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Bio-Ecology On A Mixed Prairie Near Hays, Kansas

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BIO-ECOLOGY ON A MIXED PRAIRIE

NEAR HAYS, KANSAS

being

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by

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TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

INTRODUCTION

A survey of the activity of wild animals in connection with range conditions and range management is greatly needed in western Kansas. To have a well managed range one should have an understanding of the ecological factors which benefit or deplete the native vegetation that is essential for production of livestock. The impact of grazing, and the effect of changes in edaphic and atmospheric environment on the prairie have further emphasized the importance of a cover of grass in preventing erosion.

The coaction of rabbits, rodents, carnivores and birds in many ways has a part in the utilization of plants on an area. Rabbits and rodents in particular have been destructive or have partly consumed plant materials desired by man or by domesticated livestock. Hawks, owls and coyotes take a toll of rabbit and rodent population for food. It is not at all uncommon for hawks, owls, or coyotes to prey upon calves, lambs, pigs, poultry, or beneficial game and song birds.

Large populations of jack rabbits were found over most of western Kansas during the drought of 1933 to 1939 inclusive. The rabbits were utilizing large quantities of plant materials that were needed for the maintenance of farm livestock. Rabbit drives conducted during the recent drought frequently penned as many as 1,000 to 3,000 jack rabbits on 640 acres. The importance of plants to animals is generally known but the manner in which the plants make use of animals in their way of life is a study that needs much more attention. Perhaps more important relationships between native plants and native animals could be found if studies were conducted for this purpose.

As the animals travel from one area to another it is possible that seeds may cling to their furry coats and be carried to great distances. The dissemination of seeds in the fecal pellets, however, seems to be the most effective way in which they are dispersed by these animals.

In western Kansas several grasses have appeared early when natural revegetation was allowed to occur on barren areas. One of the first pioneers was sand dropseed accompanied by Texas crabgrass and windmill grass. Just how they made their entrance into the new field so quickly was not fully known.

The present research is concerned with the bio-ecology of the mixed prairie, especially with the utilization and dissemination of plants by native animals.

RELATED STUDIES

The mixed prairie was first identified as a distinct plant association by Clements (1920) who described its nature and range, also the grouping of dominants. Albertson (1937) segregated the mixed prairie near Hays, Kansas, into three types. The Big bluestem dominates the ungrazed lowlands and ravines. Little bluestem and its associates are most common on the hillsides, while the short grasses occupy the high level land. The growth and seed yields of native prairie plants near Hays, Kansas, were studied by Brown (1942). Sand dropseed produced 172, 87, and 163 pounds per acre respectively during the years 1939, 1940, and 1941.

Vorhies and Taylor (1933) made a study of the life history and

ecology of jack rabbits in Arizona. Indications were that daily movements of jack rabbits depend on food and shelter relations. In their study they found that 15 jack rabbits would consume as much forage as one sheep and that 74 jack rabbits would eat as much as one mature cow. In making studies of forage consumption of jack rabbits on a cow-rabbit comparison, Arnold (1942) found that 55 to 69 rabbits would consume as much forage as one cow in maximum competition. In minimum competition, however, it was found that 240 to 280 rabbits would consume that amount.

The effect of jack rabbits on the rate of recovery of deteriorated range land in New Mexico was studied by Parker (1938). He found that jack rabbits may consume as much as 99.4 percent of the perennial grass foliage. It is inadvisable to attempt artificial reseeding of similar range land with grasses or palatable forbs without accompanying efforts to eradicate or control the rodents and rabbits. In Arizona, Vorhies and Taylor (1933) found a significant relationship between numbers of fecal pellets and abundance of jack rabbits.

Hendrickson (1929), of Iowa, found that 0.55 and 0.52 pellet per square foot represents about one jack rabbit and one cottontail respectively per acre. The same author (1938) found that small trees and shrubs made up a good portion of the winter diet of the cottontail. Pellet counts indicated that the heaviest population of cottontails was in apple orchards with prunings and mown red clover or in apple orchards with prunings and winter rye. Timmons (1942) observed the jack rabbits eating prickly pear cactus fruits in west-central Kansas and disseminating the seed in their fecal pellets. The germination of the seeds found in jack rabbit droppings was 62 percent in comparison to 44 in hand picked seeds.

Extensive eating of cactus pads and prickly pear fruit was reported by Riegel (1941) during the fall and winter of 1939 and 1940, near Hays, Kansas. Most of the seeds eaten with the fruit passed through the digestive tracts of the rabbits unharmed. Spermophiles were observed to feed on cactus seeds and to bury the seeds in the ground in caches. Seedlings of prickly pear were found emerging from these buried stores.

Germination of seeds in pellets of the ring-necked pheasants was studied in West Virginia where Swank (1944) examined pheasant droppings and collected seeds for germination. Approximately 6 percent of the hard-coated seeds passed through the digestive tract unharmed. These seeds germinated more quickly than those not exposed to such treatment.

Studies on the effect of drought on animal population in western Kansas were made by Wooster (1935 and 1939). Jack rabbits increased greatly during the drought. The meadow mouse decreased from 2,500 per square mile to a point where no signs of its activity could be detected.

Weaver and Flory (1934) made a study of climax prairie and some environmental changes resulting from breaking. Increase of rabbit population on overgrazed as compared with stabilized areas, and a similar change in the abundance of spermophiles may be cited as examples of a disturbed natural balance. Rabbits and rodents very much prefer the more succulent forbs that are so plentiful in disturbed areas.

The relation of jack rabbits to grazing in Southern Arizona was studied by Taylor, Vorhies and Lister (1935). Indications are that rabbits prefer grazed areas as compared to areas under total protection, or to those lightly grazed.

Taylor (1944) reports from Eastern Texas that up to a certain point rabbits benefit from livestock grazing, tending to be scarce or absent when thick herbage, whether grass or forbs, covers the ground and obstructs their vision. Thus as overgrazing removes the vegetation jack rabbits tend to increase, the cottontails tend to decrease.

LOCATION AND DESCRIPTION OF AREA

The area selected in this investigation contain approximately 550 acres in or near the college pasture about 2.5 miles west of Hays, Kansas (Fig. 1). The portion studied in the pasture comprises about 405 acres of which 129 acres are short grass, 152 acres are little bluestem and its associates, and 44 acres are lowland. In 1920, eighty acres were abandoned as farm land and fenced in with the college pasture where revegetation occurred naturally.

Bordering the south side of the pasture is an area of artificial revegetation comprising 54 acres seeded in 1941. Fifty acres were seeded to blue grama and 4 acres were seeded to a mixture of switch grass, side-oats grama and little bluestem.

Across the road to the east from the area of artificial revegetation is located the ungrazed little bluestem type comprising approximately 36.5 acres. Along the southeast side of the pasture lies a 54.5 acre wheat field which completes the area observed in this study.

TOPOGRAPHY

The land of this section of the state is typically rolling as is much of the west-central Kansas. The altitude varies from around 2,000 feet in the lowlands to approximately 2,200 feet on the highest hills

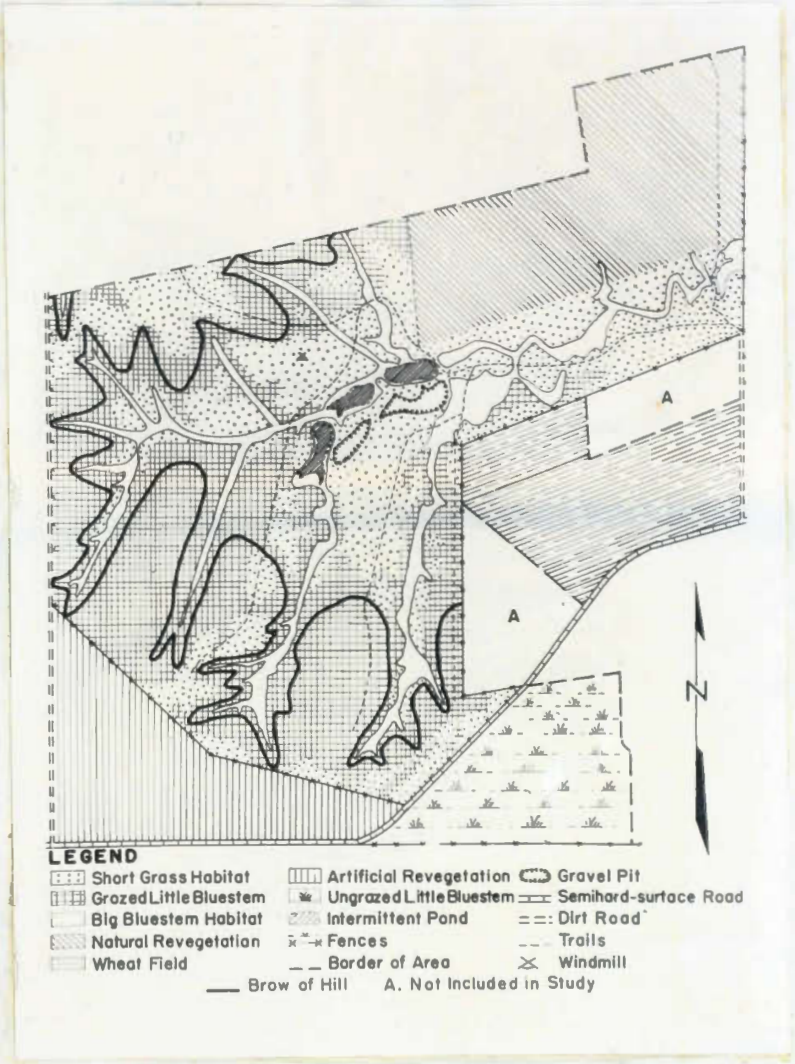

Fig. 1. A drawing of the study area showing the location of the different plant habitats.

and table lands. A large winding ravine runs diagonally across the area, and tributaries from several directions connect with this ravine to form a broken topography. A broad strip of rather irregular, nearly level tableland stretches between the heads of the tributary ravines and slopes gently to the brows of the hills where the descent is commonly abrupt to the nearly level lowland (Albertson 1937).

The degree of slope varies considerably on the little bluestem types. Over most of the area it is from 3 to 20 percent but in some places, where the layer of soil is thin and the vegetation is sparse, the slope is often as much as 60 percent. The other plant types, however, are on areas with slight inclines of 3 to 6 percent.

The nearly normal precipitation during the present research failed to produce much runoff due to a heavy cover of litter and living vegetation. The wheat field lacking ground protection washed considerably along the slopes.

SOIL CONDITIONS

The fine textured soils on the area studied are a part of the residual soil group of Kansas (Throckmorton 1932). Those on nearly level highlands and hillsides have been formed from the Fort Hays limestone but infiltrated with sand from overlying Tertiary deposits which have now been completely eroded leaving the soil on the upper slopes thin and rocky. The eroded materials from the level highlands and hills have been carried down by force of water and gravity onto the lower slopes and ravines forming a deep and fertile alluvial soil (Albertson 1937). The rains of late summer and fall and the occa-

sional snows throughout the winter made soil conditions conducive to plant development.

V E G E T A T I O N

The vegetation of the area varied in degrees of mixture of native grasses and forbs. Weeds and occasional shrubs were represented on some of the plant habitats. The basal cover was determined by charting 6 to 13 meter quadrats on each area. The composition and basal area are given for all types having a cover of native vegetation. A list of the plants found to be of greatest value to the native animals of the area is given in Table 1.

Table 1. The grasses, forbs, and shrubs found to be most important as aids to native prairie animals.

Common Name	Scientific Name
GRASSES	
Big bluestem	Andropogon furcatus
Blue grama	Bouteloua gracilis
Buffalo grass	Buchloe dactyloides
Green foxtail	Setaria viridis
Hairy dropseed	Sporobolus pilosus
Heavy sedge	Carex gravida
Hooker's dropseed	Sporobolus hookeri
Indian grass	Sorghastrum nutans
Little bluestem	Andropogon scoparius
Sand dropseed	Sporobolus cryptandrus
Side-oats grama	Bouteloua curtipendula
Stinkgrass	Eragrostis cilianensis
Switch grass	Panicum virgatum
Western wheat grass	Agropyron smithii
Windmill grass	Chloris verticillata
FORBS AND WEEDS	
Annual sunflower	Helianthus annuus
Blazing star	Liatris punctata
Broom weed	Gutierrezia sarothrae
Cactus	Opuntia macrorrhiza
Chalk lily	Nuttallia decapetala
Cocklebur	Xanthium commune
Ground cherry	Physalis lanceolata
Houstonia	Houstonia angustifolia

Table 1 - Cont'd.

Common Name	Scientific Name
Ironweed	Vernonia baldwini
Ivory-seeded borage	Onosmodium occidentale
Lead plant	Amorpha canescens
Low milkweed	Asclepias pumila
Low townsendia	Townsendia exscapa
Maximilian sunflower	Helianthus maximiliani
Many-flowered aster	Aster multiflorus
Perennial ragweed	Ambrosia psilostachya
Pitcher's sage	Salvia pitcheri
Prairie alfalfa	Psoralea tenuiflora
Prairie coneflower	Ratibida columnaris
Prairie pansy	Viola rafinesquii
Purple poppy-mallow	Callirrhoe involucrata
Rayless thelesperma	Thelesperma gracile
Redroot pigweed	Amaranthus retroflexus
Rigid-leaved goldenrod	Solidaga rigida
Bee bush	Cleome serrulata
Russian thistle	Salsola pestifer
Sensitive brier	Morongia uncinata
Single fruited croton	Croton monanthogynus
Skull cap	Scutellaria resinosa
Snow-on-the-mountain	Euphorbia marginata
Soapweed	Yucca glauca
Spiny sideranthus	Sideranthus spinulosus
Tetraneuris	Tentraneuris stenophylla
Texas croton	Croton texensis
Texas sandwort	Arenaria texana
Velvety goldenrod	Solidago mollis
Wavy-leaved thistle	Cirsium undulatum
Whitlow wort	Par nychia jamesii
Wild onion	Allium nuttallii
TREES AND SHRUBS	
American elm	Ulmus americana
Chokecherry	Prunus melanocarpa
Hackberry	Celtis occidentalis
Ill-scented sumac	Rhus trilobata
Prairie rose	Rosa suffulta
Smooth sumac	Rhus glabra

Short Grass

The short grass (Buchloe-Bouteloua) type was a moderately grazed pasture found widely distributed over the nearly level uplands (Fig. 2).

Fig. 2. A short grass habitat showing a dense cover of blue grama and buffalo grass and scattered plants of broom weed.

Fig. 3. A lowland habitat with heavily grazed big bluestem, wheat grass, blue grama and buffalo grass forming a lower story of vegetation.

Smaller areas also occurred at the base of the hills particularly on south-facing slopes. The basal cover of buffalo grass was 65.2 percent and that of blue grama 24 percent with all other grasses making less than 0.5 percent. The abundance of short grasses in comparison to that of taller species created a continuous cover of short vegetation with clumps of mid grasses in the more favorable places such as buffalo wallows. There were 16 species of grasses and 59 of forbs found on this area.

Lowland

A total of 15 species of grasses and 30 species of forbs and weeds was observed on the area. Buffalo grass, side-oats grama and blue grama were the dominant species due to moderate or heavy grazing by livestock (Fig. 3). In other places western wheat grass formed a nearly pure stand while in some areas it was open and overtopped a lower story of short grasses. Big bluestem, the dominant species on the ungrazed lowland type, remained only as remnants of the original stand. The grasses on this lowland arranged according to percent of ground cover are buffalo grass 35.6, side-oats grams 21.4, blue grams 5.4, western wheat grass 2.8, and big bluestem 1.5 percent. Other species of grass made up less than 1 percent of the cover.

Grazed Little Bluestem

The most extensive type was the grazed little bluestem and its associates of 16 species of grasses and 85 species of forbs and weeds (Fig. 4). The area occupied the hillsides and extended across the

Fig. 4. Lightly grazed little bluestem habitat and its associates of which side-oats grama, blue grama and hairy grama are most common, often giving an appearance of the charter grasses.

Fig. 5. Little bluestem not grazed by livestock, uniformly clothed with mid grasses thereby reducing the short grasses.

shallow ravines, also over the brows of the hills and far beyond where the slopes continued, but gave way to the short grasses on the level upland. The presence of closely grazed mid grasses together with blue grama and other short grasses created an appearance of an unusually large amount of the shorter type of vegetation with scattered clumps of unmolested vegetation. The percent ground cover for side-oats grama was 38.8, blue grama 4.2, big bluestem 3.3 and little bluestem 2.7. The remaining 2.8 percent was occupied by the less important species of grass.

Ungrazed Little Bluestem

The ungrazed little bluestem type not having been grazed by livestock was more uniformly clothed with mid grasses thereby reducing the amount of shorter species, especially at the base of the slopes (Fig. 5). A total of 25 species of grasses, and 59 of forbs and shrubs was found on this area. The grasses with the percent of basal cover are as follows: side-oats grama 48.2, little bluestem 6.9, big bluestem 6.5, and all other species of grass 1.2 percent.

Natural Revegetation

In 1920, eighty acres of cultivated land were abandoned and fenced in with the college pasture (Fig. 6). There were 9 species of grass and 17 species of forbs and weeds found growing on this area. Buffalo grass had 26.6 percent basal cover, sand dropseed 5.2, blue grama 3.3, and all other grasses less than 0.5 percent. The sand dropseed had a small basal cover but the high spreading foliage made the appearance of uniformity of cover over most of the area with islands of buffalo grass scattered throughout.

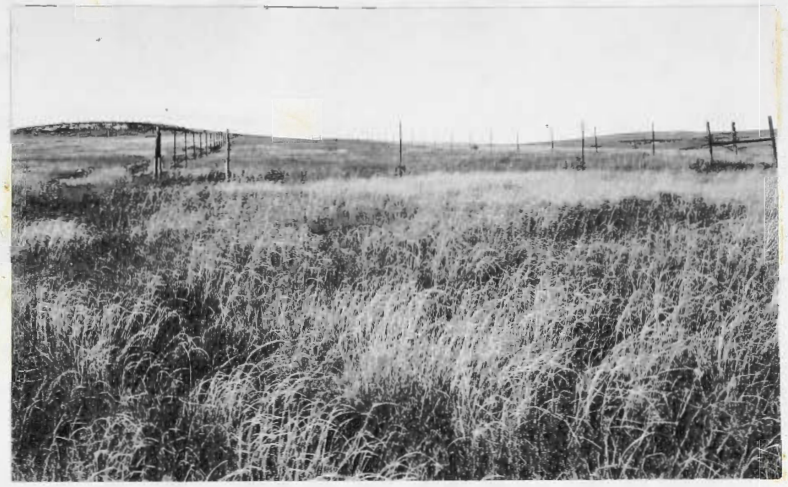

Fig. 6. Natural revegetation habitat showing a sparse stand of buffalo grass overtopped by sand dropseed and perennial ragweed.

Fig. 7. A well established artificial revegetation area of blue grama seeded in 1941 with an abundance of litter and much of last year's growth remaining.

Artificial Revegetation

Cultivation on this area was discontinued in 1933 and in the spring of 1941 about 54 acres were seeded to native grasses as discussed under "Location and Description of the Area." The area of level land had a basal cover of 69.1 percent blue grama and 1.7 sideoats grama (Fig. 7). Cover on gentle slopes seeded to a mixture of taller grasses was switch grass 12.9 percent, Texas crabgrass 1.7, and all other grasses 1.7 percent. Even though the basal cover was somewhat less than in native short grass the accumulated debris was so heavy that scarcely any soil was exposed. The dead material from previous years growth was 2 to 3 inches deep.

Wheat Field

The wheat field included in the study had been continuously cropped to wheat for several years and was used primarily to compare the activity and populations of animals on this area with those on native prairie.

C L I M A T O L O G I C A L C O N D I T I O N S

Precipitation

Data on climate were secured from the United States Weather Bureau, Hays, Kansas. Total precipitation for September 1944 to May 1945 inclusive was 12.22 inches which was 0.02 inch above normal (Table 2). Precipitation in September was 1.83 inches below normal, March 0.80 below and April 1.42 inches above normal. During the remaining months it varied little from average.

Table 2. Monthly precipitation (P) for September to May 1945 with departure from the normal (D), also mean average temperature (T) and departure from the normal (D). Hays, Kansas.

Month	Precipitation P inches	D	Temperature T degrees	D
September	0.44	-1.83	68.6	-0.6
October	1.33	-0.11	57.4	+1.0
November	1.38	+0.43	44.2	+2.1
December	0.93	+0.29	30.1	-1.6
January	0.68	+0.34	32.8	+3.4
February	0.67	-0.10	35.2	+2.9
March	0.08	-0.80	50.0	+7.5
April	3.63	+1.42	50.8	-2.1
May	3.78	+0.38	62.0	-0.4
Monthly Average above normal		+0.02		+1.36

Temperature

The monthly temperatures during the period of study averaged 1.36 degrees Fahrenheit above normal for each month (Table 2). During October, November, January, and February it was 1.0, 2.1, 3.4, and 2.9 degrees F., respectively, above normal and during March it was 7.5 degrees F. above. The mean average for December and April was 1.6 and 2.1 degrees, respectively, below normal. For September and May it deviated but slightly below average.

METHODS OF STUDY

Early in the fall of 1944 the areas of vegetation were selected and studies were initiated. Several afternoons each week were spent on the area or in the laboratory throughout the period of investigation. This study involved the use of traps, food and nest materials, fecal pellets census, line counts of animals, quantity of seeds per acre in pellets, percent germination of seeds found in pellets and of those collected by hand, and the food selected by mice when fed in the laboratory.

Trapping

Traps were used on representative areas to determine the abundance of each species of rodents. The number of mice was found by arranging 24 mouse traps in a gridiron pattern on an acre of each type of vegetation for 7 days each month. Larger traps were used when needed.

The traps were baited with a mixture of peanut butter, raisins, wheaties, grains, and grass and forb seeds. Several areas also were studied for a period of three months with unbaited traps to compare with the catches made with baited traps on a similar area.

Food and Nest Materials

Much data on food habits, nest materials and home life were gathered by excavating burrows and caches.

The species of plants, of which the seeds, stems, or leaves were stored in nests, burrows or caches, were assumed to be those utilized in some manner by animals. Further evidence was obtained by taking into the

laboratory for analysis the stomach contents of animals taken on the area. When recently deposited fecal pellets were found near partly eaten vegetation, it was assumed that these plants were utilized by the animals that deposited the pellets. Further evidence was gained by opening the pellets in order to identify their contents.

Census of Fecal Pellets

This type of count was used to estimate relative numbers and activity of rabbits under various ecological conditions. The pellets also were analyzed for viability of seeds that might aid in plant dissemination.

The pellet census was made by placing on the ground a wooden frame enclosing one square foot and recording the number of the recently deposited pellets within the square. The observer then walked 50 feet, and again placed the square on the ground and made another count. This procedure was continued until 80 counts were made for each plant type. Pellet counts were conducted on each area from October 1944 to March 1945 inclusive.

Line Counts

Line counts were made by using two cars spaced approximately 75 feet apart with a wire dragged between them to flush the rabbits. The counts were used in correlation with the fecal pellet counts taken each month on the plant types to get an index of the number of rabbits per acre on the basis of number of pellets to the square foot. This was accomplished by taking the pellets per square foot and dividing by the

number of jack rabbits per acre observed while making line counts.

Quantity of Seeds per Acre in Pellets

All pellets on an area of 30 square feet in the artificial revegetation and grazed little bluestem types were gathered each month to estimate the amount of sand dropseed per acre contained in fecal pellets.

Germination of Seed

Germination tests were essential in this study to determine the viability of seeds found in pellets of wild animals in comparison to those not exposed to such conditions. All seeds were tested in petri dishes and also sterilized soil. Those placed in the petri dishes were not exposed to freezing and thawing temperature whereas those tested in soil were planted in flats and placed outside where the seeds were exposed to the same weather conditions as were the seeds in the prairie. Unbroken rabbit pellets that contained seeds were tested in soil. Also, studies were made on the area throughout the spring months to find the seedlings growing from fecal pellets.

Choice of Food by Mice in Laboratory

A harvest mouse and a white-footed mouse were placed in cages and fed for a week on a mixture of grains, grasses and forb seeds and several species of insects to determine the amount and variety of the diet which they selected.

RESULTS

Only native animals found to be important in the utilization of plants and the dispersal of plant seeds were considered in this problem.

The following animals were present on all seven plant types:

Jack rabbit Lepus californicus melanotis Mearns

Cottontail Sylvilagus floridanus mearnsi Allen

White-footed mouse Peromyscus maniculatus nebrascensis Coues

Gray harvest mouse Reithrodontomys montanus griseus Baird

Ring-necked pheasant Phasianus colchicus torquata Gmelin

The prairie harvest mouse (Reithrodontomys megolatis dychei Allen) was found only on the artificial revegetation, ungrazed little bluestem and grazed little bluestem, while the presence of the spermophile (Citellus tridecemlineatus arenicola A. H. Howell) was limited to the short grass, natural revegetation and artificial revegetation types. The pocket mouse (Perognathus hispidus paradoxus Merriam) and wood rat (Neotoma floridana campestris Allen) were seen on only the grazed little bluestem area. The meadow mouse (Microtus ochrogaster haydenii Baird) was collected on small areas in the natural revegetation and ungrazed little bluestem types.

THE JACK RABBIT

Activity of the jack rabbit was observed on all habitats, but nowhere was utilization extensive enough to furnish competition for domestic livestock (Fig. 8). A total of 34 different species of plants on all habitats was found to furnish some food from this animal (Table 3).

Fig. 8. The jack rabbit, found everywhere in the mixed prairie. It consumed a large variety of native plants and dispersed many seeds in pellets.

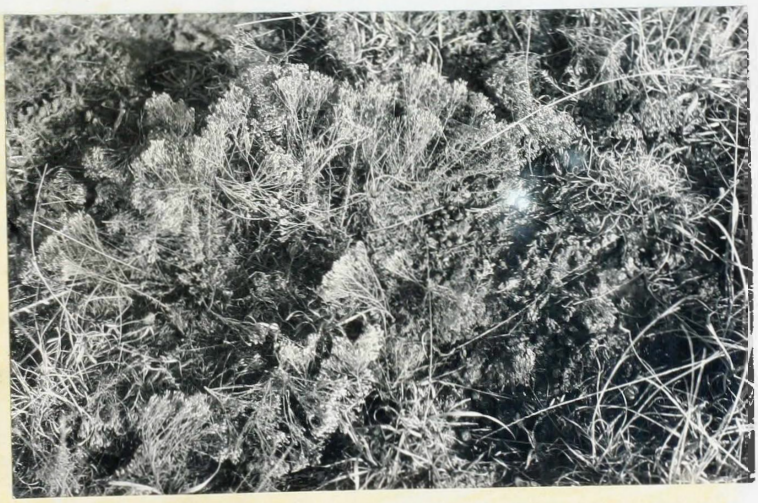

Fig. 9. Broom weed was the plant most heavily grazed by jack rabbits during the fall and winter months.

Several species of plants were severely eaten while others were utilized very lightly. Greatest activity occurred on the grazed little bluestem type where 9 species of grasses and 15 of forbs were partly consumed. The plants on the remaining habitats were utilized to some extent but only a few species were eaten in noticeable amounts.

Table 3. Plants eaten(*) by the jack rabbit in artificial revegetation (AR), natural revegetation (NR), short grass (SG), lowland (LL), grazed little bluestem (GLB), and ungrazed little bluestem (ULB). The symbol (NF) is used to indicate the type of vegetation in which the plants were not found.

GRASSES	AR	NR	SG	LL	GLB	ULB
Big bluestem		NF			*	
Blue grama		*	*		*	
Buffalo grass		*	*			
Hairy dropseed	NF	NF	NF	NF	*	
Heavy sedge				*	NF	*
Hookers dropseed	NF	NF	NF	*		
Little bluestem		NF		NF	*	
Sand dropseed	*	*	*	*	*	*
Side-cats grama		NF			*	*
Stink grass		*			NF	NF
Switch grass	*	NF	NF		*	
Western wheat	*	*	*	*	*	*

Table 3 - continued.

FORBS	AR	NR	SG	LL	GLB	ULB
Blazing star	NF			NF	*	*
Broom weed	*		*	NF	*	*
Cactus		*	*	NF		
Chalk lily	NF	NF	NF	NF	*	
Ground cherry	NF	*	*	NF	NF	
Houstonia	NF	NF	NF	NF	*	*
Ivory-seeded borage	NF	NF	NF		*	
Lead plant		NF			*	
Low townsendia	NF	NF	NF	NF	*	
Many-flowered aster					*	
Perennial ragweed			*			*
Prairie alfalfa				NF	*	
Prairie cone flower					*	
Prairie pansy			*			
Redroot pigweed			*		NF	
Russian thistle					*	
Soapweed	NF	NF		NF	*	*
Spiny sideranthus			*	NF	*	
Tetraneuris	NF	NF	NF	NF	*	
Texas sandwort	NF	NF	NF	NF		*
Velvety goldenrod						*
Whitlow wort	NF	NF	NF	NF	*	*

The more heavily utilized plants were broom weed, soapweed, cactus, chalk lily, heavy sedge, sand dropseed, western wheat grass, blue grama and buffalo grass. Broom weed was heavily eaten during the fall and winter on all areas in which it was found (Fig. 9). The part of the plant affected was a small portion of the stem below the branches of the flower stalk. The long needle-like leaves of the soapweed were heavily grazed during the winter months and in some instances the plants were entirely defoliated (Fig. 10). Cactus, though very scarce, was eaten profusely and late in November the fruits had been completely devoured but the pads formed a portion of the rabbit's diet throughout the winter months. The upper portion of the tap root and leaves of seedlings of the chalk lily were severely eaten after the first damaging frost in the fall.

The green leaves of western wheat grass and heavy sedge were utilized to within 2 to 3 inches of the ground throughout the period of study, whereas the leaves and leaf sheaths surrounding the inflorescence of sand dropseed were most commonly eaten. Blue grama and buffalo grass were utilized lightly but on several occasions rabbits dug beneath the snow and fed on the green vegetation in the crowns of these grasses (Fig.11).

For three days after a 4 to 6 inch snow Russian thistle and tetraneuris were extensively used as emergency food (Fig. 12). A wheat field was utilized considerably in local areas during the fall and winter where rabbits often dug beneath the snow to feed on the green wheat (Fig. 13). It was evident that jack rabbits preferred grazed areas with scattered clumps of taller vegetation. These areas furnished a variety of succulent herbage and a quick escape and the scattered

Fig. 10. The soapweed was eaten in abundance by jack rabbits during the winter months.

Fig. 11. Jack rabbits dug beneath the snow and fed on the green vegetation in the crowns of such plants as blue grama and buffalo grasses.

Fig. 12. The Russian thistle was eaten in emergency by jack rabbits when most of the vegetation was covered with snow.

Fig. 13. Green wheat covered with snow did not escape foraging by the jack rabbits.

clumps provided a comfortable place to hide and rest.

In correlating the line counts and pellet counts taken on the various areas, it was discovered that 0.54 pellet per square foot indicated approximately one jack rabbit per acre. According to number of pellets found, the jack rabbit was most abundant on the moderately grazed little bluestem type. The number per square foot on this type was .64, .58, and .60 for October, November and December, respectively, but it decreased to .19, .21 and .12 for January, February and March (Table 4). The rabbits apparently shrifted their activity during the winter to a nearby wheat field where the pellet counts were .09, .19, and .22, respectively, for October, November, and December, but increased to .50, .38, and .32 for January, February, and March.

The number of pellets was larger on the border between the grazed little bluestem and artificial revegetation than it was on the short grass and lowland areas. The natural revegetation had a fairly high pellet count during autumn as compared to most of the other types but dropped abruptly in December due to a prairie fire.

Table 4. Average number of jack rabbit pellets per square foot on different types of vegetation and border between artificial revegetation and grazed little bluestem.

TYPE	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Artificial Revegetation	.26	.16	.21	.06	0	0
Natural Revegetation	.43	.25	Fire	.08	.05	.16
Short Grass	.18	.10	.05	.05	0	.03
Lowland	.12	.25	.19	0	.01	.27
Grazed Little Bluestem	.64	.58	.60	.19	.21	.16
Ungrazed Little Bluestem	.26	.10	.17	0	0	0
Wheat Field	.09	.19	.22	.50	.38	.32
Border	.39	.43	.47	.22	.19	.26

Number of Seeds Found in Pellets

Numerous seeds of several plants were found in the fecal pellets of jack rabbits (Table 5). Sand dropseed made up 93 percent of the seeds found on all plant types, and redroot pigweed, buffalo grass, cactus, ground cherry, Hooker's dropseed and prairie pansy constituted the remaining 7 percent. Seeds were most numerous when taken from pellets deposited in October and November but the number became less during February and March.

Table 5. Number of seeds of each species found in jack rabbit pellets on the various habitats.

ARTIFICIAL REVEGETATION	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
No. pellets analyzed	36	35	34	38	25	32	200
No. pellets containing seeds	27	31	28	6	3	2	97
No. seeds in pellets-sand dropseed	227	538	174	23	5	3	970
Average seeds per pellet	6.4	14.9	5.1	0.6	0.2	.09	4.9

NATURAL REVEGETATION							
No. pellets analyzed	90	65	Fire destroyed vegetation	24	22	41	242
No. pellets containing seeds	84	61		2	6	6	159
No. seeds in pellets-Buffalo grass				3			3
Cactus	15						15
Sand Dropseed	17,730	91.27			23	19	26,899
Average seeds per pellet	197.1	140.4		0.1	1.0	0.7	111.2

SHORT GRASS							
No. pellets analyzed	38	77	15	22	38	42	190
No. pellets containing seeds	38	69	3	0	0	0	110
No. seeds pellets-Buffalo grass	14	5					19
Cactus		9					9
Ground Cherry	49						49
Prairie pansy	6						6
Sand dropseed	721	614	4				1,339
Redroot pigweed	7	2					9
Average seeds per pellet	20.9	8.2	1.3	0	0	0	7.5

Table 5--Continued

LOWLAND	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
No. pellets analyzed	40	38	21	18	20	41	178
No. pellets containing seeds	40	36	17	3	2	2	100
No. seeds in pellets-sand dropseed	409	257	76	8	3	4	757
Average seeds per pellet	10.2	6.8	3.7	0.5	0.2	0.1	3.2
GRAZED LITTLE BLUESTEM							
No. pellets analyzed	180	42	58	35	27	39	381
No. pellets containing seeds	80	27	16	3	0	1	127
No. seeds in pellets-Redroot pigweed	44						44
Sand dropseed	342	169	175	9	0	1	996
Average seeds per pellet	1.9	4.0	3.0	0.3	0	.02	2.7
UNGRAZED LITTLE BLUESTEM							
No. pellets analyzed	15	6	15	19	12	10	7.7
No. pellets containing seeds	0	0	5	0	1	0	6
No. seeds per pellet-Sand dropseed	0	0	13	0	1	0	14
Average seeds per pellet	0	0	0.9	0	0.1	0	0.2

Table 5--Continued

WHEAT FIELD	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
No. pellets analyzed	40	39	49	44	43	43	258
No. pellets containing seeds	40	31	2	0	2	1	76
No. seeds in pellets-Buffalo grass	8						8
Cactus		2					2
Ground cherry	5						5
Hookers dropseed	27	2					29
Redroot pigweed	29	48					77
Sand dropseed	211	104	2	0	3	1	321
Average seeds per pellet	6.6	4.0	1.0	0	1.5	1.0	1.7

Approximately 65.5 percent of the pellets collected on the natural revegetation area contained seeds. The average was 111.2 seeds per pellet with some collected in October running as high as 574 (Table 6). On the artificial revegetation type 46.5 percent of the pellets collected had seeds and the average was 4.9 seeds per pellet. Of the pellets taken on the short grass type, 57.9 percent contained seeds averaging 7.5 per pellet. The percentage of seed-bearing pellets collected on the lowland, grazed little bluestem, ungrazed little bluestem and the wheat field was, respectively, 56.2, 33.3, 7.8, and 29.0. The average number of seeds per pellet in the same order was 3.2, 2.7, 0.2, and 1.7.

Table 6. Number of jack rabbit pellets collected on various types of vegetation.

HABITAT	No. of pellets collected	No. pellets with seed	% pellets with seed	Av. No. seeds per pellet
Natural Revegetation	242	159	65.5	111.2
Artificial Revegetation	200	97	46.5	4.9
Short grass	190	110	57.9	7.5
Lowland	178	100	56.2	3.2
Grazed Little Bluestem	381	127	33.3	2.7
Ungrazed Little Bluestem	77	6	7.8	0.2
Wheat Field	258	76	29.0	1.7

Quantity of Seed in Pellets

In October an average of 179 pellets was found on an area of 30 square feet (Table 7). The pellets in the natural revegetation type (Table 5) contained an average of 197.1 seeds per pellet, of which 179 were sand dropseed. From the above figures it can be calculated (179 x 197) that 36,442 seed of sand dropseed were contained in the pellets found on an area of 30 square feet. There are 1452 of such areas per acre. Further calculation (1452 x 36,442) gives 42,913,684 - the number of seeds of this grass deposited in pellets on an acre of natural revegetation. The number of seeds per pound was determined by carefully separating 6 samples of 1 gram each and counting the number of seeds in each gram. The number varied between 13,139 and 13,440 and averaged 13,225. By multiplying this number by the number of grams per pound

(13,225 x 454) the number of seeds per pound (6,004,150) was ascertained. From these data it was found that in October approximately 7.14 pounds of seeds per acre were deposited in jack rabbit pellets on the natural revegetation type. For the corresponding month on grazed little bluestem the average number of seeds per pellet was 2.7 and 215 pellets were collected on the 30 square feet. Following the calculations as above, it was found that about 2 ounces of seed per acre were deposited in pellets on this plant type during October.

The number of pounds of seed of this species of grass deposited during the six months (October to March) was approximately 12.75 and 0.5, respectively, for the natural revegetation and the grazed little bluestem types. The big decrease in number of seeds deposited in pellets in December and thereafter on the natural revegetation was doubtless due to the fire in late November that destroyed all the vegetation.

Table 7. Number of jack rabbit pellets collected on an area of 30 square feet.

HABITAT	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Natural Revegetation	179	164	72	74	114	130	733
Grazed Little Bluestem	215	200	171	131	137	142	996

Germination of Seeds

The viability of seeds germinated in petri dishes was less (except buffalo grass) than when the seeds were tested in soil (Table 8). Buffalo grass seeds in petri dishes were 100 percent viable but only

57.5 percent when hand-picked. The soil test showed 90.0 percent germination from pellet borne seeds and 36.5 percent from hand collected ones. No signs of germination were found in cactus seeds in the petri dish test. In the soil test, however, 57.0 percent germinated from seeds taken from pellets and 42.0 percent from hand gathered seeds. The percentage of viable seeds taken from pellets in petri dishes for sand dropseed, Hooper's dropseed and redroot pigweed was, respectively, 4.2, 20.0, and 18.4 and in the picked seeds it was 3.0, 14.0, and 24.0, whereas in the soil tested seeds taken from pellets in the same order it was 31.3, 40.0, and 10.0 and for the hand-gathered seeds 42.0, and 70.0, and 77.0 percent.

Only seeds of the prairie pansy and ground cherry, collected from pellets, were available for germination. The percent germination was nil for the seeds of both species when tested in the petri dish but when tested in soil it was, respectively, 25.9 and 60.0 percent.

Table 8. Percent germination of seeds taken from jack rabbit pellets in comparison with percent germination of hand-picked seeds.

PLANT	Petri Dish Germination		Soil Germination	
	Rabbit Pellets	Hand-picked	Rabbit Pellets	Hand-picked
Buffalo grass	100	57.5	90.0	36.5
Cactus	0	0	57.0	42.0
Ground cherry	0	no sample	60.0	no sample
Hooker's dropseed	20	14	40.0	70.0
Prairie pansy	0	no sample	25.9	no sample
Redroot pigweed	18.4	24	10.0	77.0
Sand dropseed	4.2	3	31.3	42.0

THE COTTONTAIL

Utilization by cottontails was observed on a total of 32 different species of plants. Most of these plants were on the ungrazed little bluestem type where 7 species of grass, 12 of forbs, and 2 of shrubs were partly eaten (Table 9). Extensive plant foraging was found on the border of the grazed little bluestem near the lowland where 3 species of grass, 9 of forbs and 4 of shrubs were partly consumed.

Shrubs were the part of vegetation most generally utilized. Prairie rose, chokecherry, smooth sumac and ill-scented sumac often were badly barked or browsed to within 2 to 5 inches of the ground. The leaves of wheat grass and sand dropseed were grazed in appreciable amounts on all plant types. The leaves and stems of heavy sedge and broom weed were eaten in small quantities on areas in which they were found. Leaves of soapweed were consumed in small amounts and the plants served as a protection for the cottontails (Fig. 14).

It was found by correlating the line count and pellet count that 0.50 pellet per square foot indicated about one cottontail to the acre.

According to pellet counts, the cottontails were most numerous on the lowland and ungrazed little bluestem types (Table 10). The number of pellets per square foot on these two types was, respectively, 0.97, 0.72, 0.89, and 0.36, 0.46, and 0.55 for October, November and December. The numbers decreased on the closely grazed lowland for January, February, and March, when it was 0.20, 0.15, and 0.15 as in the order listed above whereas it increased on the ungrazed little bluestem to 0.57, 0.46, and 0.50. The concentration of pellets on the artificial

Table 9. Plants eaten (*) by the cottontail in artificial revegetation (AR), natural revegetation (NR), short grass (SG), lowland (LL), grazed little bluestem (GLB), and ungrazed little bluestem (ULB). The symbol (NF) is used to indicate the type of vegetation in which the plants were not found.

GRASSES	AR	NR	SG	LL	GLB	ULB
Big bluestem						*
Blue grama	*		*			
Buffalo grass		*	*			
Green foxtail	*					
Heavy sedge				*	NF	*
Hooker's dropseed	NF	NF	NF	*		*
Little bluestem		NF		NF	*	*
Sand dropseed	*	*	*	*	*	*
Side-oats grama		NF			*	
Switch grass	*	NF	NF	*		*
Western wheat	*	*	*	*		*
FORBS AND WEEDS						
Annual sunflower				*		*
Blazing star	NF			NF		*
Broom weed			*	NF	*	*
Houstonia	NF	NF	NF	NF	*	*
Lead plant		NF				*
Maximilian sunflower	NF	NF	NF	NF	*	
Purple poppy-mallow	NF	NF		*	NF	*
Rayless thelesperma				NF		*
Rigid-leafed goldenrod	NF	NF	NF		*	
Russian thistle					*	*
Skull cap	NF	NF	NF	NF	*	*
Many flowered Aster				*		
Soapweed	NF	NF		NF	*	*
Tetraneuris	NF	NF	NF	NF	*	*
Whitlow wort	NF	NF	NF	NF	*	*
Yellow oxalis	*					
SHRUBS						
Buckbrush	NF	NF	NF	*	NF	NF
Chokecherry	NF	NF	NF	NF	*	NF
Ill scented sumac	NF	NF	NF	NF	*	*
Prairie rose	NF	NF	NF	*	*	*
Smooth sumac	NF	NF	NF	*	*	NF

revegetation along the border between this type and the grazed little bluestem was slightly lower than on the above mentioned types. The natural revegetation, short grass and wheat field showed a very small pellet count.

Table 10. Average number of cottontail pellets per square foot on different types of revegetation and border between artificial revegetation and grazed little bluestem.

TYPE	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Artificial Revegetation	.74	.46	.30	.18	.08	.10
Natural Revegetation	0	0	0	0	.15	.18
Short grass	0	0	.15	.21	.10	.05
Lowland	.97	.72	.89	.20	.15	.15
Grazed Little Bluestem	.26	.30	.30	.17	.08	.06
Ungrazed Little Bluestem	.36	.46	.55	.57	.46	.50
Wheat Field	.02	.04	.07	0	0	0
Border	.46	.55	.30	.28	.15	.10

Number and Species of Seeds in Pellets

On the natural revegetation area 39.7 percent of the pellets collected contained seeds with an average of 1.16 seeds of sand dropseed per pellet (Table 11). On the artificial revegetation type, 29.1 percent of the pellets contained seeds averaging 0.67 per pellet. The number of pellets containing seeds was relatively low on the grazed and ungrazed little bluestem types also the average number of seeds per pellet was less than one. On the other plant types, the numbers were negligible.

Table 11. Record of cottontail pellets collected on various types of vegetation.

TYPES	No. of pellets collected	No. of pellets with seeds	Percent of pellets with seeds	Average No. of seeds per pellet
Artificial Revegetation	271	79	29.1	.67
Natural Revegetation	114	43	39.7	1.16
Short Grass	147	14	9.5	.95
Lowland	356	14	3.9	.10
Grazed Little Bluestem	234	34	14.6	.98
Ungrazed Little Bluestem	255	44	15.2	.47

Pellets deposited in October, November, and December contained the largest amount of seeds, but the number was less in February and March. Sand dropseed comprised more than 99 percent of the seeds found in pellets, the remainder being prairie rose and smooth sumac. As many as 34 seeds of sand dropseed were taken from one pellet collected in October on the natural revegetation type.

Germination of Seeds

Germination tests were made on sand dropseed, smooth sumac and the prairie rose. Only sand dropseed was viable in both the petri dish and the soil germination test (Table 12). When tested in petri dishes, 7 percent of the seeds taken from pellets were viable but only 3.0 percent of the hand picked seeds germinated, whereas the soil tested seeds had a viability of 62.5 percent for those collected from pellets and 42.0 per-

Fig. 14. Soapweed in the grazed little bluestem type near the ravines furnished food and shelter for the cottontails and jack rabbits.

Fig. 15. A wood rat nest built in a pile of stones on a moderately grazed little bluestem area.

cent for the hand gathered seeds. Only soil tested seeds of sumac were viable. For seeds removed from pellets it was 32.0 percent and for the hand collected seeds 19.0 percent. The prairie rose failed to germinate in either of the methods.

Table 12. Percent germination of seeds taken from cottontail pellets.

PLANT	Petri dish germination		Soil Germination	
	Fecal Pellets	Hand Picked	Fecal Pellets	Hand Picked
Prairie rose	0	0	0	0
Sand dropseed	7.0	3.0	62.5	42.0
Smooth sumac	0	0	32.0	19.0

THE PHEASANT

Pheasant activity was evident on all plant types and particularly on the ungrazed little bluestem, the lowland, along partition fences and on other areas containing a tall growth of vegetation. It was difficult to determine the food habits of this bird as only a few seeds were found in pellets also many of the pellets had been broken by mice and the seeds destroyed. Some of the seeds found in small numbers in these droppings were smooth sumac, prairie rose, ill-scented sumac and hackberry.

The test of the viability of seeds was based on only a few representing each species and no more than 25 seeds were available for any one plant. Only soil tested seeds of smooth sumac, prairie rose, and ill-scented sumac were found to be viable and none of the seeds in the petri dish tests germinated. The percent of viability of the pellet borne

seeds of hackberry, ill-scented sumac, and smooth sumac was 33.3, 10.0 and 20.0 respectively, whereas in hand picked seeds it was 0, 5,0, and 19.0 percent.

THE WOOD RAT

Activity of the wood rat was found only in an abandoned stone quarry bordered by shrubs which furnished food and nest materials. The nest was built upon a burrow leading into some rocks and was constructed from twigs mostly of chokecherry, smooth sumac, hackberry, elm, and ill-scented sumac. Other plants used in the nest were chalk lily, broom weed, prairie alfalfa, Maximilian sunflower, Russian thistle and horse weed with scattered pieces of stones and cow dung (Fig. 15).

The food of this animal was mainly seeds of smooth sumac, ill-scented sumac, chokecherry and prairie rose hips, also the seeds of soapweed and chalk lily were eaten in small amounts.

Only seeds of ill-scented sumac and smooth sumac taken from pellets were viable. The percent viability for soil tested seeds taken from pellets was 14.2 and 23.3, respectively, for ill-scented sumac and smooth sumac but it was 5.0 and 19.0 for hand picked seeds. None of the seeds tested in petri dishes germinated.

THE WHITE-FOOTED MOUSE

The white-footed mouse was most widely distributed and most abundant of the mammals found on the plant types (Fig. 16). It was caught from burrows, open nests, piles of weeds, cactus plants, holes beneath rocks, cracks in banks and from runs of the meadow mouse. The

number caught was greatest on the lowland. Least activity was found on the short grass and artificial revegetation types (Table 13).

Table 13. Number of white-footed mice caught on each habitat.

HABITAT	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Artificial Revegetation	3	4	3	4	3	3	2	22
Natural Revegetation	1	1	0	4	3	8	9	26
Short Grass	2	1	0	11	1	0	2	17
Lowland	6	4	3	11	9	5	12	50
Grazed Little Bluestem	1	3	4	14	10	5	2	39
Ungrazed Little Bluestem	2	1	2	3	12	13	5	38

Baited traps failed to increase the number caught of the white-footed mouse, in fact the largest catches (32 in comparison to 28) were made from those unbaited.

Caches of stored seeds and pellets found near freshly eaten plants indicated that 24 different species, of which 7 were grasses and 17 were forbs, furnished some food for these animals (Table 14).

Fig. 16. A white-footed mouse and young caught from a bank in a lowland habitat.

Fig. 17. The harvest mouse was common on most of the habitats covered with a heavy growth of taller grasses.

Table 14. Plants eaten (*) by the white-footed mouse in artificial revegetation (AR), natural revegetation (NR), short grass (SG), lowland (LL), grazed little bluestem (GLB), and ungrazed little bluestem (ULB). The symbol (NF) is used to indicate the type of vegetation in which the plants were not found.

GRASSES	AR	NR	SG	LL	GLB	ULB
Blue grama	*	*	*			
Buffalo grass		*	*			
Green foxtail	*					
Indian grass	NF	NF	NF	*		
Little bluestem		NF		NF	*	
Side-oats grama		NF			*	*
Switch grass	*	NF	NF	*		*
FORBS AND SHRUBS						
Blazing star	NF		*	NF	*	*
Broom weed			*	NF	*	*
Buckbrush	NF	NF	NF		*	
Cactus		*	*	NF		
Cocklebur		NF	*			
Common sunflower		*	*	*	*	*
Ill-scented sumac					*	
Ironweed	NF	NF	NF	*	NF	NF
Maximilian sunflower	NF	NF	NF	NF	*	*
Perennial ragweed		*	*			
Prairie rose	NF	NF	NF		*	*
Purple coneflower	NF	NF	NF	NF		*

Table 14--Continued

	AR	NR	SG	LL	GLB	ULB
Smooth sumac	NF	NF	NF		*	NF
Snow-on-the-mountain			*			
Wavy-leaved thistle			*			
Whitlow wort	NF	NF	NF	NF	*	*
Wild alfalfa			*	NF		

The short grass and grazed little bluestem types furnished 11 species each for food. The common sunflower was most heavily utilized, also buffalo grass and cactus seeds were extensively eaten. Cow dung and pheasant droppings were an important part of their diet when most vegetation was blanketed with snow. It was evident that the mice were seeking the seeds found in the droppings. Evidence from excavated burrows showed that much of the diet of this mouse consisted of crickets, beetles, moths, millepedes, and grasshoppers. The latter two were found throughout the winter on sunny days even when most of the ground was covered with snow. A mouse was brought to the laboratory and at the end of a week it had eaten 88.2 grams of insects as compared to 11.6 grams of mixed grains and seeds. The weight of the mouse at the beginning was 20.7 grams and only 20.8 grams at the end of the test. Insects, especially grasshoppers, were preferred to grains and seeds of native plants.

NEST MATERIALS

Nests were constructed mainly of the leaves of grasses preferably blue grama and buffalo grass forming the outer portion of the nest intermixed with little barley, side-oats grama, and big bluestem. The inner lining of the nest was usually of the leaves of sand dropseed and the pappus from milkweed and wavy-leaved thistle. The less common plants used as nest material were common sunflower, perennial ragweed, and Hooker's dropseed. Hair and feathers were found in the lining of several nests.

BREEDING HABITS

Nowhere in literature has the author found any reference to winter breeding in Kansas of any species of a white-footed mouse. Gravid females were caught throughout the fall and winter, the number of embryos per gravid female varied from 2 to 5 with an average of 3.64. In September 57.14 percent of the females caught were gravid but the number decreased to 4.76 and 3.57 percent, respectively, in December and January and then increased to 35.3 percent in March. Possibly the winter breeding activity was caused by the temperature which was considerably above normal throughout the study.

THE HARVEST MOUSE

Two species of the harvest mouse were caught on the area, the most common being the little gray harvest mouse, the smaller of the two species, which was found on all plant types, whereas the prairie harvest

mouse was only on the artificial revegetation and ungrazed little bluestem where a thick cover of grasses was maintained (Fig. 17).

Largest numbers of the harvest mouse were caught during the winter months on the artificial revegetation and the lowland types (Table 15). Natural revegetation had a fair population of these mice until after a fire in late November. The number was slightly less on the short grass and ungrazed little bluestem but only one specimen was taken from the grazed little bluestem.

Table 15. Number of Harvest mice caught on each habitat.

HABITAT	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Artificial Revegetation	2	2	4	3	4	20	5	40
Natural Revegetation	4	4	3	Destroyed by fire				11
Short Grass	2	2	3	2	1	7	3	20
Lowland	1	3	4	7	7	1	2	25
Grazed Little Bluestem	0	0	0	0	0	0	1	1
Ungrazed Little Bluestem	1	1	0	0	8	6	3	19

The nest of this mouse was a ball of grass leaves with an opening in the side. It was generally suspended a few inches from the ground in the taller grasses or sometimes placed on the ground or in tin cans or other objects on or near the ground. Such grasses as big and little bluestem, blue grama and side-oats grama formed the bulk of the nest material, the inner lining being of sand dropseed and the pappus from the low milkweed and wavy-leaved thistle.

Grasshoppers and the seeds of buffalo grass and switch grass made up most of the diet of this rodent but Indian grass, crowns of blue grama, and the flower heads of broom weed, iron weed, snow-on-the-mountain and Maximilian sunflower were often utilized. The cactus fruit and seeds were also eaten on the areas where it was found.

Forty-one mice were caught with baited traps as compared to 16 with the unbaited ones. Gravid females were caught during all months of the study except December and January.

THE POCKET MOUSE, MEADOW MOUSE AND SPERMOPHILE

Only three pocket mice were caught and they were found in the grazed little bluestem type near the brows of hills where limestone was exposed. The entrances to the burrows were plugged with fresh dirt and it was difficult to excavate the holes as they went down into the cracks of the rock near the surface. The following seeds were collected from the pockets of these mice: bee bush, snow-on-the-mountain, perennial ragweed, Pitcher's sage, single-fruited croton, sensitive brier, ivory seeded borage, wild alfalfa and Texas croton. Beneath a small rock a cache of 313 seeds was found containing approximately the same species as above named plants

The meadow mouse, the most abundant rodent in much of the native prairie several years ago, was found only in small areas in the ungrazed little bluestem and the artificial revegetation types where a heavy growth of wheat grass was intermixed with other midgrasses. On the natural revegetation type, 82 skulls of meadow mice, that evidently had been dead for a year or more, were found on an area approximately 6

acres in size after the vegetation was destroyed by a fire (Fig. 19). Plants stored in burrows for food listed in the order of abundance were the stems and crowns of wheat grass, little barley, buffalo grass, blue grama, side-oats grama, and perennial ragweed. Nests were made from grasses of which side-oats grama, wheat grass and little barley were most important, intermixed with smaller amounts of blue grama, buffalo grass and sand dropseed.

The spermophile was found on the short grass, natural revegetation and small portions of the artificial revegetation types (Fig. 20). This animal went into hibernation about October 21 and was first seen in the Spring on March 5. Stored food was taken from several burrows and caches and the most common plants represented were buffalo grass burs and crowns, little barley stems and seed, and wild onion bulbs. Some of the less common plants utilized were blue grama crowns, cactus seeds, roots of blazing star and underground stems of perennial ragweed. Fragments of grasshoppers, crickets, beetles and spiders were commonly found in the burrows. The nest was a mat-like structure on the floor of an enlarged chamber near the surface of the soil. Little barley was most extensively used as nest material, but blue grama, buffalo grass, sand dropseed, wheat grass and windmill grass were occasionally used.

ANIMALS AS AIDS IN PLANT DISPERSAL

Seedlings were found growing from pellets deposited by jack rabbits and cottontails on several of the plant types but nowhere could seedlings be found emerging from the pellets of pheasants and wood rats.

Fig. 18. Skulls of the meadow mouse were found in large numbers on natural revegetation where this animal was at one time very common.

Fig. 19. The spermophile was found only on the short grass, natural revegetation or artificial revegetation types.

The jack rabbit was the most important agent in seed dispersal. During the spring of 1945 as many as 32 seedlings of sand dropseed were found emerging from one jack rabbit pellet. On a reconnaissance survey, 47 jack rabbit pellets and 3 cottontail pellets, with seedlings of sand dropseed growing from them, were found on a wheat field or one of the revegetation types (Fig. 20). Twelve pellets also were found containing seedlings of the redroot pigweed and 2 others each with a buffalo grass seedling. Seedlings were growing from caches of buffalo grass and cactus seed buried by the spermophile along the border of a wheat field (Fig. 22).

Young plants of buffalo grass also were emerging from caches of seed stored by the white-footed mouse but none of the cactus and cocklebur seed had germinated.

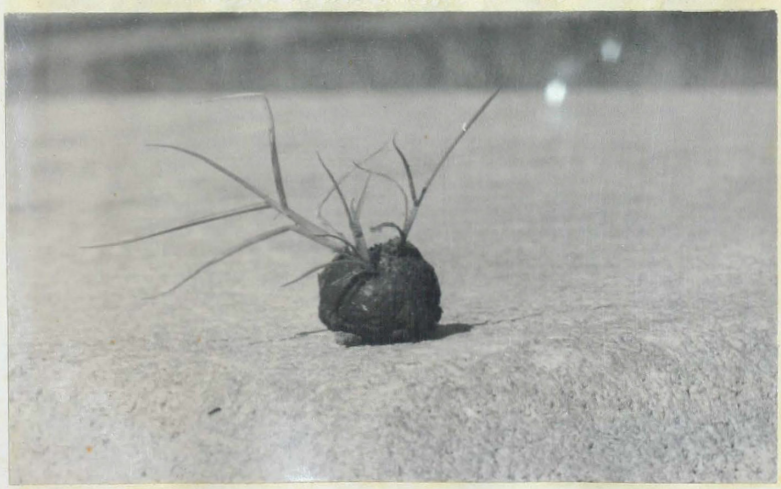

Fig. 20. Seedlings of sand dropseed growing from jack rabbit pellets.

Fig. 21. Cactus seedlings were often found growing from seed embedded in pellets of the jack rabbit.

Fig. 22. Cactus seedlings growing from a spermophile cache.

SUMMARY

The utilization and dissemination of native plants by native animals on a mixed prairie near Hays, Kansas were studied. If recently deposited pellets were found near plants partly eaten it was considered that these plants were utilized by the animal that deposited the pellets.

The jack rabbit was found to utilize a total of 34 species of plants but not extensively enough to furnish serious competition for livestock. Even the cottontail secured food from 31 species but several were of such non-important woody plants as smooth sumac, chokecherry and prairie rose.

A total of 24 species of plants served as food for the white-footed mouse but a feeding experiment indicated that 88 percent of its diet consisted of insects of which grasshoppers were preferred.

Approximately 63 percent of the diet of the harvest mouse was insects.

Jack rabbits were most abundant on the grazed areas due, perhaps, to the succulent herbage for food, the short turf for a quick escape and the scattered bunches of vegetation to furnish protection.

The cottontail, however, preferred areas with a thick growth of the taller grasses and societies of weeds and shrubs accompanied with rocks and burrows for protection.

The wood rat and pocket mouse occurred only on the rocky hills, whereas the spermophile preferred the short grass, or other types where the vegetation was closely grazed.

The meadow mouse, common to numerous before the great drought of 1933 to 1939, was found occasionally on areas dominated by mid-grasses. The fact that 82 skulls were collected on 6 acres indicated that this rodent was recently quite abundant on this area.

Baiting of traps failed to increase the catches of the white-footed mouse but it did increase the catches of the harvest mouse.

Gravid females of the white-footed mouse were caught during each month of the study from September to March inclusive.

A close correlation was found between the number of pellets and the abundance of jack rabbits and cottontails frequenting an area.

A count of 0.54 jack rabbit pellet per square foot represented approximately one rabbit per acre and 0.50 pellet per square foot indicates about one cottontail on an acre.

Seeds of several species of plants were taken from fecal pellets of the jack rabbit, cottontail, pheasant and the wood rat. Germination tests showed that many of the seeds were viable and that passing through the digestive tracts of these animals increased the germination of some of the seeds. This was especially true of sand dropseed, buffalo grass, cactus and smooth sumac.

The jack rabbit aided most in disseminating seeds in pellets. The cottontail, pheasant and the wood rat were less important in this respect. Approximately 12.75 pounds of seed of sand dropseed were deposited in jack rabbit pellets on an acre in the natural revegetation type. This is considerably more than is recommended for reseeding abandoned cultivated fields.

Numerous seedlings of sand dropseed and of other species were observed growing from jack rabbit pellets, expecially on cultivated fields and revegetation areas.

The spermophile and white-footed mouse disseminated the seed of cactus and buffalo grass by storing them in caches, and occasionally young plants were found growing from deposits of this kind.

It seems reasonable to assume from the preceeding data that native animals, especially the rabbits and rodents, are of considerable assistance in introducing seeds of prairie plants into abandoned cultivated fields and range land denuded by drought or over-grazing.

BIBLIOGRAPHY

1. Albertson, F. W. "Ecology of Mixed Prairie in West-Central Kansas." (Reprint from Ecological Monographs, Vol. 7. no. 4, pp. 481-547, October, 1937).

Gives the plant habitats represented in the college pasture with the representative species found in each habitat.

2. Arnold, J. F. and Reynolds, H. S. "Droppings of Arizonia and Antelope Jack Rabbits and the Pellet Census." (Journal of Wildlife Management, Vol. 7, no. 3, pp. 322-327, July 1943).

Tells how the "pellet census," is used in determining rabbit populations.

3. Bass, N. W. Geologic Investigations in Western Kansas. Lawrence, Kansas, University of Kansas, 1926, pp. 1-96. (State Geologic Survey, Kansas Bulletin no. 11, 1926).

A survey of the geology of Ellis County, Kansas.

4. Black, J. D. Mammals of Kansas. Topeka, Kansas State Printing Plant, 1937, pp. 116-217. (Thirtieth Biennial Report of the Kansas Board of Agriculture, Vol. no. 35, 1937).

A revised list of the species of mammals known to have been collected in Kansas; giving the range of the species and subspecies of each.

5. Blair, W. F. "Technique for the Study of Mammal Population." (Journal of Mammalogy, Vol. 22, pp. 148-156, May, 1941).

Gives a very detailed study of the best methods for trapping of mammals, selection of areas, trapping pattern, and best baits to use for the best catches.

6. Brown, H. Ray "Growth and Seed Yields of Native Prairie Plants in Various Habitats of the Mixed Prairie." (Transactions

of the Kansas Academy of Science. Topeka, Kansas State Printing Plant, 1943, Vol. 46, pp. 87-99).

Gives the variations in seed yields of native prairie plants in various habitats of the mixed prairie near Hays, Kansas.

7. Burnett, W. L. Jack Rabbits of Eastern Colorado. Fort Collins, Colorado, Agriculture College, 1926, pp. 1-18. (Colorado Agricultural College Circular no. 52, November, 1926).

Discusses the life history of the jack rabbit in Eastern Colorado.

8. Costello, David F. "Natural Revegetation of Abandoned Plowed Land in the Mixed Prairie Association of Northeastern Colorado." (Ecology, Vol. 25, no. 3, pp. 312-326, July, 1944).

Population studies of jack rabbits by means of "pellet count" made on abandoned fields and native shortgrass; and the destruction of plant seedlings by the jack rabbits.

9. Dice, L. R. "Methods for Indicating the Abundance of Mammals." (Journal of Mammalogy, Vol. 12, no. 4, pp. 376-381, November, 1931).

Excellent material on how to select and trap areas for mammal population counts for rodents especially.

10. Errington, P. L., Hamerstrom F., and Hamerstrom, Jr. F. N. The Great Horned Owl and Its Prey in North-Central United States. Ames, Iowa, State College, 1940, pp. 759-849. (Agriculture Experiment Station, Iowa State College of Agriculture and Mechanic Arts Research Bulletin no. 277, September, 1940).

A very detailed study of the food habits of the great horned owl.

11. Flora, S. D. Climatological Data. Topeka, Kansas, 1944-45. (United States Department of Commerce, Weather Bureau, Kansas Section, 1944-45).

Weather reports for Kansas giving the percipitation and temperature at various stations throughout the state.

12. Hendrickson, George O. "Winter Food and Cover of Mearns Cottontail." (Transaction of the Third North American Wildlife Conference. Washington, D. C., 1938, pp. 787-793).

A study of the plants used for food and cover by the Mearns cottontail in Central Iowa.

13. Hendrickson, George O. "Inventory Methods for Mearns Cottontail." (Transactions of the Fourth North American Wildlife Conference. Washington, D. C., 1939, pp. 209-215).

Gives the procedure used in making and tabulating "pellet census" counts.

14. Hibbard, Claude W. "A Checklist of Kansas Mammals, 1943". (Transactions of the Kansas Academy of Science. Topeka, Kansas State Printing Plant, 1944, Vol. 47, pp. 61-88).

A revised checklist of Kansas mammals.

15. Long, W. S. "Check-List of Kansas Birds." (Transactions of the Kansas Academy of Science. Topeka, Kansas State Printing Plant, 1940, Vol. 43, pp. 433-456).

The check-list of Kansas birds brought up to date including the present day species that have been discovered at various times.

16. Nelson, Edward W. "Smaller North American Mammals". (National Geographic Magazine, Vol. 33, no. 5, pp. 371-493, May, 1918).

List of small mammals of North America; with valuable data on rodents giving their range, distribution, and activities.

17. Parker, K. W. Effects of Jack Rabbits on the Rate of Recovery of Deteriorated Range Land. State College, New Mexico, New Mexico Agricultural College, 1938, pp. 1-3. (New Mexico College of Agricultural Experiment Station Press Bulletin 839, January 5, 1938).

States the deterioration of range land by jack rabbits was as much as 99.4 percent of perennial grass forage in New Mexico.

18. Phillips, Paul. "The distribution of Rodents in Overgrazed and Normal Grassland of Central Oklahoma." (Ecology, Vol. 17, no. 4, pp. 673-679, October, 1936).

The study and comparison of rodent activity and populations in overgrazed and normal grassland of Central Oklahoma.

19. Riegel, D. A. "Some Coactions of Rabbits and Rodents With Cactus." (Transactions of the Kansas Academy of Science. Topeka, Kansas State Printing Plant, 1941, Vol. 44, pp. 96-103).

A very detailed study of some coactions of rabbits and rodents with cactus in the college pasture. good illustration as to how animals survive drought periods when food is scarce.

20. Swank, Wendell G. "Germination of Seeds after Ingestion by Ring-necked Pheasants." (Journal of Wildlife Management, Vol. 8, no. 3, pp. 223-231, July , 1944).

Pheasants as aides in scattering food plants from the unbroken seeds that are eliminated in fecal pellets.

21. Taylor, Walter P. and McGinnies, W. G. "The Bio-Ecology of Forest and Range." (Scientific Monthly, Vol. 27, pp. 177-182, August, 1928).

Discusses the Bio-ecology relation of plants and animals, the response to the habitat, reaction upon it and the co-actions between members of wild animals and domestic livestock on the range.

22. Taylor, Walter P. "Methods of Determining Rodent Pressure on the Range." (Ecology, Vol. 7, no. 2, pp. 523-542, July 1930).

The importance of jack rabbits in range management and the amount of forage consumed on an animal unit basis.

23. Taylor, Walter P., Vorhies, C. T., and Lister, P. B. "The Relation of Jack Rabbits to grazing in Southern Arizona." (Journal of Forestry, Vol. 33, no. 5, pp. 490-498, May, 1935).

Gives the food habits and the amount of food eaten by jack rabbits and evaluating the damage done to forage plants by jack rabbits on the range.

24. Timmons, F. L. "The Dissemination of Prickley Pear Seed by Jack Rabbits." (Journal of the American Society of Agronomy, Vol. 34, no. 6, pp. 513-520, June 1942).

Explains how jack rabbits feed upon prickley pear and the seeds that pass through the digestive tract unharmed show a higher germination than seeds not eaten by the rabbits.

25. Throckmorton, R. I. Kansas Soils and Soil Map. Topeka, Kansas State Printing Plant, 1932, pp. 91-102. (Twenty-eight Biennial Report of the Kansas Board of Agriculture, Vol. no, 33, 1932).

Gives the soil of Kansas and their formation.

26. Vorhies, Charles T. and Taylor, Walter P. The Life Histories and Ecology of Jack Rabbits, Lepus alleni alleni and Lepus californicus ssp., in Relation to Grazing in Arizona. Tucson, Arizona, University of Arizona, 1933, pp. 471-574. (University of Arizona Agriculture Experiment Station Technical Bulletin no. 49, May, 1933).

Life history of the Allen's jack rabbit and the Arizona jack rabbit in relation to range management. Gives the destruction done to grasses and grass seedlings that causes denudation of much of the Arizona range land.

27. Vorhies, Charles T. and Taylor, Walter P. Life History and Ecology of the White-throated Wood Rat, Neotoma albigula albigula Hartley, in relation to Grazing in Arizona. Tucson, Arizona, University of Arizona, 1940, pp. 455-529. (University of Arizona Experiment Station Technical Bulletin no. 86, June 1940).

A detailed study on the food habits and nesting habits of the white-throated wood rat. The habits are much like the wood rat that dwells in the rocks at the college pasture.

28. Weaver, J. E. and Flory, Evan L. "Stability of Climax Prairie and Some Environmental Changes Resulting From Breaking." (Ecology, Vol. 15, no. 4, pp. 333-347, October 1934).

Explains how overgrazing encourages increased rodent and jack rabbit populations.

29. Webb, John. "Identification of Rodents and Rabbits by Their Fecal Pellets." (Transactions of the Kansas Academy of Science. Topeka, Kansas State Printing Plant, 1940, Vol. 43, pp. 479-481).

A key and illustrated pictures showing how to identify rabbits and rodents by their fecal pellets. A good way to study food habits of rodents and rabbits.

30. Wooster, L. D. "Notes on the Effects of Drought on Animal Population in Western Kansas." (Transactions of the Kansas Academy of Science. Topeka, Kansas State Printing Plant, 1935, Vol. 38, pp. 351-352).

Compares the effect of drought on rodent populations in the Mixed prairie association.

31. Wooster, L. D. "The Effects of Drouth on Rodent Population." (Turtox News, Vol. 17, no. 1, pp. 26-27, January, 1939).

A detailed study of rodent populations in Western Kansas and how they are affected by drouth.