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Circle West Vegetation Monitoring Study

First Annual Report

for the period
August 14-26, 1978

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INTRODUCTION

The Circle West vegetation monitoring program was begun in 1978 at the request of Dreyer Brothers, Inc., to provide long-term monitoring of the productivity of certain vegetation types in McCone County, Montana. This study is essentially a continuation of the Circle West Baseline Vegetation Study, the rationale and results of which have previously been published (Prodgers 1978).

METHODS

Aerial Production

Twelve permanently fenced exclosures (figure 1) were sampled during this study. (NOTE: exclosure No. 9, Juho/Ansc-Agsp, is shown in figure 1 but was not sampled in 1978). The 1978 productivity sampling procedures were the same as those used in 1977. Sampling took place from August 14, 1978 through August 26, 1978. The number of productivity samples taken per exclosure was determined using 1977 data.

Frequency and Coverage

In each exclosure, twenty 20 cm x 50 cm plots were sampled for coverage using the technique described by Daubenmire (1959). Coverage was estimated as accurately as possible; cover classes were not used. Plots were located along contours in series of ten. None of these plots have been clipped. Color transparencies were taken of each plot at the time of sampling.

RESULTS

Aerial Production

Increased precipitation and greatly reduced grasshopper densities combined to result in much higher productivity values in 1978 than in 1977. In 1978, May-June precipitation at Circle, Montana, was 23.9 cm (9.4 in) and April-July precipitation was 32.8 cm (12.9 in). Grasshoppers, when present at the productivity exclosures, were observed in small numbers. Changes in productivity between 1977 and 1978, expressed in kilograms per hectare, are summarized in table 1.

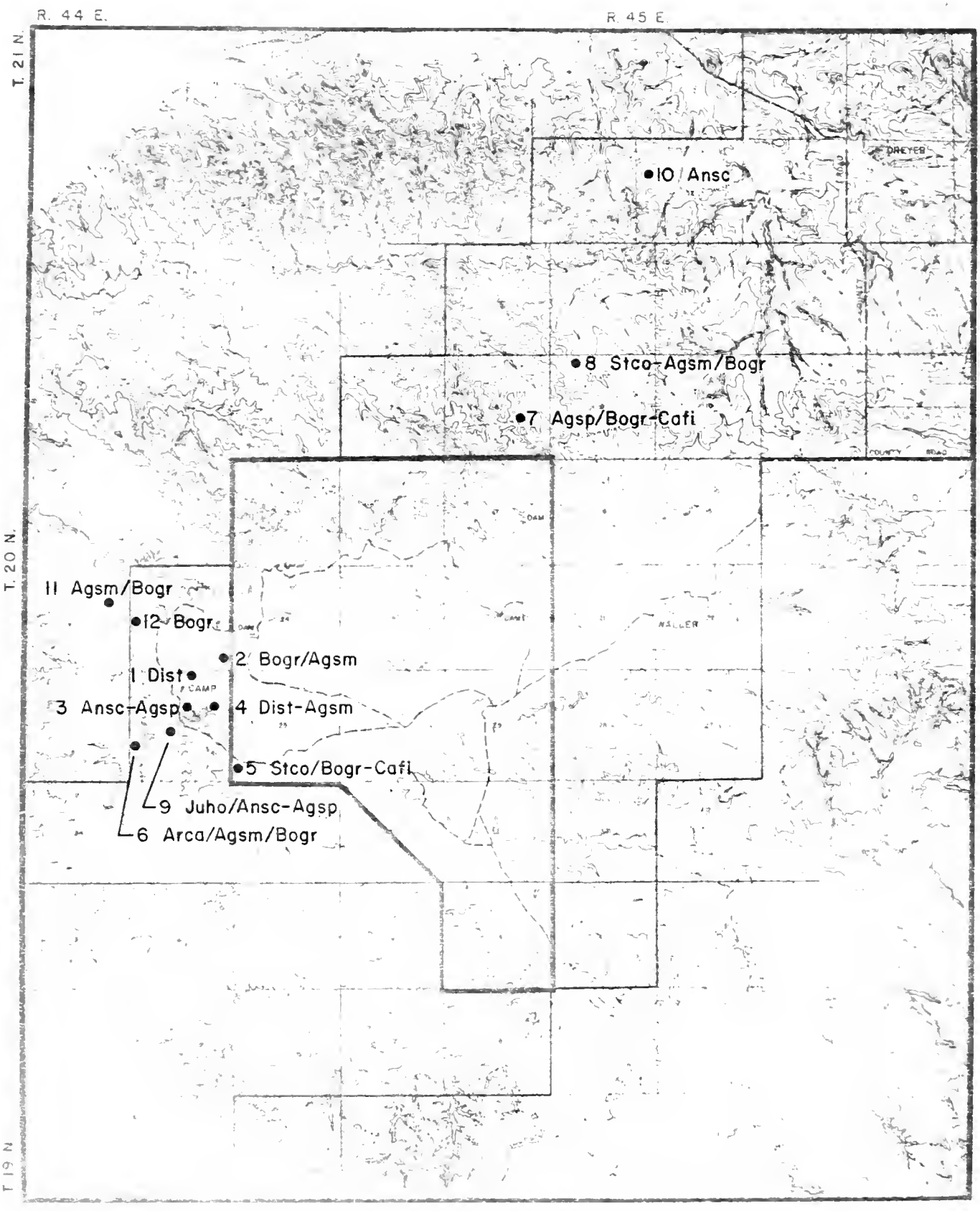

FIGURE I. LOCATION OF CIRCLE WEST VEGETATION EXCLOSURES

(NOTE: Exclosure 13, Bogr-Cafi/Stco, is located off the map in the southwest corner, Sec. 8, T. 20 N. R. 46 E.)

Table 1. Summary of 1977 and 1978 production data.

Community Type	Exclosure No. 1/	1977 Production 2/	1977 Rank	1978 Production 2/	1978 Rank	1978 Production / 1977 Production	Significance of Difference
Dist	1	970	1	1075	10	1.11	.20
Ansc	10	840	2	1049	11	1.25	.05
Dist-Agsm	4	813	3	2071	1	2.55	<.001
Arca/ Agsm Bogr	6	800	4	2024	2	2.53	<.001
Ansc-Agsp	3	560	5	1152	8	2.06	<.001
Bogr-Cafi/ Stco	13	406	6	1290	6	3.86	<.001
Agsp/ Bogr-Cafi	7	372	7	1284	7	2.45	<.001
Stco-Agsm/ Bogr	8	334	8	1420	5	4.25	<.001
Stco/ Bogr-Cafi	5	218	9	1141	9	5.23	<.001
Agsm/ Bogr	11	202	10	1672	4	8.28	<.001
Bogr	12	198	11	778	12	3.93	<.001
Bogr-Agsm	2	16	12	1955	3	122	<.001

1/See Figure 1.
2/in Kg/ha

Cool season grasses experienced the greatest increase in productivity. The aerial production of Agropyron smithii increased an average of 629 percent in four exclosures, not including the spectacular 44,722 percent increase in the Bogr/Agsm c.t. exclosure. This species was the highest producer in four exclosures in 1978 compared to one exclosure in 1977. Stipa comata, usually considered a cool season grass, increased an average 442 percent in productivity in three exclosures. In the Stco-Agsm/Bogr c.t. exclosure, A. smithii out produced S. comata in 1978 but not in 1977. Agropyron spicatum increased an average 279 percent in two exclosures.

As for warm season grasses, the aerial production of Andropogon scoparius decreased in the Ansc c.t. exclosure and increased insignificantly in the Ansc-Agsp c.t. exclosure. Apparently the cool temperatures prevented this species from efficiently using the additional precipitation. Bouteloua gracilis, another warm season grass, increased by an average of 297 percent in eight exclosures. Flowering in this species was not prevalent and productivity appeared higher in 1976, a year of near average precipitation.

Smoliak's (1956) equation relating May-June precipitation to production did not apply well in the Stco-Agsm/Bogr c.t. exclosure in 1978. His equation predicts that 9.4 inches of precipitation would result in 682 kilograms/hectare, but aerial production was actually 1420 kilograms/hectare. This might be explained by the fact that the average May-June precipitation used by Smoliak in developing his equation was 3.7 inches. Also, the Stco-Agsm/Bogr c.t. exclosure apparently contained more S. comata and A. smithii and less B. gracilis than Smoliak's community.

The higher precipitation of 1978 apparently resulted in more heterogeneity within exclosures. In 1977, production in replicates within exclosures was non-homogenous in three exclosures, while in 1978 five exclosures appeared to be non-homogenous at the .05 probability level.

Figures 2 through 4 show the dramatic 1978 increase in productivity for the Stco/Bogr-Cafi, Agsp/Bogr-Cafi, and Bogr exclosures. Figures 5 and 6 show typical stands of tall coulee shrub communities and silver sagebrush stands.

Other interesting changes can be found by comparing tables 2 through 13 with the 1977 data (Prodgers 1978). In these tables, means ($\bar{X}$) and standard deviations (S) are in kilograms per hectare (for pounds per acre multiply by 0.892). Coefficients of variation (CV) are presented as decimals. N is the theoretical number of plots necessary to obtain a sample mean within 20 percent of the true mean eighty percent of the time, and n is the number of samples taken.

Exclosures were divided into two replicates to determine the homogeneity of exclosures. The results of sum productivity values for the replicates were compared using a t-test and the .05 probability level. All exclosures except the Dist. Dist-Agsm, Stco/Bogr-Cafi, Bogr-Cafi/Stco and Agsp/Bogr-Cafi exclosures were homogeneous at the .05 probability level.

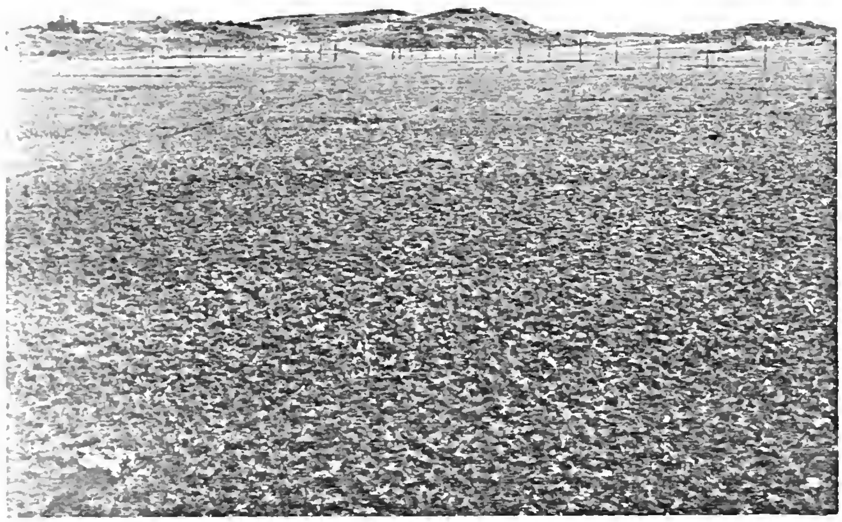

Figure 2. Exclosure [illegible] Stco/Bogr-Cari, in 1977 (top) and 1978 (bottom)

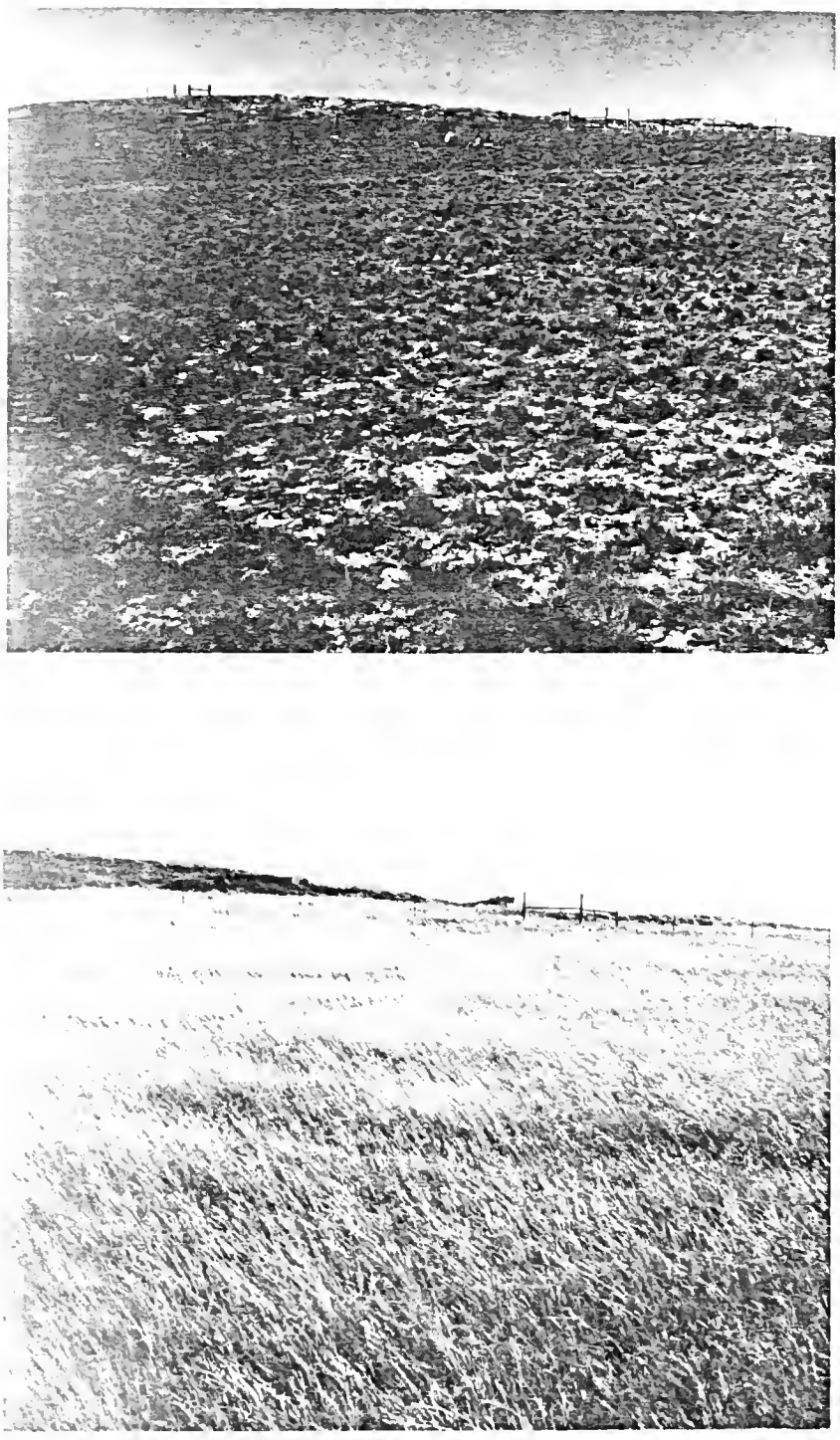

Figure 2. Exclosure 7 (Agsp/Bogr-Cafi) in 1977 (top) and 1978 (bottom)

Figure 4. Exclosure #12 (bogr) in 1977 (top) and 1978 (bottom)

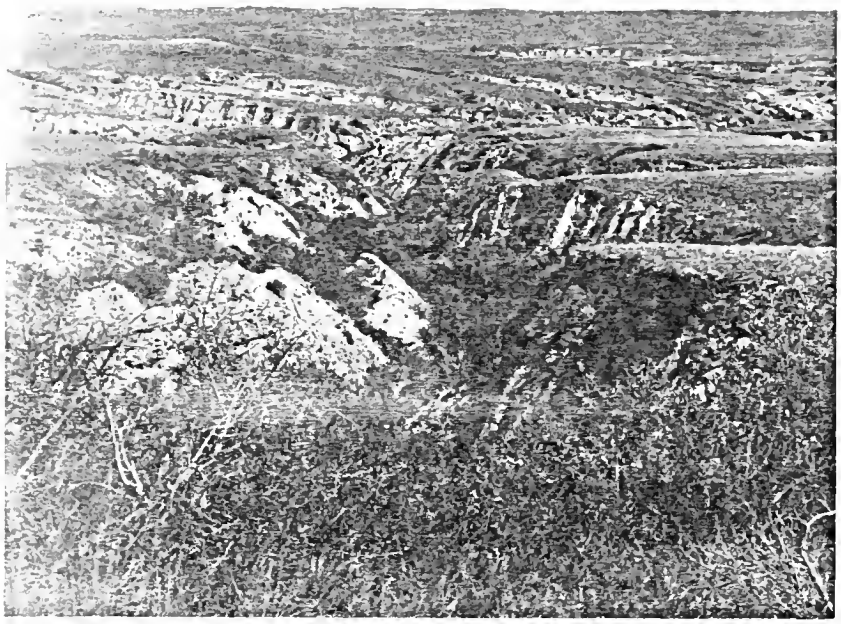

Figure 5. Typical tall shrub coulee with Shepherdia argentea. (This picture represents the Cornus stolonifera phase of the Shar/Syoc-Rosa c.t..)

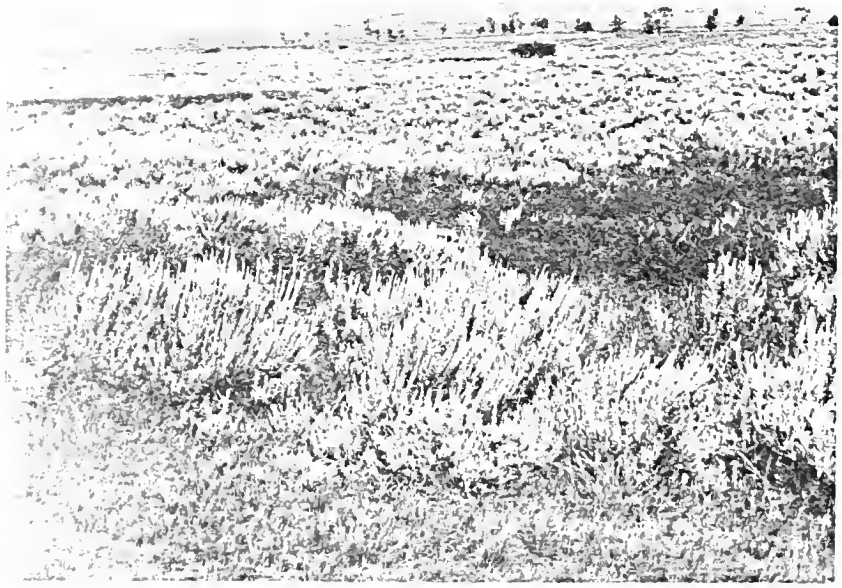

Figure 6. Typical silver sagebrush (Artemisia cana) flat with patches of Symphoricarpos occidentalis and Rosa arkansana.

Table 2. *Distichlis stricta* c.t. (n = 10)

	Dist	Litter	Σ Productivity
$\bar{X}$	1055	416	1075
S	212	152	202
CV	.20	.36	.19
N	2		2

Table 3. *Distichlis stricta*-*Agropyron smithii* ecotone (n = 15)

	Dist	Agsm	Hemi	Thero	Litter	ΣProductivity
$\bar{X}$	1393	418	167	59	521	2071
S	389	234	120	66	169	505
CV	.28	.56	.72	1.03	.32	.24
N	4	13				3

Table 4. *Bouteloua gracilis* c.t. (n = 12)

	Bogr	Thero	Geo	Litter	ΣProductivity
$\bar{X}$	513	167	98	375	778
S	337	176		129	479
CV	.66	1.06		.34	.62
N	13				16

Table 5. Agropyron smithii/Bouteloua gracilis c.t. (n = 27)

	Agsm	Bogr	Thero	Hemi	Geo	Litter	Σ Productivity
$\bar{X}$	1062	414	76	44	54	363	1672
S	418	238				206	450
CV	.39	.57				.57	.27
N	6	14					3

Table 6. Bouteloua gracilis/Agropyron smithii c.t. (n = 35)

	Bogr	Agsm	Thero	Litter	Σ Productivity
$\bar{X}$	203	1610	158	280	1955
S	186	823	181	168	903
CV	.92	.51	1.14	.60	.46
N	35	11			9

Table 7. Stipa comata/Bouteloua gracilis-Carex filifolia c.t. (n = 13)

	Stco	Bogr	Cafi	Geo	Thero	Litter	Σ Productivity
$\bar{X}$	856	54	3	178	41	120	1141
S	224	46		83.6	26	80	210
CV	.26	.85		.47	.63	.67	.18
N	3	30					2

Table 8. Bouteloua gracilis-Carex filifolia/Stipa comata c.t. (n = 15)

	Bogr	Cafi	Stco	Thero	Geo	Litter	Σ Productivity
$\bar{X}$	253	183	662	75	64	267	1290
S	116	112	277			147	415
CV	.46	.61	.42			.55	.32
N	9	15	7				4

Table 9. Stipa comata-Agropyron smithii/Bouteloua gracilis c.t. (n = 14)

	Stco	Agsm	Bogr	Hemi*	Thero	Cham	Litter	Σ Productivity
$\bar{X}$	354	421	93	342	98	44	356	1420
S	217	226	90	212	82		205	271
CV	.61	.54	.97	.62	.84		.58	.19
N	16	4	38					2

* mostly Carex filifolia

Table 10. Andropogon scoparius c.t.(n = 19)

	Ansc	Hemi	Geo	Cham	Litter	Σ Productivity
$\bar{X}$	692	194	73	42	660	1049
S	268	161			336	301
CV	.39	.83			.51	.29
N						4

Table 11. Andropogon scoparius-Agropyron spicatum c.t. (n = 15)

	Ansc	Agsp	Hemi	Cham	Geo	Litter	Σ Productivity
$\bar{X}$	128	315	513	127	60	438	1152
S	215	223	220	143		326	342
CV	1.69	.71	.43	1.13		.74	.30
N	116	21					4

Table 12. Agropyron spicatum/Bouteloua gracilis-Carex filifolia c.t. (n= 20)

	Agsp	Bogr	Cafi	Hemi	Cham	Thero	Litter	Σ Productivity
$\bar{X}$	517	58	78	365	183	79	306	1284
S	343	92	58	204	174	57	196	246
CV	.66	1.59	.74	.56	.95	.72	.64	.19
N	18	104	22					2

Table 13. Artemisia cana/Agropyron smithii/Bouteloua gracilis c.t. (n = 25)

	Arca	Agsm	Bogr	Hemi	Cham	Thero	Geo	Litter	Σ Productivity
$\bar{X}$	602	666	262	258	117	84	75	633	2024
S	424	478	190	240				540	512
CV	.70	.72	.73	.93				.85	.25
N	20	21	22						3

Frequency and Coverage

Data on the species composition, average coverage, and frequency of exclosures are summarized in Table 14.

Table 14.

Species Composition: Average Coverage and Frequency within Exclosures (n = 20 plots/exclosure)

	Exclosure											
	Arca/ Agsm/ Bogr	Stco/ Bogr- Cafi	Bogr- Cafi/ Stco	Ansc- Agsp	Bogr/ Agsm	Agsm/ Bogr	Agsp/ Bogr- Cafi	Dist/ Agsm	Bogr	Stco- Agsm/ Bogr	Dist	Ansc
Achillea millifolium	1.0(10)[1/]	-	-	-	-	-	-	1.5(40)	-	-	-	-
Agropyron smithii	35.5(100)	-	-	-	47.0(100)	48.8(100)	-	23.2(100)	3.8(10)	24.0(100)	-	-
Agropyron spicatum	-	-	-	12.5(55)	-	-	39.5(100)	-	-	-	-	-
Allium textile	0.5(5)	-	-	-	-	-	-	-	-	-	-	-
Andropogon scoparius	-	-	-	12.1(55)	-	-	-	-	-	-	-	55.5(100)
Antennaria parvifolia	-	-	-	-	-		-	-	-	-	-	1.8(15)
Aristida longiseta	-	-	-	7.0(25)	-	-	-	-	-	-	-	-
Artemisia cana	43.2(85)	-	-	-	-	-	-	-	-	-	-	-
Artemisia dracunculus	-	-	-	-	-	-	-	-	-	-	-	0.5(5)
Artemisia frigida	4.5(40)	-	1.0(5)	4.4(40)	-	-	-	2.1(10)	-	-	-	1.4(25)
Astragalus missouriensis	-	-	0.5(5)	-	-	-	-	-	-	2.1(20)	-	-
Bouteloua gracilis	33.0(70)	8.6(80)	37.0(100)	1.3(10)	44.5(100)	28.8(100)	20.8(85)	5.2(50)	93.2(100)	19.8(100)	-	-
Calamagrostis montanensis	0.9(10)	-	-	-	-	-	-	-	-	-	-	-
Calamovilfa longifolia	-	-	-	-	-	-	-	-	-	-	-	0.5(5)
Campanula rotundifolia	-	-	-	1.0(20)	-	-	-	-	-	-	-	-
Carex eleocharis	-	-	-	-	2.5(35)	8.3(80)	-	-	-	20.7(90)	-	-

Table 14 (Continued).

	Exclosure											
	Arca Agsm/ Bogr	Stco/ Bogr-Cafi	Bogr-Cafi/ Stco	Ansc-Agsp	Bogr/ Agsm	Agsm/ Bogr	Agsp/ Bogr-Cafi	Dist/ Agsm	Bogr	Stco-Agsm/ Bogr	Dist	Ansc
Carex filifolia	1.0(10)	-	16.1(95)	16.5(65)	-	-	7.8(95)	2.1(15)	-	-	-	3.3(30)
Carex pensylvanica	-	-	-	-	-	-	-	-	-	-	-	0.9(20)
Chrysopsis villosa	-	-	-	1.3(5)	-	-	-	-	-	-	-	-
Cirsium undulatum	-	-	-	0.9(5)	-	-	-	-	-	-	-	-
Distichlis stricta	-	-	-	-	-	-	-	43.4(100)	-	-	57.3(100)	-
Echinacea pallida	-	-	-	-	-	-	-	-	-	-	-	3.0(65)
Eurotia lanata	-	-	-	-	-	-	2.5(45)	-	-	-	-	-
Festuca octoflora	-	-	-	-	1.7(50)	2.5(55)	-	-	1.0(55)	-	-	-
Gaura coccinea	-	-	1.1(20)	0.9(10)	-	-	-	-	-	-	-	-
Gutierrezia sarothrae	-	-	-	6.0(25)	-	-	10.8(35)	-	-	-	-	0.6(10)
Hedeoma hispida	0.9(45)	0.5(40)	-	-	2.1(70)	0.7(60)	-	-	1.1(70)	-	-	-
Koeleria cristata	0.8(5)	-	-	2.5(40)	-	-	1.5(20)	1.7(20)	-	3.5(35)	-	3.5(60)
Linum perenne	-	-	-	0.5(5)	-	-	-	-	-	-	-	-
Linum rigidum	2.6(25)	2.1(50)	0.5(5)	-	-	-	6.5(70)	-	-	2.4(20)	-	-
Lygodesmia juncea	-	2.3(20)	-	-	-	-	-	-	-	-	-	-
Muhlenbergia cuspidata	-	-	-	9.7(60)	-	-	-	-	-	-	-	1.4(20)

Table 14 (Continued).

Species Composition, Average Coverage and Constancy of Exclosures N = 20

	Exclosure											
	Arca/ Agsm/ Bogr	Stco/ Bogr- Cafi	Bogr- Cafi/ Stco	Ansc- Agsp	Bogr/ Agsm	Agsm/ Bogr	Agsp/ Bogr- Cafi	Dist/ agsm	Bogr	Stco- Agsm/ Bogr	Dist	Ansc
Oryzopsis hymenoides	-	-	-	1.0(5)	-	-	-	-	-	-	-	-
Oxytropis spp.	-	-	-	-	-	-	-	-	-	-	-	1.0(10)
Petalostemon spp.	-	-	-	0.5(10)	-	-	-	-	-	-	-	1.0(30)
Phlox hoodii	-	-	0.6(10)	-	-	-	3.9(75)	1.0(20)	-	-	-	1.0(20)
Plantago Patagonica	-	1.4(95)	2.8(90)	-	-	-	0.5(35)	2.2(80)	6.0(95)	-	-	-
Plantago spinulosa	1.0(30)	-	-	-	-	-	-	-	-	-	-	-
Poa sandbergii	1.0(10)	-	-	2.8(55)	-	-	-	-	1.0(20)	1.7(30)	-	1.6(25)
Poa spp.	-	-	-	-	-	-	-	7.8(75)	-	-	-	-
Solidago missouriensis	-	-	-	-	-	-	-	-	-	-	-	6.1(40)
Stipa comata	4.0(30)	66.8(100)	43.3(100)	10.3(45)	-	0.5(5)	10.5(60)	7.0(45)	-	27.3(100)	-	0.8(10)
Stipa viridula	8.5(35)	-	-	5.0(30)	-	-	-	-	-	-	-	-
Tragopogon dubius	-	-	-	-	-	-	-	-	-	0.5(10)	-	-
Bare ground	2.5(75)	13.0(100)	8.6(100)	4.9(80)	13.9(100)	11.7(100)	11.0(100)	7.8(100)	4.6(100)	14.1(100)	38.8(100)	25.3(100)
Rock	-	-	-	11.3(100)	-	-	-	-	-	-	-	-
Litter	75.5(100)	9.1(100)	24.0(100)	50.5(100)	6.4(100)	15.3(100)	40.5(100)	73.5(100)	34.5(100)	26.5(100)	24.5(100)	59.5(100)
Lichens	-	1.5(90)	-	1.3(15)	2.6(100)	9.1(100)	1.4(90)	-	-	-	-	-

1/Average coverage (constancy)

ACKNOWLEDGMENTS

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