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Vegetational Analysis of the S. H. Ordway Jr. Memorial Prairie

Charles L. Lura
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VEGETATIONAL ANALYSIS OF THE

S. H. ORDWAY JR. MEMORIAL PRAIRIE

BY

CHARLES L. LURA

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S.H. ORDWAY JR. MEMORIAL PRAIRIE

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily those of the major department.

H. L. Hutcheson — Date
Thesis Adviser

Gerald A. Myers — Date
Head, Biology Dept.

VEGETATIONAL ANALYSIS OF THE

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Abstract

CHARLES L. LURA

Under the supervision of Professor H. L. Hutcheson

This thesis culminates the final segment of a two-part study to establish base-line data on the present vegetational composition of the S. H. Ordway Jr. Memorial Prairie. Mean standing crop and mulch were 341.1 $g \cdot m^{-2}$ and 136.3 $g \cdot m^{-2}$ respectively. Forbs accounted for 21% of the standing crop. Much of the variation in productivity between 1977 and 1978 may be attributed to variation in environmental factors preceeding each sampling period. Basal cover averaged 10.2%. Cool season species constituted most of the basal cover in all pastures with Poa pratensis and Carex spp. contributing substantially. Basal cover of individual species or ecological groups should not be interpreted as a reflection of their productivity. Diversity indices and similarity coefficients were computed by pasture. Productivity and species composition were analyzed by pasture. Significant differences ($P \leq .05$) between pastures were found for grass, forb, and mulch biomass, and for relative density or relative frequency of sixteen plant species.

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C. L. L.

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INTRODUCTION

Once occupying one-third of the North American continent, prairie was the most extensive natural vegetation type (Costello 1969). Native prairie is now disappearing at an alarming rate. It is important to preserve tracts of native prairie for their biological, scientific, educational, and aesthetic values. The Samuel H. Ordway Jr. Memorial Prairie was established by The Nature Conservancy in 1975 to help foster the preservation, understanding, and management of our vanishing prairies. Because of the outstanding quality of this prairie, The Nature Conservancy has designated it as a model preserve. Management goals include the preservation and enhancement of this prairie. Management techniques being used simulate the factors which maintained our prairies in their presettlement condition.

This thesis is the culmination of a two part study to establish baseline data on the present vegetational composition of the study area. It is hoped that this data will enable a more effective assessment of vegetational changes and the effects of various management techniques.

DESCRIPTION OF STUDY AREA

The Samuel H. Ordway Jr. Memorial Prairie is located in McPherson County in north-central South Dakota. South Dakota Highway 10 forms its northern border with the north-east corner of the study area lying 9.6 km (6 miles) west of Leola, South Dakota. The study area includes parts of townships 125-126 north latitude and ranges 68-69 west longitude. The total area is 3,127 ha or approximately 12 square miles.

The study area lies on the eastern edge of the Coteau du Missouri. This extensive highland is a part of the Missouri Plateau of the Great Plains province. On the northern South Dakota border the Coteau is approximately 120 km wide and tapers to a width of about 40 km on the Nebraska border. The Coteau is bordered by the Missouri River Trench to the west and the James River Basin to the east (Flint 1955). The elevation of the study area is about 610 m above sea level (Lokemoen et al. 1975).

The entire study area is underlain by bedrock aquifers more than 305 m below the surface. A deep glacial aquifer from 46-116 m below the surface underlies the study area west of a line extending from the northeast corner of Section 23, T. 126 N., R. 69 W., to the southwest corner of Section 3, T. 125 N., R. 69 W. (Hamilton 1974).

The uppermost bedrock of the vicinity is Cretaceous Pierre Shale. Prior to glaciation the topography was a result of the Ancient Grand River which cut its way through the bedrock flowing in a southeasterly direction (Christensen 1977).

The only ice sheet to cover the north-central part of South Dakota was of late Wisconsin age during the Pleistocene Epoch. The ice

sheet moved into South Dakota about 17,000 years ago through the James River Basin. Although confined by the Coteau du Missouri on the west and the Coteau des Prairies on the east, the active James Lobe continued to advance and began to expand onto both Coteaus. Approximately 15,000 years ago a late Wisconsin ice sheet covered much of eastern South Dakota. The massive James Lobe continued to move south in the James Basin while the relatively thin ice on the Coteau du Missouri stagnated (Christensen 1977).

Most of the study area is located on the Bowdle end moraine which was formed between the stagnant ice on the Missouri Coteau and the active James Lobe to the east. The James Lobe remained active enough to deposit superglacial drift on marginal areas which reach a thickness of up to 75 m and width of 1.6 to 6.4 km in central McPherson County. Today the Bowdle end moraine represents the separation line between the stagnant ice deposits typical of the Missouri Coteau and the active ice deposits of the James River Basin (Christensen 1977).

Due to the large amounts of superglacial till, which insulated the stagnant ice on the Missouri Coteau, ice remained here for about 5,000 years. Ice was completely gone from the James Basin about 11,000 years ago while an additional 2,000 years were required to melt all the ice on the Coteau (Christensen 1977).

Most of the study area lies on the Bowdle end moraine, which contains high ridges or is linear in topography. The end moraine crests run in a southwesterly direction. The southeastern portion of the study area is a stagnation moraine with a rugged, hummocky topography which is the result of ice blocks buried within the drift. A ground moraine,

having slightly less relief than the stagnation moraine, extends into the east side of the study area. The entire area is a heterogeneous mixture of boulders, sand, silt, and clay, showing much relief (Christensen 1977).

The Ordway Memorial Prairie contains an estimated 400 wetlands, the largest occupying approximately 48.6 ha. As no rivers or streams traverse the area, drainage is incomplete with wetlands absorbing the runoff (Lokemoen et al. 1975).

The most common soil association present is Vida-Williams loam (U.S.D.A. Soil Conserv. Serv. 1976). This fine-loamy, mixed typic Argiboroll is common to upland glacial till with 6-15% slope (Westin and Malo 1978). Another common soil association is Vida-Zahill loam which has properties similar to Vida-Williams loam but occupies slopes of 15-25%. Both associations are subject to severe wind and water erosion. Among other associations that can be found interspersed throughout the study area are Williams-Bowbells, Williams-Bowbells-Nishon complexes, and Williams-Bowbells-Parnell complexes. Parnell soils are found on or near lowland ponds over much of the study area (U.S.D.A. Soil Conserv. Serv. 1976).

Kuchler (1964) classifies the potential natural vegetation of the study area as a moderately dense, short or medium tall Agropyron-Stipa association. The dominants would be Agropyron smithii[1], Bouteloua gracilis, Stipa comata, and Stipa viridula. Other components would include Andropogon scoparius, Artemisia frigida, Artemisia ludoviciana,

[1]Scientific names are according to Van Bruggen (1976).

Aster ericoides, Carex spp., Koeleria pyramidata, Liatris punctata, Psoralea agrophylla, Solidago spp., and Stipa spartea.

Because the study area is on the eastern edge of this association it would be expected to be influenced by the association to the east which Kuchler (1964) describes as a dense, medium tall to tall Agropyron-Andropogon-Stipa association. Components of this association which he does not list in the Agropyron-Stipa association are Andropogon gerardi, Bouteloua curtipendula, and Rosa arkansana. Hertz (1976) inventoried the vascular flora and established an herbarium to document species found on the study area.

Ordway Prairie has a continental climate characterized by large differences in temperature from summer to winter. Temperatures may rise above 38 C (100 F) in summer and drop to more than -34 C (-30 F) in winter. The average annual precipitation at Leola is 50.2 cm or about 20 in (U. S. Dept. of Commerce 1973).

The Ordway Prairie lies in an area formerly used as hunting grounds by the Dakota or Sioux Indians. Buffalo, elk, pronghorn antelope, waterfowl and other wildlife species were presumably abundant (Lokemoen et al. 1975). Tepee rings on the study area substantiate at least seasonal presence of the Indians.

Thomas Boylan purchased the study area from the State of South Dakota in segments beginning in 1952 (Ode and Tieszen 1978). Deferred grazing, water development, and cross fencing were used as management techniques. Deferments were rotated to rest each pasture once every five years (Pozarnsky 1966). Boylan sold the study area to Leroy

Hoffman in 1969 (Ode and Tieszen 1978). Hoffman used the Hormay Rest-Rotation grazing system which simulates the grazing effects of native herbivores, especially buffalo (Lokemoen et al. 1975).

The Nature Conservancy, a national nonprofit organization dedicated to the preservation of ecologically significant land, purchased the study area from Leroy Hoffman in 1975. Paul Bultsma was chosen by the Conservancy in 1976 to manage the prairie and coordinate research. An energetic plan is underway to restore and maintain the Ordway Prairie in its potential natural vegetational state. Present management techniques include warm season deferred grazing and controlled burning.

METHODS

Selection of Sampling Locations

Transect locations used in this study are those determined and used by Carl (1978). The locations were limited to uplands and covered the various soil types within each pasture. Of the 100 transect locations 96 were indexed by fence posts with the remainder located by field notes only. Figure 1 shows the transect distribution while Table 1 provides the number of transects per pasture and pasture size. Grazing treatments (Table 3) were unaltered.

Sampling

Ten sampling points on each transect were standardized at 6.10 m (20 ft.) intervals with the first sampling point located 15.24 m (50 ft.) from the fence to avoid border disturbance. Species frequency, species density, percent basal cover, and productivity were determined for each sampling point.

Productivity sampling consisted of clipping a 0.1 m^2 quadrat at ground level. The clippings were separated into grasses, forbs, and mulch, oven dried for 24 hours at 109 C and then weighed to the nearest 0.01 gram. Productivity data were collected from July 23 to August 12, 1978 while species composition data were collected from August 14 through August 25, 1978.

Species frequency was determined by identifying all species within a 0.1 m^2 quadrat. Species density and percent basal cover were determined with the aid of a point frame. The point frame described by Levy and Madden (1933) consisted of ten 0.75 m pins at 10.0 cm intervals

ORDWAY PRAIRIE

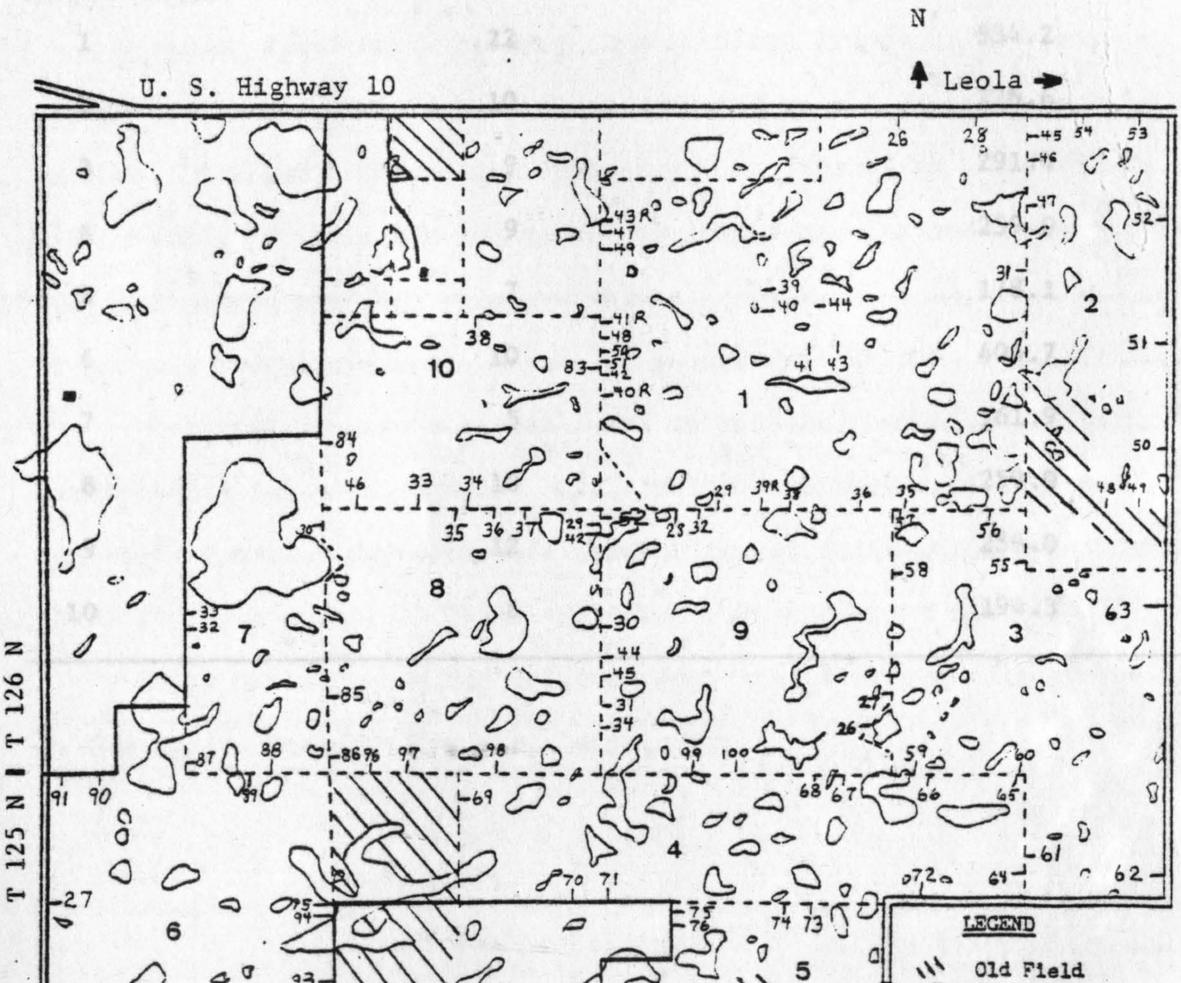

Fig. 1. Transect distribution (S. H. Ordway Jr., Memorial Prairie, 1978).

Table 1. Number of transects in each of the 10 sampled pastures of the S. H. Ordway Jr. Memorial Prairie, 1978.

Pasture	Number of Transects	Pasture size (ha)
1	22	534.2
2	10	226.6
3	9	291.4
4	9	259.0
5	7	178.1
6	10	404.7
7	5	161.9
8	10	259.0
9	12	259.0
10	6	194.3

mounted on a frame at an oblique angle. Each stem struck at ground level by a pin was identified and recorded in field notes.

Data Analysis

Means, standard deviations, and standard errors of the means, along with analysis of variance were computed on all data for each pasture. Species analyzed for frequency were limited to a $\geq$ 20.0% frequency along at least one transect. Species frequency and density data were also converted into relative values. Analysis of variance was used to provide the significance levels of pasture differences for all data.

Relative density data were used to compute community similarity coefficients for each pasture. Raw density data were used to compute Simpson's index of diversity and probability of interspecific encounter (PIE) for each pasture. These indices are discussed by Cox (1976).

Full descriptions and original data sheets are on file at the S. H. Ordway Jr. Memorial Prairie, Leola, SD.

RESULTS AND DISCUSSION

Basal Cover

The mean basal cover was 10.2%. Carl (1978) reported a mean of 12.5% for the study area. Table 2 compares the basal cover data of this study to that of Carl (1978). No explanation for these differences could be found. Pastures were subject to various grazing treatments in 1977 and 1978. Table 3 presents the grazing treatments for each pasture from 1976 through 1978. Hanson et al. (1978) found basal cover to vary considerably between years at Cottonwood, SD. Analysis of variance showed no significant difference ($P \leq .05$) in percent basal cover between pastures.

Productivity

Productivity, as reflected by standing crop data, is summarized in Table 4. Values for live biomass ranged from 282.6 $g \cdot m^{-2}$ to 398.2 $g \cdot m^{-2}$. The mean value for live biomass was 341.1 $g \cdot m^{-2}$. Variation in productivity is partially a result of the ratio of warm to cool season species (Redmann 1968). Although standing crop sampling did not involve the separation of warm and cool season species, a correlation would appear to exist between the density of warm season species and standing crop. Cosby (1964) states that a wider annual yield variation occurs in warm season species because they are more dependent on timely summer rains. Table 5 compares standing crop data of other studies on prairies in North and South Dakota.

Precipitation has been shown to have a profound effect on productivity. Rogler and Haas (1947) found a significant correlation

Table 2. Mean percent basal cover of the 10 sampled pastures of the S. H. Ordway Jr. Memorial Prairie, 1977 and 1978.[1]

Pasture Number	1978	1977
1	9.1 ± 0.6	11.5 ± 0.4
2	13.9 ± 1.4	12.1 ± 0.5
3	12.6 ± 1.4	12.3 ± 0.6
4	12.7 ± 1.1	10.7 ± 0.6
5	12.7 ± 1.3	12.3 ± 0.6
6	9.0 ± 1.1	10.6 ± 0.5
7	7.2 ± 1.2	11.3 ± 0.7
8	7.6 ± 0.6	15.6 ± 0.5
9	9.3 ± 0.6	14.2 ± 0.5
10	8.3 ± 1.0	14.9 ± 0.7
$\overline{X}$	10.2 ± 0.4	12.5 ± 0.2

[1]1977 data are those of Carl (1978).

Table 3. Grazing Treatments of the 10 Sampled Pastures of S. H. Ordway Jr. Memorial Prairie, 1976-1978.[1]

Pasture Number	Grazing Treatments 1976	1977	1978
1	Rest	April 27-Sept. 27 (.61)	April 21-May 25 (.27)
2	Rest	April 20-June 1 (.71)	April 15-June 6 (.14)
3	May 15-Oct. 15 (.68)	Rest	April 15-May 29 (.63)
4	Rest	May 15-Oct. 17 (.63)	April 27-May 29 (.18)
5	Rest	April 15-June 1 (.61)	April 20-June 5 (.88)
6	Rest	Oct. 22-Nov. 10 (0.1)	April 14-June 5 (.45) Sept. 8-Oct. 25 (.53)
7	Rest	Rest	Oct. 11-Nov. 10 (.24)
8	Rest	Rest	June 1-Nov. 10 (.48)
9	Rest	May 1-June 1 (.79)	Rest
10	May 15-Oct. 15 (.63)	Oct. 15-Dec. 31 (.17)	Jan. 1-June 1 (.33) Sept. 1-Nov. 9 (.09)

[1]Numbers in parentheses are AUM per acre.

Table 4. Mean biomass ($g \cdot m^{-2}$) of grass, forbs and mulch in the 10 sampled pastures of S. H. Ordway Jr. Memorial Prairie, 1978.

Pasture Number	Sample Size	Grass	Forbs	Mulch
1	220	274.8 ± 16.1	70.9 ± 8.1	132.5 ± 10.4
2	100	230.6 ± 18.4	78.1 ± 21.1	146.1 ± 17.2
3	90	201.2 ± 16.5	84.4 ± 9.0	120.3 ± 11.5
4	90	241.4 ± 15.5	69.0 ± 8.5	101.7 ± 6.1
5	70	236.6 ± 17.1	109.1 ± 25.1	108.3 ± 18.0
6	100	264.5 ± 17.9	30.8 ± 5.2	135.6 ± 16.2
7	50	324.6 ± 34.2	36.4 ± 5.8	168.2 ± 19.3
8	100	326.7 ± 18.9	54.5 ± 4.8	213.5 ± 12.1
9	120	306.8 ± 22.1	91.4 ± 9.4	98.6 ± 13.5
10	60	287.0 ± 19.2	95.0 ± 23.1	163.5 ± 20.1
$\overline{X}$	1000	269.3	71.6	136.3

Table 5. Standing crop values of some studies on North and South Dakota Prairies.

Productivity ($g \cdot m^{-2}$)	Location	Reference
340.9	S. H. O. P.[1]	Present Study
133.3	S. H. O. P.	Carl (1978)
96.3	w S. D.	Hanson et al. (1978)
111.0	w N. D.	Cosby (1964)
134.0	w N. D.	Redmann (1975)
149.4	S. H. O. P.	Ode and Tieszen (1978)
183.7	S. H. O. P.	Barnes and Tieszen (1978)
191.4	w N. D.	Dix (1960)
200.0	w N. D.	Redmann (1968)
244.0	w N. D.	Abouguendia (1973)
255.6	w N. D.	Lauenroth (1970)
303.0	w N. D.	Whitman (1974b)
334.8	e N. D.	Hadley (1970)
404.0	S. H. O. P.	Puetz (1977)
472.2	e N. D.	Ralston and Dix (1966)

[1]S. H. Ordway Jr. Memorial Prairie

between April through July precipitation and productivity of the same season. They also found a significant correlation between the amount of fall soil moisture and productivity the following season. Smoliak (1956) correlated May through June precipitation with productivity and reported a .859 correlation coefficient. Cosby (1964) found that the productivity of a wet year may be twice that of a dry year.

Figure 2 compares standing crop data of this study with that of Carl (1978). Much of the difference in productivity between the two studies may be explained by differing amounts of precipitation. Meteorological information for the area is presented in Table 6.

Increased precipitation and plant vigor appear to be the major factors influencing the increased productivity from 1977 to 1978. The ratio of warm to cool season species along with each pasture's former and present management are among other factors influencing productivity.

Table 7 presents the percentage of live biomass contributed by forbs in each pasture. Forbs contributed 21% of the mean live biomass. Data from Carl (1978) showed forbs to contribute 34% of the mean live biomass. Data from Hanson et al. (1978) show forb biomass to account for 23% of the standing crop in late July under high range conditions in western South Dakota. Redmann (1975) showed forb biomass to be 40% of the standing crop on a Stipa spartea-forb community in western North Dakota. He suggests that a large number of forbs is a natural characteristic of some communities of the mixed grass prairie.

Mulch biomass of this study varied from 98.6 $g \cdot m^{-2}$ to 213.5 $g \cdot m^{-2}$ with a mean of 136.3 $g \cdot m^{-2}$. Carl (1978) reported a mean of 104.0 $g \cdot m^{-2}$. Ode and Tieszen (1978), Barnes and Tieszen (1978), and Puetz

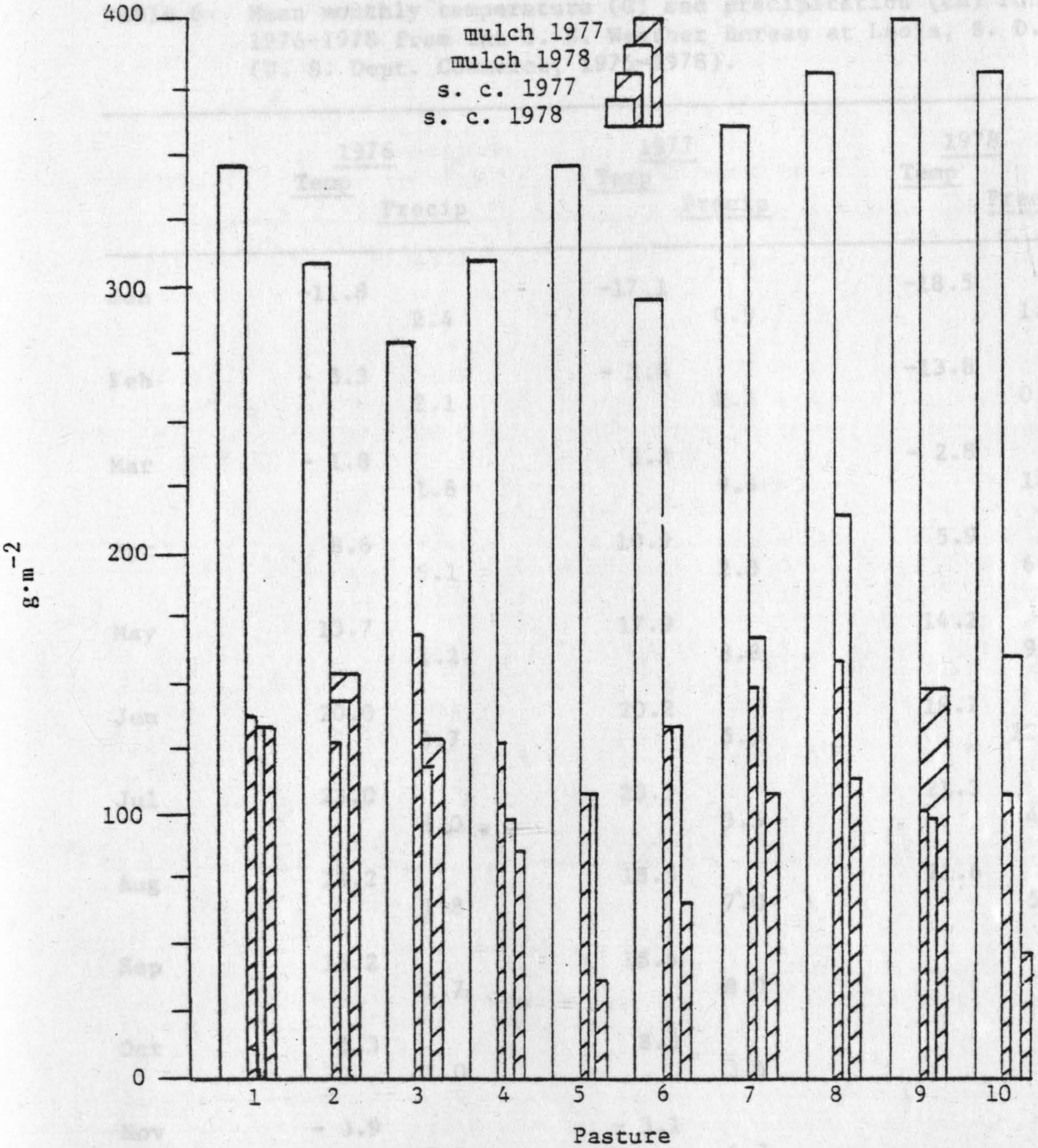

Fig. 2. Standing crop and mulch biomass ($g \cdot m^{-2}$) for the 10 sampled pastures of the S. H. Ordway Jr., Memorial Prairie, 1977 and 1978.[1]

[1]1977 data are those of Carl (1978).

Table 6. Mean monthly temperature (C) and precipitation (cm) for 1976-1978 from the U. S. Weather Bureau at Leola, S. D., (U. S. Dept. Commerce, 1976-1978).

	1976		1977		1978	
	Temp	Precip	Temp	Precip	Temp	Precip
Jan	-11.8	2.4	-17.1	0.9	-18.5	1.1
Feb	- 3.3	2.1	- 3.6	2.3	-13.8	0.6
Mar	- 1.8	1.8	1.2	9.4	- 2.8	1.2
Apr	8.6	5.1	10.9	2.3	5.9	6.0
May	13.7	1.2	17.9	8.8	14.2	9.3
Jun	20.0	8.7	20.2	5.3	18.7	12.1
Jul	23.0	3.0	23.3	5.5	21.3	4.8
Aug	23.2	1.8	18.5	7.0	21.6	5.7
Sep	16.2	1.7	15.4	8.0		
Oct	5.3	1.0	8.5	3.4		
Nov	- 3.9	0.1	- 3.1	6.7		
Dec	-10.4	0.7	-12.0	2.5		
Annual	6.6	29.5	6.7	62.0		

Table 7. Percent of the standing crop contributed by forbs in the 10 sampled pastures of the S. H. Ordway Jr. Memorial Prairie, 1978.

Pasture	Production ($g \cdot m^{-2}$)	Percent Forbs	Mulch ($g \cdot m^{-2}$)
1	345.7	20.5	132.5
2	308.7	25.3	146.1
3	282.6	29.9	120.3
4	310.4	22.2	101.7
5	345.7	31.6	108.3
6	295.3	10.4	135.6
7	361.0	0.1	168.2
8	381.2	9.5	213.5
9	398.2	23.0	98.6
10	382.0	24.9	163.5
$\overline{X}$	341.1	21.0	136.3

(1977), reported values of 154.4 $g \cdot m^{-2}$, 175.3 $g \cdot m^{-2}$, and 222.0 $g \cdot m^{-2}$ respectively for portions of the study area. On an _Andropogon scoparius-Stipa spartea_ dominated community in western North Dakota, Redmann (1975) reported 181.0 $g \cdot m^{-2}$ of mulch.

Mulch serves as a source of food and shelter for many types of soil organisms. It also retards raindrop splash, surface runoff, and evaporation (Anderson et al. 1970). An excesssive amount of mulch may, however, have detrimental effects on grassland function. Ehrenreich (1959) found large accumulations of mulch to retard growth of an Iowa prairie. Wright (1974) stated that litter accumulation in excess of 224.0 $g \cdot m^{-2}$ lowers soil temperature which reduces bacterial activity, thus tying up nutrients. Kucera (1970) recommended burning a Missouri prairie every three years to prevent accumulation of mulch from modifying the vegetational composition.

Analysis of variance showed significant differences ($P \leq .05$) between pastures for grass, forb, and mulch biomass. This was expected as a result of the variation in management.

Pasture Comparisons

Table 8 lists all species encountered in frequency and density sampling. Species used in pasture comparisons were selected on the basis of a $\geq$ 30% frequency in at least one pasture. These species and their abbreviations are given in Table 9. Table 10 presents the relative frequencies of these species, while Table 11 presents their relative densities. Figures 3-12 compare the relative frequency and relative density values of these species to those from Carl (1978). Forb species data were pooled for ecological implications.

Table 8. Plant species encountered in quadrat and point frame sampling at the S. H. Ordway Jr. Memorial Prairie, 1978.

Scientific Name	Common Name
Achillea millefolium L.	yarrow
Agropyron repens (L.) Beauv.	quackgrass
Agropyron smithii	western wheatgrass
Agropyron caninum (L.) Beauv.	slender wheatgrass
Agoseris glauca (Pursh) D. Dietr	false dandelion
Allium stellatum Ker.	wild onion
Ambrosia artemisiifolia L.	small ragweed
Ambrosia psilostachya DC.	ragweed
Amorpha canescens Pursh.	lead plant
Andropogon gerardi Vit.	big bluestem
Andropogon scoparius Michx.	little bluestem
Anemone canadensis L.	meadow anemone
Anemone cylindrica A. Gray	thimble flower
Anemone patens L.	pasque flower
Aristida longiseta Steud.	red threeawn
Artemisia drucunculus L.	green sagewort
Artemisia frigida Willd.	fringed sagewort
Artemisia ludoviciana Nutt.	cudweed sagewort
Aster ericoides L.	manyflowered aster
Astragalus adsurgens Pallas	locoweed
Bouteloua curtipendula (Michx.) Torr.	sideoats grama

Table 8. (continued)

Scientific Name	Common Name
Lotus purshianus Clem. & Clem.	trefoil
Lygodesmia juncea (Pursh) D. Don	skeletonplant
Melalotus spp.	sweetclover
Muhlenbergia cuspidata (Torr.) Rydb.	plains muhly
Orthocarpus luteus Nutt.	owl's clover
Oxalis stricta L.	yellow woodsorrel
Panicum perlongum Nash.	panicgrass
Panicum virgatum L.	switchgrass
Penstemon gracilus Nutt.	slender beardtongue
Petalostemon purpureum (Vent.) Rydb.	purple prairieclover
Phleum pratense L.	timothy
Physalis virginiana Mill.	waterfall
Poa pratensis L.	kentucky bluegrass
Polygala alba Nutt.	white milkwort
Polygala verticillata L.	whorled milkwort
Polygonum convolvulus L.	black bindweed
Psoralea argophylla Pursh.	silverleaf scurfpea
Ratibida columnifera (Nutt.) Woot. & Standl.	upright coneflower
Rosa blanda Ait.	wild rose
Rosa arkansanas Porter	arkansas rose
Salsola iberica Sennen & Pau.	russian thistle
Setaria glauca (L.) Beauv.	yellow foxtail
Solidago canadensis L.	canada goldenrod

Table 8. (continued)

Scientific Name	Common Name
Solidago missouriensis Nutt.	prairie goldenrod
Solidago mollis Bartl.	soft goldenrod
Solidago rigida L.	rigid goldenrod
Sphaeralcea coccinea (Pursh) Rydb.	scarlet globemallow
Stipa comata Trin. & Rupr.	needleandthread
Stipa spartea Trin.	porcupine grass
Stipa viridula Trin.	green needlegrass
Symphoricarpos occidentalis Hook.	wolfberry
Tragopogon dubius Scop.	yellow goatsbeard
Vernonia fasciculata Michx.	ironweed

Table 9. Scientific names and abbreviations of species used in pasture comparisons, S. H. Ordway Jr. Memorial Prairie, 1978.

Scientific Name	Abbreviation
Agropyron smithii	Agsm
Ambrosia artemisiifolia	Amar
Andropogon gerardi	Ange
Andropogon scoparius	Ansc
Artemisia frigida	Arfr
Artemisia ludoviciana	Arlu
Aster ericoides	Aser
Bouteloua curtipendula	Bocu
Bouteloua gracilis	Bogr
Calamovilfa longifolia	Calo
Carex spp.	Casp
Cirsium flodmani	Cifl
Helianthus rigidus	Heri
Muhlenbergia cuspidata	Mucu
Panicum perlongum	Pape
Poa pratensis	Popr
Psoralea argophylla	Psar
Solidago rigida	Sori
Stipa comata	Stco
Stipa spartea	Stsp
Stipa viridula	Stvi

Table 10. Relative frequency and standard error (percent) of the species used in pasture comparisons, (S. H. Ordway Jr. Memorial Prairie, 1978).

Pasture	Agsm	Amar	Ange	Ansc	Arfr	Arlu	Aser	Bocu	Bogr	Calo	Casp	Cifl	Heri	Mucu	Pape	Popr	Psar	Sori	Stco	Stsp	Stvi
1	3.8 ± 0.8	4.0 ± 0.7	2.6 ± 1.0	5.2 ± 1.0	2.6 ± 0.4	4.5 ± 0.5	4.3 ± 0.5	1.9 ± 0.7	1.8 ± 0.4	3.7 ± 0.7	10.8 ± 0.5	0.6 ± 0.2	3.9 ± 0.7	0.8 ± 0.2	3.1 ± 0.4	11.3 ± 0.8	1.3 ± 0.3	1.1 ± 0.6	3.5 ± 0.6	4.2 ± 1.0	6.2 ± 0.7
2	8.7 ± 1.2	2.3 ± 0.7	1.8 ± 0.7	4.1 ± 1.1	2.9 ± 0.7	4.1 ± 0.5	4.9 ± 0.5	0.0 ± 0.0	1.5 ± 0.4	1.2 ± 0.4	9.1 ± 0.8	1.0 ± 0.4	1.8 ± 0.8	0.2 ± 0.2	2.4 ± 0.7	12.6 ± 0.7	1.7 ± 0.5	1.0 ± 0.5	8.5 ± 1.0	0.6 ± 0.6	8.7 ± 0.8
3	5.9 ± 0.8	2.8 ± 0.8	1.0 ± 0.6	4.7 ± 1.5	2.2 ± 0.8	5.7 ± 0.4	4.3 ± 0.9	0.0 ± 0.0	4.6 ± 0.7	2.2 ± 0.9	10.6 ± 0.8	1.5 ± 0.6	3.2 ± 1.3	0.6 ± 0.5	5.1 ± 1.0	9.3 ± 0.7	3.1 ± 0.5	1.2 ± 0.5	6.5 ± 0.8	0.9 ± 0.6	5.0 ± 0.8
4	4.3 ± 0.9	2.8 ± 1.1	1.5 ± 0.7	3.4 ± 1.3	4.0 ± 0.6	5.6 ± 0.9	4.5 ± 0.7	0.7 ± 0.6	2.5 ± 0.5	1.7 ± 0.7	11.5 ± 0.3	3.4 ± 0.7	3.2 ± 0.9	0.5 ± 0.3	2.6 ± 0.7	11.9 ± 0.4	3.5 ± 0.9	0.7 ± 0.3	6.4 ± 0.9	2.2 ± 1.0	7.4 ± 0.7
5	7.8 ± 1.5	2.6 ± 0.9	3.5 ± 2.0	3.0 ± 1.0	0.8 ± 0.4	6.3 ± 1.0	2.9 ± 0.6	0.0 ± 0.0	3.7 ± 0.3	0.7 ± 0.4	9.2 ± 0.4	2.9 ± 0.8	3.4 ± 1.3	0.9 ± 0.3	3.4 ± 0.9	12.8 ± 1.2	4.3 ± 1.1	1.2 ± 0.9	5.5 ± 1.2	1.1 ± 0.4	4.6 ± 0.5
6	6.3 ± 1.5	4.6 ± 1.0	2.5 ± 1.1	5.8 ± 1.2	1.8 ± 0.6	4.2 ± 1.1	3.2 ± 0.7	1.5 ± 0.9	3.8 ± 1.3	3.8 ± 1.2	10.6 ± 1.1	1.8 ± 0.8	2.1 ± 0.9	3.1 ± 0.9	2.2 ± 0.5	12.4 ± 0.7	1.8 ± 0.6	0.1 ± 0.1	6.5 ± 1.1	3.1 ± 1.4	4.4 ± 1.1
7	5.3 ± 2.2	1.5 ± 0.5	1.9 ± 1.3	3.9 ± 1.8	1.5 ± 0.5	3.9 ± 1.9	2.0 ± 0.7	3.2 ± 2.6	1.9 ± 1.0	4.0 ± 1.3	12.9 ± 0.4	1.8 ± 0.7	4.7 ± 2.2	3.3 ± 1.2	0.3 ± 0.3	10.7 ± 2.0	1.4 ± 0.7	1.0 ± 1.0	8.2 ± 2.6	6.5 ± 2.3	8.0 ± 2.5
8	6.3 ± 1.1	6.3 ± 1.3	0.8 ± 0.7	4.7 ± 1.4	2.1 ± 0.7	7.0 ± 0.8	4.8 ± 0.6	0.6 ± 0.3	3.4 ± 1.0	4.0 ± 1.5	11.7 ± 0.5	2.5 ± 0.5	2.2 ± 1.0	0.9 ± 0.5	1.4 ± 0.7	13.4 ± 0.8	0.5 ± 0.3	1.0 ± 0.3	4.5 ± 1.0	1.2 ± 0.6	8.8 ± 0.8
9	5.1 ± 0.7	7.3 ± 0.9	0.2 ± 0.2	5.5 ± 1.2	3.8 ± 0.7	3.6 ± 0.4	5.2 ± 0.7	0.5 ± 0.2	5.1 ± 1.0	3.2 ± 0.7	10.4 ± 0.4	1.6 ± 0.6	2.3 ± 0.7	1.8 ± 0.4	3.2 ± 0.4	9.9 ± 0.6	1.5 ± 0.5	0.7 ± 0.3	5.7 ± 0.7	1.0 ± 0.4	6.1 ± 0.9
10	3.3 ± 1.0	4.1 ± 0.8	0.8 ± 0.8	5.6 ± 1.1	1.6 ± 0.8	3.9 ± 0.7	1.5 ± 0.8	1.2 ± 0.6	3.2 ± 0.8	8.4 ± 1.6	13.6 ± 0.7	0.3 ± 0.3	3.9 ± 1.3	3.8 ± 1.3	3.2 ± 1.0	9.4 ± 1.5	2.3 ± 0.9	0.0 ± 0.0	6.6 ± 1.2	2.7 ± 1.2	5.0 ± 1.3

Table 11. Relative density and standard error (percent) of the species used in pasture comparisons, (S. H. Ordway Jr. Memorial Prairie, 1978).

Pasture	Agsm	Amar	Ange	Ansc	Arfr	Arlu	Aser	Bocu	Bogr	Calo	Casp	Clfl	Heri	Mucu	Pape	Popr	Psar	Sori	Stco	Stsp	Stvi
1	1.0 ± 0.7	0.4 ± 0.4	6.8 ± 3.7	13.1 ± 3.2	1.0 ± 0.7	0.0 ± 0.0	0.0 ± 0.0	1.4 ± 1.0	3.9 ± 1.5	2.7 ± 1.2	17.2 ± 3.0	0.0 ± 0.0	0.0 ± 0.0	1.0 ± 0.7	1.1 ± 1.1	29.8 ± 4.2	0.0 ± 0.0	0.5 ± 0.5	5.3 ± 2.5	5.7 ± 1.8	7.8 ± 2.1
2	10.0 ± 2.9	0.0 ± 0.0	4.3 ± 3.7	14.0 ± 5.8	1.3 ± 1.3	0.6 ± 0.6	0.0 ± 0.0	0.0 ± 0.0	1.6 ± 1.1	3.0 ± 2.5	16.7 ± 3.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	27.5 ± 4.7	0.0 ± 0.0	0.0 ± 0.0	8.8 ± 2.5	0.0 ± 0.0	9.9 ± 3.6
3	1.5 ± 1.0	1.7 ± 1.1	0.9 ± 0.9	25.1 ± 7.6	0.0 ± 0.0	0.0 ± 0.0	0.9 ± 0.9	0.0 ± 0.0	5.5 ± 1.5	3.1 ± 1.7	18.5 ± 3.4	2.0 ± 2.0	0.0 ± 0.0	0.8 ± 0.8	0.0 ± 0.0	26.0 ± 6.4	0.0 ± 0.0	0.6 ± 0.6	9.2 ± 2.8	0.0 ± 0.0	4.3 ± 2.4
4	0.9 ± 0.9	0.0 ± 0.0	1.9 ± 1.9	13.3 ± 6.9	0.9 ± 0.9	0.0 ± 0.0	0.0 ± 0.0	0.5 ± 0.5	8.6 ± 2.1	1.9 ± 1.3	26.1 ± 4.8	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	1.1 ± 1.1	26.9 ± 3.7	0.9 ± 0.9	0.0 ± 0.0	5.6 ± 1.9	2.0 ± 1.4	6.6 ± 2.7
5	5.2 ± 4.2	0.0 ± 0.0	12.4 ± 8.1	4.0 ± 2.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	7.4 ± 4.7	1.3 ± 1.3	8.5 ± 3.3	0.0 ± 0.0	0.0 ± 0.0	0.9 ± 0.9	1.8 ± 1.2	44.0 ± 7.0	0.0 ± 0.0	0.0 ± 0.0	7.8 ± 3.2	0.9 ± 0.9	1.8 ± 1.8
6	2.6 ± 1.4	0.0 ± 0.0	6.7 ± 5.1	13.3 ± 4.2	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	1.1 ± 1.1	8.1 ± 3.1	3.8 ± 2.7	15.1 ± 5.3	0.0 ± 0.0	0.0 ± 0.0	1.1 ± 1.1	0.0 ± 0.0	35.6 ± 9.3	0.0 ± 0.0	0.0 ± 0.0	4.2 ± 1.7	3.6 ± 2.6	3.2 ± 1.7
7	2.5 ± 2.5	0.0 ± 0.0	6.7 ± 6.7	6.4 ± 4.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	1.8 ± 1.8	0.0 ± 0.0	2.9 ± 2.9	17.2 ± 8.1	0.0 ± 0.0	0.0 ± 0.0	2.9 ± 2.9	0.0 ± 0.0	8.3 ± 5.3	0.0 ± 0.0	3.3 ± 3.3	13.3 ± 9.7	14.2 ± 10.6	20.4 ± 10.1
8	4.7 ± 2.5	0.0 ± 0.0	2.2 ± 2.2	14.6 ± 5.8	1.7 ± 1.7	0.0 ± 0.0	0.0 ± 0.0	1.4 ± 1.4	5.6 ± 2.9	1.0 ± 1.0	14.9 ± 4.7	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	37.5 ± 7.3	0.0 ± 0.0	0.0 ± 0.0	4.3 ± 3.4	2.4 ± 1.6	9.8 ± 4.4
9	5.1 ± 2.3	0.0 ± 0.0	2.3 ± 2.3	28.5 ± 7.7	1.0 ± 1.0	1.0 ± 1.0	0.0 ± 0.0	0.0 ± 0.0	12.2 ± 3.9	3.0 ± 1.7	18.1 ± 4.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	1.4 ± 1.4	18.0 ± 4.4	0.0 ± 0.0	0.0 ± 0.0	5.7 ± 3.0	0.0 ± 0.0	1.7 ± 1.7
10	0.0 ± 0.0	0.0 ± 0.0	4.8 ± 4.6	16.7 ± 7.5	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	4.2 ± 2.6	11.1 ± 4.3	22.6 ± 8.9	0.0 ± 0.0	1.4 ± 1.4	2.1 ± 2.0	0.0 ± 0.0	11.9 ± 4.9	0.0 ± 0.0	0.0 ± 0.0	13.6 ± 6.1	6.5 ± 4.1	1.9 ± 1.8

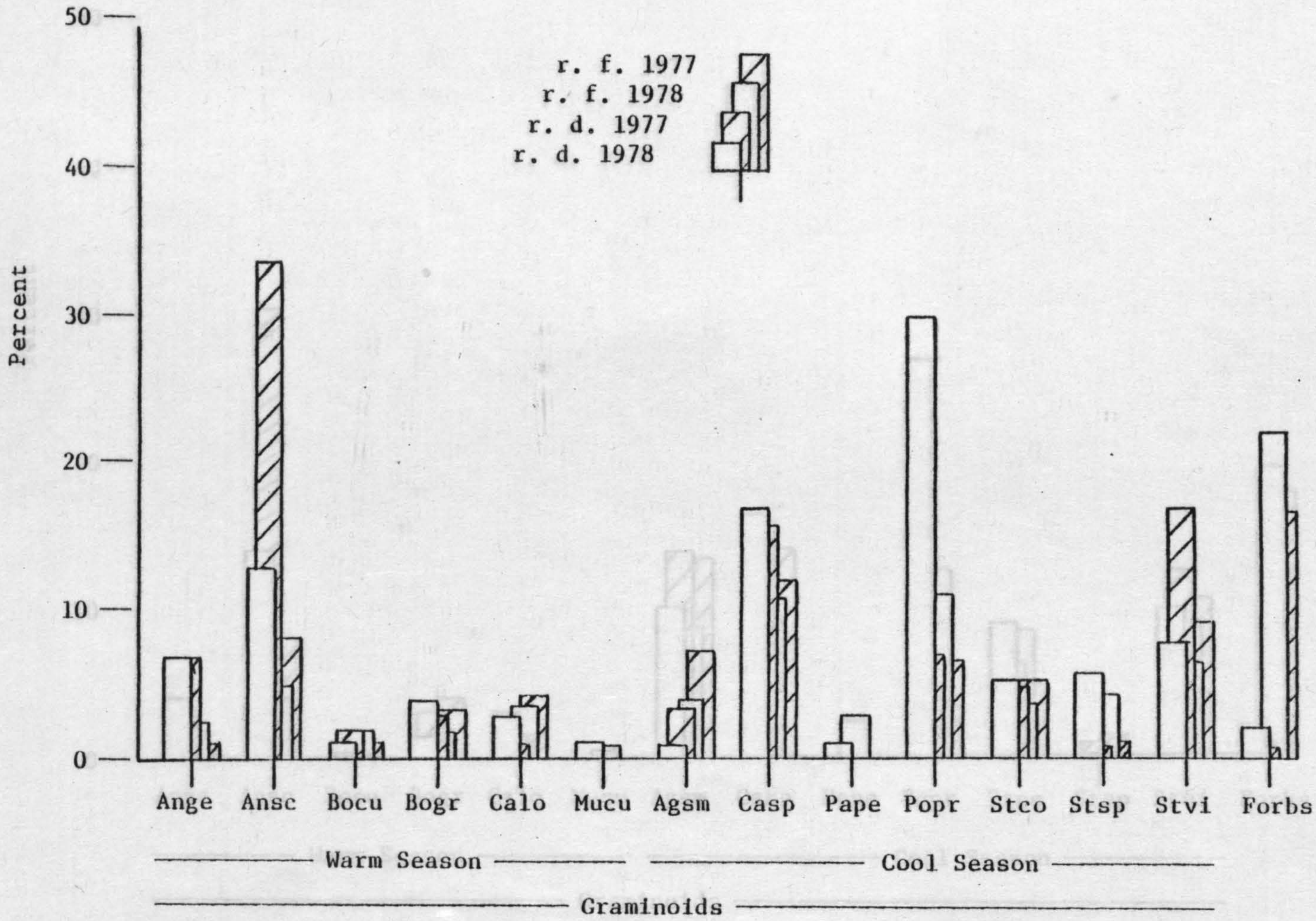

Fig. 3. Relative density and relative frequency of common species in pasture 1, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

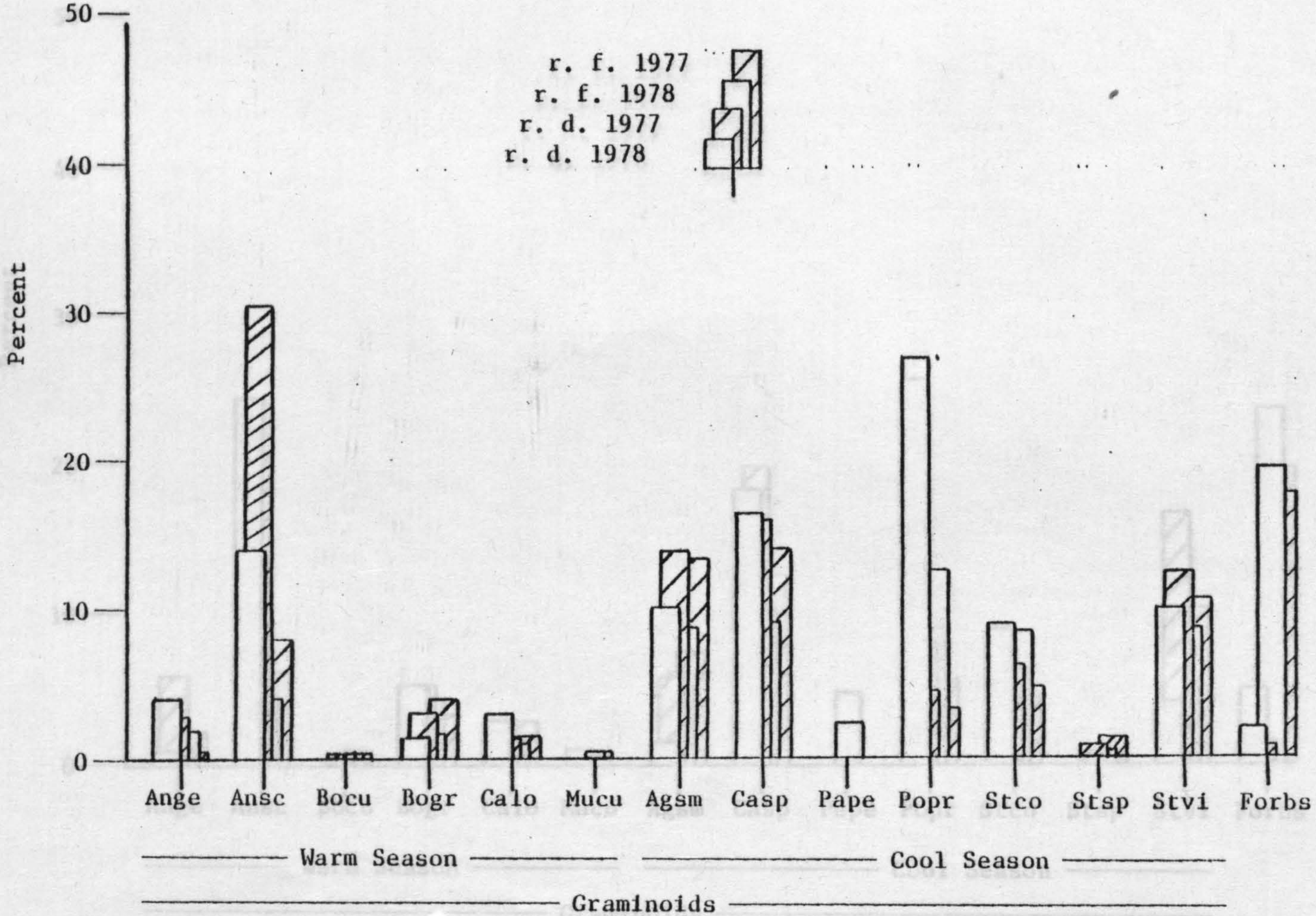

Fig. 4. Relative density and relative frequency of common species in pasture 2, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

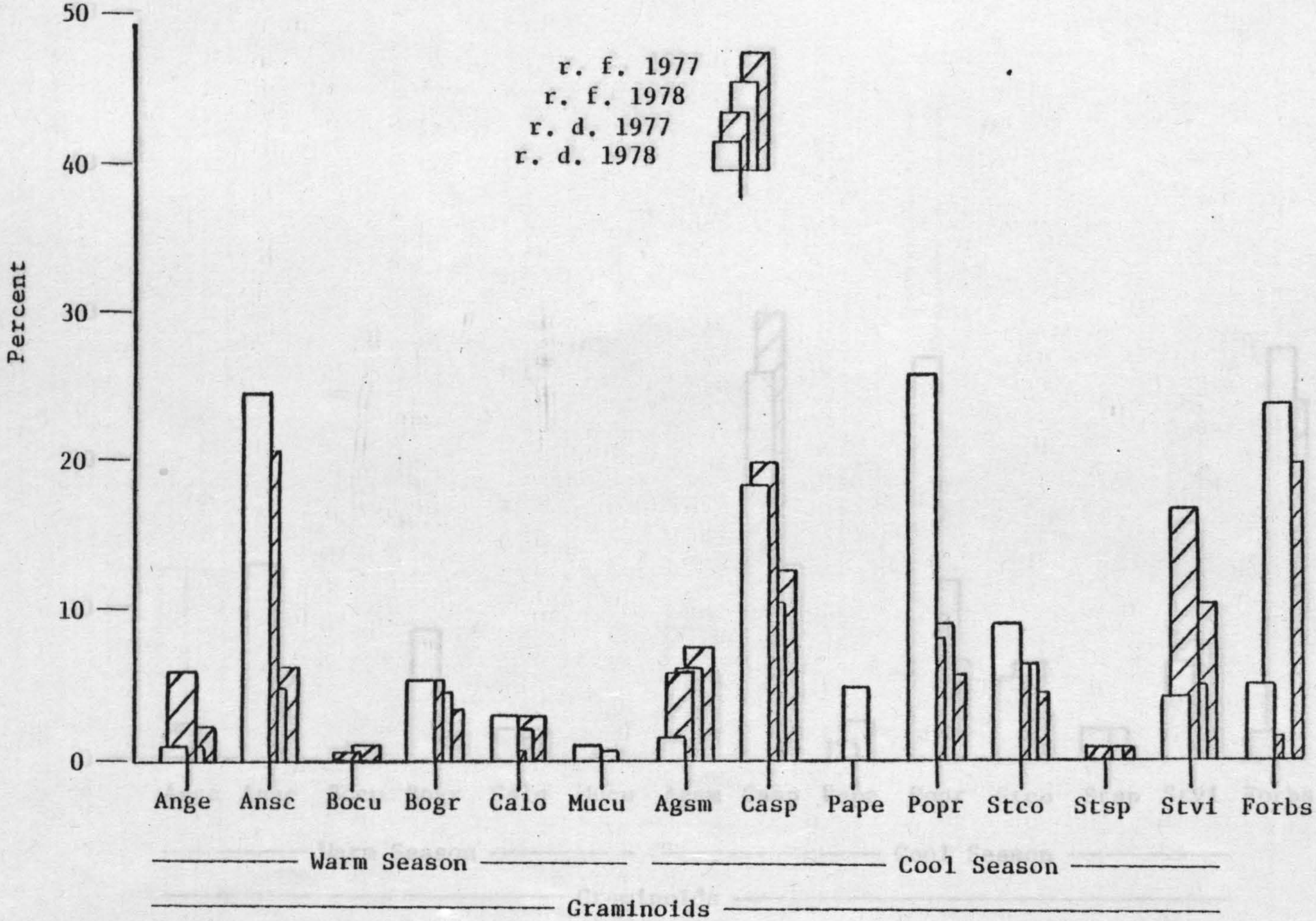

Fig. 5. Relative density and relative frequency of common species in pasture 3, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

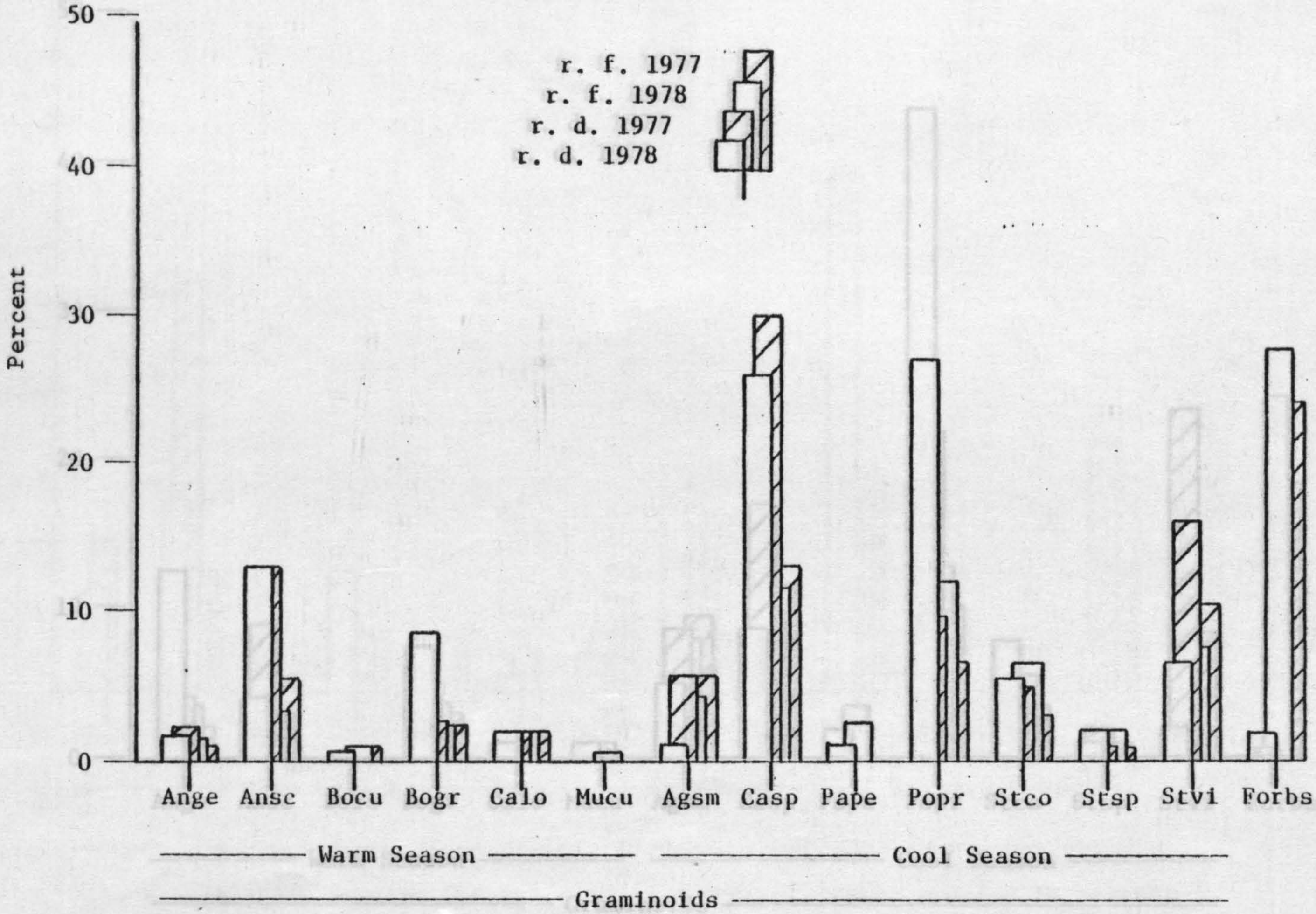

Fig. 6. Relative density and relative frequency of common species in pasture 4, 1977 and 1978.[1]

[1] 1977 are those of Carl (1978).

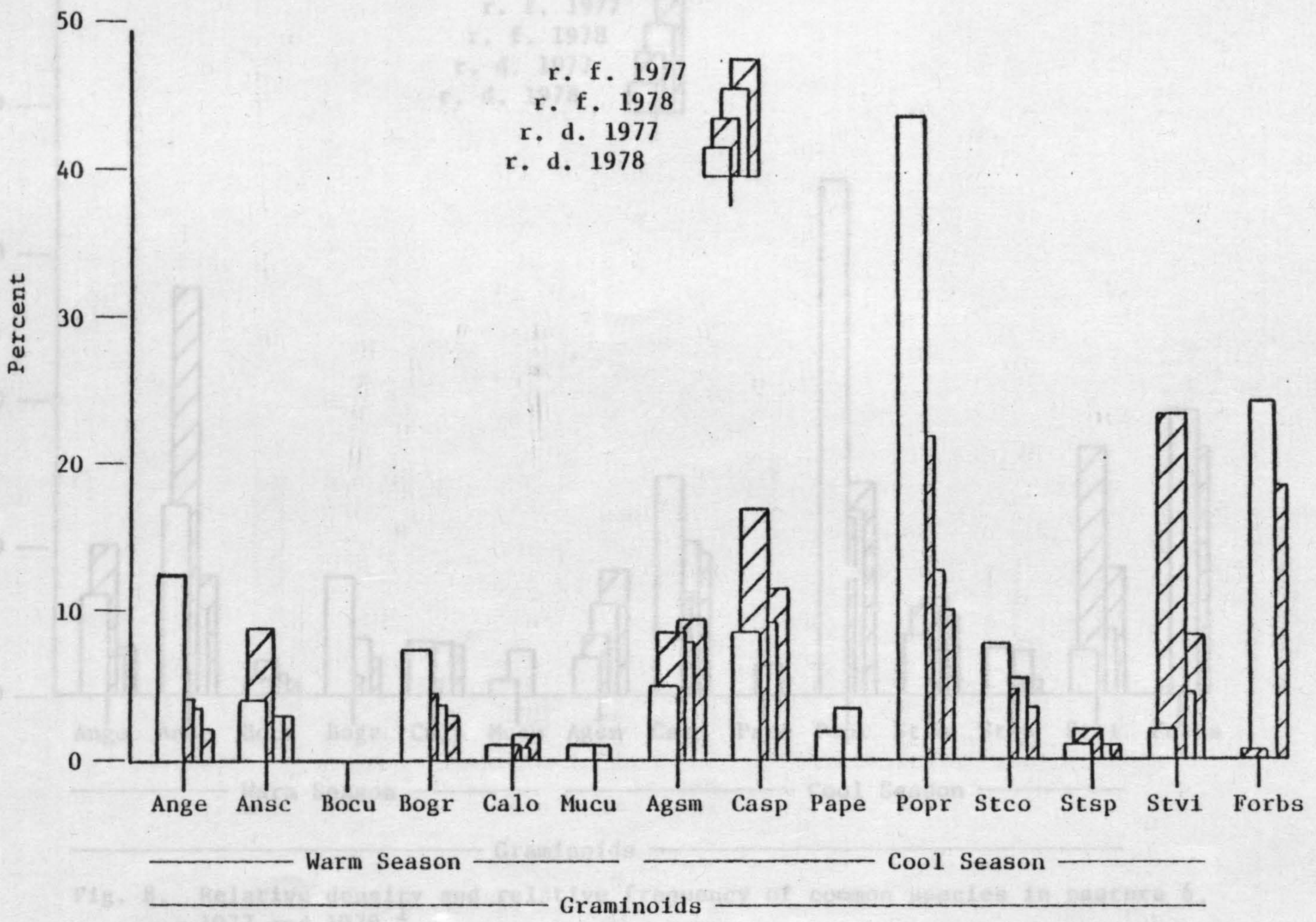

Fig. 7. Relative density and relative frequency of common species in pasture 5, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

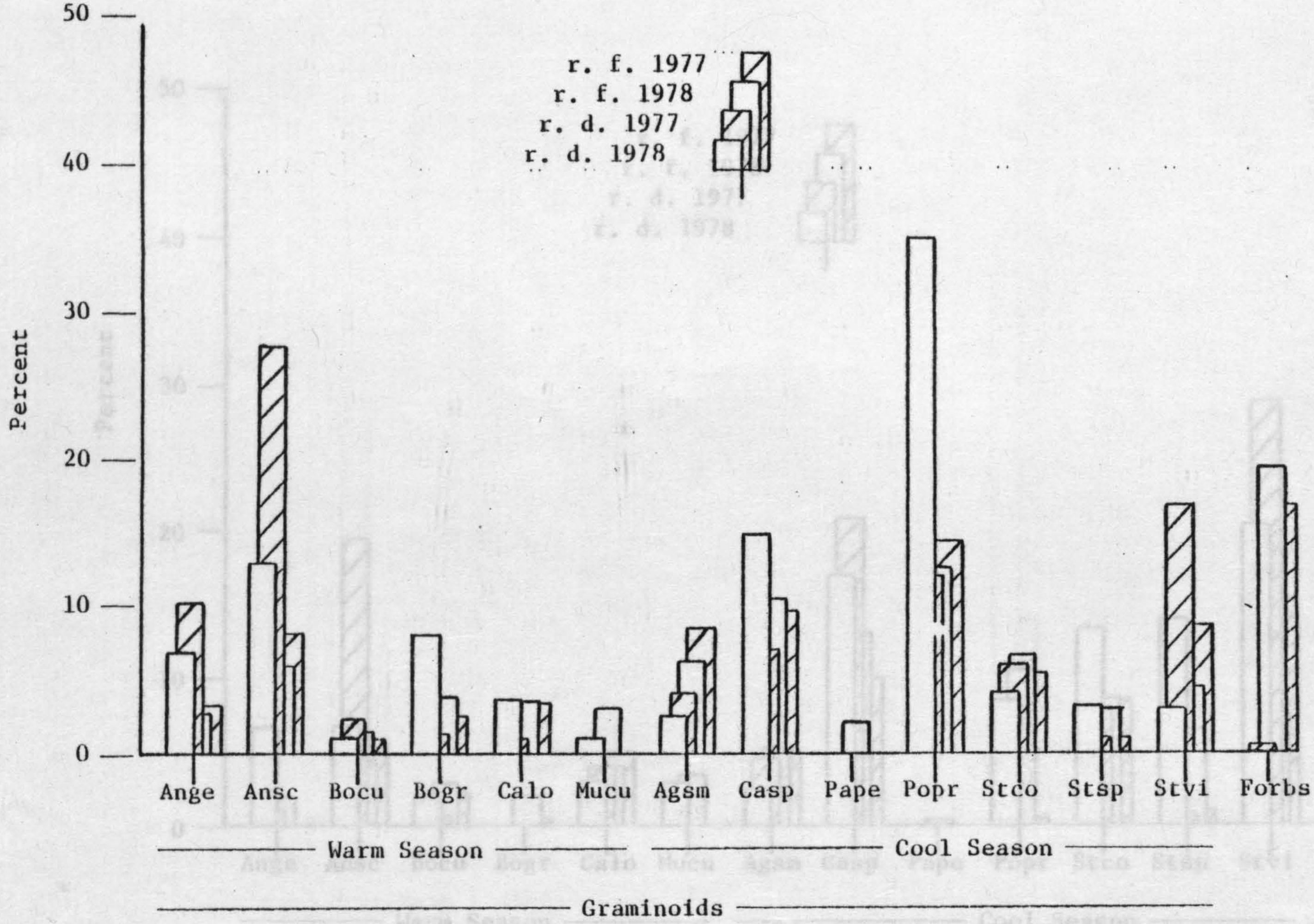

Fig. 8. Relative density and relative frequency of common species in pasture 6, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

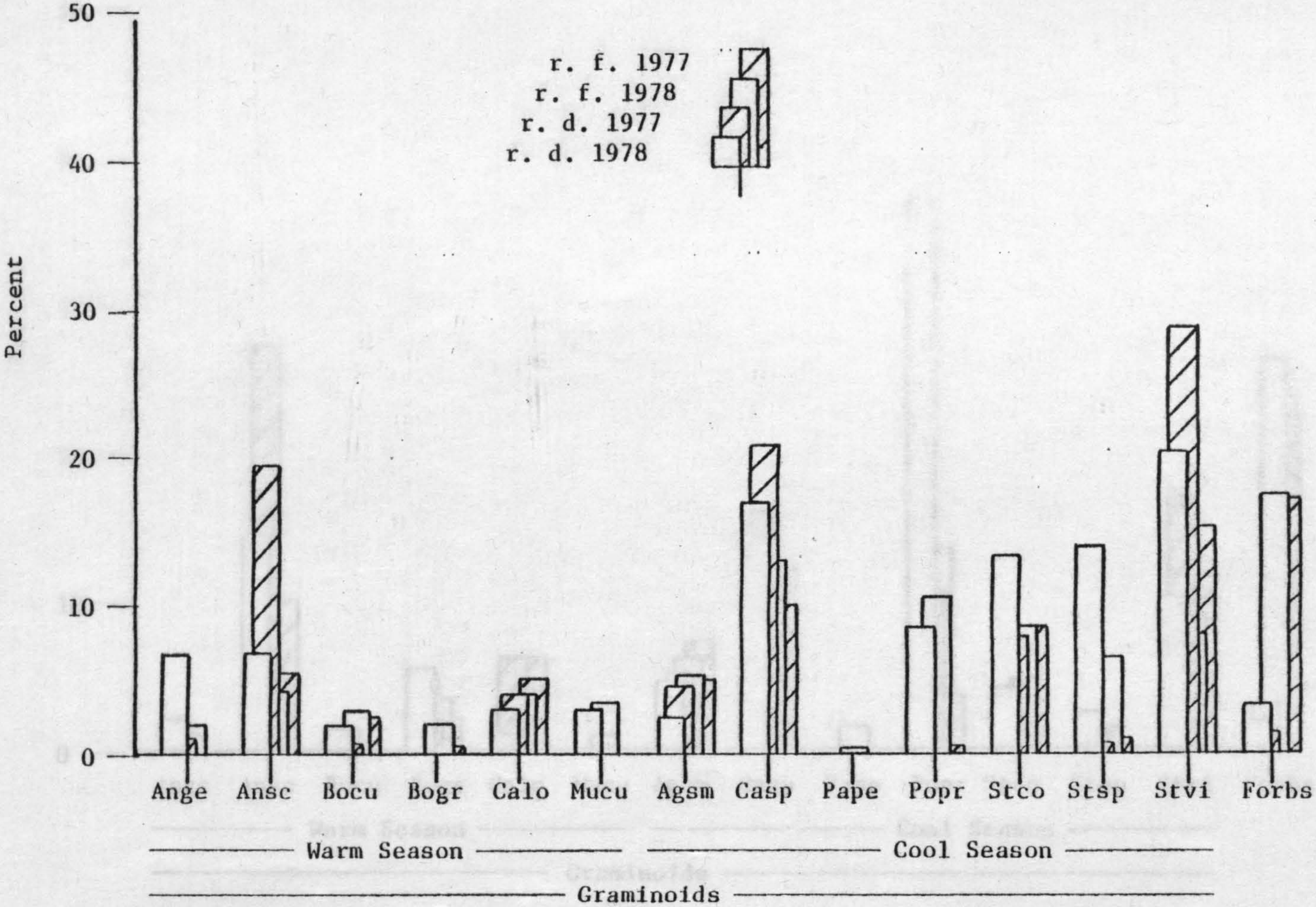

Fig. 9. Relative density and relative frequency of common species in pasture 7, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

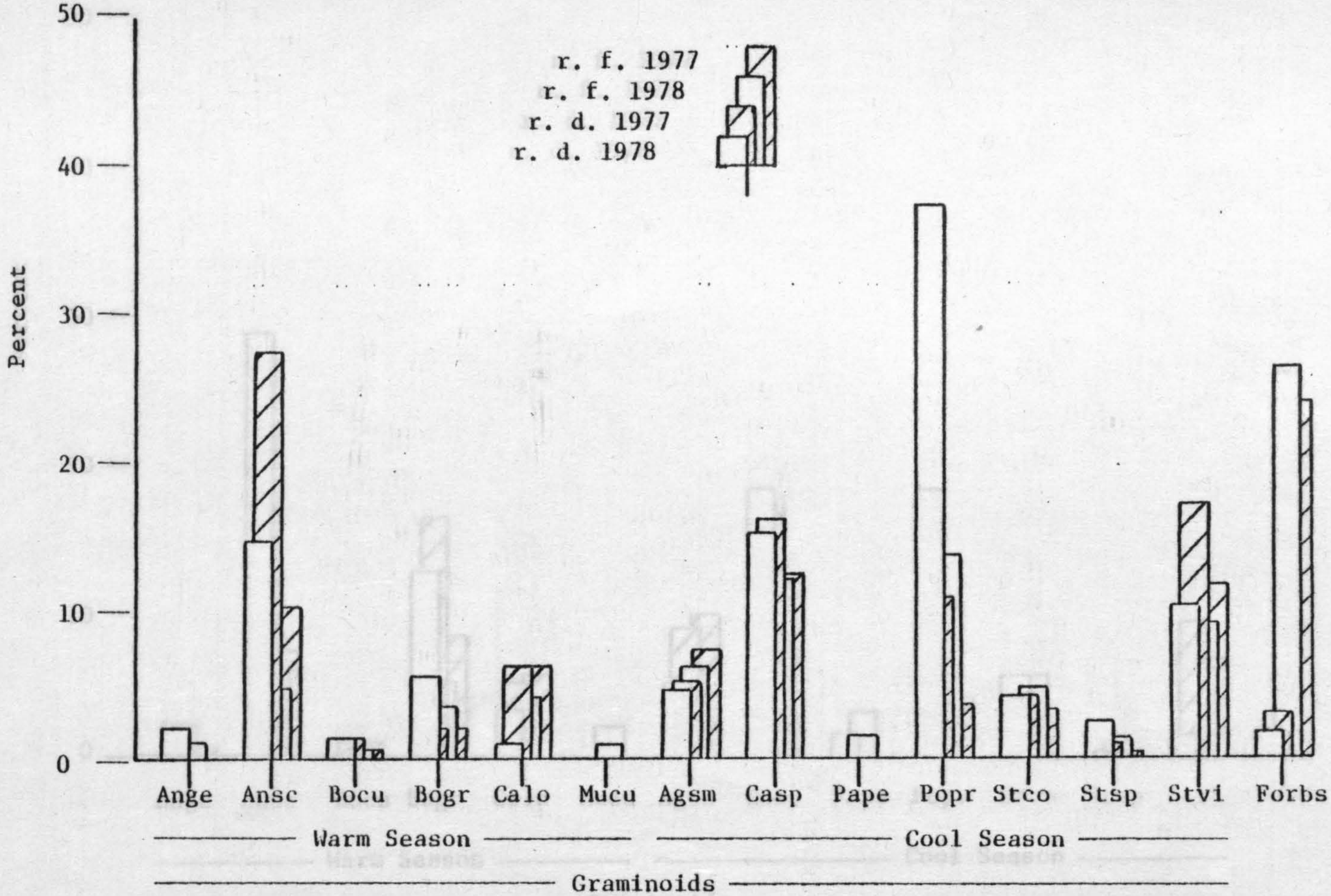

Fig. 10. Relative density and relative frequency of common species in pasture 8, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

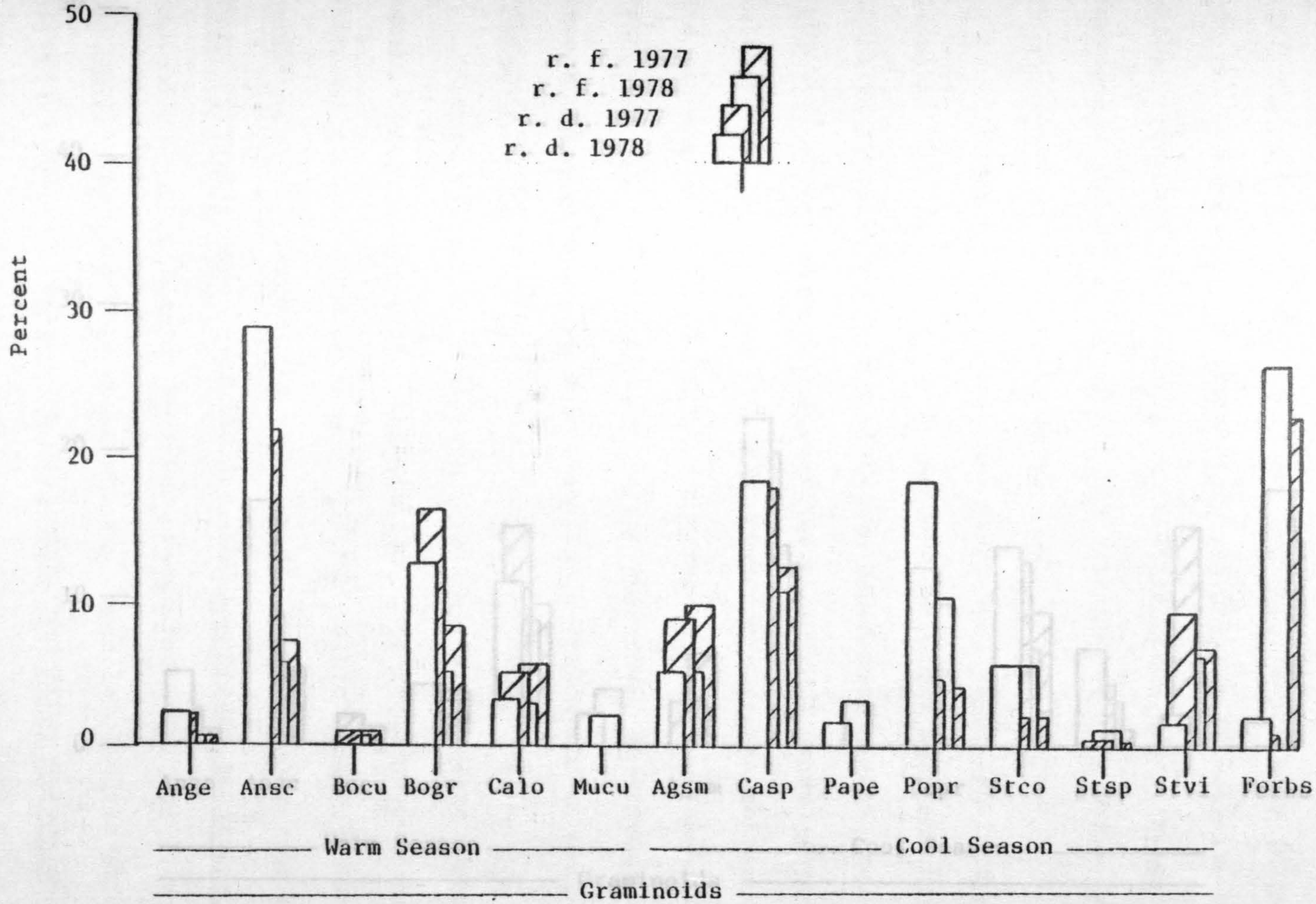

Fig. 11. Relative density and relative frequency of common species in pasture 9, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

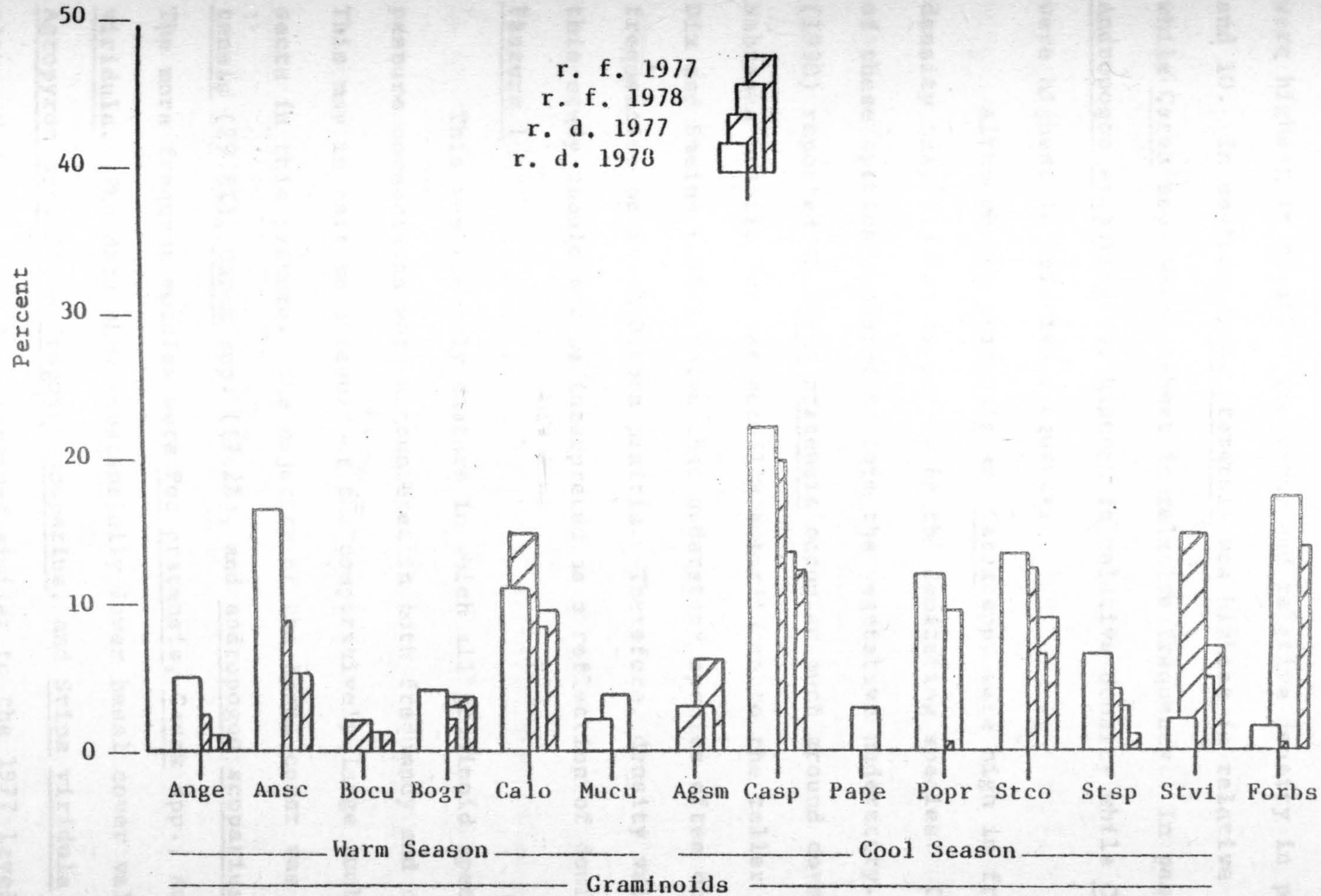

Fig. 12. Relative density and relative frequency of common species in pasture 10, 1977 and 1978.[1]

[1] 1977 data are those of Carl (1978).

Poa pratensis exhibited the highest relative frequency and relative density of the species in pastures 1, 2, 4, 5, 6 and 8. Carex spp. were highest in relative frequency and relative density in pastures 7 and 10. In pasture 3 Poa pratensis was highest in relative density while Carex spp. were highest in relative frequency. In pasture 9 Andropogon scoparius was highest in relative density while Carex spp. were highest in relative frequency.

Although Poa pratensis and Carex spp. were high in frequency and density they did not appear to be the dominating species. Individuals of these species appeared to form the vegetative understory. Steiger (1930) reported that Poa pratensis occupied much ground cover on a Nebraska prairie but was actually subordinate to the taller bluestems. Dix and Smeins (1967) noted that understory species often occur with high frequencies on North Dakota prairie. Therefore, density values from this study should not be interpreted as a reflection of dominance.

Pasture 1

This was the only pasture in which all graminoid species used in pasture comparisons were encountered in both frequency and density data. This may in part be a result of the comparatively large number of transects in this pasture. The majority of the basal cover was Poa pratensis (29.8%), Carex spp. (17.2%), and Andropogon scoparius (13.1%). The more frequent species were Poa pratensis, Carex spp., and Stipa viridula. The data show substantially lower basal cover values for Agropyron smithii, Andropogon scoparius, and Stipa viridula in 1978 although frequency values remained similar to the 1977 levels. Marked increases in basal cover of Poa pratensis and Stipa spartea are also

shown by the data. Stipa spartea also shows an increase in frequency (Fig. 3).

Pasture 2

Agropyron smithii exhibited its highest value for relative frequency (8.7%) and relative density (10.0%) in this pasture. Basal cover was predominantly Poa pratensis (27.5%), Carex spp. (16.7%), and Andropogon scoparius (14.0%). Poa pratensis, Carex spp., Stipa comata, Stipa viridula, and Agropyron smithii were the more frequent species. The data shows Andropogon scoparius to have declined markedly in basal cover and frequency while Poa pratensis had increased in both (Fig. 4).

Pasture 3

This pasture contained the highest forb basal cover (5.2%) and the lowest basal cover for Andropogon gerardi (0.9%). Basal cover was primarily Poa pratensis (26.0%), Andropogon scoparius (25.1%), and Carex spp. (18.5%). Frequent species were Carex spp., Poa pratensis, and Stipa comata. The data show substantially lower basal cover values in 1978 for Agropyron smithii, Andropogon gerardi, and Stipa viridula. Basal cover for Calamovilfa longifolia and Poa pratensis appeared to be substantially higher in 1978 (Fig. 5).

Pasture 4

Basal cover of Poa pratensis (26.9%), and Carex spp. (26.1%) were much higher than the other species. Andropogon scoparius ranked third in basal cover with 13.3%. Carex spp. displayed their highest basal cover while Agropyron smithii exhibited its lowest (0.9%). The more frequent species were Poa pratensis, Carex spp., Stipa viridula, and Stipa comata. The data show basal cover to be substantially lower in 1978

for Agropyron smithii, Andropogon gerardi, and Stipa viridula although their frequency values changed but little (Fig. 6).

Pasture 5

This pasture contained the highest basal cover for a single species. Poa pratensis accounted for 44.0% of the basal cover. Carex spp. exhibited their lowest basal cover (8.5%) while Andropogon gerardi displayed its highest basal cover (12.4%) and relative frequency (3.5%). Species with high frequency values were Poa pratensis, Carex spp., and Agropyron smithii. The data shows the basal cover of Poa pratensis to be substantially higher in 1978 although its frequency remained similar to the 1977 level. Basal cover appeared to be markedly lower in 1978 for Carex spp. and Stipa viridula, the drop in the latter being very pronounced (Fig. 7).

Pasture 6

Basal cover was primarily Poa pratensis (35.6%), Carex spp. (15.1%), and Andropogon scoparius (13.3%). Species with high frequency values were Poa pratensis, Carex spp., Stipa comata, Agropyron smithii, and Andropogon scoparius. Basal cover of Andropogon scoparius and Stipa viridula appeared to be markedly lower in 1978 while basal cover of Bouteloua gracilis, Carex spp., and Poa pratensis were substantially higher. Frequency values of these species, however, remained much the same (Fig. 8).

Pasture 7

This pasture contained the lowest basal cover of Poa pratensis (8.3%). The largest basal cover of Stipa spp. (47.9%) was also found here. Carex spp. and Poa pratensis were the more frequent species. The

data shows frequency and basal cover of Poa pratensis and Stipa spartea to be markedly higher in 1978. Basal cover of Andropogon scoparius is shown to have declined substantially although its frequency remained similar to the 1977 value (Fig. 9).

Pasture 8

Poa pratensis (37.5%), Carex spp. (14.9%), and Andropogon scoparius (14.6%) occupied most of the basal cover. Poa pratensis and Carex spp. were the more frequent species. The data shows a substantial increase in basal cover of Poa pratensis. Marked decreases in basal cover are shown for Andropogon scoparius and Calamovilfa longifolia (Fig. 10).

Pasture 9

Andropogon scoparius exhibited its highest basal cover here (28.5%). Carex spp. and Poa pratensis were high in both basal cover and frequency. The data shows a marked increase in both basal cover and frequency for Poa pratensis. Stipa viridula is shown to have declined substantially in basal cover but remained similar in frequency (Fig. 11).

Pasture 10

Carex spp. exhibited their highest basal cover here (22.6%). Other species with high values were Andropogon scoparius (16.7%), Poa pratensis (11.9%), Stipa comata (13.6%), and Calamovilfa longifolia (11.1%). Frequency values for Poa pratensis and Carex spp. were comparatively high. The data shows a substantial increase in basal cover of Poa pratensis and Stipa viridula; the increase in the former being very pronounced. Frequency for Stipa viridula remained similar to the

1977 level but Poa pratensis showed a large increase. Agropyron smithii and Bouteloua curtipendula are shown to have decreased markedly (Fig. 12).

Species Composition

Forb basal cover may be useful in determining range condition or trend. On a western North Dakota prairie studied by Whitman (1974a), forbs made up about 5% of the cover under undisturbed conditions but increased considerably with heavy grazing. Forb basal cover may, however, be quite variable (Hanson et al 1978). Using Whitman's 5% as a standard, forb basal cover data does not appear to indicate an overgrazed or low condition range.

Basal cover data of graminoids are broken down to the warm and cool season components in Table 12. Cool season graminoids constitute the majority of the basal cover in all pastures. Cool season species may not, however, be the most productive. Warm and cool season species differ physiologically, thus respond differently to environmental factors, i.e. temperature, precipitation, and light (Waller and Lewis 1979). Productivity of these components would be expected to vary seasonally in response to local weather conditions while basal cover may not.

Species diversity is a function of the number of species present and the uniformity with which the individuals are distributed among species (Hurlbert 1971). Diversity indices reflect organizational features important to community function (Cox 1976). Although relatively few species account for most of the energy flow in a community, it is the large number of rare species that largely determines the species diver-

Table 12. Relative basal cover (percent) of warm and cool season graminoids in the 10 sampled pastures of S. H. Ordway Jr. Memorial Prairie, 1978.

	Graminoids		
Pasture	Warm Season	Cool Season	Others
1	29.2	67.9	2.9
2	22.9	72.9	4.2
3	35.4	59.5	5.1
4	27.1	69.2	3.7
5	26.0	70.0	4.0
6	35.8	64.3	0.0
7	20.8	75.9	3.3
8	24.8	73.6	1.6
9	46.0	51.9	2.1
10	38.9	57.9	3.2
$\overline{X}$	30.7	66.3	3.0

sity (Odum 1971). Indices vary in assumptions concerning species abundance, distribution, and effect of sample size. Simpson's Index of Diversity and Probability of Interspecific Encounter (PIE) are sensitive to species numbers and to distribution changes among individuals of a species (Cox 1976).

Diversity indices are summarized in Table 13. Simpson's index increases from a value of 1.0 in a community consisting of one species to an infinite value for a community in which every individual belongs to a different species (Cox 1976). It is sensitive to only the more abundant species, and therefore may be regarded as a measure of dominance concentration (Whittaker 1965). Probability of Interspecific Encounter was proposed by Hurlbert (1971). It corresponds to the proportion of encounters between individuals moving in a random manner that involve individuals of different species. Values would thus range from 0.0-1.0.

Order of magnitude of pastures with lower diversity values were the same for the two indices. Pasture 5 was the least diverse followed by pastures 8, 6, 9 and 3 respectively. The indices were not, however, in agreement for the more diverse pastures. This may be a reflection of the different sensitivities to species abundance.

Pasture similarity coefficients were computed from relative density data as outlined by Cox (1976). These values are presented in Fig. 13. A maximum value of 1.0 can be obtained if both pastures are identical in species composition and their respective quantitative values. Coefficients of $\geq$ 0.85 may be considered identical (Cox 1976). Pastures 1 and 6, plus 6 and 8, may then be considered identical in spe-

Table 13. Diversity indices for the 10 sampled pastures of the S. H. Ordway Jr., Memorial Prairie, 1978.

Pasture	Simpson's Index	PIE
1	6.58	.848
2	6.63	.842
3	5.89	.830
4	5.93	.911
5	4.62	.783
6	5.55	.820
7	9.40	.894
8	5.27	.810
9	5.84	.829
10	9.14	.891

	10	9	8	7	6	5	4	3	2	1
10										
9	.64									
8	.57	.68								
7	.63	.47	.53							
6	.64	.68	.86	.55						
5	.48	.55	.70	.43	.74					
4	.65	.72	.79	.51	.79	.60				
3	.67	.80	.73	.52	.74	.58	.77			
2	.62	.70	.81	.60	.75	.62	.76	.77		
1	.68	.67	.83	.64	.86	.66	.83	.76	.81	

(Pasture)

Fig. 14. Similarity coefficients between pastures of the S. H. Ordway Jr. Memorial Prairie, 1978.

cies composition.

Table 14 summarizes analysis of variance results on the relative density and relative frequency of species used in pasture comparisons. Species exhibiting a significance level of ≤ 0.5 indicate differences in the population between pastures.

Table 14. Summary of analysis of variance on relative frequency (0) and relative density (X) of species between pastures of S. H. Ordway Jr. Memorial Prairie, 1978.

Species	Significance Level .05	.01	.005
Agropyron smithii	XO		
Ambrosia artemisiifolia			0
Andropogon gerardi			
Andropogon scoparius			
Artemisia frigida	0		
Artemisia ludoviciana	0		
Aster ericoides		0	
Bouteloua curtipendula			
Bouteloua gracilis	0		
Calamovilfa longifolia			0
Carex spp.			0
Cirsium flodmani			0
Helianthus rigidus			
Muhlenbergia cuspidata			0
Panicum perlongum			0
Poa pratensis	XO		
Psoralea argophylla			0
Solidago rigida			
Stipa comata		0	
Stipa spartea	X	0	
Stipa viridula	X	0	

SUMMARY

The mean standing crop of the study area in 1978 was 341.1 g m^{-2}. This is quite productive in comparison to other prairies in North and South Dakota. Forbs accounted for 21% of the standing crop. The mean mulch biomass was found to be 136.3 g m^{-2}. Significant differences ($P \leq .05$) between pastures were found for grass, forb, and mulch biomass. Much of the variation in productivity between this study and that of Carl (1978) may be attributed to variation in environmental factors preceeding the sampling periods.

No significant differences ($P \leq .05$) in per cent basal cover between pastures were found. Basal cover averaged 10.2%. Cool season species constituted the majority of the basal cover in all pastures with *Poa pratensis* and *Carex* spp. contributing substantially. Basal cover values of individual species or ecological groups should not be interpreted as a reflection of their productivity.

Sixteen species were found to have significant differences ($P \leq .05$) between pastures in relative frequency or relative density. *Agropyron smithii*, *Poa pratensis*, *Stipa spartea*, and *Stipa viridula* showed significant differences in both categories. The remaining species exhibited significance only in relative frequency. These consisted of 3 cool-season species, 3 warm season species, and 6 species of forbs.

Pastures 7 and 8 may be in need of a more intensive management, i.e. spring burning, or intensive early stocking of livestock. Pasture 8 contained a large amount of mulch (213.5 g m^{-2}) which may be tying up nutrients and shifting the vegetational composition toward domination

by cool season species. The conditions in pasture 7 are similar although the species composition of the cool season component differs. Pastures 9 and 10 may be in excellent range condition. Basal cover of warm season species was highest in these pastures while that of Poa pratensis was comparatively low. All other pastures appear similar in productivity and species composition, and are probably in good range condition. Pasture similarity coefficients and diversity indices indicate the entire study area is relatively homogeneous and consists of a varied species composition.

The objective of this study was to establish base-line data on the present vegetational composition of the study area. The information contained in this study provides a reference point which may enable studies in the future to determine the effects of various management techniques on vegetational composition.

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