

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

ProQuest Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

UMI[®]

PREVIEW

NOTE TO USERS

This reproduction is the best copy available.

UMI[®]

PREVIEW

UNIVERSITY OF NEBRASKA LIBRARIES

MANUSCRIPT THESIS

Permission to use this thesis has been given by the author or department under whose direction it is written.

Approved by author

Approved by department

It is expected that proper credit will be given for any quotations taken from this work. Extensive copying or publication of the thesis in whole or in part requires the written consent of the author or department.

This thesis has been used by the following person, whose signatures attest their acceptance of the above restrictions.

A library which borrows this thesis for use by its patrons is expected to secure the signature of each user.

NAME AND ADDRESS	DATE
------------------	------

PREVIEW

PREVIEW

**STAGES IN SUCCESSION TO TRUE PRAIRIE AS
REPRESENTED BY MIDWESTERN PASTURES**

by

John W. Voigt

A THESIS

**Presented to the Faculty of
The Graduate College in the University of Nebraska
In Partial Fulfillment of Requirements
For the Degree of Doctor of Philosophy
Department of Botany**

Under the Supervision of Dr. J. E. Weaver

Lincoln, Nebraska

December 3, 1949

**UNIVERSITY
OF NEBRASKA
LIBRARY**

UMI Number: DP13997

UMI[®]

UMI Microform DP13997

Copyright 2006 by ProQuest Information and Learning Company.
All rights reserved. This microform edition is protected against
unauthorized copying under Title 17, United States Code.

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

20-5-50-Ladme

ACKNOWLEDGEMENT

The writer wishes to acknowledge his indebtedness to Dr. J. E. Weaver for outlining the plan of investigation, for help in describing the pastures and for several of the photographs. His aid in organizing the data is also greatly appreciated.

J.W.V.

PREVIEW

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	1
CLASSES OF PRAIRIE PLANTS	3
PROCESS OF DEGENERATION OF PRAIRIE	6
AREAS STUDIED.	7
Location and Size	8
Topography, Water, and Soils	10
VEGETATION	12
Excellent Pastures	12
Good Pastures	15
Fair Pastures	18
Poor Pastures	21
METHODS	23
COMPOSITION OF VEGETATION IN THE RAYMOND SERIES	26
COMPARISON OF PASTURES	31
Excellent Grade Pastures	33
Good Grade Pastures	35
Fair Grade Pastures	38
Poor Grade Pastures	40
Resume	42
Occurrence of Forbs	42
BASAL AREA, MULCH, AND BARE SOIL	47
UNCONSUMED FORAGE FURNISHED BY GRASSES AND BY FORBS	50
Forage from Grasses	51

TABLE OF CONTENTS (Continued)

	<u>Page</u>
Forage from Forbs	53
Resume	54
DISCUSSION	55
SUMMARY	62
LITERATURE CITED	70

PREVIEW

STAGES IN SUCCESSION TO TRUE PRAIRIE
AS REPRESENTED BY MIDWESTERN PASTURES

INTRODUCTION

After 80 years of settlement in the prairies of eastern Nebraska, considerable native grassland still remains. Many meadows represent unbroken prairie but even larger tracts are in native pasture. The remaining areas of grassland in the True Prairie association in western Iowa, eastern Nebraska, and parts of four adjoining states have been fully described by Weaver and Fitzpatrick (1932, 1934). The harmful effects of placing too many cattle in an area of fenced grassland and of permitting grazing too early in spring and too late in autumn have been pointed out by Weaver and Hansen (1941). Under moderate grazing, the vegetation in some prairies has changed relatively little even after a quarter-century. Such grazing is to a degree that will permit the more desirable forage plants to maintain or increase their abundance and yet permit the removal of much of the entire forage year by year. But under excessive use the prairie deteriorates and the plant population gradually changes until finally only grasses of poor quality, weeds, and bare soil remain. After years of close observation and experiment, Weaver and Hansen (1941, 1941a) classified deteriorating grassland into four grades—excellent, good, fair, and poor pastures.

UNIVERSITY
OF NEBRASKA
LIBRARY

Even after eight good years following drought, its marks upon the native plant cover are still clear, although slowly fading. Chief among these are a great decrease in little bluestem (Andropogon scoparius)¹ and a correspondingly great increase in amount of big bluestem (A. furcatus). Both prairie dropseed (Sporobolus heterolepis) and tall dropseed (S. asper) have also increased. Moreover, certain native forbs have become far less abundant while others are much more numerous than before the drought. Still another drought-recovery phenomenon is a great increase in the amount of Kentucky bluegrass (Poa pratensis) (Weaver 1950). These changes affected not only the climax prairie but also the very numerous degenerate prairies called pastures, of whatever grade.

In this study the composition of the vegetation in each of the four grades of pasture is examined and compared as regards species of grasses and forbs. The amount of vegetation available for forage during the growing season was also ascertained as well as the amount of litter or mulch left on the soil. While this study is largely a story of degeneration it is also one of plant succession, since each stage in degeneration is also a stage in the subsere from which, under proper rest or careful use, the vegetation may develop to the next higher stage as from fair pasture to good or from good to excellent. These stages of pastures, like the stages in a sere,

¹ The nomenclature of grasses follows Hitchcock's "Manual of the Grasses of the United States; that of other plants Britton and Brown's "Illustrated Flora."

represent only a median condition where the change from one type of vegetation to another is very pronounced. The change in both instances is gradual. Pastures upon which mulch is accumulating are usually on the upgrade, those with little or no mulch are generally on the downgrade. Active erosion is found in pastures of lower grade, while erosion scars are generally healing in those of good or excellent condition. Since composition of vegetation is the best criterion of the stage of degeneration or regeneration (development toward the climax), here major attention is given to the kind and amount of vegetation.

CLASSES OF PRAIRIE PLANTS

The native prairie plants have been separated into four classes by Weaver and Hansen (1941_a) according to the manner in which they respond to grazing. Their lists of species belonging to each class were compiled only after constantly checking the behavior of each species concerned in many pastures over a period of 12 years.

The first class includes grasses that decrease under grazing. In common usage species in this group are designated as decreasers. Here are included all of those grasses that are best-liked and most readily grazed by cattle. This includes about a dozen species. For brevity, only those that occurred abundantly in this study are listed.

Decreasers

Big bluestem
Andropogon furcatus

Little bluestem
Andropogon scoparius

Prairie dropseed
Sporobolus heterolepis

Tall dropseed
Sporobolus asper

Needlegrass
Stipa spartea

Plains muhly
Muhlenbergia cuspidata

June grass
Koeleria cristata

Indian grass
Sorghastrum nutans

A second class, decreaseers among forbs, included practically all the legumes but in this postdrought study only two in the list of 12 legumes and 32 other forbs (Weaver and Hansen 1941) were of sufficient abundance to warrant individual consideration. These are lead plant (Amorpha canescens) and wild alfalfa (Psoralea floribunda).

The third class is that of grasses that increase under grazing, and a fourth consists of forbs that respond in the same manner. The complete lists are quite long; the partial ones necessary in this study follow:

Increaseers

GRASSES

Kentucky bluegrass
Poa pratensis

Side-oats grama
Bouteloua curtipendula

Blue grama
Bouteloua gracilis

Scribner's Panic grass
Panicum scribnerianum

FORBS

Yarrow
Achillea occidentalis Raf.

Prairie cat's-foot
Antennaria campestris

Prairie mugwort
Artemisia gnaphalodes

Many-flowered aster
Aster multiflorus

GRASSES (Continued)

Wilcox' panic grass
Panicum wilcoxianum

Hairy grama
Bouteloua hirsuta

Sedges
Cyperaceae

Rushes
Juncaceae

FORBS (Continued)

Daisy fleabane
Erigeron ramosus

Pennyroyal
Hedeoma hispida

Yellow oxalis
Oxalis stricta

Smooth goldenrod
Solidago glaberrima

Baldwins ironweed
Vernonia baldvini

While the first four classes deal with prairie species only, the fifth and sixth include grasses and forbs not common to prairie but weedy species that invade only after various prairie plants have been greatly weakened or have died.

Invaders

GRASSES

Sand dropseed
Sporobolus cryptandrus

Western wheat grass
Agropyron smithii

Purple lovegrass
Eragrostis spectabilis

Ticklegrass
Agrostis hiemalis

Little barley
Hordeum pusillum

Brome grasses
Bromus spp.

Tumblegrass
Schedonnardus paniculatus

FORBS

Annual ragweed
Ambrosia elatior

Western ragweed
Ambrosia psilostachya

Flodman's thistle
Cirsium flodmani

Wavy-leaved thistle
Cirsium undulatum

Spotted spurge
Euphorbia maculata

Snow-on-the-mountain
Euphorbia marginata

Gumweed
Grindelia squarrosa

GRASSES (Continued)

Annual dropseeds
Sporobolus vaginiflorus
Sporobolus neglectus

Bead grass
Paspalum stramineum

Six-weeks fescue
Festuca octoflora

Crabgrass
Digitaria sanguinalis

Stinkgrass
Eragrostis cilianensis

Canada bluegrass
Poa compressa

FORBS (Continued)

Peppergrass
Lepidium densiflorum

Horseweed
Leptilon canadense

Pursh's plantain
Plantago purshii

Knotgrass
Polygonum aviculare

Dandelion
Taraxacum officinale

Vervain
Verbena stricta

PROCESS OF DEGENERATION

Climax grassland, when grazed lightly, may retain essentially its natural composition over extremely long periods. It is only when grazing animals are circumscribed in their range by fences and when too large a population is thus confined that grazing and trampling become so excessive that the normal cover cannot be maintained.

The selection of grass types and preference for certain species by livestock is marked when forage is plentiful. Repeated partial removal of the most palatable grasses results in better growth of the remaining vegetation. In fact, if certain favored plants are grazed too early, too often, and too closely, they will disappear entirely. Less desirable species then receive more light and increased water, as well as additional nutrients, which are normally used by the more

palatable grasses. In consequence, they flourish and may actually increase, often with marked rapidity. Thus, during the early stages of grassland degeneration there is considerable shifting of the plant population, but this is entirely among the species which are normal components of native prairie.

As the hold of native species is weakened by continued pasturing or intense overgrazing, invaders come in. The great stability of natural grassland and the absence of weeds have been emphasized by Weaver and Flory (1934). But under pasturing many small, bare places appear. The bare areas invite invaders, which once established, furnish seed for a new population. Gradually, the native grasses and forbs are partially or entirely replaced by invading species which are better adapted to close grazing and trampling. Nearly all of these are less productive, or less palatable, or both, than the original occupants. With the disappearance of most of the native population the prairies are far advanced on their way toward final disintegration (Fig. 1).

THE AREAS STUDIED

The grasslands considered here occur within the western portion of the True Prairie association. They are located near Lincoln, Nebraska, in Lancaster county, which is about 80 miles east of the transitional area or ecotone that grades into mixed prairie. They consist of three groups or series of native pastures. Each series includes four grades of pasture.



Fig. 1. View from a high-grade native pasture (right foreground and opposite ungrazed prairie on the left) into one of low grade, in right background. The light color is due to an abundance of ripened downy brome (Bromus tectorum). The dark bunches are ironweed (Vernonia baldwini). The left background was also prairie, but the vegetation has only partly degenerated under grazing and the pasture is still of medium grade. Photo near Lincoln, June 20, 1944.

One pasture in each series has been grazed for only a few seasons or so moderately that it has not degenerated greatly from the condition of natural prairie. This is the excellent grade. A second one, because of longer or more intensive grazing, consists of about half native prairie vegetation and half Kentucky bluegrass or blue grama or both of these grasses. It is a good grade pasture. A third, or fair grade pasture in each series, has been overgrazed for a long period of years. Practically all of the native species have been replaced either by nearly pure stands of bluegrass or blue grama and buffalo grass (Buchloe dactyloides) or by a mixture of these species. The fourth or poor grade pasture is very much degenerated. It is like the third except annual early grazing or overstocking or both have weakened the grasses so greatly that bluegrass and short grass no longer furnish a continuous carpet of vegetation but occur in patches between which there is much bare soil or soil clothed only by invading weedy grasses and forbs.

Location and Size

The first series of pastures was selected from range lands 7 to 9 miles northwest of the University of Nebraska and about 1 mile east of the highway to Raymond. This road skirts the broad floodplain of Oak Creek on the east at the foot of a long range of prairie-covered hills. The excellent grade pasture in this Raymond series is in Section 21, Township 11 N., Range 6 W. Like the others it is enclosed by a barbed wire

fence. It is about 55 acres in area. The good grade pasture, of approximately the same size, is located half a mile south of the first. A half-mile north of the excellent pasture is the one of fair grade, with a nearly pure cover of bluegrass. It is about 70 acres in extent. The poor grade pasture lies half a mile west of the good pasture and is about 45 acres in area.

The second series is located 5 miles west of Lincoln, on similar rolling upland. All of the pastures are about 3 miles west of the Lincoln Municipal Airport, except that of fair grade which is located on similar terrain 3 miles west and 4 miles south of the preceding. The excellent pasture of this Airport series is in Section 12, Township 10 N., Range 6 E. It contains about 70 acres. The good pasture is located a mile southeast of this one and it is about 50 acres in extent. The poor grade pasture is approximately the same size as the good one and lies one-fourth mile southeast of it. The pasture of fair ~~was~~ ^{is} to the southeast is in section 33, Township 9 N., Range 5 E. Its area is about 60 acres.

The third series of pastures ~~were~~ ^{was} selected on rolling range lands about 18 miles southwest of Lincoln and 4 miles southwest of Denton. All grades occur within a distance of 2 miles. The excellent pasture consists of about 200 acres. It is in Section 4, Township 9 N., Range 5 E. Only about 60 acres of this pasture were sampled. The good pasture contains about 220 acres and lies about one-half mile south of the excellent

one. About 60 acres of it were sampled. The fair pasture is located about three-fourths mile north and west of the excellent one; two adjacent areas, each of about 25 acres were sampled in this study. The poor pasture lies across the road, east and a half-mile north of the excellent one. Like most poor pastures, it has a smaller area than those of higher grade.

Topography, Water, and Soil

The topography in all twelve pastures was that of moderately rolling upland. Each pasture has one complete hill or ridge with slopes of various exposures, some level upland and at least small amounts of nearly level land along the ravines (Fig. 2). The general elevation is between 1,200 and 1,400 feet. In places ravines were 10 to 15 feet deep and had steep slopes, which were mostly covered with vegetation. Above these slopes, more gentle ones prevailed. They varied from 2-5 to 7-10 percent over the greatest expanse of the hills, some of which had gently sloping to nearly level tops. The hilltops are between 50 and 130 feet above the ravines. Although much runoff water may be carried down the ravines during heavy rains, nearly all are dry, except for a few days after a rain.

Enough water is impounded in spring to last during the grazing season by dams which have been placed across some of the larger ravines (Fig. 3). Water for stock is obtained in some pastures from these artificial ponds. Often this supply

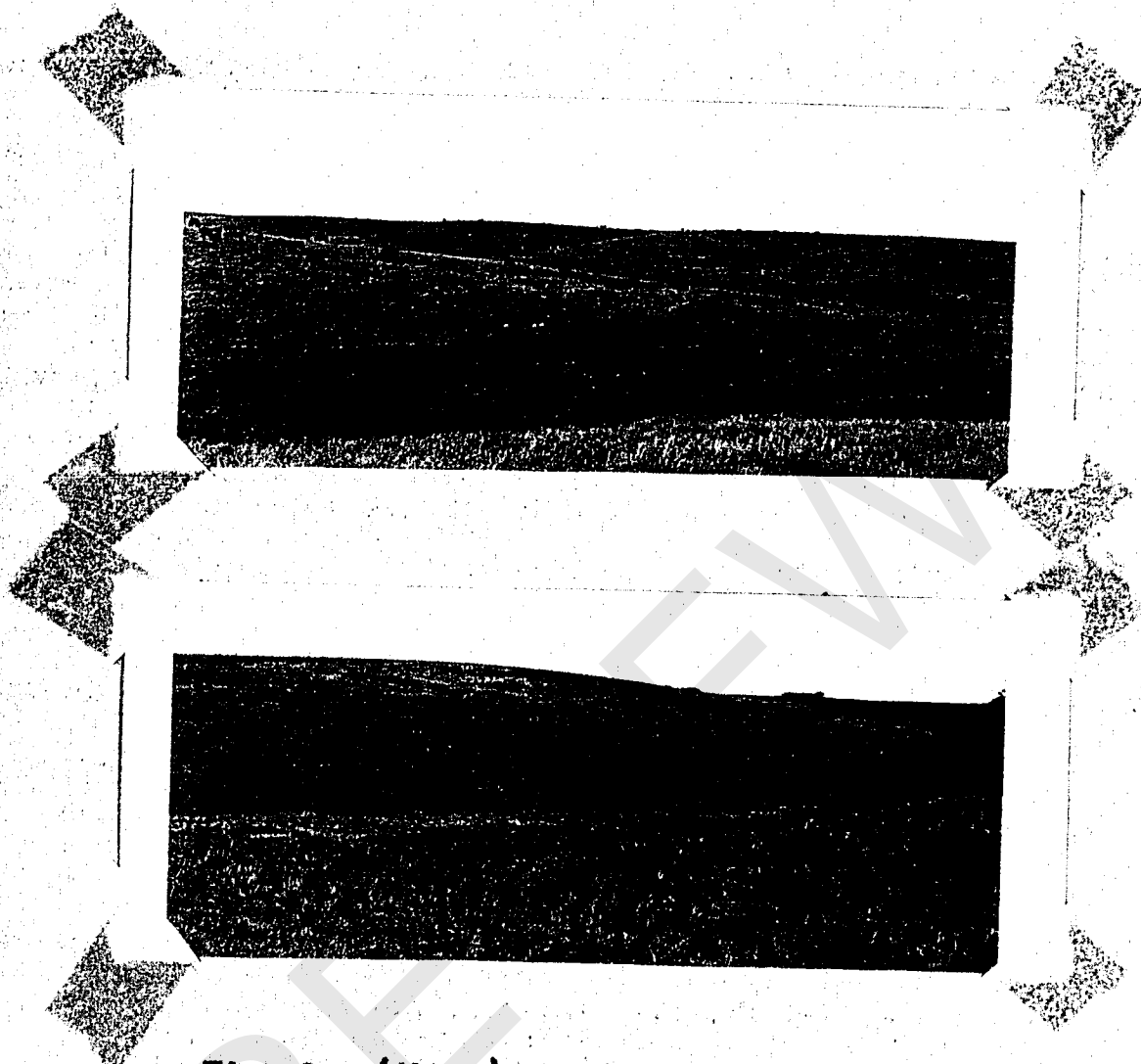


Fig. 2. (Above) Typically hilly land clothed mostly with bluestems (*Andropogon*), dropseeds (*Sporobolus*), and Kentucky bluegrass (*Poa pratensis*). The prairie is annually grazed from early spring until late fall. (Below) View in the excellent pasture of the Raymond series showing the south slope of the central large hill and lower land in the foreground. The bunches are mostly little bluestem (*Andropogon scoparius*).



Fig. 3. Typical view in a high-grade pasture showing a portion of a pond where the water has been impounded by an earthen dam. Note the good cover of vegetation, isolated bunches of little bluestem, and absence of weeds.