AN ABSTRACT OF THE THESIS OF

THOMAS R BUNCH for the M. S. in Range Management
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Title FORAGE PRODUCTION ON RANGE SITES IN EAST CENTRAL MALHEUR COUNTY, OREGON

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Objectives of this investigation were two-fold: (1) to determine crested wheatgrass production on selected range sites and (2) to evaluate present and potential production on public and private lands in the study area. Field studies were carried out in 1963 and 1964 near Jordan Valley, Malheur County, Oregon, on the East Cow Creek and Soldier Creek Allotments of the Bureau of Land Management, Vale Grazing District.

Sixteen paired exclosures with nine, 9.6-square-foot circular plots within each exclosure were used to determine production on range sites in improved and unimproved condition. The improved areas had been seeded to crested wheatgrass. Three different range sites were differentiated on the basis of dominant shrub, dominant grass, soils, landform, and aspect. Crested wheatgrass two-year

average production varied from 250 to 1,350; 250 to 1,850; and 150 to 1,600 pounds per acre on Sites I, II, and III, respectively.

A range inventory method was developed and the entire East Cow Creek Allotment (50,175 acres) and permittee properties (14,010 acres) were inventoried. Present production, potential production, and information for determining acreages in need of and suitable for various range improvement and management practices were obtained.

FORAGE PRODUCTION ON RANGE SITES IN EAST CENTRAL MALHEUR COUNTY, OREGON

by

THOMAS R BUNCH

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Associate Professor of Range Management

In Charge of Major

Redacted for Privacy

Head of Department of Animal Science

Redacted for Privacy

Head of Department of Farm Crops

Redacted for Privacy

Dean of Graduate School

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INTRODUCTION

The need for understanding a range resource precipitated this study. The Agricultural Economics Department of Oregon State University in developing a range research project in linear programming lacked physical production data to make their desirable economic interpretations. This study was initiated as a companion investigation to supply production figures from various improvement practices used as alternatives in their economic evaluations.

Large portions of the semi-arid range lands of Oregon are producing forage considerably below their productive capacity. Production is a real concern to both public agencies and private landowners. A thorough understanding of the range site is basic to estimating potential production or to determining present production. Seeding and sagebrush spraying have been used to obtain increased forage on many range areas throughout the Northwest.

Crested wheatgrass (Agropyron desertorum (Fisch.) Schult.), an introduced perennial bunchgrass, has been seeded on many semi-arid range lands in Oregon. This grass has become a favorite with many land-use administrators as successful seedings are more common with it than many other species. Since 1962, an accelerated

range improvement program has been underway in Malheur County, Oregon. Much of the activity has centered around crested wheatgrass seedings.

Range management physical input data were needed for public and private range lands, in the study area, to be analyzed by linear programming. Objectives of the study were two-fold: (1) determine crested wheatgrass production on selected range sites, and (2) determine present and potential production on public and private lands in the study area.

To accomplish the first objective, a sampling procedure was designed to measure and compare production on selected range sites in an improved and unimproved condition. The second objective was accomplished by developing a range inventory method that provided information for determining acreages in need of and suitable for various improvement and management practices.

DESCRIPTION OF THE STUDY AREA

The study area included the entire East Cow Creek Allotment and most of the Soldier Creek Allotment of the Bureau of Land Management, Vale District. The area is bounded on the east by the Idaho State line, the north by Cow Creek and Jordan Creek and the south and west by the Owyhee River. Rome, Oregon, is located near the west end of the study area and Jordan Valley near the east (Figure 1). Cultivated land in the area lies predominately along Jordan Creek. The elevations range from approximately 3,400 to 5,000 feet above sea level.

Physiography

The Cow Creek and Soldier Creek Allotments are located within the Payette section of the Columbia Plateaus province, as classified by Newcomb (20, p. 159-164). His classification includes four groups of underlying rock: (1) The Owyhee basalt of Miocene age, (2) sedimentary beds of the Rome Basin probably of Miocene and Pliocene age, (3) young lavas which block Cow Creek and Cow Lakes, and (4) broad alluvial deposits upstream from where the young-lava dammed off Jordan Creek, near the present community of Danner.

The study area is a dissected plateau with little, if any,

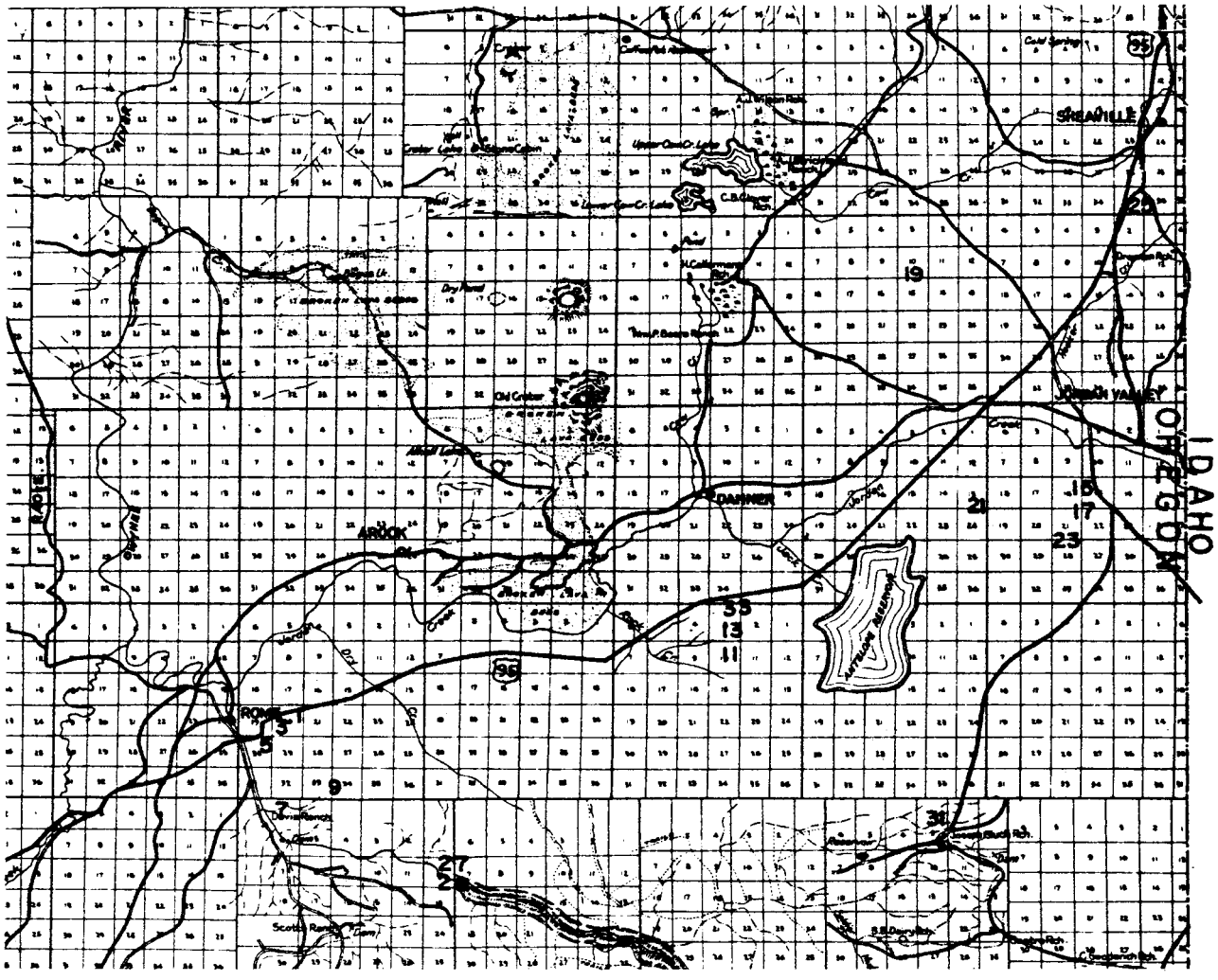

Figure 1. Study area with numbers (boldface) indicating sample plot locations.

interior drainage. It is in the smoother portion of the Owyhee Uplands which Dicken (9, p. 77) describes as more plateau-like than its associated basin range or high lava plains. Baldwin (3) describes the area as a broad north plunging basin drained by the Owyhee River with less prominent faults than the basin and range area in Oregon.

Newcombe (20, p. 161) describes the area as consisting of multiple plateaus with many shallow creek valleys which run water but a few days in most years. He states, "from much of the area the runoff is small."

Sedimentary material is exposed extensively just northeast of the study area, in the Sucker Creek Valley. These sediments are predominately capped by lava in the immediate study area (Figure 2).

Jordan Craters (24, p. 48) consisting of four recent volcanoes are located in the area. Lava flow from the northern most volcano dammed off Cow Creek forming the Cow Lakes. The recent flow, which covers approximately 50 to 60 square miles, has no soil formation or vegetation on it. Older flows have some soil formation and scattered vegetation.

Climate

The study area has a semi-arid climate with cold winters and warm, very dry summers. Danner, Oregon, located in the approximate center of the study area, has a 20-year mean annual

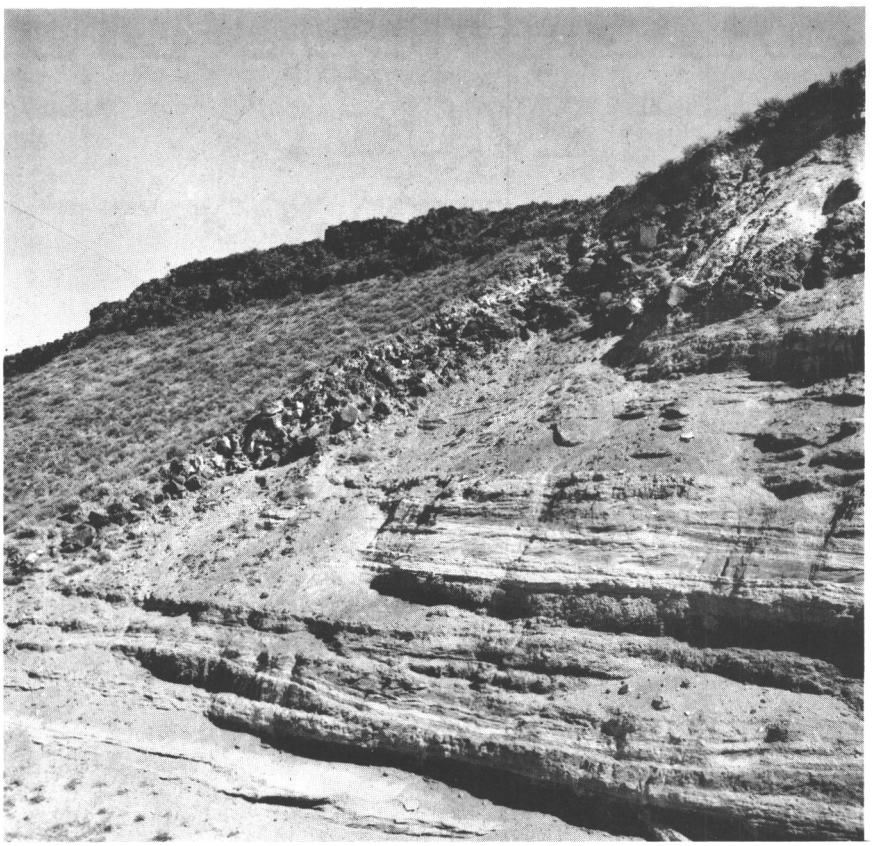

Figure 2. Typical geological formation in study area showing sediments capped by lava.

precipitation of 11.57 inches with May being the wettest month of the year (Figure 3). According to Sneva and Hyder (27, p. 8), the median annual precipitation for the Danner Station is 10.8 inches.

Most of the moisture occurs as snow between the months of November and March. July, the hottest month of the year, has a mean monthly temperature of 68.5°F. January, the coldest month, has a mean monthly temperature of 25.6°F.

Soils

According to the U. S. Department of Agriculture Yearbook, Soils and Men (29), the study area is within the Portneuf-Sagemore soil association, bordered by the McCammon-Deschutes soil association. Soils in the area are mapped in the Sierozem zone by Cheney, et al. (5). This broad level of classification is of little value when working at the more refined range site level.

Culver (7, p. 81-97) described ten tentative soil series in and near the study area. Seven of these series are classified as Brown soils, two as Minimal Brown soils, and one as Lithosolic.

There has not been an intensive soil survey in southern Malheur County. Therefore, correlated soil series have not been set up. However, soils in the area may be similar to those in southwestern Idaho as described by Fosberg (12). No soil correlations were attempted in this study.

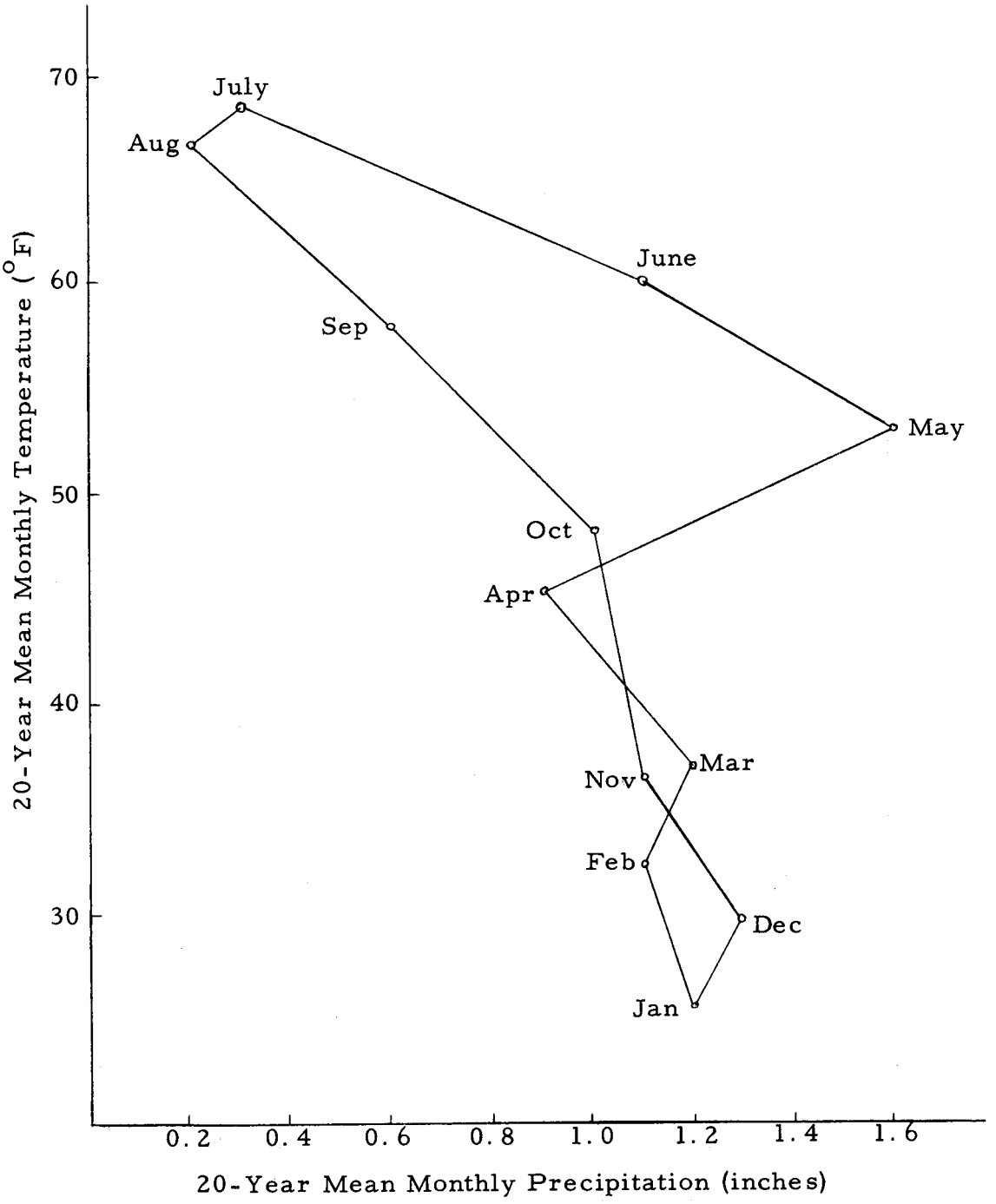

Figure 3. Hythergraph for the Danner, Oregon, Weather Station, 1944-1963 inclusive.

Vegetation

The only known intensive vegetation study in the area is that made by Culver (7). Axelrod (2), Eckert (11), Hansen (13), Anderson (1), Billings (4), Daubenmire (8), Tueller (28), and Hironaka (14) have made vegetation studies in ecologically similar areas.

Three major types based on the dominant shrubs are identified by Culver (7, p. 20). These three types are: (1) Artemisia tridentata, Nutt., (2) Artemisia rigida (Nutt.) Gray, and (3) Artemisia arbuscula, Nutt. Culver also states that these types can be broken down into specific associations, each with its related soils. Specific vegetation-soil relationships pertinent to this study are discussed later.

METHODS AND PROCEDURES

Location of Study Plots

A reconnaissance of East Cow Creek and Soldier Creek Allotments was made to locate suitable sample sites. It was necessary to determine increases in herbage production, on selected range sites, resulting from seeding crested wheatgrass. To accomplish this, study locations were selected so that paired improved and unimproved plots were included in a single range site. Consideration was given to spacial distances and vegetation aspects; in addition, soil pits were dug and soils examined. Where little evidence of native vegetation remnants existed on the improved areas, primary emphasis was placed on soils in deciding comparability of study plots.

Range Sites

A range site is defined here as an environmental unit of the landscape with inherent management limitations. Due to environmental influences, some sites will produce more of a given forage than others. All areas do not require the same management. Procedures were developed for grouping sample plots into range sites.

Sample areas with different dominant shrub layers were put into different range sites. The dominant shrub on the seeded areas was identified by remnants remaining after plowing and by vegetation

on adjacent non-plowed areas. Within a dominant shrub group, sample areas were split again by their dominant grass species. This was interpreted to be desirable perennial species as identified by remnants. For this study, Agropyron spicatum (Pursh) Scribn. and Smith, Festuca idahoensis Elmer, and Elymus cinereus Scribn. and Merr. were considered to be the desirable perennial species. General soils information obtained from soil pits (Figure 4), land forms, and aspects at the sample locations were also recorded and used as a basis of grouping sample plots according to range site.

Production

Paired, 16-foot-square exclosures, made of woven wire, were constructed on selected sample sites (Figure 5). One exclosure of each pair was located on the improved and one on the native or unimproved area. Exclosures were for the purpose of protecting sample plots from grazing livestock.

Nine, 9.6-square-foot circular plots were arranged in each exclosure. A two and a half foot border remained between sample plots and the inside edge of the exclosure.

Since production data were to be taken for two years, it was necessary to determine which of the sample plots would be clipped each year. The nine, 9.6-square-foot circular plots within each exclosure were numbered from north to south beginning with number

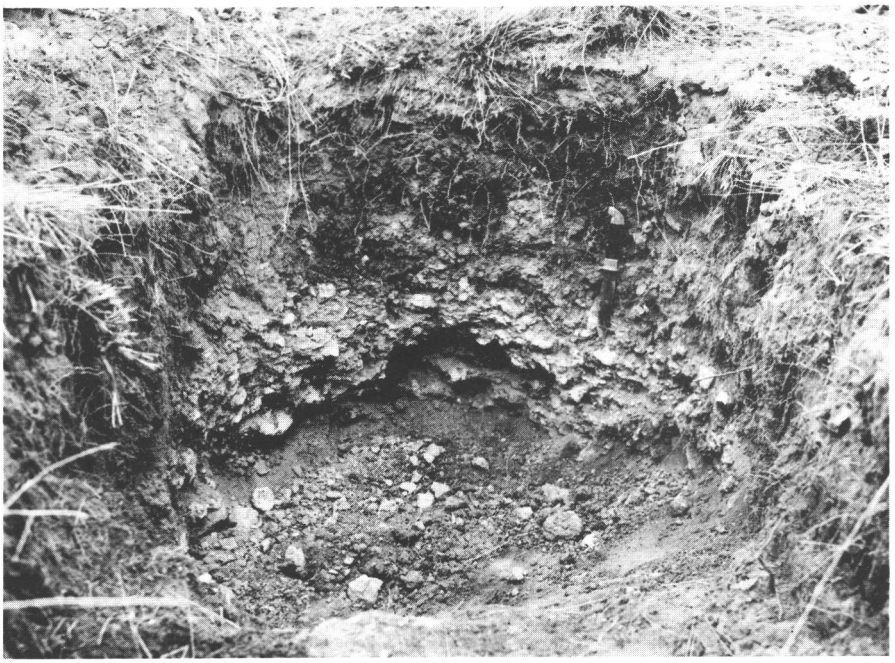

Figure 4. Example of pit excavated for gathering soils data.

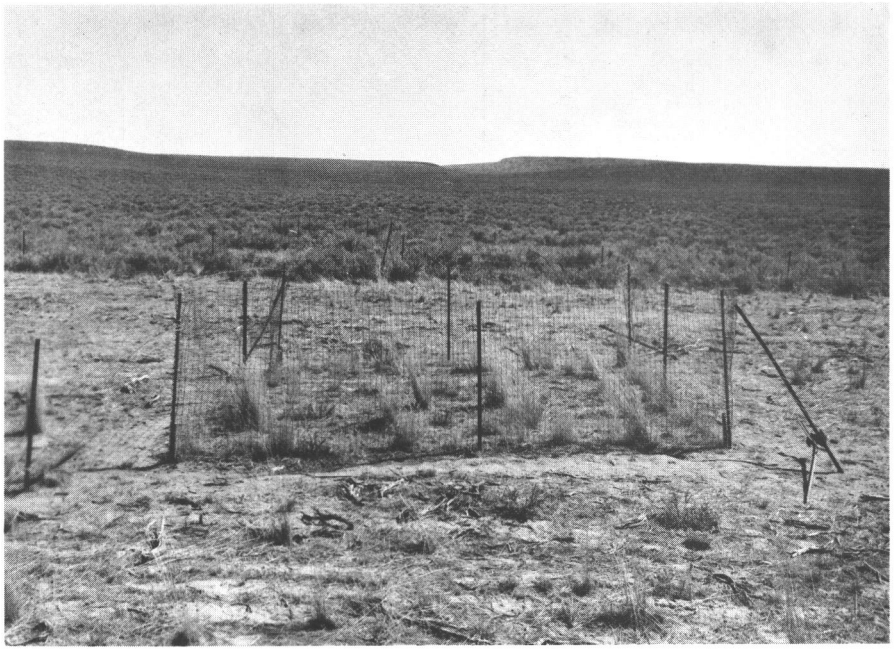

Figure 5. Example of paired exclosures showing improved (foreground) and unimproved (background) plots on the same site.

one in the northwest corner and ending with number nine in the southeast corner. Seventy-five sets of nine random numbers were drawn from Li's (18, p. 507-516) random number table. The first four random numbers drawn represented plots to be clipped in 1963. The second four numbers drawn were to be clipped in 1964. One plot area remained unclipped in the two-year study.

All grasses and forbs on the sample plots were clipped at ground level and separated by species at time of clipping. Time of clipping was determined by the growth stage of crested wheatgrass. Clipping was started when seeds were in the dough stage and completed prior to time of seed maturity. Hyder and Sneva (16) indicate herbage production reaches maximum shortly after anthesis.

Samples were oven-dried to an average of eight percent moisture, weighed to the nearest gram, and expressed in pounds per acre. Temperature could not be fully controlled in the large forage drying facilities used. Therefore, some samples were oven-dried in a small controllable facility, and the average moisture calculated to be eight percent. Production was based on mean weight of forage clipped from four sample plots in each exclosure, each year. Forage yields were also corrected to the median year using the formula of Sneva and Hyder (27, p. 4-6). According to them, 75 to 90 percent of the yield fluctuations among years can be attributed to variation in precipitation amounts.

Frequency

A rating of the relative degree of success of range seedings was desired. It appeared that a frequency technique would provide the required information.

A frequency sampling procedure was patterned after Hyder and Sneva (15). A welded steel frame, 2-feet square, subdivided into four, 1-foot squares, with a 2-inch square located in the lower right-hand corner of each 1-foot square, was used. Presence of all plant species occurring in the 2-inch square and the 1-foot square was recorded. When recording frequency, for a plant to be counted, it had to be rooted at least 50 percent within the designated square. A plant recorded in the 2-inch square was automatically counted as being present in the 1-square-foot plot.

To obtain meaningful data on high density species, the 2-inch square was added to the design of Hyder and Sneva. Cheatgrass, Bromus tectorum L. was common enough that 100 percent frequency was obtained on some range sites when using the 1-foot square.

Frequency data were taken near each exclosure and on the same range site. Sampling procedures were as follows: A 100-foot tape was stretched between two pins. At 10-foot intervals starting at the 10-foot mark, (10, 20, 30 -- 100), a continuous belt was run at right angles by placing the 2 x 2-foot frame five times for a total

of 10 linear feet from the baseline tape. This provided 20, square-foot observations per cluster or 200 square feet of sample area from which to calculate mean frequency of the species. This technique also provided 800 square inches of sample area from which mean frequency of high occurring species, such as cheatgrass, was calculated.

Inventory

A major portion of the research effort in this study was directed toward providing the Agricultural Economics Department with basic data for use in a linear programming project. The Agricultural Economics Department, after consultation with the Range Management staff, preferred information concerning the acres per animal unit month for varying periods of time throughout the grazing season in categories of seedable, sprayable, other-poor, other-good, and presently seeded to crested wheatgrass. A relatively simple, but satisfactory inventory technique was developed to provide the information.

Criteria

Criteria were developed for judging each category. For an area to be included in the seedable category, the slope had to be such that present-day equipment could be used; it had to have a soil of

sufficient depth to support a satisfactory stand of crested wheatgrass; the soil had to be sufficiently free of stone to allow plowing and drilling; and the more desirable perennial grass species such as Agropyron spicatum (Pursh) Scribn. and Smith, Festuca idahoensis Elmer, and Elymus cinereus Scribn. and Merr. were practically absent.

The sprayable category required an understory of desirable perennial grass species in sufficient quantity to respond to the removal of the shrub species. Sufficient quantity was defined as plants present in the interspaces between the shrubs and spaced with no greater distance than man can step, which would be approximately four feet. Two species, Agropyron spicatum and Festuca idahoensis, were considered as the desirable perennials in making the decision of categorizing an area as sprayable.

Areas in the other-poor category were those with an undesirable vegetation cover that could not qualify as seedable or sprayable based upon above qualifications.

The other-good category were those areas having an abundance of desirable perennials and where competition from shrubs was not critical. No improvement practices would be required other than sound range management.

Present herbage production was estimated by production classes. Three classes, 0-100, 100-200, and 200-plus pounds per acre were used. For analysis, the midpoint of the first two classes,

50 and 150 pounds per acre, and 225 pounds per acre for the third class was used.

The dominant shrub type was indicated for each mapping unit and where a complex was mapped, both shrubs were recorded with the one occupying the most area indicated first.

Procedure

Aerial photos were taken to the field and each homogeneous or complex of homogeneous areas was delineated and recorded by symbolization. All homogeneous types of vegetation that could be seen on the ground and marked on the aerial photos were delineated.

Figure 6 is an example of the mapping units made in this study. Each map unit had a set of symbols indicating the categories discussed above. Appendix A explains the symbolization used in obtaining the inventory data.

Acetate overlays were produced from the aerial photos and all computations were made from the overlays. Acreages were computed for each map unit by the use of an acreage grid at a ratio of one dot to 0.996 acres. Homogeneous units were summarized for each use category. These acreages and production data by classes were supplied to the agricultural economists. Estimated potential production was also provided where applicable.

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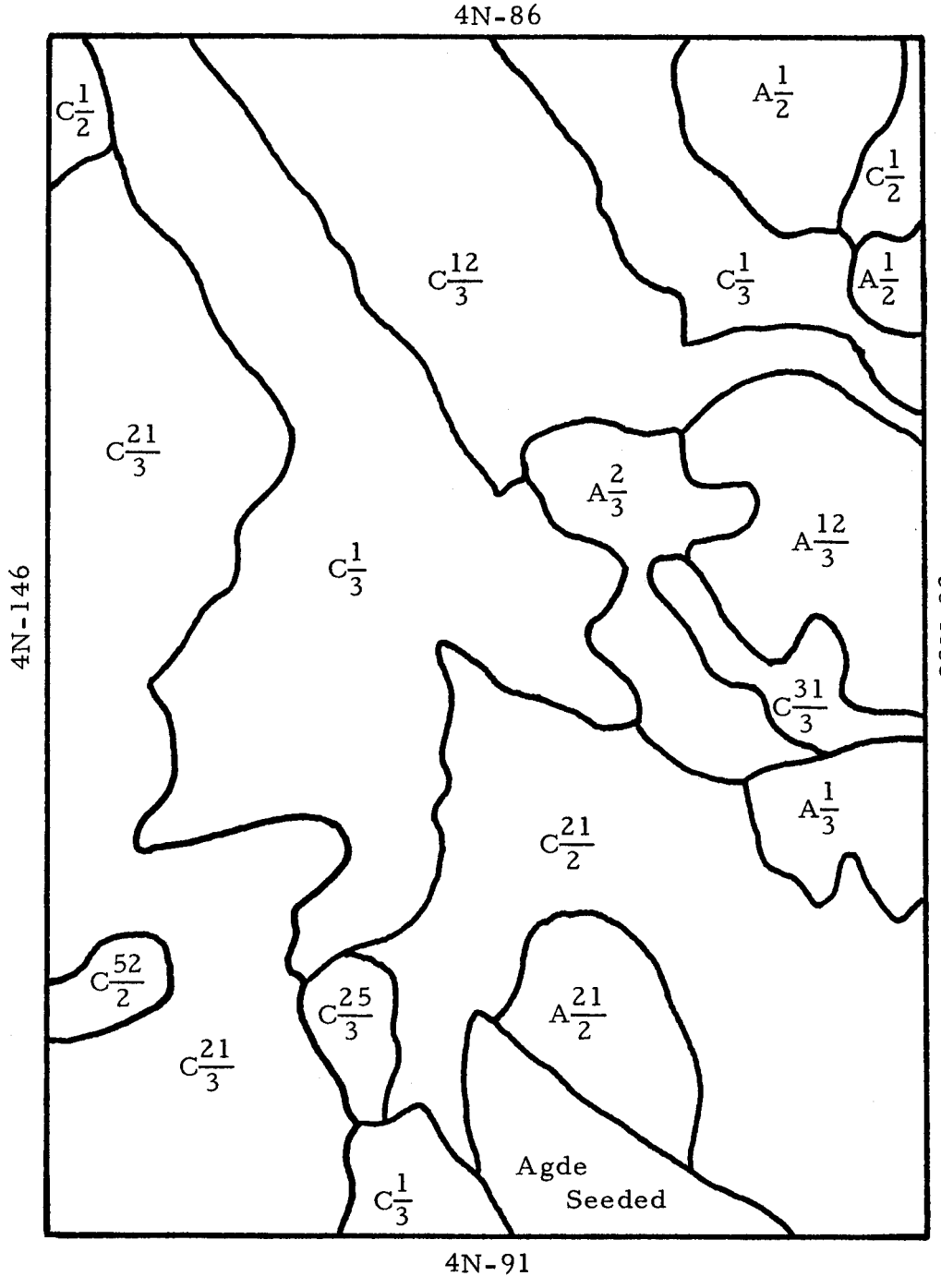

Figure 6. An overlay indicating delineations made on aerial photograph in gathering inventory data.

RESULTS

Range Sites

The 16 paired exclosures fell into three broad range sites. Site I (Figure 7) and Site II (Figure 8) had a shrub overstory of Artemisia tridentata while Artemisia arbuscula was the dominant shrub on Site III (Figure 9). Site I and Site II were differentiated by native grass dominants. Agropyron spicatum and Elymus cinereus were the dominant grasses on Site I and II, respectively.

Solum depth averaged 31, 46, and 30 inches on Sites I, II, and III, respectively. Depth to clay accumulation varied in Site I from four to nine inches and from six to nine inches in II and III.

Landform of Site II was characterized as "valley bottom" with no pronounced aspect. Site I was located on slopes varying from one to four percent with an aspect ranging from South to North-Northwest. See Appendix B for individual site grouping characteristics.

Production

Site I

Improved. Ten of the study locations represented Site I. Mean total herbage production on this site varied from 250 to 2,100 pounds per acre in 1963 and 200 to 1,100 pounds per acre in 1964 (Table 1). The two-year average varied from 300 to 1,450 pounds

Figure 7. Example of Site I occupied by Artemisia tridentata and Agropyron spicatum prior to improvement.

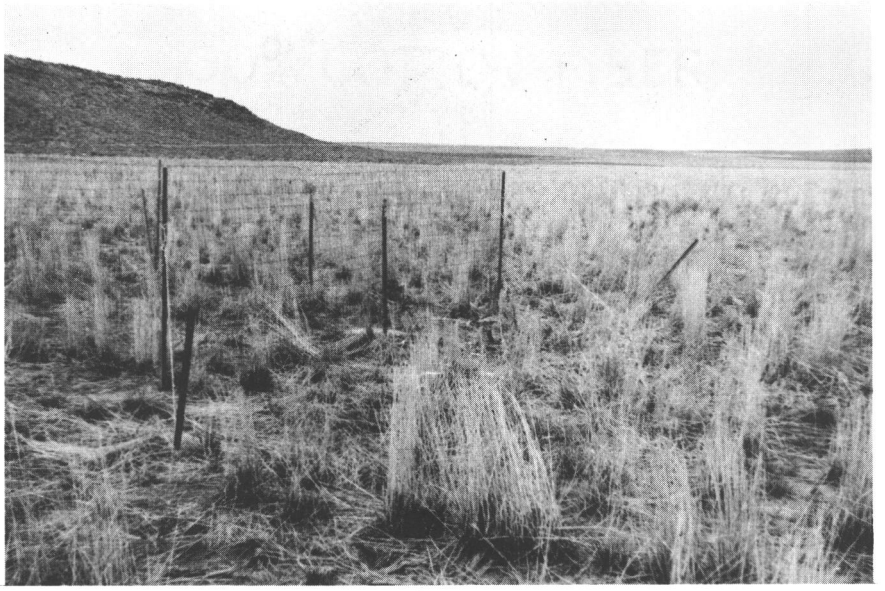

Figure 8. Example of Site II occupied by Artemisia tridentata and Elymus cinereus prior to improvement.

Figure 9. Example of Site III occupied by Artemisia arbuscula and Festuca idahoensis prior to improvement.

Table 1. Site I mean herbage production on improved locations.

Plot	Total Herbage 1963	Total Herbage 1964	2-Year Average	Crested Wheatgrass 1963	Crested Wheatgrass 1964	2-Year Average
1	700[1/] (450-800)[2/]	450 (250-800)	600	450 (250-600)	450 (250-800)	450
3	500 (400-800)	350 (250-400)	400	350 (150-750)	350 (200-400)	350
5	800 (550-1100)	550 (200-1250)	700	650 (350-950)	550 (200-1200)	600
7	450 (150-1050)	200 (100-250)	300	400 (T-1050)[3/]	150 (100-150)	250
13	1850 (1300-2150)	600 (450-800)	1200	1600 (1300-1750)	550 (450-800)	1050
33	2100 (1800-2450)	650 (400-850)	1400	2100 (1800-2400)	650 (400-850)	1350
21	1800 (950-2450)	1100 (500-2100)	1450	1300 (550-2150)	1000 (450-2050)	1150
15	1000 (500-1450)	650 (450-850)	800	550 (100-1300)	550 (350-750)	550
17	250 (100-500)	800 (450-1250)	550	100 (50-250)	650 (250-1100)	400
23	850 (450-1150)	900 (850-1000)	850	450 (200-700)	750 (600-850)	600

1/ Herbage weighed to nearest 10 pounds per acre and rounded to the nearest 50 pounds per acre for reasonable precision.

2/ Range of samples. 3/ (T) represents 20 pounds per acre and less.

per acre. The largest part of this production was made up of crested wheatgrass. This grass varied from 100 to 2,100 pounds per acre in 1963 and from 150 to 1,000 pounds per acre in 1964. The two-year average for crested wheatgrass varied from 250 to 1,350 pounds per acre.

Unimproved. Production was low on this part of Site I except for plot 22 which had a two-year average of 1,700 pounds per acre total herbage (Table 2). Cheatgrass contributed 1,600 pounds per acre of this total. Total herbage, two-year average, varied from 150 to 1,700 pounds per acre.

Site II

Improved. Plots 11, 27, and 29 were included in Site II and had a two-year average production of 1,700, 1,800, and 1,900 pounds per acre, respectively (Table 3). Little variability in total herbage production was shown among the three plots. Crested wheatgrass production varied considerably on this site as the two-year average was 250, 1,600, and 1,850 pounds per acre for plots 11, 27, and 29, respectively. Mean total herbage production was extremely variable between years. In 1963, mean total herbage production was 2,950, 2,650, and 3,200 pounds per acre; and in 1964, 450, 950, and 600 pounds per acre on plots 11, 27, and 29, respectively.

Unimproved. Total herbage production was predominantly

Table 2. Site I mean herbage production on unimproved locations.

Plot	Total Herbage 1963	Total Herbage 1964	2-Year Average	Cheatgrass 1963	Cheatgrass 1964	2-Year Average
2	150[1/] (100-200)[2/]	150 (T-250)[3/]	150	100 (T-150)	100 (T-150)	100
4	450 (350-550)	100 (50-100)	250	450 (350-550)	50 (50-100)	250
6	350 (300-400)	100 (T-150)	250	350 (300-400)	100 (T-150)	200
8	300 (200-600)	150 (100-200)	200	300 (150-450	100 (50-150)	200
14	250 (200-300)	150 (100-200)	200	--- ---	T T	T
34	50 (50-100)	[4/] ---	--	T T	--- ---	T
22	2200 (1800-2800)	1250 (850-1450)	1700	2150 (1750-2800)	1050 (600-1400)	1600
16	650 (250-1000)	700 (600-900)	700	100 (T-250)	200 (T-550)	150
18	250 (150-300)	500 (300-700)	350	150 (50-250)	350 (200-550)	250
24	650 (250-1400)	350 (250-450)	500	600 (250-1400)	T T	300

1/ Herbage weighed to nearest 10 pounds per acre and rounded to the nearest 50 pounds per acre for reasonable precision.

2/ Range of samples. 3/ (T) represents 20 pounds per acre and less.

4/ Plot 34 was plowed in the fall of 1963; therefore, no production data were obtained in 1964.

cheatgrass on the unimproved portion of this site. Two-year average total herbage production was 1,200, 450, and 150 pounds per acre with cheatgrass accounting for 1,150, 450, and 150 pounds per acre of this total (Table 4). Mean total herbage production varied from 150 to 1,800 pounds per acre in 1963 and from 200 to 600 pounds per acre in 1964.

Site III

Improved. Plots 19, 25, and 31 were included in this site and had a two-year average, total herbage production, of 1,950, 1,900 and 1,050 pounds per acre, respectively (Table 5). Two-year average crested wheatgrass production was 850, 1,600, and 150 pounds per acre for the same plots. Total herbage and crested wheatgrass production was quite variable between 1963 and 1964 (Table 5).

Unimproved. Total herbage production on the unimproved portion of this site had a two-year average of 200, 450, and 400 pounds per acre (Table 6). Cheatgrass had a two-year average of 50 pounds per acre on all three plots.

Frequency

Site I had a range in frequency from 32 to 80 percent for established crested wheatgrass in 1963 (Table 7). Of the ten plots sampled, seven were separated by a frequency of seven percent or

Table 3. Site II mean herbage production on improved locations.

Plot	Total Herbage 1963	1964	2-Year Average	Crested Wheatgrass 1963	1964	2-Year Average
11	2950[1/] (2350-3400)[2/]	450 (300-650)	1700	350 (50-600)	150 (50-400)	250
27	2650 (2350-2950)	950 (500-1600)	1800	2300 (1700-2700)	850 (400-1550)	1600
29	3200 (1900-4150)	600 (200-950)	1900	3150 (1800-4100)	550 (200-900)	1850

Table 4. Site II mean herbage production on unimproved locations.

Plot	Total Herbage 1963	1964	2-Year Average	Cheatgrass 1963	1964	2-Year Average
12	1800[1/] (1100-2850)[2/]	600 (450-650)	1200	1750 (1000-2800)	550 (450-600)	1150
28	700 (200-1250)	200 (200-250)	450	700 (200-1250)	200 (200-250)	450
30	150 (T-200)[3/]	200 (150-300)	150	100 (T-150)	200 (150-250)	150

1/ Herbage weighed to nearest 10 pounds per acre and rounded to the nearest 50 pounds per acre for reasonable precision.

2/ Range of samples. 3/ (T) represents 20 pounds per acre and less.

Table 5. Site III mean herbage production on improved locations.

Plot	Total Herbage 1963	1964	2-Year Average	Crested Wheatgrass 1963	1964	2-Year Average
19	3050[1/] (2100-4100)[2/]	800 (650-950)	1950	1100 (750-1550)	600 (350-800)	850
25	2400 (1950-3300)	1450 (800-3000)	1900	1850 (650-3050)	1350 (700-2950)	1600
31	1300 (900-1750)	750 (650-900)	1050	50 (T-100)[3/]	200 (50-300)	150

Table 6. Site III herbage production on unimproved locations.

Plot	Total Herbage 1963	1964	2-Year Average	Cheatgrass 1963	1964	2-Year Average
20	200[1/] (100-250)[2/]	150 (100-250)	200	50 (T-100)	T[3/] (T-50)	50
26	450 (200-850)	400 (250-650)	450	50 (T-50)	50 (T-50)	50
32	300 (150-450)	500 (350-700)	400	50 (T-50)	50 (T-50)	50

1/ Herbage weighed to nearest 10 pounds per acre and rounded to the nearest 50 pounds per acre for reasonable precision.

2/ Range of samples. 3/ (T) represents 20 pounds per acre and less.

Table 7. Crested wheatgrass and cheatgrass percent frequency.

Plot	Crested Wheatgrass Seedlings 1963	1964	Difference Between Yrs.	Established Crested Wheatgrass Plants 1963	1964	Difference Between Yrs.	Cheatgrass 1963	1964	Difference Between Yrs.
				SITE I					
1	31	24	- 7[1/]	39	48	+ 9	38	32	- 6
3	26	7	-19	36	46	+10	37	37	--
5	50	22	-28	38	50	+12	36	37	+ 1
7	49	9	-40	34	54	+20	12	19	+ 7
13	68	17	-51	80	70	-10	32	64	+32
33	39	25	-14	69	78	+ 9	4	27	+23
21	34	42	+ 8	44	64	+20	54	56	+ 2
15	26	27	+ 1	32	38	+ 6	58	68	+10
17	28	34	+ 6	34	40	+ 6	60	61	+ 1
23	2	3	+ 1	35	35	--	72	63	- 9
				SITE II					
11	8	0	- 8	26	43	+17	90	80	-10
27	62	62	--	40	39	- 1	24	70	+26
29	70	43	-27	40	50	+10	20	56	+36
				SITE III					
19	6	10	+ 4	15	22	+ 7	96	99	+ 3
25	52	14	-38	42	58	+16	22	51	+29
31	13	0	-13	16	18	+ 2	45	67	+22

1/ Minus (-) indicates 1964 frequency was less than 1963 frequency and plus (+) indicates 1964 frequency was greater than 1963 frequency.

less. Frequency ratings for most plots in 1964 were higher and ranged from 35 to 78 percent.

Crested wheatgrass on the three plots in Site II had frequency ratings of 26, 40, and 40 percent in 1963 and 43, 39, and 50 percent in 1964. Plots in Site III had frequencies of 15, 42, and 16 percent in 1963 and 22, 58, and 18 percent in 1964. Frequency ratings of crested wheatgrass seedlings for 11 of the 16 plots were lower in 1964 than 1963 (Table 7).

Inventory

Public Land

A total of 50,175 calculated acres were inventoried on the East Cow Creek Allotment (Appendix C). Inventoried categories, acreages, and percentages were as follows:

Seedable	11,584 acres	23 percent
Sprayable	5,509 acres	11 percent
Other-poor	26,972 acres	54 percent
Other-good	1,261 acres	2 percent
Crested wheatgrass	4,724 acres	10 percent
Island[1/]	125 acres.	

1/ This island was encircled by Lower Cow Lake and, therefore, was inventoried only as an island.

Permittee Land

Permittee properties totaling 14,010 acres in eight land ownerships were inventoried (Appendix D). Inventoried categories, acreages, and percentages were as follows:

Seedable	1,084 acres	8 percent
Sprayable	2,053 acres	15 percent
Other-poor	4,647 acres	33 percent
Other-good	37 acres	0.3 percent
Cropland	6,189 acres	44 percent.

DISCUSSION AND CONCLUSIONS

Production

Herbage production fluctuation between 1963 and 1964 was expected. Variable production between years has been reported by Cooper and Hyder (6), Eckert et al. (10), Hyder and Sneva (16, 17), Lorenz and Rogler (19), Reynolds and Springfield (23), and Springfield (25). Crested wheatgrass production varied by as much as 500 percent during the 1953-1963 period at the Benmore Experimental Range (30). Most authors have attributed the change between years to the climatic fluctuations and predominately to the fluctuation in precipitation.

Frequency-Production Relationship

There appeared to be little relationship between frequency of established crested wheatgrass plants and herbage production in 1963 and 1964 (Table 8). Crested wheatgrass production decreased in 1964 on 13 of the 16 sample plots. Only two plots had a reduction in crested wheatgrass frequency.

The increase in established crested wheatgrass plants in 1964 may have been related to the relative high frequency of crested seedlings in 1963 (Table 7). Seedling frequency increased in 1964 only on five of the 16 sample plots.

Table 8. Crested wheatgrass production and percent frequency.

Plot	Percent Frequency 1963	Percent Frequency 1964	Percent Frequency Difference Between Years	Production 1963	Production 1964	Production Difference Between Years
			Site I			
1	39	48	+ 9[1]	450[2]	440	- 10[3]
3	36	46	+10	370	330	- 40
5	38	50	+12	630	550	- 80
7	34	54	+20	390	140	- 250
13	80	70	-10	1580	570	-1010
33	69	78	+ 9	2100	640	-1460
21	44	64	+20	1320	980	- 340
15	32	38	+ 6	560	550	- 110
17	34	40	+ 6	120	630	+ 510
23	35	35	--	460	770	+ 310
			Site II			
11	26	43	+17	340	160	- 180
27	40	39	- 1	2310	860	-1450
29	40	50	+10	3160	560	-2600
			Site III			
19	15	22	+ 7	1120	600	- 520
25	42	58	+16	1830	1340	- 490
31	16	18	+ 2	70	180	+ 110

1/ Plus (+) indicates 1964 frequency was greater than 1963 frequency and minus (-) indicates 1964 frequency was less than 1963 frequency. 2/ Herbage weighed to nearest 10 pounds per acre.
3/ Minus (-) indicates 1964 production was less than 1963 production and plus (+) indicates 1964 production was greater than 1963 production.

Based on the crested wheatgrass seeding success-rating scale developed by Hyder and Sneva (15) for areas receiving 10 to 12 inches average annual precipitation, using the 1964 frequency data, seven plots were excellent, four good, three fair, and two poor.

Frequency-production relationships as it pertains to individual plots are discussed in following production sections.

Site I

Improved. This site was represented by 10 sets of paired plots. Within Site I there was some variation as crested wheatgrass two-year average production varied from 250 to 1,350 pounds per acre (Table 1). Total herbage two-year average production varied from 300 to 1,450 pounds per acre.

Plots 1, 3, 5, and 7 were quite similar and had the lowest average production per acre of any sampled. Two-year average of total herbage production varied from 300 to 700 pounds per acre and crested wheatgrass two-year average production varied from 250 to 600 pounds per acre (Table 1). These four plots are located near Rome (Figure 1). This area appeared to get less precipitation than most of the study area.

Plots 13, 33, and 21 were quite similar and the highest producing plots on this site. Crested wheatgrass two-year average production was 1,050, 1,350, and 1,150 pounds per acre for plots 13, 33,

and 21, respectively (Table 1). Mean average for crested wheatgrass production on these plots varied more between years than other plots. Production was 1,600, 2,100, and 1,300 pounds per acre in 1963 and 550, 650, and 1,000 pounds per acre in 1964 for plots 13, 33, and 21, respectively.

It appears on Site I that a crested wheatgrass stand with a frequency of 44 percent or greater produced a greater amount of forage in 1963 than a stand with a lower frequency (Table 8). In 1964 this was not so and possibly was due to the lower spring precipitation and associated cooler temperatures. Site characteristics as indicated in Appendix B appear to be similar to other plots. It was felt that changes in production were not due to site differences.

Plots 15, 17, and 23 represent the Festuca idahoensis phase of the Artemisia tridentata/Agropyron spicatum association as described by Culver (7).

Crested wheatgrass production on plots 17 and 23 was 120 and 460 pounds per acre in 1963 and increased to 630 and 770 pounds per acre in 1964, respectively (Table 8). This variation may have been due to sampling techniques as the general trend was towards less herbage production in 1964.

The increase in crested wheatgrass frequency in 1964 on plot 17 was small and apparently did not account for increased herbage production (Table 8). Eight of the ten plots on this site had an

increase in percent frequency and a decrease in production. Crested wheatgrass frequency on plot 23 was 35 percent for both 1963 and 1964.

Unimproved. Herbage production on these plots consisted predominantly of cheatgrass and was essentially devoid of perennial vegetation. Excluding plot 22, the total herbage two-year average production varied from 150 to 700 pounds per acre (Table 2). Plot 22 total herbage production was 2,200 and 1,250 pounds per acre in 1963 and 1964, respectively. Of this total, cheatgrass contributed 2,150 and 1,050 pounds per acre for the same period. This high cheatgrass production may be explained in part by the absence of sagebrush and scarcity of other species. Fires burning over the area in past years have resulted in the elimination of most of the sagebrush, perennial grass and forb species.

Site II

Improved. Plots 11, 27, and 29 represent this site and may be examples of the Artemisia tridentata/Elymus cinereus association as described by Culver (7).

Plots 27 and 29 had 2,310 and 3,160 pounds per acre crested wheatgrass production, respectively, in 1963 (Table 8). These were the two highest producing plots sampled in 1963. Frequency of crested wheatgrass was 40 percent for both plots in 1963 (Table 8). In 1964 the frequency was 39 and 50 percent for plots 27 and 29,

respectively. There was little change in frequency on plot 27 but plot 29 had an increase of 10 percent in 1964. Production dropped to 860 and 560 pounds per acre for plots 27 and 29, respectively.

This reduction may have been in part due to the landform associated with this site. As indicated in Appendix B, this site was characterized as having a valley bottom type landform. Observations during the months of May and June in 1964 indicated that these valley bottoms had more frost, possibly caused from cold air pockets.

Crested wheatgrass two-year average production, on plot 11, was 250 pounds per acre (Table 3). This is considerably lower than plots 27 and 29 which had 1,600 and 1,850 pounds per acre, respectively. Total herbage two-year average production was 1,700, 1,800, and 1,900 pounds per acre for plots 11, 27, and 29, respectively. The difference between 250 pounds per acre of crested wheatgrass and 1,700 pounds per acre of total herbage was made up predominately of cheatgrass production.

Crested wheatgrass frequency of established plants was 43, 39, and 50 percent in 1964 for plots 11, 27, and 29, respectively (Table 7). This indicates that stand density of crested wheatgrass was not the limiting factor causing low crested wheatgrass production on plot 11. Competition from cheatgrass may have reduced production as cheatgrass frequency was 90, 24, and 20 percent in 1963 and 80, 70, and 56 percent in 1964 for plots 11, 27, and 29, respectively

(Table 7).

Unimproved. Total herbage two-year average production for plots 12, 28, and 30 was 1,200, 450, and 150 pounds per acre, respectively (Table 4). Cheatgrass two-year average production accounted for 1,150, 450, and 150 pounds per acre of this total. This indicates the area is devoid of most perennial grass and forb species. From observation, it was concluded that plots 28 and 30 had three or more times as much sagebrush cover as plot 12, and this may account for part of the herbage production between plots.

Site III

Improved. In the undisturbed state, Artemisia arbuscula was the dominant shrub of Site III. Plots 19, 25, and 31 were included in this site and had a two-year average, total herbage production of 1,950, 1,900 and 1,050 pounds per acre, respectively (Table 5). Crested wheatgrass two-year average was 850, 1,600, and 150 pounds per acre for these plots.

The low crested wheatgrass production on plot 31 may be due to the type of treatment prior to seeding. Plot 31 was located in an area where Artemisia arbuscula had been destroyed by spraying with 2,4-D. Crested wheatgrass had been drilled into the dead brush and resident perennial grasses the fall following spraying. The stand of crested wheatgrass was quite sparse with a frequency of 16 and 18

percent for the years 1963 and 1964, respectively (Table 8).

Areas on which plots 19 and 25 were located had been plowed prior to seeding and possibly accounts for the better crested wheatgrass production. Crested wheatgrass two-year average production of 1,600 pounds per acre on plot 25 is impressive (Table 5). But, production of this nature can be misleading. On most of this site, in the study area, crested wheatgrass seedings were a failure. Only small scattered areas had a stand of crested wheatgrass and it was at these locations where data were taken. Reasons for seeding failure are unknown.

Unimproved. The three locations in Site III were described by Culver (7) as examples of the Artemisia arbuscula/Festuca idahoensis association. Mean average total herbage production on this site fluctuated little between years. In 1963, production was 200, 450, and 300 pounds per acre and 150, 400, and 500 pounds per acre in 1964 on plots 20, 26, and 32, respectively (Table 6). This may be contributed to the stand of Agropyron spicatum and Festuca idahoensis present. Cheatgrass had a two-year average of 50 pounds per acre on all three plots.

Adjusted Production

The method for adjusting production as described by Sneva and Hyder (27) was followed in estimating the median yield-normal

range herbage production. Variation was as great or greater using this method when compared with unadjusted production in this two-year study.

The Theissen grid of eastern Oregon has been used to determine which weather station data are used in computing the adjusted production. This necessitated use of Danner Weather Station data for all computations, although some plots were approximately 15 to 20 miles distant. The study area was large and much variation in precipitation was observed throughout 1963 and 1964.

Inventory

Public Land

Fifteen different categories of landscapes and/or production classes of seedable range, three of sprayable range, twelve of other-poor range, and six of other-good range were mapped (Appendix C). This represented 50,175 acres on the East Cow Creek Allotment of which 11,584 acres (23 percent) were seedable, 5,509 acres (11 percent) were sprayable, 26,972 acres (54 percent) were other-poor, 1,261 acres (2 percent) were other-good, 4,724 acres (10 percent) were seeded to crested wheatgrass, and an island of 125 acres in Lower Cow Lake.

Grazing alternatives expressed in acres per animal unit

month, derived from this study, were provided to the Agricultural Economics Department for use in linear programming research and are recorded by Nielsen (21, p. 47).

With the assumptions and coefficients used by Nielsen (21) in the linear programming project, spraying sagebrush range was the most economical range improvement practice available. For this to be true, he indicates that there must be a desirable perennial grass understory to respond to the brush removal.

Permittee Land

Five categories of landscapes and/or production classes of seedable range, one of sprayable range, five of other-poor range, and one of other-good range were mapped (Appendix D). All land in cultivation, or that had been cultivated recently, was classed as crop land. This represented 14,010 acres total of private land. Crop land accounted for 6,189 acres of this total. Nielsen (21) indicates crop land production should be improved prior to undertaking any range improvement on private land.

Extended Application

An understanding of the resource is basic to sound range management planning. The inventory method used in this study provided information necessary to characterize the range land and

determine areas in need of and suitable for various improvement and management practices. It would appear that these inventory techniques could well have broad application for inventorying western range land.

SUMMARY

Objectives of this investigation were to determine crested wheatgrass production on selected range sites and evaluate present and potential production on public and private lands in the study area. This basic range information was supplied to the Agricultural Economists for use in a companion range-economic project involving linear programming techniques.

Field work was carried out in the summers of 1963 and 1964 on the East Cow Creek and Soldier Creek Allotments of the Bureau of Land Management, Vale Grazing District, located in east-central Malheur County, Oregon, near the town of Jordan Valley, Oregon.

The study area is a dissected plateau with little, if any, interior drainage. Climate is semi-arid with cold winters and warm, dry summers. Danner, Oregon, located within the study area, has a 20-year mean annual precipitation of 11.57 inches. July, the hottest month of the year, has a mean annual temperature of 68.5°F and January, the coldest month, has a mean annual temperature of 25.6°F.

Paired, 16-foot-square exclosures were constructed at each location, with one exclosure on the improved area and one on the adjacent unimproved area. Production data were obtained by clipping four random 9.6-square-foot plots per year in 1963 and 1964

out of each exclosure. Herbage production was weighed to the nearest gram and expressed in pounds per acre.

Sample plots were grouped into range sites based on the dominant shrub, dominant native perennial grass, soils, landform, and aspect. The dominant shrub and grass species on plowed areas were determined from remnants and adjacent undisturbed areas.

A frequency sampling procedure was used to rate relative degree of seeding success. A frame, 2-feet square, subdivided into four 1-foot squares, with a 2-inch square located in each 1-foot square was used in obtaining frequency data. The 2-inch square provided meaningful data for species with a high occurrence such as Bromus tectorum. Frequency data were taken near the exclosure and on the same range site.

An inventory method was developed that provided information for determining acreages in need of and suitable for various improvement and management practices. Information was obtained on 50,175 acres of public land and 14,010 acres of private land. These data were presented to the Agricultural Economists for use in the linear programming project, in categories of seedable, sprayable, other-poor, other-good, and presently seeded to Agropyron desertorum. Criteria were set up for judging each category and symbols representing all criteria were recorded on aerial photos used in the field.

The 16 paired exclosures fell into three broad range sites.

Site I was characterized by having Artemisia tridentata and Agropyron spicatum as the dominant shrub and grass species, respectively. Artemisia tridentata was the dominant shrub on Site II, but Elymus cinereus was the dominant grass species. Site III was different from Sites I and II in that Artemisia arbuscula was the dominant shrub and Festuca idahoensis was the dominant grass species.

Site I was represented by ten paired sets of sample plots. The improved portion of this site had a two-year average production of total herbage that ranged from 300 to 1,450 pounds per acre. Crested wheatgrass two-year average production ranged from 250 to 1,350 pounds per acre and accounted for most of the total production. Unimproved plots on Site I had a two-year average production of total herbage that ranged from 150 to 700 pounds per acre with the exception of one plot which produced 1,700 pounds per acre.

Site II encompassed only three paired sets of sample plots. Total herbage two-year average production was 1,700, 1,800, and 1,900 pounds per acre on the improved plots. Crested wheatgrass two-year average production was 250, 1,600, and 1,850 pounds per acre of this total. Unimproved plots on this site had a total herbage two-year average production of 1,200, 450, and 150 pounds per acre.

Site III was represented by three paired sets of sample plots. In the improved condition total herbage two-year average production was 1,950, 1,900, and 1,050 pounds per acre and crested wheatgrass

two-year average production was 850, 1,600, and 150 pounds per acre. There was little difference in the production on the unimproved plots. They had a total herbage two-year average production of 200, 450, and 400 pounds per acre and cheatgrass averaged 50 pounds per acre on all three plots.

There appeared to be little or no relationship between frequency and production of crested wheatgrass. Production of crested wheatgrass in 1964 increased, over 1963 production, on only three plots of the 16 sampled, while crested wheatgrass frequency increased or stayed the same on 14 of the 16 plots. Based on the crested wheatgrass success-rating scale developed by Hyder and Sneva (15), using the 1964 frequency data, seven plots were excellent, four good, three fair, and two poor.

The inventory of public land showed there were fifteen different categories of landscapes and/or production classes of seedable range, three of sprayable range, twelve of other-poor range, and six of other-good range. Inventory of permittee land indicated five different categories of seedable range, one of sprayable, five of other-poor, and one of other-good range. This information was needed for determining acreages in need of and suitable for various range improvement and management practices.

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APPENDICES

Appendix A. Explanation of delineation symbolization for categories used in inventory.

Symbol	Practice
A	Seedable
B	Sprayable
C	Other-Poor
D	Other-Good

Symbol	Type[1/]
1	Artemisia tridentata Nutt.
2	Artemisia arbuscula Nutt.
3	Chrysothamnus viscidiflorus (Hook.) Nutt.
4	Purshia tridentata (Pursh) DC.
5	Artemisia rigida (Nutt.) Gray.

Symbol	Production[2/]
1	Less than 100 pounds per acre
2	100 to 200 pounds per acre
3	Greater than 200 pounds per acre

For example, $A\frac{12}{2}$ (Practice $\frac{\text{Type}}{\text{Production}}$) indicates the area delineated was seedable, a complex of Artemisia tridentata and Artemisia arbuscula with Artemisia tridentata occupying more area, and the production was from 100 to 200 pounds per acre.

1/ Combinations of these symbols were used indicating complexes. The first symbol indicating the species occupying the most area.

2/ For analysis 50, 150, and 225 pounds per acre were used for class 1, 2, and 3, respectively.

Appendix B. Range site characteristics.

Plot	Solum In.	Depth to Clay Accum. In.	Structure Grade	Structure Type	Shrub	Land Form	Slope %	Aspect
				SITE I				
1	49	5	2	bk[1/]	Artr[2/]	sl[3/]	2	SSE
3	57	9	2	bk	Artr	sl	1	SSE
5	10	5	2	bk	Artr	sl	4	SW
7	29	4	2	bk	Artr	sl	3	S
13	23	7	2	bk	Artr	sl	3	W
33	30	9	2	bk	Artr	sl	2	WNW
21	28	7	2	bk	Artr	sl	3	W
15	20	8	3	pr	Artr	sl	3	NNW
17	20	5	3	pr	Artr	sl	3	NNW
23	47	7	3	pr	Artr	sl	2	NNW
				SITE II				
11	42	7	1	pr	Artr	vb		
27	60	6	1	bk	Artr	vb		
29	36	9	1	bk	Artr	vb		
				SITE III				
19	23	7	3	bk	Arar	sl	3	NNW
25	37	9	1	pr	Arar	sl	3	N
31	29	6	1	pr	Arar	sl	3	NNW

1/ Blocky - bk; Prismatic - pr.
2/ Artemisia tridentata - Artr; Artemisia arbuscula - Arar.
3/ Slope - sl; valley bottom - vb.

Appendix C. Inventory of Bureau of Land Management lands of the East Cow Creek Allotment.

Category	Acres	Category	Acres	Category	Acres	Category	Acres
A $\frac{1}{1}$ [1/]	84	B $\frac{1}{3}$	4543	C $\frac{1}{2}$	7345	D $\frac{1}{3}$	527
A $\frac{1}{2}$	1143	B $\frac{2}{3}$	255	C $\frac{1}{3}$	6009	D $\frac{12}{3}$	85
A $\frac{1}{3}$	3864	B $\frac{21}{3}$	711	C $\frac{12}{3}$	1597	D $\frac{2}{3}$	60
A $\frac{12}{2}$	745			C $\frac{13}{3}$	164	D $\frac{21}{3}$	323
A $\frac{12}{3}$	757			C $\frac{2}{2}$	161	D $\frac{25}{3}$	33
A $\frac{13}{1}$	23			C $\frac{2}{3}$	1387	D $\frac{52}{3}$	233
A $\frac{13}{2}$	255			C $\frac{21}{2}$	2885		
A $\frac{13}{3}$	500			C $\frac{21}{3}$	3052		
A $\frac{2}{1}$	84			C $\frac{25}{2}$	2351		
A $\frac{2}{2}$	915			C $\frac{25}{3}$	18		
A $\frac{2}{3}$	320			C $\frac{52}{2}$	1952		
A $\frac{21}{2}$	2765			C $\frac{31}{3}$	51		
A $\frac{21}{3}$	80						
A $\frac{23}{1}$	41						
A $\frac{3}{1}$	11						
TOTAL	11,584		5509		26,972		1261

Seeded to crested wheatgrass 4,724 acres

Island in Cow Lakes 125 acres

Calculated total 50,175 acres

1/ For symbolization explanation see Appendix A.

Appendix D. Inventory of permittee property for the East Cow Creek Allotment of the Bureau of Land Management.

Category	Acres
$A\frac{1}{3}$ [1/]	873
$A\frac{13}{3}$	110
$A\frac{3}{2}$	31
$A\frac{3}{3}$	35
$A\frac{31}{3}$	35
$B\frac{1}{3}$	2,053
$C\frac{1}{1}$	272
$C\frac{1}{2}$	1,411
$C\frac{1}{3}$	2,289
$C\frac{12}{2}$	101
$C\frac{13}{2}$	574
$D\frac{1}{3}$	37
Crop	6,189
Total	14,010

1/ For symbolization explanation see Appendix A.

Appendix E. Crop year precipitation for 1963 and 1964, Danner, Oregon, Weather Station.

Crop Year 1963			Crop Year 1964	
Month	Year	(Inches) Precipitation	Year	(Inches) Precipitation
Sept.	1962	0.14	1963	1.03
Oct.	1962	2.72	1963	1.47
Nov.	1962	1.19	1963	1.52
Dec.	1962	0.53	1963	0.99
Jan.	1963	1.21	1964	1.29
Feb.	1963	1.52	1964	0.25
March	1963	0.38	1964	0.68
April	1963	2.08	1964	0.70 1/
May	1963	1.72	1964	1.39
June	1963	2.53	1964	2.45
TOTAL		14.02		11.77

1/ This figure obtained by telephone from Mrs. Oran Rayburn, Danner, Oregon, Weather Station, August 17, 1964.