SOILS, VEGETATION AND LIVESTOCK RELATIONSHIPS ON EASTERN OKLAHOMA GRAZING LEASES

By

PAUL GAVEN KNIGHT

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1974

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
May, 1980

Name: Paul Gaven Knight Date of Degree: May, 1980

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: SOILS, VEGETATION AND LIVESTOCK RELATIONSHIPS ON EASTERN OKLAHOMA GRAZING LEASES

Pages in Study: 73 Candidate for Degree of Master of Science

Major Field: Agronomy

Scope and Method of Study: Most federal and state agencies in Oklahoma do not have enough adequately trained personnel to accurately determine and interpret the effects of grazing. Therefore, this research was initiated to provide a simple and efficient method for public land managers to evaluate grazing practices. This study primarily concerns data that pertain to the herbage residue and the ground cover on, and the condition of Eastern Oklahoma grazing allotments. The soils and vegetation of the study area are representative of the Cherokee Prairies and Ouachita Highlands land resource areas. Twelve different soil series comprising seven different range sites were examined. Data were collected during the summer and fall, 1978, using 30-m transects and 0.5-m^2 quadrats to determine standing vegetation and ground litter by weight-estimate. Data obtained from all procedures were analyzed using programs of the Statistical Analysis System. Plant specimens were deposited with the Fort Gibson Project Office and in the Oklahoma State University Herbarium.

Findings and Conclusions: The average values for standing vegetation and ground cover on a project-wide basis were lower than expected for well-managed land. A consistent decrease in standing vegetation occurred on range and pasture areas on all range sites as condition declined from excellent to depleted. On Prairie range sites in good condition decreasers Andropogon gerardii, Panicum virgatum, Schizachyrium scoparium, Sorghastrum nutans and Lespedeza cuneata averaged about 62% of the composition. On poor and depleted sites increasers Carex spp., Paspalum spp., Sporobolus spp. and Panicum oligosanthes averaged about 50% of the composition, while invader plants Ambrosia psilostachya, Andropogon virginicus, Cynodon dactylon and all cool season and warm season annual grasses averaged about 24% of the composition. This information will be used to provide the land manager an index indicating key species and the amount of herbage residue and ground cover in this area.

ADVISER'S APPROVAL Frank Crosby Jr. for Jeff Powell

1057870

SOILS, VEGETATION AND LIVESTOCK RELATIONSHIPS

ON EASTERN OKLAHOMA GRAZING LEASES

Frank Thetford Jr. for Jeff Powell

Thesis Adviser

Paul A. Vohs Jr.

Larry J. Crockett

Norman N Durham

Dean of the Graduate College

PREFACE

In recent years considerable attention has been given to the vegetative conditions of grazing leases on the Corps of Engineers reservoirs in Eastern Oklahoma. Public sentiment is that the land is being abused and that grazing of livestock is not compatible with the publics' recreational interests (hunting, fishing, camping, etc.). Therefore, this study was undertaken to learn more about the soils, vegetation and livestock grazing in this area in order to create an efficient grazing evaluation method.

This thesis is written in accordance with the style and format appropriate for the Journal of Range Management. This style and format follows that recommended by the Council of Biological Editors Style Manual and the Journal of Range Management Editor. Tables are prepared in the manner presented for use in a technical report of the United States Department of Agriculture, Corps of Engineers and for the Journal of Range Management.

My deepest love, appreciation and gratitude goes to my wife, Junelle, for her trust, devotion and love to see me through this major step in our lives and to my son, Matthew, who makes his father very proud. A great deal of love and thanks goes to my parents, Mr. and Mrs. E. P. Knight, for their understanding and encouragement through the years. A very special thanks is given to my father-in-law and mother-in-law, Mr. and Mrs. George Rendel, for their help and encouragement given during my academic career.

A very special recognition is due my major adviser, Dr. Jeff Powell, Associate Professor of Agronomy, whose guidance and advice will always be remembered. Appreciation is also extended to all of the members of my graduate committee, Dr. Frank Thetford, Assistant Professor of Agronomy, Dr. Jerry Crockett, Professor of Biological Sciences and Dr. Paul Vohs, Unit Leader, Oklahoma Cooperative Wildlife Research Unit, who are recognized for their professional advice on range, wildlife biology and plant ecology.

A special thanks goes to the range crew, Mark Hart and the "Kevin brothers," Kevin Wright and Kevin Norton, who fought ticks, chiggers and briers in helping me collect the data. Also, thanks go to Ken Hill for his assistance in data analysis and programming.

Special recognition goes to the Department of Army Corps of Engineers, Tulsa District Office, for their support and financial assistance. The foresight used to initiate a study of this type proves interest in maintaining proper land management. Corps of Engineers personnel, Max Black, deserves a great deal of recognition for his support and advice in initiating this project. Also, a special thanks goes to Gene Craig, Fort Gibson Reservoir Park Ranger, who had the patience to give a college kid some of his experience and friendship.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Proper grazing intensity is frequently more difficult to achieve by a land manager on land leased to others than on land under his direct control. In Oklahoma many federal and state agencies, as well as private companies, control large areas of land leased to livestock operators for grazing (Morris 1979). These leased areas vary in size, climate, soils, vegetation, past use and present range condition. Management practices, management abilities and concerns for proper grazing use also vary widely among lessees.

Because the land manager is interested in optimizing the use of all natural resources and satisfying the wishes of the majority of public land users, there is a real need for him to be able to accurately assess the effects of grazing and the impact of increasing or decreasing livestock grazing pressure. Many alternatives involving proper stocking rates and timing of grazing can be selected for optimal land management depending on climate, economic conditions and other use objectives.

Most federal and state agencies in Oklahoma do not have enough adequately trained personnel to accurately determine and interpret the effects of grazing. Furthermore, the personnel available are usually required to fulfill several other duties related to recreation or public relations. Consequently, it is difficult for the limited number of personnel with varying degrees of proper training and with other unrelated duties, to rapidly and accurately determine the effects of grazing. When these personnel must also make sound management recommendations for many different allotments having different ecological conditions, the task is formidable indeed.

Until such time as manpower and proper expertise are increased, the existing personnel need simple and efficient methods to inventory and analyze rangelands. These methods must also provide for recommendations that result in prudent land management and can be defended if questioned by either lessees or non-livestock interest groups.

This study was part of a more comprehensive research project that was designed to provide a simple and efficient method for public land managers to evaluate grazing practices. The data presented pertain to the productivity of Eastern Oklahoma grazing allotments based on herbaceous species composition, range site and condition class. This information will be used to provide an index for the land manager indicating key species and the amount of herbage residue and ground cover in this area.

CHAPTER II

STUDY AREA

The Corps of Engineers Fort Gibson Project (latitude 36° 17' - 35° 51' north, longitude 95° 22' - 95° 7' west) is approximately 60 km east of Tulsa, Oklahoma, in Cherokee, Mayes and Wagoner counties (Corps of Engineers 1976). The total project land area of 9,600 ha includes 132 grazing and hay production allotments. Allotments with lease agreements terminating in December, 1981, were selected for study.

The Fort Gibson Project area has a humid, temperate climate with a mean growing season of 210 days (USDA Soil Conservation Service 1975). The distribution of mean annual precipitation is 320 mm in April and May, 290 mm June through August, 250 mm in September and October and 140 mm in the five winter months. The average relative humidity is over 50% throughout the year. Mean wind speeds range from 450 km/day in March to 310 km/day in July and August.

The project is on the eastern edge of the Cherokee Prairies and the northern edge of the Ouachita Highlands (Gray and Galloway 1969). Seventy percent of the study sites were located in the Cherokee Prairies that occupy level to gently sloping plains broken by sharp east-facing escarpments and low butte-like knobs. Soils of the Prairies developed on sandy and clayey shales and sandstones and are characteristically moderately dark to dark colored and considerably leached with a moderately acid surface. A representative soil on Loamy Prairie range sites of the Cherokee Prairies is a Dennis silt loam (Appendix A). This finely mixed, thermic, Aquic Palleudoll is a deep, moderately well-drained soil with slow permeability and a high water holding capacity (USDA Soil Conservation Service 1975).

The remaining 30 percent of the study sites are within the Ouachita Highlands land resource area. Soils in the Highlands developed on shales and fill material in the valleys and sandstones, shales and slates on the ridges. These soils are strongly leached and are therefore light colored on the surface (Gray and Galloway 1969). The Hector fine sandy loam, a siliceous, thermic, Lithic Dystrochrept (Appendix A) is a characteristic soil on Shallow Savannah range sites of the Highlands. Hector soils are shallow and well drained with a moderately rapid permeability and a low water holding capacity (USDA Soil Conservation Service 1975).

The climax vegetation of the Cherokee Prairies is dominated by tall grasses intermingled with forbs and woody species. Dominant grasses on all Prairie range sites include *Andropogon gerardii* (ANGE), *Schizachyrium scoparium* (SCSC), *Sorghastrum nutans* (SONU) and *Panicum virgatum* (PAVI), whereas climax Bottomlands are dominated by *Spartina pectinata* (SPPE), *Tripsacum dactyloides* (TRDA) and *Paspalum floridanum* (PAFL). The most abundant forbs include *Schrankia uncinata* (SCUN), *Silphium laciniatum* (SILA) and *Echinacea angustifolia* (ECAN). *Crateagus* spp. (CRA), *Rubus trivialis* (RUTR) and *Ulmus alata* (ULAL) are common woody plants (USDA Soil Conservation Service 1975).

The climax vegetation of the Ouachita Highlands is dominated by an overstory of *Quercus stellata* (QUST) and *Q. marilandica* (QUMA). The understory is comprised of the woody plants *Symphoricarpos orbiculatus*

(SYOR), *Vitis* spp. (VIT), *Rhus radicians* (RHRA) and *Smilax bona-nox* (SMBO) with ANGE, SCSC, *Elymus canadensis* (ELCA), *Helianthus* spp. (HEL) and *Lespedeza* spp. (LES) being the climax herbaceous species (USDA Soil Conservation Service 1975).

Scientific names are from Gould (1969) and Waterfall (1972). The abbreviations and scientific and common names for plant species found in the study area are in Appendix B.

CHAPTER III

METHODS

In the summer and fall of 1978 a ground survey was conducted over the Fort Gibson Project lands leased for livestock grazing and hay production. Thirty-one grazing allotments (LEASE)[1] were selected for soil, vegetation and grazing analyses. Areas smaller than 20 ha were excluded so that the within-allotment variation of ecological factors and grazing distribution could be included. The maximum allotment size selected was about 220 ha.

The area of each soil mapping unit (SOIL) within each allotment was determined using a dot grid. Also, the total area of each soil was determined for the 31 allotments selected. Benchmark soils (Gray and Galloway 1969) or those soils occupying a large portion of several allotments were selected for sampling for chemical composition.

A 30-m long transect (TRAN) was selected as the sampling unit. Locations of these transects were arbitrarily determined by marking points on an aerial photo showing the soils and allotments to be sampled. The density and distribution of the transects within each soil area and allotment were chosen on the basis of soil area, the estimated time necessary to collect data from one transect and the time necessary for data

[1]Terms presented in capital letters symbolize various classification variables and kinds of data obtained that were used for computer analyses.

collection in all allotments. An attempt was made to distribute the transect locations evenly across each allotment soil area.

After each transect was located, a 50-cm by 100-cm quadrat was placed on the ground at the 10-, 20- and 30-m points along the transect. Within each quadrat field weights of each plant species, all aboveground standing vegetation (STDVEG) and ground litter (GRNLTR), including woody litter, were estimated using the weight-estimate method (Pechanec and Pickford 1937). Percent bare ground (BG) was also estimated.

One of the three quadrats was randomly selected for clipping so that the double sample method of Wilm et al. (1944) could be used. Standing vegetation clipped at ground level and ground litter were removed from the quadrat, bagged separately, weighed, air-dried to constant weight, then reweighed. Estimated field and air-dry weights for clipped subsamples were used to determine dry matter content and the estimation correction factor for herbaceous vegetation at that transect location. Species composition (%) and production (kg/ha, air-dry)[2] of standing vegetation, ground litter and total plant biomass (BIOMASS = STDVEG + GRNLTR) were calculated for each sample unit.

The 12 soils selected for study comprised seven distinct range sites (SITE) as classified by the Soil Conservation Service Mayes County Soil Survey (1975). Although range sites include more than one soil series, the application of rangeland management practices on a range site basis is often more practical than on a soil series basis.

---

[2]Oven-dry weight not available; some variability in air-dry weight but generally should not affect results when used with a large number of samples.

The seven range sites comprised three vegetation types (VEGTYPE). Vegetation types are plant communities with easily distinguishable characteristics that can provide a broader basis for management decisions and evaluations than either range sites or soil series. The three vegetation types sampled were Bottomland, Prairie and Savannah.

Both native vegetation and introduced pasture are common in the Cherokee Prairies and Ouachita Highlands. These two kinds of vegetation are often used in a complementary forage system by livestock producers. Since a reconnaisance survey showed a significant number of introduced pastures on grazing allotments in the Fort Gibson Project grazing area, the sampling units were classified as to their origin, either introduced pasture (I) or native vegetation (N).

One of the five condition classes was assigned to each sample unit to indicate the estimated degree of departure from native climax vegetation or introduced pasture's maximum potential forage production. Climax native vegetation and potential production of forage on introduced pastures are described in the Wagoner County Soil Survey (Soil Conservation Service 1976), Mayes County Soil Survey (Soil Conservation Service 1975) and Soil Conservation Service, Pryor, Oklahoma, Work Unit Range Condition Guidelines (unpublished data). The assigned classes with percent composition of climax vegetation or percent potential pasture production were as follows: Excellent (76-100%), Good (51-75%), Fair (26-50%), Poor (10-25%) and Depleted (0-9%).

All data were recorded in the field on forms designed to facilitate immediate key punching onto computer cards (Appendix C). Data were analyzed using the following procedures of the Statistical Analysis System (Barr et al. 1976). The MEANS procedure computed averages used in the

GLM (General Linear Model) procedure for determining observed significance levels. The DUNCAN procedure was used to determine which differences were statistically different. Analyzed data sets were labeled and stored on a magnetic disk at the Oklahoma State University Computer Center (Appendix C). Therefore, the data are readily available for additional analyses and merging with data from past or future studies that are similar.

CHAPTER IV

RESULTS AND DISCUSSION

Allotments

Herbage production and ground cover in areas of native vegetation varied widely among and within allotments (Table 1). Standing vegetation was determined between June and October. Depending on growing conditions in Eastern Oklahoma, this coincides with the occurrence of peak standing crop (Powell and George 1973; Powell and Baker 1974). After the peak standing crop is reached, there is a gradual to moderately rapid decrease in the weight of standing vegetation. The rate of this decrease varies with natural herbage losses and grazing pressure. Generally, variations in herbage residue due to sampling date between July and frost are relatively minor compared to other sources of variation.

Average standing vegetation ranged from 20 kg/ha on allotment number 7 to 5,770 kg/ha on allotment number 16. The coefficients of variation (% C.V. = standard deviation X 100/mean) for standing vegetation ranged from 16% of the mean on allotment number 14 to 142% of the mean on allotment number 22. The coefficient of variation is presented instead of the customary standard deviation in order to compare variation between values of different measurements (e.g., STDVEG and BG). These figures are presented merely to demonstrate variation among and within

Table 1. Average ($\bar{x} \pm$ % C.V.) native standing vegetation (kg/ha, air-dry STDVEG), ground litter (kg/ha, air-dry GRNLTR), standing vegetation plus ground litter (kg/ha, air-dry BIOMASS) and bare ground (% BG) on COE Fort Gibson Project grazing allotments, 1978.

Allotment No.	Allotment No. of Transects	STDVEG	GRNLTR	BIOMASS	BG
1	21	1820±107 def[1/]	2240± 96 efghi	4060±66 de	28±102 cdef
2	11	2400± 67 cde	3230±124 cdefg	5630±53 bcd	21± 79 defgh
3	3	150± 61 gh	5820± 44 abc	5970±44 abcd	12±138 fghi
4	8	910± 91 fgh	4260±107 bcd	5170±79 bcd	13±117 fghi
5	8	990± 73 fgh	3650± 84 cdef	4630±52 de	6±120 hi
6	6	590± 88 gh	1500± 81 efghi	2090±45 ef	21±138 defgh
7	4	20±137 h	7480± 40 a	7500±40 abc	27±117 cdefg
8	7	2820±125 bcd	6080± 80 ab	8890±37 a	17±167 efghi
9	10	4040± 45 b	970± 79 hi	5000±45 cd	42± 47 bc
10	9	1710± 38 defg	1150± 69 hi	2860±35 def	64± 25 a
11	15	3720± 38 b	270± 65 i	4000±26 de	35± 20 cd
12	5[2/]	3800± 34 b	1070± 49 hi	4860±32 cde	27± 52 cdefg
13	--	--	--	--	--
14	16	3970± 16 b	1170± 96 hi	5140±28 cd	32± 29 cde
15	5	3030± 40 bc	850± 19 hi	3880±33 def	31± 67 cdef
16	9	5770± 49 a	2000±104 efghi	7760±58 ab	21±100 defgh
17	29	1670± 82 efg	2260± 85 efghi	3930±55 de	21±107 efgh
18	7	570± 58 gh	2630± 45 defgh	3200±38 def	19±115 efghi
19	10	1170± 95 fgh	1410± 88 ghi	2580±52 ef	40± 59 c
20	5	910± 79 fgh	1430± 81 efghi	2340±64 ef	39± 76 cd
21	22	670± 79 gh	2840± 74 defg	3510±52 def	10±183 ghi
22	4	610±142 gh	7360± 30 a	7990±23 ab	60± 59 ab
23	15	1700± 59 efg	1920± 77 efghi	3620±51 def	14±124 fghi
24	21	800±100 gh	4060± 94 cd	4860±73 de	8±204 ghi
25	8	1150± 74 fgh	3940±124 cde	5090±85 cd	11± 74 fghi
26	--	--	--	--	--
27	5	1290±137 efgh	6420± 60 ab	7710±35 ab	4±104 hi
28	12	3360± 32 bc	2350± 35 defgh	5710±28 bcd	1±158 i
29	13	700± 79 gh	1250±113 hi	1950±64 f	65± 37 a
30	19	1620± 85 efg	3510± 73 cdef	5130±41 cd	6± 97 hi
31	9	820± 94 fgh	2270± 95 defghi	3090±58 def	7± 75 ghi
Average		1880± 69	2600± 94	4480±53	22± 83
Prob. Level		.01	.01	.01	.01

1/ Those means in the same column followed by the same letter are not significantly different at the 10% level.

2/ No native vegetation sampled on this allotment.

allotments and the need for stratification within allotments. All of the sampling of native vegetation within allotment number 7 was on Bottomland and Savannah range sites having a closed canopy or complete tree or brush cover greater than allowed under climax condition. These areas rarely produce a significant amount of herbage. Sampling on allotment number 16 was on the more productive Prairie range sites that had a minimum amount of woody cover.

The average native standing vegetation for all transects and all allotments was 1,800±1,200 (sd) kg/ha. Average ground litter was 2,600 ±2,400 (sd) kg/ha. Total standing vegetation plus ground litter (BIOMASS) averaged 4,480±2,370 (sd) kg/ha. The average percentage bare ground was 22±18 (sd) percent; therefore, 78% of the ground's surface was covered by plants or ground litter. Because ground litter in this study included woody material as well as herbaceous material, large values for GRNLTR and for BG (such as for allotment number 22 in Table 1) indicate a high percentage of fallen woody material and relatively little cover by leaves or herbaceous litter.

Similar measurements of herbaceous production and ground cover on introduced pastures are presented by allotment in Table 2. The range in average standing vegetation per allotment was almost as great for pastures (4,640 kg/ha) as that for native vegetation (5,750 kg/ha). Pasture conditions ranged from excellent to depleted, as did native vegetation areas, and the amount of standing vegetation in pastures generally reflected pasture condition. An exception to this occurred in areas that had been mowed for hay before sampling was conducted.

Compared to native vegetation areas, introduced pastures had more standing vegetation, about half as much ground litter, similar amounts

Table 2. Average ($\bar{x} \pm$ % C.V.) introduced pasture standing vegetation (kg/ha, air-dry STDVEG), ground litter (kg/ha, air-dry GRNLTR), standing vegetation plus ground litter (kg/ha, air-dry BIOMASS) and bare ground (% BG) on COE Fort Gibson Project grazing allotments, 1978.

Allotment					
No.	No. of Transects	STDVEG	GRNLTR	BIOMASS	BG
1	16	3560±45 cd[1/]	1150± 58 d	4710±39 cd	20± 60 bc
2	13	3270±36 cde	1200± 92 d	4460±40 cd	14± 76 cde
3	6	4370±19 abc	1200± 38 d	5570±18 abc	7± 56 de
4	9	2460±56 ef	1310± 63 cd	3770±54 cde	15±172 bcde
5	15	2060±63 efgh	2260± 52 bc	4310±51 cde	5±125 e
6	14	720±65 h	950± 92 d	1680±75 f	11±145 de
7	7	1640±75 fgh	740± 72 d	2390±66 def	6±166 e
8	21	5360±29 a	700±107 d	6060±31 ab	28± 44 a
9	12	4130±42 bc	1230± 82 d	5350±39 bc	25± 45 ab
10	--[2/]	--	--	--	--
11	--	--	--	--	--
12	--	--	--	--	--
13	39	5050±37 ab	730± 77 c	5780±34 ab	13± 62 de
14	--	--	--	--	--
15	7	3950±18 bc	840± 38 d	4790±18 bcd	31± 56 a
16	3	5230±27 ab	310± 54 d	5540±23 abc	17± 17 bcde
17	--	--	--	--	--
18	3	2440±20 efg	620± 90 d	3060 ± 4 def	17± 17 bcde
19	4	2210±21 efgh	640± 30 d	2850±14 def	15± 61 bcde
20	21	1450±40 fgh	900± 61 d	2360±38 ef	12± 96 de
21	16	1620±61 fgh	1250± 59 d	2870±33 def	13±160 cde
22	4	1670±35 efgh	1120± 51 d	2790±27 def	1±200 e
23	6	880±80 gh	4650±123 d	5530±99 abc	9±100 de
24	3	1570±10 fgh	2800± 21 bc	4370±14 cde	2±173 e
25	4	2750±17 cdef	1510± 94 cd	4260±34 cde	6±100 e
26	7	1120±49 fgh	2400± 60 bc	3530±48 cde	5±183 e
27	12	2660±64 def	1460±110 cd	4110±50 cde	3±128 e
28	3	3490±21 cde	1350± 32 cd	4850± 8 bcd	0± 0 e
29	6	1750±48 efgh	830± 53 d	2580±36 def	6± 52 e
30	11	3970±39 bc	2840± 39 b	6820±28 a	4± 49 e
31	13	1910±55 efgh	1210± 76 d	3120±41 de	18± 80 bcd
Average		3030±43	1280± 92	4300±42	13± 90
Prob. Level		.01	.01	.01	.01

1/ Those means in the same column followed by the same letter are not significantly different at the 10% level.

2/ No introduced pasture sampled on this allotment.

of biomass and less bare ground. Also, pasture standing vegetation, ground litter and ground cover averages in allotments were more uniform than those of native vegetation. This is to be expected since shading from trees and brush were less of a factor in all but poor condition pastures. Natural differences in production and cover due to site productivity were probably minimized by pasture management inputs and practices.

Range Sites

The Savannah vegetation type had significantly more ground litter than Bottomland or Prairie locations (Figure 1). The Savannah vegetation type also had the greatest variation in ground litter between sites with Shallow Savannah locations averaging about 7,000 kg/ha in contrast to Smooth Chert Savannah locations averaging only 1,900 kg/ha. The least amount of GRNLTR (800 kg/ha) was found on Claypan Prairie sites, and GRNLTR values on soils within a range site were generally similar. The greatest difference of 800 kg/ha was within the Smooth Chert Savannah range sites between GRNLTR values for Clarksville and Sallisaw soils.

A comparison of values for standing vegetation and ground litter indicated a consistent inverse relationship between the two variables, those sites with relatively large amounts of GRNLTR having relatively small amounts of STDVEG. For example, Claypan Prairie locations had the greatest STDVEG and almost no GRNLTR. Locations with large amounts of STDVEG were on well managed, grazed and mowed for hay sites with minimum amounts of brush. Locations with large amounts of GRNLTR occurred on sites dominated by woody plants and on improperly grazed range sites.

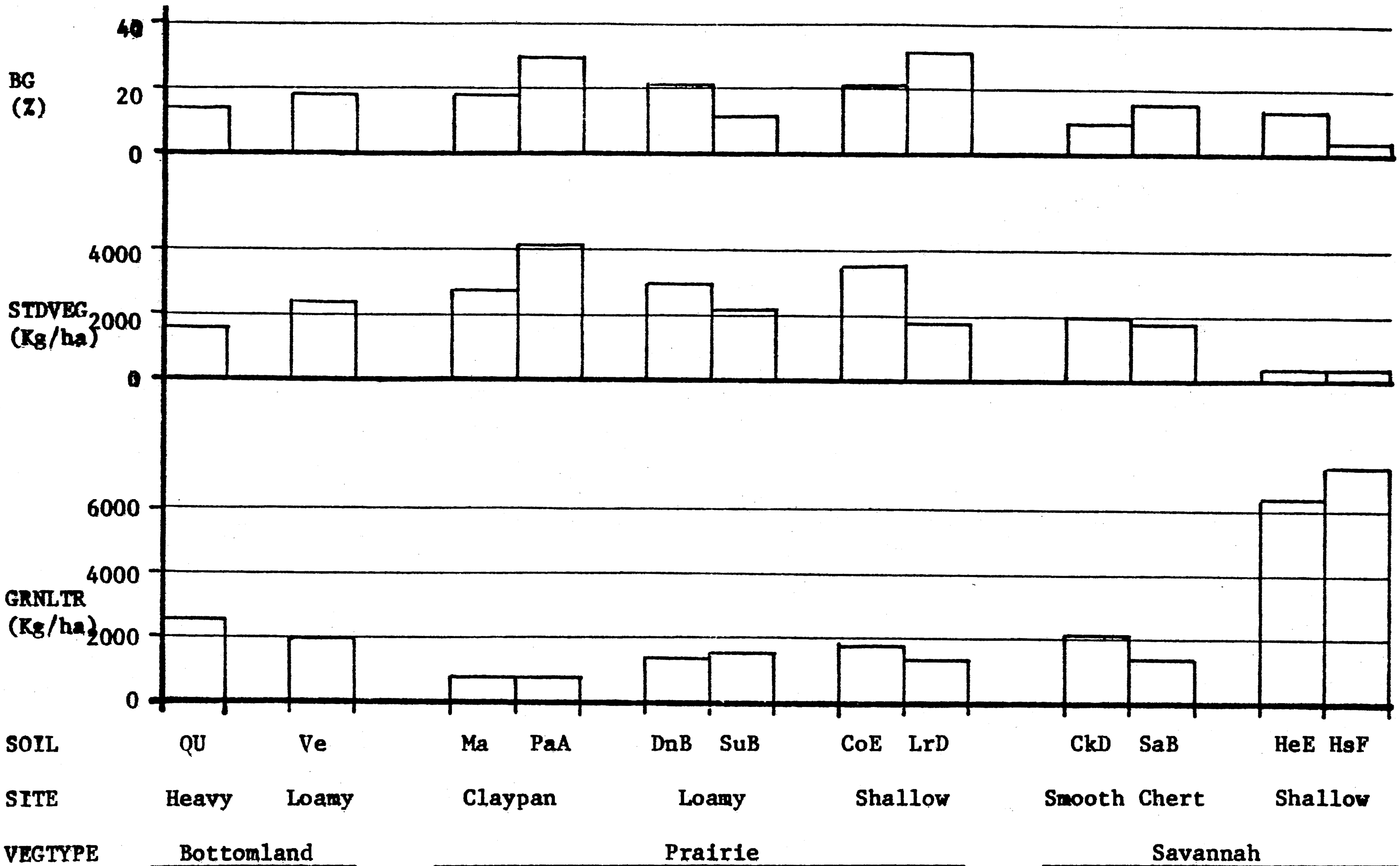


Figure 1. Average ground litter (GRNLTR), standing vegetation (STDVEG) and bare ground (BG) by vegetation type (VEGTYPE), range site (SITE) and soil (SOIL) on COE Fort Gibson Project grazing allotments, 1978. (SOIL: Qu-Quarles, Ve-Verdigris, Ma-Mayes, PaA-Parsons, DnB-Dennis, SuB-Summit, CoE-Collinsville, LrD-Lenapeh, CkD-Clarksville, SaB-Sallisaw, HeE-Hector-Enders, HsF-Hector)

Differences in standing vegetation among soils within a site were greater than differences in ground litter. For example, using the average standing vegetation for Shallow Prairie range sites (2,700 kg/ha) as a basis for proper stocking rates may cause 15-20% overuse on Lenapeh soils and a similar degree of underuse on Collinsville soils. From the standpoint of accurately determining grazing use or estimating livestock carrying capacity, accurate soils maps and the ability to distinguish between soil series appear to be important.

Large differences in bare ground also existed on soils within the Prairie sites and within the Shallow Savannah range sites. Therefore, determining ground cover only on a range site basis may limit the interpretation of data collected.

Differences in ground litter due to range site were greater for native vegetation than for pastures (Figure 2). This was expected since ground litter on areas with native vegetation was influenced greatly by the abundance of trees and brush (on certain sites). For example, ground litter on Shallow Savannah sites was twice as great as on any other site.

Many Bottomland locations had limited ground litter and a high percentage of bare ground. Apparently, flooding washed away much of the ground litter on many lower elevations. If erosion is to be minimized in these areas, the maintenance or introduction of herbaceous species capable of surviving periodic inundation should be encouraged.

Pasture standing vegetation was greatest on Claypan and Shallow Prairie sites. This is somewhat unusual because the Loamy Prairie site is considered to be more productive than either the Claypan or Shallow Prairie sites. Many of the pastures seeded to fescue (*Festuca*

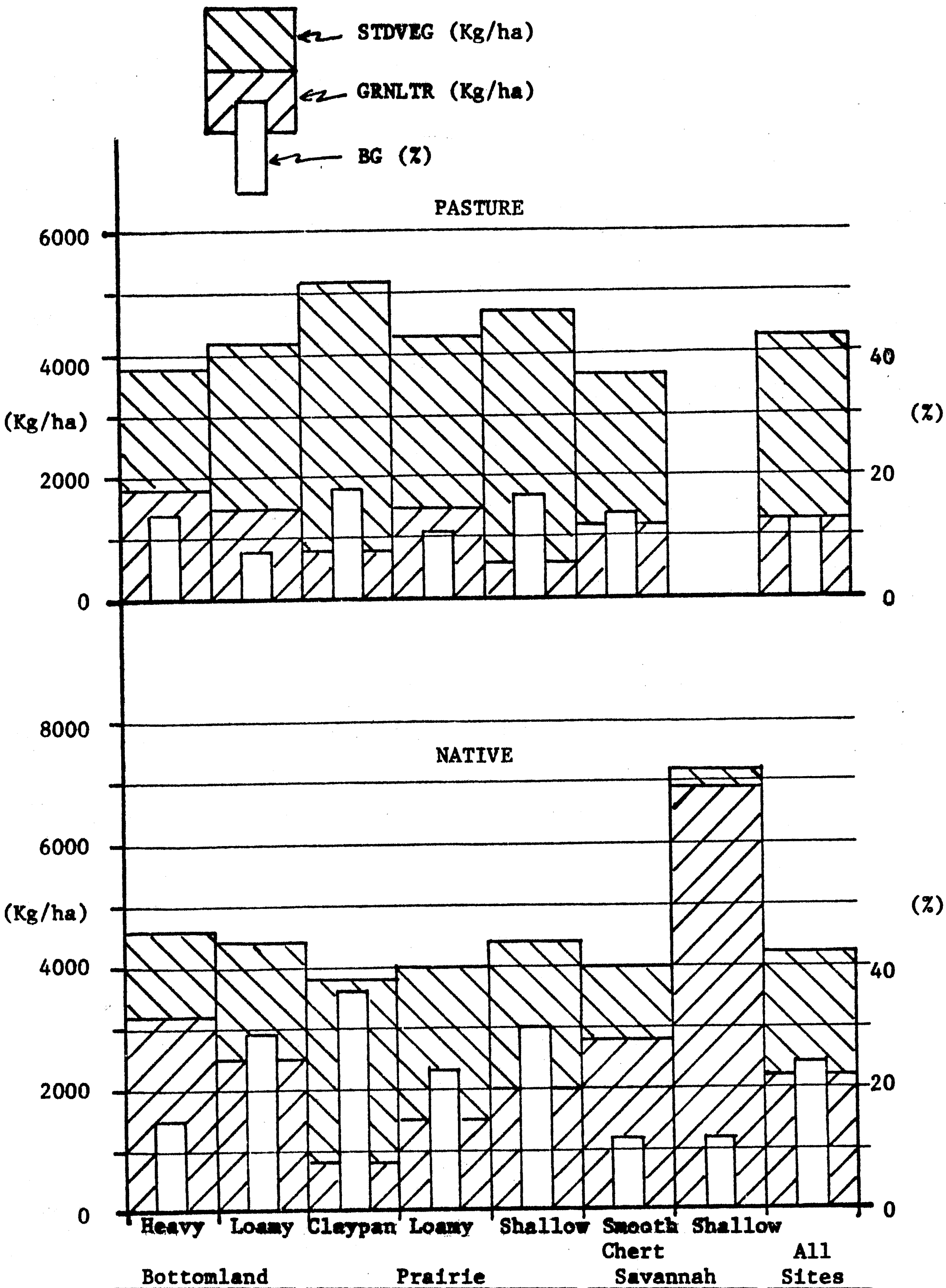


Figure 2. Average native and pasture standing vegetation (STDVEG), ground litter (GRNLTR) and bare ground (BG) for range sites on COE Fort Gibson Project grazing allotments, 1978.

arundinacea) were in better condition which contributed to higher amounts of STDVEG on the Claypan Prairie sites. No introduced pastures were found on the Shallow Savannah sites since these sites have frequent rock outcrops that make cultivation difficult.

Except for the Shallow Savannah sites, biomass values were about the same (4,000 kg/ha) across all sites for pastures and native vegetation. Therefore, under the conditions of the study, neither sites nor kind of vegetation had much affect on total herbage residue.

Range Condition

The relationships between range condition class, herbage production and ground cover is shown in Table 3 and Figure 3. Production of standing vegetation decreased greatly as condition declined from excellent to depleted. Ground litter increased slightly with a decline in condition between excellent and poor and increased greatly between poor and depleted. Much of this difference in ground litter was because of the invasion of woody species in many areas causing the depleted condition. Under pristine conditions with natural fires being more common, most of the Prairie and Savannah sites were more open. In Eastern Oklahoma decreased burning and increased grazing pressure caused a rapid invasion by woody plants (Ray and Lawson 1955). Once established, woody plants shade out the herbaceous plants which cannot compete successfully against brush and trees, even with proper grazing management.

Native standing vegetation responded to a decline in range condition with decreased production (Figure 4). Only five locations of native vegetation sampled were in excellent condition; therefore, the excellent range condition class was not included in Figure 4.

Table 3. Average ($\bar{x} \pm$ % C.V.) standing vegetation (kg/ha, air-dry STDVEG), ground litter (kg/ha, air-dry GRNLTR), standing vegetation plus ground litter (kg/ha, air-dry BIOMASS) and bare ground (% BG) on COE Fort Gibson Project grazing allotments by range condition, 1978.

	Excellent (N=44)	Good (N=82)	Fair (N=147)	Poor (N=147)	Depleted (N=172)	Probability Level
STDVEG	5940± 30 a[1/]	4210± 35 b	3060± 41 c	1750± 63 d	650±106 e	.01
GRNLTR	1100±114 b	1110±100 b	1390± 74 b	1540±100 b	3540± 96 a	.01
BIOMASS	7040± 35 a	5320± 34 b	4450± 38 c	3290± 55 c	4190± 77 c	.01
BG	12± 73 c	20± 68 ab	15±101 bc	18±112 bc	23±124 a	.01

1/ Those means in the same row followed by the same letter are not significantly different at the 10% level.

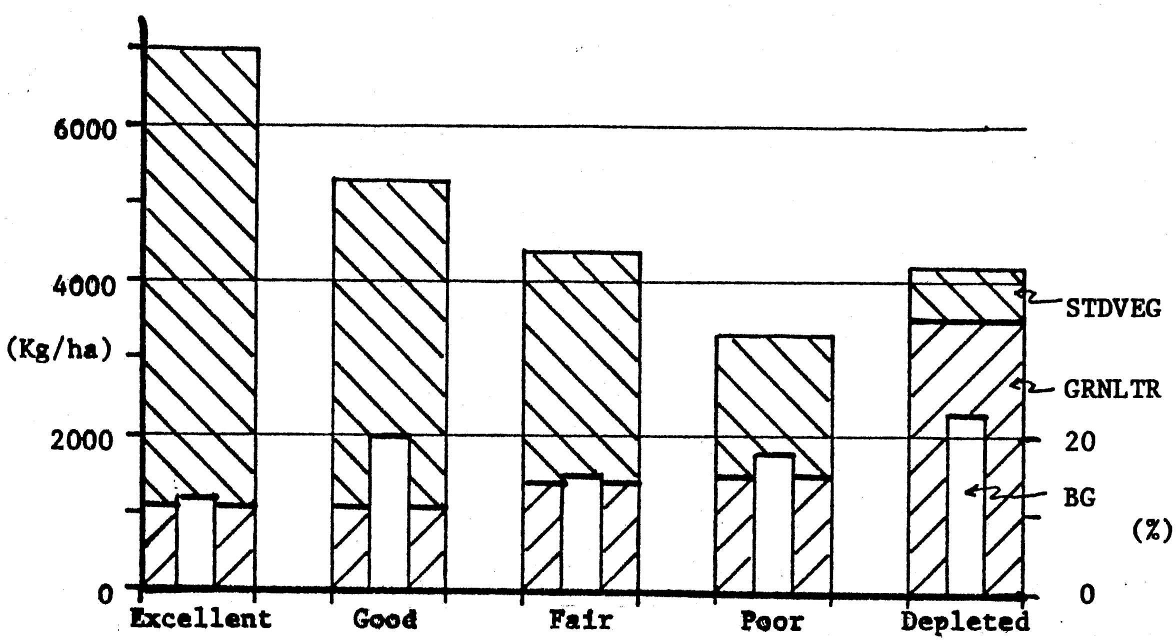


Figure 3. Average ground litter (kg/ha GRNLTR), standing vegetation (kg/ha STDVEG) and bare ground (BG) by range condition on COE Fort Gibson Project grazing allotments, 1978.

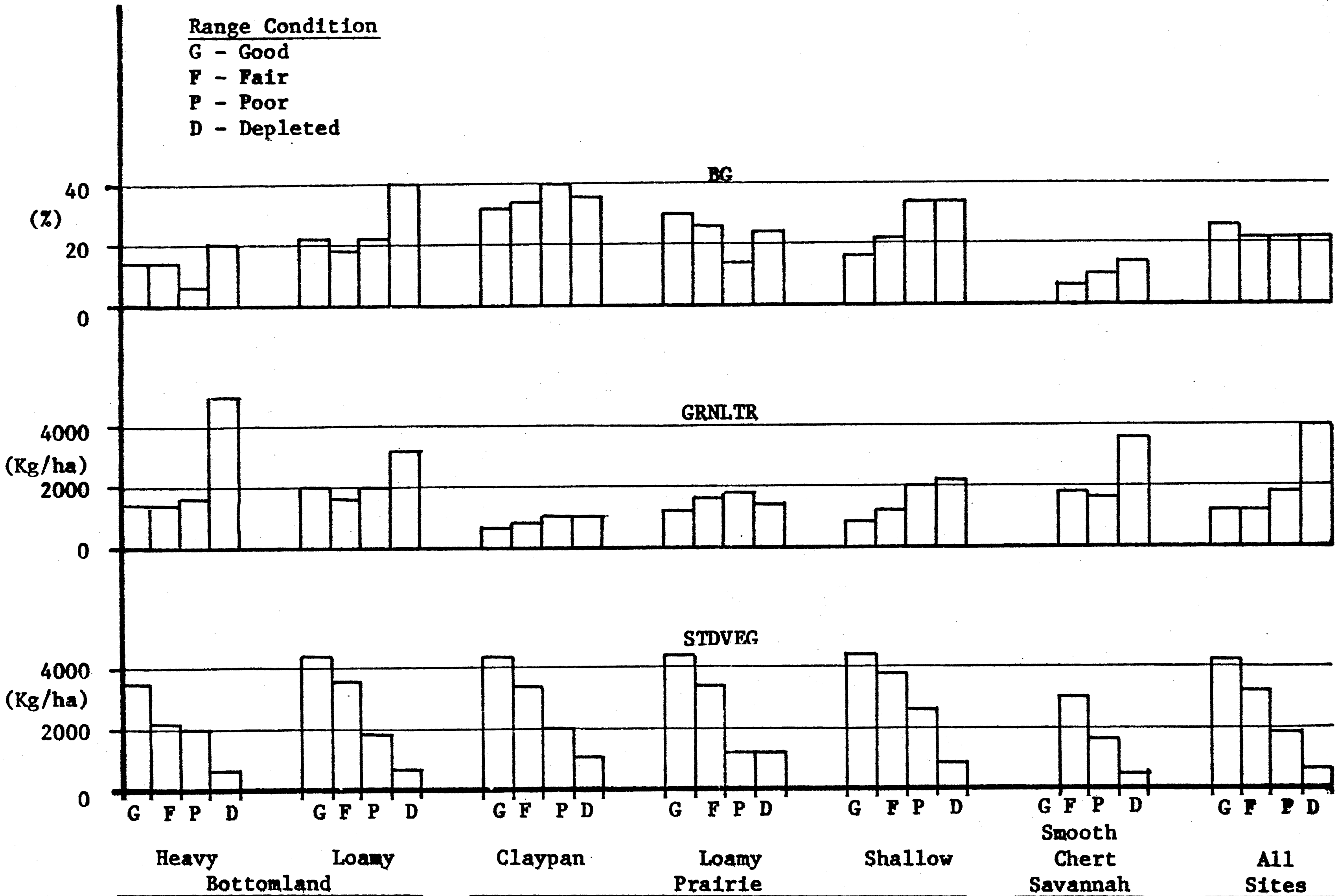


Figure 4. Average native standing vegetation (STDVEG), ground litter (GRNLTR) and bare ground (BG) for range sites and condition on COE Fort Gibson Project grazing allotments, 1978.

None of the Smooth Chert Savannah native vegetation locations were in the good or excellent condition classes. Shallow Savannah locations were only in the poor and depleted conditions and are not represented in Figure 4. Many of the Smooth Chert and Shallow Savannah locations were placed in the lower condition classes because of invasion by woody plants.

In general, the production of native standing vegetation on Prairie sites was similar for each condition class regardless of range site. Claypan Prairie sites in good condition produced 4,380 kg/ha of standing vegetation (Table 2, Appendix D). Herbaceous vegetation is 52% decreasers, such as ANGE, PAVI, SCSC, SONU and LECU (Table 4). Increasers, such as CARX, PAOL and SCAM, comprise 16% of the vegetation. Invader plants, such as AMPS, ANVI and CSAG, comprise the remaining 32%. Sites in depleted condition produced 1,040 kg/ha. Decreasers comprise 29%, increasers 39% and invaders 32% of the herbaceous vegetation (USDA Soil Conservation Service 1970).

Loamy Prairie sites in good condition produced 4,330 kg/ha of standing vegetation. Herbaceous vegetation is 61% decreasers, such as ANGE, PAVI, SCSC, SONU and TRIF (Table 5). Increasers, such as ASAS, CARX, PAOL and PASP, comprise 18% of the vegetation. Invader plants, such as AMPS, ANVI, CSAG, RUHI and WSAG, comprise the remaining 21%. As the site declines to a depleted condition, production of standing vegetation is reduced to 1,180 kg/ha. Herbaceous vegetation is 28% decreasers, 56% increasers and 16% invaders.

Shallow Prairie sites in good condition produced 4,360 kg/ha of standing vegetation. Herbaceous vegetation is 73% decreasers, such as ANGE, PAVI, SCSC and SONU (Table 6). Increasers such as AGRO, CARX,

Table 4. Native herbaceous species class composition (%) by condition class on COE Fort Gibson Project Claypan Prairie range sites, 1978.

Species Class[1/]	Class.[2/]	Condition Good	Fair	Poor	Depleted
ACLA	INV.		0.9	0.3	
AGRO	INC.	0.2	4.4		1.1
AMPS	INV.	1.5	9.9	9.2	4.7
ANGE	DEC.	4.8	1.8		
ANVI	INV.	26.8	20.1	17.2	5.9
ASAS	INC.	0.4	1.3	0.4	
ASTE	INC.		1.9	2.2	0.5
BOSA	INC.		0.2	0.3	
BOUT	INC.			1.6	
CARX	INC.	5.1	3.2	10.4	4.8
CSAG	INV.	1.5	5.5	1.6	0.5
CSPG	DEC.	0.2	0.3	1.5	
CROT	INV.			0.1	
CYDA	INV.			1.6	
DEFB	DEC.	2.2	0.3	1.4	21.5
ERAG	INC.		0.3	0.8	1.9
ERIG	INC.		0.3	0.7	
FEAR	INV.	0.2		1.6	
GUAR	INV.		0.1		2.7
GUDR	INV.			0.3	
HEAM	INV.		0.3	0.8	4.0
HELI	INC.		0.4	2.7	
INFB	INC.		0.4		
IVFB	INV.	0.3	0.7	0.6	4.0
IVCI	INV.				1.9
LECU	DEC.	5.1	7.1	14.1	1.9
LESP	DEC.	0.3	0.8	0.7	0.3
MUHL	INC.			3.2	
PAAN	INC.	0.2			
PAOL	INC.	3.5	2.4	1.7	1.6
PANI	INC.	0.2	0.7	0.7	0.3
PAVI	DEC.	8.2	2.8		
PASP	INC.	2.0	1.1	1.3	10.7
PLAN	INV.		0.3	0.4	0.5
POLY	INV.		0.1		
RUHI	INV.	0.7	2.2	0.3	0.3
RUCR	INV.	0.1	0.1	0.2	
SCSC	DEC.	23.4	8.7	1.0	
SCAM	INC.	3.8	2.5	2.2	
SETA	INV.	0.1	1.2	0.5	0.3
SOLA	INV.	0.7	0.4		
SOLI	INC.			0.7	1.1
SONU	DEC.	3.8	2.3	1.6	
SPOR	INC.	0.6	0.4	3.7	17.3
TRID	INC.		2.1		
TRIF	DEC.	3.5	6.9	3.8	5.1
VERN	INV.	0.9	5.6	1.6	3.0
WSAG	INV.		0.6	7.6	4.3
WSPG	DEC.		0.1		
TOTALS	DEC.	51.5	31.1	24.1	28.8
	INC.	16.0	21.6	32.6	39.3
	INV.	32.8	48.0	43.9	32.1

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader.

Table 5. Native herbaceous species class composition (%) by condition class on COE Fort Gibson Project Loamy Prairie range sites, 1978.

Species Class[1/]	Class.[2/]	Condition Good	Fair	Poor	Depleted
AGRO	INV.	0.5	1.1		
AMPS	INV.	4.6	3.6	2.6	3.4
ANGE	DEC.	2.5			
ANVI	INV.	7.3	7.6	24.7	2.2
ASAS	INC.	1.6		0.2	
ASTE	INC.	0.9	0.9	0.3	3.2
BOSA	INC.		0.7	1.7	
BOUT	INC.				0.3
CARX	INC.	1.8	4.5	12.3	15.0
CSAG	INV.	2.6	7.7	0.6	0.3
CSPG	DEC.		0.5	1.4	
CROT	INV.		0.2	0.7	0.2
CYDA	INV.		2.2	1.9	0.3
DEFB	DEC.	0.4			
ERAG	INC.		0.1	0.8	0.1
ERIG	INC.		0.3		
EUPA	INV.			0.2	
FEAR	INV.	0.3			0.3
GUDR	INV.			0.2	0.5
HEAM	INV.				1.3
HELI	INC.		9.0	4.7	0.9
INFB	INC.	0.9		0.6	0.4
IVFB	INV.	0.3	0.7	0.9	
IVCI	INV.		1.4	1.4	
LECU	DEC.	0.1	27.7	11.8	27.0
LESP	DEC.	0.2		0.2	0.3
MUHL	INC.			4.0	4.2
PAAN	INC.		0.2		19.6
PAOL	INC.	2.5	1.5	2.9	1.0
PANI	INC.		2.3	1.6	
PAVI	DEC.	5.9			
PASP	INC.	8.4	1.1	0.3	0.8
PLAN	INV.		0.3	0.2	
POLY	INV.		0.4	0.3	6.2
RUHI	INV.	1.1	2.4	0.2	0.2
RUCR	INV.	0.2	0.4		
SCSC	DEC.	44.9	4.5	1.6	
SCAM	INC.	0.8	1.4	1.3	
SETA	INV.		0.6	0.2	0.3
SOLA	INV.	0.6	0.6	0.2	
SOLI	INC.				0.1
SONU	DEC.	4.8			0.5
SPOR	INC.	0.3	2.5	5.4	10.8
TRID	INC.		2.3	5.2	
TRIF	DEC.	2.1	4.7		
VERN	INV.	2.0	2.3	5.6	
WSAG	INV.	2.2	4.4	4.2	0.6
WSPG	DEC.	0.4		0.2	
TOTALS	DEC.	61.3	37.4	15.2	27.8
	INC.	17.2	26.5	41.3	56.4
	INV.	21.7	35.9	44.1	15.8

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader.

Table 6. Native herbaceous species class composition (%) by condition class on COE Fort Gibson Project Shallow Prairie range sites, 1978.

Species[1/] Class	Class.[2/]	Condition Good	Fair	Poor	Depleted
ACLA	INV.		1.6	0.5	0.1
AGRO	INC.	2.8		2.8	
AMPS	INV.		1.6	1.3	2.2
ANGE	DEC.	1.5	3.2	0.1	1.9
ANVI	INV.		11.1	10.9	1.8
ASAS	INC.		1.2	0.4	0.6
ASTE	INC.		3.2	6.2	0.3
BOSA	INC.		1.9	2.2	1.5
BOUT	INC.		1.0	5.1	4.8
CARX	INC.	3.7	1.5	3.6	23.5
CSAG	INV.	3.4	5.7	10.0	3.3
CSPG	DEC.		0.2	0.1	2.5
CROT	INV.		0.5	0.1	1.8
CYDA	INV.		2.3	0.5	4.9
DEFB	DEC.		0.2	0.4	
ERIG	INC.		1.0	3.1	1.2
GUDR	INV.				2.1
HEAM	INV.			0.8	0.6
INFB	INC.	0.6			2.4
IVFB	INV.	0.6	2.3	4.1	2.1
LESP	DEC.			0.1	
MUHL	INC.			8.0	7.9
PAAN	INC.				2.5
PAOL	INC.	4.0	13.8	4.7	1.4
PANI	INC.	0.6	0.2	0.1	0.1
PAVI	DEC.	9.2		3.5	3.9
PASP	INC.	7.1	0.9	1.5	1.7
PLAN	INV.	0.3			0.3
POLY	INV.			0.6	0.1
RUHI	INV.	2.2	6.5	1.2	1.4
SCSC	DEC.	44.3	18.5	13.6	6.1
SCAM	INC.		0.2		
SETA	INV.		0.3	3.1	0.1
SOLA	INV.	0.6	1.9	0.6	0.3
SOLI	INC.			1.7	1.0
SONU	DEC.	18.4	4.2	1.2	0.4
SOHA	INV.				
SPOR	INC.		1.2	0.5	1.7
TRID	INC.				2.8
TRIF	DEC.		9.0	5.9	7.9
VERN	INV.		5.3	0.4	2.2
WSAG	INV.	0.6		1.3	0.7
WSPG	DEC.				
TOTALS	DEC.	73.4	35.3	24.9	22.7
	INC.	15.2	26.1	39.9	53.4
	INV.	11.4	38.6	35.2	23.9

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader.

PAOL and PASP, comprise 19% of the vegetation. Invader plants, such as CSAG and RUHI, comprise the remaining 8%. Sites in depleted condition produced 740 kg/ha of standing vegetation. Herbaceous vegetation is 23% decreasers, 53% increasers and 24% invaders.

Heavy Bottomland sites produced less standing vegetation than Loamy Bottomland sites in the good and fair condition classes and about the same amount in the poor and depleted classes. Heavy Bottomland sites in good condition produced 3,520 kg/ha of standing vegetation. Decreaser plants, such as ANGE, PAVI, SCSC and SONU, comprise 35% of the herbaceous vegetation (Table 7). Increaser plants, such as AGRO, CARX, PASP and TRID, comprise 47% of the vegetation. Invader plants, such as AMPS, ANVI and IVFB, comprise the remaining 18%. Under a depleted condition, production of standing vegetation is 570 kg/ha. Herbaceous vegetation is 10% decreasers, 58% increasers and 32% invaders.

Loamy Bottomland sites in good condition produced 4,420 kg/ha of standing vegetation. Herbaceous vegetation is 62% decreaser plants, such as ANGE, CSPG, LECU, SCSC and SONU (Table 8). Increaser plants, such as CARX, PAAN and SCAM comprise 14% of the vegetation. Invader plants, such as AMPS, ANVI, CSAG and CYDA, comprise the remaining 24%. Under a depleted condition, production of standing vegetation is 640 kg/ha. Herbaceous vegetation is 10% decreasers, 47% increasers and 43% invaders.

Smooth Chert Savannah sites in fair condition produced 3,050 kg/ha of standing vegetation. Decreaser plants, such as LESP and TRIF, comprise 4% of herbaceous composition (Table 9). Increaser plants, such as CARX, PAAN, PAOL and TRID, comprise 46% of the vegetation. Invader plants, such as ANVI, RUHI, SETA and WSAG, comprise the remaining 50%.

Table 7. Native herbaceous species class composition (%) by condition class on COE Fort Gibson Project Heavy Bottomland range sites, 1978.

Species[1/] Class	Class.[2/]	Condition			
		Good	Fair	Poor	Depleted
AGRO	INC.	3.2			
AMPS	INV.	5.4	2.3	2.1	
ANGE	DEC.	12.5	4.4		
ANVI	INV.	6.8	23.0	17.2	10.9
ASTE	INC.	0.8	3.5		1.1
CARX	INC.	18.1	10.3	8.6	33.1
CSAG	INV.	1.2	0.8	22.7	6.6
CSPG	DEC.	0.5	0.6	0.8	2.8
CROT	INV.			2.3	0.4
CYDA	INV.		0.6	8.1	1.8
ERAG	INC.		0.2		0.4
ERIG	INC.			1.6	0.4
EUPA	INV.		0.4	0.3	1.6
FEAR	INV.		1.8	1.3	
GUDR	INV.			0.5	
HEAM	INV.			0.1	2.5
HELI	INC.				0.3
INFB	INC.				0.3
IVFB	INV.	4.1	0.3	0.7	
IVCI	INV.		8.9	5.3	0.7
LECU	DEC.	0.4		0.4	5.2
LESP	DEC.	0.3	0.3	4.1	2.0
MUHL	INC.	1.3	3.5		0.4
PAAN	INC.	0.7	3.9	4.0	10.6
PAOL	INC.	0.5	0.3	0.9	6.2
PANI	INC.		1.6	0.3	0.9
PAVI	DEC.	1.4	0.3		
PASP	INC.	19.5	10.9	0.1	0.3
POLY	INV.		1.9		3.3
RUHI	INV.			0.8	0.4
RUCR	INV.			4.4	
SCSC	DEC.	4.5	3.1		
SCAM	INC.	1.9	0.1	0.5	
SETA	INV.		0.4	0.8	1.7
SOLA	INV.	0.1	0.1	0.1	0.2
SOLI	INV.		3.6	0.3	0.3
SONU	DEC.	10.8	4.0		
SOHA	INV.		2.5	6.1	
SPOR	INC.		0.9	3.8	3.6
TRID	INC.	1.3	1.2		0.1
TRIF	DEC.	4.7	1.3		
VERN	INV.		3.0	2.1	
WSAG	INV.		0.2		2.4
TOTALS	DEC.	35.1	14.0	5.3	10.0
	INC.	51.5	36.5	20.2	57.2
	INV.	13.4	49.5	74.5	32.8

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader.

Table 8. Native herbaceous species class composition (%) by condition class on COE Fort Gibson Project Loamy Bottomland range sites, 1978.

Species Class[1/]	Class.[2/]	Good	Fair	Poor	Depleted
		Condition			
AMPS	INV.	7.9	0.9	5.0	4.9
ANGE	DEC.	6.3			
ANVI	INV.	5.3	9.4	0.9	
ASTE	INC.		0.2	12.3	2.4
BOSA	INC.		1.0		
CARX	INC.	3.0	9.7	12.6	26.8
CSAG	INV.	1.6	8.8	7.6	1.0
CSPG	DEC.	5.5	0.1	6.8	1.9
CROT	INV.			0.7	0.3
CYDA	INV.	7.2	2.7	5.1	6.8
ERAG	INC.	1.3			
ERIG	INC.				2.3
EUPA	INV.				1.6
GUAR	INV.		6.4	2.8	
GUDR	INV.		1.0		
HEAM	INV.			2.6	0.9
HELI	INC.		5.3	4.6	
INFB	INC.				2.3
IVFB	INV.		0.6	0.5	4.7
IVCI	INV.		18.5	17.9	
LECU	DEC.	43.3			
LESP	DEC.		0.1	1.5	7.9
MUHL	INC.		2.6	2.2	8.2
PAAN	INC.	3.9	10.7	6.5	
PAOL	INC.	1.1	3.8	0.6	
PANI	INC.	0.8		0.4	0.5
PASP	INC.	0.1	0.1		0.3
PLAN	INV.	0.3			
POLY	INV.		1.6	4.2	3.4
RUHI	INV.		0.6	0.2	
RUCR	INV.		1.0		
SCSC	DEC.	4.0	11.0		
SCAM	INC.	2.8	1.1		
SETA	INV.	1.2	0.4	0.4	
SOLA	INV.	0.2	0.2	0.5	3.2
SOLI	INV.		0.8	0.2	
SONU	DEC.	2.0			
SOHA	INV.				16.6
SPOR	INC.	0.3		1.5	3.7
TRID	INC.	0.1	0.2	0.3	
TRIF	DEC.		0.6		
VERN	INV.	1.2	0.6		
WSAG	INV.	0.7		1.9	0.4
TOTALS	DEC.	61.1	11.8	8.3	9.8
	INC.	13.4	34.7	41.2	46.5
	INV.	25.5	53.3	50.5	43.7

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader..

Table 9. Native herbaceous species class composition (%) by condition class on COE Fort Gibson Project Smooth Chert Savannah range sites, 1978.

Species[1/] Class	Class.[2/]	Condition Fair	Poor	Depleted
ACLA	INV.	1.0	0.6	
AMPS	INV.		1.2	3.6
ANVI	INV.	40.5	26.3	4.6
ASTE	INC.	0.4	0.7	3.4
BOSA	INC.			0.1
COUT	INC.			0.3
CARX	INC.	12.1	3.4	15.0
CSAG	INV.	0.2	8.3	2.2
CSPG	DEC.		0.9	4.8
CROT	INV.		0.8	1.3
CYDA	INV.	0.4	2.5	17.0
DEFB	DEC.		1.7	
ERAG	INC.		1.0	2.0
ERIG	INC.	1.4	0.4	
FEAR	INV.	1.4	1.2	1.3
HEAM	INV.		1.6	0.8
INFB	INC.	6.0	0.5	0.5
IVFB	INV.	0.4	1.0	2.7
IVCI	INV.		0.6	0.3
LECU	DEC.		6.4	3.6
LESP	DEC.	2.5	1.6	1.5
MUHL	INC.		0.5	3.4
PAAN	INC.	5.8	3.3	11.4
PAOL	INC.	17.3	16.2	2.7
PANI	INC.		0.2	0.1
PASP	INC.	0.6	1.1	0.9
PLAN	INV.		0.2	0.3
RUHI	INV.	2.1	1.0	2.4
SETA	INV.	1.9	1.9	0.8
SOLA	INV.		0.4	0.1
SOLI	INC.	0.8	1.1	2.5
SOHA	INV.		2.7	
TRID	INC.	1.0	0.9	1.6
TRIF	DEC.	1.4	0.1	0.1
VERN	INV.		7.9	8.5
WSAG	INV.	2.7	1.9	0.5
TOTALS	DEC.	3.9	10.7	10.0
	INC.	44.4	29.2	43.6
	INV.	51.7	60.1	46.4

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader.

Sites in depleted condition produced 450 kg/ha of standing vegetation. Herbaceous vegetation composition is 10% decreasers, 44% increasers and 46% invaders.

The pattern of increased ground litter with a decline in range condition was consistent on all range sites. The greatest differences in ground litter were between poor and depleted conditions on the Bottomland and Savannah sites. The amount of bare ground on native vegetation locations tended to increase with poorer range condition, except on Loamy Prairie sites. No explanation for the exception is apparent at this time. Greater erosion can be expected on poor and depleted range condition areas because of the reduced ground cover (Heady 1975).

Introduced pasture standing vegetation also demonstrated a definite and consistent decrease in production as pasture condition declined (Figure 5). On Claypan Prairie sites differences in production of standing vegetation range from 5,550 kg/ha in excellent condition to 700 kg/ha in depleted condition (Table 3, Appendix D). Introduced herbaceous plants, such as CYDA, FEAR and SOHA, comprise 63% of vegetation on sites in excellent condition and only 15% on sites in depleted condition (Table 10). Invader plants, such as ANVI, EUPA and HEAM, account for 79% of the vegetation on sites in depleted condition.

Production of standing vegetation on Loamy Prairie sites ranges from 4,570 kg/ha in excellent condition to 870 kg/ha in depleted condition. Introduced plants, such as FEAR and SOHA, comprise 59% of composition on excellent condition sites (Table 11). Sites in depleted condition contain 39% introduced plants, such as CYDA; 23% increaser plants, such as CARX and PAAN and 36% invader plants, such as AMPS and ANVI.

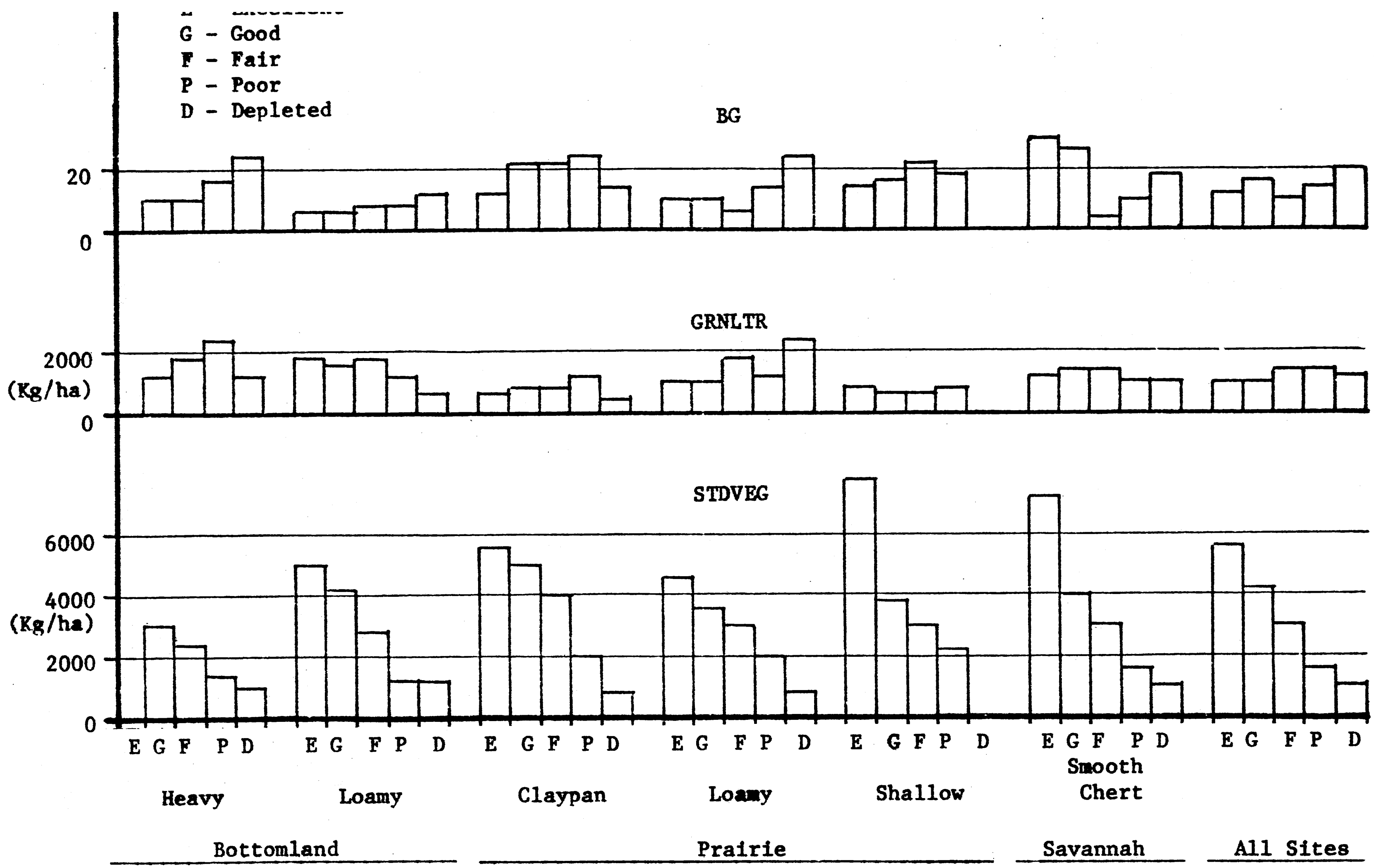


Figure 5. Average introduced pasture standing vegetation (STDVEG), ground litter (GRNLTR) and bare ground (BG) for range sites and condition on COE Fort Gibson Project grazing allotments, 1978.

Table 10. Introduced herbaceous species class composition (%) by condition class on COE Fort Gibson Project Claypan Prairie range sites, 1978.

Species Class[1/]	Class.[2/]	Excellent	Good	Fair	Poor	Depleted
		Condition				
ACLA	INV.		0.1	0.4		
AGRO	INC.	0.2	0.1	0.4	1.1	
AMPS	INV.	1.5	2.1	0.3	2.8	
ANGE	DEC.	0.1	0.2	0.2		
ANVI	INV.	6.4	6.5	6.3	6.3	3.0
ASAS	INC.	1.7	0.4	0.5	1.4	
ASTE	INC.	0.1	8.7	2.4	0.2	
BOSA	INC.	0.1		0.4		
BOUT	INC.	0.4				
CARX	INC.	1.7	1.0	6.2	8.5	5.9
CSAG	INV.	1.0	1.9	8.5	10.8	
CSPG	DEC.	0.1	0.1			
CROT	INV.		0.2	0.2	0.4	
CYDA	INT.	1.1	10.1	13.8	5.7	14.7
DEFB	DEC.	0.3	0.1			
ERAG	INC.		1.0	2.8	0.6	
ERIG	INC.	0.3	0.2			
EUPA	INV.			0.2		20.6
FEAR	INT.	65.8	26.2	12.0	21.3	
GUDR	INV.		0.2	0.1		
HEAM	INV.	0.1	0.2		1.1	55.9
INFB	INC.	0.8		0.7		
IVFB	INV.	0.3	0.3	1.5	0.7	
LECU	DEC.	1.1	27.6	12.5	13.9	
LESP	DEC.	0.3	0.5	0.5	0.9	
PAOL	INC.	0.4	0.8	1.0	2.4	
PANI	INC.	0.1	0.3	0.5	0.3	
PAVI	DEC.	0.9	0.1			
PASP	INC.	0.2	0.1	0.1	0.3	
PLAN	INV.	0.3	0.1		0.3	
POLY	INV.		0.1	0.9		
RUHI	INV.	0.6	1.3	1.0	2.1	
RUCR	INV.		0.1	0.1		
SCSC	DEC.		0.5	0.2	4.3	
SCAM	INC.	1.6	1.8	0.5	0.9	
SETA	INV.	0.1	1.0	1.3	0.3	
SOLA	INV.	0.5	0.3	0.8	0.3	
SOLI	INC.			1.5	0.3	
SONU	DEC.	0.1				
SOHA	INT.	0.1	0.1			
SPOR	INC.	1.5	0.3	0.4	0.5	
TRID	INC.			1.8	0.7	
TRIF	DEC.	9.4	5.1	9.4	10.8	
VERN	INV.	1.2			0.3	
WSAG	INV.		0.8	1.7	9.5	
TOTALS	DEC.	12.3	34.2	22.8	29.9	0.0
	INC.	9.1	14.7	19.2	17.2	5.9
	INV.	11.6	14.7	23.2	34.9	79.4
	INT.	67.0	36.4	34.8	18.0	14.7

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader; INT.-Introduced.

Table 11. Introduced herbaceous species class composition (%) by condition class on COE Fort Gibson Project Loamy Prairie range sites, 1978.

Species[1/] Class	Class.[2/]	Excellent	Good	Fair	Poor	Depleted
		Condition				
ACLA	INV.		1.3			
AMPS	INV.	1.9	3.3	12.0	19.7	3.7
ANGE	DEC.	0.1				
ANVI	INV.	7.1	1.6	1.1	3.0	9.2
ASAS	INC.	1.4				
BOSA	INC.			0.1		
CARX	INC.	1.3	2.0	4.8	3.9	4.3
CSAG	INV.	4.1	3.7	1.7	2.1	
CSPG	DEC.			0.8	0.5	
CROT	INV.	0.2		0.1		
CYDA	INT.		46.9	23.9	18.4	39.3
DEFB	DEC.	0.9	0.3			
ERAG	INC.					1.2
EUPA	INV.			0.3	1.5	
FEAR	INT.	57.8	10.3	2.9	3.8	
GUDR	INV.	0.4	4.0	0.3	0.4	
HEAM	INV.	0.5	2.5	0.7	2.0	8.6
HELI	INC.			2.5	2.2	
IVFB	INV.	0.1	0.1	0.6		
IVCI	INV.			2.9	2.0	5.5
LECU	DEC.		14.7	39.3	35.0	1.9
LESP	DEC.	0.7	0.1	0.1	0.5	0.4
MUHL	INC.			0.5		
PAAN	INC.			0.2	0.2	16.9
PAOL	INC.	0.9		0.4		0.6
PANI	INC.	0.6				
PASP	INC.	0.3		0.2	0.2	
PLAN	INV.		0.3			
POLY	INV.			0.9		
RUHI	INV.	0.3	1.8	0.4	0.3	
RUCR	INV.			0.2		
SCAM	INC.	1.2	0.7	0.2	0.6	
SETA	INV.			0.5	0.6	
SOLA	INV.	0.5	1.2	0.4	0.2	
SOHA	INT.	0.9				
SPOR	INC.				0.7	
TRIF	DEC.	17.1	5.3	1.0	2.2	
VERN	INV.	2.0		0.9		
WSAG	INV.			0.3	0.9	8.5
WSPG	DEC.			0.4		
TOTALS	DEC.	18.8	20.4	41.6	38.2	2.3
	INC.	5.7	2.7	8.9	6.7	23.0
	INV.	16.8	19.7	22.7	32.9	35.4
	INT.	58.7	57.2	26.8	22.2	39.3

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader; INT.-Introduced.

Shallow Prairie sites standing vegetation production ranges from 7,740 kg/ha in excellent condition to 2,270 kg/ha in poor condition. Introduced species comprise 63% of herbaceous vegetation on sites in excellent condition and 36% on poor condition sites (Table 12). Increaser plants comprise 25% and invaders 25% of the vegetation on sites in poor condition.

Heavy Bottomland production of standing vegetation ranges from 3,020 kg/ha on sites in good condition to 1,070 kg/ha on sites in depleted condition. Introduced plants comprise 43% of composition; increasers, such as CARX, PAAN, SOLI and TRIF, comprise 25% and invader plants, such as ANVI, POLY and VERN, comprise 25% of the vegetation on sites in good condition (Table 13).

Loamy Bottomland production of standing vegetation ranges from 5,040 kg/ha on sites in excellent condition to 1,270 kg/ha on sites in depleted condition. Introduced vegetation accounts for 60% on sites in excellent condition and 74% on sites in depleted condition (Table 14). Invaders, such as HEAM, IVCI and ANVI, comprise 35% of the vegetation on sites in excellent condition and 16% on sites in depleted condition.

Production of standing vegetation on Smooth Chert Savannah sites ranges from 7,230 kg/ha in excellent condition to 990 kg/ha in depleted condition. Introduced species comprise 21% and decreasers 56% of herbaceous vegetation on sites in excellent condition (Table 15). On sites in depleted condition introduced plants comprise 41% and invaders 37% of herbaceous vegetation.

Differences in ground litter and ground cover with respect to pasture condition were not as consistent as those for native vegetation. Differences in ground litter production between condition classes were

Table 12. Introduced herbaceous species class composition (%) by condition class on COE Fort Gibson Project Shallow Prairie range sites, 1978.

Species[1/] Class	Class.[2/]	Condition Excellent	Good	Fair	Poor
ACLA	INV.	0.3	0.3	0.4	0.2
AMPS	INV.	9.8	2.1	3.1	1.2
ANGE	DEC.	0.9	0.9	0.6	
ANVI	INV.	2.9	8.9	8.4	0.8
ASAS	INC.	4.5	2.6	1.9	0.2
ASTE	INC.	0.4	0.3	5.9	16.8
BOSA	INC.				1.8
CARX	INC.	1.3	0.7	1.3	0.6
CSAG	INV.	1.4	2.2	2.1	5.4
CSPG	DEC.		0.3	0.4	
CROT	INV.			0.2	2.6
CYDA	INT.	17.9	6.9	22.8	35.5
DEFB	DEC.	0.9	1.9	0.2	
FEAR	INT.	44.5	40.7	25.5	
GUDR	INV.				1.6
HEAM	INV.		0.3	2.7	8.8
HELI	INC.				0.4
INFB	INC.	2.2	0.7	1.1	2.8
IVFB	INV.		0.1		1.2
LECU	DEC.	0.6	0.9		
LESP	DEC.		0.3		
PAOL	INC.	0.2	0.7	1.0	0.4
PANI	INC.		0.3		
PAVI	DEC.	1.7	1.8		
PASP	INC.		0.4		1.6
PLAN	INV.		0.6		
RUHI	INV.		3.5	0.4	2.2
SCAM	INC.	1.4	0.3	0.8	
SOLA	INV.	0.3	0.6	0.8	1.2
SOLI	INC.		2.5		
SONU	DEC.	0.8	1.5	4.8	0.4
SPOR	INC.	1.3	0.3		
TRID	INC.				0.2
TRIF	DEC.	5.7	17.4	14.0	14.0
VERN	INV.	1.1		1.7	
WSAG	INV.		0.5		0.2
TOTALS	DEC.	10.6	25.0	20.0	14.4
	INC.	11.3	8.8	12.0	24.8
	INV.	15.7	18.6	20.0	25.3
	INT.	62.4	47.6	48.0	35.5

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader; INT.-Introduced.

Table 13. Introduced herbaceous species class composition (%) by condition class on COE Fort Gibson Project Heavy Bottomland range sites, 1978.

Species[1/] Class	Class.[2/]	Condition Good	Fair	Poor	Depleted
ACLA	INV.			0.1	
AMPS	INV.		5.8	4.6	16.0
ANVI	INV.	11.2	1.2	2.5	13.0
ASTE	INC.	0.6	0.8	0.5	0.7
BOSA	INC.				1.2
CARX	INC.	11.6	6.5	5.9	3.0
CSAG	INV.		5.5		
CSPG	DEC.		0.2		
CROT	INV.		0.4		
CYDA	INT.	31.8	31.9	29.8	6.3
EUPA	INV.		0.5	0.1	
FEAR	INT.	11.1	9.7	14.7	28.0
HEAM	INV.			0.2	6.3
HELI	INC.		2.1	4.6	
IVFB	INV.			0.6	
IVCI	INV.	10.8	5.8		0.2
LECU	DEC.	3.3	14.6	17.0	3.0
LESP	DEC.	0.3	3.4	4.6	4.6
MUHL	INC.		1.8	10.5	
PAAN	INC.	6.0	3.4	0.3	4.9
PANI	INC.		0.2	0.2	3.5
PASP	INC.	0.8	0.1	0.8	0.7
POLY	INV.	1.2	1.3	0.9	
RUHI	INV.				0.5
RUCR	INV.		1.4		0.7
SCAM	INC.		0.3		
SETA	INV.	2.0	0.5	0.2	0.5
SOLA	INV.		1.0	0.1	
SOLI	INC.	4.7	1.0	0.4	0.5
SPOR	INC.			0.2	
TRID	INC.	1.6		0.5	2.1
TRIF	DEC.			0.4	
VERN	INV.	3.0	0.8		0.7
WSAG	INV.		0.2	0.5	3.9
TOTALS	DEC.	3.6	18.2	22.0	7.6
	INC.	25.3	16.2	23.9	16.6
	INV.	28.2	24.4	9.8	41.8
	INT.	42.9	41.6	44.5	34.3

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader; INT.-Introduced.

Table 14. Introduced herbaceous species class composition (%) by condition class on COE Fort Gibson Project Loamy Bottomland range sites, 1978.

Species Class[1/]	Class.[2/]	Condition Excellent	Good	Fair	Poor	Depleted
AMPS	INV.	11.1	2.7	1.5	4.3	
ANVI	INV.		1.9	1.9	1.5	2.4
ASTE	INC.	1.4		1.5	0.3	
BOSA	INC.			0.1	2.3	
CARX	INC.		4.4	4.1	9.6	1.6
CSAG	INV.		0.6	1.5	0.3	
CROT	INV.		0.2	0.1		
CYDA	INT.	53.2	46.8	49.3	50.0	74.4
DEFB	DEC.					1.6
ERAG	INC.			0.2		1.6
ERIG	INC.	1.5	0.9	0.2		
EUPA	INV.	15.0	7.7	1.8	7.4	1.6
FEAR	INT.			2.2		
GUAR	INV.		0.7	2.0	0.9	
GUDR	INV.				1.9	
HEAM	INV.				1.6	6.4
HELI	INC.	1.1	0.8	2.9	1.4	
INFB	INC.			0.1		
IVFB	INV.	3.7		4.6		
IVCI	INV.	0.9	7.2	6.0	5.9	3.2
LECU	DEC.		1.0	2.0	3.9	1.6
LESP	DEC.		0.7	0.6	2.2	
MUHL	INC.		1.5	0.2		
PAAN	INC.	1.3	3.2	3.8	1.1	3.2
PAOL	INC.		0.1	0.6		
PANI	INC.				0.4	
PASP	INC.			0.5	0.7	
POLY	INV.	2.9	0.8	1.7	0.7	
RUHI	INV.				0.4	
RUCR	INV.		0.2		0.3	
SCAM	INC.			0.4		
SETA	INV.	0.6	0.7	1.3	1.1	
SOLA	INV.	0.4	0.3	0.3	0.1	
SOLI	INC.		3.3			
SOHA	INT.	7.0	8.8	8.4		
SPOR	INC.			0.1	0.3	
TRID	INC.			0.6	1.5	
VERN	INV.		5.2			
WSAG	INV.			0.4	0.3	2.4
TOTALS	DEC.	0.0	1.7	2.6	6.1	3.2
	INC.	5.3	14.2	15.3	17.0	6.4
	INV.	34.5	28.5	22.2	26.9	16.0
	INT.	60.2	55.6	59.9	50.0	74.4

1/ See Appendix E for complete species class names.

2/ **Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader; INT.-Introduced.**

Table 15. Introduced herbaceous species class composition (%) by condition class on COE Fort Gibson Project Smooth Chert Savannah range sites, 1978.

Species Class[1/]	Class.[2/]	Condition: Excellent	Good	Fair	Poor	Depleted
ACLA	INV.	0.2	0.1	0.3		
AMPS	INV.	5.5	2.5	7.1	8.8	4.1
ANVI	INV.	4.4	7.4	3.9	9.4	5.6
ASAS	INC.					0.4
ASTE	INC.	1.1	7.2	0.6	0.6	0.2
BOSA	INC.			0.2	0.8	
CARX	INC.	0.4	1.0	0.8	1.7	2.2
CSAG	INV.	2.1	0.9	0.3	2.2	0.4
CSPG	DEC.				0.8	
CROT	INV.		0.8	1.2	0.7	4.1
CYDA	INT.	20.7	27.9	42.2	39.4	41.1
ERAG	INC.	0.4	1.1	0.1	0.6	5.6
ERIG	INC.			1.7	0.4	
EUPA	INV.			1.4	5.6	6.0
FEAR	INT.		8.4	19.5	3.3	0.2
GUAR	INV.				0.2	
HEAM	INV.			1.3	0.7	5.2
HELI	INC.			0.9	0.5	
INFB	INC.					0.4
IVFB	INV.		0.2	0.8	0.8	
IVCI	INV.			1.4	5.3	1.7
LECU	DEC.	55.6	27.5	1.5	5.3	8.2
LESP	DEC.			0.2	2.2	3.0
MUHL	INC.			0.1		
PAAN	INC.		1.4	9.6	5.6	0.7
PAOL	INC.	2.4	1.4	0.9	0.6	
PANI	INC.	0.2		0.1	0.4	0.2
PASP	INC.		0.3	1.0	0.2	0.9
PLAN	INV.	0.1	0.1			
POLY	INV.	2.5	2.5	0.1		
RUHI	INV.	1.7	2.2	0.6	0.4	3.2
RUCR	INV.	0.5				
SCAM	INC.	1.9	1.6	0.1	0.1	
SETA	INV.			0.4		1.3
SOLA	INV.	0.5		0.6	0.3	1.1
SOLI	INC.			0.3	0.3	
SOHA	INT.			0.1	0.4	
SPOR	INC.			0.6		
TRID	INC.		1.1			
TRIF	DEC.		2.7	0.3	0.4	
VERN	INV.					1.3
WSAG	INV.		1.8	0.4	2.2	2.6
WSPG	DEC.				0.1	0.4
TOTALS	DEC.	55.6	30.2	2.0	8.8	11.6
	INC.	6.4	15.1	16.9	11.8	10.6
	INV.	17.3	18.4	19.3	36.3	36.5
	INT.	20.7	36.3	61.8	43.1	41.3

1/ See Appendix E for complete species class names.

2/ Classification: DEC.-Decreaser; INC.-Increaser; INV.-Invader; INT.-Introduced.

not significant at less than the 20% level on any site. Differences in ground cover due to pasture condition were significant at less than the 10% level on only the Claypan Prairie and Smooth Chert Savannah sites.

CHAPTER V

CONCLUSIONS

The 31 grazing allotments surveyed varied widely in herbage production and ground cover. The average values for standing vegetation and ground cover on a project-wide basis were lower than expected for well-managed land. Standing vegetation was greater and represented a greater proportion of the BIOMASS in pastures than in native vegetation areas.

A consistent decrease in standing vegetation occurred on range and pasture areas on all range sites as condition declined from excellent to depleted, but ground litter, BIOMASS and bare ground were not affected by condition. There were only five locations of native vegetation in excellent condition and no improved pastures on Shallow Savannah range sites.

Native vegetation on Prairie range sites averaged 62% decreaser plants, 18% increaser plants and 20% invader plants in good condition. Under depleted conditions decreasers averaged 26%, increasers 49% and invaders 24%. Bottomland sites averaged 48% decreasers, 30% increasers and 21% invaders in good condition. In depleted condition, sites averaged 10% decreasers, 52% increasers and 37% invader plants.

Tables in Appendix F indicate the key species associated with a particular range site. These key species are classified as decreaser, increaser, invader or introduced. Decreaser key species are the most productive of the perennial grasses and forbs and are the plants most palatable to livestock. The composition of these plants is higher on the excellent and good condition sites. Increaser key species are smaller, less productive and less palatable to livestock; composition is higher on fair condition sites. Invader key species provide a small amount of forage and have little or no value for grazing; composition is higher on poor and depleted condition sites. These species can help the land manager determine the productivity of a site by indicating the relative condition based upon their percent weight.

LITERATURE CITED

Department of the Army Corps of Engineers. 1976. Fort Gibson Lake information guide. Tulsa District Corps of Engineers, Tulsa, Okla.

Gould, F. W. 1968. Grass systematics. McGraw-Hill, Inc., New York. 382 p.

Gray, F. and H. M. Galloway. 1969. Soils of Oklahoma. Okla. Agr. Exp. Sta. Misc. Publ. MP-56. 65 p.

Heady, H. F. 1975. Rangeland management. McGraw-Hill Book Co., New York. 460 p.

Jameson, D. and C. Morris. 1978. Oklahoma land resource areas and ownership. In abstracts of papers presented at the 32nd Annual Meeting of the Society for Range Management, Casper, Wyom. 35 p.

Pechance, J. R. and G. D. Pickford. 1937. A weight estimate method for determination of range and pasture production. Agron. J. 29:894-904.

Powell, J. and J. F. George. 1973. Range vegetation and cattle response to short duration grazing during drought. In Eastern Pasture Res. Sta. Progress Report P-686 (Okla. Agr. Exp. Sta., Stillwater, Okla.). 32-36.

Powell, J. and R. Baker. 1974. Effects of soil differences and grazing on rangeland vegetation production and regrowth. In Eastern Pasture Res. Sta. Progress Report P-705 (Okla. Agr. Exp. Sta., Stillwater, Okla.). 33-36.

Ray, H. C. and M. Lawson. 1955. Site characteristics as a guide to forest and grazing use in the Ozarks. J. Range Manage. 8:69-73.

Soil Conservation Service. 1976. Soil survey of Wagoner County, Oklahoma. U. S. Govt. Printing Office, Wash., D. C. 66 p.

Soil Conservation Service. 1975. Soil survey of Mayes County, Oklahoma. U. S. Govt. Printing Office, Wash., D. C. 92 p.

Soil Conservation Service. 1970. Range condition class-guide: Pryor work unit, key range plants and flexible stocking rates by condition classes. U. S. Govt. Printing Office, Wash., D. C. 11 p.

Waterfall, U. T. 1972. Keys to flora of Oklahoma. Okla. State Univ. Bookstore, Okla. State Univ., Stillwater, Okla. 246 p.

Wilm, H. G., D. E. Costello and G. E. Klipple. 1944. Estimating forage yield by the double-sampling method. Agron. J. 36:194-203.

APPENDIXES

APPENDIX A

GENERALIZED DESCRIPTION OF SOIL SERIES ON FORT GIBSON PROJECT GRAZING ALLOTMENTS, 1978

Table 1. **Generalized description of soil series in study area.**

RANGE SITE Soil Series	Symbol	Family	Subgroup	Order	Depth (cm)	Permea-bility	Avail. Water Capacity
LOAMY PRAIRIE							
Dennis silt loam	DnB	Fine, mixed, thermic	Aquic Paleudolls	Mollisols	152	Slow	High
Summit clay loam	SuB	Fine, montmoril-lonitic, thermic	Vertic Agriudolls	Mollisols	152	Slow	High
CLAYPAN PRAIRIE							
Mayes silty clay loam	Ma	Fine, montmoril-lonitic, thermic	Vertic Agriaquolls	Mollisols	152	Slow	High
Parsons silt loam	PaA	Fine, mixed, thermic	Mollic Albaqualfs	Alfisols	164	Slow	High
SHALLOW PRAIRIE							
Collinsville	CoE	Loamy, siliceous, thermic	Lithic Hapludolls	Mollisols	30	Mod. - rapid	Low
Lenapeh rock out-crop	LrD	Clayey, montroil-lonitic, thermic	Lithic Vertic Argiustoll	Mollisols	50	Slow	Moderate
SMOOTH CHERT SAVANNAH							
Clarksville cherty silt loam	CkD	Loamy-skeletal, siliceous, mesic	Typic Paleudults	Ultisols	152	Mod. - rapid	Moderate
Sallisaw silt loam	SaB	Fine-loamy, sili-ceous, thermic	Typic Paleufalfs	Alfisols	162	Moderate	High
SHALLOW SAVANNAH							
Hector-Enders complex	HeE	Loamy, siliceous, thermic	Lithic Dystrochrepts	Inceptisols	50	Mod. - rapid	Low
Hector	HsF	Loamy, siliceous, thermic	Lithic Dystrochrepts	Inceptisols	50	Mod. - rapid	Low
LOAMY BOTTOMLAND							
Verdigris silty clay loam	Ve	Fine-silty, mixed, thermic	Cumulic Hapludolls	Mollisols	152	Moderate	High
HEAVY BOTTOMLAND							
Quarles silt loam	Qu	Fine, mixed, thermic	Mollic Ochraqualfs	Alfisols	152	Slow	High

APPENDIX B

PLANT SPECIES FOUND ON FORT GIBSON PROJECT

GRAZING ALLOTMENTS, 1978

Code	Scientific Name[1]	Common Name[2]
Forb Species		
ACLA	Achillea lanulosa Nutt.	Western Yarrow
ACRH	Aclypha rhomboidea Raf.	Copperleaf Annual
AGHE	Agalinis heterophylla (Nutt.) Sm.	
ALSA	Allium sativum L.	Garlic
AMPS	Ambrosia psilostachya D.C.	Western Ragweed
AMTA	Amaranthus tamarascinus Nutt.	Pigweed
AMTR	Ambrosia trifida L.	Giant Ragweed
ANNE	Antennaria neglecta Greene	Field Pussytoes
ARLU	Artemisia ludoviciana Nutt.	Louisiana Sageword Spider
ASAS	Asclepias asperula (Dene.) Woodson	Antelope-Horn
ASPI	Aster pilosus Willd.	Aster
ASSA	Aster sagittifolius	Aster
ASVI	Asclepias viridiflora Raf.	Milkweed
BAAU	Baptisia australis (L.) R. Br.	Blue Wild Indigo
BIPO	Bidens polylepis Blake	Coreopsis Beggar-ticks
BRKA	Brassia kaber (D.C.) Wheeler	Charlock
CAAL	Callirhoe alcaeoides (Michx.) Gray	Pale Poppymallow
CABU	Capsella bursa-pastoris (L.) Medic	Shepherds Purse
CAPL	Cacalia plantaginea (Raf.) Shinners	Indian Plantain
CEAM	Centaurea americana Nutt.	Basketflower
CHPI	Chrysopsis pilosa Nutt.	Golder Aster
CIMA	Cicuta maculata L.	Water Hemlock
CITE	Cirsium texanum Buckley	Thistle
COCA	Conyza canadensis (L.) Crong.	Horseweed
COGR	Coreopsis grandiflora Hogg.	Big Flower Coreopsis
CRCA	Croton capitatus Michx.	Wooly Croton
CRMO	Croton monanthogynus Michx.	Oneseed Croton
DECA	Delphinium carolinianum Walt.	Larkspur
DEHU	Desmodium hudiflorum (L.) D.C.	Tickclover
DEIL	Desmanthus illinoensis Michx.	Illinois Bundle-flower
ERTE	Erigeron tenuis T&G	Fleabane
ERYU	Eryngium yuccifolium Michx.	Buttonsnakeroot Eryngo
EUCO	Eupatorium colestinum L.	Boneset
EUPE	Eupatorium perfoliatum L.	Boneset
GECA	Geranium carolinium L.	Carolina Geranium
GUDR	Gutierrezia dracunculoides (D.C.) Blake	Annual Broomweed
HEAM	Helenium amarum (Raf.) Rock	Sneezeweed
HEIN	Heliotropium indicum (L.)	Helitrope
HELA	Heterotheca latifolia Buckl.	Camphorweed
HEMO	Helianthus mollis Lam.	Hairy Sunflower
HYTE	Hymenopappus tenuifolias Pursh.	Slim Leaf Hymenopappus
IVCI	Iva ciliata Willd.	Sumpweed
LECU	Lespedeza cuneata (Dumont) G. Don	Sericea Lespedeza
LEST	Lespedeza stuevei Nutt.	Stuves Lespedeza

Code	Scientific Name	Common Name
LEVI	Lespedeza violacea (L.) Pers.	Violet Lespedeza
LEVI	Lepidium virginicum L.	Virginia Peppergrass
LIAS	Liatris aspera Michx.	Handsome Blazingstar
LIPY	Liatris pynostachya Michx.	Tall Gayfeather
MEAL	Melilotus alba Desr.	White Sweetclover
MEOF	Melilotus officinalis (L.) Lam.	Yellow Sweetclover
MOFI	Monarda fistulosa L.	Wild Bergamont
OEBI	Oenothera biennis L.	Common Evening Primrose
OELI	Oenothera linifolia Nutt.	Narrowleaf Evening Primrose
OXCO	Oxalis corniculata L.	Horned Oxalis
PHAN	Physotegia angustifolia Furn.	Pink Lion's Heart
PHHI	Phacelia hirsuta Nutt.	Scorpion Weed
PHPI	Phlox pilosa L.	Prairie Phlox
PLAR	Plantago aristata Michx.	Bottle Brush Plantain
PLVI	Plantago virginica L.	Paleseed Plantain
PONU	Polytaenia nuttallii D.C.	Prairie Parsley
POPE	Polygonum pensylvanicum L.	Pennsylvania Smartweed
POSA	Polygala sagnuinea L.	Blood Polygala
PSTE	Psorela tenuiflora Pursh.	Manyflower Scurfpea
PTNU	Ptilimnium nuttalli (D.C.) Britt.	Mock Bishop Weed
RUAM	Rudbeckia amplexicaulis Vahl.	Clasping-Leaved Coneflower
RUCR	Rumex crispus L.	Curled Dock
RUGE	Rudbeckia grandiflora (Sweet.) D.C.	Large-Flowered Coneflower
RUHI	Rudbeckia hirta L.	Black-Eyed Susan
SACA	Sabatia campestre Nutt.	Prairie Rose Gentian
SCUN	Schrankia uncinata Willd.	Catsclaw Sensitivebriar
SEOB	Senecio obvatus Muhl.	Ragwort
SEPU	Sedum pulchellum Michx.	Stonecrop
SIAN	Sisyrinchium angustifolium Mill.	Common Blue-Eyed Grass
SOCA	Solanum carolinense L.	Carolina Horsenettle
SODE	Solidago delicatula Small.	Goldenrod
SOMI	Solidago missouriensis Nutt.	Missouri Goldenrod
SPPE	Specularia perfolia (L.) A.D.C.	Venus-Looking-Glass
STLE	Strophostyles leiosperma (T.&G.) Piper	
TRCA	Trifolium campestre Schreb.	Large Hop Clover
TROH	Tradescantia ohioensis Raf.	Spiderwort
TRPR	Trifolium pratense L.	Red Clover
VABI	Verbena bipinnatifida Nutt.	Wild Verbena
VARA	Valerianella radiata (L.) Dufr.	Cornsalad
VEBA	Vernonia baldwinii Torr.	Ironweed
VESI	Verbena simplex Lehm.	Narrowleaf Verbena
VIAN	Vicia angustifolia Riechard	Narrowleaved Vetch

Code	Scientific Name	Common Name
Grass Species		
AGHY	Agrostis hyemalis (Walt.) B.S.P.	Winter Bentgrass
ANGE	Andropogon gerardii Vitmon	Big Bluestem
ANVI	Andropogon virginicus L.	Broomsedge
ARDI	Aristida dichotoma Michx.	Churchmouse Three-awn
AROL	Aristida oligantha Michx.	Annual Three-awn
BOSA	Bothriochloa saccharoides Sw.	Silver Bluestem
BRER	Brachyelytrum erectum (Schreb.) Beauv.	
BRMO	Bromus mollis L.	Soft Chess
BRTE	Bromus tectorum L.	Downy Chess
BRUN	Bromus unioloides H.B.K.	Rescue Grass
CAAM	Carex amphibola Stend.	Narrowleaf Sedge
CABI	Carex bicknellii Britt.	Bicknell Sedge
CADA	Carex davisii Schw. & Torr.	Davis Sedge
CHLA	Chasmanthium latifolia Michx.	Broadleaf Uniola
CHVE	Chloris verticillata Nutt.	Windmill Grass
CIAR	Cinna arundinacea L.	Woodreed
CYDA	Cynodon dactylon (L.) Pers.	Bermudagrass
CYOV	Cyperus ovularis (Michx.) Torr.	Globe Flatsedge
DISA	Digitaria sanguinalis (L.) Scop.	Crabgrass
ECCR	Echinochloa crusgalli (L.)	Barnyardgrass
ELCA	Elymus canadensis L.	Canada Wild Rye
ELVI	Elymus virginicus L.	Virginia Wild Rye
ERCU	Eragrostis curtipedicellata Buckl.	Gummy Lovegrass
ERIN	Eragrostis intermedia Hitchc.	Plains Lovegrass
ERSP	Eragrostis spectabilis (Pursh.) Stend.	Purple Lovegrass
FEAR	Festuca arundinacea Schreb.	Tall Fescue
FEPA	Festuca paradoxa Desv.	Cluster Festuca
HOPU	Hordeum pussillum Nutt.	Little Barley
LEVI	Leersia virginica Willd.	Whitegrass
MACY	Manisuris cylindrica (Michx.) Kuntze	Carolina Jointail
MUFR	Muhlenbergia frondosa (Poir.) Fern.	Wirestem
MUSC	Muhlenbergia schreberi J.F. Gmel.	Nimblewill
MUSO	Muhlenbergia soblifera (Muhl.) Trin.	Rocky Muhly
PAAN	Panicum anceps Michx.	Beaked Panicum
PACA	Panicum capillarc L.	Witchgrass
PADI	Panicum dichotomiflorum Michx.	Fall Panicum
PAFL	Paspalum floridanum Michx.	Florida Paspalum
PAHI	Panicum hians EEL.	Gaping Panicum
PALA	Panicum lanuginosum EEL.	Panicgrass
PAMA	Panicum malacophyllum Nash	Softleaf Panicum
PAOL	Panicum oligosanthes Schult.	Scribners Panicum
PAPU	Paspalum pubiflorum Rupr.	Hairyseed
PAVI	Panicum virgatum L.	Switchgrass
POPR	Poa pratense L.	Kentucky Bluegrass
POSY	Poa sylvestris L.	Roughstalk Bluegrass

Code	Scientific Name	Common Name
SCAM	Scirpus americana Pers.	Americana Bulrush
SCLI	Scirpus lineatus Michx.	Rusty Bulrush
SCSC	Schizachyrium scoparium Sw.	Little Bluestem
SCPA	Schedonnardus paniculatus Nutt. Trel.	Tumblegrass
SELU	Setaria lutescens (Wiegel) F.T. Hubb	Yellow Foxtail
SOHA	Sorghum halepense (L.) Pers.	Johnson Grass
SONU	Sorghastrum nutans (L.) Nash	Indiangrass
SPAS	Sporobolus asper (Michx.) Kunth	Tall Dropseed
SPCR	Sporobolus cryptandrrus (Torr.) Gray	Sand Dropseed
SPVI	Sporobolus vaginiflorus (Torr.) Wood	Poverty Dropseed
TRDA	Tripsacum dactyloides (L.) L.	Eastern Gamagrass
TRFL	Tridens flavus (L.) Hitchc.	Purpletop
Woody Species		
ACNE	Acer negundo L.	Boxelder
ACRU	Acer rubrum L.	Red Maple
ACSA	Acer saccharum Marsh.	Sugar Maple
ACSC	Acer saccharinum L.	Silver Maple
AME	Amelanchier spp.	Serviceberry
AMFR	Amorpha fruticosa L.	Indigo Bush
BULA	Bumelia lanuginosa (Michx.) Pers.	Chittamwood
CACO	Carya cordiformis (Wang.) K. Koch	Bitternut Hickory
CAIL	Carya illinoensis (Wang.) K. Koch	Pecan
CALA	Carya laciniosa (Michx. f.) Laud.	Shellbark Hickory
CARA	Campsis radicans (L.) Seem.	Trumpet Creeper
CATE	Carya texana Buckl. (C. Buckleyi Durand)	Black Hickory
CATO	Carya tomentosa (Poir.) Nutt.	Mockernut Hickory
CECA	Cercis canadensis L.	Eastern Redbud
CELA	Celtis laevigata Willd.	Sugarberry
CEOC	Celtis occidentalis Pursh.	Hackberry
COFL	Cornus florida L.	Flowering Dogwood
CPOC	Cephalanthus occidentalis L.	Common Buttonbush
CRMA	Crataegus mackenzii Sarg.	Hawthorn
DIVI	Diospyros virginia L.	Persimmon
FRAM	Fraxinus americana L.	White Ash
FRPE	Fraxinus pennsylvanica Marsh.	Green Ash
GLTR	Gleditisa triacanthos L.	Honey Locust
GYDI	Gymocladus dioica (L.) K. Koch	Kentucky Coffeetree
ILDE	Ilex decidua Walt.	Possomhaw
JUNI	Juglans nigra L.	Walnut
JUVI	Juniperus virginiana L.	Eastern Red Cedar
LOJA	Lonicera japonica Thunb.	Honeysuckle
MAPO	Maclura pomifera (Raf.) Schn.	Osage Orange
MORU	Morus rubra L.	Red Mulberry
PAQU	Parthenocissus quinquefolia	Tree Quinquefole
PLOC	Platanus occidentalis L.	Sycamore

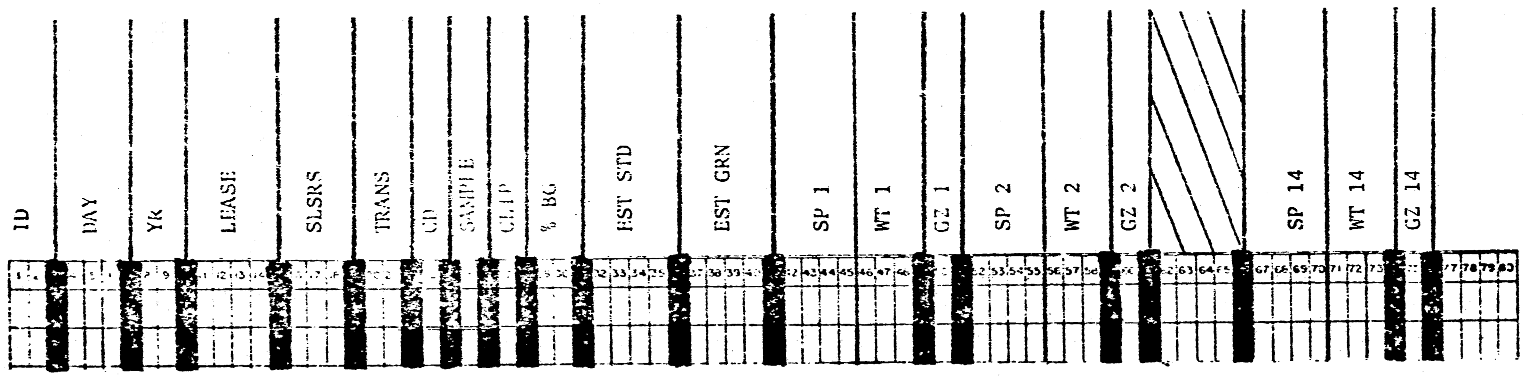
Code	Scientific Name	Common Name
PODE	Populus deltoides Marsh.	Cottonwood
PRVI	Prunus virginiana L.	Chokecherry
QUBI	Quercus bicolor Willd.	Swamp White Oak
QUMA	Quercus marilandica Muenschh.	Blackjack Oak
QUMC	Quercus macrocarpa Michx.	Pin Oak
QUME	Quercus muehlenbergii Engelm.	Chickapin Oak
QUSH	Quercus shumardii Buckl.	Shumard Oak
QUST	Quereus stellata Wang.	Post Oak
QUVE	Quercus velutina Lam.	Black Oak
QUNI	Quercus nigra L.	Water Oak
QUPA	Quercus palustris Muenchh.	Pin Oak
RHAR	Rhus aromatica Ait.	Skunkbrush
RHCO	Rhus copallina L.	Winged Sumac
RHRA	Rhus radicians L.	Poison Ivy
RHTO	Rhus toxicodendron L.	Poison Oak
ROPE	Robinia pseudo-acacia L.	Black Locust
ROSE	Rosa setigera Michx.	Prairie Rose
RUTR	Rubus trivialis Michx.	Blackberry
SAAL	Sassafras albidum (Nutt.) Nees	Sassafras
SAIN	Salix interior Rowlee	Sandbar Willow
SANI	Salix nigra Marsh	Black Willow
SMBO	Smilax bona-nox L.	Greenbriar
SMHE	Smilax herbacea L.	Greenbriar
SYOR	Symphoricarpos orbiculatus Moench	Buckbrush
ULAL	Ulmus alata Michx.	Winged Elm
ULAM	Ulmus americana L.	American Elm
ULRU	Ulmus rubra Muhl.	Slippery Elm
VIRU	Viburnum rufidulum Schultes	Possomhaw
VIVU	Vitis vulpina L.	Grape
ZAAM	Aanthoxylum americanum Mill.	Prickly-Ash

1 Scientific names from Waterfall, U. T. 1972. Keys to the flora of Oklahoma. Okla. State Univ. Student Union Bookstore, Okla. State Univ., Stillwater, Okla. 246 pp.; and Gould, F. W. 1968. Grass systematics. McGraw-Hill, Inc., New York. 382 pp.

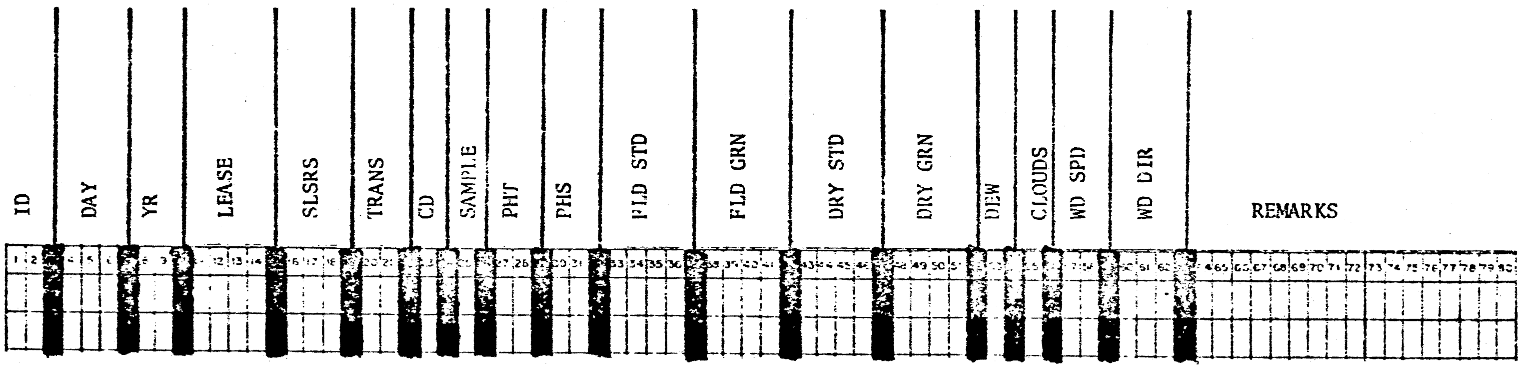
2 Common names from Barkley, T. M. 1968. A manual of the flowering plants of Kansas. Kansas State Univ. Endowment Assoc., Manhattan, Kansas. 402 pp.; and Anderson, K. L., and C. E. Owensby. 1969. Common names of a selected list of plants. Kansas Agr. Exp. Sta. Tech. Bull. 117. 61 pp.

APPENDIX C

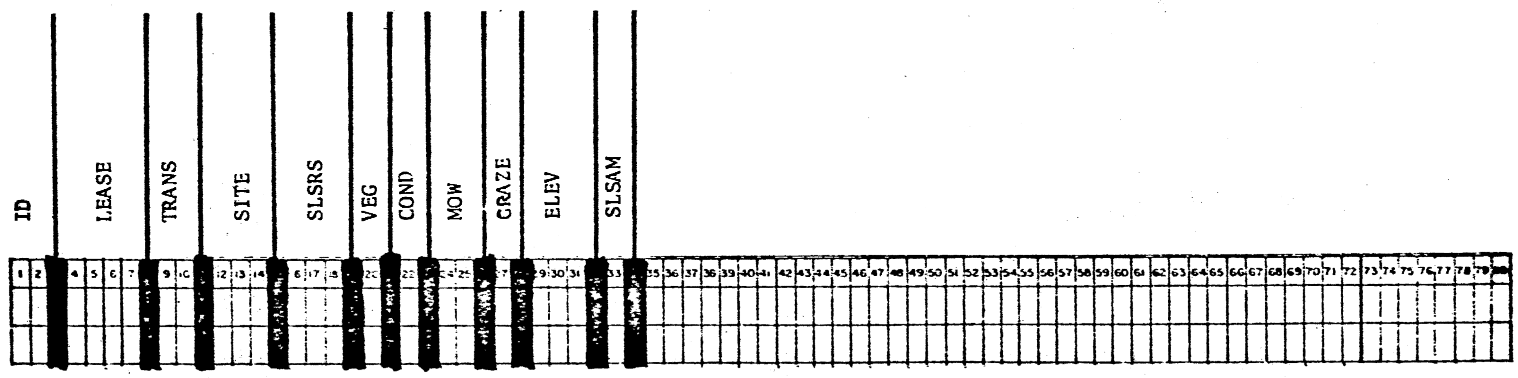
DATA SHEET, INPUT STATEMENT AND PROCEDURE STATEMENTS FOR ANALYSIS OF HERBAGE PRODUCTION AND GROUND COVER ON FORT GIBSON PROJECT GRAZING ALLOTMENTS, 1978



ID = RECORDER
DAY = DAY OF STUDY YEAR
YR = YEAR OF STUDY
LEASE = ALLOTMENT NUMBER
SLSRS = SOIL TYPE
TRANS = TRANSECT NUMBER
CD = CARD NUMBER
SAMPLE = QUADRAT NUMBER OF TRANSECT
CLIP = CLIP OR ESTIMATE QUADRAT
% BG = PRECENTAGE OF BARE GROUND
EST STD = ESTIMATE OF STANDING VEGETATION
EST GRN = ESTIMATE OF GROUND LITTER
SP1 - SP14 = HERBACEOUS SPECIES
WT1 - WT14 = HERBACEOUS SPECIES ESTIMATED WEIGHT
GZ1 - GZ14 = HERBACEOUS SPECIES GRAZED



ID = RECORDER
DAY = DAY OF STUDY YEAR
YR = YEAR OF STUDY
LEASE = ALLOTMENT NUMBER
SLSRS = SOIL TYPE
TRANS = TRANSECT NUMBER
CD = CARD NUMBER
SAMPLE = QUADRAT NUMBER OF TRANSECT
PHT = PHOTO NUMBER OF TRANSECT
PHS = PHOTO NUMBER OF SAMPLED QUADRAT
FLD STD = FIELD WEIGHT OF STANDING VEGETATION
FLD GRN = FIELD WEIGHT OF GROUND LITTER
DRY STD = AIR-DRY WEIGHT OF STANDING VEGETATION
DRY GRN = AIR-DRY WEIGHT OF GROUND LITTER
DEW = NUMERICAL RATING FOR AMOUNT OF DEW PRESENT
CLOUDS = NUMERICAL RATING FOR AMOUNT OF CLOUDS PRESENT
WD SPD = WIND SPEED
WD DIR = WIND DIRECTION



ID = RECORDER
LEASE = ALLOTMENT NUMBER
TRANS = TRANSECT NUMBER
SITE = RANGE SITE
SLSRS = SOIL TYPE
VEG = ORIGIN OF VEGETATION
COND = CONDITION OF VEGETATION
MOW = VEGETATION MOW FOR HAY
GRAZE = VEGETATION GRAZED OR DEFERRED
ELEV = ELEVATION OF TRANSECT
SLSAM = SOIL SAMPLED FOR CHEMICAL ANALYSIS

S T A T I S T I C A L   A N A L Y S I S   S Y S T E M

```
TITLE 'FORT GIBSON'
DATA HERBS.  ALL;
INPUT ID $1-2 DAY 4-6 YR 7-8 LEASE $11-14 SLSRS $16-18 TRANS 20-21 CD
   23
SAMPLE 25 CLIP $27 BG 29-30 ESTSTD 32-35 ESTGRN 37-40 SPI $42-45 WT1
   46-48
GZ1 50 SP2 $52-55 WT2 56-58 GZ2 60 SP3 $62-65 WT3 66-68 GZ3 70 SP4
   $72-75
WT4 76-78 GZ4 80 #2 ID $1-2 DAY 4-6 YR 7-8 LEASE $11-14 SLSRS $16-18
   TRANS 20-21
CD 23 SAMPLE 25 SP5 $27-30 WT5 31-33 GZ5 35 SP6 $37-40 WT6 41-43 GZ6 45
SP7 $47-50
WT7 51-53 GZ7 55 SP8 $57-60 WT8 61-63 GZ8 65 SP9 $67-70 WT9 71-73 GZ9
   75
#3 ID $1-2 DAY 4-6 YR 8-9 LEASE $11-14 SLSRS $16-18 TRANS 20-21 CD 23
   SAMPLE 25
SP10 $27-30 WT10 31-33 GZ10 35 SP11 $37-40 WT11 41-43 GZ11 45 SP12 $47-
   50
WT12 51-53 GZ12 55 SP13 $57-60 WT13 61-63 GZ13 65 SP14 $67-70 WT14 71-
   73
GZ14 75;
CARDS;
DATA FLDWT.  ALL;
INPUT ID $1-2 DAY 4-6 YR 8-9 LEASE $11-14 SLSRS $16-18 TRANS 20-21 CD
   23 SAMPLE 25 PHT 27-28 PHS 30-31 FLDSTD 33-36 FLDGRN 38-41 DRYSTD
   43-46 DRYGRN 48-51 DEW 53 CLOUDS 55 WDSPD 57-58 WDDIR 60-62 REMARKS
   $64-80;
CLIP = 'C';
STDDM=0;
GRNDM=0;
IF FLDSTD-=0 THEN STDDM = DRYSTD / FLDSTD;
IF FLDRTN-=0 THEN GRNDM = DRYGRN / FLDGRN;
CARDS;
PROC SORT DATA = COE456; BY LEASE SLSRS TRANS CLIP SAMPLE;
PROC SORT DATA = COE7; BY LEASE SLSRS TRANS CLIP SAMPLE;
PROC SORT DATA = COE8; BY LEASE SLSRS TRANS CLIP SAMPLE;
DATA COE4567; MERGE COE7 COE 456; BY LEASE SLSRS TRANS CLIP SAMPLE;
DATA COE45678; MERGE COE8 COE4567; BY LEASE SLSRS TRANS CLIP SAMPLE;
DATA COEC; SET COE45678; IF CLIP - 'C';
MFS = 0;
MFG = 0;
IF ESTSTD-=0 THEN MFS = (DRYSTD / ESTSTD) * 20;
IF ESTGRN-=0 THEN MFG = (DRYGRN / ESTGRN) * 20;
IF ESTSTD-=0 THEN ESTDFTR = FLDSTD / ESTSTD;
IF ESTGRN-=0 THEN EGRNFTR = FLDGRN / ESTGRN;
DROP ESTSTD ESTGRN;
ODSTDDM = 0;
ODGRNDM = 0;
ODAIRST = 0;
ODAIRGN = 0;
IF FLDSTD-=0 THEN ODSTDDM = OVDRYSTV / FLDSTD;
```

```
IF FLDSTD-=0 THEN ODGRNDM = OVDRYGND / FLDGRN;
IF DRYSTD-=0 THEN ODAIRST = OVDRYSTV / DRYSTD;
IF DRYSTD-=0 THEN ODAIRGN = OVDRYGND / DRYGRN;
PROC MEANS DATA = COE456 NOPRINT; BY LEASE SLSRS TRANS;
VAR ESTSTD ESTGRN;
OUTPUT OUT = COE456X MEAN = ESTSTD ESTGRN;
PROC SORT DATA = COEC; BY LEASE SLSRS TRANS;
DATA COECEST; MERGE COEC COE456X; BY LEASE SLSRS TRANS;
STDVEG = ESTSTD * MFS;
GRNLTR = ESTGRN * MFG;
   BIOMASS = STDVEG + GRNLTR;
IF SLSRS = 'MA' OR SLSRS = 'PAA' THEN SITE = 'CLAYPAN';
IF SLSRS = 'DNB' OR SLSRS = 'SUB' THEN SITE = 'LOAMYPR';
IF SLSRS = 'COE' OR SLSRS = 'LRD' THEN SITE = 'SHALLPR';
IF SLSRS = 'SAB' OR SLSRS = 'CKD' THEN SITE = 'SMCHESA';
IF SLSRS = 'HEE' OR SLSRS = 'HSF' THEN SITE = 'SHALLSA';
IF SLSRS = 'VE'                   THEN SITE = 'LOAMYBT';
IF SLSRS = 'QU'                   THEN SITE = 'HEAVYBT';
DATA COECLASS;
INPUT ID $ 1-2 LEASE $ 4-7 TRANS 9-10 SITE $ 12-14 SLSRS $ 16-18 VEG
   $ 20 COND 22 MOW $ 24-25 GRAZE $ 27 ELEV 29-31 SLSAM $33;
IF SITE = 'LPR' OR SITE = 'CPR' OR SITE = 'SPR' THEN VEGTYPE =
   'PRAIRIE';
IF SITE = 'SCS' OR SITE = 'SSA' THEN VEGTYPE = 'SAVANNAH';
IF SITE = 'LBT' OR SITE = 'HBT' THEN VEGTYPE = 'BOTTOMLD';
CARDS;
PROC SORT DATA=COECEST; BY LEASE TRANS;
PROC SORT DATA=COECLASS; BY LEASE TRANS;
DATA COND.ALL; MERGE COECLASS COECEST; BY LEASE TRANS;

DATA PCWT; SET HGZPC.ALL;
IF VEG = 'I';
IF VEG = 'N';
PROC SORT DATA = PCWT  OUT = SCOND; BY SITE COND PS;
PROC MEANS DATA = SCOND  NOPRINT; BY SITE COND;          VAR WT;
OUTPUT OUT = TTLSCOND SUM = TOTALWT;
PROC MEANS DATA = SCOND  NOPRINT; BY SITE COND PS;       VAR WT;
OUTPUT OUT = XSCONDSP SUM = SUMWT MEAN = XSPWT;
DATA SCONDSP ; MERGE TTLSCOND XSCONDSP; BY SITE COND;
PCWT = 0;
IF TOTAL WT -= 0 THEN PCWT = SUMST/TOTALWT * 100;
IF COND = 5 THEN EWT = PCWT;
IF COND = 4 THEN GWT = PCWT;
IF COND = 3 THEN FWT = PCWT;
IF COND = 2 THEN PWT = PCWT;
IF COND = 1 THEN DWT = PCWT;
PROC SORT DATA = SCONDSP OUT = SPSCOND; BY SITE PS;
PROC MEANS DATA = SPSCOND NOPRINT ; BY SITE PS;
VAR EWT GWT FWT PWT DWT;
OUTPUT OUT = SPSCONDX MEAN = DWT GWT FWT PWT DWT;
DATA SPSCOND; SET SPSCONDX;
EXCELLEN = (CEIL(EWT*100))/100;
GOOD     = (CEIL(GWT*100))/100;
```

```
FAIR     = (CEIL(FWT*100))/100;
POOR     = (CEIL(PWT*100))/100;
DEPLETED = (CEIL(DWT*100))/100;
PROC PRINT PAGE=1 DATA = SPSCOND; BY SITE; ID PS;
VAR EXCELLEN GOOD FAIR POOR DEPLETED;
TITLE SPP. COMP. BY INTRO. VEGT. SITE AND CONDITION;
```

THE GENERAL LINEAR MODELS PROCEDURE (statistical tests of data derived from the above procedures)

```
PROC SORT DATA=COND OUT = CONDVSS; BY VEGTYPE SITE SLSRS;
PROC MEANS DATA=CONDVSS; BY VEGTYPE;
VAR STDVEG GRNLTR BIOMASS BG;
PROC GLM DATA=CONDVSS; CLASS VEGTYPE; MODEL STDVEG GRNLTR BIOMASS BG
   = VEGTYPE;
MANOVA H=VEGTYPE / PRINTE;
PROC MEANS DATA = CONDVSS; BY VEGTYPE SITE;
VAR STDVEG GRNLTR BIOMASS BG;
PROC GLM DATA = CONDVSS; BY VEGTYPE; CLASS SITE;
MODEL STDVEG GRNLTR BIOMASS BG = SITE;
PROC MEANS DATA = CONDVSS; BY VEGTYPE SITE SLSRS;
VAR STDVEG GRNLTR BIOMASS BG;
PROC GLM DATA = CONDVSS; BY VEGTYPE SITE; CLASS SLSRS;
MODEL STDVEG GRNLTR BIOMASS BG = SLSRS;

PROC SORT DATA = COND OUT= CONDVL; BY VEG LEASE;
PROC MEANS DTAT = CONDVL; BY VEG LEASE;
VAR STDVEG GRNLTR BIOMASS BG;
PROC GLM DATA = CONDVL; BY VEG; CLASS LEASE;
MODEL STDVEG GRNLTR BIOMASS BG = LEASE;
PROC MEANS DATA = CONDVL; BY VEG;
VAR STDVEG GRNLTR BIOMASS BG;

PROC SORT DATA = COND OUT= CONDVSC; BY VEG SITE COND;
PROC MEANS DATA = CONDVSC; BY VEG;
VAR STDVEG GRNLTR BIOMASS BG;
PROC GLM DATA = CONDVSC; CLASS VEG;
MODEL STDVEG GRNLTR BIOMASS BG = VEG;
PROC MEANS DATA = CONDVSC; BY VEG SITE;
VAR STDVEG GRNLTR BIOMASS BG;
PROC GLM DATA = CONDVSC; BY VEG; CLASS SITE;
MODEL STDVEG GRNLTR BIOMASS BG = SITE;
PROC MEANS DATA = CONDVSC; BY VEG SITE COND;
VAR STDVEG GRNLTR BIOMASS BG;
PROC GLM DATA = CONDVSC; BY VEG SITE; CLASS COND;
MODEL STDVEG GRNLTR BIOMASS BG = COND;
PROC SORT DATA = COND OUT = CONDCOND; BY COND;
PROC MEANS DATA = CONDCOND; BY COND;
VAR STDVEG GRNLTR BIOMASS BG;
PROC GLM DATA = CONDCOND; CLASS COND;
MODEL STDVEG GRNLTR BIOMASS BG = COND;
TITLE MEANS AND GLM FOR CONDITION AVERAGED OVER VEG, SITE ETC.;
```

THE DUNCANS PROCEDURE (statistical tests of data derived from the above procedures)

```
PROC SORT DATA=COND OUT = CONDVSS; BY VEGTYPE SITE SLSRS;
PROC DUNCAN DATA = CONDVSS ALPHA=.1; CLASSES VEGTYPE;
VAR STDVEG GRNLTR BG;
DF 589 589 589;
MS 3391066 4975649 412;
TITLE DUNCANS FOR PRODUCTION AND COVER BY VEGTYPE;
DATA CONDPRA; SET CONDVSS; IF VEGTYPE='PRAIRIE';
PROC DUNCAN DATA = CONDPRA ALPHA=.1; CLASSES SITE;
VAR STDVEG GRNLTR BG;
DF 259 259 259;
MS 4074878 1384422 373;
TITLE DUNCANS FOR PRODUCTION AND COVER BY VEGTYPE PRAIRIE;

PROC SORT DATA = COND OUT= CONDVL; BY VEG LEASE;
DATA CONDIN; SET CONDVL; IF VEG = 'I';
PROC DUNCAN DATA = CONDIN ALPHA=.1; CLASSES LEASE;
VAR STDVEG GRNLTR BIOMASS BG;
DF 249 249 249 249;
MS 1727519 1383273 3282417 142;
TITLE DUNCANS FOR PRODUCTION AND COVER OF INTRODUCED VEGETATION BY
   LEASES;
DATA CONDNA; SET CONDVL; IF VEG = 'N';
PROC DUNCAN DATA = CONDNA ALPHA=.1; CLASSES LEASE;
VAR STDVEG GRNLTR BIOMASS BG;
DF 287 287 287 287;
MS 1703730 6011510 5672223 354;
TITLE DUNCANS FOR PRODUCTION AND COVER NATIVE VEGETATION BY LEASES;

PROC SORT DATA = COND OUT= CONDVSC; BY VEG SITE COND;
DATA CONDINS; SET CONDVSC; IF VEG = 'I';
PROC DUNCAN DATA = CONDINS ALPHA=.1; CLASSES SITE;
VAR STDVEG GRNLTR BIOMASS BG;
DF 269 269 269 269;
MS 3175153 1723280 4837205 181;
TITLE DUNCANS FOR PRODUCTION AND COVER OF INTRODUCED VEGT ON ALL
   SITES;
DATA CONDNAS; SET CONDVSC; IF VEG = 'N';
PROC DUNCAN DATA = CONDNAS ALPHA=.1; CLASSES SITE;
VAR STDVEG GRNLTR BIOMASS BG;
DF 310 310 310 310;
MS 2661595 5451199 6757833 527;
TITLE DUNCANS FOR PRODUCTION AND COVER OF NATIVE VEGT ON ALL SITES;
DATA CONDICP; SET CONDVSC; IF VEG = 'I' AND SITE = 'CP';
PROC DUNCAN DATA = CONDICP ALPHA=.1; CLASSES COND;
VAR STDVEG BIOMASS BG;
DF 53 53 53;
MS 2096637 2767623 149;
TITLE DUNCANS FOR PROD AND COVER OF INTRO VEGT ON CLAYPAN PRAIRIE;
DATA CONDIHB; SET CONDVSC; IF VEG = 'I' AND SITE = 'HB';
PROC DUNCAN DATA = CONDIHB ALPHA=.1; CLASSES COND;
VAR STDVEG;
```

```
DF 38;
MS 556895;
TITLE DUNCANS FOR PROD AND COVER OF INTRO VEGT ON HEAVY BOTTOMLAND;
DATA CONDILB; SET CONDVSC; IF VEG = 'I' AND SITE = 'LB';
PROC DUNCAN DATA = CONDILB ALPHA=.1; CLASSES COND;
VAR STDVEG BIOMASS;
DF 47 47
MS 1057118 3085035;
TITLE DUNCANS FOR PROD AND COVER OF INTRO VEGT ON LOAMY BOTTOMLAND;
DATA CONDILP; SET CONDVSC; IF VEG = 'I' AND SITE = 'LP';
PROC DUNCAN DATA = CONDILP ALPHA=.1; CLASSES COND;
VAR STDVEG;
DF 44;
MS 211450;
TITLE DUNCANS FOR PROD AND COVER ON INTRO VEGT ON LOAMY PRAIRIE;
DATA CONDISC; SET CONDVSC; IF VEG = 'I' AND SITE = 'SC';
PROC DUNCAN DATA = CONDISC ALPHA=.1; CLASSES COND;
VAR STDVEG BIOMASS BG;
DF 52 52 52;
MS 1417129 1769113 177;
TITLE DUNCANS FOR PROD AND COVER OF INTRO VEGT ON SMOOTH CHERT
   SAVANNAH;
DATA CONDISP; SET CONDVSC; IF VEG = 'I' AND SITE = 'SP';
PROC DUNCAN DATA = CONDISP ALPHA=.1; CLASSES COND;
VAR STDVEG BIOMASS;
DF 13 13;
MS 888104 768086;
TITLE DUNCANS FOR PROD AND COVER OF INTRO VEGT ON SHALLOW PRAIRIE;
DATA CONDNCP; SET CONDVSC; IF VEG = 'N' AND SITE = 'CP';
PROC DUNCAN DATA = CONDNCP ALPHA=.1; CLASSES COND;
VAR STDVEG BIOMASS;
DF 46 46;
MS 1131313 1720532;
TITLE DUNCANS FOR PROD AND COVER OF NATIVE VEGT ON CLAYPAN PRAIRIE;
DATA CONDNHB: SET CONDVSC: IF VEG = 'N' AND SITE = 'HB';
PROC DUNCAN DATA = CONDNHB ALPAH=.1; CLASSES COND;
VAR STDVEG GRNLTR;
DF 53 53;
MS 857004 8554821;
TITLE DUNCANS FOR PROD AND COVER OF NATIVE VEGT ON HEAVY BOTTOMLAND;
DATA CONDNLB; SET CONDVSC; IF VEG = 'N' AND SITE = 'LB';
PROC DUNCAN DATA = CONDNLB ALPHA=.1; CLASSES COND;
VAR STDVEG;
DF 43;
MS 1382705;
TITLE DUNCANS FOR PROD AND COVER OF NATIVE VEGT ON LOAMY BOTTOMLAND;
DATA CONDNLP; SET CONDVSC; IF VEG = 'N' AND SITE = 'LP';
PROC DUNCAN DATA = CONDNLP ALPHA=.1; CLASSES COND;
VAR STDVEG BIOMASS;
DF 40 40;
MS 1652997 3466271;
TITLE DUNCANS FOR PROD AND COVER OF NATIVE VEGT ON LOAMY PRAIRIE;
DATA CONDNSC; SET CONDVSC; IF VEG = 'N' AND SITE = 'SC';
```

```
PROC DUNCAN DATA = CONDNSC ALPHA=.1; CLASSES COND;
VAR STDVEG GRNLTR;
DF 43 43;
MS 541848 4436157;
TITLE DUNCANS FOR PROD AND COVER OF NATIVE VEGT ON SMOOTH CHERT
   SAVANNA;
DATA CONDNSP; SET CONDVSC; IF VEG = 'N' AND SITE = 'SP';
PROC DUNCAN DATA = CONDNSP ALPHA=.1; CLASSES COND;
VAR STDVEG BIOMASS;
DF 37 37;
MS 782565 4847218;
TITLE DUNCANS FOR PROD AND COVER OF NATIVE VEGT ON SHALLOW PRAIRIE:

PROC SORT DATA = COND OUT = CONDCOND; BY COND;
PROC DUNCAN DATA = CONDCOND ALPHA=.1; CLASSES COND;
VAR STDVEG GRNLTR BIOMASS BG;
DF 587 587 587 587;
MS 1374207 4493149 5395546 418;
TITLE DUNCANS FOR PROD AND COVER BY COND OVER VEG, SITE, ETC.;
```

APPENDIX D

STATISTICS FOR HERBAGE PRODUCTION AND GROUND COVER ON FORT GIBSON PROJECT GRAZING ALLOTMENTS, 1978

Table 1. Average ($\bar{x} \pm$ % C.V.) standing vegetation (kg/ha, air-dry STDVEG), ground litter (kg/ha, air-dry GRNLTR) and bare ground (% BG) by vegetation type, range site and soil on COE Fort Gibson Project grazing allotments, 1978.

Vegetation Type	Range Site	Soil	No. of Transects	STDVEG (kg/ha)	GRNLTR (kg/ha)	BG (%)
Bottomland			198	2000± 77 b[1/]	2300±112 b	16±135 b
Prairie			262	3100± 66 a	1200± 99 c	23± 87 a
Savannah			132	1600±112 c	3000±103 a	13±143 c
(P<)				.01	.01	.01
Bottomland	Heavy	Quarles	99	1700± 73 b	2600±115 a	15±128 a
	Loamy	Verdigris	99	2300± 75 a	2000±101 b	18±139 a
	(P<)			.01	.08	.30
Prairie	Claypan		109	3700± 52 a	800± 73 b	26± 77 a
	Loamy		94	2700± 69 b	1500± 83 a	17±106 b
	Shallow		59	2800± 84 b	1600±107 a	26± 79 a
	(P<)			.01	.01	.01
Savannah	Chert		103	1900± 94 a	1900± 98 b	13±127 a
	Shallow		29	300±174 b	7000± 50 a	12±202 a
	(P<)			.01	.01	.01
Prairie	Claypan	Mayes	29	2700± 64 b	800± 61 a	18± 84 b
		Parsons	80	4100± 46 a	800± 78 a	29± 72 a
		(P<)		.01	.71	.01
	Loamy	Dennis	45	3100± 67 a	1500±103 a	22± 82 a
		Summit	49	2300± 67 b	1600± 63 a	12±134 b
		(P<)		.04	.73	.01
	Shallow	Collinsville	33	3700± 73 a	1700±122 a	22± 84 b
		Lenapeh	26	1700± 76 b	1500± 71 a	32± 71 a
		(P<)		.01	.57	.07
Savannah	Chert	Clarksville	61	2100± 99 a	2200± 99 a	11±127 a
		Sallisaw	42	1700± 81 a	1400± 76 b	16±124 a
		(P<)		.39	.03	.14
	Shallow	Hector-Enders	17	200±192 a	6500± 53 a	17±172 a
		Hector	12	300±160 a	7400± 46 a	4±129 a
		(P<)		.76	.47	.13

1/ Those means in the same row followed by the same letter are significantly different at the 10% level.

Table 2. Average ($\bar{x}$ ± % C.V.) native standing vegetation (kg/ha, air-dry STDVEG), ground litter (kg/ha, air-dry GRNLTR), standing vegetation plus ground litter (kg/ha, air-dry BIOMASS) and bare ground (% BG) for range sites and condition class on COE Fort Gibson Project grazing allotments, 1978.

	Range Condition					
Site	Excellent	Good	Fair	Poor	Depleted	Probability Level
Heavy Bottomland	(N=0)	(N=5)	(N=15)	(N=9)	(N=18)	
STDVEG	-- 1/	3520± 28a 2/	2120± 55b	2000± 58b	570±115c	.01
GRNLTR	--	1420± 71b	1330± 86b	1660± 50b	4930± 80a	.01
BIOMASS	--	4940± 34a	3450± 56a	3660± 36a	5510± 68a	.13
BG	--	15±110a	14±107a	7± 65a	19±142a	.52
Loamy Bottomland	(N=0)	(N=5)	(N=10)	(N=10)	(N-12)	
STDVEG	--	4420± 49a	3600± 34a	1760± 46b	640±157c	.01
GRNLTR	--	2090± 87a	1520± 54a	1990± 79a	3290± 98a	.23
BIOMASS	--	6510± 37a	5120± 34a	3740± 50a	3930± 83a	.18
BG	--	22± 52a	17± 87a	22±109a	39±102a	.20
Claypan Prairie	(N=1)	(N=10)	(N=18)	(N=16)	(N=6)	
STDVEG	--	4380± 22b	3490± 34c	1980± 48d	1040±110e	.01
GRNLTR	--	590± 75a	720± 61a	1000± 59a	1080± 89a	.27
BIOMASS	--	4970± 26b	4210± 29b	2980± 44c	2110± 77c	.01
BG	--	33± 24a	34± 49a	41± 66a	36±109a	.63
Loamy Prairie	(N=1)	(N=10)	(N=10)	(N=12)	(N=12)	
STDVEG	--	4330± 42b	3380± 54b	1200± 47c	1180± 41c	.01
GRNLTR	--	1140±127a	1620± 60a	1770± 50a	1440± 70a	.74
BIOMASS	--	5470± 50a	5000± 50a	2970± 26b	2610± 39b	.01
BG	--	29± 25a	26± 63a	14±110a	25±112a	.30
Shallow Prairie	(N=3)	(N=2)	(N=6)	(N=10)	(N=21)	
STDVEG	7980±19a	4360± 41b	3800± 31b	2670± 39c	740± 65c	.01
GRNLTR	3513±93	790± 61a	1120± 41a	1920± 83a	2270± 93a	.37
BIOMASS	11490±40a	5150± 44b	4930± 29b	4590± 31b	3000± 76b	.01
BG	5± 0	17± 20a	22± 38a	33± 65a	35± 76a	.20
Smooth Chert Savannah	(N=0)	(N=0)	(N=5)	(N=15)	(N=26)	
STDVEG	--	--	3050± 34a	1690± 59b	450± 97c	.01
GRNLTR	--	--	1880± 65b	1700± 60b	3680± 71a	.01
BIOMASS	--	--	4930± 40a	3390± 40a	4130± 57a	.30
BG	--	--	5±204a	9±103a	14±155a	.52
All Sites	(N=5)	(N=32)	(N=64)	(N=75)	(N=141)	
STDVEG	7730±15a	4240± 35b	3160± 44c	1830± 54d	580±117e	.01
GRNLTR	2630±99ab	1140±108b	1260± 73b	1700± 70b	4010± 87a	.01
BIOMASS	10360±35a	5370± 38b	4420± 42b	3530± 41	4600± 72b	.01
BG	6±37a	26± 43a	22± 77a	22±105a	23±128a	.52

1/ No transects.

2/ Those means in the same row followed by the same letter are significantly different at the 10% level.

Table 3. Average ($\bar{x}$ ± % C.V.) introduced pasture standing vegetation (kg/ha, air-dry STDVEG), ground litter (kg/ha, air-dry GRNLTR), standing vegetation plus ground litter (kg/ha, air-dry BIOMASS) and bare ground (% BG) for range sites and condition class on COE Fort Gibson Project grazing allotments, 1978.

	Range Condition					
Site	Excellent	Good	Fair	Poor	Depleted	Probability Level
Heavy Bottomland	(N=0) 1/	(N=7) 2/	(N=14)	(N=15)	(N=6)	
STDVEG	--	3070± 24a	2330± 27b	1330± 69c	1070± 47c	.01
GRNLTR	--	1210± 90a	1750± 63a	2460±142a	1250± 93a	.57
BIOMASS	--	4280± 26a	4080± 32a	3780± 88a	2320± 62a	.39
BG	--	11±109a	10±137a	15±109a	24± 78a	.25
Loamy Bottomland	(N=5)	(N=10)	(N=20)	(N=13)	(N=4)	
STDVEG	5040± 8a	4120± 39a	2710± 30b	1280± 60c	1270±114c	.01
GRNLTR	1860± 68a	1560± 65a	1720± 78a	1190±112a	590± 62a	.41
BIOMASS	6900± 22a	5680± 39a	4430± 39a	2470± 60c	1860± 97c	.01
BG	7± 64a	5± 94a	8±131a	8±105a	11±138a	.19
Claypan Prairie	(N=19)	(N=16)	(N=13)	(N=8)	(N=2)	
STDVEG	5550± 30a	5090± 29a	3920± 28b	2050± 78c	700± 40c	.01
GRNLTR	610± 60a	820± 70a	760± 65a	1160± 92a	450± 47a	.23
BIOMASS	6160± 27a	5910± 30a	4680± 28b	3210± 62c	1150± 42c	.01
BG	11± 58b	21± 41a	21± 56a	24±105a	13± 85ab	.05
Loamy Prairie	(N=7)	(N=5)	(N=19)	(N=12)	(N=6)	
STDVEG	4570± 27a	3700± 14ab	3070± 45b	2060±100c	870± 73c	.01
GRNLTR	930±121a	900± 37a	1780± 64a	1220± 58a	2460±124a	.20
BIOMASS	5500± 37a	4600± 14a	4850± 39a	3280± 71a	3330± 90a	.12
BG	9± 85a	11± 59a	6±126a	31±100a	23±125a	.12
Shallow Prairie	(N=4)	(N=4)	(N=4)	(N=5)	(N=0)	
STDVEG	7740± 21a	3750± 18b	2850± 21bc	2270± 21c	--	.01
GRNLTR	750± 62a	540± 44a	500 ±32a	730± 51a	--	.62
BIOMASS	8490± 16a	4290± 20b	3350± 21bc	3000± 10c	--	.01
BG	15± 38a	16± 29a	21± 49c	17± 45a	--	.67
Smooth Chert Savannah	(N=4)	(N=8)	(N=13)	(N=21)	(N=11)	
STDVEG	7230± 28a	3960± 43b	3070± 48b	1660± 49c	990± 43c	.01
GRNLTR	1260± 91a	1320±145a	1440± 55a	1020± 75a	1000± 73a	.77
BIOMASS	8490± 21a	5280± 21b	4510± 39b	2680± 45c	1990± 41c	.01
BG	29± 33a	26± 85a	3± 86c	11±122bc	18± 77ab	.01
All Sites	(N=39)	(N=50)	(N=83)	(N=74)	(N=29)	
STDVEG	5700± 30a	4190± 35b	2980± 39c	1670± 72c	1000± 66e	.01
GRNLTR	910± 95a	1090± 95a	1480± 74a	1370±133a	1260±127a	.19
BIOMASS	6610± 29a	5280± 31b	4460± 36c	3040± 68d	2260± 76e	.01
BG	12± 71bc	16± 84ab	10±115c	13±112bc	20± 97a	.01

1/ No transects.

2/ Those means in the same row followed by the same letter are not signigicantly different at the 10% level.

APPENDIX E

COMPLETE SPECIES CLASS NAMES USED IN TEXT ON FORT GIBSON PROJECT GRAZING ALLOTMENTS, 1978

Table 1. Complete species class names used in text on Fort Gibson Project grazing allotments, 1978.

Species Class[1/]	Species Code	Classification[2/]
Achillea lanulosa	ACLA	INV.
Agrostis spp.	AGRO	INC.
Ambrosia psilostachya	AMPS	INV.
Andropogon gerardii	ANGE	DEC.
A. virginicus	ANVI	INV.
Asclepias asperula	ASAS	INC.
Aster spp.	ASTE	INC.
Bothriochloa saccharoides	BOSA	INC.
Bouteloua spp.	BOUT	INC.
Carex spp.	CARX	INC.
Cool Season Annual Grass	CSAG	INV.
Cool Season Perennial Grass	CSPG	DEC.
Croton spp.	CROT	INV.
Cynodon dactylon	CYDA	INT., INV.
Decreaser Forbs	DECF	DEC.
Eragrostis spp.	ERAG	INC.
Erigeron spp.	ERIG	INC.
Eupatorium spp.	EUPA	INV.
Festuca arundinacea	FEAR	INT., INV.
Gaura spp.	GUAR	INV.
Gutierrezia dracunculoides	GUDR	INV.
Helenium amarum	HEAM	INV.
Helianthus spp.	HELI	INC.
Increaser Forbs	INCF	INC.
Invader Forbs	INVF	INV.
Iva ciliata	IVCI	INV.
Lespedeza cuneata	LECU	DEC.
L. spp.	LESP	DEC.
Muhlenbergia spp.	MUHL	INC.
Panicum anceps	PAAN	INC.
P. oligosanthes	PAOL	INC.
P. spp.	PANI	INC.
P. virgatum	PAVI	DEC.
Paspalum spp.	PASP	INC.
Plantago spp.	PLAN	INV.
Polygonum spp.	POLY	INV.
Rudbecki hirta	RUHI	INV.
Rumex crispus	RUCR	INV.
Schizachyrium scoparium	SCSC	DEC.
Scirpus americana	SCAM	INC.
Setaria spp.	SETA	INV.
Solanum spp.	SOLA	INV.
Solidago spp.	SOLI	INC.
Sorghastrum nutans	SONU	DEC.
Sorghum halepense	SOHA	INT., INV.
Sporobolus spp.	SPOR	INC.
Tridens spp.	TRID	INC.

Species Class[1/]	Species Code	Classification[2/]
Trifolium spp.	TRIF	DEC.
Vernonia spp.	VERN	INV.
Warm Season Annual Grass	WSAG	INV.
Warm Season Perennial Grass	WSPG	DEC.

1/ One or more species of same genus or similar phenological growth stages or growth form.

2/ INV.-Invader; INC.-Increaser; DEC.-Decreaser; INT.-Introduced.

APPENDIX F

KEY SPECIES CLASSES FOR RANGE SITES ON FORT GIBSON PROJECT GRAZING ALLOTMENTS, 1978

Table 1. Native key species classes (%) by condition class on COE Fort Gibson Project Claypan Prairie range sites, 1978.

Species Class	Class.	Condition Good	Fair	Poor	Depleted
SCSC	DEC.	23.0	9.0	1.0	
SONU	DEC.	4.0	2.0	2.0	
PAOL	INC.	4.0	2.0	2.0	2.0
SPOR	INC.	0.6	0.4	4.0	17.0
ANVI	INV.	27.0	20.0	17.0	6.0
HEAM	INV.		0.3	0.8	4.0

Table 2. Native key species classes (%) by condition class on COE Fort Gibson Project Loamy Prairie range sites, 1978.

Species Class	Class.	Condition Good	Fair	Poor	Depleted
SCSC	DEC.	45.0	5.0	2.0	
HELI	INC.		9.0	5.0	0.9
PAOL	INC.	3.0	2.0	3.0	1.0
ANVI	INV.	7.0	8.0	25.0	2.0
POLY	INV.		0.4	0.3	6.0

Table 3. Native key species classes (%) by condition class on COE Fort Gibson Project Shallow Prairie range sites, 1978.

Species Class	Class.	Condition Good	Fair	Poor	Depleted
SCSC	DEC.	44.0	19.0	14.0	6.0
PAOL	INC.	4.0	14.0	5.0	1.0
ANVI	INV.		11.0	11.0	2.0
CYDA	INV.		2.0	0.5	5.0

Table 4. Native key species classes (%) by condition class on COE Fort Gibson Project Heavy Bottomland range sites, 1978.

Species Class	Class.	Condition Good	Fair	Poor	Depleted
ANGE	DEC.	13.0	4.0		
SONU	DEC.	11.0	4.0		
PAAN	INC.	0.7	4.0	4.0	11.0
CSAG	INV.	1.0	0.8	23.0	7.0

Table 5. Native key species classes (%) by condition class on COE Fort Gibson Project Loamy Bottomland range sites, 1978.

Species Class	Class.	Condition Good	Fair	Poor	Depleted
CSPG	DEC.	6.0	0.1	7.0	2.0
PAAN	INC.	4.0	11.0	7.0	
ANVI	INV.	5.0	9.0	1.0	
SOLA	INV.	0.2	0.2	0.5	3.0

Table 6. Native key species classes (%) by condition class on COE Fort Gibson Project Smooth Chert Savannah range sites, 1978.

Species Class	Class.	Condition Fair	Poor	Depleted
LESP	DEC.	3.0	2.0	2.0
PAOL	INC.	17.0	16.0	3.0
ANVI	INV.	41.0	26.0	5.0
CYDA	INV.	0.4	3.0	17.0

Table 7. Introduced key species classes (%) by condition class on COE Fort Gibson Project Claypan Prairie range sites, 1978.

Species Class	Class.	Excellent	Good	Fair	Poor	Depleted
		Condition				
CYDA	INT.	1.0	10.0	14.0	6.0	15.0
FEAR	INT.	66.0	26.0	21.0	12.0	
PAOL	INC.	0.4	0.8	1.0	2.0	
CSAG	INV.	1.0	2.0	9.0	11.0	
WSAG	INV.		0.8	2.0	10.0	

Table 8. Introduced key species classes (%) by condition class on COE Fort Gibson Project Loamy Prairie range sites, 1978.

Species Class	Class.	Excellent	Good	Fair	Poor	Depleted
		Condition				
CYDA	INT.		47.0	24.0	18.0	39.0
FEAR	INT.	58.0	10.0	3.0	4.0	
CARX	INC.	1.0	2.0	5.0	4.0	4.0
HEAM	INV.	0.5	3.0	0.7	2.0	9.0
IVCI	INV.			3.0	2.0	6.0

Table 9. Introduced key species classes (%) by condition class on COE Fort Gibson Project Shallow Prairie range sites, 1978.

Species Class	Class.	Excellent	Good	Fair	Poor
		Condition			
CYDA	INT.	18.0	7.0	23.0	36.0
FEAR	INT.	45.0	41.0	26.0	
PAOL	INC.	0.2	0.7	1.0	0.4
CSAG	INV.	1.0	2.0	2.0	5.0
HEAM	INV.		0.3	3.0	9.0

Table 10. Introduced key species classes (%) by condition class on COE Fort Gibson Project Heavy Bottomland range sites, 1978.

Species Class	Class.	Condition Good	Fair	Poor	Depleted
CYDA	INT.	32.0	32.0	30.0	6.0
FEAR	INT.	11.0	10.0	15.0	28.0
CARX	INC.	12.0	7.0	6.0	3.0
AMPS	INV.		6.0	5.0	16.0
WSAG	INV.		0.2	0.5	4.0

Table 11. Introduced key species classes (%) by condition class on COE Fort Gibson Project Loamy Bottomland range sites, 1978.

Species Class	Class.	Condition Excellent	Good	Fair	Poor	Depleted
CYDA	INT.	53.0	47.0	49.0	50.0	74.0
CARX	INC.		4.0	4.0	10.0	2.0
AMPS	INV.	11.0	3.0	2.0	4.0	
IVCI	INV.	0.9	7.0	6.0	6.0	3.0

Table 12. Introduced key species classes (%) by condition class on COE Fort Gibson Project Smooth Chert Savannah range sites, 1978.

Species Class	Class.	Condition Excellent	Good	Fair	Poor	Depleted
CYDA	INT.	21.0	28.0	42.0	39.0	41.0
FEAR	INT.		8.0	20.0	3.0	0.2
PAAN	INC.		1.0	10.0	6.0	0.7
HEAM	INV.			1.0	0.7	5.0
WSAG	INV.		2.0	0.4	2.0	3.0

VITA

Paul G. Knight

Candidate for the Degree of

Master of Science

Thesis: SOILS, VEGETATION AND LIVESTOCK RELATIONSHIPS ON EASTERN OKLAHOMA GRAZING LEASES

Major Field: Agronomy

Biographical:

Personal Data: Born in Miami, Oklahoma, June 25, 1952, the son of Mr. and Mrs. Ernest P. Knight. Married Junelle Rendel February 19, 1972.

Education: Graduate from Miami High School, Miami, Oklahoma, in May, 1970; received Bachelor of Science degree in Wildlife Ecology from Oklahoma State University in 1975; completed requirements for the Master of Science degree at Oklahoma State University in May, 1980.

Professional Experience: Graduate Research Assistant, Oklahoma State University, June 1978 - August 1979; Range Conservationist, USDA Soil Conservation Service, September - present.

Professional Organization: Society for Range Management.