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THE ANALYSIS OF THE RESTORATION OF THE GEORGE
WASHINGTON CARVER NATIONAL MONUMENT
PRAIRIES FOR FALL 1981 TO SUMMER 1985

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Contract No. CX-6000-2-0074

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ABSTRACT

A historical, vegetational, and soil analysis was initiated in 1981, on the prairie area at George Washington Carver National Monument. This analysis revealed six prairie management units whose flora ranged from an approximation of a native prairie to a depauperate array of encroaching woody vegetation, noxious weeds and cool season grasses. The intent of the study was to review management recommendations and practices for the restoration and maintenance of the George Washington Carver prairie areas to the historic scene of 1860-1880. Separate management plans were developed for each unit that included burning, discing, mowing, plowing, woody plant removal, seeding, and planting with propagated native prairie species. Follow-up studies were conducted on these management units that mimicked the pre-management studies. It was found that in all units except Unit # 4, the native prairie species greatly increased and the noxious plants were controlled. In Unit # 4, the vegetational composition improved but not as dramatically as the other units. The soil analysis showed that the soil conditions either improved or stayed the same under this regime of management techniques. A future management program is also included.

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INTRODUCTION

GEORGE WASHINGTON CARVER NATIONAL MONUMENT

This report details the analysis of the restoration of the prairies of George Washington Carver National Monument from fall 1981 to summer of 1985. (Contract No. CX-6000-2-0074) between the National Park Service and Missouri Southern State College). The intent of the study was to review management recommendations and practices for the restoration and maintenance of the George Washington Carver prairie areas to the historic scene of 1860-1880. The project area comprises 85.2 hectares (210 acres) of land located in Sec. 7, T26N, R31W in north-central Newton County, which is 4.7 kilometers (3 miles) south-west of Diamond, Missouri. Prior to settlement, prairie dominated one half of the land area within Missouri. The George Washington Carver National Monument includes the original homestead of Moses Carver, a colorful frontier figure and slaveholder of the mother of George Washington Carver. The Carver homestead dates from approximately 1835. Agricultural records for the 1850-1880 period show that Carver had only 100 acres of improved land within his 240 acre homestead. On the remainder of unimproved land, Carver maintained woodland and prairie, most likely using the prairie for pasture and hay. Since the land left the hands of the Carver family shortly after the turn of the century, agricultural practices were changed to a more intensive approach. In 1943 the park was authorized by Congress as a National Monument to honor the life

and achievements of George Washington Carver and is listed on the National Register of Historic Places.

OBJECTIVES AND PHILOSOPHY

PARK MANDATE AND OBJECTIVES OF THE PRAIRIE RESTORATION ACTION PLAN

The cornerstone of this study is the objectives developed by the National Park Service and outlined in the Prairie Restoration Action Plan for George Washington Carver National Mounument. The management policies of the National Park Service state that the Service will perpetuate the historic scene in a manner appropriate to each historic place; and to the extent possible, cultural resources and their environments shall be preserved in their historic form and appearance. The management objectives of the George Washington Carver National Monument are "To restore the historic scene to that of the Moses Carver farm of the 1860's and 1870's. Major goals included in this restoration project are assessment of the vegetational status of the pre-prairie units; elimination of existing populations of non-native cool season grasses, invading woody species and control of species recognized as prairie typical, but only when present in small populations; establishment of native prairie grasses and forbs; uses of manipulative practices that will ensure the stability of the native prairie species once they are established (varying in technique, timing, and duration dependent on a continuous monitoring program to evaluate the status of the developing prairie)" Davis, 1982.

Jackson and Bensing (1982) found that all six prairie management areas were native prairies during the 1860's and 1870's. Therefore, the overall objective is to restore these areas to a vegetational composition that approximates the historic scene. A historic picture of a native prairie would include such grasses as Adropogon gerardi (big bluestem), Adropogon scoparius (little bluestem), Sorghastum nutans (indian grass), Panicum virgatum (switch grass), and Bouteloua curtipendula (sideoats gramma).

Objectives of this report are to determine the post-management status of the George Washington Carver Prairies by vegetational community composition and soil analysis; and to suggest modification for future management plans based on findings of the surveys.

PRAIRIE MANAGEMENT UNITS

From the results of the 1982 study, the George Washington Carver National Monument prairie was divided into six management units (Figure 1). These six units contain approximately 80% of the prairie identified by the historic base map for the park (Figure 2). This map represents the physical appearance of the Moses Carver farm, prior to the turn of the century. A brief description of these six units will be included here. Unit #1 is located in the northeast corner. It comprises 1.57 hectares (3.85 acres) of relatively level land, with a border of trees along the northern edge. Unit #2 consists of 1.19 hectares (2.92 acres) in the northwest part, and is bordered by the Harkins Branch on the north and west, and the Carver Branch on the south.

Unit #3, in the southwest corner, contains 2.34 hectares (5.73 acres). On the western edge, forest encroachment is seen. Unit #4 is centrally located behind the visitors' center. Its 2.74 hectares (6.70 acres) are bordered with a forest area on the north, and a hedgerow along the western edge. The ground slopes up towards the north. Unit #5 is also in the central region and is just south of Unit #4. It is the largest of all the areas, with 3.75 hectares (9.18 acres). A slight rise is seen in the central portion of this area. Unit #6 is a small strip of land running parallel to the hedgerow on the western border of Unit #5. This is a small unit with 0.53 hectares (1.3 acres).

SOIL CLASSIFICATION

The study revealed information pertaining to the soil types, boundaries of each type, and native vegetation using the Soil Survey by the United States Department of Agriculture Soil Conservation Service as a guideline. The following soil types were found: 1) Wanda, 2) Carytown, 3) Keeno, 4) Hoberg, 5) Secesh-Cedargap (USDA soil analysis for Newton County). The boundaries of the existing soils are shown in Figure 3. The native vegetation for these types of soils is usually prairie vegetation, although it is possible to alter soil type by manipulating the vegetation of an area.

PRE-MANAGEMENT PRACTICE DESCRIPTIONS, MANAGEMENT RECOMMENDATIONS,
AND MANAGEMENT ACTION FOR THE PRAIRIE UNITS

The following is a description of the prairie management units as they existed just prior to the implementation of the management practices in 1981.

Management Unit #1

Management Unit #1 appears to be less disturbed than some of the other areas. From a 1953 aerial photograph, it can be seen that this area is distinct, and was not tilled as was the surrounding land (Figure 4). This area is somewhat lower and may not have been suitable for plowing. The Land Use Permit (1951-1952, Carver Files) designates Unit #1 as pasture land. Within the last 20 years, it has never been plowed, seeded, or fertilized (Alford, 1981). The Land Use Permit of 1966-1976, puts this area under a Special Use Permit to Melvin Alford. In 1976 he was using it for grazing. This permit was then continued until 1983. It is usually mowed in June, and then once again in late summer or early fall (Alford, 1981).

The soil survey of Unit # 1, showed that the major portion of this area consists of Keeno cherty silt loam, derived from the weathering of residual limestone, with chert on top and interspersed with fragipan (Figure 3). The soil is thought to be derived from prairie vegetation. This soil is moderately sloping (2 - 9% slopes), with moderately slow permeability (.2 - .6 in/hr), moderately well drained, and low water holding capacity. The northern edge of this unit is Cedargap cherty silt loam (Figure 3). This soil is pebble-free in the upper 12 to 20

inches. It consists mainly of silty sediments and cherty material deposited by flowing water. This soil is thought to be derived from prairie vegetation. It is nearly level bottom soil (0 - 1% slopes), with moderately rapid permeability (2.0 - 6.0 in/hr), moderately good drainage, and has medium water holding capacity.

Because the soil is deep in relation to the other units, Unit # 1 could support mesic or dry mesic prairie.

MANAGEMENT RECOMMENDATIONS FOR UNIT 1

Evidence supports this area as historical prairie (Toogood, 1973). The vegetational analysis indicates that this area is not a climax prairie community, but does not show serious deviation from the normal sequence of seres found in native prairie succession. Based on vegetation composition, Unit # 1 is the closest approximation to native prairie in the park. Big bluestem and broom sedge are the two most important grasses of this prairie and have identical importance values. Fescue, a cool-season agricultural invader, is the third most important grass and would be considered an anomaly in a native prairie successional sequence (Odum, 1971). Its importance is probably due to adjacent areas being seeded to fescue for forage production. The western one-third of this unit has been protected from grazing and fire, which has resulted in a dense unnatural stand of sumac and other noxious woody species. Their removal should be part of the management plan of this area.

Specific management goals for Unit #1 were as follows:

- a. Establish the unit as a grassland area with a mesic prairie ecosystem.
- b. Establish a high diversity of forbs over the entire unit compatible with its utilization for grazing. Forbs are desirable in this area because it is quite visible to road traffic. Grazing period shall be determined on height and condition of the vegetation. Fire can be used at specific times of the year to favor either the forbs or the warm-season grasses.
- c. Prescribed burn conducted just after the bluegrass greens (mid-April), to reduce cool-season grass competition, remove organic matter to facilitate reseeding, and to stimulate existing warm-season grasses.
- d. Overseeding of native grass and forb seed (using drill) to increase the percentage of native grasses within the stand.

Seeding rates:

(Common name nomenclature of plants according to Flora of Missouri, Julian Steyermark (1977), Iowa State University Press).

Big Bluestem (native)....	4.5	lbs/ac	PLS	X	2.5ac	=	11.25	lbs	PLS
Indian grass (native)....	3.5	lbs/ac	PLS	X	2.5ac	=	8.75	lbs	PLS
Switchgrass (Blackwell)..	0.25	lbs/ac	PLS	X	2.5ac	=	.625	lbs	PLS
Little Bluestem (Aldous).	0.25	lbs/ac	PLS	X	2.5ac	=	.625	lbs	PLS
Maximillian Sunflower....	7.0	oz/ac		X	2.5ac				
Illinois Bundleflower...	14.0	oz/ac		X	2.5ac				
White Prairie Clover.....	4.0	oz/ac		X	2.5ac				
Rattlesnake Master.....	4.0	oz/ac		X	2.5ac				
Thickspike Gayfeather...	13.0	oz/ac		X	2.5ac				
Yellow Prairie Coneflower	4.0	oz/ac		X	2.5ac				

- e. Mowing should be used during the first year to control weed growth. The weeds should never be allowed to get very much taller than the new grass population. Weed control will not be a problem after late July, and mowing should be stopped to allow for next spring's fuel to build up.
- f. Mechanical removal of invading woody species on the raised western section of this unit. Once removed, frequent observation should be made throughout the year checking for woody sprout growth from remaining rootstock.

Management Action for Unit # 1:

- a. Monitoring - Fall (1981) premanagement practice sampling; 1982-1984 spring and fall samples; .
- b. Prescribed Burning - March 24, 1982; March 31, 1983. The area was not burned in 1984 in order to measure revegetation success.
- c. Mowing - July 3, 1982, Eastern portion, ht. 6"; August 1, 1982, Western portion, ht. 10", June 2, 1983, Western portion, ht. 6"; June 1, 1984, Western portion, ht. 6".
- d. Herbicide Application
- e. Seeding - May 10, 1982, initial overseed; May 13-14, 1983, Western portion reseeded; April 23, 1984, Forbs established; May 30, 1984, indian paintbrush from roadside established; June 9-10, 1984, contract for (1000 forbs).
- f. Plowing
- g. Discing
- h. Mechanical Removal - Selective hand cutting of sumac, locust, and poke.

MANAGEMENT UNIT 2

Management Unit #2 has a history of heavy grazing. The Land Use Permit of 1951-1952 designates this area as pasture land. The aerial photograph of 1953 indicates that some denuding of the land was occurring, but no tillage lines are seen (Figure 6). In 1966, the area was under a special use permit to Melvin Alford, which has continued to the present. In 1967-1968 the growth was quite heavy and was mowed. Since then, it has been grazed through the summer of 1981 (Alford, 1981).

The soil survey map (Figure 3) shows this area to be Cedargap cherty silt loam with a deep alluvial, flat prairie soil (see description for Unit #1). This area could support mesic as well as dry mesic prairie vegetation.

Unit #2 shows a low level of maturity due to pasture abuses. Several woody species were scattered throughout this area, with quite a few bare areas where no vegetation is growing, and there are signs of erosion along the streams. Vegetation composition indicate severe overgrazing.

The Jackson and Bensing (1982) study of this unit shows some early evidence of tillage (1938 photograph), but the species composition, historical records, and personal interviews indicate that it has been subjected to severe overgrazing for years. Because of the weedy nature of this vegetation, there is little value in a prairie management practice to save the remnant native vegetation.

The specific management goals for Unit # 2 are as follows:

- a. Establish the unit as a grassland area with a mesic prairie ecosystem.
- b. Establish a low diversity of forbs over the unit which is compatible with grazing. The length and intensity of the grazing period shall be determined by factors such as height and condition of the vegetation. Fire can be used at specific times of the year to favor either the forbs or the warm-season grasses.
- c. Plow, disc, and reseed.

Seeding rates: (Common name nomenclature according to Flora of Missouri, Julian Steyermark (1977), Iowa State University Press.

Big Bluestem (native)...	4.5	lbs/ac	PLS X 3.0ac	=	13.5	lbs	PLS
Indian Grass (native)...	3.5	lbs/ac	PLS X 3.0ac	=	10.5	lbs	PLS
Switchgrass (Blackwell)...	0.25	lbs/ac	PLS X 3.0ac	=	.75	lbs	PLS
Little Bluestem (Aldous)...	0.25	lbs/ac	PLS X 3.0ac	=	.75	lbs	PLS
Maximillian Sunflower...	6.0	oz/ac	X 3.0ac				
Illinois Bundleflower...	12.0	oz/ac	X 3.0ac				

- d. Mowing as recommended in Unit #1
- e. Specific removal of the few invading woody species not removed by plowing.

Management Action for Unit #2:

- a. Monitoring - Fall (1981) permanent practice sampling; 1982-1984, spring and fall samples;
- b. Prescribed Burning - April 24, 1984.
- c. Mowing - August, 1982.
- d. Grazing
- e. Herbicide Application
- f. Seeding - May 10, 1982, initial seeding; May 13-14, 1983, reseeded; May 30, 1984, Indian paintbrush from roadside established; June 9-10, 1984, contract for (600 forbs).
- g. Plowing
- h. Discing
- i. Mechanical Removal of woody species

MANAGEMENT UNIT 3

Management Unit #3 is the only recently planted area. The Land Use Permit of 1951-1952 allowed it to be used for cropping. Corn was planted in 1955, oats in 1956, and no crops were planted were planted in 1957. The 1953 aerial photograph shows that corn was planted in the northeast corner, near the cemetery (Figure 8). The far western portion of this unit resembles a native prairie overgrown by woody vegetation.

In 1965 or 1966, fescue was seeded and some fertilizing may have been done at this time. A special use permit was issued to Melvin Alford, from 1966 to 1983. There has been light grazing on Unit # 3 since then, but this unit is usually cut for hay (Alford, 1981).

The Soil Survey Map (Figure 4) shows most of Unit #3 to consist of Pembroke silt loam. This soil was originally from a more pure limestone and is made up of silt sediments that have either washed or blown in. In this area, the wind blown material appears on top. The rounded pebbles that are found seem to indicate some deposition by flowing water. This soil is also thought to be derived from prairie vegetation. It is a gently sloping (1 - 5% slopes), dark prairie soil, with moderate permeability (.6 - 2.0 in/hr), it drains well, and has a high water holding capacity.

The sections of Unit # 3 with deep soil could support either a dry mesic or mesic prairie. The western portion of this area, where the woody species are invading, is Keeno cherty silt loam (see description for Unit #1). This type of soil could best support a dry mesic prairie because of its poor water holding capacity.

Unit #3 is characterized by a dominance of fescue, a cool-season grass, in the eastern portion, and heavy tree encroachment in the western part (Figure 9). The ground slopes upward where the woody species are invading. In the western portion, several small stands of little bluestem are found, but the growth of the trees and shrubs is quite thick. Several woody species, such as Rosa multiflora (multiflora rose), are invading the eastern portion.

The Jackson and Bensing (1982) study of this unit shows that the eastern portion of this area has been subjected to intensive tillage-based agriculture for many years before it was designated as a pasture. This is apparent by an examination of the aerial

photographs and the species composition, which shows broom sedge and fescue to be the dominant plants. The western end has been protected from grazing and fire, which has resulted in a dense unnatural stand of noxious woody species. Their removal should be part of the management plan of this area.

The specific management goals for this unit are as follows:

- a. Establish the unit as a grassland area with a mesic to dry mesic prairie ecosystem.
- b. Establish a low diversity of forbs over the unit which is compatible with grazing.
- c. Make Unit #3 continuous with Unit #5 in accordance with the historic base map.
- d. Remove fence separating Unit #3 from Unit #5.
- e. Remove scrub growth from dry mesic portion of Unit #3.
- f. Initiate some type of cropping lasting for two years in the mesic portion of Unit #3 to eliminate the fescue.
- g. Shallow disc and reseed (using drill) the dry mesic portion of Unit #3.

Seeding rates: (Common name nomenclature according to Flora of Missouri, Julian Steyermark (1977), Iowa State University Press).

Little Bluestem (Aldous)	.2.5	lbs/ac PLS X 2.6ac = 6.5 lbs PLS
Sideoats Grama (El Reno)	.2.0	lbs/ac PLS X 2.6ac = 5.2 lbs PLS
Big Bluestem (native)	...0.5	lbs/ac PLS X 2.6ac = 1.3 lbs PLS
Indian Grass (native)	...0.25	lbs/ac PLS X 2.6ac = .65lbs PLS
Maximillian Sunflower	...5.0	oz/ac X 2.6ac
Illinois Bundleflower	..10.0	oz/ac X 2.6ac

- h. Mow during the first year to control weed growth.

Management Action for Unit #3:

- a. Monitoring -- Fall (1981) premanagement practice sampling upper portion; 1982-1984, spring and fall samples of upper portion.
- b. Prescribed Burning - March 24, 1982 (upper portion); March 31, 1983 (upper portion); April 24, 1984 (upper portion).

- c. Mowing - June 29, 1983, upper portion, ht. 10" - 12".
- d. Grazing
- e. Herbicide Application -- July 23, 1983 (Roundup); May 24-25, 1984 (Roundup).
- f. Seeding -- Spring 1982, upper portion hand-seeded; June 6, 1984, lower portion hand-seeded; May 30, 1984, indian paintbrush from roadside established; June 9-10, 1984, contract for (1200 forbs).
- g. Plowing - April, 1984.
- h. Discing - April, 1984.
- i. Mechanical Removal -- Spring 1982, rocks removed; 1982-1984, hand cutting of woody species (upper portion).

MANAGEMENT UNIT 4

Management Unit #4 has had quite a varied history. The Land Use Permit of 1951-1952 excludes this area from both pasture and cropping, but the upper portion was fenced and was possibly used as pasture. A 1952 photograph shows that the southwest corner, including the fencerow, contained undisturbed grasses that have been mowed within the last year (Figure 10). The upper, northeast portion shows much damage due either to livestock or tilling. Another 1952 photograph also shows this disturbance above the fence line. The 1953 aerial photograph indicates that the land was plowed above the fence line. Tree removal has taken place, thus adding to the disturbance. According to Alford (1981), this area has not been plowed for 20 or more years. It was excluded from the special use permit of 1966, and therefore has been left undisturbed since then. Some annual mowing was done, but it is now limited to every three years (Alford, 1981).

The soil survey map (Figure 3) shows Unit #4 to consist entirely of Keeno cherty silt loam (see description for Unit #1).

Management Unit #4 slopes gently upward to the north. It is bordered by a forest area on the north. A hedgerow is seen along the western edge, and the land between this and the far western fence is also included in this Unit. Several woody tree species are scattered throughout the western portion. Along the southern edge, the nature trail separates Unit # 4 from Unit #5. In the south-central portion, a stand of trees is present.

The Jackson and Bensing (1982) study shows Unit #4 with a diverse and bizarre history. Evidence shows that it was a barnyard, a plowed field, the site for a roadway, and once contained pipelines and leaching fields. Vegetational composition shows the cool-season grass, Poa, which will inhibit any other prairie species unless a management practice is aimed at its removal. There is also a varied assortment of weedy and perennial grasses and herbs. Although the soil is classified as Keeno cherty silt loam, it has been highly modified and deepened by the addition of organic material. The northern portion is best suited for a dry mesic prairie vegetation because of its south-facing exposure and slope. The lower portion, which is relatively level and poorly drained, could support a mesic prairie. Because of its close proximity to Unit #5, it shares many of the same species and, therefore, has a high degree of similarity to Unit #5.

MANAGEMENT RECOMMENDATIONS FOR UNIT 4

The specific management goals for this unit are as follows:

- a. Establish the unit as a grassland area with a mesic to dry mesic prairie ecosystem.
- b. Establish a high diversity of forbs.
- c. Prescribed burn after the bluegrass greens (mid April) to reduce competition from cool-season grasses and woody species; remove organic matter before reseeding; and to stimulate existing warm-season grasses.
- d. Shallow disc and reseed (using drill). Although the portion between these two units will support a mesic prairie, while the middle portion of each will support a dry mesic prairie, only one seed mix will be used that contains elements of both prairie types. The vegetation response to the specific environment will dictate the type of prairie that results.

Seeding rates:

(Common name nomenclature according to Flora of Missouri, Julian Steyermark (1977), Iowa State University Press.)

Little Bluestem (Aldous)...	2.5 lbs/ac	PLS X 16ac	= 40 lbs	PLS
Sideoats Grama (El Reno)...	2.0 lbs/ac	PLS X 16ac	= 32 lbs	PLS
Big Bluestem (native).....	0.5 lbs/ac	PLS X 16ac	= 8 lbs	PLS
Indian Grass (native).....	0.25 lbs/ac	PLS X 16ac	= 4 lbs	PLS
Switchgrass (Blackwell)...	0.25 lbs/ac	PLS X 16ac	= 4 lbs	PLS
White Prairie Clover.....	37.7 oz.	per 16ac		
Blackeyed Susan.....	27.0 oz.	per 16ac		
Rattlesnake Master.....	39.7 oz.	per 16ac		
Compass Plant.....	27.7 oz.	per 16ac		
Pitcher Sage.....	25.0 oz.	per 16ac		
Button Blazing Star.....	24.0 oz.	per 16ac		
Skyblue Aster.....	23.0 oz.	per 16ac		
Sweet Blackeyed Susan.....	9.0 oz.	per 16ac		
Pale Purple Coneflower....	23.0 oz.	per 16ac		
Thickspike Gayfeather.....	33.0 oz.	per 16ac		
Illinois Bundleflower.....	20.7 oz.	per 16ac		
Purple Prairie Clover.....	40.7 oz.	per 16ac		
Yellow Prairie Coneflower.	25.0 oz.	per 16ac		
Maximillian Sunflower.....	20.0 oz.	per 16ac		
Lead Plant.....	13.0 oz.	per 16ac		
New Jersey Tea.....	13.0 oz.	per 16ac		
Goats Rue.....	13.0 oz.	per 16ac		
Butterfly Milkweed.....	13.0 oz.	per 16ac		
Roundhead Lespedeza.....	17.7 oz.	per 16ac		
Cat Claw.....	17.7 oz.	per 16ac		
Roundhead Prairie Clover...	4.7 oz.	per 16ac		
Partridge Pea.....	4.7 oz.	per 16ac		

Cupplant.....4.7 oz. per 16ac
Purple Prairie Coneflower..4.7 oz. per 16ac
Wild Senna.....4.7 oz. per 16ac
Dotted Gayfeather.....4.7 oz. per 16ac

- e. Mowing during the first year to control weed growth.

Management Action for Unit # 4:

- a. Monitoring -- Fall (1981) premanagement practice sampling; 1982-1984, Spring and Fall samples.
- b. Prescribed Burning -- March 24, 1982; March 31, 1983; March 29, 1984, (Western portion).
- c. Mowing -- June 24, 1983, Eastern portion, May 31, 1984, haying (Eastern portion).
- d. Grazing
- e. Herbicide Application
- f. Seeding -- May 10, 1982, initial seeding; May 13-14, 1983, Eastern portion.
- g. Plowing
- h. Discing -- Spring 1982.
- j. Mechanical Removal of woody species.

MANAGEMENT UNIT 5

Portions of management Unit #5 are relatively undisturbed. The 1951-1952 Land Use Permit excludes the cemetery area from any cropping or grazing, but other areas within this unit may not have been disturbed. A 1952 photograph shows the lower two-thirds of Unit # 5 in crops, and a triangle at the top left in grasses (Figure 10). Another 1952 photograph shows strong tillage lines in the lower portion with disturbed land. The 1953 aerial photograph shows the middle of this area to be native grasses.

The corn and milo that were planted in Unit #3, near the cemetery, extended over into the western part of this unit. Within the last 20 years, this area has not been plowed, and was excluded from the special use permit of 1966. Annual mowing was done, but it is presently mowed every 3 years (Alford, 1981).

The soil survey map (Figure 3) shows Unit #5 to consist mainly of Keeno cherty silt loam (see description for Unit #1). The south-western portion of this area (near Unit #3) is Pembroke silt loam (see description for Unit #3).

Unit #5 is characterized by a slight rise in the middle with a relative absence of any woody species. The land slopes downward towards the southwestern corner, near Unit #3. Several large stands of big bluestem are evident and scattered throughout this area. A few stands of indian grass (Sorghastrum nutans) and little bluestem are also present. These plant species were not sampled in the vegetation survey. Most of these plant species are in the northwestern portion; however, a few are near the southern border. A stand of cotton grass (Andropogon ternarius) is near the eastern edge.

MANAGEMENT RECOMMENDATIONS FOR UNIT #5

Unit #5 has portions which are as disturbed as Unit #3, and some that are as stable as Unit #1. This can be seen from the aerial photographs, personal interviews, and the vegetational composition. The vegetational sampling shows native species occurring along with weedy species, such as bluegrass. Bluegrass forms a dense, unnatural undergrowth in the disturbed sections,

and its removal should be a part of the management plan. There are several pure stands of native grasses such as big bluestem, little bluestem, and indian grass, that need to be delimited and spared from any management practice. The soils are relatively shallow and probably would best support a dry mesic prairie.

Because the historic base map shows the area contained in Unit #4 and Unit #5 as a single purpose area, they will be managed similarly. Units #4 and #5 do not have the impact of grazing. As this is a highly visible area, it will be managed to reestablish a prairie with the widest possible diversity of grasses and forbs compatible with the local environment.

Specific management goals for Unit # 5:

- a. Establish the unit as a grassland area with a mesic to dry mesic prairie ecosystem.
- b. Establish a high diversity of forbs.
- c. Make Unit #5 continuous in accordance with the historic base map.
- d. Remove the fence separating Unit #5 from Unit #3 and the interior lane fence running along the west boundary of Unit #5.
- e. Prescribed burn conducted just after the bluegrass greens up (mid April) to reduce competition from cool-season grasses and woody species, to remove organic matter to facilitate reseeding, and to stimulate existing warm-season grasses.
- f. Shallow disc and reseed (using drill). Although the portion between these two units will support a mesic prairie, while the middle portion of each will support a dry mesic prairie, only one seed mix will be used that contains elements of both prairie types. The vegetation response to the specific environment will dictate the type of prairie that results.

Seeding rates:

(Common name nomenclature according to Flora of Missouri,
Julian Steyermark (1977), Iowa State University Press.)

Little Bluestem (Aldous)...	2.5 lbs/ac	PLS X 16ac	= 40 lbs PLS
Sideoats Grama (El Reno)...	2.0 lbs/ac	PLS X 16ac	= 32 lbs PLS
Big Bluestem (native).....	0.5 lbs/ac	PLS X 16ac	= 8 lbs PLS
Indian Grass (native).....	0.25lbs/ac	PLS X 16ac	= 4 lbs PLS
Switchgrass (Blackwell)...	0.25lbs/ac	PLS X 16ac	= 4 lbs PLS
White Prairie Clover.....	37.7 oz.	per 16ac	
✓ Blackeyed Susan.....	27.0 oz.	per 16ac	
Rattlesnake Master.....	39.7 oz.	per 16ac	
Compass Plant.....	27.7 oz.	per 16ac	
Pitcher Sage.....	25.0 oz.	per 16ac	
Button Blazing Star.....	24.0 oz.	per 16ac	
Skyblue Aster.....	23.0 oz.	per 16ac	
Sweet Blackeyed Susan.....	9.0 oz.	per 16ac	
✓ Pale Purple Coneflower....	23.0 oz.	per 16ac	
Thickspike Gayfeather.....	33.0 oz.	per 16ac	
Illinois Bundleflower.....	20.7 oz.	per 16ac	
Purple Prairie Clover.....	40.7 oz.	per 16ac	
✓ Yellow Prairie Coneflower.	25.0 oz.	per 16ac	
Maximillian Sunflower.....	20.0 oz.	per 16ac	
Lead Plant.....	13.0 oz.	per 16ac	
New Jersey Tea.....	13.0 oz.	per 16ac	
Goats Rue.....	13.0 oz.	per 16ac	
Butterfly Milkweed.....	13.0 oz.	per 16ac	
Roundhead Lespedeza.....	17.7 oz.	per 16ac	
Cat Claw.....	17.7 oz.	per 16ac	
Roundhead Prairie Clover...	4.7 oz.	per 16ac	
Partridge Pea.....	4.7 oz.	per 16ac	
Cupplant.....	4.7 oz.	per 16ac	
✓ Purple Prairie Coneflower..	4.7 oz.	per 16ac	
Wild Senna.....	4.7 oz.	per 16ac	
Dotted Gayfeather.....	4.7 oz.	per 16ac	

f. Mow during the first year to control weed growth.

Management Action of Unit # 5:

- a. Monitoring -- Fall (1981) premanagement practice sampling; 1982-1984 spring and fall sampling.
- b. Prescribed Burning -- March 24, 1982; March 31, 1983. The area was removed in 1984 from the prescribed burn program to allow monitoring of revegetative success, free from the impact of fire.
- c. Mowing -- June 24, 1983 NE corner, June 1, 1984 sumac areas,

- d. Grazing
- e. Herbicide Application -- June 1, 1983 wick application; August 10, 1983, wick application; May 24, 1984, wick application.
- f. Seeding
 - 1. May 10, 1982, initial seeding;
 - 2. May 13-14, 1983, NE corner reseeded;
 - 3. July 23, 1983, roadside forbs transplanted;
 - 4. April 23, 1984, forbs established;
 - 5. May 30, 1984, indian paintbrush from roadside established;
 - 6. June 9-10, 1984, contract for (1800 forbs);
 - 7. June 23, 1984, roadside shooting star transplanted.
- g. Plowing
- h. Disking -- Spring 1982
- i. Mechanical Removal -- Hand cutting of sumac 1982-1984.

MANAGEMENT UNIT 6

This unit is a long narrow strip along the western edge of Unit #5 (1.5 acres). The soil survey map (Figure 3) shows Unit #6 to consist entirely of Keeno cherty silt loam (see description for Unit #1).

MANAGEMENT RECOMMENDATIONS FOR UNIT #6

Specific management goals for Unit # 6 include:

- a. Establish the unit as a dry mesic/mesic prairie ecosystem.
- b. Establish a high diversity of forbs.
- c. Include Unit #6 in all post-planting management evaluations.

Management Action for Unit # 6:

- a. Monitoring -- 1982-1984 spring and fall samples.
- b. Prescribed Burning -- March 24, 1982; March 31, 1983.
The area was removed from the prescribed burn program to allow monitoring of vegetation.
- c. Mowing
- d. Grazing
- e. Herbicide Application
- f. Seeding -- May 10, 1982 initial seeding; June 9-10, 1984, contract for (400 forbs).
- g. Plowing
- h. Discing -- Spring 1982.
- i. Mechanical Removal -- Selective hand cutting of woody species (north end).

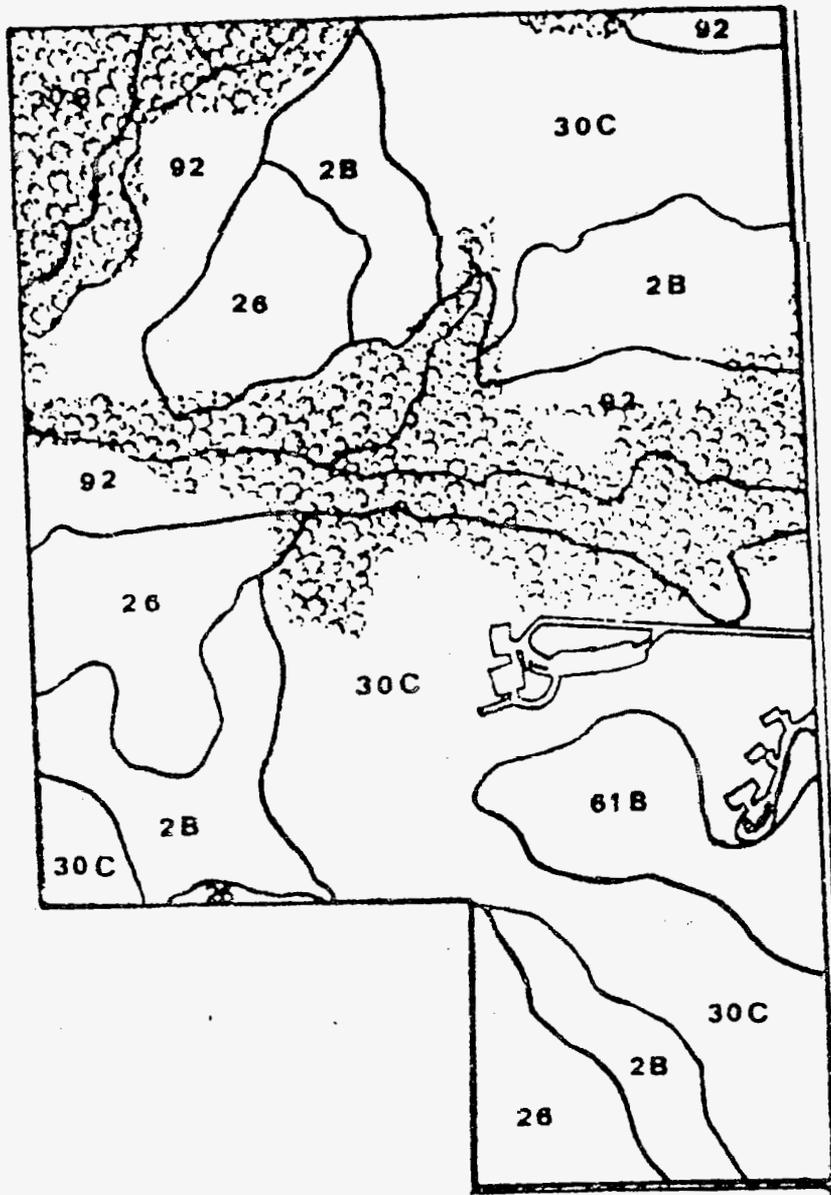


FIGURE 2.

Historic base map of George Washington Ca
National Monument.

FIGURE 3.

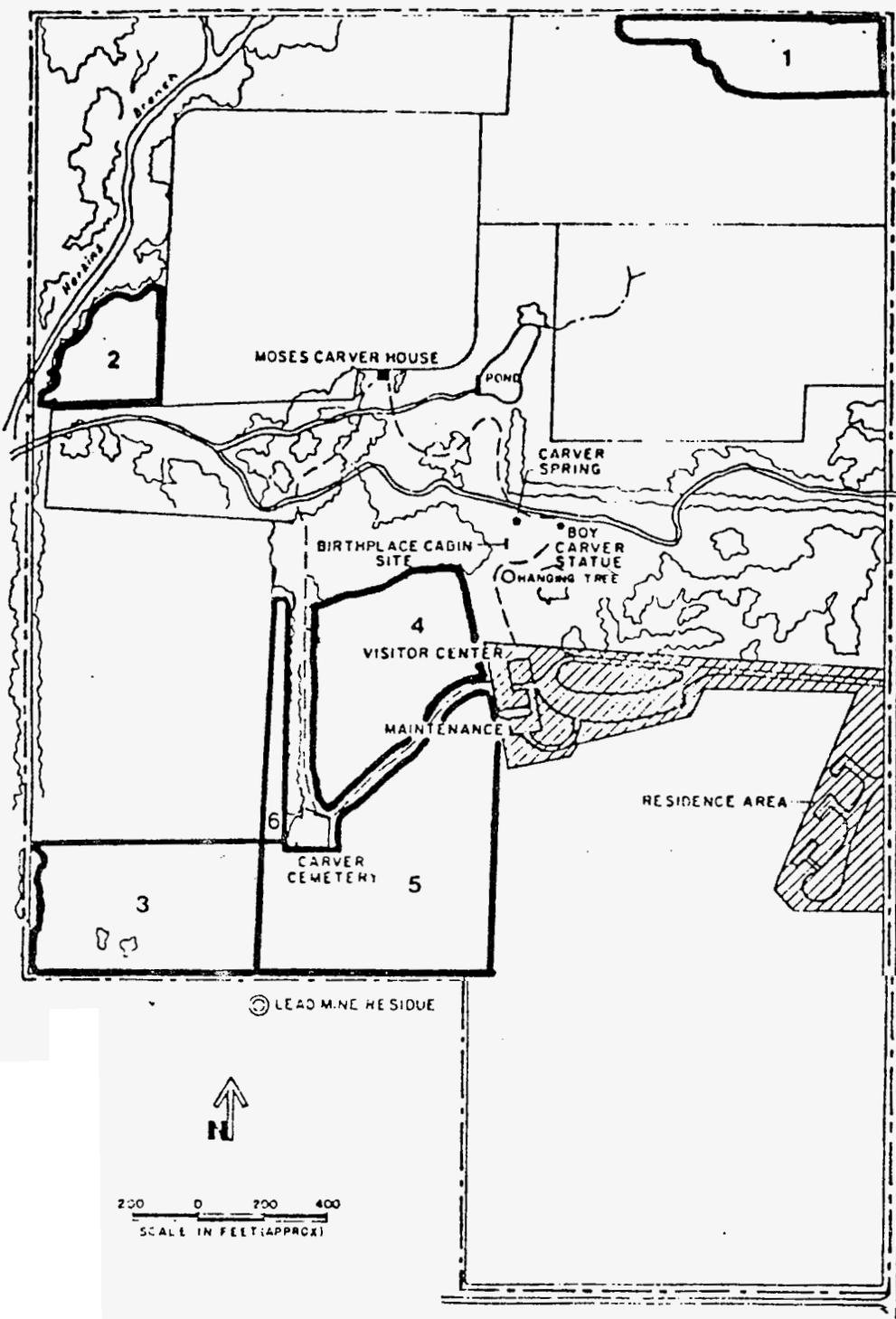
Map of the major soil types found in George Washington Carver National Monument.



LEGEND

(1" = 1 mile)

<u>MAP SYMBOL</u>	<u>SOIL SERIES</u>
2B	WANDA
26	CARYTOWN
30C	KEENO
61B	HOBERG
92	SECESH-CEDARGAP



SIX PRAIRIE MANagements UNITS OF

GEORGE WASHINGTON CARVER NATIONAL MONUMENT

ACREAGE. 1-3.8A	4-4.6A
2-2.8A	5-9.7A
3-4.3A	6-1.5A

METHODS

VEGETATIONAL ANALYSIS

VEGETATIONAL SAMPLING DATA: The vegetation in the prairie units were sampled in the spring and fall of each year (except the summer of 1984).

The quadrat plot method of sampling was used. In each sample plot, the list-count methods were used to tabulate the species and numbers present (Jackson and Bensing, 1982). The plot size was determined by using a sample plot that gave an 85% frequency for the most common species (calculated from an earlier study). This resulted in a 20 cm X 50 cm plot size.

Transects were made across the environmental gradients, from east to west in each of the six management units. The transects were spaced 30 meters apart. Sampling was begun on the northernmost transect. Each 20 cm X 50 cm plot was placed along the transect at 30 meter intervals. Next, the southernmost transect was sampled, and then a transect approximately in the middle of the area was done. After this, a species area curve was utilized to determine if adequate sampling had been done to represent the community.

To construct a species area curve, the number of new species accumulated in each sample is plotted on the y axis. The number of plots is shown on the x axis. The graph of these numbers constitutes the species area curve. When the points are joined, the curve first rises abruptly, because many new species occur in the first samples. Then it tends to level off as fewer new species are added with increased sampling. The break in the

curve represents the point beyond which added sampling effort yields diminishing returns. It is generally agreed that sampling is adequate once the curve has flattened out.

Once the raw data of the community was collected, some quantitative method of analyzing this data was carried out. The relative frequency, relative density, relative cover, and importance values were calculated for each of the species found, in each of the six management units.

The frequency value gives an expression of the percentage of sample plots in which a species occurs. The formula for frequency is:

$$\frac{\text{the number of plots in which species A occurs}}{\text{total number of plots sampled}} \times 100$$

The relative frequency was found by giving the species with the highest frequencies, a relative frequency of 100%, and comparing the frequencies of the other species in relation to this. For example, if species A was found in 11 out of 12 plots sampled, then its frequency would be 100% (if no species were found in all 12 plots).

The density is the average number of individuals per area sampled. Density is calculated from the formula:

$$\frac{\text{total number of individuals of species A}}{\text{total area sampled}} \times 100$$

Once the highest number of individuals of any one species was determined, this number was used to calculate the relative densities of the other species.

While frequency and density indicate distribution and numbers, they do not indicate size, volume of space occupied, or amount of ground covered or shaded. Therefore, another value, the cover, was considered. Cover is the result of both numbers and massiveness. Cover classes were used and values were determined from observations of the amount of ground covered. The following classes were used:

- Class A = covering less than 5% of the ground surface
- Class B = covering 5% to 25%
- Class C = covering 25% to 50%
- Class D = covering 50% to 75%
- Class E = covering 75% to 100%

A specific percentage was given to each species by taking an average of all of its different cover classes. For example, Class A was counted as 2.5%, B as 15%, C as 37.5%, D as 62.5%, and E as 87.5%. Then an average figure was found for each species. The highest cover percentage was given a value of 100%, and the others were based on this, to find their relative cover values.

The importance value index is based on the fact that most species do not normally reach a high level of importance in the community, but those that do, serve as an index or guiding species. Once importance values have been obtained for species, the communities can then be grouped by their leading dominants, according to importance values, and the groups are then placed in a logical order based on the relationships of several predominant species.

Importance values were obtained by adding the relative frequency, the relative density, and the relative cover of species A, and then dividing by 3.

METHODS OF SOIL CLASSIFICATION

Soil samples were taken from approximately 30 randomly selected areas within the 210 acre boundary of George Washington Carver National Monument. Sample number, date sample was taken, vegetation surrounding sample area, and slope of study area, along with a soil profile description, was recorded for each of the 30 soil samples.

Changes in soil type were marked on an aerial photograph to better define the line dividing the soils. A fairly accurate soil survey map was then constructed. (Circular 915, Extension Division, University of Missouri, Columbia, 1970).

The newly published USDA Soil Survey of Newton County (1984) was used as a guide to find what soil types existed in the study area. A soil description was also provided for each soil type along with a standard profile description to be used for comparison in determining the horizons.

SOIL ANALYSIS

A detailed soil analysis of the six Carver prairies was also done. Soil was collected from the six management units to get as close a random sample as possible of each of the communities.

Five liters of soil were collected in each of the units, one from each of the 4 corners, and one about in the middle of the area. These were then mixed together to obtain a 1-liter sample for that specific unit. Soil samples were collected the year prior to, the study as well as each year of the study. The samples were taken to the Newton County Soil Conservation Service in Neosho, Missouri, for soil testing. The pH, Phosphorus (P₂ O₅), potassium(K), calcium(Ca), magnesium(Mg), zinc(Zn), organic matter, neutral acidity, cation exchange capacity(CEC), and soil texture of each liter sample was tested.

MONITORING OF MANAGEMENT TECHNIQUES

The management techniques were monitored and evaluated using the same methods that were used in collecting the soil data and vegetational analysis data. This information was then used to modify the techniques used in the prairie restoration program.

RESULTS

RESULTS OF PREMANAGEMENT VEGETATIONAL SAMPLING

PREMANAGEMENT RESULTS FOR UNIT ONE

Unit # 1 actually consists of two distinct areas. The eastern portion, which is the only area that was sampled, has some diversity of warm-season grasses with several good-sized stands of Andropogon Gerardi (big bluestem) and Sorghastrum nutans (indian grass). The western portion was quite overgrown with Rhus glabra (sumac), Rubus spp. (blackberry), Shrankia uncinata (sensitive briar), and other woody species.

The results of the vegetational sampling are given in Tables 1 and 2, with the species listed according to importance values. Mouse-ear chickweed is of great importance here due to the time of sampling. Broom sedge and big bluestem were of equal importance, indicating that the prairie has not regressed yet to the state of being dominated by broom sedge, which is an indicator of low fertility. It still has a good percentage of native grasses, as indicated by the big bluestem. This unit is perhaps the most mature of all the Carver prairies. The presence of a blackberry species indicates that the western, woody portion may be starting to encroach on the eastern grassland area. None of the nine most important species in Unit # 1 appear on the state or national rare and endangered species list.

PREMANAGEMENT RESULTS FOR UNIT TWO

As seen in Tables 3 and 4 of the sampling results, no prairie indicator species were found in this unit. Fescue is the dominant species here, and mouse-ear chickweed is the second most dominant. No species from this unit appear on the state or national rare and endangered species list.

PREMANAGEMENT RESULTS FOR UNIT THREE

The results of the vegetational sampling (Tables 5 and 6) show broom sedge was the dominant species here. Broom sedge is able to compete better in soils of low fertility. Fescue was also quite abundant. On the basis of our sampling methods, no indicator species were found in this unit. The presence of the elm seedlings indicates that the western woody area is slowly encroaching into the eastern portion.

No species from this unit appear on the state or national rare and endangered species list.

PREMANAGEMENT RESULTS FOR UNIT FOUR

The results of the sampling in this unit (Tables 7 and 8) indicate that bluegrass was the dominant species. Switchgrass (Panicum anceps) was the second most dominant species and is considered to be an indicator of a native prairie. Overall, a greater number and abundance of forbs is seen here, as compared to other units. No broomsedge was sampled here.

None of these 24 dominant species found from our sampling are listed on the state or national rare and endangered species list.

PREMANAGEMENT RESULTS FOR UNIT FIVE

From the sampling data (Tables 9 and 10), golden aster appeared to be the dominant species. In the fall of 1981, golden aster was at its peak flowering time, so this may have affected the sampling results. Broom sedge is the next in importance. However, two native prairie grasses (switchgrass and big bluestem) are not far behind. Broom sedge is present, but there is still an abundance of a few of the native species. Sumac (Rhus spp.) is also present. Some sumac species are known to exert allelopathic effects on seedlings and thus the presence of these proceed tree invasion.

None of the species found in the sampling of this unit appeared on the state or national rare and endangered species list.

PREMANAGEMENT RESULTS FOR UNIT SIX

This management unit was not established until the second year of the study, and is not included in this section.

RESULTS OF POST-MANAGEMENT VEGETATIONAL SAMPLING

RESULTS AFTER MANAGEMENT FOR UNIT ONE

Table 1 shows the change in the five most important species in the fall sampling period, based on importance value, during the years of the study for Unit # 1. Andropogon virginicus and Ambrosia spp have dropped out while Andropogon gerardi and Panicum anceps have increased. Table 2 shows the change in the

five most important species in the spring sampling period, based on importance value. During the sample period, Andropogon scoparius has changed very little while Poa spp. has increased.

RESULTS AFTER MANAGEMENT FOR UNIT TWO

Table 3 shows the change in the five most important species in the fall sampling period, based on importance value, during the years of the study for Unit # 2. Festuca spp. has dropped out while Sorghastrum nutans and Panicum virgatum have increased. Table 4 shows the change in the five most important species in the spring sampling period, based on importance value. During the sample period Ambrosia artemisiifolia has dropped out while Sorghastrum nutans and Andropogon scoparius have become the most important species.

RESULTS AFTER MANAGEMENT FOR UNIT THREE

Table 5 shows the change in the five most important species in the fall sampling period, based on importance value, during the years of the study for Unit # 3. Festuca spp. and Andropogon virginicus have dropped out while Andropogon scoparius has become the second most important plant in the unit. Table 6 shows the change in the five most important species in the summer sampling period, based on importance value. During the sample period, Smilax bona-nox and Ambrosia artemisiifolia have dropped out while Andropogon scoparius has remained the same.

RESULTS AFTER MANAGEMENT FOR UNIT FOUR

Table 7 shows the change in the five most important species in the fall sampling period, based on importance value, during the years of the study for Unit # 4. Festuca spp. and Poa spp. have dropped out while Panicum spp. has become a very important genus in the unit. Table 8 shows the change in the five most important species in the summer sampling period, based on importance value. During the sample period Andropogon scoparius increased in importance and weedy species such as Croton spp. and Oxalis spp. dropped out.

RESULTS AFTER MANAGEMENT FOR UNIT FIVE

Table 9 shows the change in the five most important species in the fall sampling period, based on importance value, during the years of the study for Unit # 5. Andropogon virginicus dropped out, while Sorghastrum nutans and Andropogon scoparius have appeared in the top five plants. Table 10 shows the change in the five most important species in the summer sampling period, based on importance value. During the sample period, Andropogon scoparius increased in importance, and weedy species such as Croton spp. and Rhus spp. dropped out.

RESULTS AFTER MANAGEMENT FOR UNIT SIX

Table 11 shows the change in the five most important species in the fall sampling period, based on importance value, during the years of the study for Unit # 6. Very little significant change has occurred during this sample period. Table 10 shows the

change in the five most important species in the summer sampling period, based on importance value. During the sample period, very little change has been observed.

TABLE ONE: Fall analysis for unit #1 in year '81, '82, '83, and '84.
Species ranked in descending order based on importance
value.

FALL 1981

1. Cerastium vulgatum
2. Aandropogon virginicus
3. Andropogon gerardi
4. Festuca spp.
5. Tridens flavus

FALL 1982

1. Andropogon gerardi
2. Tridens flavus
3. Setaria spp.
4. Ambrosia artemisiifolia
5. Andropogon scoparium

FALL 1983

1. Andropogon gerardi
2. Oxalis stricta
3. Hiracium pratense
4. Festuca elatior
5. Acalpha gracilens

FALL 1984

1. Andropogon scoparius
2. Panicum anceps
3. Sorghastrum nutans
4. Agrostis alba
5. Panicum Oligosanthos

TABLE TWO: Summer analysis of vegetation of Unit #1 for years '82, '83, and '85. Species ranked in descending order based on importance value.

SUMMER 1982

1. Andropogon Gerardi
2. Andropogon scoparius
3. Croton spp.
4. Ruellia humilis
5. Tridens flavus

SUMMER 1983

1. Andropogon Scoparius
2. Festuca elatior
3. Carex spp.
4. Oxalis stricta
5. Plantago virginica

SUMMER 1985

1. Poa pratensis
2. Andropogon scoparius
3. Festuca elatior
4. Tridens flavens
5. Panicum Oligosantes

TABLE THREE: Vegetational analysis from Unit #2 for fall in years '81, '82 '83, '84. Species ranked in descending order based on importance value.

FALL 1981

1. Festuca spp.
2. Cerastium vulgatum
3. Paspalum ciliatifolium
4. Oxalis stricta
5. Eleusine indica

FALL 1982

1. Ambrosia artemisiifolia
2. Setaria spp.
3. Panicum anceps
4. Eleusine indica
5. Paspalum laeve

FALL 1983

1. Digitaria filiformis
2. Ambrosia artemisiifolia
3. Hiracium pratense
4. Dactylus glomeratata
5. Setaria sp.

FALL 1984

1. Sorghastrum nutans
2. Panicum virgatum
3. Cerastium vulgatum
4. Andropogon Gerardi
5. Oxalis stricta

TABLE FOUR: Vegetational analysis for Unit #2 for Summer '82 '83, and '85. Species ranked in descending order based on importance value.

SUMMER 1982

1. Ambrosia artemisiifolia
2. Panicum anceps
3. Eleusine indica
4. Andropogon scoparius
5. Setaria spp.

SUMMER 1983

1. Ambrosia artemisiifolia
2. Festuca elatior
3. Andropogon scoparius
4. Acalypha gracilens
5. Carex spp.

SUMMER 1985

1. Sorghastrum nutans
2. Andropogon scoparius
3. Poa pratensis
4. Panicum Oligosanthos
5. Eleusine indica

TABLE FIVE: Vegetational analysis of Unit #3 in fall '81,
'82, '83, and '84. Species ranked in descending order
based on importance value.

FALL 1981

1. Andropogon virginicus
2. Festuca spp.
3. Tridens flavus
4. Muhlenbergia spp.
5. Ambrosia artemisiifolia

FALL 1982

1. Rhus copallina
2. Ambrosia artemisiifolia
3. Oxalis spp.
4. Andropogon scoparius
5. Smilax Bona-nox

FALL 1983

1. Panicum sphaerocarpon
2. Hiracium pratense
3. Muhlenbergia soboligera
4. Andropogon gerardii
5. Oxalis stricta

FALL 1984

1. Cerastium vulgatum
2. Andropogon scoparius
3. Poa pratensis
4. Panicum oligosanthos
5. Rubus spp.

TABLE SIX: Vegetation analysis of Unit #3 in summer of '82, '83, and '85. Species ranked in descending order based on importance value.

SUMMER 1982

1. Smilax Bona-nox
2. Oxalis spp.
3. Ambrosia artemisiifolia
4. Andropogon scoparius
5. Panicum anceps

SUMMER 1983

1. Carex spp.
2. Poa pratense
3. Panicum sphaerocarpon
4. Lonicera japonica
5. Rubus spp.

SUMMER 1985

1. Poa pratensis
2. Bromus tectorum
3. Panicum sphaerocarpon
4. Andropogon scoparius
5. Andropogon virginicus

TABLE SEVEN: Vegetational analysis of unit four in the Fall of '81, '82, '83, and '84. Species ranked in descending order based on importance value.

FALL 1981

1. Poa spp.
2. Panicum virgatum
3. Cerastium vulgatum
4. Festuca spp.
5. Tridens flavus

FALL 1982

1. Setaria spp.
2. Oxalis spp.
3. Solanum rostratum
4. Croton spp.
5. Andropogon scoparius

FALL 1983

1. Setaria spp.
2. Hiracium pratense
3. Poa pratense
4. Erigeron canadensis
5. Panicum anceps

FALL 1984

1. Rumex acetosella
2. Panicum anceps
3. Panicum oligosanthos
4. Agrostis alba
5. Cerastium vulgatum

TABLE EIGHT: Vegetational analysis of Unit #4 for summer 1982, 1983 and 1985. Species ranked in descending order based on importance value.

SUMMER 1982

1. Croton spp.
2. Erigeron canadensis
3. Lactuca canadensis
4. Oxalis spp.
5. Andropogon scoparius

SUMMER 1983

1. Panicum anceps
2. Carex spp.
3. Rumex acetosella
4. Erigeron strigosus
5. Ambrosia artemisiifolia

SUMMER 1985

1. Tridens flavus
2. Andropogon scoparius
3. Rumex acetosella
4. Andropogon virginicus
5. Dactylis glomerata

TABLE NINE: Vegetational analysis of Unit #5, fall of '81, '82, '83, 84. Species ranked in descending order based on importance value.

FALL 1981

1. Chrysopsis pilosa
2. Andropogon virginicus
3. Panicum virgatum
4. Andropogon Gerardii
5. Muhlenbergia spp.

FALL 1982

1. Andropogon Gerardii
2. Setaria spp.
3. Tridens flavus
4. Croton spp.
5. Panicum anceps

FALL 1983

1. Panicum anceps
2. Hiracium pratensa
3. Panicum sphaerocarpon
4. Panicum virgatum
5. Andropogon Gerardii

FALL 1984

1. Cerastium vulgatum
2. Panicum anceps
3. Sorghastrum nutans
4. Hieracium spp.
5. Andropogon scoparius

TABLE TEN: Vegetational analysis of Unit #5 for summer 1982,
1983 and 1985. Species ranked in descending order
based on importance value.

SUMMER 1982

1. Rhus copallina
2. Croton spp.
3. Tridens flavus
4. Rudbeckia hirta
5. Andropogon scoparius

SUMMER 1983

1. Panicum anceps
2. Hiracium pratensa
3. Panicum sphaerocarpon
4. Panicum virgatum
5. Andropogon Gerardii

SUMMER 1985

1. Andropogon scoparius
2. Andropogon virginicus
3. Tridens flavens
4. Panicum sphaerocarpon
5. Panicum anceps

TABLE ELEVEN: Vegetational analysis of Unit #6 for fall of '83 and '84. Species ranked in descending order based on importance value.

FALL 1983

1. Hieracium longipilum
2. Panicum sphaerocarpon
3. Panicum anceps
4. Poa pratensis
5. Oxalis stricta

FALL 1984

1. Panicum oligosanthos
2. Panicum anceps
3. Panicum virgatum
4. Aster pilosus
5. Oxalis stricta

TABLE TWELVE: Vegetational analysis of Unit #6 for summer
1983 and 1985. Species ranked in descending order
based on importance value.

SUMMER 1983

1. Andropogon scoparius
2. Carex spp.
3. Rudbeckia hirta
4. Erigeron strigosa
5. Oxalis stricta

SUMMER 1985

1. Andropogon scoparius
 2. Tridens flavens
 3. Chrysanthemum leucanthemum
 4. Panicum oligosanthos
 5. Panicum virgatum
-

SOILS ANALYSIS

The soil analysis showed content changes in the following factors before and during the years of the study: cation exchange capacity, neutral acidity, organic matter, magnesium, calcium, potassium, phosphorus, and the change in pH.

SOIL ANALYSIS FOR UNIT ONE

The soil analysis in Unit # 1 showed that the cation exchange capacity, the neutral acidity, the organic matter, the magnesium, and calcium all increased and improved during the course of the study. Potassium dropped, phosphorus increased, and the pH improved greatly during the years of the study.

SOIL ANALYSIS FOR UNIT TWO

The soil analysis in Unit # 2 showed that the cation exchange capacity, the neutral acidity, the organic matter, and magnesium, all increased and improved during the course of the study. Calcium was variable, potassium and phosphorus dropped, and the pH became even more basic during the years of the study.

SOIL ANALYSIS FOR UNIT THREE

The soil analysis in Unit # 3 showed that the cation exchange capacity, the neutral acidity, the organic matter, and the magnesium all increased and improved during the course of the study. Calcium was variable, potassium and phosphorus increased,

and the pH became even more basic and was in need of lime during the years of the study.

SOIL ANALYSIS FOR UNIT FOUR

The soil analysis in Unit # 4 showed that the cation exchange capacity, the neutral acidity, the organic matter, and magnesium all slightly increased and improved during the course of the study. Calcium decreased, potassium and phosphorus greatly decreased, and the pH became even more basic and was in need of lime during the years of the study.

SOIL ANALYSIS FOR UNIT FIVE

The soil analysis in Unit # 5 showed that the cation exchange capacity and the neutral acidity increased; the organic matter decreased. Magnesium and calcium slightly increased and improved during the course of the study. Potassium and phosphorus greatly decreased, and the pH was variable.

SOIL ANALYSIS FOR UNIT SIX

The soil analysis in Unit # 6 was conducted only in 1985 and showed that the soil had a pH level of 4.9, a phosphorus level of 8 lbs/ac, a potassium level of 100 lbs/ac, all of which are very low values. The soil had a calcium content of 2088 lbs/ac and a magnesium level of 220 lbs/ac, both in the medium range. The organic matter was 3.4%, the neutral acidity was 6.0 mili-equivalents, and the cation exchange capacity was 12.3 mili-equivalents.

DISCUSSION AND CONCLUSIONS

SOIL CLASSIFICATION

This soil survey has evaluated and defined boundaries for each soil type of George Washington Carver National Monument (Figure 3).

Park officials' objective of restoring George Washington Carver National Monument to its initial native tall grass prairie, seems very feasible on the existing soils.

All soil types appear to have the potential to grow prairie vegetation, including the woodland areas, which is mainly Secesh-Cedargap complex. The Secesh-Cedargap complex of the study area was divided into separate divisions with the Secesh in the high bottom part and the Cedargap comprising the flood plain part.

Four of the six prairie management units (# 3, # 4, # 5, and # 6) are made up of the Keeno series. A portion of # 1 is also made up of the same series. This indicates that these areas were at one time tall grass prairie, and therefore could be restored to that appearance on these soil types. Prairie # 2 and the remaining portion of # 1 is made up of the Secesh-Cedargap complex. This indicates native vegetation of grasses and hardwoods for the Secesh portion of the complex, and tall grass prairie for the Cedargap portion of the complex.

SOIL ANALYSIS

In no instance was an overall soil degradation seen, either in nutrient concentration, pH, or soil environment in any of the management units. The soil condition improved in those management units that had a good representative array of native prairie grasses and forbs at the end of the study (Units # 1, # 2, and # 5). It seems safe to assume that the management practices used did not damage the soils, and in all probability, improved them.

VEGETATIONAL TRENDS

The following is a summary of the conclusions of the vegetation analysis for each prairie management unit.

In Unit # 1, the the change in the vegetational composition is the result of a successful prairie monitoring program. Table 1 shows the change in the five most important species in the fall sampling period, based on importance value. Andropogon virginicus and Ambrosia spp have dropped out, while Andropogon gerardi and Panicum anceps have increased. This meets the objectives of the program by promoting native species and reducing noxious weeds. Table 2 shows the change in the five most important species in the spring sampling period, based on importance value. Andropogon scoparius has changed very little, while Poa spp. has increased. These results show variable success and demonstrate that cool-season grasses will continue to be a problem here. The results

of the woody species control program show that the methods were successful in the removal of woody species. This can be seen by comparing the photograph of this this unit with the one taken in August, 1985 (Figures 4 and 5). This can also be seen by comparing the artist's interpretation of Unit # 1 at the start of the study with the one of Unit # 1 at the end of the study (Figures 12 and 13). The western portion of this unit still represents an area which contains a large population of non-native species. Recent evaluation indicates a persistence of cool-season grasses, but also a good array of native species typical of a virgin prairie. This unit also contains a population of royal catchfly, examined as a possible candidate for endangered species.

In Unit # 2 there has been a dramatic improvement in the vegetational composition. Table 3 shows the change in the five most important species in the fall sampling period, based on importance value, for Unit # 2. Festuca spp. has dropped out, while Sorghastrum nutans and Panicum virgatum have increased. Table 4 shows the change in the five most important species in the spring sampling period, based on importance value. Ambrosia artemisiifolia has dropped out, while Sorghastrum nutans and Andropogon scoparius have become the most important species. All of these results promote the objectives of this program by reducing the importance of noxious weeds and increasing the importance of the native prairie species. The results of the woody species control program show that the methods were successful in the removal of woody species. This can be seen by comparing the early aerial photograph of this unit with the one

taken in August, 1985 (Figures 6 and 7). This can also be seen by comparing the artist's interpretation of Unit # 2 at the start of the study to that of the end of the study (Figures 14 and 15). Adverse climatic conditions necessitated the reseeding of this unit in 1983. April 24, 1984, marked the first burn for this unit and the results were very successful, resulting in a rank growth of prairie grass and a dramatic vegetational change from an over-grazed area to one resembling a native prairie.

In Unit # 3, there has been much success with the western end of the prairie, but the eastern end is still in the middle of a fescue removal program. Table 5 shows the change in the five most important species in the fall sampling period, based on importance value, for Unit # 3. Festuca spp. and Andropogon virginicus have dropped out, while Andropogon scoparius has become the second most important plant. Table 6 shows the change in the five most important species in the summer sampling period, based on importance value. Smilax bona-nox and Ambrosia artemisiifolia have dropped out, while Andropogon scoparius has remained the same. These results show success in woody species removal, noxious species reduction, and the establishment of native species. This can be seen by comparing the early aerial photograph of this unit with the one taken in August, 1985 (Figures 8 and 9). This can also be seen by comparing the artist's interpretation of Unit # 3 at the start of the study to that of the end of the study (Figures 16 and 17). The success of prescribed burns prior to 1984 were limited. Mowing added needed ground cover to assist burns in April, 1984. This

resulted in a successful burn which impacted species of blackberry, sumac, and poke.

In Unit # 4 the success was good on the western end, but very poor on the eastern end. This is probably a result of this area being a barnyard for so many years. Table 7 shows the change in the five most important species in the fall sampling period, based on importance value, for Unit # 4. Festuca spp. and Poa spp. have dropped out, while Panicum spp. has become a very important genus in the unit. Table 8 shows the change in the five most important species in the summer sampling period, based on importance value. Andropogon scoparius increased in importance and weedy species such as Croton spp. and Oxalis spp. dropped out. This shows that the management objectives were met, and the techniques used here were appropriate for this type of prairie restoration. The results of the woody species control program show that the methods were successful in the removal of woody species. This can be seen by comparing the early aerial photograph of this unit with the one taken in August, 1985 (Figures 10 and 11). This can also be seen by comparing the artist's interpretation of Unit # 4 at the start of the study to that of the end of the study (Figures 18 and 19). The dense growth of fescue and the premanagement history of this unit have combined to resist most management actions such as mowing and prescribed burning. The western portion contains native grasses, but weedy species dominated the eastern half.

In Unit # 5 there was a good representation of native species at the start of the study, which has improved during the course of the study. Table 9 shows the change in the five most

important species in the fall sampling period, based on importance value, for Unit # 5. Andropogon virginicus dropped out, while Shorghastrum nutans and Andropogon scoparius have appeared in the top five plants. Table 10 shows the change in the five most important species in the summer sampling period, based on importance value. Andropogon scoparius increased in importance and weedy species such as Croton spp. and Rhus spp. dropped out. These results are consistent with the management objectives outlined. The native grasses have increased and the noxious and woody species have decreased. The results of the woody species control program show that the methods were successful in the removal of woody species. This can be seen by comparing the early aerial photograph of this unit with the one taken in August, 1965 (Figures 10 and 11). This can also be seen by comparing the artist's interpretation of Unit # 5 at the start of the study to that of the end of the study (Figures 20 and 21). This unit contains a large population of royal catchfly (S. regina), examined for candidacy as an endangered species. According to a recent evaluation, a large stand of native grasses and forbs is established.

In Unit # 6, because of its small size and recent addition to the study, definite conclusions can not be drawn, but some trends are seen. Table 11 shows the change in the five most important species in the fall sampling period, based on importance value. Very little significant change has occurred during this sample period. Table 10 shows the change in the five most important species in the summer sampling period, based on

importance value. The results of the woody species control program show that the methods were successful in the removal of woody species. This can be seen by comparing the early aerial photograph of this unit with the one taken in August, 1985 (Figures 10 and 11). This can also be seen by comparing the artist's interpretation of Unit # 6 at the start of the study to that of the end of the study (Figures 22 and 23). Overall, it can be concluded that this unit shows excellent seeding establishment and growth potential.

Figure 4

A pre-management survey aerial photograph showing prairie management Unit #1.

Figure 5

An aerial photograph taken in August of 1985, showing the results of the prairie management program in management Unit #1.

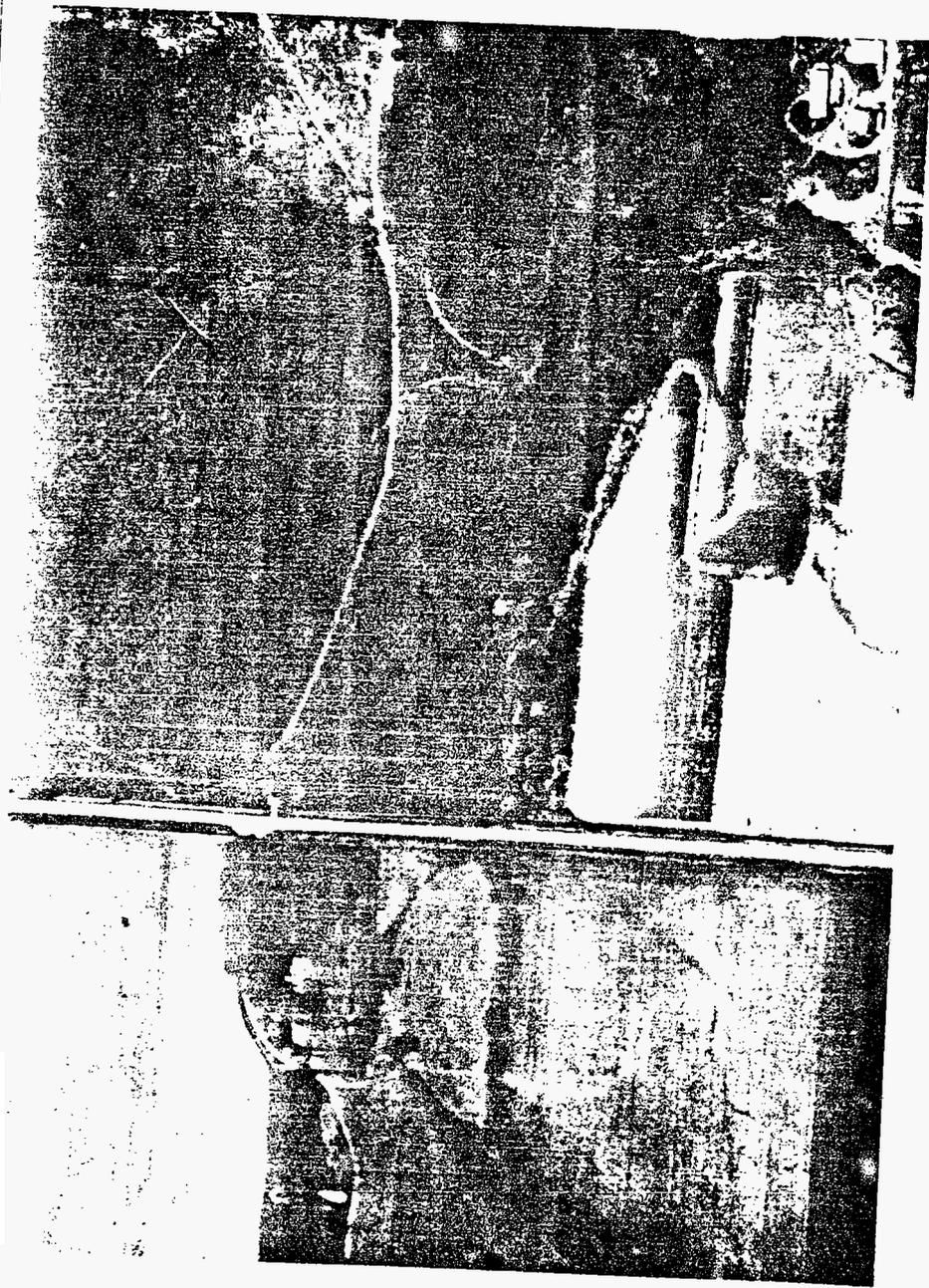




Figure 6

A pre-management survey aerial photograph showing prairie management Unit #2.



Figure 7

An aerial photograph taken in August of 1985, showing the results of the prairie management program in management Unit #2.



Figure 8

A pre-management survey aerial photograph showing prairie management Unit #3.





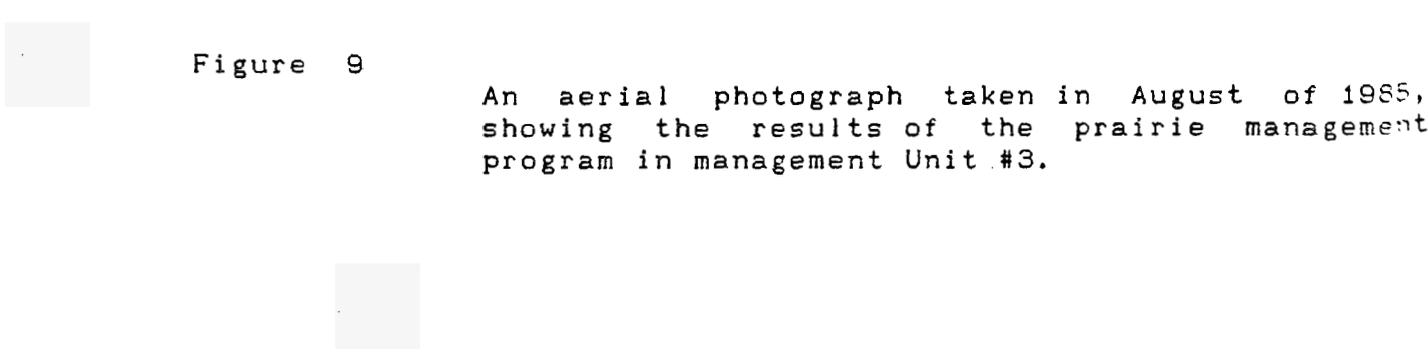


Figure 9

An aerial photograph taken in August of 1965, showing the results of the prairie management program in management Unit #3.



Figure 10

A pre-management survey aerial photograph showing prairie management Units #4, #5, and #6.



Figure 11

An aerial photograph taken in August of 1985 showing the results of the prairie management program in management Units #4, #5, and #6.



Figure 12

Artist's interpretation of Unit #1 prior to use
of management practices.

UNIT 1
Before

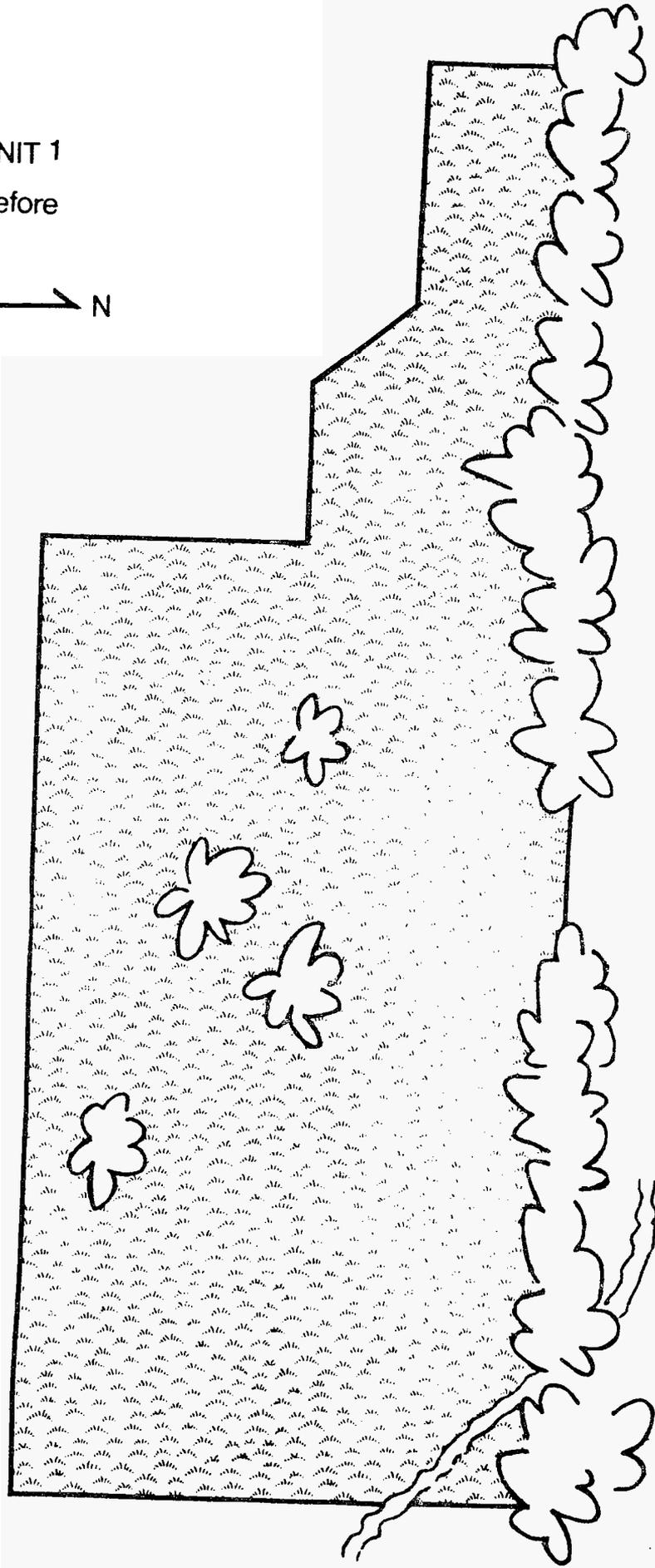


Figure 13

Artist's interpretation of Unit #1 at the end of the study in August of 1985.

UNIT 1

After

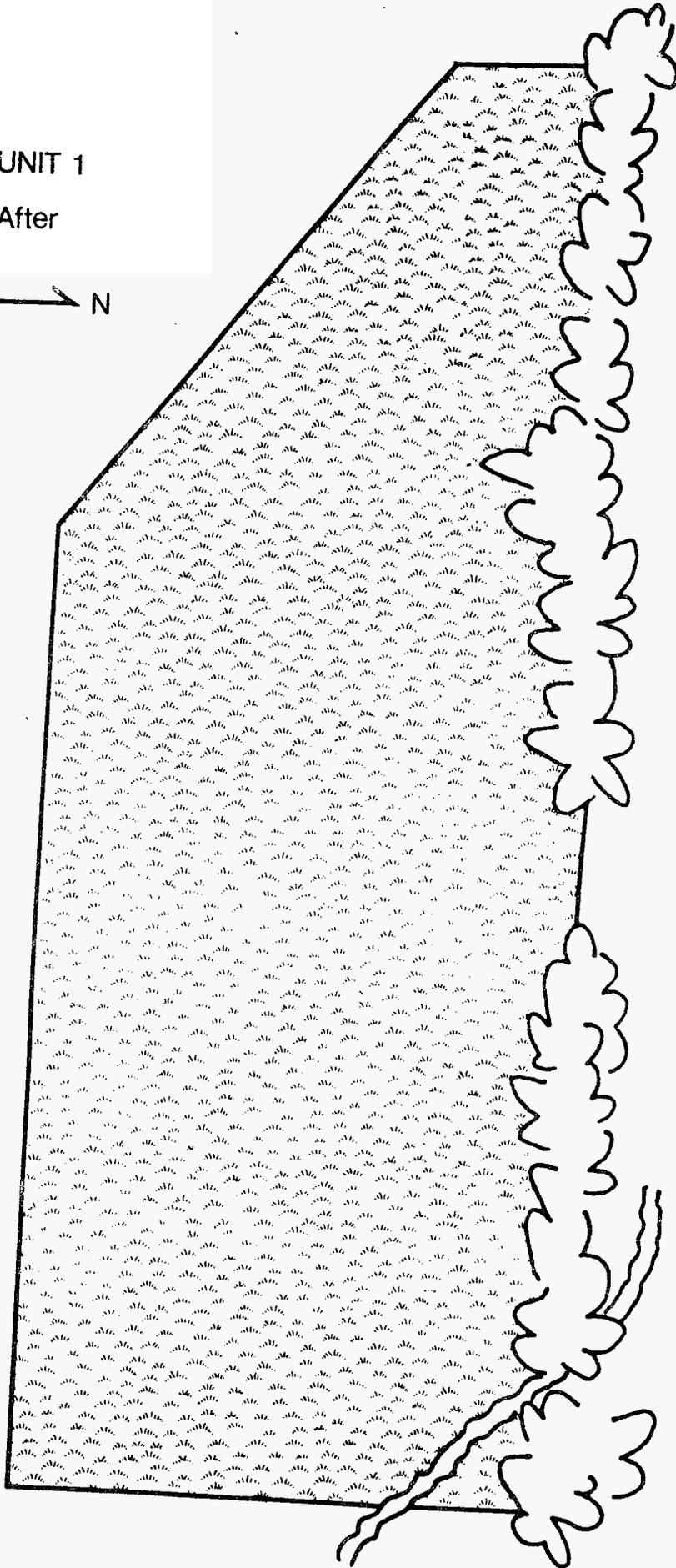


Figure 14

Artist's interpretation of Unit #2 prior to use
of management practices.

UNIT 2

Before

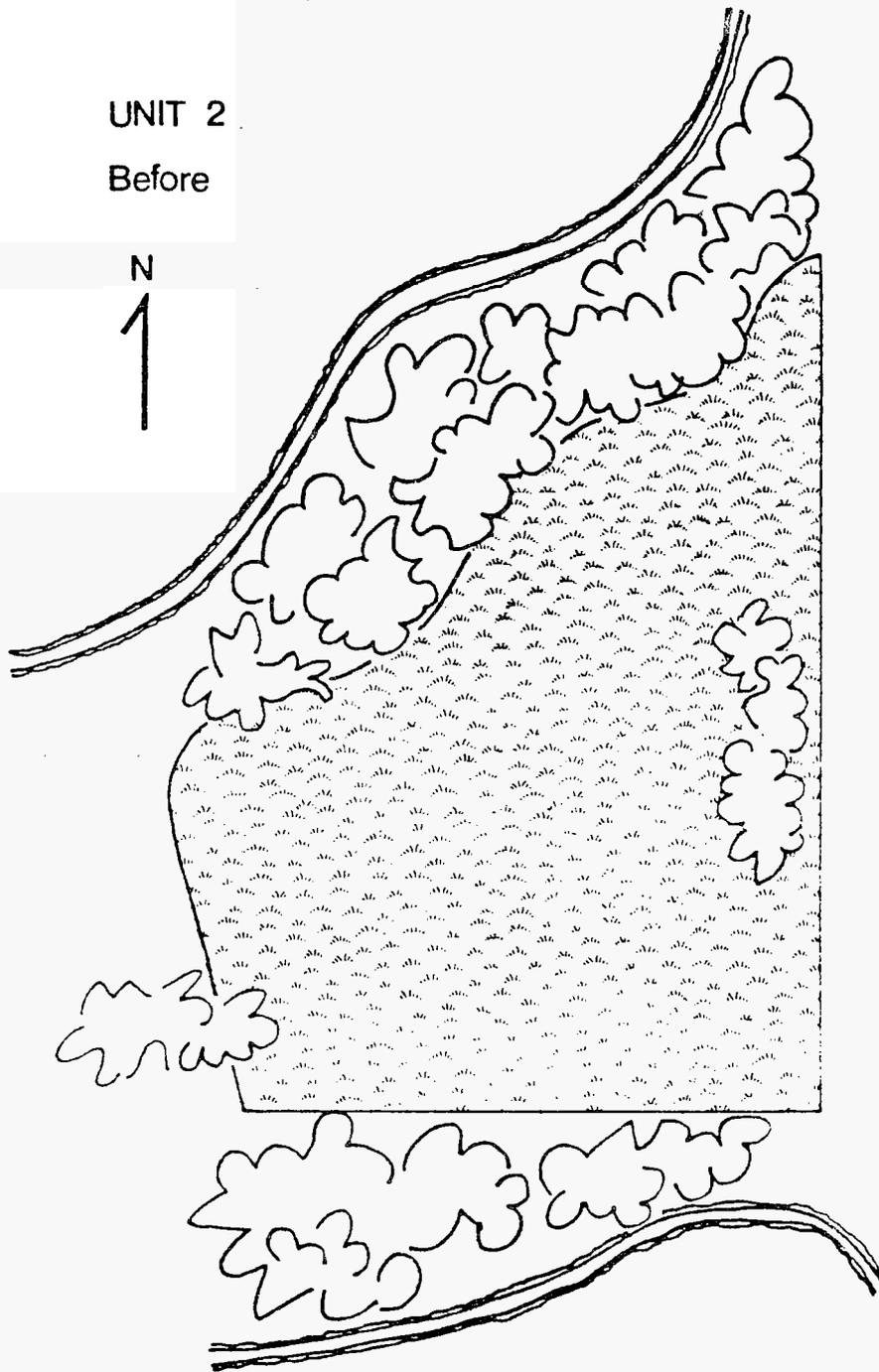


Figure 15

Artist's interpretation of Unit #2 at the end of the study in August of 1985.

UNIT 2

After

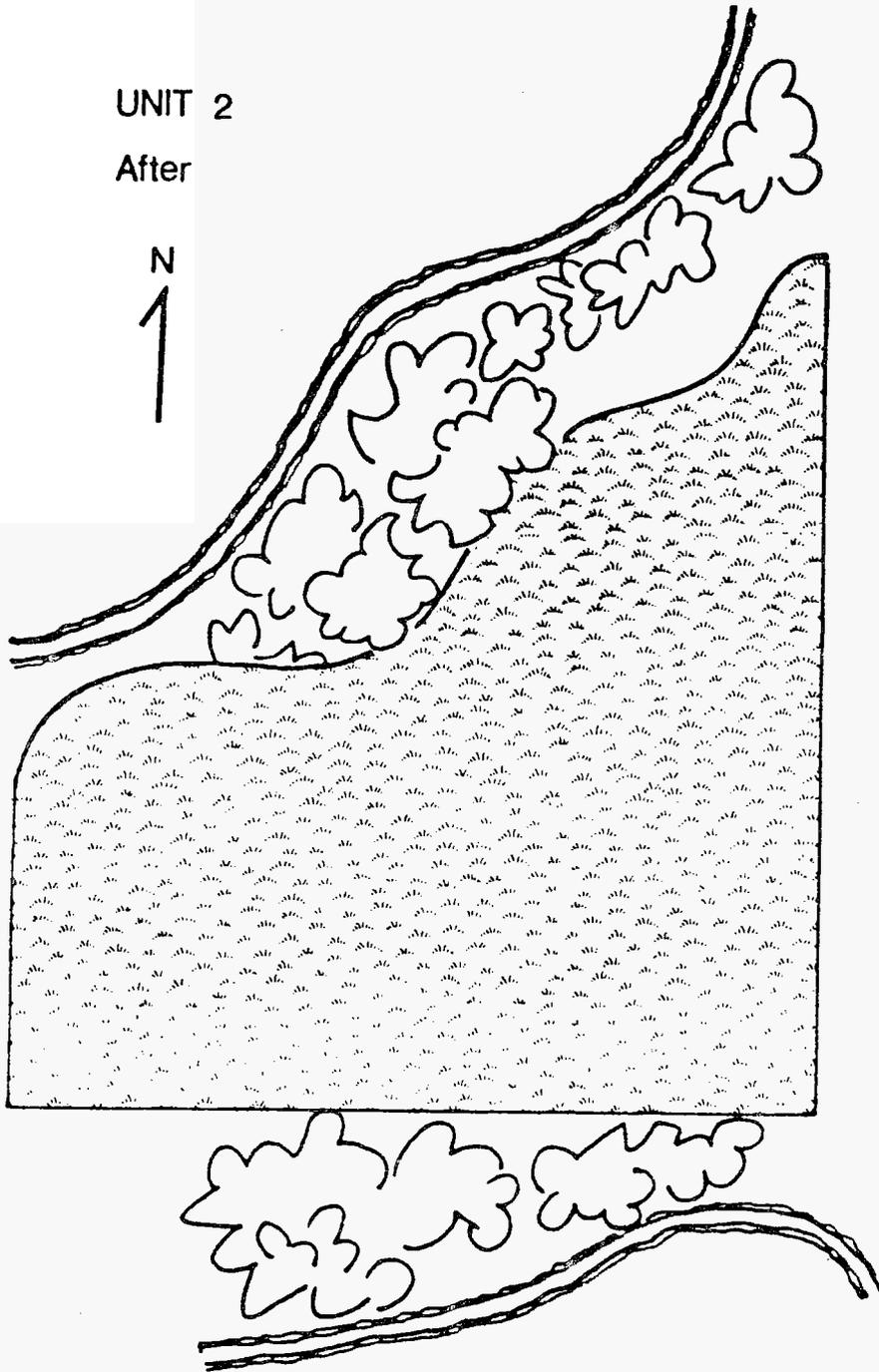
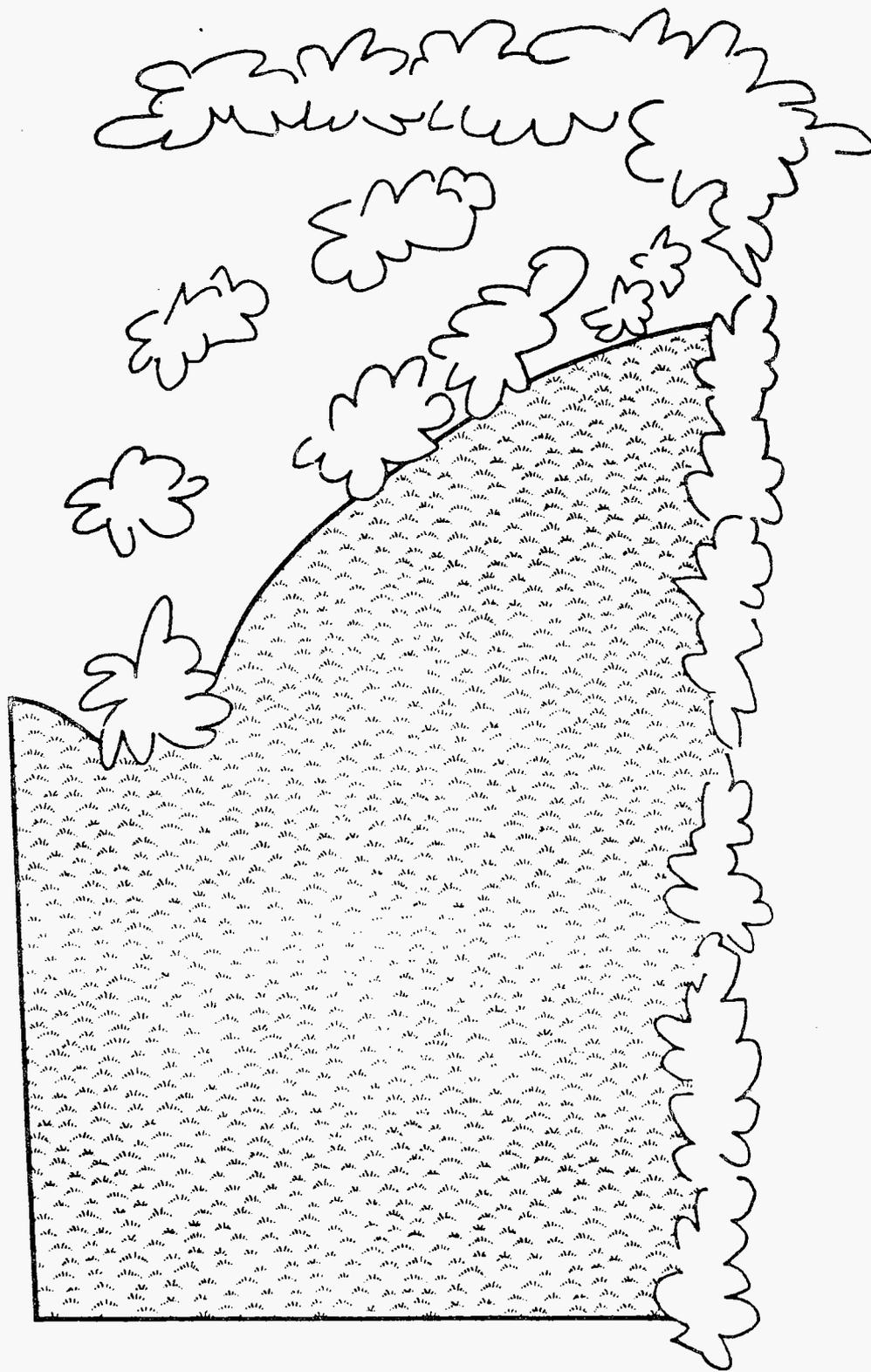


Figure 16

Artist's interpretation of Unit #3 prior to use
of management practices.



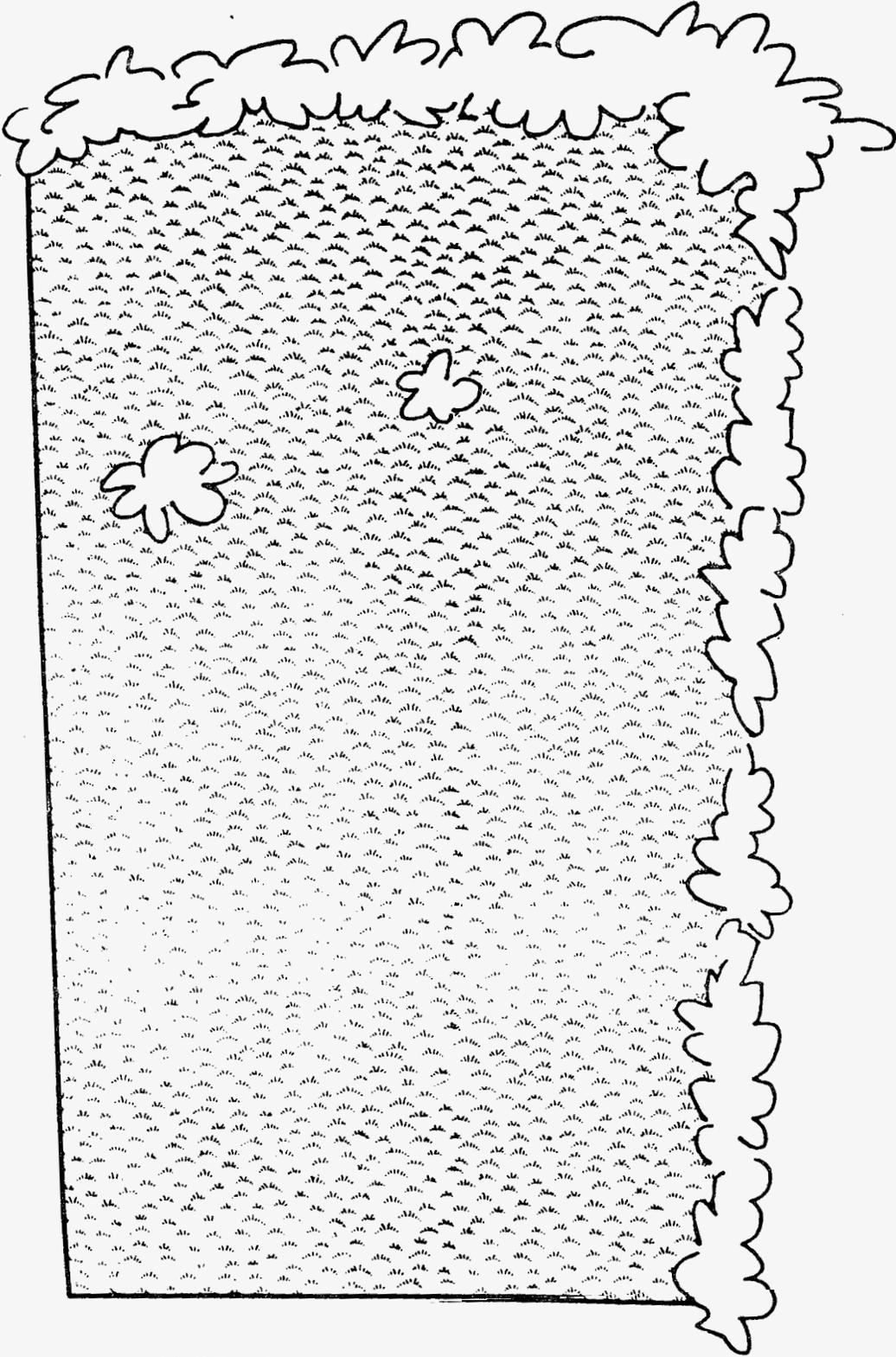
UNIT 3

Before



Figure 17

Artist's interpretation of Unit #3 at the end
of the study in August of 1985.



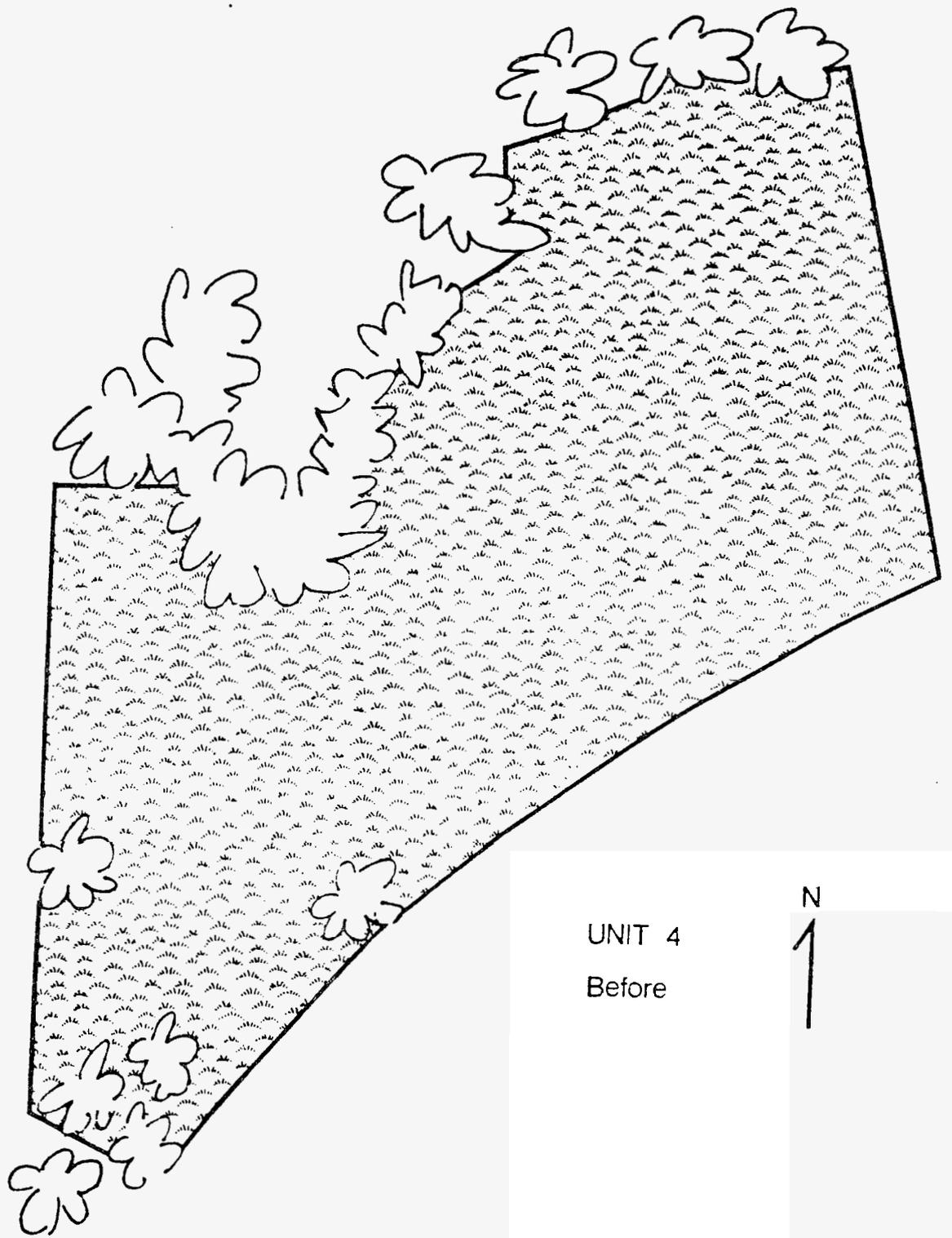
UNIT 3

After



Figure 18

Artist's interpretation of Unit #4 prior to use
of management practices.



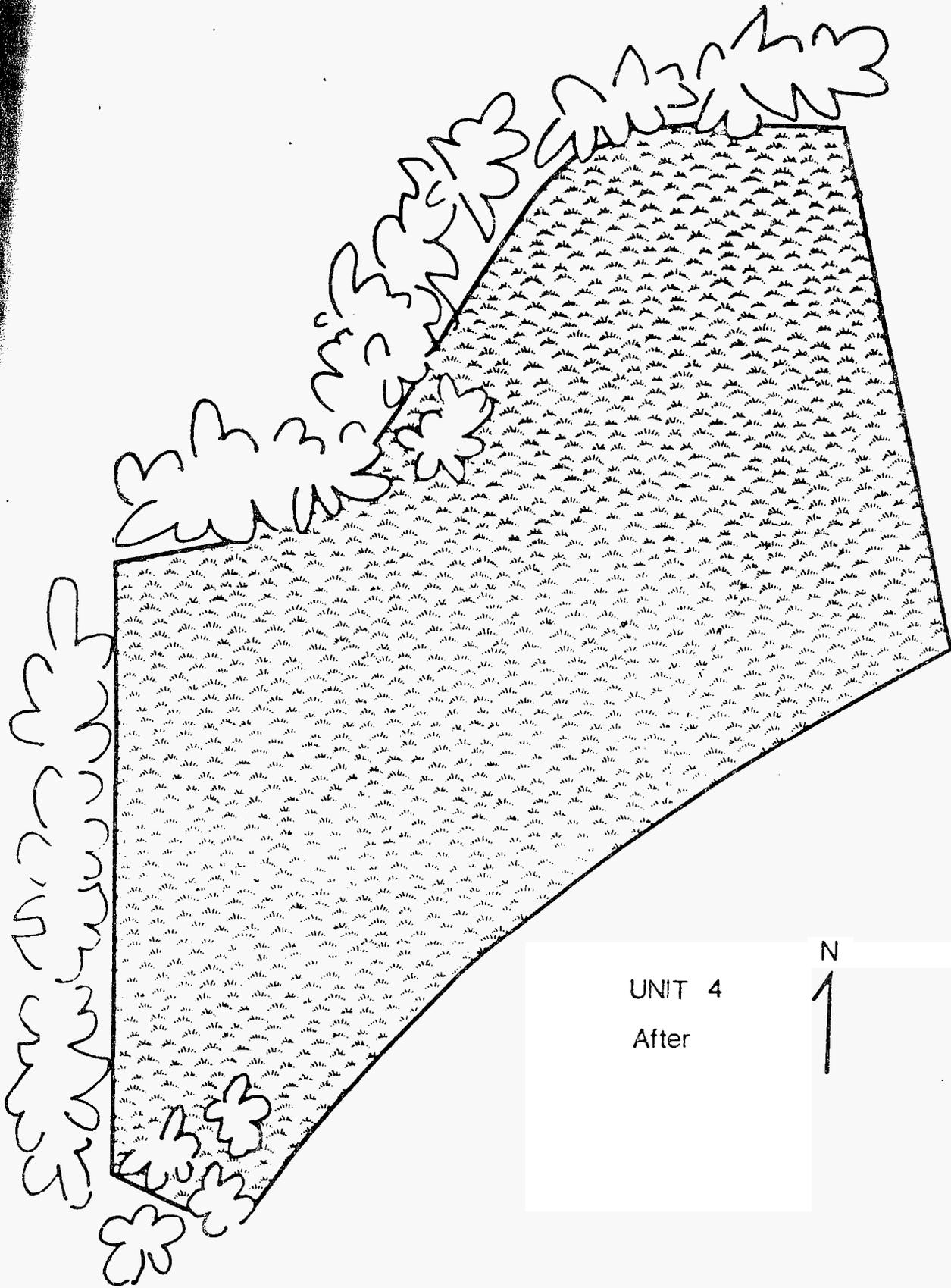
UNIT 4

Before



Figure 19

Artist's interpretation of Unit #4 at the end of the study in August of 1985.



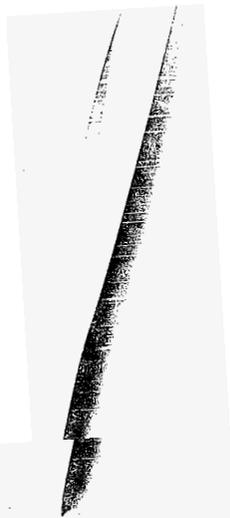
UNIT 4
After





Figure 20

Artist's interpretation of Unit #5 prior to use of management practices.



UNIT 5
Before

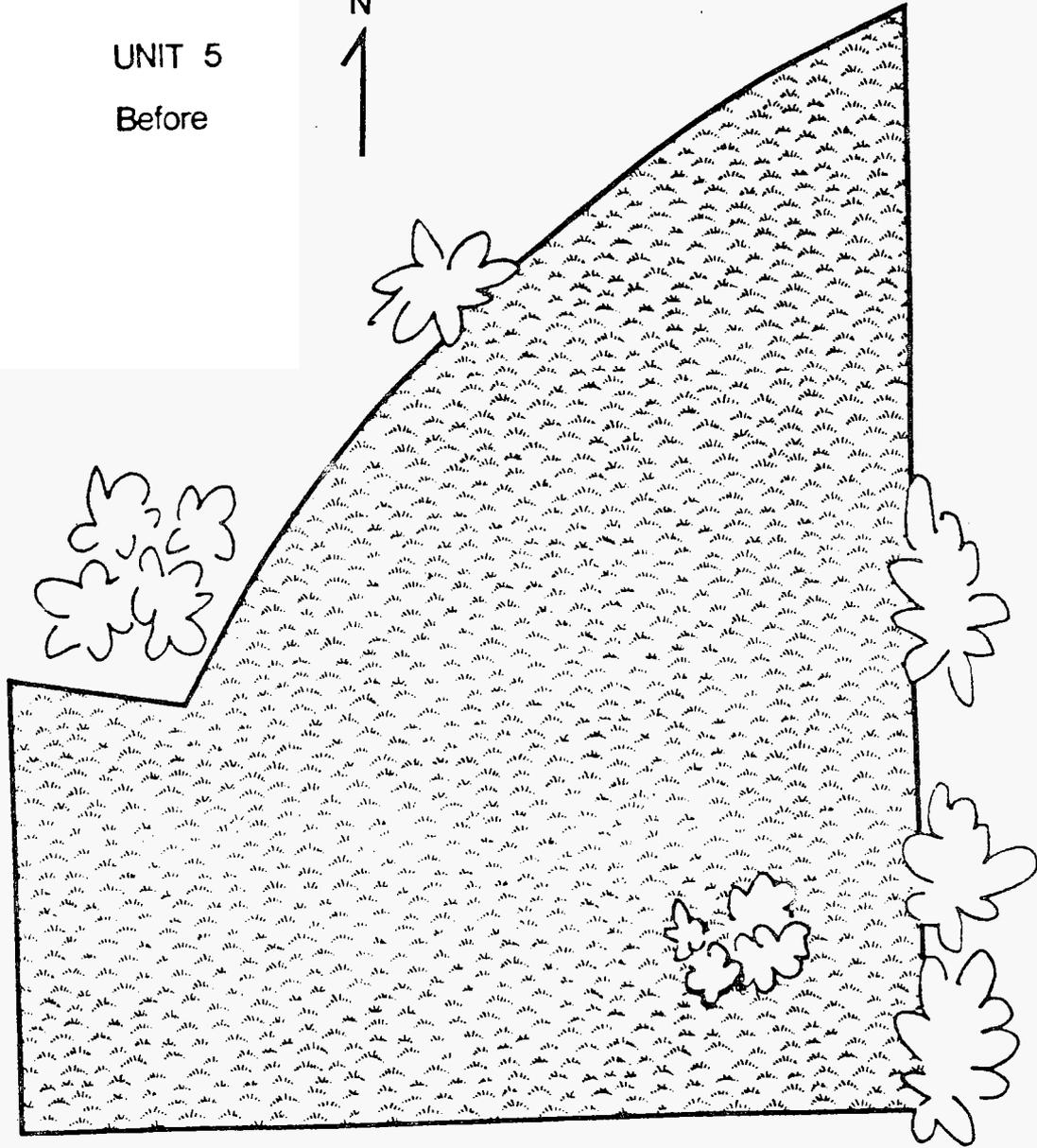


Figure 21

Artist's interpretation of Unit #5 at the end of
the study in August of 1985.

UNIT 5
After

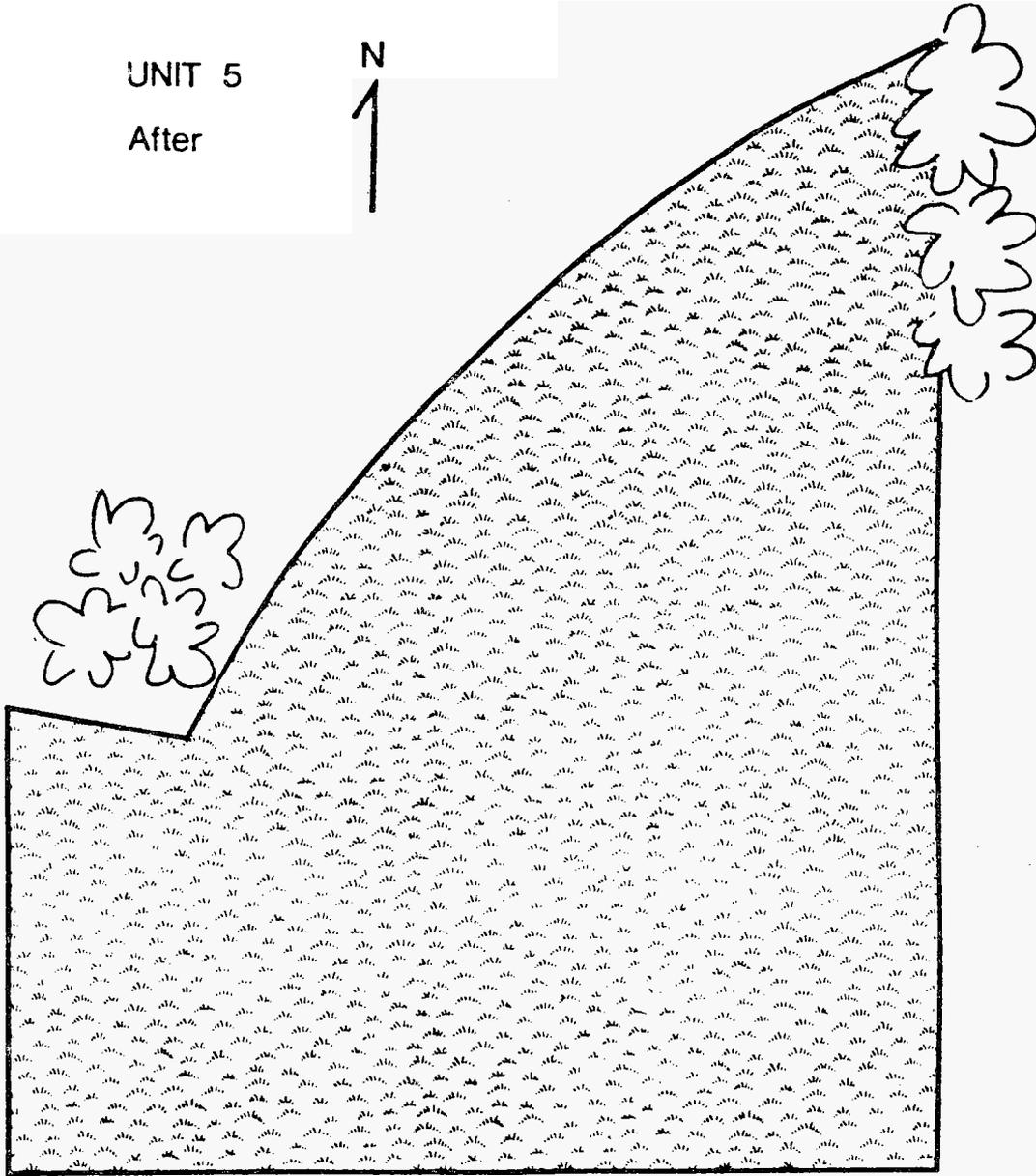
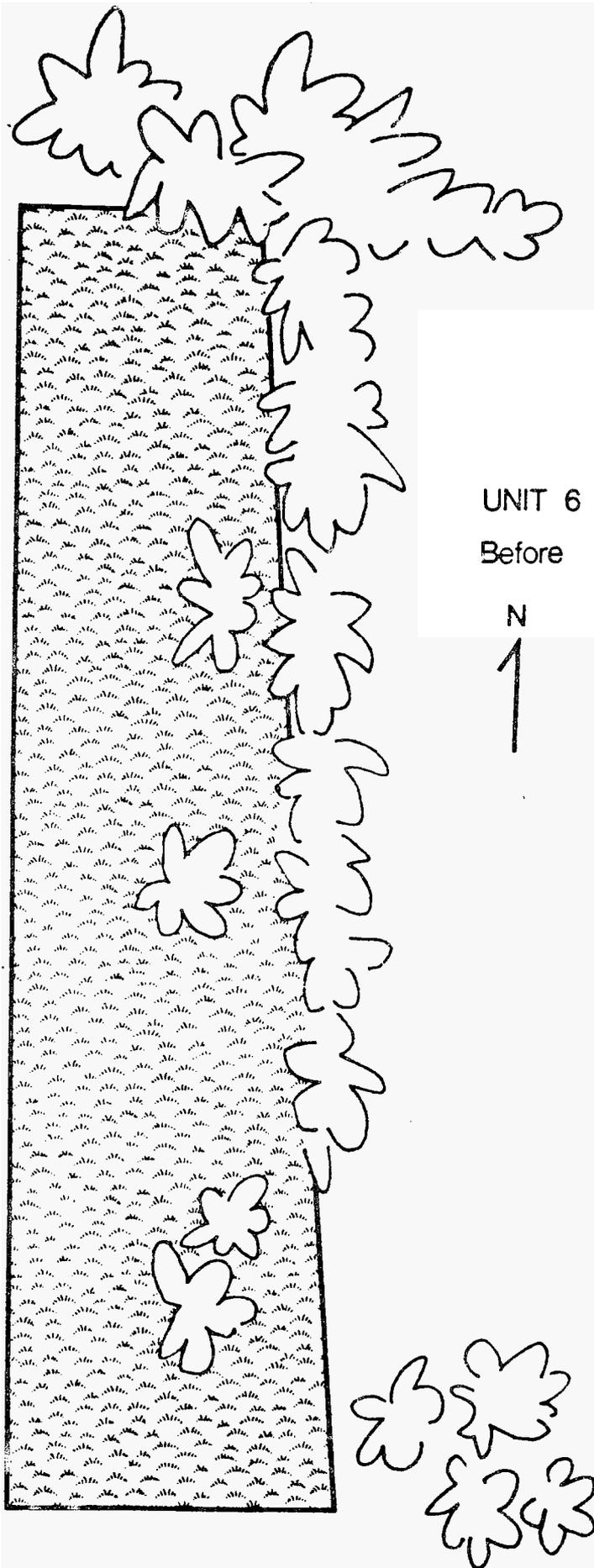


Figure 22

Artist's interpretation of Unit #6 prior to use
of management practices.



UNIT 6

Before

N



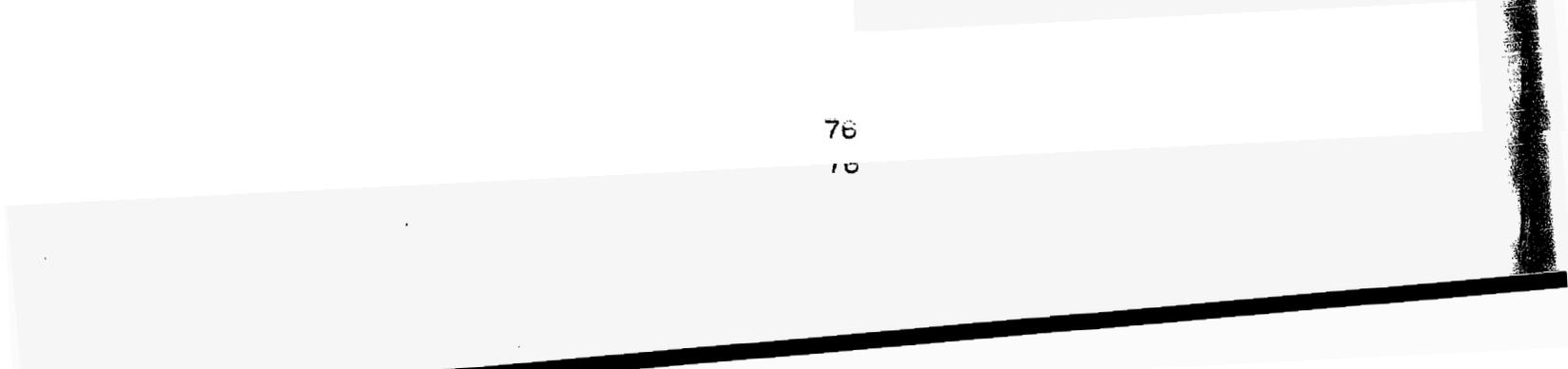


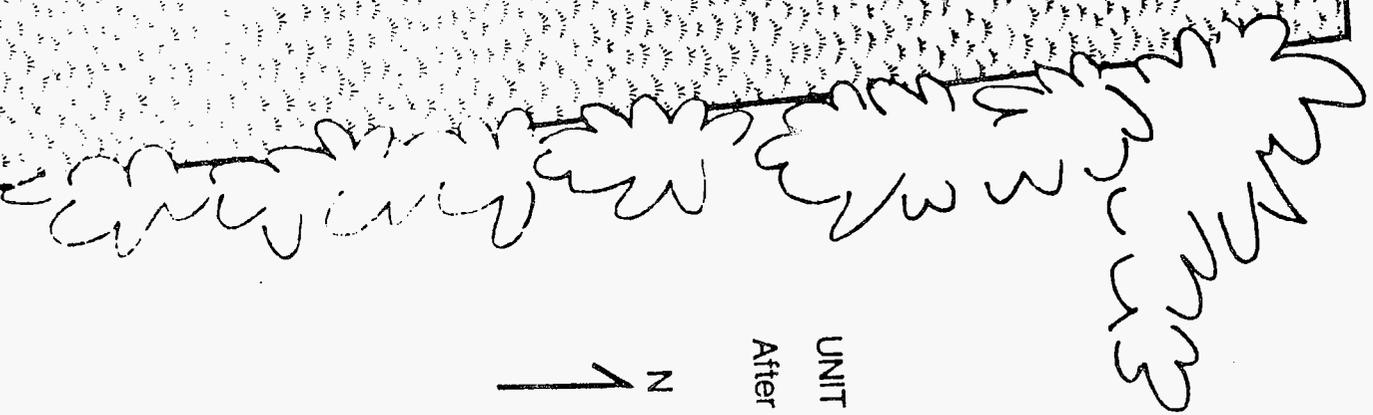
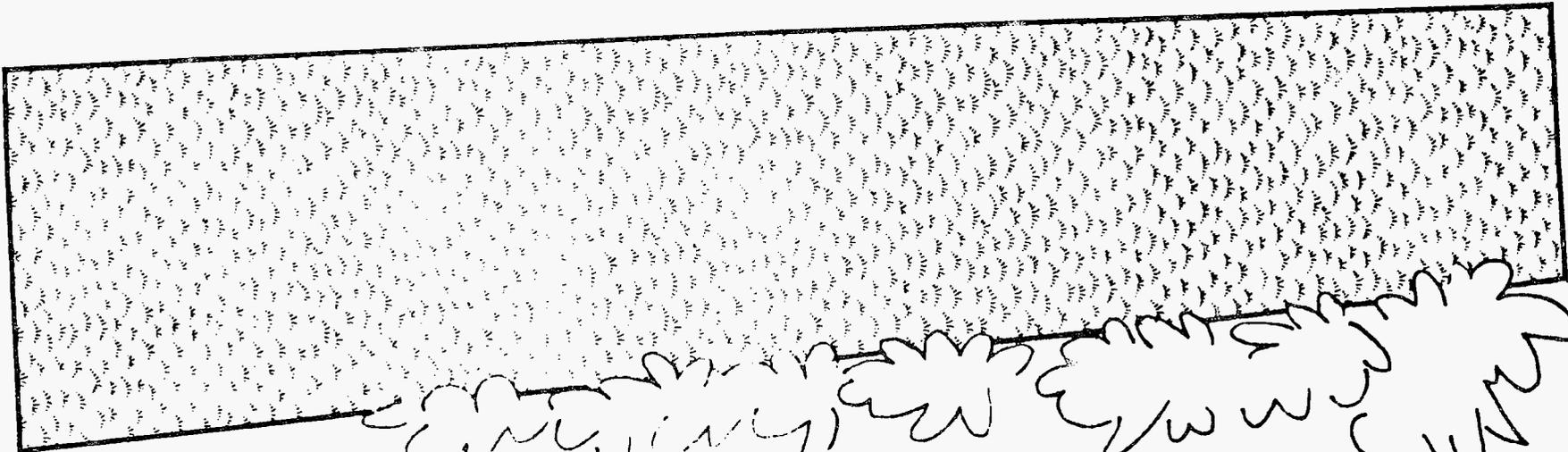
Figure 23

Artist's interpretation of Unit #6 at the end of the study in August of 1985.



76
70





UNIT 6
After

Hand-drawn scribbles or markings on the right side of the diagram.

FUTURE PRAIRIE MANAGEMENT PROGRAM

MANAGEMENT RECOMMENDATIONS FOR PRAIRIE UNIT ONE

This unit has a good stand of native grasses and forbs, and extreme management techniques should be avoided in order to protect these plants. The major problems are woody encroachment and fescue invasion. This prairie should be burned frequently in the early spring to kill the cool-season grasses like fescue without hurting the native warm season grasses. Constant checking of the invasion of sumac, rose, and blackberry should occur, especially on the eastern end of the unit. These plants should be hand removed twice a year and applications of herbicides like "Round-Up" should be used if there is any indication that the woody perennials are getting out of control. The unit should be mowed twice a year, once in early June to eliminate the seed heads of weedy annuals, and again in mid to late July to eliminate the seed heads of the cool-season grasses. No mowing should occur later than August in order to protect the reproduction of the native grass species. This unit should undergo a vegetational analysis on a regular basis. This analysis should include vegetational sampling and aerial and fixed point photography. A management regime for this prairie is shown below.

MANAGEMENT TECHNIQUES FOR UNIT ONE

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG	ANALYSIS
1987	APRIL	X	X		
	MAY		X		
	JUNE				X
	JULY		X		
	AUGUST				
	SEPT				
	OCT		X		

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG	ANALYSIS
1988	APRIL		X		
	MAY		X		
	JUNE				
	JULY		X		
	AUGUST				
	SEPT				
	OCT		X		

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG	ANALYSIS
1989	APRIL	X			
	MAY		X	X	
	JUNE				
	JULY		X		
	AUGUST				
	SEPT				
	OCT		X		

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG	ANALYSIS
1990	APRIL				
	MAY				
	JUNE				X
	JULY				
	AUGUST				
	SEPT				
	OCT		X		

MANAGEMENT RECOMMENDATIONS FOR PRAIRIE UNIT TWO

This unit has a good stand of switch grass and few other native forbs and grasses. The major problem is lack of diversity. Constant checking for the invasion of woody species should occur because the unit is small and has woods on all but one side. The unit should be mowed twice a year, once in early June to eliminate the seed heads of weedy annuals, and again in mid- to late July to eliminate the seed heads of the cool-season grasses. No mowing should occur later than August in order to protect the reproduction of the native grass species. This unit should undergo a vegetational analysis on a regular basis. This analysis should include vegetational and soil sampling also aerial and fixed point photography. A management regime for this prairie is shown below.

MANAGEMENT TECHNIQUES FOR UNIT TWO

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1987	APRIL	X	X	
	MAY		X	
	JUNE			
	JULY		X	X
	AUGUST			
	SEPT			
	OCT			X

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1988	APRIL			
	MAY		X	
	JUNE			
	JULY		X	
	AUGUST			
	SEPT			

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1989	APRIL	X		
	MAY		X	
	JUNE			
	JULY		X	
	AUGUST			
	SEPT			

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1990	APRIL			
	MAY			
	JUNE			X
	JULY			
	AUGUST			
	SEPT			X

X.

MANAGEMENT RECOMMENDATIONS FOR PRAIRIE UNIT THREE

This unit has a fair stand of native grasses. The major problems are woody encroachment and fescue invasion. This prairie should be burned frequently in the early spring to kill the cool season grasses like fescue without hurting the native warm-season grasses. Constant checking of the invasion of briar, rose, and blackberry should occur, especially on the eastern end of the unit. These plants should be hand removed twice a year and applications of herbicides like "Round-Up" should be used if there is any indication that the woody perennials are getting out of control. The unit should be mowed twice a year, once in early June to eliminate the seed heads of weedy annuals and again in mid- to late July to eliminate the seed heads of the cool season grasses. No mowing should occur later than August in order to protect the reproduction of the native grass species. This unit should undergo a vegetational analysis on a regular basis. This analysis should include soil and vegetational sampling, also aerial and fixed-point photography. A management regime for this prairie is shown below.

MANAGEMENT TECHNIQUES FOR UNIT THREE

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1987	APRIL	X	X	
	MAY		X	X
	JUNE			
	JULY		X	
	AUGUST			X
	SEPT			
	OCT		X	

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1988	APRIL		X	X (if needed)
	MAY		X	
	JUNE			
	JULY		X	
	AUGUST			
	SEPT			
	OCT		X	

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1989	APRIL	X		
	MAY		X	X
	JUNE			
	JULY		X	
	AUGUST			
	SEPT			
	OCT		X	

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1990	APRIL			
	MAY			X
	JUNE			
	JULY			
	AUGUST			X
	SEPT			
	OCT		X	

MANAGEMENT RECOMMENDATIONS FOR PRAIRIE UNIT FOUR

This unit has a fair stand of native grasses and forbs. The major problem is an abundance of weedy species and fescue and bluegrass invasion. This prairie should be burned frequently in the early spring to kill the cool-season grasses like fescue without hurting the native warm-season grasses. Constant checking of the invasion of sumac should occur. These plants should be hand removed twice a year and applications of herbicides like "Round-Up" should be used if there is any indication that the woody perennials are getting out of control. The unit should be mowed twice a year, once in early June to eliminate the seed heads of weedy annuals and again in mid-to late July to eliminate the seed heads of the cool-season grasses. No mowing should occur later than August in order to protect the reproduction of the native grass species. This unit should undergo a vegetational analysis on a regular basis. This analysis should include soil and vegetational sampling, also aerial and fixed-point photography. A management regime for this prairie is shown below.

MANAGEMENT TECHNIQUES FOR UNIT FOUR

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1987	APRIL	X		
	MAY		X	
	JUNE			
	JULY		X	X
	AUGUST			
	SEPT			
	OCT			X
<hr/>				
YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1988	APRIL		X	
	MAY		X	
	JUNE			
	JULY		X	
	AUGUST			
	SEPT			
	OCT			
<hr/>				
YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1989	APRIL	X		
	MAY		X	
	JUNE			
	JULY		X	
	AUGUST			
	SEPT			
	OCT			X
<hr/>				
YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS
1990	APRIL			
	MAY			
	JUNE			
	JULY			X
	AUGUST			
	SEPT			
	OCT			X

MANAGEMENT RECOMMENDATIONS FOR PRAIRIE UNIT FIVE

This unit has a good stand of native grasses and forbs and extreme management techniques should be avoided in order to protect these plants. The major problems are sumac encroachment and fescue invasion. This prairie should be burned frequently in the early spring to kill the cool-season grasses like fescue without hurting the native warm-season grasses. Constant checking of the invasion of sumac and blackberry should occur. These plants should be hand removed. The unit should be mowed twice a year, once in early June to eliminate the seed heads of weedy annuals and again in mid to late July to eliminate the seed heads of the cool-season grasses. No mowing should occur later than August in order to protect the reproduction of the native grass species. This unit should undergo a vegetational analysis on a regular basis. This analysis should include vegetational and soil sampling, also aerial and fixed-point photography. A management regime for this prairie is shown below. It is suggested that prairie forb bedding plants be put in this unit on an occasional basis in the spring.

GE

MANAGEMENT TECHNIQUES FOR UNIT FIVE

YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS	ANALYSIS
1987	APRIL	X			
	MAY		X		
	JUNE				
	JULY		X		X X
	AUGUST				
	SEPT				
	OCT				X X
<hr/>					
YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS	ANALYSIS
1988	APRIL				
	MAY		X		
	JUNE				
	JULY		X		
	AUGUST				
	SEPT				
	OCT				
<hr/>					
YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS	ANALYSIS
1989	APRIL	X			
	MAY		X		
	JUNE				
	JULY		X		
	AUGUST				
	SEPT				
	OCT				
<hr/>					
YEAR	MONTH	BURN-MOW-RESEED-PULL	WOODY PLANT-	HERBICIDE-VEG ANALYSIS	ANALYSIS
1990	APRIL				
	MAY				
	JUNE				
	JULY				X X
	AUGUST				
	SEPT				
	OCT		X		X X

GE

MANAGEMENT RECOMMENDATIONS FOR PRAIRIE UNIT SIX

This unit has a good stand of native grasses and forbs and extreme management techniques should be avoided in order to protect these plants. The major problem is that the native species are declining in this area. The cause for this is unknown. This prairie should be burned frequently in the early spring. The unit should be mowed twice a year, once in early June to eliminate the seed heads of weedy annuals and again in mid to late July to eliminate the seed heads of the cool-season grasses. No mowing should occur later than August in order to protect the reproduction of the native grass species. This unit should undergo a vegetational analysis on a regular basis. This analysis should include vegetational and soil sampling, also aerial and fixed point photography. A management regime for this prairie is shown below. It is suggested that prairie forb bedding plants be put in this unit on an occasional basis in the spring.

RGE

BURN-MOW-RESEED-PULL WOODY PLANT- HERBICIDE-VEG ANALYSIS

YEAR	MONTH	BURN	MOW	RESEED	PULL	WOODY PLANT	HERBICIDE	VEG ANALYSIS
1987	APRIL	X						
	MAY		X					
	JUNE							X
	JULY		X					
	AUGUST							
	SEPT							XX
	OCT							
1988	APRIL			X				
	MAY		X					
	JUNE							
	JULY		X					
	AUGUST							
	SEPT							
	OCT							
1989	APRIL	X						
	MAY		X					
	JUNE							
	JULY		X					
	AUGUST							
	SEPT							
	OCT							
1990	APRIL							
	MAY							
	JUNE							X
	JULY							
	AUGUST							
	SEPT							X
	OCT							X

RGE

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