new leaves were produced by grazed western aster and common dandelion plants, as well as by grazed cinquefoil and Oregon checker-mallow, species which are not known to be utilized by sage grouse, but which were important in the meadow community (Figs. 21 and 22). Where not grazed, leaves of these forbs were dry and weathered by the second week of August. Yarrow matures earlier in the season than other food forbs, but grazed plants produced some green leaves during August. Protected plants had become completely weathered much

Table 20. Percent cover of litter, grasses/grass-likes, forbs, and percent bareground inside and outside the exclosure at South Catnip Creek following 5 weeks of moderate grazing.

	% Cover		
	Grazed	Ungrazed	
Food Forb	$\bar{X}$ CL[a]	$\bar{X}$ CL	Significance of difference
Litter	38.6 ± 2.7	36.7 ± 3.1	NS
Grass/grass-likes	25.6 ± 3.1	28.5 ± 2.7	NS
Forbs	15.8 ± 1.8	21.2 ± 2.5	**
Bareground[b]	28.8 ± 4.1	31.2 ± 4.0	NS

[a]95% confidence limits.
[b]Expressed as % bareground.
**Significant at 0.01 level of probability (t-test).

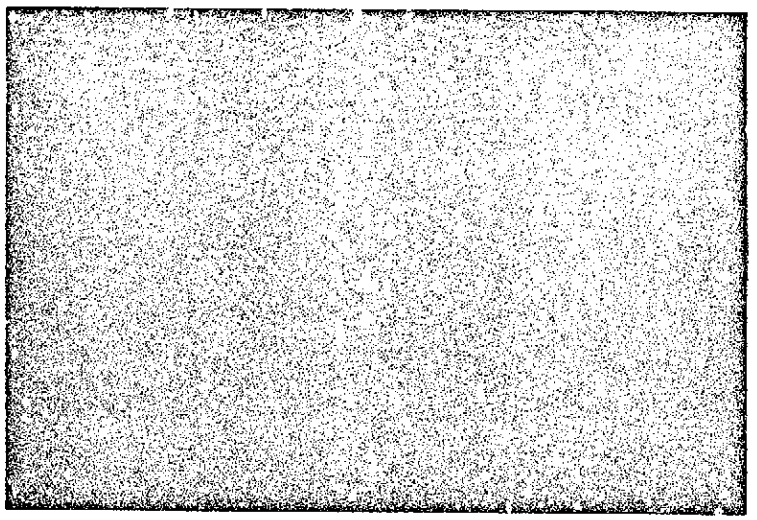


Fig. 20. A comparison of grazed vegetation at South Catnip Creek with protected vegetation inside the temporary exclosure on 14 August, 1982, shows the grazing treatment was effective in stimulating regrowth.

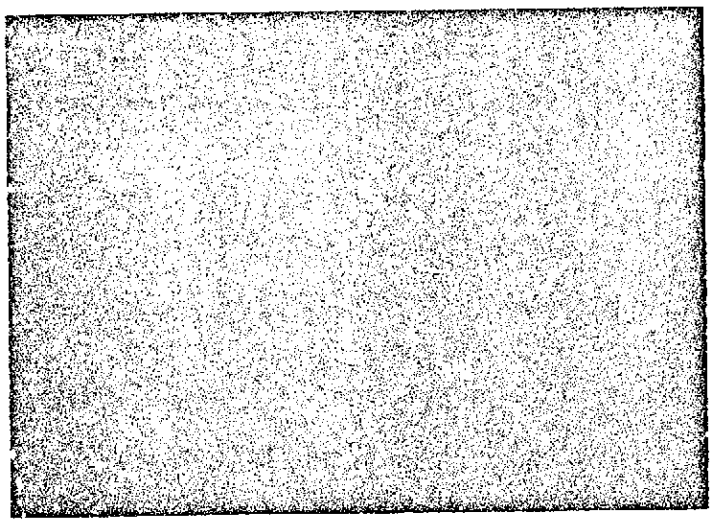


Fig. 21. Regrowth of grazed western aster (lower tip of knife), cinquefoil (center of photo), and common dandelion (upper middle right hand edge of photo) at South Catnip Creek approximately 3 weeks after the grazing treatment.

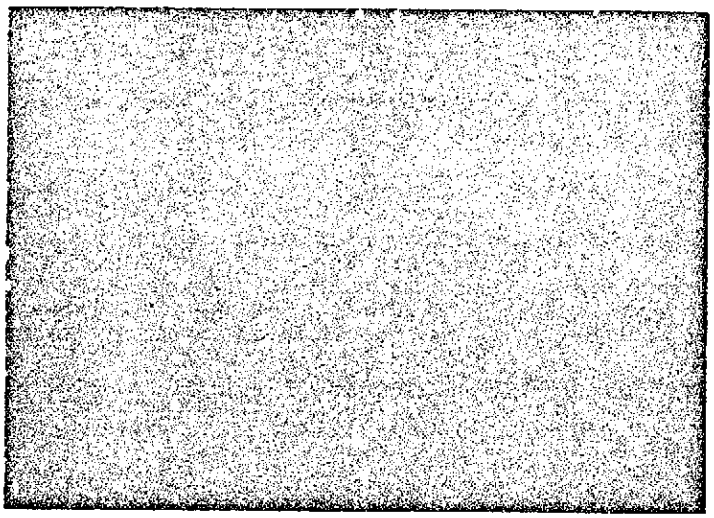


Fig. 22. Regrowth of Oregon checker-mallow (above and to the left of knife) at South Catnip Creek approximately 3 weeks after the grazing treatment.

earlier in the summer (Fig. 23).

Much of the regrowth weathered rapidly at Catnip, but percent succulent leaves of the 3 main sage grouse food forbs and cinquefoil were still substantially higher for the grazed plants than the protected plants on 12 August (Table 21). In the grazed portion of the meadow, over 50 percent of the leaves of western aster and common dandelion were still succulent, while less than 15 percent of the leaves of these forbs were still young and green inside the exclosure. Where yarrow and cinquefoil had been grazed, over 40 percent of the leaves were succulent, while less than 11 percent of the leaves of these species were still succulent inside the exclosure.

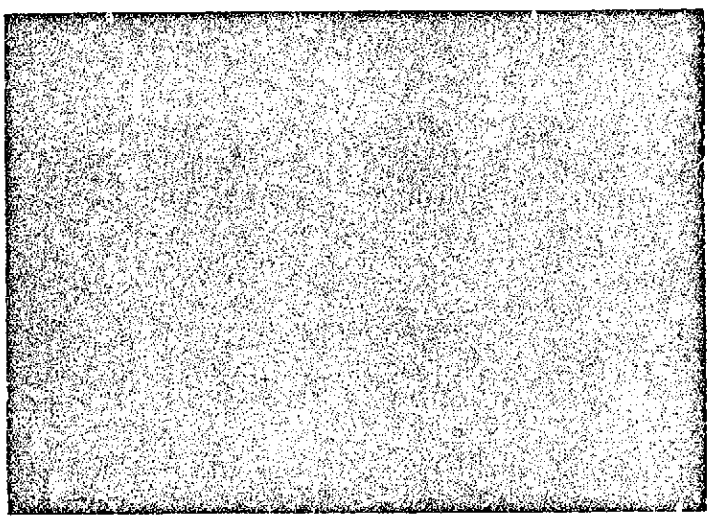


Fig. 23. In the ungrazed exclosure at South Catnip Creek, yarrow matured early in the summer, and by early August, the plants were completely weathered and dry (center of photo). Cured cinquefoil leaves are also visible in the left hand margin of the photo.

Table 21. Percent succulent leaves of grazed and ungrazed yarrow, western aster, cinquefoil, and common dandelion at South Catnip Creek on 12 August, 1982. Grazing occurred from 14 June until the third week of July.

Food Forbs	Succulent leaves: Grazed $\bar{X}$ CL[a]	Succulent leaves: Ungrazed $\bar{X}$ CL	Significance of difference
Cinquefoil	42.2 ± 5.7	10.3 ± 2.2	**
Common dandelion	58.1 ± 7.1	14.1 ± 3.6	**
Western aster	50.3 ± 5.9	14.1 ± 2.7	**
Yarrow	42.2 ± 5.7	10.3 ± 2.2	**

[a]95% confidence limits.
**Significant at the 0.01 level of probability (t-test).

When the temporary exclosure was removed during the first week of September, some grazed portions of the meadow were still providing succulent forage (Fig. 24). While vegetative growth had ceased in dry areas, grazed plants in moist areas continued to grow.

Long Term Effects of Grazing

Forb diversity or number of forbs present on a meadow was not clearly related to the past grazing history of a meadow. The average number of total terrestrial forb species and the average number of food forb species found were similar for meadows with histories of heavy grazing and meadows with histories of moderate grazing or protection (Table 22). Total numbers of forbs on heavy use meadows ranged from a low

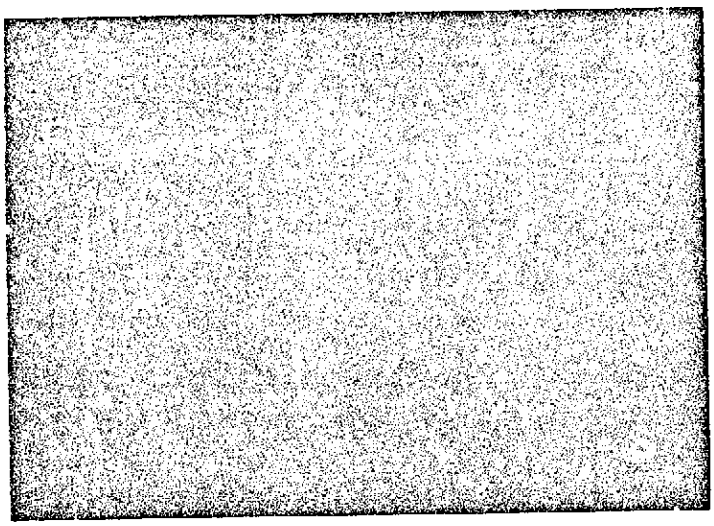


Fig. 24. When the temporary exclosure at South Catnip Creek was removed during the first week of September, 1982, (upper right in photo) grazed vegetation outside the exclosure was still providing some succulent forage.

Table 22. Comparison of total number of terrestrial forb species and sage grouse food forb species between study meadows with histories of past heavy grazing and study meadows with histories of moderate grazing or protection.

Meadows	Total no. forb species	No. food forb species
Histories of past heavy grazing		
Bateman	35	10
Hell Creek	41	11
Badger Creek	28	9
Little Catnip Springs	40	9
Bald Mountain Creek-Range	37	10
Average	36	10
Histories of moderate grazing or protection		
Badger Shearing Pen	25	8
West Rock Springs Exclosure	26	4
North Catnip Creek	35	10
South Catnip Creek	28	5
Bald Mountain Creek-Refuge	32	12
Hobble Springs	36	11
Lower Last Chance	57	13
Upper Last Chance	51	10
Average	36	9

of 28 for Badger Creek to a high of 40 for Little Catnip Springs.

Number of food forb species for all 5 heavy use meadows were similar, ranging from 9 to 11. Total number of forbs on light, moderate, or no use meadows ranged from a low of 25 for Badger Shearing Pen to a high of 57 for Lower Last Chance. West Rock Springs Exclosure supported the fewest number of food forbs, with 4 species, while Lower Last Chance supported the most, with 13 species. Although most of the study meadows supported from 9 to 13 species of food forbs, regardless of grazing histories, the low numbers of food forbs found on West Rock Springs Exclosure and South Catnip Creek were exceptions. Both these meadows had histories of almost complete protection. However, North Catnip Creek, also essentially a protected meadow, had twice as many food forbs as South Catnip Creek.

Some species of forbs appeared to be widely distributed on all types of meadows regardless of past grazing histories, while others were mostly associated with meadows which had received past heavy use or had received only moderate grazing or protection. Selection of 5 forbs with the highest abundance indices on each of the study meadows resulted in a list of 30 species for comparison (Table 23). The 3 main food forbs; yarrow, western aster, and common dandelion, were included in the 5 most abundant forbs more than once on both kinds of meadows, but yarrow and western aster seemed to be abundant slightly more often on moderate use or protected

Table 23. Forb abundance on study meadows in relation to their past grazing histories. Number of meadows shown represents number of times in which a forb species was 1 of the 5 most abundant forbs (based on abundance indices) on a particular meadow[a].

Forb species	No. meadows: Meadows with histories of past heavy use[b] N=5	Meadows with histories of moderate use or protection[c] N=8	Total
Yarrow*	2	6	8
False dandelion*	0	1	1
Arnica	0	1	1
Louisiana sagebrush*	0	1	1
Aster campestris	0	1	1
Western aster*	2	4	6
Specklepod loco milkvetch* (*Astragalus lentiginosus*)	0	1	1
Primrose	3	1	4
Thistle	3	3	6
Blue-eyed Mary	1	0	1
Flixweed tansymustard	1	1	2
Sticky willow-weed (*Epilobium adenocaulon*)	0	1	1
Spreading fleabane (*Erigeron divergens*)	0	1	1
Hairstem groundsmoke (*Gayophytum ramosissimum*)	1	0	1
Lanceleaf goldenweed (*Haplopappus lanceolatus*)	0	1	1
Wild iris	2	1	3
Stickseed (*Lappula Redowskii*)	1	1	2
Pepperweed	0	1	1
Spanish clover (*Lotus*) (*Purshianus*)	1	0	1
Chamissoi Indianlettuce	2	0	2
False caraway	0	2	2
Popcornflower (*Plagiobothrys leptocladus*)	1	1	2
Polygonum arenastrum[d]	2	0	2
Cinquefoil	2	4	6
Oregon checker-mallow	0	2	2
Longstalk starwort	1	0	1
Common dandelion*	5	6	11
Cup clover*	1	3	4
Sierra clover (*Trifolium Hormskioldii*)*	1	0	1

[a]More than 5 species are represented for some meadows since some forbs received the same abundance indices.

[b]Meadows with histories of past heavy use include: Bateman, Hell creek, Badger Creek, Little Catnip Springs, and Bald Mountain Creek-Range.

[c]Meadows with histories of moderate use or protection include: Badger Shearing Pen, West Rock Springs Exclosure, North Catnip Creek, South Catnip Creek, Bald Mountain Creek-Refuge, Hobble Springs, Upper Last Chance, and Lower Last Chance.

[d]Common name not known.

*Sage grouse food forbs.

meadows. While common dandelion was one of the 5 most abundant forbs on 6 of 8 protected to moderate use meadows, it was in the top 5 on all meadows with histories of heavy use. Several forbs which seemed to be associated with moderate, light, or no grazing included false caraway (Perideridia sp.), cinquefoil, Oregon checker-mallow, and cup clover (Trifolium cyathiferum). Nine additional species were 1 of the 5 most abundant forbs on 1 protected or moderate use meadow, but were not as abundant on any of the heavy use meadows. Forbs which seemed to be associated with meadows with histories of heavy use included; primrose (Camissonia tenacetifolia), thistle, wild iris, Chamissoi Indianlettuce (Montia Chamissoi), and a species of knotweed, Polygonum arenastrum. An additional 4 species were included in the 5 most abundant forbs on 1 heavy use meadow, but were not abundant on any of the moderate use or protected meadows.

Exclosure Comparisons

Bateman Springs

Five years of protection on this once highly degraded meadow resulted in an increase in herbaceous cover and a decrease in percent bareground (Table 24). Although the change in cover of litter was not significant, percent cover of sedges and bluegrass increased significantly under protection ($P \leq 0.05$). Cover of clover sp. and western aster was significantly higher inside the exclosure, while percent

bareground was significantly lower ($P \leq 0.01$). The most dramatic difference between the grazed and fenced areas was the vigorous re-establishment of clover under total protection. While cover of clover was over 46 percent inside the exclosure, it was absent where heavy grazing had persisted.

The only form of forb cover that was significantly higher on the outside of the Bateman Springs exclosure fence than on the inside was popcornflower ($P \leq 0.01$). Although they did

Table 24. Percent cover of litter, bareground, and herbaceous vegetation inside and outside the Bateman Springs exclosure fence.

	% Cover		
	Inside exclosure $\bar{X}$ CL[a]	Outside exclosure $\bar{X}$ CL	Significance of difference
Litter	17.19 ± 2.75	15.19 ± 2.77	NS
Sedge/bluegrass	27.54 ± 2.94	22.95 ± 3.07	*
Bareground	33.55 ± 3.96	55.63 ± 4.50	**
Forbs			
Clover	46.33 ± 6.51	0.0	**
Common dandelion	15.84 ± 1.63	5.20 ± 1.19	**
Primrose	9.86 ± 1.71	4.76 ± 1.26	**
Western aster	2.84 ± 0.16	0.24 ± 0.02	**
Popcornflower	0.21 ± 0.17	1.80 ± 0.90	**
Incidentals			
	Thistle	*Polygonum arenastrum*[b] Autumn willow-weed Thistle	

[a]95% confidence limits.
[b]Common name not known.
*Significant at 0.05 level of probability (t-test).
**Significant at 0.01 level of probability (t-test).

not occur in sufficient quantities for sampling, autumn willow-weed and a species of knotweed, Polygonum arenastrum, were found only in the area outside the fence.

Hell Creek Sheep Pen

Since the bighorn sheep pen was constructed in 1938, significant changes have occurred in the percent cover of litter, bareground, forbs, grasses, and grass-likes in the fenced portion of the meadow (Table 25). Percent cover of litter increased significantly inside the pen ($P \leq 0.01$), while percent cover of bluegrass, sedge, and baltic rush together was significantly higher on the side of the meadow grazed by cattle ($P \leq 0.01$). While there was less than 1% bareground on either side of the pen fence, there was significantly more bareground inside ($P \leq 0.05$). Percent cover of common dandelion, western aster, and yarrow was significantly higher outside the pen ($P \leq 0.01$), while only cover of wild iris was higher inside ($P \leq 0.01$).

A greater diversity of forbs occurred in the protected portion of the meadow, although many were incidental in distribution and were not adequately sampled.

Bald Mountain Creek-Refuge and Range

Approximately 40 years of differences in grazing management policies led to significant changes in the litter and herbaceous cover of the Bald Mountain Creek meadow (Table 26). Percent cover of litter was over 3 times higher on the

Table 25. Percent cover of litter, bareground, and herbaceous vegetation inside and outside the Hell Creek Sheep Pen fence.

	% Cover		
	Inside Sheep Pen $\bar{X}$ CL[a]	Outside Sheep Pen $\bar{X}$ CL	Significance of difference
dLitter	40.11 ± 5.02	11.64 ± 1.55	**
Grasses/ Grass-likes[b]	34.11 ± 5.49	57.85 ± 4.49	**
Bareground	0.62 ± 0.20	0.34 ± 0.07	*
Forbs			
Common dandelion	2.04 ± 0.41	14.52 ± 0.68	**
Western aster	6.33 ± 1.69	10.27 ± 1.74	**
Yarrow	5.22 ± 1.62	6.48 ± 1.61	NS
Wild iris	13.00 ± 2.99	5.22 ± 4.81	**
Cinquefoil	1.07 ± 0.44	1.09 ± 0.41	NS
Incidentals[c]			
	Long-leaf arnica (*Arnica longifolia*)		
	Potentilla biennis		
	Clover		
	Dock (*Rumex* sp.)		
	Water groundsel (*Senecio hydrophilus*)		
	Knotweed (*Polygonum* sp.)		
	Oregon checker-mallow		
	Rydberg penstemon		
	Sticky willow-weed		
	False caraway		

[a]95% confidence limits.
[b]Grasses and grass-likes include: bluegrass, sedge, and baltic rush.
[c]Incidental species shown occurred only inside the pen.
*Significant at 0.05 level of probability (t-test).
**Significant at 0.01 level of probability (t-test).

Table 26. Percent cover of litter, bareground, and herbaceous vegetation inside and outside the Bald Mountain Creek Refuge/Range boundary fence. The Refuge portion of the meadow is considered to be inside the exclosure fence.

	% Cover		
	Inside exclosure $\bar{X}$ CL[a]	Outside exclosure $\bar{X}$ CL	Significance of difference
Litter	15.40 ± 3.82	4.65 ± 1.70	**
Wheatgrass/ meadow barley	14.89 ± 3.27	9.65 ± 2.01	**
Bluegrass	10.12 ± 2.64	15.25 ± 3.42	*
Bareground	9.52 ± 3.40	10.60 ± 5.16	**
Baltic rush	1.62 ± 0.40	0.05 ± 0.11	**
Sedge	0.71 ± 0.35	2.79 ± 1.00	**
Forbs			
Aster campestris[b]	17.74 ± 4.06	11.43 ± 3.53	*
Yarrow	14.45 ± 3.00	4.59 ± 1.62	**
Common dandelion	6.66 ± 1.68	11.68 ± 3.01	**
Louisiana sagebrush	2.92 ± 1.80	0.22 ± 0.21	**
Clover	2.63 ± 1.42	3.38 ± 2.09	NS
False dandelion	1.30 ± 0.81	3.65 ± 1.33	**
Incidentals	Mustard (Brassicaceae sp.) Water groundsel Thistle Blue-eyed Mary Longstalk starwort Slender false phlox Oregon checker-mallow False caraway	Cinquefoil Wild iris Lupine (*Lupinus* sp.) Milkvetch Stickseed Autumn willow-weed Oregon checker-mallow Thistle	

[a]95% confidence limits.
[b]Common name not known.
*Significant at 0.05 level of probability (t-test).
**Significant at 0.01 level of probability (t-test).

Refuge side of the fence than on the Range side. Percent cover of meadow barley (Hordeum brachyantherum), wheatgrass (Agropyron sp.), and baltic rush was also significantly higher on the Refuge side ($P \leq 0.01$), while percent cover of bluegrass and sedge was significantly higher on the Range side ($P \leq 0.01$, $P \leq 0.05$, respectively). Percent bareground was also significantly higher on the Range side of the fence than on the Refuge side ($P \leq 0.01$).

With the exception of clover and several incidentals, differences in percent cover of forbs inside and outside the exclosure fence were significant. Percent cover of common dandelion and false dandelion was significantly higher on the Range side ($P \leq 0.01$), while cover of yarrow, a species of aster, Aster campestris, and Louisiana sagebrush was significantly higher on the Refuge side ($P \leq 0.01$).

Upper Hobble Springs Exclosure

Protection from 40 years of moderate grazing pressure in the wet meadow type at Upper Hobble Springs exclosure resulted in a significant increase in percent cover of litter, wheatgrass, and meadow barley ($P \leq 0.01$) and a significant decrease in percent cover of baltic rush ($P \leq 0.01$, Table 27). Additionally, a fine leafed species of sedge occurred only in the grazed area in the outside meadow, while percent cover of a broader leafed species of sedge was not significantly different either inside or outside the exclosure.

Although total forb cover was similar on both the pro-

Table 27. Percent cover of litter, bareground, and herbaceous vegetation inside and outside the Upper Hobble Springs exclosure fence.

	% Cover				Significance of difference
	Inside exclosure		Outside exclosure		
	$\bar{X}$	CL[a]	$\bar{X}$	CL	
Litter	32.53	± 8.22	1.00	± 0.64	**
Sedge[b]	10.69	± 3.10	12.67	± 3.13	NS
Sedge[c]	5.53	± 2.05	0.00		
Baltic rush	13.01	± 2.89	22.85	± 5.47	**
Wheatgrass/ meadow barley	6.29	± 2.81	2.25	± 0.84	**
Bareground	3.85	± 1.85	1.96	± 1.00	NS
Bluegrass	1.58	± 1.08	2.15	± 0.84	NS
Forbs					
Clover	10.24	± 3.85	17.17	± 4.47	*
Longstalk starwort	7.74	± 1.93	1.29	± 0.40	*
Yarrow	7.30	± 1.94	2.30	± 0.65	**
Arnica	3.68	± 2.90	0.36	± 0.61	**
Common dandelion	4.45	± 1.46	9.58	± 1.92	**
Chamissoi Indianlettuce	2.46	± 1.24	2.47	± 1.13	NS
False dandelion	1.56	± 0.82	0.26	± 0.23	**
Western aster	1.26	± 0.83	1.57	± 0.41	NS
Incidentals					
Mustard	The same 5 species occurred both inside and outside the the exclosure				
Water groundsel					
Lineleaf Indianlettuce (*Montia linearis*)					
Oregon checker-mallow					
Thistle					

[a]95% confidence limits.
[b]An unidentified species of sedge with broad leaves.
[c]An unidentified species of sedge with fine, narrow leaves.
*Significant at 0.05 level of probability (t-test).
**Significant at 0.01 level of probability (t-test).

tected and grazed areas, differences in the percent cover of many individual species of forbs were significant. Percent cover of common dandelion and clover was significantly higher outside the exclosure ($P \leq 0.01$, $P \leq 0.05$, respectively), while percent cover of longstalk starwort, yarrow and false dandelion was significantly higher inside ($P \leq 0.01$). Additionally, percent cover of arnica was also significantly higher where the meadow had been protected ($P \leq 0.05$). There was no significant difference in the percent cover of Chamissoi Indianlettuce and western aster on either protected or grazed side of the exclosure fence. The same species of incidental forbs occurred both inside and outside the exclosure.

DISCUSSION

Food Habits

Diets of young grouse on the Sheldon National Wildlife Refuge indicated definite preferences for certain species and for certain phenological stages. Not only did yarrow, western aster, and common dandelion form the greatest bulk of the forb component of the diet, these species were used most frequently. Although all 3 species are common throughout meadows on the Sheldon, sage grouse were selective when foraging on them, as usually only succulent parts were consumed. In most cases, crops contained only newly grown leaf tips. On rare occasions mature leaves, seeds, and flower buds were taken. Mature leaves of dandelion were found more often in crops than leaves of other species, possibly because dandelion appears to retain its succulence after maturation.

By late July and early August, young grouse were found to feed more heavily on shrubs. Although leaves of big and low sagebrush formed the greatest portion of the shrub component of the diet by weight, leaves of the little green rabbitbrush were used most frequently. Young grouse seemed particularly attracted to this shrub where it grew along the edges of meadows. Savage (1968) noted that the moisture content for little green rabbitbrush growing on meadow edges was higher than for plants growing on the surrounding slopes in late summer. The need for moist forage was probably particularly important in the exceptionally dry summer of

1981. By early August few succulent forbs were available anywhere and most sources of water had gone dry.

Meadow Use

Peak attendence of sage grouse on meadows occurred from the late July-early August through the mid-August survey periods. Earlier, males were more abundant on meadows than hens with broods, but by the end of July the proportion and number of males present had declined. Hens and juveniles were highest in late July-early August, but were slightly less abundant during mid-August and along with the males, had decreased in numbers by the end of August. A rapid decrease in meadow use by all sex and age classes by the end of the summer parallels the findings of others (Pyrah 1954, Savage 1968, Oakleaf 1971). Cessation of growth by forbs, changes in nutritional needs, and changes in moisture content of shrubs are probably important factors.

All 13 meadows selected for study in 1982 received at least some use by sage grouse. Only on Bald Mountain Creek-Refuge were sage grouse not flushed more than once, while 7 of the meadows supported sage grouse summer-long. Interestingly, Bald Mountain Creek-Range, separated from Bald Mountain Creek-Refuge only by a fence, supported the highest average for sage grouse per hectare. The highest average number of birds counted on any of the study meadows was recorded for Lower Last Chance.

Meadow Selection

Many factors may influence sage grouse use of meadows including meadow size, distribution of succulent vegetation (Oakleaf 1971), availability of water, presence of preferred food species, degree of shrubby cover (Savage 1968), and herbaceous cover height (Klebenow 1982). Grazing by cattle can affect some or all of these factors and was found to be a major influence on use of the 13 study meadows in 1982. Since sample size was limited by the use of the 13 study meadows and since only one field season's data was used in the analysis, different kinds of comparisons were made to define the relationship between cattle grazing and use of meadows by sage grouse.

Four different tests or comparisons were used in the evaluation. All 4 were in agreement that grazing was an important influence. Although there was little difference in use of grazed and ungrazed meadows when surveys were initiated, sage grouse per hectare values were much higher for grazed meadows as a group by mid-August. Additionally, sage grouse per hectare values were also higher for almost all grazed meadows on an individual basis during the latter part of the summer. Only 1 meadow, Hobble Springs, out of 13 study meadows did not fit this pattern. A 2-way ANOVA also showed that grazing explained a highly significant portion of the total variation in meadow use while time (when the meadow was surveyed) did not. The Chi-square analysis indicated

sage grouse appeared to utilize both grazed and ungrazed meadows in proportion to their availability during the first survey but showed a pronounced selection for grazed meadows as the summer progressed. In late July and throughout August use of grazed meadows was much higher than would be expected if no avoidance for those areas was occurring. In contrast, use of ungrazed meadows during that period was much lower than expected if no selection was occurring. Finally, use indices (which includes not only differences in number of grouse on a per hectare basis, but also number of times a meadow supported grouse) were higher for most grazed meadows than for ungrazed meadows. Additionally, when indices for meadow use by hens and juveniles only were considered, all values without exception were higher for the grazed meadows than for the ungrazed meadows.

Although no previous studies have dealt specifically with the effects of cattle grazing on meadows and sage grouse, several authors have alluded to beneficial effects. Neel (1980) suggested that grazing could enhance meadows for grouse by creating patchy openings to allow easier access to succulent forbs, and possibly allow for better forb growth. Klebenow (1982) reported grouse sought areas in the meadow where cover height was less than normal for the meadow. Oakleaf (1971) found that heavy vegetation on ungrazed meadows was not utilized by sage grouse and that feeding birds seemed to prefer the more open meadows. However, a negative relationship between grazing and sage grouse has also been

reported by these and other authors. Neel (1980) believed that grazing could set back vigorous stands of preferred food forbs and that prolonged grazing and repeated cattle congregation rendered meadows less suitable for sage grouse use. Oakleaf (1971) warned that overuse by livestock could result in the deterioration of a meadow and loss of its succulent forbs. Similarly, Savage (1968) recommended protection of meadows from abuse for the benefit of sage grouse.

Use of Areas Within Meadows

Several factors were found to influence sage grouse use of areas within meadows in 1982. Selection for areas within meadows where dandelion was rated as common or abundant was statistically significant, as was avoidance of dense cover. Oakleaf (1971) and Neel (1980) reported grouse were attracted to meadow areas supporting succulent forbs and preferred food species, respectively. Common dandelion has been shown to be a highly preferred food item for sage grouse by many authors (Savage 1968, Klebenow and Gray 1968, Peterson 1969, Oakleaf 1971). Additionally Oakleaf (1971) and Klebenow (1982) agreed that sage grouse tended to avoid meadow areas of tall, dense vegetation.

Although not tested statistically, presence of water and cattle may affect the distribution of grouse on meadows. Usually, when water became unavailable on any part of a meadow, use of the area by grouse decreased. Savage (1968) and Oakleaf (1971) both reported similar results. Sage

grouse reaction to the presence of cattle was difficult to define, but in general, birds appeared to avoid close contact.

Relationship of Food Forb Abundance and Phenology to Meadow Use

Of the 3 main food forbs, only the abundance of common dandelion was significantly positively correlated with sage grouse per hectare during the first and second surveys. Especially during the first survey when the relationship was highly significant, sage grouse appeared to select for meadows with high dandelion abundance indices (2.70 or greater). In comparison, meadows which supported less use by sage grouse early in the summer had abundance indices ranging from 1.32 to 2.29.

While phenology of the 3 food forbs and sage grouse per hectare were not correlated during the first 2 meadow surveys, the relationship was highly significant by mid-August. At that time, sage grouse appeared to be attracted to meadows supporting high phenology indices for yarrow, dandelion, and western aster.

The succulence of dandelion may have been more important than the succulence of yarrow and western aster during the mid-August survey. Although the multiple correlation coefficient was significant for phenology of the 3 food forbs and sage grouse per hectare during the third survey, the intercorrelation of the independent variables made it impossible

to tell whether or not sage grouse were responding to 1 or all of tha forbs. However, of the 3, dandelion had the highest simple correlation coefficient for phenology and sage grouse per hectare.

The fact that sage grouse appeared to be influenced first by food forb abundance and then by phenology probably relates to changes in climatic conditions and plant development. The spring and early summer of 1982 were unusually cold and wet, and plant growth was initiated much later than normal. When the birds were first observed on meadows in early to mid-July, growing forbs were widely available and sage grouse would not have to select for areas supporting succulent vegetation. However, late July and all of August were characterized by very little precipitation and high temperatures, and succulent vegetation was becoming increasingly difficult to find. By mid-August when sage grouse use of meadows was at its peak in 1982 and the difference in use of grazed and ungrazed meadows was greatest, forbs on most grazed meadows were largely desiccated. Sage grouse may then have had to select for meadows on the basis of succulence. No correlation between phenology and meadow use could be demonstrated in late August but by then even forbs on grazed meadows were becoming weathered. Additionally, sage grouse use of meadows was decreasing as birds shifted from summer to fall habitat.

Effects of Grazing on Forbs

Although sample size was insufficient to evaluate the effects of seasonal cattle grazing on forb abundance, even very moderate levels of grazing appeared to affect forb phenology. Normal processes of maturation were interrupted when plants were grazed, and many forbs on grazed meadows continued to support new growing leaves throughout the summer. In comparison, on ungrazed meadows, forbs became mature and weathered soon after seed set and seed dispersal.

For the 3 food forbs, yarrow, western aster, and common dandelion, phenology indices on grazed meadows were consistently higher and declined at a slower rate than indices on ungrazed meadows. Even when a meadow was used only lightly, these 3 species usually showed some evidence of having been grazed and responded by producing new leaf tissue.

Additionally, percentages of weathered forbs of all species found on most ungrazed meadows were considerably higher than for most grazed meadows throughout the summer. Two meadows, Bald Mountain Creek-Refuge and Bald Mountain Creek-Range, showed exceptions to this pattern. Possibly important was the presence of sand bars in the Refuge creek channel and the lack of soil moisture in the Range creek channel. Silt and sand washed down from the upper reaches of the drainage had accumulated in the thick baltic rush clogged channel on the Refuge side of the fence. Many species of forbs were found growing and establishing on the sand bars throughout the summer, and the result was an increase in the overall succulence rating for the meadow. Although important

sage grouse food forbs were present and grazed on the Bald Mountain Creek-Range meadow, regrowth was limited by an absence of soil moisture. Deep cut channels had left a lowered water tables and many forbs were desiccated by mid-August. Interestingly, Bald Mountain Creek-Range supported some of the highest use by sage grouse of any of the study meadows. Although many forbs became desiccated on the area by August, it was the only meadow where dandelion received an abundance rating of 4, meaning that it occurred in dense stands to the exclusion of other species. Thus it appears sage grouse will continue to use a meadow in spite of its condition as long as food sources remain available.

Cattle grazing on meadows appeared to be effective in stimulating regrowth of forbs as long as it occurred prior to the cessation of plant growth. The excellent regrowth response of forbs observed at West Rock Springs Exclosure resulted when most of the forbs on the meadow were still in the early leaf stage when grazed. Regrowth of forbs also occurred at South Catnip Creek although the forbs were grazed later in the growing season. Still, few had progressed beyond the bloom stage at the time grazing was initiated. Common dandelion presented somewhat of an exception to this pattern since it tended to remain green and growing long after seed cast. Where it grew in moist areas, it would respond to grazing by production of new leaves throughout most of the summer.

The severe treatment applied to West Rock Springs

Exclosure showed a dramatic increase in the availability of succulent leaves as a result of grazing. The percentage of succulent leaves present for grazed plants was over 90 for all 3 of the food forb species. In comparison, percent succulent leaves of ungrazed yarrow, dandelion, and western aster ranged from about only 4 to 24 percent. Although not measured, the response by many other grazed herbaceous species at West Rock Springs was equally impressive.

The rapid recovery of plants to the extremely heavy use that occurred at West Rock Springs Exclosure was probably due to a combination of factors. The meadow was in good condition initially as it had not been grazed in many years and an abundance of thick herbaceous cover was present. Also, early summer precipitation, coupled with the moisture naturally present in the meadow, allowed for a rapid growing response by the plants once grazing pressure was removed.

Moderate levels of grazing also appeared to be effective in stimulating regrowth of forbs on meadows. Regrowth of the 3 food forbs and cinquefoil was evident at South Catnip Creek although grazing pressure was not sufficient to cause a significant change in the percent cover of litter, grasses, and grass-likes. Percent of succulent leaves for grazed plants at Catnip ranged between 42 and 58 percent in comparison to the percentages of 10 to 14 percent recorded for ungrazed plants.

Besides the severity of the grazing treatments, there are other factors to consider when comparing plant responses

between South Catnip Creek and West Rock Springs Exclosures. South Catnip was grazed later in the growing season and it represented a drier type of meadow than West Rock Springs. Under these circumstances, response can be expected to be less dramatic.

The grazing treatment applied to West Rock Springs Exclosure showed that grazing affected protein and fiber levels in forbs as well as the presence of succulent leaves. Grazed food forbs were higher in crude protein and lower in crude fiber when compared to ungrazed food forbs in July and August. While the attraction of sage grouse to succulent vegetation has already been described, Oakleaf (1971) reported that protein appeared to be a key nutrient obtained by sage grouse from meadow vegetation.

Response by forbs to the effects of long-term grazing were shown by comparisons between meadows with different grazing histories and by exclosure comparisons at Bateman Springs, Hell Creek Sheep Pen, Bald Mountain Creek-Refuge and Range, and Hobble Springs. Although generalizations are difficult to make because of differences in meadows, distribution of some species appeared to be tied to grazing. "Weedy species" such as primrose, stickseed, knotweed, blue-eyed Mary, slender false phlox, and members of the Brassicaceae family were typically more abundant on meadows with histories of heavy use and on areas having the appearance of being deteriorated. Some species of clover also seemed to increase with grazing. Sierra clover occurred in

dense stands at Hell Creek, and percent cover of another species of clover was significantly greater outside the Hobble Springs exclosure than inside. In general, however, a greater variety of forbs seemed to occur on meadows with histories of moderate use or protection.

Of the 3 main food forbs, common dandelion was most notably affected by grazing. Percent cover was much greater in grazed areas outside exclosures on all areas studied except Bateman. There, dandelion was in the process of becoming re-established as the meadow recovered from years of past abuse. The pattern of response to past grazing for the other 2 food forbs was less clear. In 2 of the exclosure comparisons, percent cover of yarrow was significantly greater in the protected area. The difference in percent cover of yarrow inside and outside the sheep pen at Hell Creek was not significant and the forb did not occur in the areas where transects were established at Bateman. In the 3 exclosure comparisons where western aster occurred, percent cover of the forb was greater in the exclosure at Bateman, greater outside the protected area at Hell Creek, and not significantly different inside and outside the Hobble Springs Exclosure. However, both yarrow and western aster were abundant more often on meadows with histories of protection or moderate use than on meadows with histories of heavy use.

CONCLUSIONS AND RECOMMENDATIONS

1. Common dandelion, western aster, and yarrow repre-

sent important food forb species utilized by juvenile sage grouse.

The importance of these species has been well documented in the literature and were shown to be important in both years of this study. Because these forbs are common and because they are selected for, they provide a good basis for evaluating the effects of changes in the plant food resource in relation to sage grouse use of meadow habitat.

2. Meadows receive more use, proportionally, by hens and juveniles as a group than by adult males.

Hens and juveniles used meadows to a greater degree and with more consistency than groups of adult males. Although the relationship between cattle grazing on meadows and sage grouse use of meadows probably holds true for all sex and age classes, the effects of grazing are probably more significant to hens with broods, presumably because of the greater nutritional requirements of developing juveniles.

3. Sage grouse use of meadow habitat should be evaluated over time since many factors which influence meadow use change over the summer.

Sage grouse were found to respond initially to abundance of common dandelion, then to food forb phenology as the summer progressed. Changes in climatic conditions and the availability of succulent forage were believed to be major factors. By conducting counts at 2 week intervals throughout the period of meadow use, relationships between the food plant resource and sage grouse became apparent which would

have otherwise gone undetected with a single survey.

4. Sage grouse are attracted to meadows grazed by cattle.

Grazing by cattle prior to the cessation of plant growth on mountain meadows increases the quality of the food forb resource for sage grouse. Grazing increases succulence of forbs by interrupting and delaying maturation. New leaf tissue is higher in crude protein and lower in crude fiber than mature tissue. Sage grouse appeared to seek sources of succulent forbs by selecting for meadows grazed by cattle.

5. Long-term effects of grazing on the quantity of the food forb resource for sage grouse are difficult to measure and should be evaluated in future studies.

With the exception of common dandelion and a few "weedy" species, no firm conclusions could be drawn about how long-term grazing has affected the quantity of the food forb resource for sage grouse. Limited data suggests a few species may have increased on meadows with histories of moderate to heavy grazing at the expense of forb species diversity.

The role of common dandelion in terms of its importance to sage grouse and in terms of its role in meadow ecosystems deserves further study. Its use as a key food species by sage grouse has been documented in numerous studies and it seemed to be the single most important factor in explaining sage grouse use of meadows and areas within meadows in 1982. The distribution of dandelion is closely tied to grazing, it

increases with grazing and is noticeably less abundant in communities protected for long periods such as West Rock Springs Exclosure. Perhaps most significant is that common dandelion is an exotic and not native to sage grouse habitat. Under pristine conditions, it would be interesting to consider what first occupied the prominent place that dandelion now holds in sage grouse diets and mountain meadow ecosystems. A study on the ecology of this unique forb might yield important insights into how the environment for sage grouse has changed and how sage grouse have responded to those changes.

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APPENDIX I

Strutting Ground Counts

Table 1. Sage grouse strutting ground counts made on the Sheldon National Wildlife Refuge and Range in 1981 and 1982.

Strutting ground	No. males	No. females	Total	Date	Time	Location (UTM[a])
1981						
Gooch Lake	74	21	96	3-24	0600	03149,46349
Bald Mountain Lake	86[b]	--	--	4-10	0600	02863,46383
Catnip Table	69	0	69	5-01	0530	02964,46383
Mule Mountain West	22	11	33	3-28	0630	02892,46360
Swan Lake	22	3	25	4-06	0630	02909,46382
1982						
Bald Mountain Lake	60[b]	--	--	4-24	0600	02863,46383
Mule Mountain West	0	0	0	4-25	0630	02892,46360

[a]Universal Transverse Mercator System.
[b]Minimum number of males present. Birds flushed before it could be determined whether or not there were additional males or females on the ground.

APPENDIX II

Late Spring-Early Summer Observations

1981

Other than on strutting grounds, concentrations of sage grouse were first seen along the north and northeast facing foothills of Bald Mountain. Beginning in early April, from 1 to 4 hens were consistently seen between 0430 and 0530 along the road in big sagebrush/bitterbrush (Pursha tridentata) habitat about 1 1/2 km south of the Bald Mountain Lake lek. By late May and early June, large groups of males were commonly seen along the ridges south and west of the Bald Mountain Lake lek and north of the Catnip Table lek. As many as 60 males at one time were observed in the rimrock ridges west of Bald Mountain Lake in early June. Between 4 June and 20 June, separate groups of male and female sage grouse ranging in size from 4 to 20 birds were flushed or observed almost daily by vehicle or horseback along the Bald Mountain foothills.

The first brood was seen on 15 June and included a hen with 2 small chicks. From 23 June on, broods were observed almost daily, mostly near water, roadsides, and meadow vegetation in the Bald Mountain Area. Other areas on the Sheldon undoubtably supported broods, but in 1981, field work was concentrated in the vicinity of Bald Mountain. Many broods

were observed along the intermittent creek (fire lookout road) which drains from the north side of Bald Mountain towards Bald Mountain Lake. As long as water was present in the creek channel, until about 20 July in 1981, hens with broods could be flushed along the creek. Average brood size varied among age classes, but averaged 3.3 for broods observed in the Bald Mountain area.

Meadow Surveys

Sage grouse were seen regularly using meadows by 3 July in 1981. The birds probably first began to use meadows 1 to 2 weeks earlier as a group of males was flushed from the perimeter of a meadow on 20 June and crop collections containing meadow forbs were made on 29 June. A total of 358 observations of sage grouse were made on portions of 7 Refuge meadows and 12 Range meadows between 14 July and 18 August (Table 1). Detailed observations of 2 additional Refuge meadows, Upper and Lower Last Chance, were also made on a daily basis but will be discussed later. The figures in Table 1 show only the number of sage grouse observed at 1 point in time at a particular location. Survey results between meadows are not comparable since no adjustments were made for amount of area covered and different meadows were surveyed at different times of the day. Also, additional observations of grouse were made on some of these meadows, but are not shown in Table 1.

Almost 42 percent of 358 meadow observations were juve-

Table 1. Number of juvenile, adult female, adult male, and unclassified sage grouse observed on meadow surveys in 1981.

Meadow	Date of survey	No. sage grouse observed				
		Juveniles	Adult females	Adult males	Unclassified	Total
Dump[a]*	7/14	0	1	0	0	1
	7/15	5	5	0	3	13
Bateman	7/16	3	0	33	0	39
	7/28	0	0	8	0	8
Hell Creek	7/16	7	2	0	0	9
	7/16	22	1	0	0	23
West Rock Springs unfenced[b]	7/17	3	0	3	0	6
	7/28	2	6	0	0	8
West Rock Springs fenced[c]	7/28	0	0	0	0	0
Fire Lookout Road[d]*	7/20	0	15	0	0	15
	7/23	7	2	0	0	9
Lower Last Chance Hay Meadow	7/21	0	0	0	0	0
Hobble Springs*	7/22	9	3	0	0	12
	8/5	0	0	0	0	0
Mule Springs*	7/23	3	1	0	0	4
	8/2	0	0	0	0	0
	8/20	0	0	0	0	0
Miller and Lux*	7/27	0	0	2	0	2
	8/10	0	0	0	0	0
	8/12	0	0	0	0	0
Butler Crossing Inside Catnip Fence	7/27	0	0	0	0	0
Butler Crossing Outside Catnip Fence	7/27	9	2	0	0	11
North Catnip Creek	7/28	12	2	12	0	26
	8/4	6	7	22	6	41
Gooch Camp Spring	7/28	3	1	0	0	4
South Catnip Creek	8/10	13	9	11	0	33
	8/11	0	1	0	0	1
	8/24	0	0	0	0	0
Little Catnip Springs	8/3	0	0	0	0	0
	8/4	0	0	20	0	20
	8/10	3	0	3	0	6
	8/11	0	0	0	0	0
Bald Mountain Creek-Refuge*	8/5	9	2	0	0	11
	8/13	10	0	17	0	27
	8/18	3	0	0	0	3
Bald Mountain Creek-Range	8/5	0	0	0	0	0
	8/13	15	3	0	0	18
	8/18	6	1	0	2	9

[a]Small unnamed drainage north of the dump at the old Refuge Headquarters.
[b]Meadow area below the old ranch house at West Rock Springs.
[c]Fenced spring source at the old ranch house at West Rock Springs.
[d]Meadow area along the intermittent creek drainage on the north side of Bald Mountain.
*Refuge meadows.

niles, over 36 percent were adult males, 18.7 percent were adult females, and 3 percent could not be classified. Adult males were typically flushed in large groups, and often from the same area a week later. Meadows which were found to support concentrations of males included: Bateman, North Catnip Creek, Little Catnip Springs, and Bald Mountain Creek-Refuge. Males were also observed to arrive at meadows earlier in the morning than the hens and juveniles, and spend less time foraging. Although only individual hens with their broods were first observed on meadows, by late July hens and juveniles were often present in groups.

Water appeared to be the single most important factor in determining use of different meadows and use of areas within meadows. The year of 1981 was truly a drought throughout Nevada and on the Sheldon many springs and seeps which normally supported water were dry by early summer. Forbs became desiccated on drying meadows, and succulent vegetation was limited to a very few, widely scattered sources of water.

Sage grouse responded to the loss or availability of water on meadows. In early July when water was available in the creek channel, sage grouse were consistently flushed along the fire lookout road on Bald Mountain. By 22 July, the only water present was a small amount of seepage around a trough in the upper end of the drainage. A few sage grouse were flushed near this area during the last week of July, but by August, one of the best areas for sage grouse on Bald

Mountain no longer supported birds. The meadow areas below the old Headquarter's dump and below the old ranch house at West Rock Springs were used by grouse only during the first half of July as no water was available on either area. The Lower Last Chance hay meadow, which was not known to be used by grouse at all in 1981, was completely dry by June. Sage grouse were flushed only once from Miller and Lux and Mule Springs meadows which were dry by early July. These areas did support cattle troughs, but in a situation which occurred throughout the Refuge and Range in 1981, thirsty cattle kept the water level so low, no overflow was available for grouse. On meadows where water was present only in limited amounts, including the Bald Mountain Creek meadows and Bateman Springs, sage grouse observations were confined to the area immediately surrounding the water source.

The relationship between the presence of cattle on meadows and sage grouse use of meadows was difficult to define. Meadow areas important to sage grouse were also important to cattle. Many of the meadows surveyed in 1981 contained significant concentrations of cattle as the dry conditions forced them to congregate in areas of limited water and succulent vegetations which were also key areas for grouse. Sometimes sage grouse were observed feeding right in the same areas where cattle concentrated. This happened at Hell Creek, where 22 juveniles were observed feeding on grazing induced regrowth within a few meters of cattle. Other times, grouse appeared to avoid cattle if given the opportunity to

select a protected area. At Little Catnip Springs, no sage grouse were flushed from the creek channel when cattle were concentrated there, but rather, birds were flushed just below in the fenced portion of Catnip Meadow. When the cattle were up on the hillside away from the creek bottom at Little Catnip Springs, sage grouse were sometimes flushed from the creek channel. Where cattle were present on Miller and Lux Meadow and in the meadow area below Mule Springs, no sage grouse were observed. No water was available for grouse, however, in either of these 2 areas.

Upper and Lower Last Chance Meadows

Additional insights into the effects of water, grazing, and the presence of cattle were gained through late summer observations of sage grouse on the Upper and Lower Last Chance meadows. Water was available on both meadows (just below the old ranch house, but not in the lower hay meadow at Lower Last Chance) in mid-July when large groups of sage grouse were using the protected upper meadow. The lower meadow (the boundary between the 2 was a fence) was being used heavily by cattle as it was almost the sole source of water and succulent vegetation in the 2777 ha Racetrack allotment. From about 7 July until about 22 July, large numbers of sage grouse were consistently flushed from the upper meadow. On one occasion, as many as 85 grouse were flushed in meadow vegeation surrounding the only source of water on the meadow. No birds were ever observed where

cattle were present in the lower meadow, although more water was available there than in the upper meadow.

Cattle were removed from the Racetrack allotment during the second week of July. Although use of the meadow had been heavy, the moisture naturally present in the meadow allowed for rapid greenup. By the end of July, sage grouse appeared to shift from the upper meadow to the lower meadow in the span of a few days. By 27 July, large numbers of grouse were observed feeding and watering at the lower meadow, while very few grouse were observed on the upper meadow. Water was still available in Upper Last Chance, although only a small amount remained in a single waterhole.

The availability of more water at Lower Last Chance and the absence of cattle may have attracted the grouse to Lower Last Chance, but the regrowth of grazed vegetation seemed particularly important. Hens and juveniles were frequently seen foraging in heavily grazed areas for significant periods of time. Often a hen with her brood or a small group of sage grouse would fly down from the surrounding foothills and land in the ungrazed area of Upper Last Chance. From there the birds would walk through the tall dry vegetation, cross under the fence to the lower meadow, and remain to feed for as long as 40 minutes or more in the grazed area. A close look at the ground revealed that tiny new leaves of western aster, yarrow, and common dandelion were coming up everywhere. Also, several crops of juveniles observed feeding in this area were full of new succulent leaves of these 3 species.

1982

While sage grouse were observed daily along the Bald Mountain foothills in May and June of 1981, almost none were found in the same area in 1982. Both the foothills and the higher elevations of Bald Mountain, along with surrounding low sage flats and table rims were searched intensively on horseback. Very few sage grouse were seen until the latter part of June. A few males were occasionally observed in the foothills around the Last Chance Ranch, but the first brood of 2 chicks was not seen until 25 June. Not until the first part of July could sage grouse be seen with any frequency.

The drought of 1981 ended with a wetter than normal winter in 1982. Springs which were dry in 1981 were flowing vigorously in May and June, and meadows were wet with standing water. Although May precipitation was near normal, heavy rains occurred almost daily throughout June and into the first 2 weeks of July. Total June precipitation recorded at Dufferena was 2.67 cm above normal. Observations of sage grouse seemed to be inversely related to moisture conditions. As rains became less frequent and temperatures rose, sage grouse were seen with increasing regularity. The first observation of sage grouse on meadows occurred on 1 July, but birds did not regularly use meadows for another 10 days.

APPENDIX III

Stratification of Study Meadows into Types

Type descriptions for study meadows, including some of the more important characteristics of each type are described in the first section, while type delineations as mapped from aerial photographs are shown in the second section.

Type Descriptions

Bateman

Bateman meadow was divided into 3 types. Type 1 was located just below the spring source and represented a narrow zone of riparian vegetation bordered by tall sagebrush. Type 2 included a mosaic of sedges and baltic rush interspersed with a variety of grasses and forbs. Soil alkalinity in type 3 appeared to limit the vigor and distribution of herbaceous vegetation, and the area was characterized by pockets of baltic rush, grasses and forbs in between large patches of bareground. Water was generally available summer-long in all 3 types, although the creek channel in type 3 was periodically dry and flowing in the latter part of August.

The 3 types varied in size, degree of cover, abundance and distribution of herbaceous cover, and use by sage grouse (Table 1). A cover rating of 9.0 in type 1 was due to surrounding sagebrush concealing models in the narrow meadow area, while the rating of 10.5 in type 2 was largely the result of herbaceous, rather than shrubby, vegetation concealing the models (Fig. 1). Type 2 was the major meadow type used by sage grouse.

Hell Creek

Three separate meadow types were identified at Hell Creek. The types were similar in composition of herbaceous vegetation but differed primarily in width of the riparian

Table 1. Size, cover and food forb abundance ratings, and number of sage grouse flushes recorded for the Bateman meadow types.

Type	Size (ha)	Cover rating	Abundance rating			No. sage grouse flushes
			Yarrow	Western aster	Common dandelion	
1	0.12	9.0	2	2	3	1
2	2.27	10.5	2	3	3	6
3	5.75	25.5	1	1	2	3

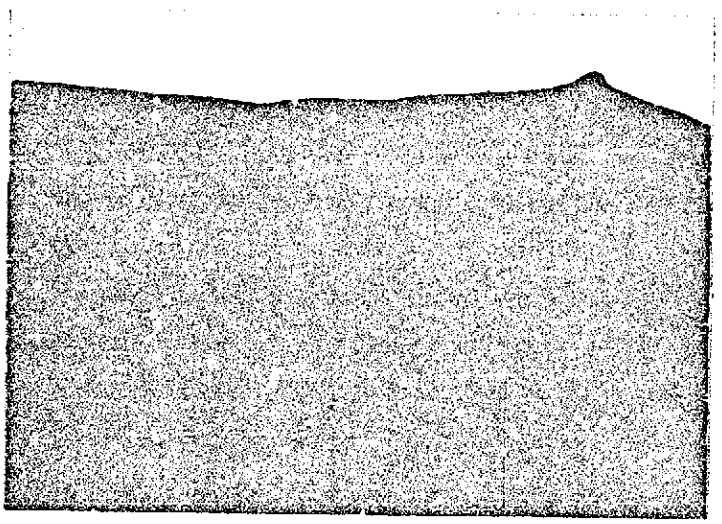


Fig. 1. Fencing in 1977 appears to have allowed for good recovery of the herbaceous vegetation in type 2 of Bateman meadow. Baltic rush, sedge, grasses and a variety of forbs provide partial concealment for cover models in the photo, 5 are visible and 2 are partially visible from this angle. The cover rating for this type was 10.5.

zone. Type 1, in the lower reaches of the creek, formed the widest and most open part of the meadow. Riparian vegetation in type 2 was confined to a narrow zone bordered by tall sagebrush. The distribution of meadow vegetation in type 3 was even further restricted by cut banks and sagebrush present almost to the banks of the creek. Water, in the form of a perennial creek, was available season-long in all 3 types.

While the 3 types had similar distribution of food forbs, they varied in terms of size, degree of cover, and use by sage grouse (Table 2). The width of the riparian zone in types 2 and 3 limited the size of these types, although they were similar in length to type 3. Tall sagebrush borders were effective in concealing models in the limited meadow area of types 2 and 3 which received cover ratings of only 7.5 and 2.5, respectively. Although scattered sagebrush and wild iris provided cover for the models near the center of type 1, fairly heavy grazing resulted in a cover rating of 23.0 (Fig. 2) in mid-August. Initially, the type received a cover rating of 16.0 in early July, but as grazing pressure increased, cover decreased. The rating of 23.0 represents conditions on type 1 when sage grouse use of meadows, in general, was at its peak. All 3 food forbs were common on all types with the exception of western aster, which was rated as occasional in type 3. Sage grouse were flushed 3 times from types 2 and 3, but only once from type 1, although numerous droppings were present along its sagebrush/meadow edge. Additionally, 22 juvenile sage grouse were observed

Table 2. Size, cover, and food forb abundance ratings, and number of sage grouse flushes recorded for the Hell Creek meadow types.

			Abundance rating			
Type	Size (ha)	Cover rating	Yarrow	Western aster	Common dandelion	No. sage grouse flushes
1	2.10	23.0	3	3	3	1
2	0.40	7.5	3	3	3	3
3	0.20	2.5	3	2	3	3

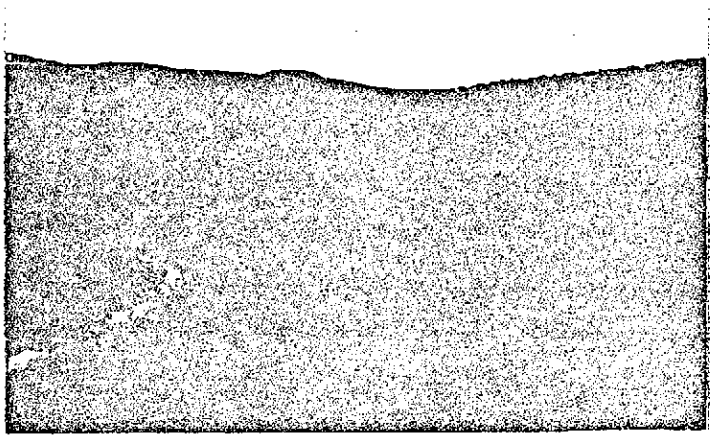


Fig. 2. Grazing pressure in type 1 on Hell Creek increased as the summer progressed. By mid-August, only sagebrush and wild iris, rather than grasses and forbs, were providing cover for the models. The cover rating for this type was 23.0.

feeding together on the same occasion in the type 1 area in 1981.

Badger Shearing Pen

The Badger Shearing Pen meadow was divided into 3 types. While types 1 and 2 included a narrow zone of meadow vegetation around the creek channel, type 3 represented a mosaic of sagebrush, grasses, and forbs. Type 2 differed from type 1 primarily in the distribution of Valerian (Valeriana edulis), which was common in the small mesic area of type 2, but rare elsewhere in the meadow. Water was available season-long in Badger Creek which was close to or adjacent to all 3 meadow types.

The types differed in both physical and vegetative characteristics and in use by sage grouse (Table 3). Sagebrush and herbaceous vegetation provided cover for the models in all 3 types, but the thick brush characterizing type 3 resul-

Table 3. Size, cover and food forb abundance ratings, and number of sage grouse flushes recorded for the Badger Shearing Pen meadow types.

			Abundance rating			
Type	Size (ha)	Cover rating	Yarrow	Western aster	Common dandelion	No. sage grouse flushes
1	0.45	9.5	2	2	3	3
2	0.12	14.0	2	1	1	0
3	6.48	5.0	0	1	2	1

ted in a cover rating for that type of only 5.0. At least 2 of the 3 sage grouse food forbs occurred in all 3 types, while type 1 supported the highest ratings for the 3 forbs. Sage grouse were flushed 3 times from type 1 and once from type 3. No birds were ever observed in the small area representing type 2.

Badger Creek

Badger Creek was stratified into 3 separate meadow types. Types 1 and 2 represented a narrow band of riparian vegetation along the creek channel, while type 3 supported tall dense sagebrush. Type 2 appeared to be the small remnant of a once larger area of meadow vegetation. Although this type still supported meadow species, numerous young rubber rabbitbrush (Chysothamnus nauseosus), plants were present along the meadow/brush edge. Small, wet channels supporting baltic rush and forbs were interspersed throughout decadent and dying sagebrush in type 3, distinguishing the area from the monotypic big sagebrush community characterizing most of Badger Flat. Water was available summer-long along most of Badger Creek, with the exception of the lower end near type 2 which began to dry up in late August.

The 3 types varied in size, cover, forb abundance, and use by sage grouse (Table 4). Dense sagebrush in type 3 and sagebrush along the edges of type 1 concealed many of the cover models and reduced the cover ratings for the 2 types. Type 2, with a cover rating of 38.0, was almost entirely

open. Of the main sage grouse food forbs, only common dandelion was present in all 3 meadow types. Sage grouse were flushed most often from type 1, although on 3 occasions, birds were flushed from type 3.

Table 4. Size, cover, and food forb abundance ratings, and number of sage grouse flushes recorded for the Badger Creek meadow types.

			Abundance rating			
Type	Size (ha)	Cover rating	Yarrow	Western aster	Common dandelion	No. sage grouse flushes
1	1.25	18.0	0	1	3	9
2	0.17	38.0	0	0	2	0
3	0.81	6.5	1	1	3	3

West Rock Springs Exclosure

The small West Rock Springs Exclosure meadow was stratified into 2 types, including the lower wet end, and the remaining drier, upland portion. Water was available in the form of a springhead for the duration of the summer in type 1, although no water was present in type 2.

Size, and ratings for cover and abundance of food forbs were similar for the 2 types, but sage grouse were flushed only from type 1 (Table 5), The heavy grazing the meadow had received in June resulted in almost no concealment of cover models, although regrowth in the wetter type 1 provided some cover by mid-August, when measurements were made. Yarrow and

western aster were common throughout the meadow, but common dandelion occurred only occasionally in type 1 and was rare in type 2.

Table 5. Size, cover and food forb abundance ratings, and number of sage grouse flushes recorded for the West Rock Springs Exclosure meadow types.

			Abundance rating			
Type	Size (ha)	Cover rating	Yarrow	Western aster	Common dandelion	No. sage grouse flushes
1	0.28	30.0	3	3	2	4
2	0.46	38.0	3	3	1	0

North Catnip Creek

Three separate meadow types were identified at North Catnip Creek. Type 1 represented the grass/grass-like/forb zone along the creek channel, while type 2 included a more monotypic baltic rush type around the spring source. Baltic rush interspersed with Nevada bluegrass (Poa nevadensis) and mat muley characterized the drier type 3. Water was available summer-long in the form of a perennial creek below the spring source.

Differences in size, cover, and food forb abundance ratings, and use by sage grouse are shown in Table 6. Tall, dense herbaceous vegetation provided almost complete concealment for the models in type 1 (Fig. 3). The models were more visible in types 2 and 3 where the composition and height of

Table 6. Size, cover, and food forb abundance ratings, and number of sage grouse flushes recorded for the North Catnip Creek meadow types.

Type	Size (ha)	Cover rating	Abundance rating			No. sage grouse flushes
			Yarrow	Western aster	Common dandelion	
1	0.69	3.5	2	3	2	5
2	1.50	13.5	2	2	2	10
3	4.65	13.0	3	2	1	2

Fig. 3. Tall dense herbaceous vegetation in type 1 of North Catnip Creek meadow resulted in a cover rating of 3.5. Of 10 models present in area shown in the photo, 1 is visible and 1 is partly visible.

herbaceous cover were limited by drier soils. While the 3 food forbs occurred in all 3 types, western aster and common dandelion were more common in the wetter areas and yarrow was more common in the drier upland edges of the meadow. Sage grouse were flushed most often from type 2, although birds were flushed on 5 occasions from type 1 and 2 times from type 3.

Little Catnip Springs

The Little Catnip Springs meadow was stratified into 2 types. Type 1 represented a narrow band of riparian vegetation bordering the creek in the lower portion of the meadow. Type 2 included a similar, but wider, zone of riparian vegetation below the spring source. Succulent vegetation in both types was confined to the moist banks around the creek, while the drier outer edges were surrounded by big and low sagebrush. Catnip Creek flowed through both types thoughout the summer.

Distribution of food forbs was the same in both types, but the 2 areas differed in terms of size, degree of cover, and use by sage grouse (Table 7). Herbaceous vegetation in either type was not sufficient to provide cover for the models, however, the surrounding sagebrush obscured almost all the models in type 1, and some of the models in type 2. Sage grouse were flushed most often from type 1.

South Catnip Creek

Table 7. Size, cover, and food forb abundance ratings, and number of sage grouse flushes recorded for the Little Catnip Springs meadow types.

Type	Size (ha)	Cover rating	Abundance rating			No. sage grouse flushes
			Yarrow	Western aster	Common dandelion	
1	0.28	2.0	2	2	2	7
2	1.86	18.0	2	2	2	3

Six separate types were defined in the large South Catnip Creek meadow. Type 1 included a narrow area of riparian vegetation bordered by big sagebrush. Type 2 represented the largest part of the meadow and included 2 broad areas of meadow vegetation connected by the narrow small type 3. Type 4 represented a drier portion of the meadow and included a mixture of grasses, grass-likes, and forbs, which were interspersed with big sagebrush. Types 5 and 6 were both open grassy areas similar to type 2, but they supported fewer forbs than type 2 and were considerably drier. Type 5 represented the only portion of the South Catnip Creek meadow which contained no water, and much of the herbaceous vegetation in this area had become desiccated by late July. Water was available summer-long as a perennial creek or spring source in all other parts of the meadow.

The 6 types at South Catnip Creek included a wide range in size, degree of cover, food forb abundance ratings, and use by sage grouse (Table 8). Grazing on the meadow in late

June and early July resulted in cover ratings of 33.5 or more in types 2, 5, and 6. Although grazing was fairly heavy in type 4, scattered brush provided some concealment for the cover models. Cover ratings were lowest for types 1 and 3 where sagebrush borders obscured cover models from view in the narrow zone of meadow area. The 3 main forbs were rated as occasional or common throughout most of the meadow. Only in types 1 and 5 were any of these forbs absent or rare. Type 2, by far, supported the greatest majority of sage grouse flushes, although sage grouse were flushed 3 and 4 times from types 1 and 4, respectively.

Table 8. Size, cover, and food forb abundance ratings, and number of sage grouse flushes, recorded for the South Catnip Creek meadow types.

			Abundance rating			
Type	Size (ha)	Cover rating	Yarrow	Western aster	Common dandelion	No. sage grouse flushes
1	0.36	18.0	1	2	2	3
2	5.18	33.5	3	3	3	15
3	0.04	7.0	2	2	2	0
4	0.69	21.0	3	3	3	4
5	0.61	35.0	1	0	1	0
6	0.61	35.0	3	2	2	0

Bald Mountain Creek-Range

The portion of the Bald Mountain Creek meadow located on

the former Range was stratified into 5 different types. Type 1 represented a small mesic area supporting a mixture of baltic rush, bluegrass, and forbs. Type 2 included the limited amount of meadow vegetation present in a stream channel which was cut 1/2 m to 1 m deep. Type 3 was characterized by a fairly narrow zone of baltic rush and forbs, while type 4 represented a very small, but diverse, area of meadow vegetation interspersed with big sagebrush. Type 5 still supported herbaceous meadow vegetation, but a lack of soil moisture and rapidly invading sagebrush indicated the area was rapidly becoming a meadow remnant. Water was present in small pools throughout the summer in types 2 and 3. While types 1 and 4 were adjacent to types 2 and 3, and therefore close to water; no water was available in or near type 5.

Differences in size, cover, and food forb abundance, and use by sage grouse varied considerably among the 5 types (Table 9). Surrounding brush obscured most of the cover models in the limited meadow area in type 1 which received a cover rating of only 6.0. Although types 2 and 3 were surrounded by tall sagebrush, both represented fairly wide open areas and cover ratings were 27.0 and 26.0, respectively. Type 4 was so limited in size, sagebrush obscured almost all of the cover models. In the open heavily grazed type 5, almost all 10 models were visible from any direction (Fig. 4). Common dandelion was rated as abundant or common in all types except 2, while distribution of the other 2 forbs were

Table 9. Size, cover, and food forb abundance ratings, and number of sage grouse flushes recorded for the Bald Mountain Creek-Range meadow types.

Type	Size (ha)	Cover rating	Abundance rating			No. sage grouse flushes
			Yarrow	Western aster	Common dandelion	
1	0.53	6.0	1	0	4	10
2	0.61	27.0	2	1	1	0
3	0.24	26.0	2	1	3	3
4	0.04	4.0	2	0	3	0
5	1.50	38.0	1	0	3	2

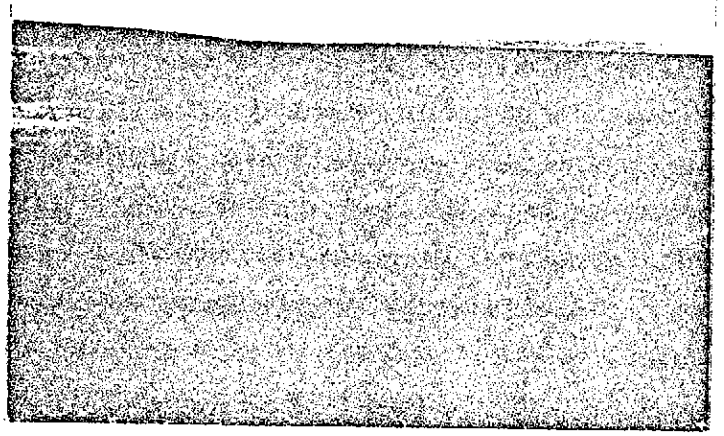


Fig 4. Almost all 10 cover models are visible from 4 directions in type 5 of Bald Mountain Creek-Range. The area received a cover rating of 38.0 out of a possible 40.0. Only an occasional wild iris is effective in concealing models in this open heavily grazed area. Sage grouse were observed feeding in this type on 2 occasions.

much more limited. Yarrow was rated as occasional in types 2, 3, and 4, and rare in types 1 and 5. Western aster was absent from types 1, 4, and 5, and rare in types 2 and 3. The majority of sage grouse flushes were recorded in type 1, although birds were flushed 3 times from type 3 and 2 times from type 5.

Bald Mountain Creek-Refuge

The 2 types identified at Bald Mountain Creek-Refuge included the narrow zone of riparian vegetation bordering the creek and an adjacent small diverse area of meadow vegetation. Type 1 was primarily a wet baltic rush type which included a wide variety of grasses and forbs, while type 2 represented a small mesic area supporting herbaceous vegetation interspersed with shrubs. Free flowing water was available season-long in the Bald Mountain Creek channel.

Although no sage grouse was ever flushed from either type, the 2 areas varied in vegetative and physical characteristics (Table 10). Dense baltic rush, along with a heavy buildup of litter, resulted in complete concealment of the cover models in type 1. Both brush and herbaceous vegetation were effective in covering most of the models in type 2. Common dandelion and yarrow occurred in both types, but were more common in type 2. Western aster was rare in type 1 and absent from type 2.

Hobble Springs

Table 10. Size, cover, and food forb abundance ratings, and number of sage grouse flushes recorded for the Bald Mountain Creek-Refuge meadow types.

			Abundance rating			
Type	Size (ha)	Cover rating	Yarrow	Western aster	Common dandelion	No. sage grouse flushes
1	0.45	0.0	1	1	2	0
2	0.04	6.0	3	0	3	0

Four separate meadow types were described for Hobble Springs. Type 1, which was characterized by Nevada bluegrass, baltic rush, and an abundance of clover, was the wettest part of the meadow. Type 2 included the drier, upland edges and contained the greatest diversity of forbs and grasses. While type 3 represented an alkaline grassy area containing only limited amounts of forbs, type 4 included a small, open area supporting baltic rush and an abundance of the 3 food forbs.

The 4 types varied widely in size, cover, food forb abundance ratings, and in use by sage grouse (Table 11). Tall dense herbaceous vegetation was effective in obscurring most of the models in types 2 and 3, and almost all of the models in type 1. Type 4 was more open than other parts of the meadow, and its rating of 17.0 indicated a moderate number of models were visible. Type 4 also supported the greatest distribution of the 3 food forbs, all of which occurred throughout the meadow. Only western aster was rated

as rare in any of the 4 types. While sage grouse were never flushed from type 3 and only once from type 4, birds were flushed 5 times from type 1 and 7 times from type 2.

Table 11. Size, cover and food forb abundance rating, and number of sage grouse flushes recorded for the Hobble Springs meadow types.

			Abundance rating			
Type	Size (ha)	Cover rating	Yarrow	Western aster	Common dandelion	No. sage grouse flushes
1	1.38	1.0	2	1	3	5
2	1.94	5.0	3	2	2	7
3	2.35	9.0	2	1	2	0
4	0.08	17.5	3	3	3	1

Lower Last Chance

Four meadow types were described for the Lower Last Chance meadow. Type 1 represented a small baltic rush/sedge area which contained standing water until the end of August. Type 2 included both a wet baltic rush/sedge channel and drier surrounding edges, which supported a wide diversity of forbs and grasses. Type 3 was similar to the drier portions of type 2, but was narrower and lacked type 2's wet meadow vegetation. Type 4 included an expansive mosaic of wet and dry areas supporting meadow grasses, grass-likes, and forbs. The area was once a native hay meadow and numerous old irrigation channels were interspearsed throughout the tall plain

of meadow grasses. While standing and free flowing water was available summer-long in types 1 and 2, the creek channel in type 3 became dry near the end of July. Standing water was present in the old irrigation ditches in type 4 only during the first survey period in mid-July.

The 4 types differed in size, cover, food forb abundance ratings, and use by sage grouse (Table 12). While type 4 made up the largest portion of the meadow, tall vigorous herbaceous vegetation in all 4 types was effective in concealing almost all of the cover models (Fig. 5). Much of the taller vegetation consisted of Nevada bluegrass and the cover ratings were all 2.0 or less. Yarrow and western aster were common in all parts of the meadow except in type 1 where both were rated as occasional. Common dandelion was common in type 4, but was rated as occasional in types 2 and 3, and rare in type 1. While most sage grouse flushes were recorded for type 4, use by sage grouse in this area was limited to the first 2 surveys when water was still available. Birds were flushed once from type 3 and 4 times from type 2.

Upper Last Chance

The large diverse Upper Last Chance meadow was divided into 8 separate types. Type 1 represented the drier upland edges of the meadow's south end, and included a wide distribution of grass and forb species. Types 2 and 3 were similar to and adjacent to type 1, but 2 was drier, while type 3 held standing water over part of the summer. Type 4 represented

Table 12. Size, cover, and food forb abundance ratings, and number of sage grouse flushes recorded for the Lower Last Chance meadow types.

Type	Size (ha)	Cover rating	Abundance rating			No. sage grouse flushes
			Yarrow	Western aster	Common dandelion	
1	0.12	1.0	2	2	1	0
2	0.85	2.0	3	3	2	4
3	0.36	1.5	3	3	2	1
4	8.98	0.0	3	3	3	7

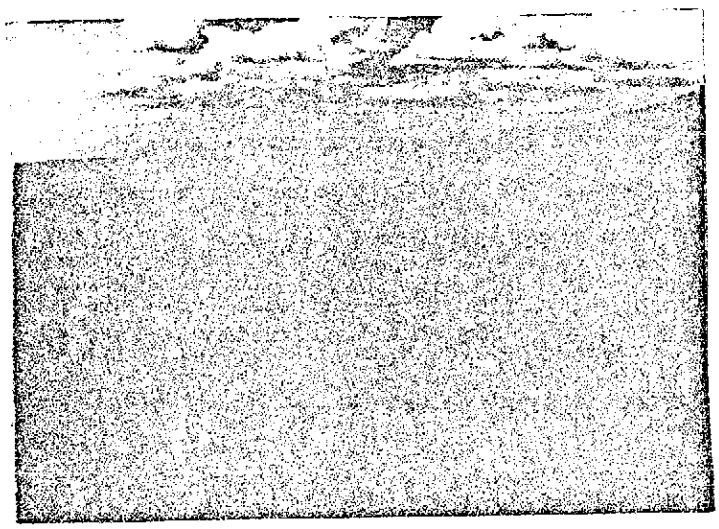


Fig. 5. Tall vigorous herbaceous vegetation, which characterized most of the Lower Last Chance meadow in 1982, was effective in concealing most of the cover models. Of the 10 models visible in this photo of type 2, only 1 is visible, and 2 are partly visible for a cover rating of 2.0.

the wettest portion of the meadow and was characterized by an abundance of clover in a wet baltic rush/sedge channel. The small type 5 included a semi-wet area supporting an abundance of common dandelion while type 6 represented a dry grassy area with few forbs. Type 7 supported a small stand of Great Basin wildrye (Elymus cinereus), while type 8 included a wide diversity of forbs and grasses in addition to scattered clumps of wildrye. Standing water was present for part of the summer in types 1, 2, and 3, while waterholes in types 4 and 8 held water throughout August. Types 5, 6, and 7 were dry, but were in the vicinity of the waterholes.

The types differed in size, cover, food forb abundance ratings, and use by sage grouse (Table 13). Wide differences in type sizes and cover ratings show the amount of variability present in the Upper Last Chance meadow. Tall thick grass in types 1, 2, 3, and 7, and thick forb and baltic rush cover in type 4 resulted in cover ratings for these types of 7.5 or less. The short, thick growth of the grasses in type 5 and the scattered clumpy distribution of both forbs and grasses in type 7, resulted in the same cover reading of 11.0 for these areas. Type 4 represented the most open portion of the meadow with a rating of 20.0. The 3 food forbs occurred throughout the meadow, but were most common in types 1, 2, 5, and 8. Only in types 6 and 7 were any of the 3 food forbs absent. The greatest number of sage grouse flushes were recorded for types 2 and 4, although birds were flushed 3 times from type 8. With the exception of type 7 where no

birds were recorded, sage grouse were flushed once from each of the remaining 4 types.

Table 13. Size, cover, and food forb abundance ratings, and number of sage grouse flushes recorded for the Upper Last Chance meadow types.

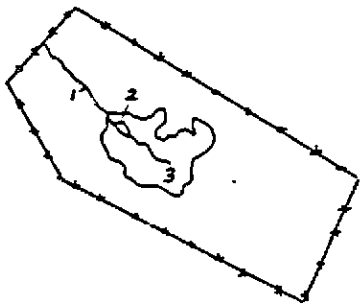
			Abundance rating			
Type	Size (ha)	Cover rating	Yarrow	Western aster	Common dandelion	No. sage grouse flushes
1	4.98	5.5	3	2	3	1
2	3.84	11.0	3	3	2	7
3	0.93	1.5	3	2	1	1
4	5.10	1.5	1	1	2	7
5	0.40	20.0	3	3	4	1
6	3.68	11.0	2	1	0	1
7	0.61	7.5	2	1	0	0
8	1.38	11.0	2	2	3	3

Type Delineations

Scale: one inch on the map ≈ 24,000 on the ground (2.54 cm = 60,960 cm).

Bateman

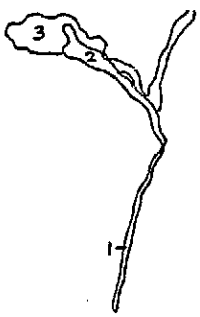
Hell Creek



Badger Shearing Pen

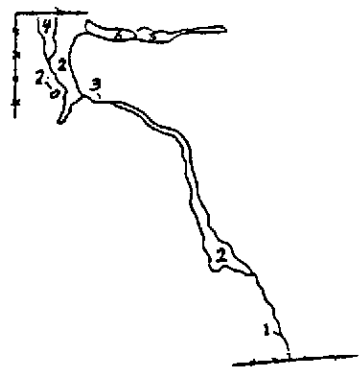
Badger Creek

West Rock Springs Exclosure

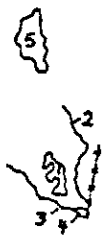


North Catnip Creek

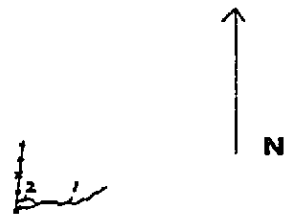
Little Catnip Springs



South Catnip Creek

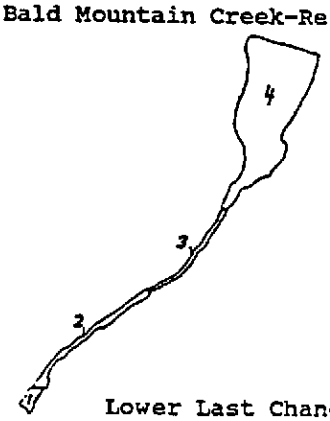


Bald Mountain Creek-Range

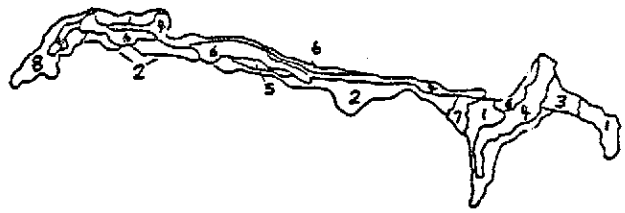


Bald Mountain Creek-Refuge

Hobble Springs



Lower Last Chance



Upper Last Chance

APPENDIX IV

Abundance and Phenology Ratings for Forbs Found on Study Meadows by Type.

The first value represents the abundance rating, while the following 4 values represent phenology ratings for each of the 4 survey periods (Mid-July, late July-early August, Mid-August, Late August). Numbers shown as fractions represent the situation where about half the forbs of a particular species were in 1 phenological stage while the other half were in another at 1 point in time. A number 9 denotes missing data.

Table 1. Forb abundance and phenology ratings by type for Bateman.

	Meadow type		
	1	2	3
*Achillea lanulosa**	2-6433	2-6433	1-6431
*Agoseris glauca**	1-5611 (5)	2-5511	--
Agoseris sp.	1-3211	--	--
*Aster occidentalis**	2-6664	3-6664	1-6411
*Astragalus agrestis**	1-5855	3-5555	--
*Astragalus lentiginosus**	1-5555	--	--
Camissonia tenacetifolia	1-6551	1-6568 (11)	3-3688 (511)
Chamaesaracha nana	2-3111	1-9339	--
Chenopodium sp.	--	--	1-4433
Cirsium sp.	2-3211	1-3211	1-8211
Collinsia parviflora	2-1111	--	--
*Descurainia Sophia**	1-3111	1-3111	1-2111
Epilobium adenocaulon	3-6221	2-6421	--
Epilobium paniculatum	1-6432	1-4321	2-6432
Haplopappus lancelolatus	3-6322	1-6322	1-6422
Iris missouriensis	2-3111	--	--
Iva axillaris	--	1-9499	--
Lupinus sp.	1-6422	--	--
*Microsteris gracilis**	--	1-1111	2-1111
*Monolepis Nuttalliana**	--	1-3211	2-4111
Montia Chamissoi	2-6555	2-5555	--
Orthocarpus hispidus	1-1111	--	--
Penstemon Rydbergii	--	1-3211	--

Table 1 Continued

Perideridia sp.	1-8664	--	--
Plagiobothrys leptocladus	--	1-64$\overset{1}{3}$1	3-44$\overset{1}{1}$11
Polygonum arenastrum	--	1-71$\overset{1}{7}$1	3-77$\overset{1}{7}$1
Potentilla anserina	--	--	1-9211
Potentilla biennis	--	1-9993	--
Potentilla gracilis	--	1-6322	--
Sidalcea oregana	1-8621	--	--
Sisyrinchium idahoense	1-3999	--	--
Senecio hydrophilus	--	1-6633	1-9732
Stellaria longipes	--	1-3211	--
*Taraxacum officinale**	3-5551	3-55$\overset{11}{5}$5	2-55$\overset{111}{5}$5
*Trifolium cyathiferum**	--	1-4321	--

*Sage grouse food forbs.

Table 2. Forb abundance and phenology ratings by type for Hell Creek.

	Meadow type		
	1	2	3
*Achillea lanulosa**	3-6432	3-6448 (11)	3-6448 (111)
*Agoseris glauca**	1-4211	1-2211	1-4211
Allium sp.	--	1-3111	--
*Aster occidentalis**	3-6688 (11)	3-8678 (1111)	2-8688 (1111)
*Astragalus agrestis**	1-4555	1-3555	1-7655 (4)
*Astragalus lentiginosus**	1-3299	--	--
*Astragalus** sp.	--	--	1-8899
Cirsium vulgare	2-8773	2-8773	2-8873
Cirsium sp.	2-2288 (11)	2-3288 (11)	2-3211
Collinsia parviflora	1-1111	2-1111	1-1111
Collomia grandiflora	--	2-4221	1-9921
*Descurainia Sophia**	1-4311	2-1111	1-3211
Epilobium adenocaulon	1-4322	--	--
Epilobium paniculatum	--	1-6432	--
Erigeron divergens	1-1111	--	1-3111
Gnaphalium palustre	1-9943	1-9933	--
Iris missouriensis	2-3332	2-3332 (21)	2-3332 (11)
Lappula Redowskii	--	1-9911	--
Linum perenne	--	--	1-7999
Lupinus sp.	1-3362 (2)	1-4822 (3)	2-3882 (33)
*Microsteris gracilis**	--	1-1111	2-1111
*Monolepis Nuttalliana**	1-4321	--	--
Montia Chamissoi	2-5555	2-5555	2-5555

Table 2 Continued

Penstemon Rydbergii	1-4332	1-3332	1-4321
Perideridia sp.	1-8643	--	--
Plagiobothrys leptocladus	2-4411	--	--
Polygonum arenastrum	1-7611	--	--
Potentilla anserina	--	--	1-9998
Potentilla biennis	1-8432	1-8493	1-4322
Potentilla gracilis	2-6321	2-6328 1	2-4318 1
Rumex sp.	1-4332	1-4332	1-9933
Sidalcea oregana	1-6322	2-4321	1-4311
Sisyrinchium idahoense	--	--	1-4999
Senecio hydrophilus	1-6999	--	--
Senecio integerrimus	1-4911	1-4911	1-4311
Solidago spectabilis	--	--	1-7643
Stellaria longipes	2-4211	2-4111	2-4111
*Taraxacum officinale**	1111 3-5588	1111 3-5588	1111 3-5588
*Trifolium Wormskioldii**	1 2-4511	4-4555	11 3-4555
Urtica sp.	--	--	1-8643
Valeriana edulis	1-4221	--	1 1-3121

*Sage grouse food forbs.

Table 3. Forb abundance and phenology ratings by type for Badger Shearing Pen.

	Meadow type		
	1	2	3
*Achillea lanulosa**	2-6433 (11)	2-6411	--
*Aster occidentalis**	2-6664	1-6663 (1)	1-8811 (1)
*Astragalus agrestis**	1-5555	--	1-5211
*Astragalus lentiginosus**	1-6555	--	2-5222
Camissonia tenacetifolia	2-6628 (4 1)	--	2-6518 (1)
Chamaesaracha nana	--	--	1-1111
Chenopodium sp.	--	--	1-1111
Cirsium sp.	3-3288 (11)	3-3211	3-2811 (1)
*Descurainia Sophia**	--	--	1-2111
Epilobium adenocaulon	2-6422	--	--
*Eriophyllum lanatum**	2-4322	--	1-4321
Haplopappus lanceolatus	2-6321	3-4322	3-4322
Iris missouriensis	1-3211	--	--
Iva axillaris	--	--	1-7999
Linum perenne	--	--	1-2111
Lupinus sp.	1-6432	--	1-8422
Montia Chamissoi	2-6466 (33)	--	--
Orthocarpus hispidus	1-1111	--	1-2111
Potentilla anserina	2-4211	--	--
Potentilla gracilis	1-4332	1-4321	1-4311
Senecio hydrophilus	3-6632	--	--
Stellaris longipes	2-6911	--	--
*Taraxacum officinale**	3-5555 (11)	1-5521	2-5511 (1)

Table 3 Continued

*Trifolium Wormskioldii**	1-5555	--	--
Valeriana edulis	1-6922	3-4221	1-4211

*Sage grouse food forbs.

Table 4. Forb abundance and phenology ratings by type for Badger Creek.

	Meadow type		
	1	2	3
*Achillea lanulosa**	--	--	1-6431
*Arabis** sp.	--	1-3111	--
*Aster occidentalis**	1-8866	--	1-8664
*Astragalus agrestis**	1-5551	1-9851	--
Boraginaceae sp.	--	--	1-4111
Camissonia tenacetifolia	2-6555	--	2-6511
Chamaesarcha nana	2-2111	--	--
Chenopodium sp.	1-4321	1-7311	--
Cirsium sp.	2-8888 (3331)	1-3211	2-3388 (11)
Collinsia parviflora	2-1111	--	2-1111
*Descurainia Sophia**	2-3211	--	2-3111
Epilobium adenocaulon	1-4432	--	--
Epilobium paniculatum	1-6432	--	1-6432
Haplopappus lanceolatus	2-4322	3-5322	--
Iva axillaris	--	2-7399	--
Lappula Redowskii	2-4321	--	3-4111
Lupinus sp.	--	--	1-6432
*Microsteris gracilis**	--	--	3-1111
*Monolepsis Nuttalliana**	1-4321	1-7321	1-4321
Montia Chamissoi	2-6555	--	2-6555
Plagiobothrys leptocladus	1-4431	1-6411	1-4211
Polygonum arenastrum	3-7777 (11)	1-7611	2-7333 (11)
Potentilla anserina	2-8522	2-8511	--

Table 4 Continued

Potentilla gracilis	--	--	1-4322
Senecio hydrophilus	1-8842	--	--
Stellaria longipes	2-6411	--	1-4311
*Taraxacum officinale**	3-5555 111	2-1111	3-5551 11
*Trifolium Wormskioldii**	3-5555 11	2-5521	--

*Sage grouse food forbs.

Table 5. Forb abundance and phenology ratings by type for West Rock Springs.

	Meadow type	
	1	2
*Achillea lanulosa**	3-8888	3-8888
*Agoseris glauca**	--	1-8642
Arnica longifolia	2-6633	1-2222
*Aster occidentalis**	3-8886	3-8888
Barbarea orthoceras	2-8811	1-8611
Camissonia tenacetifolia	1-6499	1-6499
Cirsium sp.	2-8888	2-8888
Collinsia parviflora	1-4911	--
Epilobium andenocaulon	2-6241	2-9911
Epilobium paniculatum	1-8643	1-8632
Erigeron divergens	--	1-6621
Iris missouriensis	2-3221	2-3211
Montia Chamissoi	2-8881	--
Montia linearis	1-4111	--
Penstemom Rydbergii	2-8841	1-8731
Perideridia sp.	1-8666	1-8664
Plagiobothrys leptocladus	2-6431	2-4311
Polygonum arenastrum	1-8777	--
Potentilla biennis	2-8888	--
Potentilla gracilis	2-8888	2-8881
Rumex sp.	1-9933	--
Sidalcea oregana	2-8743	2-8831
Senecio hydrophilus	1-8811	1-8811

Table 5 Continued

*Taraxacum officinale**	2-8888	1-8881
Veronica peregrina	1-9911	--
Zigadenus sp.	1-8999	1-4999

*Sage grouse food forbs.

Table 6. Forb abundance and phenology ratings by type for North Catnip Creek.

	Meadow type		
	1	2	3
Achillea lanulosa*	2-6631	2-6643	3-1111
Agoseris glauca*	--	1-4321	1-3111
Arnica longifolia	2-6432	1-6433	1-6411
Aster occidentalis*	3-8776	2-8766	2-1111
Astragalus agrestis*	1-8455	1-8555	1-8831
Cirsium sp.	2-3221	1-2211	1-1111
Collinsia parviflora	--	--	1-1111
Descurainia Sophia*	--	1-4321	2-3111
Epilobium adenocaulon	2-6432	2-6642	--
Epilobium paniculatum	1-6432	1-6632	--
Erigeron divergens	--	--	2-2111
Gentiana calycosa	1-6644	1-8664	--
Haplopappus lanceolatus	--	--	1-3111
Hypericum formosum	3-6443	1-6433	1-6111
Iris missouriensis	2-3332	1-3332	--
Lappula Redwoskii	--	1-6431	2-6421
Lepidium perfoliatum*	--	2-4321	2-2111
Linum perenne	2-6433	1-6432	--
Lupinus sp.	1-6432	1-9992	1-8399
Microsteris gracilis*	--	1-1111	--
Montia Chamissoi	2-6555	2-6555	--
Montia linearis	2-6433	2-1111	--
Orthocarpus hispidus	--	--	1-9911

Table 6 Continued

Penstemon Rydbergii	2-6432	1-6432	1-4111
Perideridia sp.	1-8664	1-8664	1-4332
Potentilla anserina	1-5222	1-8222	--
Potentilla biennis	1-8888	1-8888	--
Potentilla gracilis	3-6432	2-6433	2-1111
Sidalcea oregana	3-6$\overset{3}{4}$2	1-64$\overset{2}{4}$3	--
Sisyrinchium idahoense	1-6432	--	--
Solidago spectabilis	3-7764	3-7743	--
Stellaria longipes	1-6$\overset{3}{4}$42	1-6432	--
*Taraxacum officinale**	2-5555	2-5555	1-1111
*Tragapogon dubius**	--	1-8643	--
*Trifolium cyathiferum**	2-5211	--	--

*Sage grouse food forbs.

Table 7. Forb abundance and phenology ratings by type for Little Catnip Springs.

	Meadow type	
	1	2
*Achillia lanulosa**	2-6643	2-6641
*Agoseris glauca**	1-6211	--
Aquilegia sp.	1-6999	--
*Aster occidentalis**	2-8766	2-8766
*Astragalus agrestis**	2-5555	1-5552
Boraginaceae sp.	1-6431	--
Camissonia tenacetifolia	1-5552	1-5555
Chenopodium sp.	--	1-4322
Cirsium vulgare	2-8763	--
Cirsium sp.	1-2221	2-3111
Collinsia parviflora	1-1111	--
*Descurainia Sophia**	1-3111	2-3111
Epilobium paniculatum	--	2-6432
Erigeron divergens	1-6321	1-3111
Erysimum repandum	--	2-9432
Gnaphalium palustre	1-9992	--
Haplopappus lanceolatus	1-5421	1-5421
Hypericum formosum	1-6432	1-6443
Iva axillaris	1-8884	--
Iris missouriensis	2-3321	1-3111
Iris axillaris	1-8884	--
Lotus Purshianus	2-6643	--
Lupinus sp.	--	1-6432

Table 7 Continued

Madia gracilis	1-9943	--
*Microsteris gracilis**	2-1111	1-1111
Montia Chamissoi	2-6555	1-5555
Navarretia Breweri	1-4321	1-6432
Orthocarpus hispidus	--	1-6432
Penstemon Rydbergii	--	1-4311
Perideridia sp.	1-8664	1-8943
Plagiobothrys leptoclaudus	2-6432	1-6432
Polygonum arenastrum	1-8774	2-8774 (11)
Potentilla gracilis	2-6421	2-6431
Senecio integerrimus	1-1111	1-5311
Sidalcea oregana	2-6432	2-6431
Sisyrinchium idahoense	--	2-4399
Stellaria longipes	1-6432	1-5432
*Taraxacum officinale**	2-5558 (11)	2-5555 (11)
*Trifolium cyathiferum**	--	2-3211
*Trifolium Wormskioldii**	--	1-4332
Zigadenus sp.	--	1-9911

*Sage grouse food forbs.

Table 8. Forb abundance and phenology ratings by type for South Catnip Creek.

	Meadow type					
	1	2	3	4	5	6
*Achillea lanulosa**	1111 1-2288	6111 3-8888	1111 2-9888	2 11 3-8888	1-7811	1111 3-8888
*Agoseris glauca**	1-4332	1 1-3228	--	1-5611	--	1-1111
Arnica longifolia	3 2-6681	1 1-2888	1-3888	1 1-2811	--	--
Aquilegia sp.	--	--	--	--	1-8888	--
*Aster occidentalis**	7 2-8886	3-8887	6 2-8888	11 3-8888	--	6611 2-8888
*Astragalus agrestis**	5 1-5888	5 1-5858	1-8888	55 1-8888	--	1-5811
Camissonia tenacetifolia	--	--	1-5555	1-6555	1-3322	1-5522
Cirsium sp.	2-8888	2 1 3-2888	1 2-8888	3 1 2-8888	--	1 2-3188
Epilobium paniculatum	2-6622	1-6544	2-8644	--	--	--
Hapolopappus lanceolatus	1-4321	1-4321	1-4321	--	--	--
Hypericum formosum	--	1-9988	3-9988	--	--	--
Iris missouriensis	--	2-1111	2-1111	2-3111	--	--
Linum perenne	--	--	1-9988	1-9988	--	1-9988
Lupinus sp.	1-6422	1-6422	--	1-9993	--	1-9992
Montia Chamissoi	2-6555	1-6555	1-9995	--	--	--
Orthocarpus hispidis	--	1-9993	--	--	--	--
Perideridia sp.	--	1-8866	2-8666	1-8666	--	1-8666
Polygonum arenastrum	1-8877	--	--	--	--	--
Polygonum Kelloggii	--	--	--	1-9221	--	--
Potentilla anserina	--	--	1-9998	--	--	--
Potentilla biennis	1-8888	--	--	--	--	--
Potentilla gracilis	1-6888	1 3-8888	3-8888	4-8888	1-8818	11 3-8888
Rumex sp.	--	--	--	--	--	1-9998
Sidalcea oregana	11 1-1188	1 1-4888	1 2-8888	2-8888	--	11 2-1888
Sisyrinchium idahoense	--	1-6999	--	--	--	--
Stellaria longipes	--	2-6411	--	1-9911	--	1-9911
*Taraxacum officinale**	1111 2-5586	1 3-5588	15 1 3-5888	5 3-8888	1-5511	1111 2-5788
Valleria edulis	--	1-9988	--	--	--	11 2-3288

*Sage grouse food forbs.

Table 9. Forb abundance and phenology ratings by type for Bald Mountain Creek-Range.

	Meadow type				
	1	2	3	4	5
Achillea lanulosa[◊]	1-6111	2-8641	2-6631	2-6631[1]	1-6631
Agoseris glauca[◊]	2-2211	--	1-5555	1-5211	2-5511
Artemisia ludoviciana*	--	2-8776	--	--	1-8876
Aster campestris	1-7761	--	3-8511	2-8666[1]	2-7611
Aster occidentalis*	--	1-8866	1-8866	--	--
Astragalus agrestis*	--	--	2-5555	--	--
Boisduvalia densiflora	--	1-8643	--	--	--
Boraginaceae sp.	--	2-8421	--	--	--
Camissonia tenacetifolia	2-6521	3-6555	3-6555	1-9998	1-6558[1]
Cirsium sp.	1-3211	1-8888[1]	2-2111	1-3111	1-5521
Descurainia Sophia*	--	1-6321	--	--	--
Epilobium adenocaulon	--	1-8643	--	--	--
Gnaphalium palustre	--	1-4432	2-4432	--	--
Haplopappus lanceolatus	1-6521	--	1-6555	--	2-6521
Iris missouriensis	3-2111	--	--	2-2111	2-2111
Iva axillaris	--	1-8999	--	--	--
Lotus Purshianus	3-8743	3-6443	2-9943	--	4-9421
Lupinus sp.	1-6432	1-6443	--	1-6632	--
Madia gracilis	--	1-6421	--	--	--
Microsteris gracilis*	--	1-3211	--	--	--
Monolepis Nuttalliana*	--	1-4321	--	--	--
Navarretia Breweri	--	2-6643	1-6443	--	--
Navarretia propinqua	--	2-8443	2-6443	--	--
Perideridia sp.	1-6632	--	--	1-6632	--
Plagiobothrys leptocladus	2-6111	3-6433	1-6643	--	--
Polemoniaceae sp.	--	1-6649	--	--	--
Polygonum arenastrum	2-8621	3-8666	1-7766	--	--
Potentilla anserina	--	--	2-5555	--	--

Table 9 Continued

Potentilla biennis	--	1-9988	--	--	--
Potentilla gracilis	1-7432	2 1-8438	--	1-8888	1-7888
Rumex sp.	--	2-5555	1-9933	--	--
Sidalcea oregana	--	2-4332	1-4321	1-6311	--
Stellaria longipes	--	2-8311	--	--	--
*Taraxacum officinale**	1 4-5581	1 1-8555	55 3-5588	11 3-5588	1 3-5881
*Trifolium cyathiferum**	2-4111	1-6322	2-5511	2-5111	2-4111
Veronica peregrina	1-4421	2-6441	--	--	--
Verbascum Thapsus	--	1-8888	1-8776	--	--

*Sage grouse food forbs.

Table 10. Forb abundance and phenology ratings by type for Bald Mountain Creek-Refuge.

	Meadow type	
	1	2
*Achillea lanulosa**	1-6633	3-6631
*Agoseris glauca**	1-5521	2-6311
Arnica longifolia	1-6443	--
*Artemisia ludoviciana**	3-8776	3-8774
Aster campestris	3-8666	4-8666
*Aster occidentalis**	1-8876	--
*Astragalus filipes**	1-3311	--
Boisduvalia densiflora	1-8644	--
Boraginaceae sp.	1-6431	--
Camissonia tenacetifolia	3-5555	--
Cirsium sp.	1-8888	1-3111
*Descurainia Sophia**	--	1-4311
Gnaphalium palustre	2-4433	--
Haplopappus lanceolatus	1-6322	--
Iris missouriensis	1-4333	--
*Lactuca Serriola**	1-8643	--
Lupinus sp.	1-6433	--
*Microsteris gracilis**	--	2-2111
*Monolepis Nuttalliana**	1-4311	--
Navarretia Breweri	1-6441	--
Navarretia propinqua	1-6442	--
Perideridia sp.	1-8643	2-6642
Plagiobothrys leptocladus	2-6432	--

Table 10 Continued

Polygonum arenastrum	2-8777	--
Potentilla anserina	1-6955	--
Potentilla biennis	1-8888	--
Rumex sp.	2-4333	--
Sidalcea oregana	2-6432	2-6321
*Taraxacum officinale**	2-5588 55	3-5511
*Tragopogon dubius**	1-8692	--
*Trifolium cyathiferum**	3-4411	2-2111
Verbascum Thapsus	1-8888	--

*Sage grouse food forbs.

Table 11. Forb abundance and phenology ratings by type for Hobble Springs.

	Meadow type			
	1	2	3	4
*Achillea lanulosa**	2-6631	3-66$\overset{1}{4}$1	2-66$\overset{1}{4}$1	3-$\overset{6}{8}$111
*Agoseris glauca**	2-4322	2-4211	1-3211	2-4211
Allium sp.	--	1-6311	--	--
Arnica longifolia	2-6643	2-4211	--	--
*Aster occidentalis**	1-866$\overset{4}{6}$	2-86$\overset{11}{6}$6	1-8111	3-8711
*Astragalus agrestis**	--	1-2111	--	--
Astragalus sp.*	1-5555	--	--	--
Brassicaceae sp.	--	1-4311	--	--
Camissonia tenacetifolia	--	1-2221	1-6551	--
Chenopodium sp.	--	--	1-9993	--
Cirsium sp.	--	1-2211	--	1-3211
*Crepis acuminata**	--	1-3311	--	--
Epilobium adenocaulon	1-8622	1-6311	--	--
Epilobium paniculatum	2-8622	1-8632	--	1-8632
Erigeron divergens	--	2-3211	3-6321	1-6311
Haplopappus lanceolatus	--	1-6421	2-6421	1-6621
Iris missouriensis	2-4333	1-4331	1-3211	--
Iva axillaris	--	2-84$\overset{33}{8}$8	2-8433	--
Lotus Purshianus	2-8632	--	--	--
Lupinus sp.	--	2-6432	--	--
*Microsteris gracilis**	--	1-4111	2-1111	--
Montia Chamissoi	2-6655	--	--	--
Orthocarpus hispidus	2-6421	--	--	--

Table 11 Continued

Penstemon Rydbergii	1-6432	--	1-6411	1-6411
Perideridia sp.	3-8664	2-6643	1-8642	2-8643
Potentilla gracilis	2-6432	2-6411	1-6322	1-$\overset{6}{7}$421
Sidalcea oregana	1-6431	2-6411	--	1-6411
Senecio hydrophilus	2-7744	--	--	--
Senecio integerrimus	--	1-1111	1-1111	--
Senecio serra	--	1-3311	--	--
Stellaria longipes	2-6431	2-6111	--	1-6111
*Taraxacum officinale**	3-555$\overset{1}{5}$	2-5111	2-5511	3-5111
*Tragopogon dubius**	--	2-4211	--	--
*Trifolium cyathiferum**	4-4311	--	1-4111	2-4311
*Trifolium Wormskioldii**	1-9944	--	--	--
Zigadenus sp.	--	1-9911	--	--

*Sage grouse food forbs.

Table 12. Forb abundance and phenology ratings by type for Lower Last Chance.

	Meadow type			
	1	2	3	4
Achillea lanulosa*	2-6655	3-66$\overset{1}{31}$	3-6611	3-66$\overset{1}{31}$
Agoseris glauca*	--	2-3332	2-5522	2-5521
Allium sp.	--	1-6991	1-6411	--
Amsinckia tessellata	--	1-9954	--	--
Arnica longifolia	1-7433	1-6432	--	2-7631
Artemisia ludoviciana*	--	2-8743	--	--
Aster campestris	--	--	--	1-8999
Aster occidentalis*	2-8666	3-87$\overset{1}{66}$	3-87$\overset{11}{65}$	3-8551
Astragalus agrestis*	2-9555	2-6555	--	--
Astragalus lentiginosus*	--	1-3211	--	--
Boisduvalia densiflora	--	--	1-8664	1-8644
Boraginaceae sp.	--	--	--	2-4321
Brassicaceae sp.	--	2-4433	1-4331	1-4311
Camissonia tenacetifolia	--	1-55$\overset{21}{55}$	2-6421	1-9992
Chamaesaracha nana	--	--	--	1-1111
Chenopodium sp.	--	1-7999	--	--
Cirium sp.	--	2-3111	2-3111	2-2111
Collinsia parviflora	--	1-1111	2-1111	--
Delphinium Nuttallianum	--	--	--	2-6111
Epilobium adenocaulon	1-8622	1-86$\overset{2}{24}$	--	1-6311
Epilobium paniculatum	--	1-8633	1-8622	1-8632
Erigeron divergens	--	2-6422	--	1-6311
Gnaphalium palustre	--	1-9931	--	1-9931

Table 12 Continued

Haplopappus lanceolatus	--	2-6431	1-6432	2-6422
Hypericum formosum	1-7632	--	--	--
Iris missouriensis	--	2-4331	2-3331	--
Iva axillaris	--	3-8433 1/3	2-8843	1-8443
*Lactuca Serriola**	--	--	1-9994	--
Lithophragma tenellum	--	--	1-8999	--
Lupinus sp.	--	--	2-8432	1-8332
Madia gracilis	--	--	1-6943	1-8433
*Microsteris gracilis**	--	--	1-1111	2-1111
*Monolepis Nuttalliana**	--	1-4331	--	--
Montia Chamissoi	3-6655	1-6655 1/5	1-8111	--
Montia linearis	--	1-1111	2-1111	2-1111
Navarretia Breweri	--	1-9911	1-6621	--
Navarretia propinqua	--	--	2-6622	2-6411
Orthocarpus luteus	1-6643	1-6643	2-6431	2-6421
Penstemon Rydbergii	1-8643	2-6432	2-6321	1-6431
Perideridia sp.	2-8666	1-8664	2-7644	2-6644
Plagiobothrys leptocladus	--	1-6111	2-6611	2-6111
Polygonum arenastrum	--	1-8666	--	--
Polygonum Kelloggii	--	--	--	1-6211
Potentilla biennis	1-8886	1-8886 66	--	--
Potentilla gracilis	2-7655 33	2-7433	2-6611	1-6631 1/3
Rumex sp.	1-7433	1-7333	2-4333	1-4333
Sidalcea oregana	2-6422	2-6433	2-6421	2-6421
Sisyrinchium idahoense	1-8869	--	--	--

Table 12 Continued

Senecio hydrophilus	1-7743	--	--	1-7699
Senecio integerrimus	--	1-3211	--	1-4111
Stellaria longipes	2-6655	1-6655	--	2-6111
*Taraxacum officinale**	1-5555	2-5555	2-5511	3-55$\overset{1}{5}$1
*Tragopogon dubius**	--	--	1-4211	1-4322
*Trifolium cyathiferum**	2-6321	2-5551	3-4311	4-4111
*Trifolium Wormskioldii**	1-7643	1-6651	--	--
Urtica sp.	--	1-9949	--	--
Zigadenus sp.	--	1-9911	2-4311	2-4311

*Sage grouse food forbs.

Table 13. Forb abundance and phenology ratings by type for Upper Last Chance.

	Meadow type							
	1	2	3	4	5	6	7	8
Achillea lanulosa*	1-6661	3-6111	3-6631	1-6633	3-6633	2-6311	2-6111	2-6611
Agoseris glauca*	1-6311	1-6511	2-6511	1-4332	2-5522	—	1-1111	1-4322
Arnica longifolia	3-6431	2-5321	3-6432	2-6632	3-6633	—	—	2-6333
Artemisia ludoviciana*	1-8776	—	1-8776	—	—	—	—	3-8774
Aster occidentalis*	2-8661	3-8751	2-8666	1-8666	3-8768	1-8311	1-8761	2-8766
Astragalus arearia*	1-6431	2-6421	—	—	2-9955	—	1-2111	2-5555
Balsamorhiza orthocarpa	1-6311	—	—	—	—	—	—	1-9991
Boisduvalia densiflora	—	—	1-9996	—	—	—	—	—
Camissonia tenaceifolia	1-6655	1-6511	1-6611	—	—	—	—	1-6522
Cirsium sp.	2-4211	1-3111	1-4211	—	2-3211	1-2111	1-2111	1-3111
Collinsia parviflora	1-1111	1-1111	—	—	—	2-1111	—	—
Delphinium Huttallianum	2-6111	—	1-6411	—	—	—	—	—
Epilobium adenocaulon	—	—	—	1-6432	—	—	—	1-4321
Epilobium paniculatum	1-8632	2-8641	1-8832	—	—	1-6432	1-3641	2-8643
Erigeron divergens	—	2-6311	—	—	1-6421	—	2-6321	—
Erigeron sp.	—	—	—	—	—	—	1-6221	—
Erysimum repandum	—	1-6311	—	—	—	—	—	1-9931
Gnaphalium palustre	—	—	1-6431	—	—	—	—	—
Haplopappus lanceolatus	—	2-6421	—	—	—	1-2211	1-6321	—
Iris missouriensis	2-3211	1-3331	2-2111	2-4111	1-3211	—	1-2111	2-4333
Iva axillaris	—	1-8886	—	—	—	2-8411	2-8411	—
Lappula Redowskii	—	1-6431	—	—	—	—	—	—
Linum perenne	2-6432	2-6411	—	—	2-6421	1-4321	—	2-6422
Lotus Purshianus	—	—	—	—	—	—	—	1-6611
Lupinus sp.	1-6442	1-6432	—	—	—	—	1-6432	—
Madia gracilis	—	—	1-9992	—	—	—	—	—
Microsteris gracilis*	1-6111	—	—	—	—	—	1-1111	—
Montia Chamissoi	—	—	2-5551	—	—	—	—	1-6411
Montia linearis	1-1111	2-1111	1-1111	2-1111	—	—	—	2-2111
Navarretia Breweri	—	—	2-6421	—	—	—	—	—
Navarretia propinqua	1-6621	1-6111	—	—	—	—	—	—
Orthocarpus hispidus	1-6643	1-6442	—	—	—	—	—	—
Penstemon Rydbergii	1-6431	1-6431	1-6431	1-6432	2-6421	1-6311	1-6431	1-6432
Perideridia sp.	3-8664	3-8663	2-8664	2-8666	—	—	—	2-8664
Plagiobothrys leptocladus	1-6641	—	1-6411	1-6431	—	1-6111	—	2-6421
Polygonum Kellogii	—	—	1-9911	—	—	—	—	—
Potentilla gracilis	2-6432	2-6431	3-6432	1-6432	1-6411	1-2221	1-3221	1-6431

Table 13 Continued

Rubus sp.	--	--	1-4333	1-4333	--	--	1-3221	1-4331
Sidalcea oregana	2-6411	2-6411	2-6421	1-6421	--	1-6211	1-4211	2-7411
Sisyrinchium idahoense	--	--	--	1-6499	--	--	--	--
Senecio hydrophilus	--	--	1-8643	2-7643	--	1-7411	--	1-9932
Senecio integerrimus	--	1-2111	--	--	--	1-2111	1-1111	1-1111
Senecio serra	--	1-8641	--	1-8999	--	--	--	2-6432
Stellaria longipes	2-6611	1-6111	1-6111	2-6431	3-6633	--	--	3-6111
*Taraxacum officinale**	2-5211	1 2-5551	1-5511	1 2-5555	11 4-5555	--	--	1 3-5555
*Tragopogon dubius**	--	1-5552	--	--	--	--	1-4332	--
*Trifolium cyathiferum**	2-4111	2-1111	--	4-4311	2-4431	1-4111	3-3211	2-3311
*Trifolium Wormskioldii**	2-6411	--	--	2-4311	--	--	--	--
Vallaria edulis	2-5551	--	--	--	--	--	--	1-7211
Veronica peregrina	--	--	1-6411	--	--	--	--	--
Zigadenus sp.	1-6421	--	--	--	--	--	--	--

*Sage grouse food forms.

APPENDIX V

Overall Abundance and Phenology Indices for Forbs Found on Study Meadows.

Phenology indices are given for each of the 4 survey periods (Mid-July, Late July-early August, Mid-August, and Late August). A value of 9.00 denotes missing data.

Table 1. Forb abundance and phenology indices for Bateman.

		Phenology			
	Abundance	1	2	3	4
*Achillea lanulosa**	1.29	6.00	4.00	3.00	1.59
*Agoseris glauca**	0.57	1.48	1.47	0.29	0.29
Agoseris sp.	0.01	0.04	0.03	0.01	0.01
*Aster occidentalis**	1.57	6.00	4.59	2.05	1.88
*Astragalus agrestis**	0.85	1.47	1.49	1.47	1.47
*Astragalus lentiginosus**	0.01	0.07	0.07	0.07	0.07
Camissonia tenacetifolia	2.41	3.88	5.35	4.23	4.45
Chamaesaracha nana	0.31	9.00	0.85	0.85	9.00
Chenopodium sp.	0.71	2.83	2.83	2.12	2.12
Cirsium sp.	1.03	6.52	2.00	3.52	3.52
Collinsia parviflora	0.03	0.01	0.01	0.01	0.01
*Descurainia Sophia**	1.00	2.29	1.00	1.00	1.00
Epilobium adenocaulon	0.60	1.76	1.14	0.59	0.29
Epilobium paniculatum	1.71	5.44	3.72	2.72	1.72
Haplopappus lanceolatus	1.03	6.00	3.71	2.00	2.00
Iris missouriensis	0.03	0.04	0.01	0.01	0.01
Iva axillaris	0.28	9.00	1.12	9.00	9.00
Lupinus sp.	0.01	0.09	0.06	0.03	0.03
*Microsteris gracilis**	1.69	0.99	0.99	0.99	0.99
*Monolepis Nuttalliana**	1.69	3.66	1.26	0.99	0.99
Montia Chamissoi	0.59	1.48	1.47	1.47	1.47
Orthocarpus hispidus	0.01	0.01	0.01	0.01	0.01
Penstemon Rydbergii	0.28	0.84	0.56	0.28	0.28

Table 1 Continued

Perideridia sp.	0.01	0.12	0.09	0.09	0.06
Plagiobothrys leptocladus	2.40	4.50	2.88	1.26	0.99
Polygonum arenastrum	2.40	6.90	5.22	3.94	0.99
Potentilla anserina	0.71	9.00	1.41	0.71	0.71
Potentilla biennis	0.28	9.00	9.00	9.00	0.84
Potentilla gracilis	0.28	1.67	0.84	0.56	0.56
Sidalcea oregana	0.01	0.12	0.09	0.03	0.01
Sisyrinchium idahoense	0.01	0.04	9.00	9.00	9.00
Senecio hydrophilus	0.99	9.00	6.62	2.96	2.25
Stellaria longipes	0.28	0.84	0.56	0.28	0.28
*Taraxacum officinale**	2.29	5.00	3.59	3.03	2.97
*Trifolium cyathiferum**	0.28	1.12	0.84	0.56	0.28

*Sage grouse food forbs.

Table 2. Forb abundance and phenology indices for Hell Creek.

		Phenology			
	Abundance	1	2	3	4
*Achillea lanulosa**	3.00	6.00	3.89	2.89	2.56
*Agoseris glauca**	1.00	3.70	2.00	1.00	1.00
Allium sp.	0.15	0.44	0.15	0.15	0.15
*Aster occidentalis**	2.93	5.67	5.44	4.43	4.50
*Astragalus agrestis**	1.00	4.07	5.00	5.00	5.00
*Astragalus lentiginosus**	0.78	2.33	1.56	9.00	9.00
*Astragalus** sp.	0.07	0.59	0.59	9.00	9.00
Cirsium vulgare	2.00	8.00	7.07	7.00	3.00
Cirsium sp.	2.00	2.22	2.00	4.24	4.24
Collinsia parviflora	1.15	1.00	1.00	1.00	1.00
Collomia grandiflora	0.37	9.00	9.00	0.44	0.22
*Descurainia Sophia**	1.15	3.48	2.63	1.00	1.00
Epilobium adenocaulon	0.78	3.11	2.33	1.56	1.56
Epilobium paniculatum	0.15	0.89	0.59	0.44	0.30
Erigeron divergens	0.85	1.00	0.85	0.85	0.85
Gnaphalium palustre	0.93	9.00	9.00	3.56	2.78
Iris missouriensis	2.00	3.00	2.85	2.78	2.00
Lappula Redowskii	0.15	9.00	9.00	0.15	0.15
Linum perenne	0.07	0.52	9.00	9.00	9.00
Lupinus sp.	1.07	3.15	3.56	3.81	2.00
*Microsteris gracilis**	0.30	0.22	0.22	0.22	0.22
*Monolepis Nuttalliana**	0.78	3.11	2.33	1.56	0.78

Table 2 Continued

Montia Chamissoi	2.00	5.00	5.00	5.00	5.00
Penstemon Rydbergii	1.00	3.85	3.00	2.93	1.93
Perideridia sp.	0.78	6.22	4.67	3.11	2.33
Plagiobothrys leptocladus	1.56	3.11	3.11	0.78	0.78
Polygonum arenastrum	0.78	5.44	4.67	0.78	0.78
Potentilla anserina	0.07	9.00	9.00	9.00	0.59
Potentilla biennis	1.00	7.70	3.93	9.00	2.15
Potentilla gracilis	2.00	5.85	3.00	1.93	1.78
Rumex sp.	1.00	9.00	9.00	3.00	2.07
Sidalcea oregana	1.15	5.56	3.00	1.93	1.78
Sisyrinchium idahoense	0.07	0.30	9.00	9.00	9.00
Senecio hydrophilus	0.78	4.67	9.00	9.00	9.00
Senecio integerrimus	1.00	4.00	9.00	1.00	1.00
Solidago spectabilis	0.07	0.52	0.44	0.30	0.22
Stellaria longipes	2.00	4.00	1.78	1.00	1.00
Taraxacum officinale*	3.00	3.00	3.00	4.50	4.50
Trifolium Wormskioldii*	2.37	4.00	3.30	1.74	1.89
Urtica sp.	0.07	0.59	0.44	0.30	0.22
Valeriana edulis	0.85	3.33	1.63	1.67	0.85

*Sage grouse food forbs.

Table 3. Forb abundance and phenology indices for Badger Shearing Pen.

		Phenology			
	Abundance	1	2	3	4
Achillea lanulosa*	0.16	0.49	0.32	0.14	0.14
Aster occidentalis*	1.06	7.84	4.62	1.36	1.23
Astragalus agrestis*	0.98	4.91	2.16	1.24	1.24
Astragalus lentiginosus*	1.90	4.98	2.16	2.16	2.16
Camissonia tenacetifolia	1.97	5.90	4.91	1.05	4.42
Chamaesaracha nana	0.92	0.92	0.92	0.92	0.92
Chenopodium sp.	0.92	0.92	0.92	0.92	0.92
Cirsium sp.	3.00	2.08	4.30	1.22	1.22
Descuranina Sophia*	0.92	1.84	0.92	0.92	0.92
Epilobium adenocaulon	0.13	0.38	0.26	0.13	0.13
Eriophyllum lanatum*	1.05	3.93	2.95	1.97	1.05
Haplopappus lanceolatus	2.94	4.13	3.00	2.00	1.94
Iris missouriensis	0.06	0.19	0.13	0.06	0.06
Iva axillaris	0.92	6.43	9.00	9.00	9.00
Linum perenne	0.92	1.84	0.92	0.92	0.92
Lupinus sp.	0.98	7.74	3.93	2.03	1.97
Montia Chamissoi	0.13	0.38	0.26	0.29	0.29
Orthocarpus hispidus	0.98	1.90	0.98	0.98	0.98
Potentilla anserina	0.13	0.26	0.13	0.06	0.06
Potentilla gracilis	1.00	4.00	3.00	1.14	1.06
Senecio hydrophilus	0.19	0.38	0.38	0.19	0.13
Stellaria longipes	0.13	0.38	9.00	0.06	0.06

Table 3 Continued

*Taraxacum officinale**	2.05	5.00	3.16	1.14	1.13
*Trifolium Wormskioldii**	0.06	0.32	0.32	0.32	0.32
Valeriana edulis	1.03	4.13	9.00	1.08	1.06

*Sage grouse food forbs.

Table 4. Forb abundance and phenology indices for Badger Creek.

	Abundance	Phenology 1	2	3	4
*Achillea lanulosa**	0.36	2.18	1.45	1.09	0.36
Arabis sp.*	0.08	0.23	0.08	0.08	0.08
*Aster occidentalis**	0.92	7.39	6.66	5.54	4.82
*Astragalus agrestis**	0.54	9.00	3.41	3.18	0.64
Boraginaceae sp.	0.36	1.45	0.36	0.36	0.36
Camissonia tenacetifolia	1.85	5.54	4.62	3.17	3.17
Chamaesaracha nana	1.12	1.12	0.56	0.56	0.56
Chenopodium sp.	0.64	2.78	1.91	1.12	0.64
Cirsium sp.	1.92	4.40	3.96	4.79	4.23
Collinsia parviflora	1.85	0.92	0.92	0.92	0.92
*Descurainia Sophia**	1.85	2.77	1.48	0.92	0.92
Epilobium adenolcaulon	0.56	2.24	2.24	1.68	1.12
Epilobium paniculatum	0.92	5.91	3.70	2.77	1.85
Haplopappus lanceolatus	1.35	2.70	1.91	1.27	1.27
Iva axillaris	0.15	0.53	0.23	9.00	9.00
Lappula Redowskii	2.21	3.70	2.04	1.48	0.92
Lupinus sp.	0.36	2.18	1.45	1.09	0.73
*Microsteris gracilis**	1.09	0.36	0.36	0.36	0.36
*Monolepsis Nuttalliana**	1.00	4.23	3.00	2.00	1.00
Montia Chamissoi	1.85	5.54	4.62	4.62	4.62
Plagiobothrys leptocladus	1.00	5.61	4.00	2.48	1.00
Polygonum arenastrum	2.48	7.00	5.47	3.04	3.04

Table 4 Continued

Potentilla anserina	1.27	5.09	3.18	1.20	1.20
Potentilla gracilis	0.36	1.45	1.09	0.73	0.73
Senecio hydrophilus	0.56	4.48	4.48	2.24	1.12
Stellaria longipes	1.48	5.54	5.54	0.92	0.92
*Taraxacum officinale**	2.92	4.70	2.85	2.85	2.12
*Trifolium Wormskioldii**	1.83	3.18	3.18	1.83	1.76

*Sage grouse food forbs.

Table 5. Forb abundance and phenology indices for West Rock Springs Exclosure.

	Abundance	Phenology 1	2	3	4
*Achillea lanulosa**	3.00	8.00	8.00	5.82	4.50
*Agoseris glauca**	0.62	4.97	3.73	2.49	1.24
Arnica longifolia	1.38	3.51	3.51	2.38	2.38
*Aster occidentalis**	3.00	8.00	8.00	5.82	4.12
Barbarea orthocaeras	1.38	8.00	6.76	1.00	1.00
Camissonia tenacetifolia	1.00	6.00	4.00	9.00	9.00
Cirsium sp.	2.00	8.00	8.00	8.00	4.50
Collinsia parviflora	0.38	1.51	9.00	0.38	0.38
Epilobium adenocaulon	2.00	3.51	2.00	1.57	1.00
Epilobium paniculatum	1.00	8.00	6.00	3.38	2.38
Erigeron divergens	0.62	3.73	3.73	1.24	0.62
Iris missouriensis	2.00	3.00	2.00	1.38	1.00
Montia Chamissoi	0.76	3.03	3.03	2.46	0.38
Montia linearis	0.38	1.51	0.38	0.38	0.38
Penstemon Rydbergii	1.38	8.00	7.38	3.38	1.00
Perideridia sp.	1.00	8.00	6.00	6.00	4.76
Plagiobothrys leptocladus	2.00	4.75	3.38	1.38	1.00
Polygonum arenastrum	0.38	3.03	2.65	2.65	2.65
Potentilla biennis	0.76	3.03	3.03	3.03	3.03
Potentilla gracilis	2.00	8.00	8.00	5.82	2.32
Rumex sp.	0.38	9.00	9.00	1.14	1.14
Sidalcea oregana	2.00	8.00	7.62	3.38	1.76

Table 5 Continued

Senecio hydrophilus	1.00	8.00	8.00	1.00	1.00
*Taraxacum officinale**	1.38	8.00	8.00	8.00	3.65
Veronica peregrina	0.38	9.00	9.00	0.38	0.38
Zigadenus sp.	1.00	5.51	9.00	9.00	9.00

*Sage grouse food forbs.

Table 6. Forb abundance and phenology indices for North Catnip Creek.

		Phenology			
	Abundance	1	2	3	4
Achillea lanulosa*	2.68	2.60	2.60	1.86	1.44
Agoseris glauca*	0.90	2.92	1.34	1.12	0.90
Arnica longifolia	1.10	6.00	4.00	1.64	1.54
Aster occidentalis*	2.10	3.24	2.92	2.70	2.60
Astragalus agrestis*	1.00	8.00	7.04	3.64	2.28
Cirsium sp.	1.10	1.42	1.32	1.10	1.00
Collinsia parviflora	0.68	0.68	0.68	0.68	0.68
Descurainia Sophia*	1.58	2.92	1.34	1.12	0.90
Epilobium adenocaulon	0.64	1.92	1.72	1.18	0.64
Epilobium paniculatum	0.32	1.92	1.72	0.96	0.64
Erigeron divergens	1.36	1.36	0.68	0.68	0.68
Gentiana calycosa	0.32	2.36	1.92	1.72	1.28
Haplopappus lanceolatus	0.68	2.04	0.68	0.68	0.68
Hypericum formosum	1.42	6.00	1.96	1.74	1.64
Iris missouriensis	0.42	0.96	0.96	0.96	0.64
Lappula Redowskii	1.58	5.39	3.60	2.02	0.90
Lepidium perfoliatum*	1.80	2.24	1.34	1.12	0.90
Linum perenne	0.42	1.92	1.28	0.96	0.74
Lupinus sp.	1.00	9.00	9.00	9.00	9.00
Microsteris gracilis*	0.22	0.22	0.22	0.22	0.22
Montia Chamissoi	0.64	1.92	1.60	1.60	1.60
Montia linearis	0.64	0.82	0.62	0.52	0.52

Table 6 Continued

Orthocarpus hispidus	0.68	9.00	9.00	0.68	0.68
Penstemon Rydbergii	1.10	4.64	1.96	1.64	1.32
Perideridia sp.	1.00	5.82	3.96	3.96	2.64
Potentilla anserina	0.32	2.26	0.64	0.64	0.64
Potentilla biennis	0.32	2.56	2.56	2.56	2.56
Potentilla gracilis	2.10	2.60	1.96	1.64	1.54
Sidalcea oregana	0.52	1.92	1.28	1.23	0.75
Sisyrinchium idahoense	0.10	0.61	0.40	0.30	0.20
Solidago spectabilis	0.96	2.24	2.24	1.48	1.06
Stellaria longipes	0.32	1.92	1.28	1.01	0.64
*Taraxacum officinale**	1.32	2.28	2.28	2.28	2.28
*Tragapogon dubius**	0.22	1.75	1.32	0.88	0.66
*Trifolium cyathiferum**	0.20	0.50	0.20	0.10	0.10

*Sage grouse food forbs.

Table 7. Forb abundance and phenology indices for Little Catnip Springs.

	Abundance	Phenology 1	2	3	4
*Achillea lanulosa**	2.00	6.00	6.00	2.70	1.13
*Agoseris glauca**	0.13	0.79	0.26	0.13	0.13
Aquilegia sp.	0.13	0.79	9.00	9.00	9.00
*Aster occidentalis**	2.00	8.00	7.00	5.67	5.67
*Astragalus agrestis**	1.13	5.00	5.00	4.80	2.20
Boraginaceae sp.	0.13	0.79	0.52	0.39	0.13
Camissonia tenacetifolia	1.00	5.00	5.00	5.00	4.61
Chenopodium sp.	0.87	3.48	2.61	1.74	1.74
Cirsium vulgare	0.26	1.05	0.92	0.77	0.39
Cirsium sp.	1.87	2.87	1.13	1.13	1.00
Collinsia parviflora	0.13	0.13	0.13	0.13	0.13
*Descurainia Sophia**	1.87	3.00	1.00	1.00	1.00
Epilobium paniculatum	1.74	5.21	3.48	2.61	1.74
Erigeron divergens	1.00	3.39	1.26	1.13	1.00
Erysimum repandum	1.74	9.00	3.48	2.61	1.74
Gnaphalium palustre	0.13	9.00	9.00	9.00	0.26
Haplopappus lanceolatus	1.00	5.00	4.00	2.00	1.00
Hypericum formosum	1.00	6.00	4.00	3.87	2.87
Iris missouriensis	1.13	3.00	1.26	1.13	1.00
Iva axillaris	0.13	1.05	1.05	0.59	0.33
Lotus Purshianus	0.26	0.79	0.79	0.52	0.39
Lupinus sp.	0.87	5.21	3.48	2.61	1.74

Table 7 Continued

Madia gracilis	0.13	9.00	9.00	0.52	0.39
*Microsteris gracilis**	1.13	1.00	1.00	1.00	1.00
Montia Chamissoi	1.13	5.13	5.00	5.00	5.00
Navarretia Breweri	1.00	5.74	3.87	2.87	1.87
Orthocarpus hispidus	0.87	5.21	3.48	2.61	1.74
Penstemon Rydbergii	0.87	3.48	2.61	0.87	0.87
Perideridia sp.	1.00	8.00	9.00	4.26	3.13
Plagiobothrys leptocladus	1.13	6.00	4.00	3.00	2.00
Polygonum arenastrum	1.87	8.00	7.00	4.39	2.70
Potentilla gracilis	2.00	6.00	4.00	2.87	1.00
Senecio integerrimus	1.00	4.48	2.74	1.00	1.00
Sidalcea oregana	2.00	6.00	4.00	2.13	1.13
Sisyrinchium idahoense	1.74	3.48	2.61	9.00	9.00
Stellaria longipes	1.00	5.13	4.00	3.00	2.00
*Taraxacum officinale**	2.00	5.00	5.00	3.00	3.20
*Trifolium cyathiferum**	1.74	2.61	1.74	0.87	0.87
*Trifolium Wormskioldii**	0.87	3.48	2.61	2.61	1.74
Zigadenus sp.	0.87	9.00	9.00	0.87	0.87

*Sage grouse food forbs.

Table 8. Forb abundance and phenology indices for South Catnip Creek.

		Phenology			
	Abundance	1	2	3	4
*Achillea lanulosa**	2.74	6.33	4.39	4.21	4.21
*Agoseris glauca**	0.91	2.81	2.35	1.70	3.38
Arnica longifolia	0.89	1.87	6.28	5.93	3.49
Aquilegia sp.	0.08	0.65	0.65	0.65	0.65
*Aster occidentalis**	2.62	7.26	7.27	6.72	5.95
*Astragalus agrestis**	0.92	4.89	7.35	4.57	5.53
Camissonia tenacetifolia	0.26	1.23	1.14	0.81	0.81
Cirsium sp.	2.53	2.56	4.70	7.35	4.30
Epilobium paniculatum	0.08	5.86	4.48	3.78	2.88
Haplopappus lanceolatus	0.74	2.98	2.23	1.49	0.74
Hypericum formosum	0.71	9.00	9.00	5.58	5.58
Iris missouriensis	1.58	0.97	0.79	0.79	0.79
Linum perenne	0.18	9.00	9.00	1.43	1.43
Lupinus sp.	0.91	9.00	9.00	9.00	1.92
Montia Chamissoi	0.79	9.00	9.00	9.00	3.72
Orthocarpus hispidis	0.69	9.00	9.00	9.00	2.07
Perderidia sp.	0.87	6.96	6.62	5.22	5.22
Polygonum arenastrum	0.05	0.36	0.36	0.34	0.34
Polygonum Kelloggii	0.09	9.00	0.18	0.18	0.09
Potentilla anserina	0.01	9.00	9.00	9.00	0.04
Potentilla biennis	0.05	0.38	0.38	0.38	0.38
Potentilla gracilis	2.83	7.90	8.00	7.14	5.29

Table 8 Continued

Rumex sp.	0.08	9.00	9.00	9.00	0.65
Sidalcea oregana	1.10	3.68	7.01	6.90	4.46
Sisyrinchium idahoense	0.69	4.15	9.00	9.00	9.00
Stellaria longipes	1.65	9.00	9.00	0.87	0.87
*Taraxacum officinale**	2.70	4.87	5.11	6.98	4.49
Valleria edulis	0.85	9.00	9.00	5.90	5.90

*Sage grouse food forbs.

Table 9. Forb abundance and phenology indices for Bald Mountain Creek-Range.

		Phenology			
	Abundance	1	2	3	4
Achillea lanulosa*	1.30	5.90	5.09	2.83	1.00
Agoseris glauca*	1.49	3.41	3.37	1.12	1.12
Artemisia ludoviciana*	0.93	5.78	5.57	5.06	4.34
Aster campestris	1.48	5.63	4.85	1.77	0.83
Aster occidentalis*	0.29	2.33	2.33	1.75	1.75
Astragalus agrestis*	0.16	0.41	0.41	0.41	0.41
Boisduvalia densiflora	0.21	1.67	1.25	0.84	0.63
Boraginaceae sp.	0.42	1.67	0.84	0.42	0.21
Camissonia tenacetifolia	1.76	9.00	9.00	9.00	4.06
Cirsium sp.	1.08	4.98	4.70	2.98	1.73
Descurainia Sophia*	0.21	1.25	0.63	0.42	0.21
Epilobium adenocaulon	0.21	1.67	1.25	0.84	0.63
Gnaphalium palustre	0.37	1.16	1.16	0.87	0.58
Haplopappus lanceolatus	1.29	4.66	3.89	1.80	1.11
Iris missouriensis	1.60	1.42	0.71	0.71	0.71
Iva axillaris	0.21	1.67	9.00	9.00	9.00
Lotus Purshianus	3.39	9.00	9.00	2.92	1.93
Lupinus sp.	0.40	2.42	1.64	1.42	1.02
Madia gracilis	0.21	1.25	0.84	0.42	0.21
Microsteris gracilis*	0.21	0.63	0.42	0.21	0.21
Monolepis Nuttalliana*	0.21	0.84	0.63	0.42	0.21
Navarretia Brewerii	0.50	1.75	1.58	1.16	0.87

Table 5 Continued

Navarretia propinqua	0.58	2.16	2.43	1.16	0.87
Perideridia sp.	0.20	1.17	1.17	0.59	0.39
Plagiobothrys leptocladus	1.07	2.84	1.51	1.14	1.05
Polemoniaceae sp.	0.21	1.25	1.25	0.84	9.00
Polygonum arenastrum	1.07	3.70	2.92	2.11	1.93
Potentilla anserina	0.16	0.41	0.41	0.41	0.41
Potentilla biennis	0.21	9.00	9.00	1.67	1.67
Potentilla gracilis	0.92	6.65	5.78	5.39	5.63
Rumex sp.	0.50	9.00	9.00	1.29	1.29
Sidalcea oregana	0.51	1.25	0.91	0.80	0.51
Stellaria longipes	0.42	1.67	0.63	0.21	0.21
*Taraxacum officinale**	2.76	5.63	6.54	4.77	1.92
*Trifolium cyathiferum**	1.79	4.51	1.75	1.21	1.21
Veronica peregrina	0.37	1.33	1.16	0.42	0.29
Verbascum Thapsis	0.29	2.33	2.25	2.25	2.16

*Sage grouse food forbs.

Table 10. Forb abundance and phenology indices for Bald Mountain Creek-Refuge.

		Phenology			
	Abundance	1	2	3	4
*Achillea lanulosa**	1.16	6.00	6.00	2.00	1.92
*Agoseris glauca**	1.08	5.08	4.48	1.92	1.00
Arnica longifolia	0.92	5.51	3.67	3.67	2.72
*Artemisia ludoviciana**	3.00	8.00	7.00	7.00	5.84
Aster campestris	3.08	8.00	6.00	6.00	5.80
*Aster occidentalis**	0.92	7.35	7.35	6.43	5.51
*Astragalus filipes**	0.92	2.76	2.76	0.92	0.92
Boisduvalia densiflora	0.92	7.35	5.51	3.67	3.67
Boraginaceae sp.	0.92	5.51	3.67	2.76	0.92
Camissonia tenacetifolia	2.76	4.59	4.59	4.59	4.59
Cirsium sp.	1.00	7.59	7.43	7.43	7.43
*Descurainia Sophia**	0.08	0.33	0.24	0.08	0.08
Gnaphalium palustre	1.84	3.67	3.67	2.76	2.76
Haplopappus lanceolatus	0.92	5.51	2.76	1.84	1.84
Iris missouriensis	0.92	3.67	2.76	1.84	1.84
*Lactuca Serriola**	0.92	7.35	5.51	3.67	2.76
Lupinus sp.	0.92	5.51	3.67	2.76	2.76
*Microsteris gracilis**	0.16	0.16	0.08	0.08	0.08
*Monolepsis Nuttalliana**	0.92	3.67	2.76	0.92	0.92
Navarretia Brewerii	0.92	5.51	3.67	3.67	0.92
Navarretia propinqua	0.92	5.51	3.67	3.67	1.84
Perideridia sp.	1.08	7.84	6.00	4.00	2.92

Table 10 Continued

Plagiobothrys leptocladus	1.84	5.51	3.67	2.76	1.84
Polygonum arenastrum	1.84	7.35	6.43	6.43	6.43
Potentilla anserina	0.92	5.51	9.00	4.59	4.59
Potentilla biennis	0.92	7.35	7.35	7.35	7.35
Rumex sp.	1.84	3.67	2.76	2.76	2.76
Sidalcea oregana	2.00	6.00	3.92	2.92	1.92
*Taraxacum officinale**	2.08	5.00	5.00	6.05	6.05
*Tragopogon dubis**	0.92	7.35	5.51	9.00	1.84
*Trifolium cyathiferum**	2.92	3.84	3.76	1.00	1.00
Verbascum Thapsis	0.92	7.35	7.35	7.35	7.35

*Sage grouse food forbs.

Table 11. Forb abundance and phenology indices for Hobble Springs.

		Phenology			
	Abundance	1	2	3	4
*Achillea lanulosa**	2.35	6.01	5.93	2.60	1.00
*Agoseris glauca**	1.59	3.59	2.24	1.24	1.24
Allium sp.	0.34	2.02	1.01	0.34	0.34
Arnica longifolia	1.15	2.79	2.11	1.30	1.06
*Aster occidentalis**	1.37	8.00	3.97	3.04	2.80
*Astragalus agrestis**	0.34	0.67	0.34	0.34	0.34
Astragalus sp.*	0.24	1.20	1.20	1.20	1.20
Brassicaceae sp.	0.34	1.35	1.01	0.34	0.34
Camissonia tenacetifolia	0.75	3.13	2.72	2.72	0.75
Chenopodium sp.	0.41	9.00	9.00	9.00	1.23
Cirsium sp.	0.35	0.72	0.70	0.35	0.35
*Crepis acuminata**	0.34	1.01	1.01	0.34	0.34
Epilobium adenocaulon	0.58	3.94	2.45	0.82	0.82
Epilobium paniculatum	0.83	4.73	3.55	1.53	1.18
Erigeron divergens	1.91	3.55	1.94	1.17	0.76
Haplopappus lanceolatus	1.17	4.56	3.07	1.52	0.76
Iris missouriensis	1.23	3.54	2.55	2.14	1.47
Iva axillaris	1.49	5.97	2.98	3.08	3.08
Lotus Purshianus	0.48	1.92	1.44	0.72	0.48
Lupinus sp.	0.67	2.02	1.35	1.01	0.67
*Microsteris gracilis**	1.15	1.76	0.75	0.75	0.75
Montia Chamissoi	0.48	1.44	1.44	1.20	1.20

Table 11 Continued

Orthocarpus hispidus	0.48	1.44	0.96	0.48	0.24
Penstemon Rydbergii	0.66	3.98	2.65	1.14	0.90
Peridaridia sp.	1.83	7.33	6.00	4.48	2.83
Potentilla gracilis	1.58	6.01	3.59	1.90	1.65
Sidalcea oregana	0.93	3.55	2.37	1.07	0.59
Senecio hydrophilus	0.48	1.68	1.68	0.96	0.96
Senecio integerrimus	0.75	0.75	0.75	0.75	0.75
Senecio serra	0.34	1.01	1.01	0.34	0.34
Stellaria longipes	1.17	3.55	1.31	1.07	0.59
*Taraxacum officinale**	2.25	5.00	3.59	1.96	1.48
*Tragopogon dubius**	0.67	1.35	0.67	0.34	0.34
*Trifolium cyathiferum**	1.40	2.65	1.17	0.66	0.66
*Trifolium Wormskioldii**	0.24	9.00	9.00	0.96	0.96
Zigadenus sp.	0.34	9.00	9.00	0.34	0.34

*Sage grouse food forbs.

Table 12. Forb abundance and phenology indices for Lower Last Chance.

		Phenology			
	Abundance	1	2	3	4
Achillea lanulosa*	2.99	6.00	6.00	2.00	1.05
Agoseris glauca*	1.98	4.78	4.78	2.06	1.11
Allium sp.	0.12	0.70	9.00	9.00	0.12
Amsinckia tessellata	0.08	9.00	9.00	0.41	0.33
Arnica longifolia	1.84	6.67	5.60	2.90	1.07
Artemisia ludoviciana*	0.16	0.66	0.58	0.33	0.25
Aster campestris	0.87	6.97	9.00	9.00	9.00
Aster occidentalis*	2.99	8.00	5.25	5.04	1.33
Astragalus agrestis*	0.19	9.00	0.47	0.47	0.47
Astragalus lentiginosus*	0.08	0.25	0.16	0.08	0.08
Boisduvalia densiflora	0.91	7.25	5.44	3.69	3.62
Boraginaceae sp.	1.74	3.48	2.61	1.74	0.87
Brassicaceae sp.	1.07	3.95	3.05	1.22	1.15
Camissonia tenacetifolia	1.02	9.00	9.00	9.00	2.02
Chamaesaracha nana	0.87	0.87	0.87	0.87	0.87
Chenopodium sp.	0.08	0.58	9.00	9.00	9.00
Cirsium sp.	1.98	2.09	0.99	0.99	0.99
Collinsia parviflora	0.15	0.12	0.12	0.12	0.12
Delphinium Nuttallianum	1.74	5.23	0.87	0.87	0.87
Epilobium adenocaulon	0.97	5.98	3.18	1.06	1.14
Epilobium paniculatum	0.99	7.91	6.02	2.93	2.06
Erigeron divergens	1.04	5.72	2.94	1.04	1.04

Table 12 Continued

Gnaphalium palustre	0.95	9.00	9.00	2.86	0.95
Haplopappus lanceolatus	1.94	5.93	3.95	2.09	1.89
Hypericum formosum	0.01	0.08	0.07	0.03	0.02
Iris missouriensis	0.23	0.43	0.35	0.35	0.12
Iva axillaris	1.19	7.91	4.09	2.87	2.88
Lactuca Serriola*	0.03	9.00	9.00	9.00	0.14
Lithophragma tenellum	0.03	0.28	9.00	9.00	9.00
Lupinus sp.	0.94	7.25	2.75	2.72	1.81
Madia gracilis	0.91	7.18	9.00	2.75	2.72
Microsteris gracilis*	1.78	0.91	0.91	0.91	0.91
Monolepis Nuttalliana*	0.08	0.33	0.25	0.25	0.08
Montia Chamissoi	0.15	0.84	0.60	0.51	0.34
Montia linearis	1.89	0.99	0.99	0.99	0.99
Navarretia Brewerii	0.12	9.00	9.00	0.15	0.12
Navarretia propinqua	1.81	5.44	3.69	0.94	0.94
Orthocarpus luteus	1.91	6.00	4.19	2.22	1.19
Penstemon Rybergii	1.12	6.02	3.99	2.98	1.11
Perideridia sp.	1.92	6.22	6.00	4.19	4.02
Plagiobothrys leptocladus	1.89	5.93	1.16	0.99	0.99
Polygonum arenastrum	0.08	0.66	0.49	0.49	0.49
Polygonum Kelloggii	0.87	5.23	1.74	0.87	0.87
Potentilla biennis	0.09	0.75	0.67	0.67	0.56
Potentilla gracilis	1.13	6.09	5.84	2.07	1.20
Rumex sp.	1.03	4.28	3.01	3.00	3.00
Sidalcea oregana	2.00	6.00	4.00	2.08	1.18
Sisyrinchium idahoense	0.01	0.09	0.09	0.07	9.00

Table 12 Continued

Senecio hydrophilus	0.38	6.18	5.31	9.00	9.00
Senecio integerrimus	0.95	3.73	1.04	0.95	0.95
Stellaria longipes	1.85	5.79	1.44	1.34	1.34
*Taraxacum officinale**	2.86	5.00	5.00	3.12	1.38
*Tragopogon dubius**	0.91	3.62	2.68	1.78	1.78
*Trifolium cyathiferum**	3.78	4.11	1.42	1.34	1.00
*Trifolium Wormskioldii**	0.09	0.58	0.56	0.46	0.12
Urtica sp.	0.08	9.00	9.00	0.33	9.00
Zigadenus sp.	1.89	9.00	9.00	0.99	0.99

*Sage grouse food forbs.

Table 13. Forb abundance and phenology indices for Upper Last Chance.

		Phenology			
	Abundance	1	2	3	4
Achillea lanulosa*	2.24	6.00	4.41	2.19	1.51
Agoseris glauca*	0.89	4.16	2.16	1.40	1.15
Arnica longifolia	1.89	4.77	3.46	2.18	1.20
Artemisia ludoviciana*	0.41	2.79	2.41	2.44	1.96
Aster occidentalis*	1.75	8.00	5.77	3.90	2.89
Astragalus agrestis*	0.80	3.01	2.14	1.54	0.74
Barbarea othrocaeras	0.30	9.00	9.00	9.00	0.30
Boisduvalia densiflora	0.04	9.00	9.00	9.00	0.27
Camissonia tenacetifolia	0.53	3.19	2.94	1.55	1.07
Cirsium sp.	1.01	2.35	1.06	0.76	0.76
Collinsia parviflora	0.77	0.60	0.60	0.60	0.60
Delphinium Nuttallianum	0.52	0.50	0.42	0.28	0.28
Epilobium adenocaulon	0.31	1.73	1.17	0.85	0.55
Epilobium paniculatum	0.99	5.54	4.38	2.49	1.33
Erigeron divergens	0.44	1.39	0.69	0.28	0.23
Erigeron sp.	0.03	0.71	0.06	0.06	0.03
Erysimum repandum	0.25	9.00	9.00	0.38	0.25
Gnaphalium palustre	0.04	0.27	0.18	0.13	0.04
Haplopappus lanceolatus	0.37	1.63	1.17	0.60	0.39
Iris missouriensis	1.42	2.71	1.58	1.32	0.96
Iva axillaris	0.59	3.11	2.41	1.67	0.85
Lappula Redowskii	0.18	1.10	0.73	0.55	0.18

Table 13 Continued

Linum perenne	1.19	3.74	2.55	1.42	0.99
Lotus Purshianus	0.07	0.40	0.40	0.07	0.07
Lupinus sp.	0.45	2.70	1.80	1.77	0.90
Madia gracilis	0.04	9.00	9.00	9.00	0.09
*Microsteris gracilis**	0.27	1.46	0.27	0.27	0.27
Montia Chamissoi	0.15	0.62	0.49	0.29	0.11
Montia linearis	1.27	0.84	0.78	0.78	0.78
Navarretia Brewerii	0.09	0.27	0.18	0.09	0.04
Navarretia propinqua	0.42	2.53	1.61	0.66	0.42
Orthocarpus hispidus	0.42	2.53	2.16	1.69	1.08
Penstemon Rydbergii	1.15	6.00	3.82	2.63	1.31
Perideridia sp.	1.97	6.21	4.65	4.65	3.41
Plagiobothrys leptocladus	0.83	4.61	2.66	1.79	0.77
Polygonum Kelloggi	0.04	9.00	9.00	0.04	0.04
Potentilla gracilis	1.64	5.21	3.59	2.76	1.53
Rumex sp.	0.38	1.50	1.12	1.12	0.96
Sidalcea oregana	1.51	5.89	3.51	1.27	0.98
Sisyrinchium idahoense	0.02	0.11	0.08	9.00	9.00
Senecio hydrophilus	0.77	9.00	9.00	1.53	1.17
Senecio integerrimus	0.45	0.81	0.45	0.45	0.45
Senecio serra	0.56	3.81	9.00	9.00	9.00
Stellaria longipes	1.45	4.77	2.81	1.32	0.83
*Taraxacum officinale**	1.89	3.97	3.26	2.44	1.45
*Tragopogon dubius**	0.21	1.03	1.01	1.01	0.43
*Trifolium cyathiferum**	2.25	3.18	1.66	0.99	0.96
*Trifolium Wormskioldii**	0.96	2.40	1.68	0.48	0.48

Table 13 Continued

Valleria edulis	0.54	1.65	1.32	1.26	0.30
Veronica peregrina	0.04	0.27	0.18	0.04	0.04
Zigadenus sp.	0.24	1.43	0.95	0.48	0.24

*Sage grouse food forbs.