THE PATTERN OF RETROGRESSION OF NATIVE VEGETATION IN NORTH CENTRAL OKLAHOMA

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1962

Submitted to the faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
May, 1964

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Thesis Approved:

Thesis Adviser

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PREFACE

Gratefulness is expressed to the many individuals on whose land this investigation was conducted. Indebtedness is acknowledged to the writer's adviser, Dr. Don Dwyer, for his invaluable counsel, and to the graduate committee, Drs. Jerry Crockett, W. W. Huffine and Billy Tucker, for their timely assistance.

Heartfelt appreciation is expressed to the writer's wife, Connie Rae, for her encouragement throughout this research and for the work in typing of this thesis.

Appreciation is also extended to the parents of the writer for their guidance and understanding.

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CHAPTER I

INTRODUCTION

Disturbance of plant cover by overuse, such as grazing and mowing, upsets orderly succession and causes retrogression. Knowledge of the reaction of vegetation to grazing use is at present incomplete (Parker, 1954). Isolated observations have indicated only that vegetative retrogression does occur. The steps by which change from climax vegetation occurs is undefined in north central Oklahoma. According to Ellison (1960), overgrazing initiates a destructive type of secondary succession resulting in a change in the composition of the vegetation. Plant communities that become established under extended heavy use or abuse are usually a mixture that is less palatable to the grazing animal and ordinarily are less productive. Increased knowledge of the stages of succession and the causes that delay or reverse their natural progress is needed. Range condition needs to be studied in order to relate range condition to productivity which may be tied directly to animal output and rancher income (Costello, 1956).

The term "retrogression" was suggested by Sampson (1919) for the negative character of change associated with grazing. If overuse continues year after year the result is destruction of the plant cover. Such conditions cause a reversion of the vegetation to a lower successional

stage. Weaver and Clements (1938) describe the process of retrogression that occurs on native vegetation.

The primary purpose of this study was to determine the pattern of retrogression that occurs on the loamy prairie range site in north central Oklahoma. Also an attempt was made to determine the relationship between condition of the range and amount of soil moisture.

CHAPTER II

REVIEW OF LITERATURE

Range condition is a practical representation of the major successional stages of plant communities as influenced by grazing use. The trend associated with retrogression is a primary factor that determines the range condition. Major factors considered in trend are density and composition of the vegetation and litter and stability of the soil. Composition of the vegetation denotes the quality of the range and is the best indicator of long time trends (Parker, 1954).

Changes in the Vegetation

A smaller number of species occurs on moderately grazed pastures compared to undisturbed prairie (Kelting, 1954 and Canfield, 1948). Kucera (1956), in north central Missouri, found a 41 per cent reduction in the number of species from a moderately or lightly grazed prairie to an overgrazed prairie.

Tomanek and Albertson (1953) found that basal density increased as grazing intensity became more severe, being greatest on heavily grazed range and least on ungrazed or lightly grazed areas. However, the heavily grazed pasture had one half as many plant stems per unit area as the nongrazed, indicating a reduction in plant vigor due to grazing. Nongrazed areas produced approximately twice as much forage

as heavily grazed pastures. The increase in basal area due to grazing is not true in all circumstances. Klemmedson (1956) and Johnston (1962) state that plant density decreases with deterioration in range condition.

Grazing or mowing affects plants in various ways. Launchbaugh (1955) charted the pattern of change in decreaser, increaser and invader plants in the San Antonio Prairie. As stocking rate was increased per cent composition of decreasers, primarily Andropogon scoparius[1], declined from 68 per cent to less than three per cent. Increaser plants increased from 30 per cent composition to 80 per cent on the moderately heavy grazed pastures and then decreased to 57 per cent composition on the overgrazed pasture. Overgrazing resulted in an increase in invaders from a trace in the lightly used pastures to approximately 40 per cent composition in the heavily used pastures. Weaver and Tomanek (1951), in a study near Lincoln, Nebraska, found vegetational trends similar to Launchbaugh's (1955). Composition of decreasers, mostly Andropogon scoparius and A. gerardi, declined from 72 per cent on excellent condition range to seven per cent on fair condition range. Increaser grasses, Bouteloua spp. and Poa spp., increased from 18 per cent on excellent condition range to 66 per cent composition on fair condition range while invaders increased from zero on the excellent to 21 per cent on the fair condition range.

A successional series in southwestern Texas was outlined by Buechner (1950). Climax was characterized by Andropogon spp. and Bouteloua

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[1]Scientific names follow Waterfall, U. T. 1960. Keys to the Flora of Oklahoma.

curtipendula while good condition range contained some Andropogons, but Bouteloua curtipendula was dominant. Voight and Weaver (1951), describing retrogression, found that decreaser plants, mostly Andropogon gerardi and A. scoparius, composed 67 per cent, increasers 30 per cent, invaders 2.1 per cent and forbs 0.9 per cent of the vegetation on excellent condition range. Vegetation on good condition range consisted of 45 per cent decreasers, 60 per cent increasers, 3.1 per cent invaders and 2.0 per cent forbs. Fair condition pastures contained four per cent decreasers, 88 per cent increasers, 6.2 per cent invaders, and two per cent forbs. Range in poor condition had two per cent decreasers, 32 per cent increasers, 47.5 per cent invaders and 19 per cent forbs.

In central Oklahoma the dominants of the mixed grass prairie, Andropogon scoparius and Bouteloua curtipendula, decreased in abundance even under moderate grazing and were eliminated under severe use (Smith, 1940). Bouteloua curtipendula withstood overgrazing longer than Andropogon scoparius. As these species disappeared from the flora, dominance was assumed by the short grasses Buchloe dactyloides, Bouteloua gracilis, and B. hirsuta. As severe use continued these short grasses were replaced by species from the genera Chloris, Schedonnardus, Aristida, Bromus, Festuca, and Hordeum (Smith, 1940).

Similar results have been found in other areas. In Iowa Ehrenreich and Aikman (1963) listed Andropogon gerardi, A. scoparius, Sorghastrum nutans, Panicum virgatum, Elymus canadensis, Amorpha canescens and Petalostemum purpureum as decreasers. Some of the increasers were Panicum oligosanthes, Carex spp., Achillea spp., Aster ericoides, and Baptisia leucophaea. No important invaders were present. Andropogon

gerardi, A. scoparius, Panicum virgatum and Sorghastrum nutans were co-dominants of undisturbed prairie in central Oklahoma (Ahshapanek, 1962). Buck and Kelting (1962) in a survey of the tall grass prairie in north-eastern Oklahoma found Andropogon scoparius, A. gerardi, Panicum virgatum, Sorghastrum nutans, Leptoloma cognatum and Aster ericoides to be the most frequent species on 68 excellent condition prairie sites.

Dyksterhuis (1949), charting the change in vegetation due to overgrazing in the Fort Worth Prairie, found that decreasers declined from 67 per cent on excellent condition range to less than two per cent on poor condition pastures. Increasers rose from 3.0 per cent on excellent condition range to 88 per cent on fair condition sites then decreased as overuse continued. Invader plants increased from two per cent on excellent condition range to 47 per cent on poor condition range.

Four reasons for a species' susceptibility or resistance to grazing or mowing use are: (1) growth habit, (2) leaf and flower stalk heights, (3) height of growing points, and (4) ratio of fertile to vegetative stems (Branson, 1953). Palatability is also an important factor to be considered in the response of certain species to use. Archibald, et al., (1943) state that preference to grasses was directly related to vitamin A content and succulence and indirectly related to fiber content.

Changes in Soil Moisture and Frequency and Abundance of Mulch

The amount of mulch occurring on the soil surface is dependent on past use and condition of the range (Dyksterhuis and Schmutz, 1947).

Grazing reduces the amount of mulch on a given site (Hopkins, 1954 and Rauzi, 1960). An increase in mulch indicates an improvement in range condition and that recent grazing use has not been abnormally heavy (Humphrey, 1949). The amount of mulch diminished from 5,300 pounds on the ungrazed range to 2,340 pounds on moderately grazed range to 1,240 pounds on the heavily grazed range (Duvall, 1962).

Much emphasis has been placed on the effect of surface condition of soil on the plant-water relationship. Duley and Kelly (1941) and Duley and Domingo (1949) state that surface condition of the soil is more important than soil type or previous soil moisture on rate of intake of rainfall. Soils covered with good condition native sod furnish the best condition for intake of rainfall (Duley and Kelly, 1939). Native sod with grass clipped close and surface debris (mulch) removed to simulate an overgrazed condition absorbed rainfall at a rate only slightly above bare soil.

Mulch conserves moisture primarily in the upper two feet of the soil according to Stephenson and Schuster (1945). Many authors agree that mulch is an important factor in intake and conservation of soil moisture (Ellison, 1960; Rauzi, 1960; Beutner and Anderson, 1943; Hopkins, 1954).

CHAPTER III

MATERIALS AND METHODS

Selection of Study Areas

Investigation of the retrogression pattern of native vegetation was conducted on the loamy prairie range site, the dominant grassland site in north central Oklahoma. Study areas were selected to represent various stages of vegetative departure from the potential of the site. Care was taken in selection of the study areas to avoid sites that had ever been cultivated.

The loamy prairie range sites are gently to steeply rolling, deep, loamy upland soils. The soils are neutral to slightly acid with slow to medium permeability (U. S. D. A. Soil Conserv. Serv., 1961).

The climate of the study region includes hot, often dry summers; mild autumns; mild to cold winters and cool springs. Average annual precipitation for the study region is 32.2 inches. Approximately 70 per cent of the total precipitation (favorable to the warm season grasses of the area) occurs from April to October.

Relative Composition and Basal Cover of Grasses

The point intercept method of vegetation analysis (Levy and Madden, 1933) was used to determine the per cent basal cover and per cent species

composition of the grasses on each study area. The sampling apparatus used consisted of a metal frame containing ten sliding pins located at three inch intervals and inclined at a slight angle.

Samples were taken at equal distances along predetermined transects. Hits were recorded when the pins contacted the base of a grass. Brown (1954) states that the number of points necessary to accurately analyze an area depends upon the nature of the vegetation, plant density and method of recording hits. Two hundred sets, 2,000 points, were taken in each study area during this investigation. Basal cover of grasses was determined by the following formula:

$$\frac{\text{Total hits all species}}{\text{Total no. of points}} \times 100$$

Relative composition of grasses was determined by the following formula:

$$\frac{\text{Total hits for a species}}{\text{Total hits all species}} \times 100$$

Forb Species and Numbers

The square foot method was used to determine the abundance and species of forbs present on each study area. Fifty square foot samples were taken at regular intervals along predetermined transects. The square foot sampling tool was placed at the point of the toe on the final pace and the species and number of each species occurring in the sample were recorded.

Quantity and Frequency of Occurrence of Mulch

The quantity of mulch present on each area investigated was determined by collecting all mulch from twenty, $11\frac{1}{2}$ by 24 inch, quadrats. Each individual sample was dried at 100^{o} C. for 36 hours

and weights were recorded in grams. Pounds of mulch per acre was calculated by multiplying the average weights in grams by the factor of 50.

Frequency of mulch occurrence was determined in conjunction with species composition determination by the point intercept method. A hit was recorded when a pin came in contact with mulch, but had not touched a plant. (In other words, one of three things was recorded at one observation: (1) a species of grass, (2) mulch or (3) bare ground.)

Soil Moisture

Soil moisture measurements on two pastures that differed widely in vegetative composition were taken with a Nuclear Chicago probe (P-19) and scaler (No. 2,800). Per cent soil moisture by volume was determined at six inch intervals to a depth of four feet. These determinations were made twice monthly from April 1 to October 1 and monthly during the remaining six months of the study.

CHAPTER IV

RESULTS AND DISCUSSION

Range Condition and Grass Composition

A definite trend can be seen in the change of grass composition as vegetation retrogression occurs. Table I shows the per cent of the total composition made up by decreaser, increaser and invader grasses on the various study areas.

TABLE I

Relative Per Cent of Decreaser, Increaser, and Invader Grasses and Per Cent Basal Cover of Grasses in the Study Areas

	STUDY AREAS													
	I*	II	III	IV*	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Decreasers	93	88	86	82	81	75	57	27	26	12	6	3	1	-
Increasers	7	8	12	15	16	21	35	29	39	30	43	5	11	40
Invaders	-	4	2	3	4	4	8	44	34	57	51	92	88	60
TOTAL	100	100	100	100	101	100	100	100	99	99	100	100	100	100
Basal Cover	13	12	8	14	16	10	15	16	13	23	16	23	20	19
Range Condition	E X C E L L E N T					GOOD		FAIR		P O O R				

* Native Hay Meadows

The decreasers, little bluestem (Andropogon scoparius), big bluestem (A. gerardi), indiangrass (Sorghastrum nutans) and switchgrass (Panicum virgatum) comprise 93 per cent of the grasses in study area I and decreased to zero in area XIV.

Of the seven species of increaser grasses only blue grama (Bouteloua gracilis), sideoats grama (B. curtipendula) and hairy grama (B. hirsuta) were important. These along with tall dropseed (Sporobolus asper), scribners panicum (Panicum oligosanthes), purple lovegrass (Eragrostis spectabilis), fall witchgrass (Leptoloma cognatum) and Carex spp. increased from seven per cent in study area I to an average of 33 per cent in study areas VI through XI. The larger percentage of increasers in study area XI is due to a 21 per cent composition of sideoats grama. Mowing of this area for native hay in previous years may have resulted in an increase in sideoats grama. As would be expected from Dyksterhuis' (1949) study the increasers diminished on severely overgrazed sites (areas XII and XIII). However, the 40 per cent increasers in pasture XIV is largely due to an increase of blue grama for which there is no apparent explanation.

Invader grasses increased from a trace of buffalograss (Buchloe dactyloides) in area I to approximately 90 per cent in pastures XII and XIII. A decrease of invaders in pasture XIV is a result of the unexplainable increase of blue grama.

As range condition declined basal area of grasses increased (Table I). This was a result of the increase in buffalograss and blue grama. The average per cent basal cover of the five excellent condition pastures was 12 per cent as opposed to an average of 20 per cent basal cover for grasses in the five poor condition pastures.

Table II presents species composition of the grasses encountered in the survey and illustrates the changes that occurred between study area I, a lightly used meadow, and study area XIV, a severely overgrazed pasture. Sites I and IV are native hay meadows. The study areas are arranged in order of successively poorer range condition from I to XIV.

Little bluestem is the most abundant decreaser species, comprising 73 per cent of the grasses in the excellent condition pastures. Big bluestem is the second most abundant decreaser. Sites I and IV (meadows) have less big bluestem present than sites II, III, VI, and VII (grazed pastures), indicating that mowing a native meadow may be detrimental to big bluestem. The native hay meadows are the only excellent condition areas having any buffalograss. Big bluestem declined from approximately 18 per cent of the composition in areas II and III to 0.3 per cent in the poor condition range, area XIV. Big bluestem was present in the two poorest pastures but little bluestem was not. This suggests that big bluestem may resist continuous severe overgrazing better than little bluestem. The large percentage of big bluestem in areas VI and VII, 34.2 per cent and 15.2 per cent, respectively, is difficult to explain except both areas had a past history of overutilization; however, for the last few years prior to the study they had been lightly grazed. It is possible that big bluestem recovers more quickly than some other species after overutilization.

Indiangrass was relatively unimportant except in the meadows. Annual mowing seemed to enhance the abundance of this grass. Switchgrass was not an abundant grass at any stage in the retrogression pattern. Indiangrass and switchgrass disappeared in the poor condition pastures.

TABLE II

Changes in Grass Composition Due to Grazing and Mowing
(Per Cent Species Composition)

	STUDY AREAS													
	I*	II	III	IV*	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
DECREASER SPECIES														
Andropogon scoparius	72.9	70.1	62.9	58.7	69.6	35.3	39.7	20.8	17.2	5.8	1.6	0.8	-	-
Andropogon gerardi	10.6	17.3	18.8	7.6	7.4	34.2	15.2	5.0	8.0	5.8	4.2	2.1	0.5	0.3
Sorghastrum nutans	8.4	0.4	3.5	15.1	3.3	5.8	1.3	0.3	1.1	0.2	-	-	-	-
Panicum virgatum	0.7	0.4	0.6	0.6	0.3	-	0.3	0.9	-	0.4	-	-	-	-
TOTAL DECREASERS	92.6	88.2	85.8	82.0	80.6	75.3	56.5	27.0	26.3	12.2	5.8	2.9	0.5	0.3
INCREASER SPECIES														
Bouteloua curtipendula	4.5	4.4	0.6	2.8	7.4	13.7	20.9	10.5	10.6	11.2	21.2	3.0	1.3	-
Bouteloua gracilis	0.1	0.4	-	1.3	0.3	1.0	0.7	1.2	10.6	9.9	12.7	0.2	3.0	33.0
Bouteloua hirsuta	0.3	-	-	7.2	3.0	1.6	5.3	4.0	11.0	6.7	5.3	-	5.3	6.2
Sporobolus asper	1.0	1.2	5.9	0.6	0.3	1.6	2.6	0.9	1.9	0.2	0.6	0.2	-	-
Carex spp.	0.8	-	2.9	0.9	0.7	1.6	1.3	2.2	1.0	0.4	2.2	1.3	1.5	0.6
Panicum oligosanthes	0.2	-	-	0.6	1.6	-	1.7	1.2	-	-	0.6	-	-	-
Eragrostis spectabilis	0.4	2.0	2.9	0.6	0.7	1.0	0.7	2.8	-	0.2	-	0.2	0.2	-
Leptoloma cognatum	-	0.4	-	0.9	1.5	-	1.7	5.8	4.2	1.3	0.6	-	-	-
TOTAL INCREASERS	7.3	8.4	12.3	14.9	15.5	20.5	34.9	28.6	39.3	29.9	43.2	4.9	11.3	39.8
INVADER SPECIES														
Buchloe dactyloides	0.1	-	-	0.9	-	2.6	4.6	13.0	13.7	37.7	15.2	70.5	69.3	48.4
Setaria geniculata	-	-	-	-	-	-	0.3	0.5	2.3	-	-	-	0.5	-
Andropogon saccharoides	-	2.0	-	0.6	-	1.6	0.3	3.0	2.7	13.4	-	2.1	0.2	-
Andropogon virginicus	-	-	-	-	-	-	0.3	3.3	1.5	-	-	-	-	-
Eragrostis curtipedicellata	-	-	1.2	0.3	-	-	-	-	-	-	-	0.2	-	-
Chloris verticillata	-	0.8	0.6	-	-	-	0.3	6.4	2.7	5.2	18.0	12.4	4.3	1.0
Agrostis hiemalis	-	-	-	0.3	1.1	-	-	-	-	-	-	-	1.0	-
Aristida oligantha	-	-	-	-	0.7	-	0.3	14.5	9.9	0.4	8.7	0.6	5.3	7.3
Aristida purpurescens	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-
Bromus japonicus	-	-	-	-	0.3	-	-	-	-	-	-	-	-	0.3
Paspalum spp.	-	0.4	-	0.6	0.7	-	2.3	2.4	1.5	0.6	7.4	6.2	7.1	2.9
Poa arachnifera	-	-	-	-	-	-	-	0.6	-	-	0.9	-	-	-
Hordeum pusillum	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3
Distichlis stricta	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-
Eragrostis intermedia	-	-	-	-	-	-	-	0.5	-	-	0.3	-	-	-
TOTAL INVADERS	0.1	3.2	1.8	2.7	3.5	4.2	8.4	44.2	34.3	57.3	50.5	92.0	87.9	60.2
RANGE CONDITION	E X C E L			L E N T		G O O D		F A I R			P O O R			

* Native Hay Meadows

Sideoats grams was a relatively common occurring species in many of the pastures, especially the good and fair condition pastures as well as areas X and XI of the poor condition pastures. This species was quite variable, but averaged about 14 per cent in the intermediate condition pastures (areas VI through XI). Blue grama became a prominent increaser in the fair condition pasture IX and in the poor condition pastures, XI and XIV. The reaction of this plant to the severest grazing pressure studied is not clear.

Invader grasses of importance, other than buffalograss, were annual threeawn (Aristida oligantha), silver bluestem (Andropogon saccharoides) and windmill grass (Chloris verticillata). Many of the invader grasses, as well as some increaser grasses, had no apparent pattern or trend due to grazing pressure and resulted in fluctuations in species composition.

Effects of Grazing on Forb Population

Forbs were important in many of the study areas and in others they were relatively insignificant (Table III). Western ragweed (Ambrosia psilostachya) tended to increase with a decline in range condition. An exception to this is pasture II which had been subjected to light grazing. The livestock had "spot" grazed this pasture which resulted in an increase of western ragweed. Other perennial species that tended to increase were western yarrow (Achillea lanulosa), blackeyedsusan (Rudbeckia hirta), wavy-leaf thistle (Cirsium undulatum) and baldwin ironweed (Vernonia Baldwinii). Perennial species that showed a decrease as grazing pressures increased were blue salvia (Salvia azurea) and prairie scurfpea (Psoralea tenuiflora). Generally, the perennial species decreased in forbs per square

TABLE III

Numbers of Perennial and Annual Forbs Per Square Foot
in the Various Study Areas

	STUDY AREAS													
	I	II	III	IV*	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
PERENNIAL SPECIES														
Aster ericoides	5.60	0.72	.26	.08	.54	.16	.82	.56	.20	.06	.06	.90	.86	.46
Ambrosia psilostachya	-	2.72	.26	.04	1.38	.19	1.28	1.98	3.82	2.30	3.76	2.80	4.12	2.38
Achillea lanulosa	.30	.20	.04	-	.14	.09	.80	.70	.52	.16	.52	4.10	.86	.36
Psoralea tenuiflora	.30	.44	.44	.04	.12	.19	.76	.22	.10	.08	.04	.14	-	-
Artemisia ludoviciana	.04	.88	-	.02	.18	.16	.12	.02	1.30	-	.02	.20	.24	-
Salvia azurea	.50	.24	.02	.10	.20	.03	.16	-	-	-	.32	-	-	-
Rudbeckia hirta	.06	.32	-	.02	-	-	.14	-	.12	.04	.14	.44	.18	.18
Cirsium undulatum	-	.08	-	-	.02	-	.08	.04	-	.04	.04	.06	-	-
Vernonia Baldwinii	.04	-	-	-	-	.01	.04	.04	.06	-	.04	.36	.06	-
Other Perennial Species	.98	.24	.30	.16	.06	-	.54	.06	.18	.10	.14	.04	.16	.04
TOTAL PERENNIAL SPECIES	7.82	5.84	1.32	.46	2.64	.83	4.74	3.62	6.30	2.78	5.08	9.04	6.48	3.42
ANNUAL SPECIES														
Gutierrizia dracunculoides	-	.72	.02	-	.10	.09	.20	.46	.28	1.22	1.52	.02	.18	.10
Oxalis stricta	.06	.16	.20	.04	-	.06	-	.14	.02	.04	.74	.90	.06	1.12
Erigeron strigosus	3.50	.12	.32	.48	.08	-	.24	.34	.02	.04	.56	.10	.08	-
Conyza canadensis	-	.04	-	-	-	-	.02	.02	.06	-	.12	.02	.02	-
Euphorbia supina	-	-	.02	-	-	-	-	.04	.02	-	.38	1.00	1.26	.22
Plantago spp.	-	-	-	-	-	-	.24	-	-	.12	1.62	-	-	6.40
Other Annual Species	-	.12	-	.20	.08	-	.06	.18	-	.02	.20	.04	.06	1.50
TOTAL ANNUAL SPECIES	3.56	1.16	.56	.72	.26	.15	.76	1.18	.40	1.44	5.14	2.08	1.66	9.34
Total Forbs per square foot	11.38	7.00	1.88	1.18	2.90	.98	5.50	4.80	6.70	4.22	10.22	11.12	8.14	12.76
Range Condition	E X C E L L E N T					G O O D		F A I R		P O O R				

* Native Hay Meadows

foot with light grazing but tended to increase in abundance as grazing pressure became greater.

Annual forb species increased in most cases under progressively heavier grazing. Such species as the spurge (Euphorbia supina), marestail (Conyza canadensis), and Plantago spp. did not become important until pastures retrogressed to fair or poor condition. Annual broomweed (Gutierrizia dracunculoides) became more abundant in pastures VII, VIII, IX, X, XI, but when range utilization was severest in pastures XIII and XIV, this species diminished.

Total forb numbers appear to increase as range condition declines. However, Table III indicates there may be as many total perennial forbs in the very best pastures as in the very poorest. Forbs, especially the annuals, appear to react to seasonal weather changes and grazing practices more quickly than the grasses.

Species included as "other perennial species" were Asclepias viridis, Antennaria neglecta, Baptisia leucophaea, Callirhoe alcaeoides, C. involucrata, Desmanthus illinoensis, Hieracium longipilum, Lespedeza capitata, L. virginica, Lomatium foeniculaceum, Neptunia lutea, Oenothera serrulata, Ratibida columnifera, Ruellia cilosa, Schrankia uncinata, Solanum eleagnifolium, Solidago missouriensis, Stenosiphon linifolius, and Symphoricarpos orbiculatus.

Species included in the "other annual species" category were Acalypha virginica, Cassia fasciculata, Chrysopsis pilosa, Croton texensis, Erigeron divergens, Geranium carolinianum, Hedoma hispida, Lepidium densiflorum, Linum sulcatum, Polygola alba, Sabatia campestris and Specularia perfoliata.

Quantity and Cover of Mulch as Related to Range Condition

There was considerably less mulch present in volume and in ground cover in poor as compared to excellent condition pastures (Table IV). The data indicate that the average mulch is over one ton per acre in the excellent condition pastures and about 1,000 pounds per acre in the fair condition pastures. In severely overgrazed pastures mulch was quite limited. Per cent of ground covered by mulch was related to pounds of mulch per acre.

The amount of mulch on a range site is subject to rapid change; for example, in area III, which was overutilized after the sampling, mulch was reduced to less than one ton per acre in one year.

TABLE IV

Quantity of Mulch on the Study Areas in Pounds Per Acre and Per Cent Basal Cover of Mulch

	STUDY AREAS													
	I*	II	III	IV*	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Mulch Quantity	1890	2430	5860	1485	2480	5145	1920	835	1430	263	240	800	261	81
Mulch Cover	* *	* *	82	57	56	86	15	24	52	3	10	37	7	4
Range Condition	EXCELLENT					GOOD		FAIR		POOR				

* Native Hay Meadows

* * No data

Effect of Range Condition on Soil Moisture

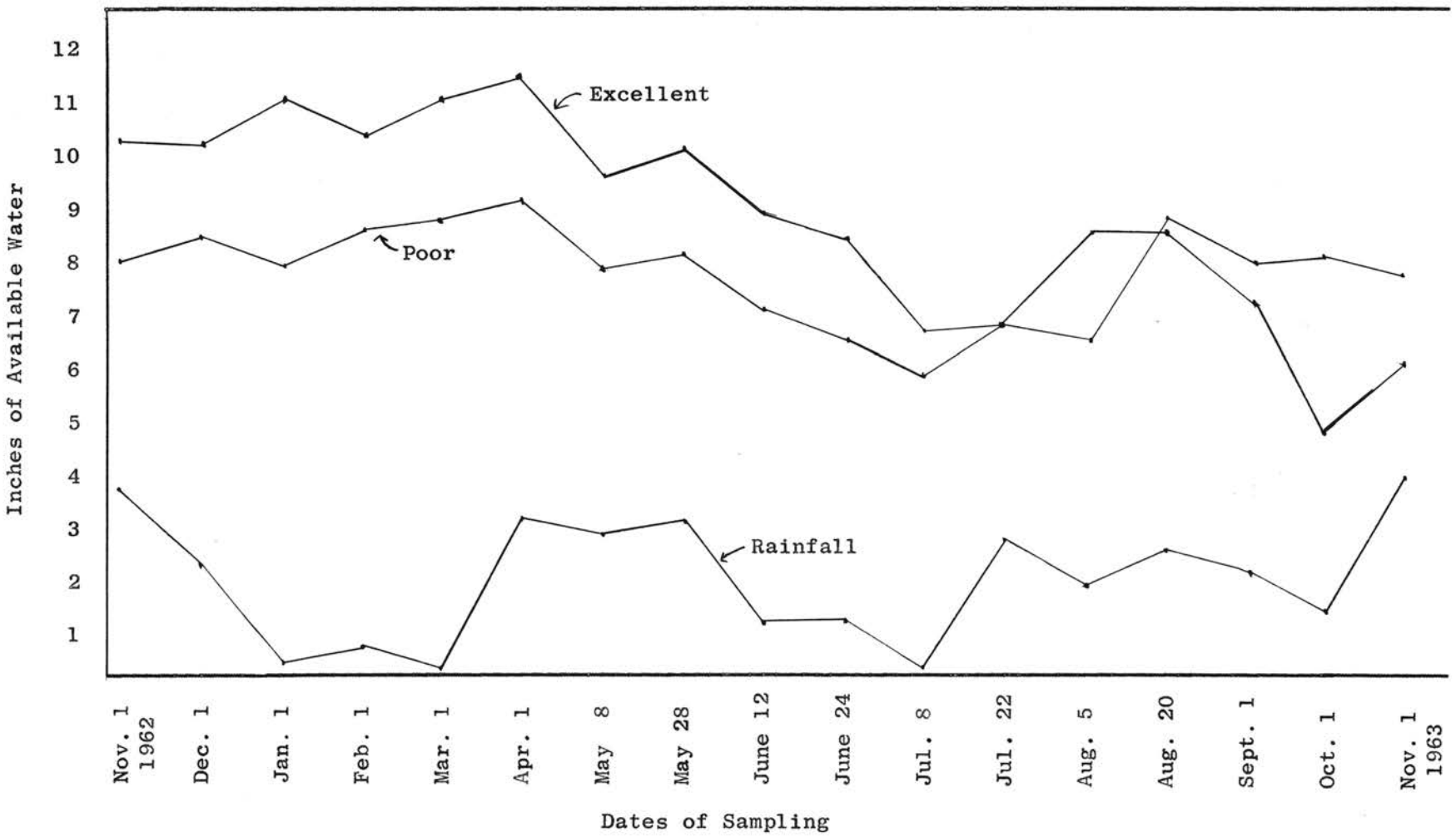
Study areas III and XIII were used to determine the effect of range condition on soil moisture. Pasture III was in excellent range condition and pasture XIII was in poor condition. A detailed examination of the soil profile immediately adjacent to the source of the soil moisture data indicated that the only difference in the profiles occurred at depths greater than 30 inches where the soil texture in pasture III contained more of the sand fraction than in pasture XIII.

Figure 1 shows the inches of available water in excellent and poor condition pastures throughout the year, and the precipitation for the interval between sampling. Overall, soil moisture in the excellent condition pasture exceeded the moisture in the poor condition by an average 1.8 inches of water available to plants in the 48 inch profile studied. However, no moisture stress was observed in either pasture during a near average rainfall year of 29.4 inches.

Throughout the dormant period, November, 1962, to April, 1963, the poor condition pasture contained fewer inches of available water in the profile than the excellent condition pasture. Once plants began to make their spring growth, water in both profiles declined even though substantial rainfall occurred in April and May. The soil in the excellent condition pasture had more inches of available water than the poor condition pasture and probably also required more water due to more forage present. In July both pastures contained approximately the same amount of moisture. The average inches of available water in the 48 inch profile of the excellent and poor condition pasture was 9.3 and 7.5 inches, respectively. These differences were significant at the 95 per cent

FIGURE 1

Available Soil Moisture in 48 inch Profile of Excellent and Poor Range Condition Sites and Rainfall Data



confidence level using a "t test". As range condition declined from excellent to poor, pounds of mulch and per cent of ground covered by mulch decreased from 5,860 pounds and 82 per cent to 261 pounds and seven per cent, respectively. This data agrees with Humphrey (1949). According to Duley and Kelly (1941) and Duley and Domingo (1949), this decrease in mulch covering could influence the amount of rainfall absorbed into the soil profile.

CHAPTER V

SUMMARY

The pattern of retrogression due to grazing for native vegetation was determined for the loamy prairie range site in north central Oklahoma. An attempt was made to determine the relationship of range condition to amount of mulch on the soil surface and to soil moisture. The loamy prairie range sites are gently rolling, deep, loamy upland soils. The soils are neutral to slightly acid with slow to medium permeability.

The important findings were:

(1) Decreasers, primarily little and big bluestem, declined from 93 per cent in excellent condition pastures to zero in extremely poor condition pastures.

(2) Sideoats grama, blue grama, and other increaser plants increased in intermediate condition pastures and usually decreased in poor condition pastures.

(3) Invader plants, primarily buffalograss, increased from zero on excellent condition pastures to 92 per cent on a poor condition pasture.

(4) Basal cover of grasses increased from 12.5 per cent in excellent and good condition pastures to 14.5 per cent in fair condition pastures and to 20 per cent in poor condition pastures.

(5) Forbs were important in many study areas and in others they were insignificant. Western ragweed, western yarrow, black-eyedsusan, and wavyleaf thistle are perennial species that increased with overgrazing. Blue salvia and prairie scurfpea decreased when overgrazed. Generally, perennial forbs decreased under light grazing but increased as grazing became heavier while annual forbs increased under overgrazing.

(6) Considerably less mulch occurred on poor condition pastures as compared to excellent and good condition sites. Average mulch per acre was 3,000, 1,130, and 330 pounds for excellent and good condition, fair condition, and poor range condition study areas, respectively. Per cent of ground covered by mulch decreased with range condition and mulch quantity.

(7) Throughout a season of near average rainfall, 29.4 inches, available water averaged 9.3 and 7.5 inches per 48 inch profile for excellent and poor range condition pastures, respectively.

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