5-1-1976

Grassland reestablishment under burning and mowing management in Eastern Nebraska.

James N. Becic

GRASSLAND REESTABLISHMENT UNDER BURNING AND MOWING MANAGEMENT IN EASTERN NEBRASKA

A Thesis

Presented to the

Department of Biology

and the

Faculty of the Graduate College

University of Nebraska

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

University of Nebraska at Omaha

by

James N. Becic

May, 1976

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

THESIS ACCEPTANCE

Accepted for the faculty of the Graduate College, University of Nebraska, in partial fulfillment of the requirements for the degree Master of Arts, University of Nebraska at Omaha.

Thesis Committee

Name	Department
D. W. Allison	Chemistry
Thomas B. Bragg	Biology

David M. Sutherland
Chairman

April 20, 1976
Date

ACKNOWLEDGMENTS

I would like to thank Dr. Thomas B. Bragg for giving freely of his time and advice often when inconvenient; his guidance and suggestions through the completion of this study was invaluable.

I would like to thank Dr. David M. Sutherland for his help in plant identifications and especially for his encouragement throughout my college years.

I would also like to thank Dr. Daniel M. Sullivan for his critical reading of the manuscript and useful suggestions.

Finally, I would like to thank my wife, Carole, whose support and encouragement was invaluable.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

INTRODUCTION

Bluestem prairie (Andropogon-Panicum-Sorghastrum) (Küchler 1964) once covered much of eastern Nebraska (Weaver 1954, Weaver and Albertson 1956, Costello 1969) but extensive cultivation since the mid-1800's has eliminated most of these native prairie stands. Four types of management have been widely used in managing remaining native bluestem prairie ranges; these include burning, mowing for hay, grazing, and prevention of burning, mowing, or grazing. Historically, burning of bluestem prairie occurred frequently in both spring and fall and was initiated by lightning and native-American Indians (Catlin 1848, Komarek 1964, 1966, Anderson 1972); grazing by large herbivores was extensive but probably less intense than present cattle grazing. Recent studies on native bluestem prairie suggest that (1) burning decreases woody plant invasion, prevents litter accumulation, improves nutrient release, and increases soil temperature (Kucera and Koelling 1964, Kucera 1970, Richards 1972, Hulbert 1973, Bragg and Hulbert 1976), (2) mowing appears to decrease soil nutrients and grass productivity, and increase annual weeds and soil compaction (Johnson 1970, Cawley 1972, Christiansen 1972, Smeins 1973), and (3) cattle grazing, depending on intensity, increases soil compaction, changes vegetative species composition by selective grazing, decreases depth and quality of grass roots, and hinders anthesis and seed production (Weaver 1950, Voigt and Weaver 1951, Owensby et al. 1973). The combined results of these studies indicate that native bluestem prairies appear to be best managed by judicious burning (Ehrenreich and Aikman 1963, Owensby and Smith 1973,

Heitlinger 1975, Hill and Platt 1975).

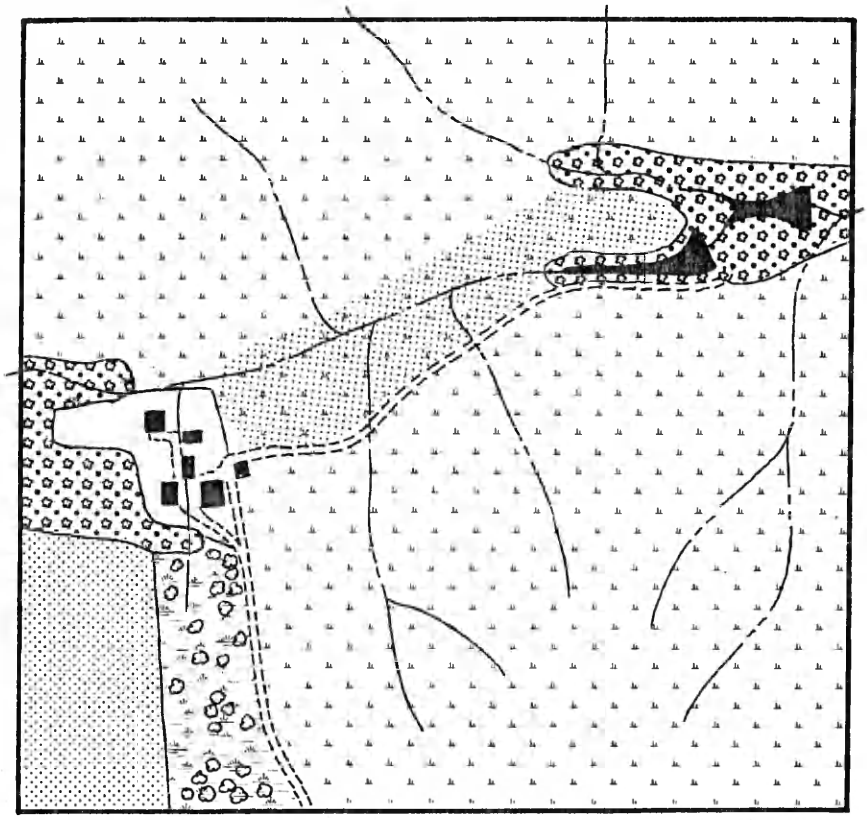
Studies on seeded and managed grasslands suggest results similar to those obtained for native bluestem prairie (Bland 1970, Schulenberg 1970, Schumacher 1975, Bragg 1976), although extensive work has not been done in this area. This study was designed (1) to evaluate the effect of various management conditions on seeding success, and (2) to conduct a vegetative survey of Allwine Prairie Preserve for use in future studies.

STUDY AREA

Allwine Prairie Preserve (Fig. 1) is a 65 hectare (160 acre) restored grassland research site situated within the portion of eastern Nebraska designated by Küchler (1964) as potential bluestem prairie. Past management conditions, and accessability to the University of Nebraska at Omaha, made Allwine Prairie Preserve an ideal site for this type of study. Three areas; tall-grass, mid-grass, and lowland-double-seeded, totaling 55 ha, were seeded to native grass species in May 1970 (Fig. 2). All seeded areas were mowed twice in each of 1970 and 1971, and mowed once in 1972. Management from 1973 to 1975, incorporating burning and mowing, varied substantially (Bragg 1975); spring burning occurred in late April or early May; fall mowing occurred in late summer or early fall. Bare ground appears to be abundant in this newly established grassland (Bragg 1976).

The research site consists of gently rolling loess hills of both north and south aspect. Hills range from 3 to 15% slope and include four principal drainage areas; vertical interval of terraces vary from 3.5 to 4.0 meters. Deep and generally well drained soils are of the Mollisol and Entisol Soil Orders, Subgroups Cumulic Haplaquolls, Cumulic Hapludolls, Typic Hapludolls, and Typic Udorthents. Mollisols of the area are slightly acid in pH, and have an upper 41 to 74 cm of silty clay loam or silt loam. Entisols, formed from calcareous, loamy, glacial till are basic in pH, with clay loam in the upper 15 cm. The climate of the area is characterized by a mean annual precipitation of 71 cm, three-fourths of which falls from April through September. Local droughts occur when

Fig. 1. Allwine Prairie Preserve.



TALL-GRASS: tall and mid-grasses - big bluestem (Andropogon gerardii), little bluestem (A. scoparius), indiangrass (Sorghastrum avenaceum), switchgrass (Panicum virgatum), and sideoats grama (Bouteloua curtipendula).

MID-GRASS: mid and short-grasses - little bluestem, sideoats grama, blue grama (Bouteloua gracilis), and buffalo grass (Buchlöe dactyloides).

LOWLAND-DOUBLE-SEEDED: seeded twice with tall grasses - big bluestem, indiangrass, and switchgrass.

BROME WATERWAY: smooth brome (Bromus inermis), with scattered trees.

TREED AREA.

PONDS & FARM STRUCTURES.

Fig. 2. Seeding plan for Allwine Prairie Preserve. Scale: 1 cm = 51 m. (Species nomenclature throughout, from McGregor 1973)

the time or distribution of precipitation is poor. Temperature ranges average from 1°C in January to 31°C in July with extremes of -23°C in January and 41°C in July not uncommon. The frost-free season averages about 167 days (climate and soils from Bartlett, 1975).

METHODS AND MATERIALS

The tall-grass portion of the prairie was divided into three management areas, (1) two-year-burn; that portion burned in the spring of 1974 and 1975, (2) two-year-mow; that portion mowed in the fall of 1973 and 1974, and (3) burn-and-mow; that portion burned in the spring of 1974 and mowed the following fall. The mid-grass, and lowland areas were not included in the management comparisons but were evaluated for the baseline study. Within each management area specific study areas were delineated based on topographic location. Study areas evaluated included upland, upper-slope, mid-slope, and lower-slope. Vegetative composition was evaluated by systematically locating 5, 2 X 10 meter plots on the slope areas and 10, 2 X 10 meter plots in both upland and lowland areas. In each plot, 10, 1 dm^2 microplots were randomly located and the canopy coverage of each species was estimated using the following categories: less than 5% coverage, 5 - 25%, 25 - 50%, 50 - 75%, 75 - 95%, and greater than 95% (Daubenmire 1959). Mid-point values of each coverage category were used for analysis. Canopy coverage of each species was separately evaluated; for convenience, weedy forbs and all species of incidental coverage, termed "combined forbs" and "other" respectively, were grouped using the maximum coverage in the plot for any species of the group. Vegetative sampling was conducted during June and July, 1975; identifications were verified at the University of Nebraska at Omaha Herbarium.

Biomass was measured in August by clipping, drying, and weighing the vegetation in 3, 0.5 m^2 plots, systematically located in a number of selected study areas. Species canopy coverage and basal area of surface

clumps and stems along 3, 1-meter transects were also recorded.

Soil data were obtained from 10, 23 cm deep, increment samples systematically collected within each selected study area. Soil texture was determined using a soil hydrometer and standard soil texture determining procedures. Organic matter, soil pH, and phosphorus, potassium, and residual nitrate content were determined by the University of Nebraska - Lincoln Soil Testing Laboratory.

RESULTS AND DISCUSSION

Response to Management

Two consecutive years of burning management substantially increased native grasses and decreased weedy forbs when compared to either the two-year-mow or the burn-and-mow areas (Figs. 3 and 4); weedy forbs were primarily horseweed (Conyza canadensis), Canada lettuce (Lactuca canadensis), sheepsorrel (Oxalis dillenii), red clover (Trifolium pratense), and yellow sweetclover (Melilotus officinalis) (common names from Anderson and Owensby, 1969). These results suggest either that (1) consecutive spring burns have a more permanent effect on reducing weedy forbs than does a single spring burn, or (2) in the year burned, weedy forbs are substantially reduced but not necessarily in subsequent years. The latter hypothesis is partially supported by the vegetational composition of the burn-and-mow area in which forb cover in 1975 was high even though the area had been burned in 1974 (Table 1). Considering the abundant open soil present (Appendix Table 2), it appears that annual, weedy forbs will continue to present problems in all areas unless some burning management is used to control them, but with time, the natural increase in native grasses should ultimately outcompete and replace weedy species.

Response to Environmental Gradients

After five years of vegetative development, the most notable segregation along natural topographic gradients, was that of big bluestem which increased from upper-slope (33%) to lower-slope (54%) and little bluestem which decreased (13% upper-slope to 10% lower-slope) (Fig. 5). Higher

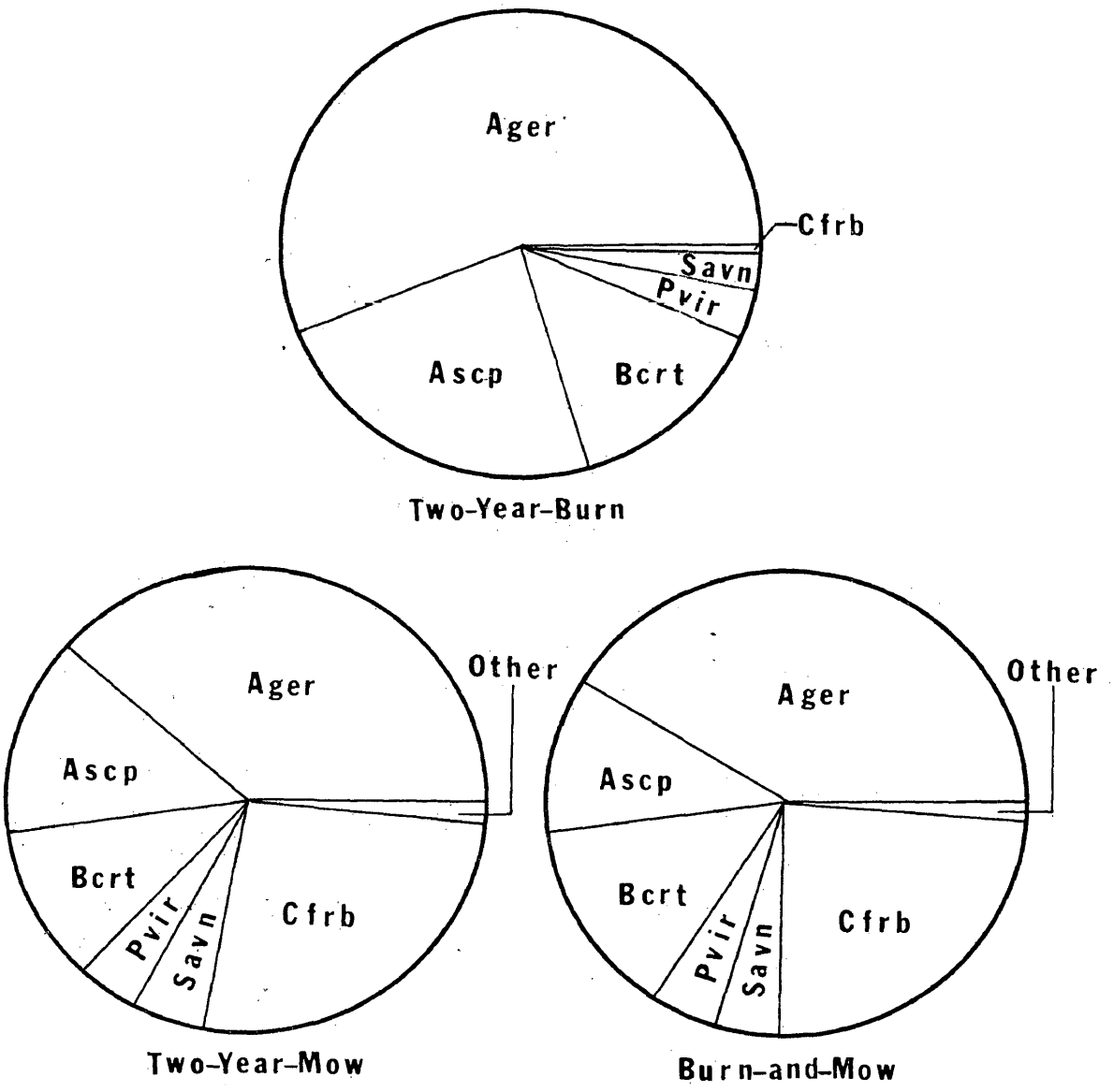


Fig. 3. Percent coverage of vegetation[1] on combined management areas.

[1]Key To Species
Ager = Andropogon gerardii
Ascp = Andropogon scoparius
Bcrt = Bouteloua curtipendula
Pvir = Panicum virgatum
Savn = Sorghastrum avenaceum
Cfrb = Combined forbs
Other = Bouteloua gracilis, Bromus inermis, Annual Grasses

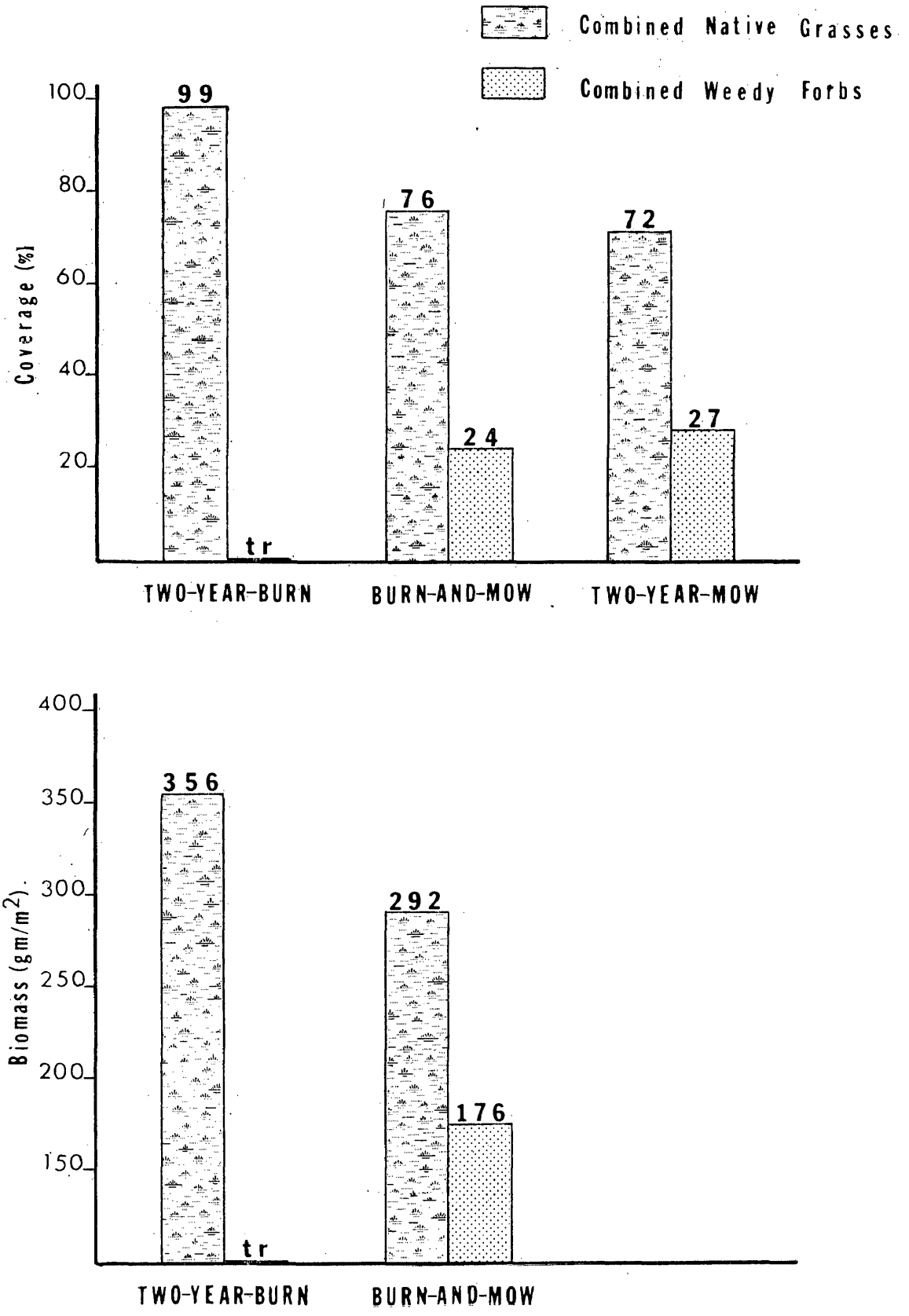


Fig. 4. Vegetative differences in three management areas. tr = less than 0.5.

Table 1. Combined relative weedy forb coverage following various management. Trace = tr (less than 0.5).

Past Management			Combined Forb Coverage (%)
1973	1974	1975[1]	1975
unburned unmowed	SPRING-BURN unmowed	SPRING-BURN	tr
unburned unmowed	SPRING-BURN FALL-MOW	unburned	24
unburned FALL-MOW	unburned FALL-MOW	unburned	27

[1] Mowed in 1975 subsequent to study.

soil moisture generally found in the lower elevations may explain this segregation (Bragg 1976). Physical soil properties (Appendix Table 1) do not appear to influence bluestem development.

Baseline Vegetative Study

Sampling in each of 9 study areas (Fig. 6) provided the 1975 vegetative composition to which future comparisons may be made (Table 2). The major seeded grasses were found to be most abundant in all areas except in area 8, and the upper-slope of area 1, where weedy forbs were dominant.

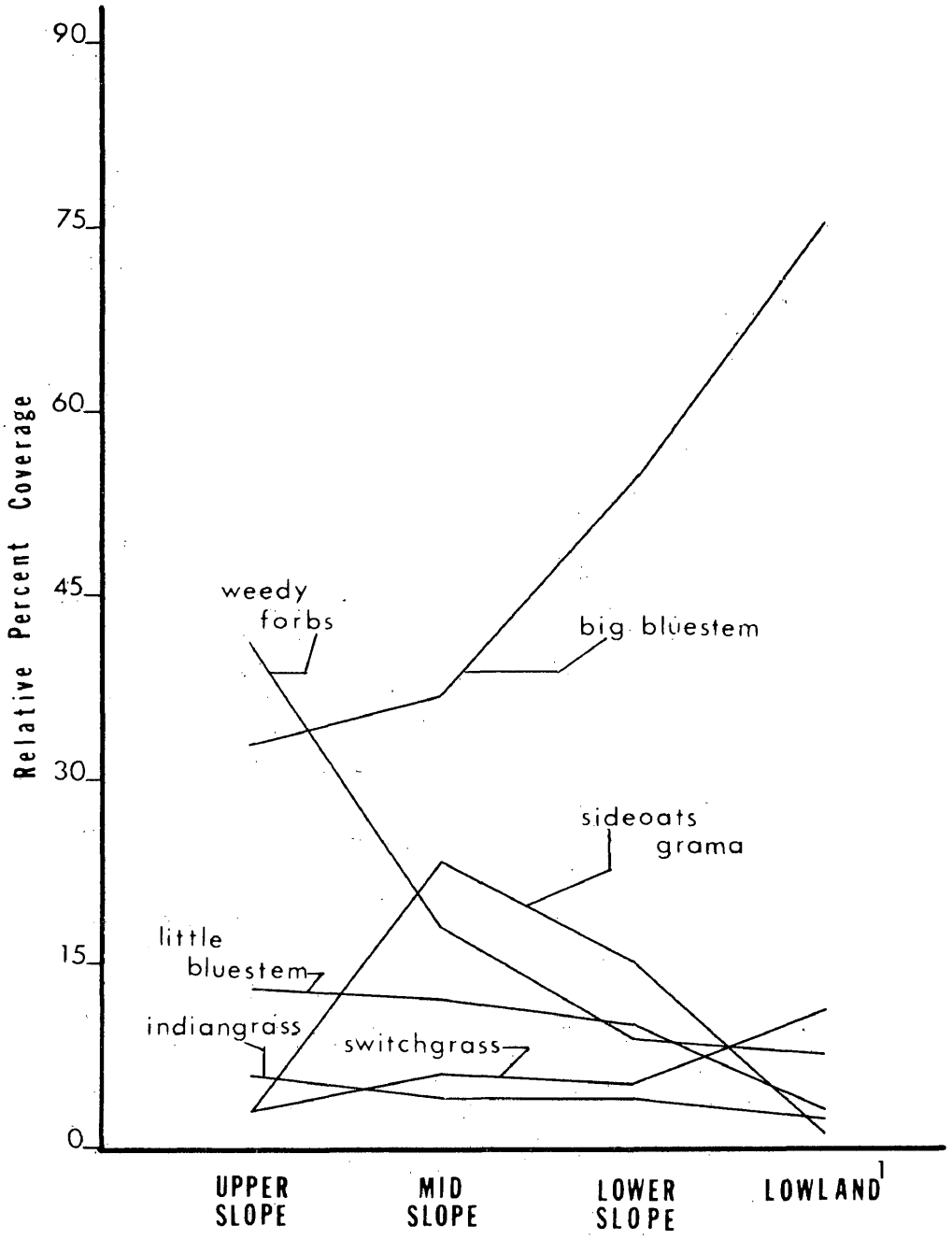


Fig. 5. Vegetative coverage in relation to topographic location on combined burn-and-mow and two-year-mow areas.

[1]Burned only in 1975.

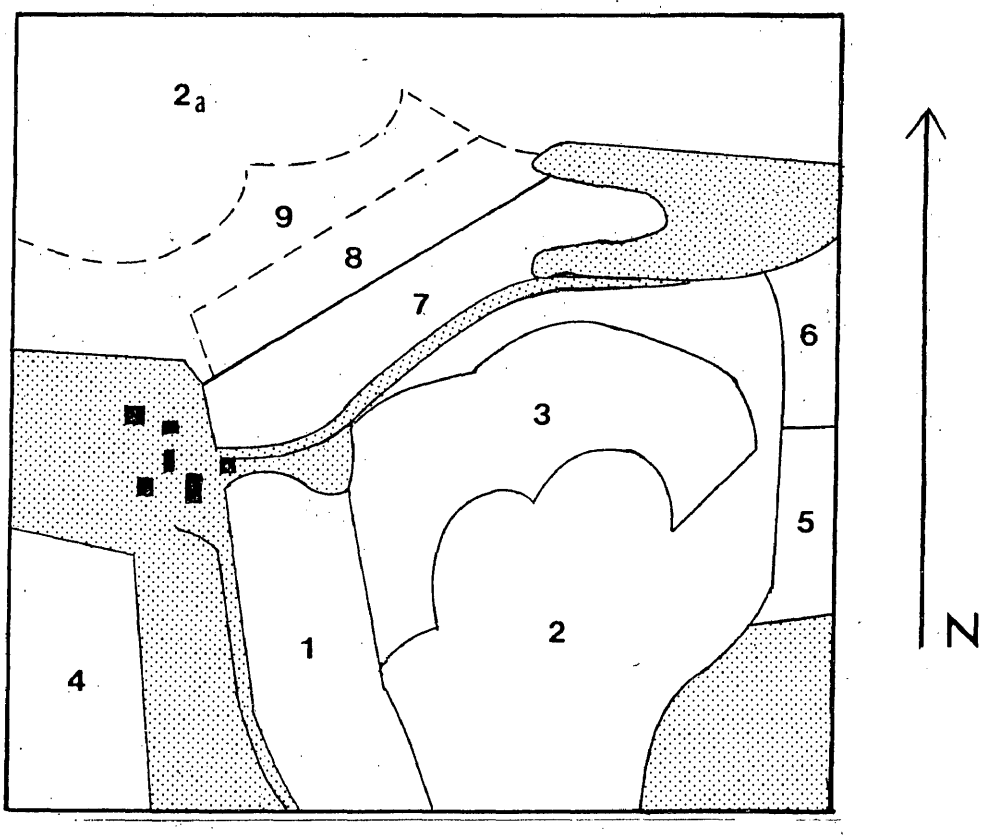


Fig. 6. Vegetative sampling areas. Broken line indicates a separate study area within the management area. (Area 2_a has the same management as area 2 but was rated separately).

Table 2. Average percent vegetational coverage of principal species in 9 study areas[1]. Upland = up, Upper-slope = us, Mid-slope = ms, Lower-slope = ls, East-slope = es, East-lowland = el, Lowland-double-seeded = ld, North-lowland = nl, North-slope = ns, Trace = tr (less than 5%).

	Tall-Grass															Mid-Grass				Misc.-Areas				
	Area-1				Area-2				Area-2_a				Area-3			Area-4				5, 6, 7, 8, 9				
	up	us	ms	ls	up	us	ms	ls	up	us	ms	ls	us	ms	ls	up	us	ms	ls	es	el	ld	nl	ns
Andropogon gerardii	34	45	32	63	40	28	43	46	61	55	34	47	50	46	45	1	0	0	0	42	93	57	50	38
Andropogon scoparius	14	26	14	10	9	18	18	12	12	9	3	9	6	22	31	65	58	51	50	13	4	3	3	14
Bouteloua curtipendula	12	4	28	8	15	5	16	9	0	5	25	26	22	4	9	14	29	28	34	21	2	1	0	7
Panicum virgatum	4	4	7	4	4	6	0	1	0	2	9	9	0	7	2	0	0	0	0	7	14	28	9	1
Bouteloua gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4	3	1	0	0	0	0	0
Sorghastrum avenaceum	2	3	8	7	15	15	tr	2	13	4	3	4	5	1	0	0	0	0	1	1	2	7	0	6
Bromus inermis	2	0	0	4	0	0	0	0	tr	3	0	0	0	0	0	12	tr	0	0	1	0	0	0	0
Annual grasses	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	tr	tr	0	0	tr	0	14	0	0
Combined forbs	29	84	7	5	17	53	33	14	16	26	14	5	tr	tr	tr	3	20	6	tr	12	9	41	89	19

[1] Coverage by individual species located in Appendix Table 2.

SUMMARY AND CONCLUSIONS

Reestablished native grasses under 3 years of burning and mowing management showed that (1) two-year-burns resulted in a greater native grass cover than two-year-mowing or burning-and-mowing (2) biomass was greater on two-year-burned areas than on burned-and-mowed areas (3) weedy forbs were substantially less on the two-year-burn, than on either the two-year-mow or the burn-and-mow areas, and (4) big bluestem increased while little bluestem decreased from upper to lower slopes. Soil differences did not appear to affect native grass establishment.

The combined results of this short term study suggest that (1) frequent burning is the best initial management for establishing native grass stands and for controlling weedy forbs and, (2) some native species begin to segregate along natural topographic gradients during the initial years of establishment.

REFERENCES CITED

Anderson, K. L., and C. E. Owensby. 1969. Common names of a selected list of plants. Agricultural Experiment Station, Kansas State University. Tech. Bull. 117. 62 p.

Anderson, R. C. 1972. Prairie history, management and restoration in Southern Illinois, pp. 15-20. In J. H. Zimmerman (ed.), Proc. Second Midwest Prairie Conference, Madison, Wisconsin.

Bartlett, P. A. 1975. Soil survey of Douglas and Sarpy Counties, Nebraska. U.S. Dep. Agr. S.C.S. 79 p.

Bland, M. K. 1970. Prairie establishment at the Michigan Botanical Gardens, pp. 46-47. In P. Schramm (ed.), Proc. of a Symposium on Prairie and Prairie Restoration, Galesburg, Illinois.

Bragg, T. B. 1975. History of Allwine Prairie Preserve. Unpublished and privately circulated data. University of Nebraska at Omaha.

Bragg, T. B. 1976. The effects of terraces on reestablishing native grasslands in eastern Nebraska, p. 39. In Abstracts of Papers Presented at the 29th Annual Meeting of the Society for Range Management, Omaha, Nebraska.

Bragg, T. B., and L. C. Hulbert. 1976. Woody plant invasion of unburned Kansas Bluestem Prairie. J. of Range Manage. 29(1): 19-24.

Catlin, G. 1848. Illustrations of the manners, customs and conditions of the North American Indians. vol. 2, 7th Ed. Henry G. Bohn, York St. London. 266 p.

Cawley, E. T. 1972. The history of prairie preservation in Iowa, pp. 22-24. In J. H. Zimmerman (ed.), Proc. Second Midwest Prairie Conference, Madison, Wisconsin.

Christiansen, P. A. 1972. Management of Hayden Prairie: past, present and future, pp. 25-29. In J. H. Zimmerman (ed.), Proc. Second Midwest Prairie Conference, Madison, Wisconsin.

Costello, D. F. 1969. The prairie world. T. Y. Crowell Co., New York. 242 p.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. N. W. Sci. 33(1): 43-64.

Ehrenreich, J. H., and J. M. Aikman. 1963. An ecological study of the effects of certain management practices on native prairie in Iowa. Ecol. Monogr. 33: 113-130.

Heitlinger, M. E. 1975. Burning a tall grass prairie to suppress sweetclover, Melilotus alba Desr., pp. 123-132. In M. K. Wali (ed.), Prairie: A Multiple View, Grand Forks, North Dakota.

Hill, G. R., and W. J. Platt. 1975. Some effects of fire upon a tall grass prairie plant community in Northwestern Iowa, pp. 103-113. In M. K. Wali (ed.), Prairie: A Multiple View, Grand Forks, North Dakota.

Hulbert, L. C. 1973. Management of Konza Prairie to approximate pre-white-man fire influences, pp. 14-17. In L. C. Hulbert (ed.), Proc. Third Midwest Prairie Conference, Manhattan, Kansas.

Johnson, A. G. 1970. Fertility level of a hay-cropped prairie, pp. 26-27. In P. Schramm (ed.), Proc. of a Symposium on Prairie and Prairie Restoration, Galesburg, Illinois.

Komarek, E. V., Sr. 1964. The natural history of lightning, pp. 139-183. Proc. Third Tall Timbers Fire Ecology Conference, Tallahasee, Florida.

Komarek, E. V., Sr. 1966. The meteorological basis for fire ecology, pp. 85-125. Proc. Fifth Tall Timbers Fire Ecology Conference, Tallahasee, Florida.

Kucera, C. L. 1970. Ecological effects of fire on tallgrass prairie, p. 12. In P. Schramm (ed.), Proc. of a Symposium on Prairie and Prairie Restoration, Galesburg, Illinois.

Kucera, C. L., and M. Koelling. 1964. The influence of fire on composition of central Missouri Prairie. The Amer. Midl. Nat. 72: 142-147.

Küchler, A. W. 1964. Potential natural vegetation of the coterminous United States. Amer. Geogr. Soc. Special Pub. No. 36. 116 p.

McGregor, R. L. 1973. Check list of Great Plains flora with synonyms. Unpublished and privately circulated. Mimeographed copy of typescript obtained from the author. 175 p.

Owensby, C. E., and E. F. Smith. 1973. Burning true prairie, pp. 1-4. In L. C. Hulbert (ed.), Proc. Third Midwest Prairie Conference, Manhattan, Kansas.

Owensby, C. E., E. F. Smith, and K. L. Anderson. 1973. Deferred-rotation grazing with steers in the Kansas Flint Hills. J. of Range Manage. 26(6): 393-395.

Richards, M. S. 1972. Management of Kalsow Prairie, pp. 30-33. In J. H. Zimmerman (ed.), Proc. Second Midwest Prairie Conference, Madison, Wisconsin.

Schulenberg, R. 1970. Summary of Morton Arboretum prairie restoration work 1963 to 1968, pp. 45-46. In P. Schramm (ed.), Proc. of a Symposium on Prairie and Prairie Restoration, Galesburg, Illinois.

Schumacher, C. M. 1975. Rangeland-a proper prairie use, pp.419-422. In M. K. Wali (ed.), Prairie: A Multiple View, Grand Forks, North Dakota.

Smeins, F. E. 1973. Influence of fire and mowing on vegetation of the Blackland Prairie of Texas, pp. 4-7. In L. C. Hulbert (ed.), Proc. Third Midwest Prairie Conference, Manhattan, Kansas.

Voigt, J. W., and J. E. Weaver. 1951. Range condition classes of native midwestern pasture: an ecological analysis. Ecol. Monogr. 22: 39-60.

Weaver, J. E. 1950. Effects of different intensities of grazing on quantity of roots of grasses. J. of Range Manage. 3(2): 100-113.

Weaver, J. E. 1954. North American Prairie. Johnson Publishing Co., Lincoln, Nebraska. 343 p.

Weaver, J. E., and F. W. Albertson. 1956. Grasslands of the Great Plains. Johnson Publishing Co., Lincoln, Nebraska. 395 p.

Appendix Table 1. Physical properties of soil within management areas. SCL = Silty Clay Loam.

	Management Areas					
	2-year burn	2-year mow	burn & mow	lowland area[1]	lowland dbl.-seed	mid-grass[1]
pH	6.3	6.6	6.4	6.6	6.9	6.3
Nitrate (ppm)	1.4	1.5	1.4	1.8	2.6	1.4
Phosphorus (ppm)	1.7	4.4	3.2	8.0	49.0	6.0
Potassium (ppm)	189	194	211	248	723	226
Organic Matter	2.47	1.84	2.42	2.37	3.42	1.97
Sand	12	13	15	12	17	11
Silt	56	56	54	59	56	56
Clay	32	31	31	29	27	33
Soil Type	SCL	SCL	SCL	SCL	SL	SCL

[1]Burned in 1975 only.

Appendix Table 2. Average percent vegetational coverage by species in the 9 study areas. Upland = up, Upper-slope = us, Mid-slope = ms, Lower-slope = ls, East-slope = es, East-lowland = el, Lowland-double-seeded = ld, North-lowland = nl, North-slope = ns, Trace = tr (less than 5%).

Species	Tall-Grass															Mid-Grass				Misc.-Areas				
	Area-1				Area-2				Area-2_a				Area-3			Area-4				5, 6, 7, 8, 9				
	up	us	ms	ls	up	us	ms	ls	up	us	ms	ls	us	ms	ls	up	us	ms	ls	es	el	ld	nl	ns
Andropogon gerardii	34	45	32	63	40	28	43	46	61	55	34	47	50	46	45	1	0	0	0	42	93	57	50	38
Andropogon scoparius	14	26	14	10	9	18	18	12	12	9	3	9	6	22	31	65	58	51	50	13	4	3	3	14
Bouteloua curtipendula	12	4	28	8	15	5	16	9	0	5	25	26	22	4	9	14	29	28	34	21	2	1	0	7
Panicum virgatum	4	4	7	4	4	6	0	1	0	2	9	9	0	7	2	0	0	0	0	7	14	28	9	1
Bouteloua gracilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4	3	1	0	0	0	0	0
Sorghastrum avenaceum	2	3	8	7	15	15	tr	2	13	4	3	4	5	1	0	0	0	0	1	1	2	7	0	6
Bromus inermis	2	0	0	4	0	0	0	0	tr	3	0	0	0	0	0	12	tr	0	0	1	0	0	0	0
Elymus canadensis	0	0	0	0	tr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buchlöe dactyloides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	tr	0	0	0	0	0	0

Appendix Table 2. (continued)

Species	Tall-Grass																Mid-Grass				Misc.-Areas				
	Area-1				Area-2				Area-2a				Area-3				Area-4				5, 6, 7, 8, 9				
	up	us	ms	ls	up	us	ms	ls	up	us	ms	ls	us	ms	ls		up	us	ms	ls	es	el	ld	nl	rs
Poa pratensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		tr	0	0	0	0	0	0	0	0
Agropyron repens	tr	tr	tr	3	tr	0	0	0	0	0	tr	0	0	0	0		0	0	0	tr	0	0	0	0	0
Setaria glauca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	3	0	0
Setaria viridis	0	0	0	0	0	0	0	0	tr	0	0	0	0	0	0		tr	tr	0	0	0	0	10	0	0
Bromus japonicus	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0		tr	0	0	0	tr	0	1	0	0
Trifolium pratense	25	82	tr	0	2	22	26	0	0	0	0	0	tr	0	0		tr	2	5	0	1	0	0	tr	0
Melilotus officinalis	0	14	2	0	2	36	0	0	0	0	0	2	0	0	0		0	17	0	0	6	0	0	0	0
Oxalis dillenii	1	tr	0	tr	3	2	0	3	tr	tr	tr	tr	0	tr	tr		1	tr	tr	tr	tr	6	2	3	2
Lactuca canadensis	2	tr	1	3	3	1	4	2	5	11	7	1	tr	0	tr		1	tr	tr	tr	1	2	6	60	1
Conyza canadensis	3	tr	tr	4	11	8	8	tr	6	4	8	1	tr	tr	tr		tr	tr	tr	0	tr	tr	tr	23	11

Appendix Table 2. (continued)

Species	Tall-Grass																Mid-Grass				Misc.-Areas				
	Area-1				Area-2				Area-2a				Area-3				Area-4				5, 6, 7, 8, 9				
	up	us	ms	ls	up	us	ms	ls	up	us	ms	ls	us	ms	ls		up	us	ms	ls	es	el	ld	nl	ns
Taraxacum officinale	tr	0	0	tr	tr	1	0	0	1	1	tr	0	0	0	0		tr	tr	0	0	tr	0	1	0	1
Convolvulus arvensis	0	0	0	0	1	0	0	tr	tr	11	0	0	0	0	0		0	0	0	0	2	0	0	0	0
Polygonum pensylvanicum	0	0	0	0	tr	0	0	0	0	0	0	0	0	0	0		tr	0	0	tr	0	tr	22	tr	0
Lepidium densiflorum	tr	0	tr	0	tr	0	0	0	tr	tr	0	0	0	0	tr		0	0	0	0	0	0	0	0	0
Medicago lupulina	0	0	0	0	2	0	5	0	0	0	0	0	tr	0	0		0	0	0	0	0	0	0	0	2
Medicago sativa	0	0	4	0	0	0	2	0	5	3	0	0	0	0	0		0	0	0	0	tr	0	0	0	2
Asclepias syriaca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	1	3	0	0
Thlaspi arvense	0	0	0	0	0	0	0	0	0	tr	0	0	0	0	0		0	0	0	0	0	tr	2	0	0
Chenopodium album	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	2	0	0	0
Physalis virginiana	tr	0	0	tr	0	0	0	0	0	0	0	0	0	0	0		1	0	0	0	0	0	tr	0	0

Appendix Table 2. (continued)

Species	Tall-Grass																Mid-Grass				Misc.-Areas				
	Area-1				Area-2				Area-2a				Area-3				Area-4				5, 6, 7, 8, 9				
	up	us	ms	ls	up	us	ms	ls	up	us	ms	ls	us	ms	ls		up	us	ms	ls	es	el	ld	nl	ns
Ambrosia trifida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	3	0	0
Abutilon theophrasti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	3	tr	0
Cannabis sativa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	tr	0	0
Tragopogon dubius	0	tr	tr	0	0	0	0	0	2	0	1	1	0	0	0		tr	0	0	0	0	0	0	2	tr
Carduus nutans	0	0	0	0	0	0	0	0	tr	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
Erigeron strigosus	0	tr	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
Acer negundo	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0		0	0	0	0	0	0	tr	0	0
Rosa arkansana	0	0	0	0	tr	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
Misc. forbs	0	0	0	0	0	0	0	tr	0	0	0	0	0	0	0		0	0	0	0	0	0	tr	0	0
Open soil	-	-	-	-	-	-	-	17	-	-	-	-	51	51	34		-	-	-	-	-	-	-	-	-