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AVIAN DISTRIBUTION AND POPULATION FLUCTUATIONS ON THE SHORTGRASS PRAIRIE OF NORTH CENTRAL COLORADO

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GRASSLAND BIOME

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ABSTRACT

Birds of the shortgrass prairie of north central Colorado were studied during 1969-70 to determine species, numbers, standing crop biomass, and population fluctuations on the Central Plains Experimental Range. Two systems of counts were used: a roadside count, and a census of six, 20-acre plots, which were used to determine the effects of grazing by cattle on the distribution of birds. Total populations, breeding-pair populations, standing crop biomass, and bird-use days were determined for two breeding seasons, a post-breeding season, and winter. The breeding population (65.5 and 48.4 pairs/100 acres in 1969 and 1970, respectively) was composed of eight species of which five provided 95% of all nesting. Horned larks and lark buntings were the most abundant nesters. Horned larks and McCown's longspurs were the primary post-breeding species. Horned larks and Lapland longspurs were the primary winter species. Plots heavily grazed by cattle received the greatest use by birds for nesting and foraging; lightly-grazed plots received the least use. The composition of populations using each plot varied considerably in numbers and species. Conclusions about the avifauna of the prairie are offered.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The International Biological Program (IBP) was formed in 1968 to study man's relationship to the environment. Worldwide, 57 nations are engaged in this endeavor. In the United States this program, sponsored by The National Science Foundation, has a primary goal of exploring the complex interrelations of six diverse ecosystems. A subsequent goal is to develop working, mathematical models for each ecosystem studied. Due to its outward appearance of simplicity, the grassland biome was chosen as a starting place for this development.

Man's economic uses of grasslands are limited, as are the number of different habitat niches available to flora and fauna. Consequently, the relationships between producers and consumers are less complex in grasslands than in forest or tropical ecosystems.

Since early 1968, scientists from several universities mainly in Colorado and Wyoming have been formulating a profile of life on the prairie—the animals and plants that live there, the foods they consume, the microhabitats they prefer, and how they interact. A portion of this study has involved determining the role of birds, their

numbers, standing crop biomass, and impact on the functioning of the prairie.

Limited research and census work with birds have been conducted on the prairies. Early studies were concerned primarily with listing the species present and determining relative abundance of each in terms of "abundant", "common", or "rare" (Nauman 1926; Dice 1930). Later studies described bird populations as number of individuals per unit area (Kendeigh 1941; Wing 1949; Cassel 1952). Salt (1953) separated avian communities in woodlands into ground, timber, foliage, and air-feeding niches and described these categories (1957) as standing crop biomass per 100 acres. His techniques were used by Logan (1961) to describe prairie populations in Weld County, Colorado (approximately 17 miles south of the IBP Intensive Site). Cody (1966a, b; 1968) separated grassland communities into various avian niches by vegetative growth form, height, time of maturing, and avian utilization of the plant cover. Wiens (1969) approached the problem of vegetational aspect, relating critical height, plant density, and percent cover to avian distribution on a Wisconsin grassland. He expressed these relationships in pairs of breeding birds per 100 acres.

Preliminary Census Work

Census work began at the Pawnee Intensive Site (IBP) in summer, 1968, to determine species, numbers, standing crop biomass, and population fluctuations of birds on the northern Colorado

shortgrass prairie. The first 8 months' census was conducted and summarized by Ryder and Cobb (1969). They established two systems of census, a roadside count and an area census of six, 20-acre plots on the Central Plains Experimental Range (CPER) near Nunn, Weld County, Colorado. They also prepared a checklist of birds of the CPER and the Pawnee National Grassland (Appendix A) based upon field observations and a review of the literature. Because of the mobility of birds and their constant fluctuations, further study was necessary to accurately describe the avian population. This report covers this continuing study during the years 1969 and 1970.

The Problem

The objectives of my study were to determine the species, numbers, distribution, and standing crop biomass of birds on the shortgrass prairie of northern Colorado. The problem was divided into three questions.

1. What species of birds are present on the study area, and in what abundance?

2. What is the nesting density on each of the study plots in pastures of varying grazing intensities and seasonal use?

3. To what extent are the numbers and standing crop biomass of each species dependent upon the vegetation resulting from various grazing techniques on the study area?

Delimitations

Two types of field counts were used to determine numbers and species of birds present. Intensive census was conducted in six, half-section pastures on the CPER. A roadside count extended through the CPER into the northwestern portion of the Pawnee National Grassland (Fig. 2). Weekly collections were used to determine weights of individuals. Data were collected from March 1, 1969 to July 31, 1970, thus two breeding seasons and the intervening winter were included.

CHAPTER II

DESCRIPTION OF STUDY AREA

The Central Plains Experimental Range is located approximately 12 miles (19.3 km) north of Nunn, Weld County, Colorado (Fig. 1 and 2) ($40^{o}50'N$, $104^{o}45'W$). It comprises about 15,000 acres (6070 ha.) of shortgrass prairie. Primary plant species are blue grama (Bouteloua gracilis) and buffalograss (Buchloe dactyloides). Certain pastures have been grazed by cattle at different, fixed intensities for the past 30 years. The vegetation of these pastures has subsequently been changed and provides a unique opportunity to study nesting preferences of birds using the area.

Topography

Elevations on the six study plots vary from 5388 to 5526 feet (1642.3-1684.3 m). The aspect is gently rolling hills, encompassing low swales, playas, and intermittent streams. Hilltops are often rocky and more barren than the surrounding sides. Although the outward appearance of the land surface is smooth, in reality the ground is a maze of grass clumps, cactus, rocks, and small depressions.

Fig. 1.--Map of Colorado showing locations of the study area and the roadside counts.

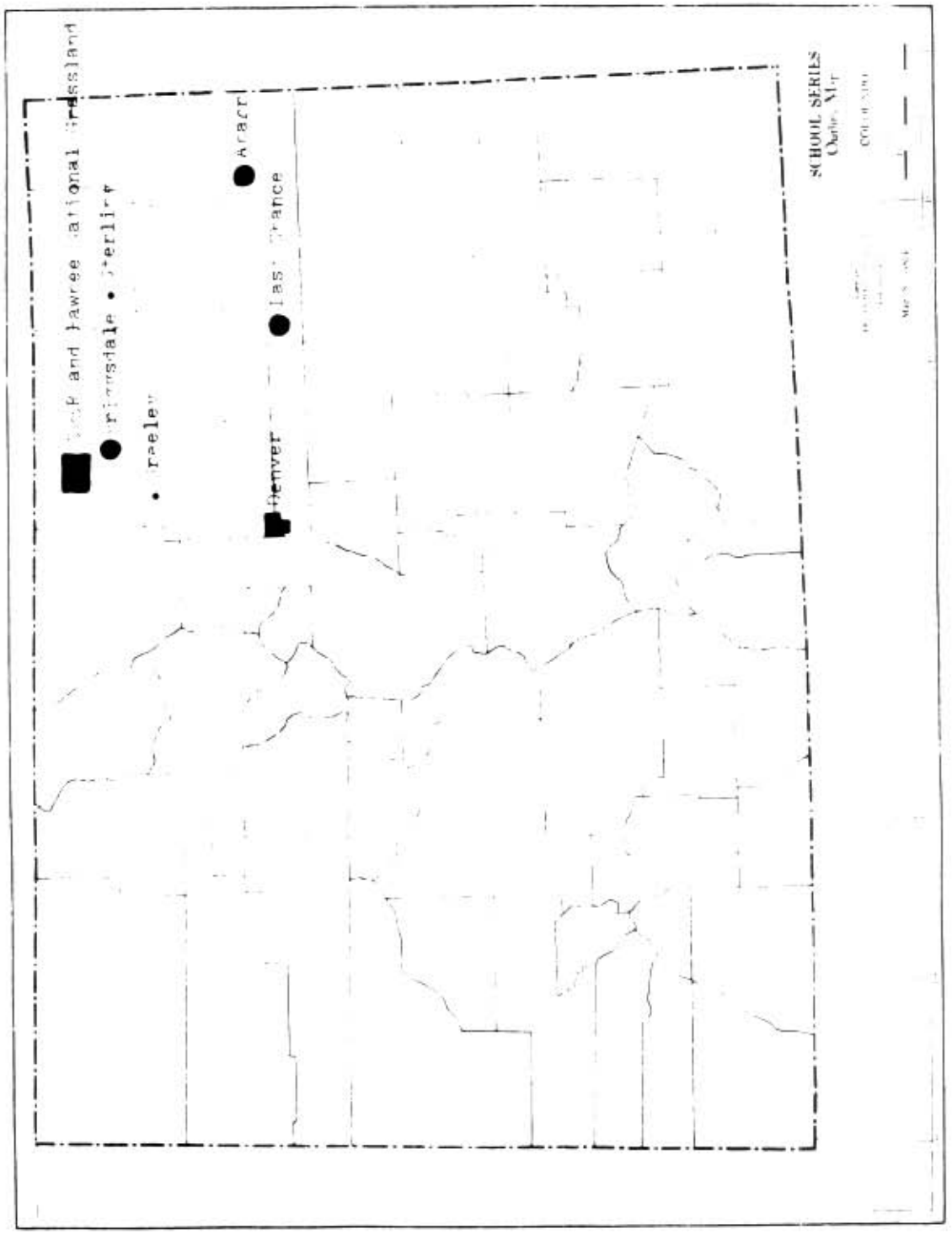
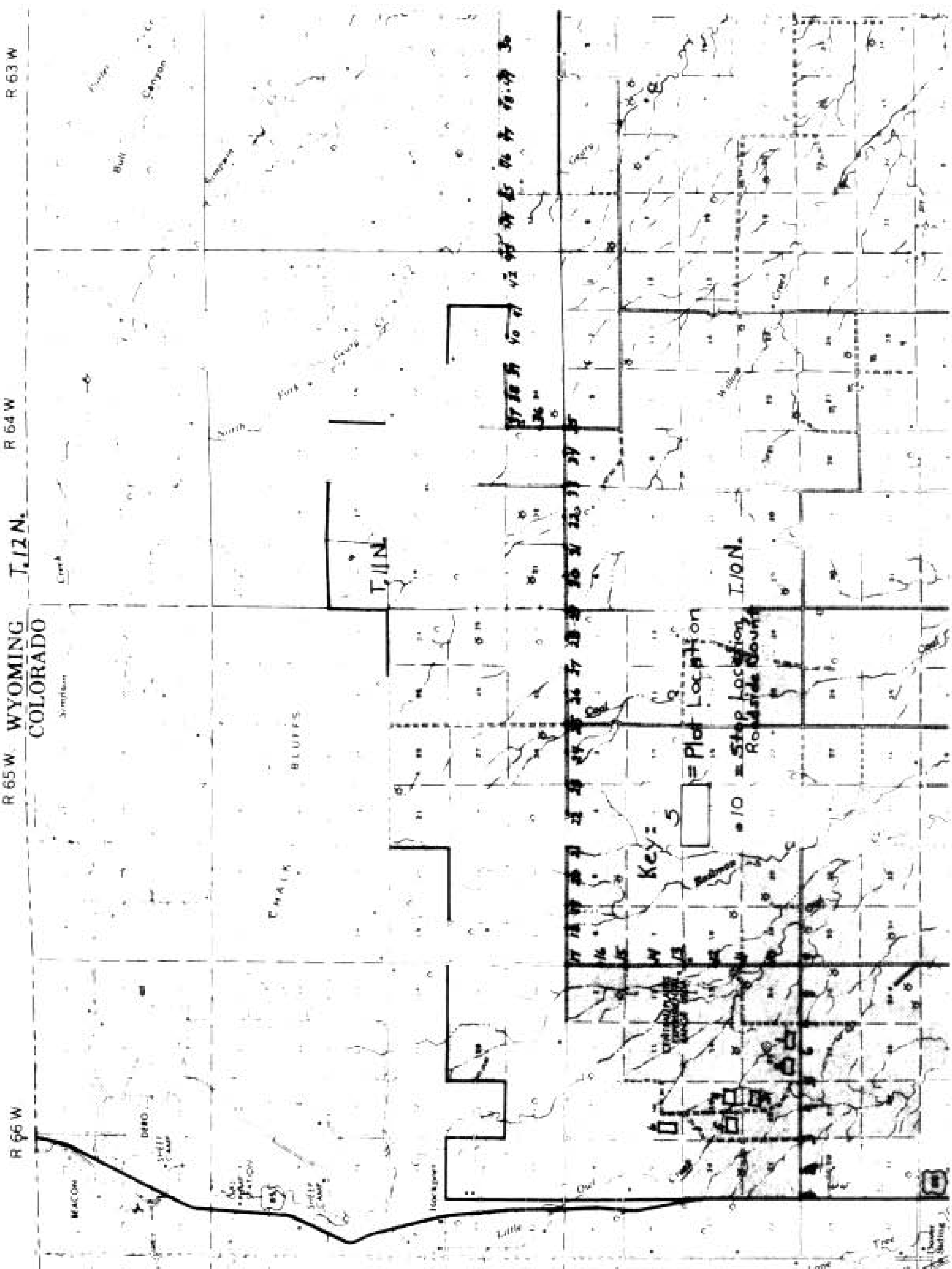

Denver
SCHOOL SERIES

Fig. 2.--Map of the Central Plains Experimental Range and Pawnee National Grassland showing the locations of six, 20-acre study plots and the roadside route.


R 63 W
R 64 W
R 65 W
R 66 W
WYOMING
COLORADO
T. 12 N.
T. 11 N.
T. 10 N.
CHALK BLUFFS
Key:
= Plot Location
• 10 = Stop Location Roadside Count

Climate

Average annual precipitation is 10-15 inches (25.4-38.1 cm), but varies from 5-25 inches (12.7-63.5 cm). Eighty percent of the precipitation falls from May through September.

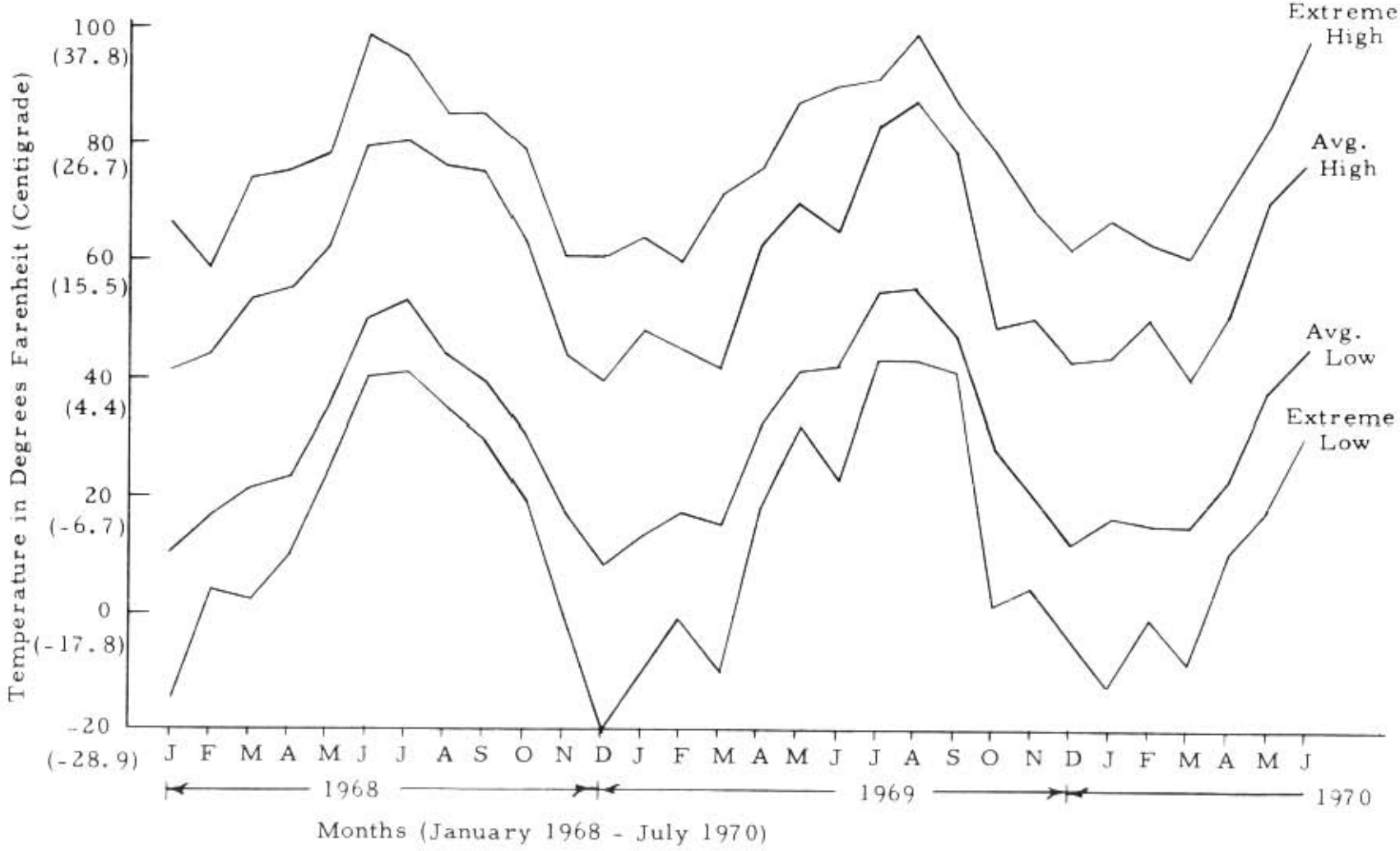
Temperatures are often extreme and variable. Summer highs during the study averaged 79°F (26.1°C); winter lows averaged 13°F (-10.6°C). A high of 99°F (37.2°C) and a low of -20°F (-28.9°C) were recorded during the study (Bement et al. 1970; Central Plains Experimental Range, Unpublished Notes). Daily temperatures fluctuated widely (Fig. 3). Wind velocities were high and caused dramatic chill effects in winter.

Vegetation

Klipple and Costello (1960) described the vegetation of the CPER as basically a blue grama-buffalograss community supplemented in many areas by thread leaf and needle leaf sedges. Midgrasses such as western wheatgrass (Agropyron smithii) and needle-and-thread (Stipa comata) are also present though they seldom dominate the cover. Three-awns (Aristida spp.) are present and important in some areas.

Important perennial forbs are scarlet globemallow (Sphaeralcea coccinea), slim flower scurfpea (Psoralea tenuiflora), slenderbush eriogonum (Eriogonum microthecium), and scarlet gaura (Gaura coccinea). Annual forbs are Russian thistle (Salsola kali),

Fig. 3.--Average monthly high and low temperatures and extremes at Central Plains Experimental Range Headquarters (Bement et al. 1970; Central Plains Experimental Range, Unpublished Notes).


Extreme High
Avg. High
Avg. Low
Extreme Low
100 (37.8)
80 (26.7)
60 (15.5)
40 (4.4)
20 (-6.7)
0 (-17.8)
-20 (-28.9)
Temperature in Degrees Farenheit (Centigrade)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J
1968
1969
1970
Months (January 1968 - July 1970)

cryptantha (Cryptantha spp.), pale evening primrose (Oenothera pallida), and lambsquarter (Chenopodium spp.) among others.

Fringed sagebrush (Artemisia frigida), fourwing saltbush (Atriplex canescens), and winterfat (Eurotica lanata) are primary browse species. Other shrubs include rubber rabbitbrush (Chrysothamnus nauseosus), broom snakeweed (Gutierrezia sarothrae), and big sagebrush (Artemisia tridentata) (Jameson 1969). Two species of cacti are present. The primary species is Opuntia polyacantha, plains pricklypear.

Grazing Study

Six, 20-acre plots were established in different pastures of varying grazing intensities and seasonal use (Table 1). Use of the pastures has been controlled by the Agricultural Research Service since 1940. Summer-use pastures were grazed from approximately May 10-November 10. Winter-use pastures were grazed from November 11-May 9. Heavy, moderate, and light intensities were established; approximately 60, 40, and 20 percent respectively, of the annual plant growth was consumed by cattle each year. Percentages of removal generally varied within ± 10%.

The effects on vegetation of these intensities and seasonal uses were summarized by Klipple and Costello (1960). They found that the light-grazed pastures were characterized by patches of heavy grazing surrounded by areas of virtually no grazing. Three-awns, snakeweed,

Table 1. Grazing intensities and representative vegetation on six, 20-acre plots on the Central Plains Experimental Range, Weld County, Colorado.

Plot	Intensity	Vegetation
23E	Heavy summer	Shortgrass, pricklypear, little litter
23W	Light summer	Short-midgrass*, pricklypear, litter
22E	Heavy winter	Short*-midgrass, saltbush, locoweed, little litter
15E	Moderate summer	Short-midgrass, few forbs, moderate litter
15W	Moderate winter	Short*-midgrass, saltbush, locoweed, litter
10S	Light winter	Short-midgrass*, saltbush, heavy litter

* Underlining to indicate dominant type.

and rabbitbrush showed little grazing use. Moderate grazing also showed patches of grazed and ungrazed vegetation. Heavy grazing was characterized by a distinct uniform appearance of the range.

Study Plot Descriptions

Each study plot measured 660 X 1320 feet (200 X 400 m) (20 acres; 8.1 ha.). Plots were originally established using fence markers one-eighth of a mile from each fence corner. They were thus centered at one end of the pasture concerned. During the first 8 months of study the plot boundaries were visually estimated using these markers. In spring, 1969, each plot location was refined by staking the perimeter and interior with 66 flat-plate, steel stakes in a grid at 132-feet (40.2 m) intervals (2 chains). Each stake was also marked with a small flag (Fig. 4). Alternating rows of stakes were painted red and yellow, and the grid was numbered to aid the observer in his location within the plot. Five plots were oriented in an east-west direction. Plot 10S was oriented north-south.

Plot 23E.--This plot was located in a heavily-grazed, summer-use pasture. It was characterized by uniform short grasses, primarily blue grama and buffalograss with an abundance of pricklypear and some pricklypoppy (Argemone spp.) (Fig. 5). Grasses seldom reached heights of 6 inches (15.2 cm); most plants were grazed to a height of 1-2 inches (2.5-5.1 cm). No saltbush was present. The

Fig. 4.--Grid marker and flag, showing numbering system used for location of birds within the plot.

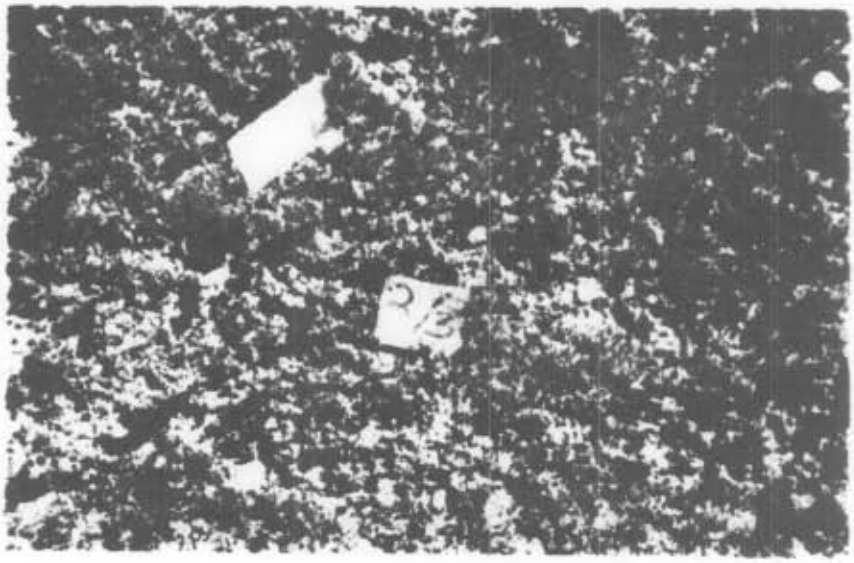
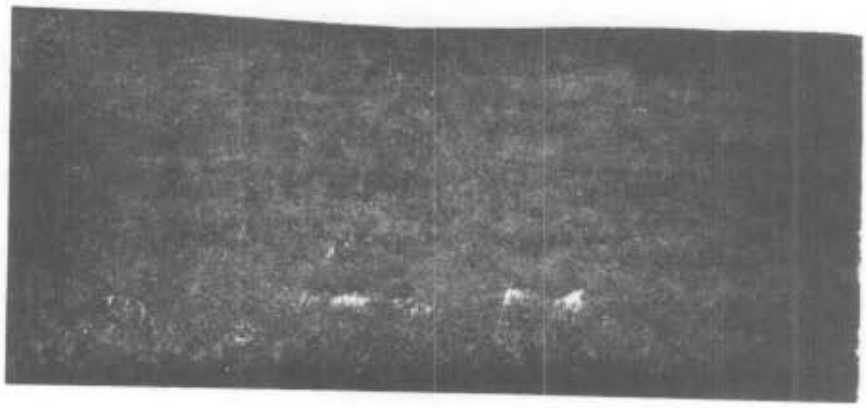
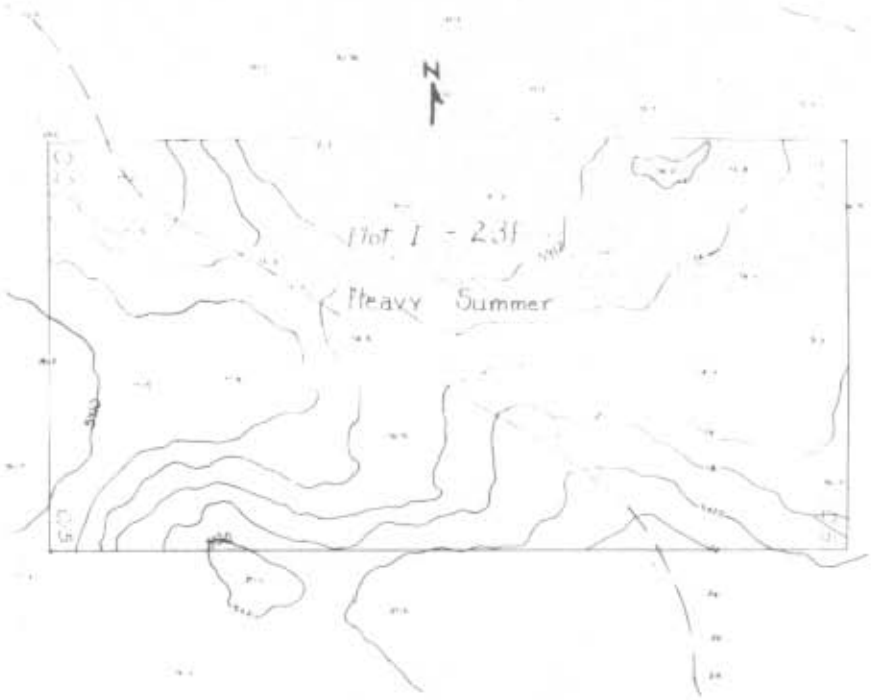


Fig. 5.--Plot 23E, looking east from stake 0/2-3, height of camera-30 inches. July 2, 1970. Primary grass is blue grama (Bouteloua gracilis). Plains prickly-pear (Opuntia polycantha) is also prominent.

Fig. 6.--Topography of Plot 23E; contour interval is two feet.




N
Plot 1 - 231
Heavy Summer

plot contained few other browse or forb species. A low ridge bisected the plot, separating two low swales (Fig. 6).

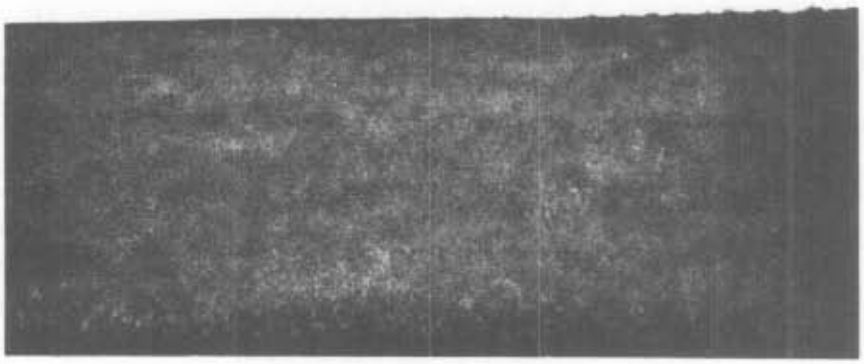
Plot 23W. --The second plot was established in a lightly-grazed, summer-use pasture, 23W, the half-section immediately west of 23E. Grasses and litter were much taller and denser; cactus was less common than on 23E. Three-awns were dense and provided good nesting cover (Fig. 7). As in all three summer-use plots, saltbush was virtually absent. Other browse species were occasionally present. The east end of this plot rose to a low hilltop which was heavily grazed (Fig. 8).

Plot 22E. --This plot was established in a heavily-grazed, winter-use pasture. Grasses on the plot maintained the uniform appearance characteristic of heavily-grazed pastures. They commonly reached heights of 8-12 inches (20.3-30.5 cm) for the plot was not grazed during the growing season. Forbs and browse, however, gave the plot a ragged appearance (Fig. 9). Saltbush and large patches of locoweed (Oxytropis spp.) were present on the western half of the plot, especially on the west-facing hillside. Saltbush plants were often grazed to within 2-4 inches (5.1-10.2 cm) of the ground.

The eastern two-thirds of this plot are relatively flat (Fig. 10). The western third slopes rapidly for 42 feet (12.8 m), levels off, and is bisected by a drainage ditch contained by an earthen dam in the

Fig. 7.--Plot 23W, looking east from stake 0/2-3, height of camera-30 inches. July 2, 1970. Primary plants are clumps of three-awns (Aristida spp.) and plains pricklypear (Opuntia polycantha).

Fig. 8.--Topography of Plot 23W; contour interval is two feet.



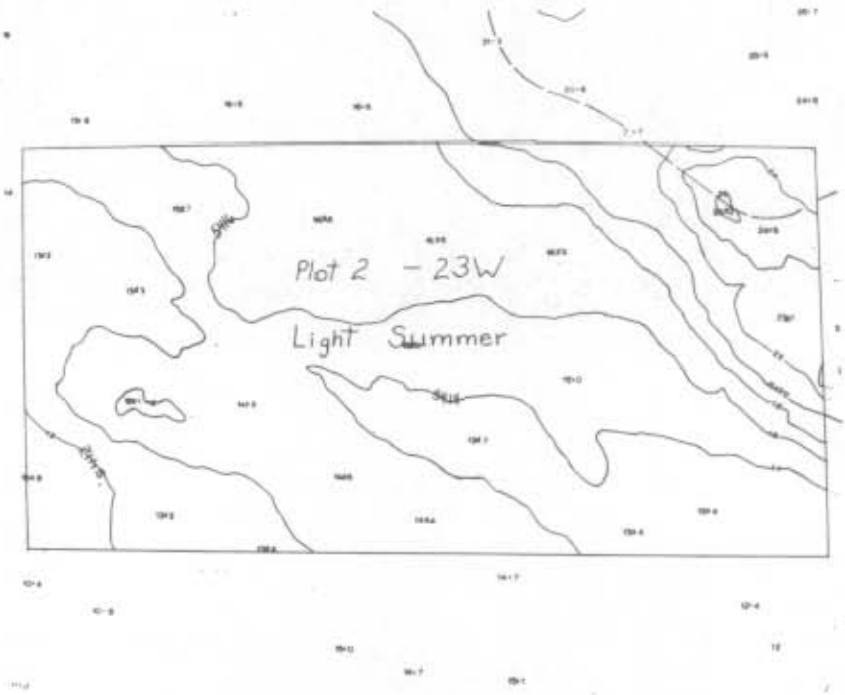
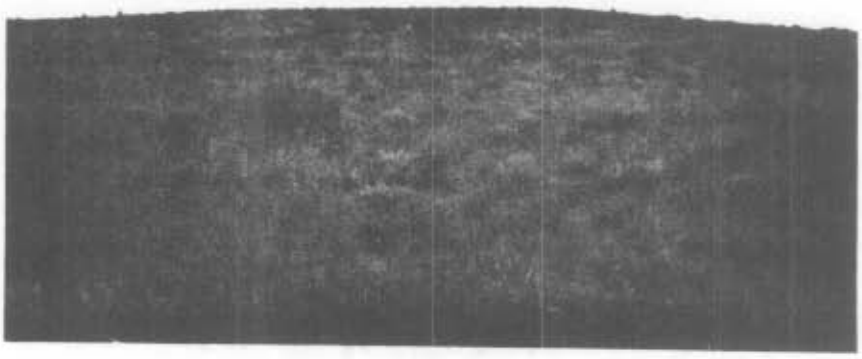
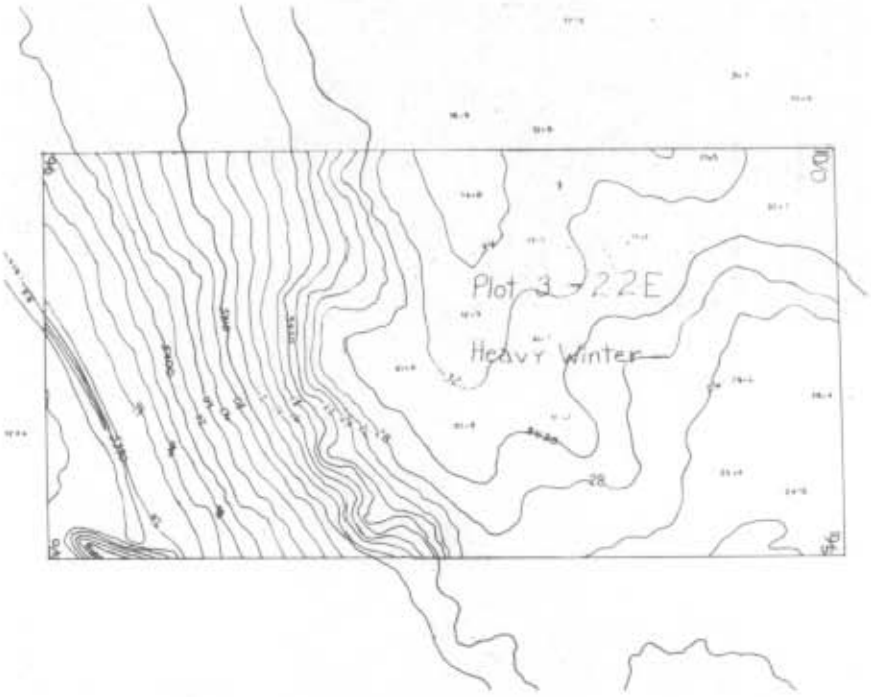

Plot 2 - 23W
Light Summer

Fig. 9.--Plot 22E, looking east from stake 0/2-3, height of camera-30 inches. July 2, 1970. Rubber rabbitbrush (Chrysothamnus nauseosus) and broom snakeweed (Gutierrezia sarothrae) are present in the foreground as is one large fourwing saltbush plant (Atriplex canescens).

Fig. 10.--Topography of Plot 22E; contour interval is two feet.




Plot 3 - 22E
Heavy Winter

southwest corner of the plot. This ditch held water for a short time in May and June, 1969, attracting red-winged blackbirds and killdeers (for scientific names of species of birds mentioned in the study see Appendix A).

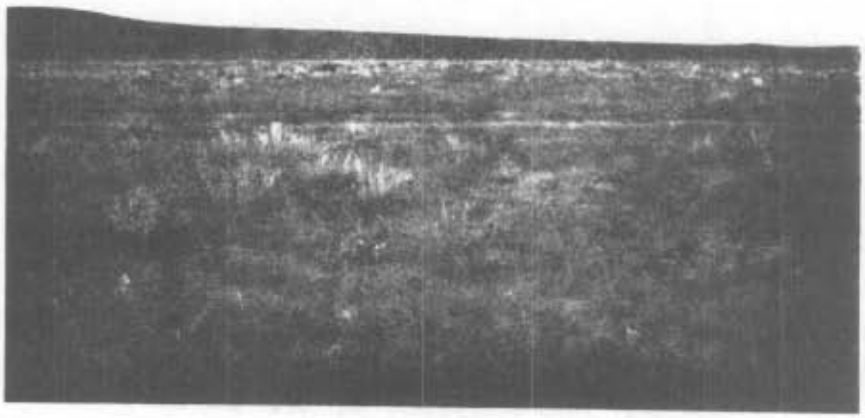
Plot 15E. --Vegetation of this moderately-grazed, summer-use plot was composed of grasses midlength between those of 23E and 23W. Three-awns were present in scattered patches, expecially in the low area near the east end of the plot. Litter was abundant (Fig. 11). Pricklypear was present, but not in as great abundance as on 23E. Virtually no saltbush was present, and rabbitbrush and snakeweed occurrence was also low.

Progressing from west to east the plot rises steeply for 30 feet (9.1 m), and then levels off for about one-half the area (Fig. 12). It then slopes gradually for 14 feet (4.3 m) to a low swale before rising 8 feet (2.4 m) in the southeast corner. An undeveloped access road crosses the west end of the plot.

Plot 15W. --This plot was established in a moderately-grazed, winter-use pasture. The soil was rocky, and forbs (especially locoweed) and saltbush were prevalent (Fig. 13). Grasses occurred in clumps and patches along the hillside which encompassed almost 80% of the area (Fig. 14). Grasses were more uniform at both ends of the plot where the hill leveled off. A small portion of the southwest corner (0.8 acres; .32 ha.) was plowed in June, 1969, as part

Fig. 11.--Plot 15E, looking east from stake 2/2-3, height of camera-30 inches. July 2, 1970. Prominent grasses are three-awns (Aristida spp.).

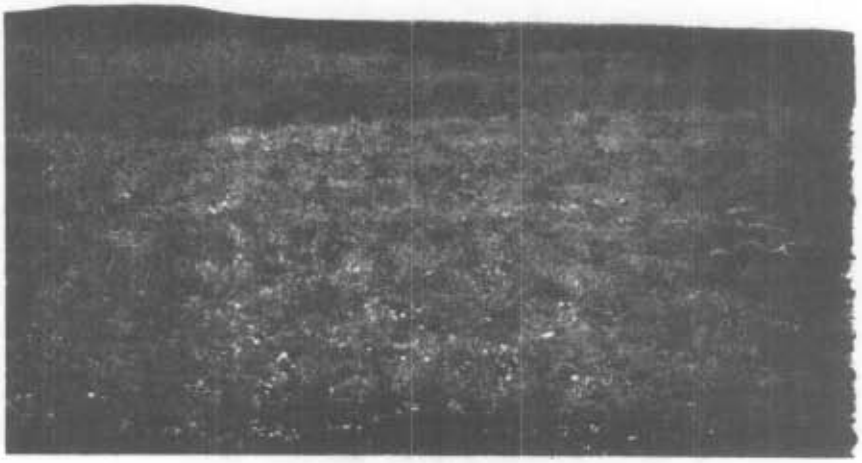
Fig. 12.--Topography of Plot 15E; contour interval is two feet.

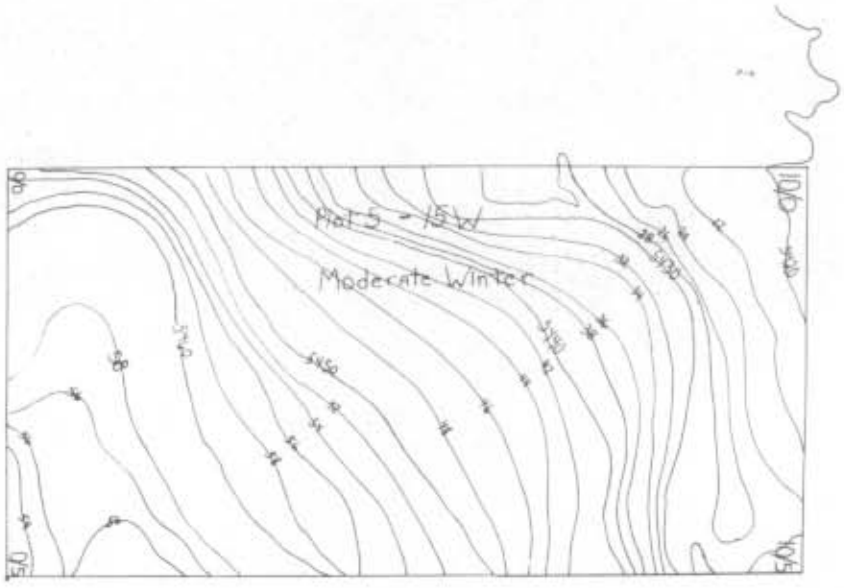



Plot 4 – 15E
Moderate Summer

Fig. 13.--Plot 15W, looking east from stake 2/2-3, height of camera-30 inches. July 2, 1970. Broom snakeweed (Gutierrezia sarothrae) and rubber rabbitbrush (Chrysothamnus nauseosus) are evident in right-center. The large shrub in the left-center is four-wing saltbush (Atriplex canescens).

Fig. 14.--Topography of Plot 15W; contour interval is two feet. (Map drawn freehand from visual estimate).




Plot 5 → 15 yd
Moderate Winter

of another study. This area continued to be used by birds which used the rows of dirt as observation posts.

Plot 10S.--The final plot was established in a lightly-grazed, winter-use pasture. Grass length was comparable to that of Plot 23W. Needle-and-thread was abundant (Fig. 15) as predicted by Klipple and Costello (1960). Saltbush was abundant and showed little grazing use. Snakeweed and rabbitbrush were also abundant. The plot contained a few areas of heavy grazing, but for the most part appeared to be little used by cattle. However, pronghorns (Antilocapra americana) were occasionally seen grazing on the plot. Plot 10S was nearly level for three-fourths of its length before rising 32 feet (9.8 m) to a rocky hilltop covered by yucca (Yucca sp.) and saltbush (Fig. 16).

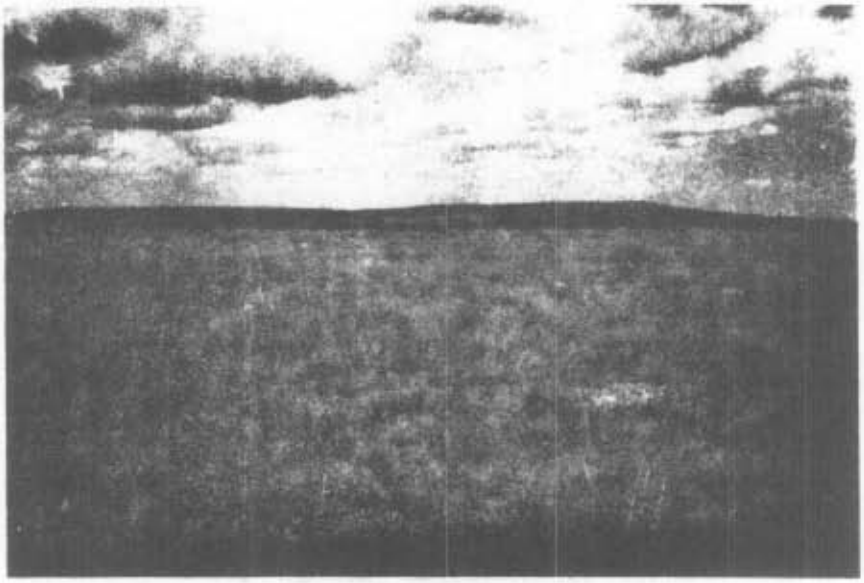
Brief summaries of the vegetation on each plot are given in Table 1.

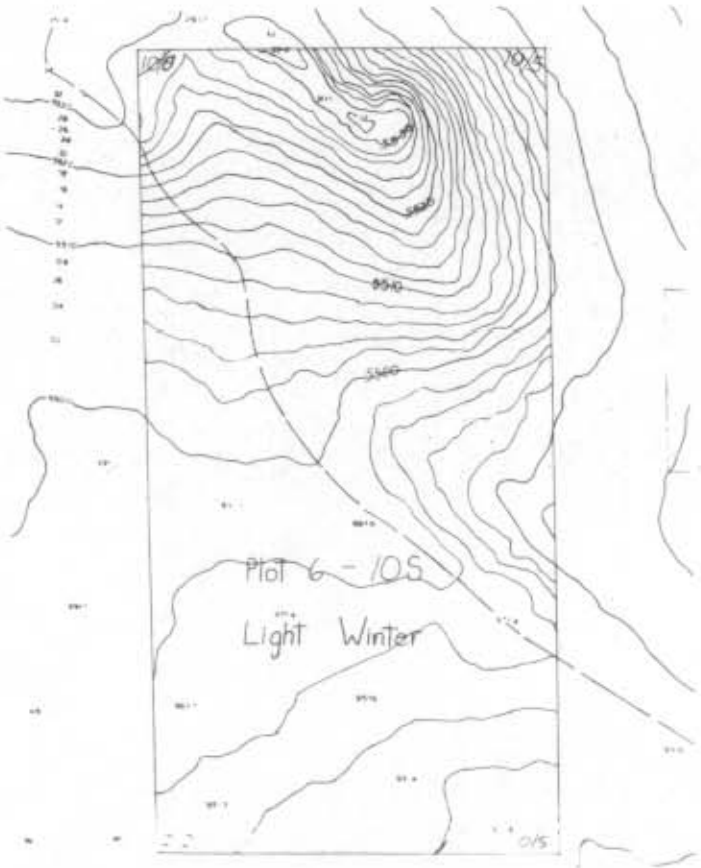
Above-ground Plant Biomass

Even though grazing studies have been conducted for 30 years, data pertaining to plant cover on all six plots during the same year following grazing are absent. Normally, plant biomass remaining on summer-use pastures was measured in October by Agricultural Research Service personnel. Unfortunately, similar measurements were not made on winter-use pastures following the winter grazing season. Biomass for all six pastures was normally estimated in

Fig. 15.--Plot 10S, looking north from stake 0/2-3, height of camera-30 inches. July 2, 1970. Needle-and-thread (Stipa comata) appears as tall grass in left foreground. Large shrubs in distance are fourwing saltbush (Atriplex canescens).

Fig. 16.--Topography of Plot 10S; contour interval is two feet.




Plot 6 - 105
Light Winter

October. Data from 1968 (Bement and Hyder 1969) and 1969 (Bement et al. 1970) are summarized in Table 2. The figures show a distinct ranking in pounds per acre of plant biomass, increasing as grazing intensity decreases. Naturally, winter-use pastures retained more biomass, for they had not yet been grazed at the time of estimation.

Direct analysis of these data was difficult since some pastures were being grazed during the breeding season and some were not. Differences between the summer-use and winter-use pastures were reflected to a certain extent by the plant species present as well as by plant biomass. Saltbush was virtually absent from summer-use pastures, but was quite common in winter-use areas. Numbers of these shrubs increased as the grazing intensity decreased. Plants in heavily-grazed pastures were often decimated by grazing and provided little useful cover. Snakeweed and rabbitbrush were also common on winter-use pastures though the frequency was not determined.

Vegetation of Roadside Routes

The 24.5-mile (39.4 km), 50-stop roadside count route proceeded through the CPER, extending into the northwest portion of the Pawnee National Grassland (Fig. 2). The route encompassed large areas of mostly shortgrass prairie with some shrubs, primarily fourwing saltbush. Nine stops encompassed hay, corn, or

Table 2. October plant biomass on six pastures at Central Plains Experimental Range, 1968-69.*

Plot	Plant Biomass Remaining, lb./acre (gm/m^2)					
	1968		1969		Average	
Summer-use						
23E	173	(19.4)	164	(18.4)	168.5	(18.9)
15E	321	(36.0)	262	(29.4)	291.5	(32.7)
23W	386	(43.3)	326	(36.5)	356.0	(39.9)
Winter-use						
22E	643	(72.1)	645	(72.3)	644.0	(72.2)
15W	839	(94.0)	757	(84.9)	798.0	(89.5)
10S	816	(91.5)	1017	(114.0)	916.5	(102.7)

* From Bement and Hyder (1969) and Bement et al. (1970).

wheat fields. Two of these were sprinkle-irrigated. The remainder were dryland farming. Two stops were adjacent to windbreaks; five included buildings within their boundaries (Table 3).

Two additional roadside counts were made each year (Fig. 1). One was near Abarr, Yuma County, Colorado. This count traversed a short-midgrass/brush area for 60% of the route. The remainder was divided between wheat farming and shortgrass prairie. The second count began nine miles northwest of Last Chance, Washington County, Colorado. It traveled through wheat farming and shortgrass areas. Results of another count conducted each year by Dr. R. A. Ryder in shortgrass prairie near Briggsdale, Weld County, Colorado were included for comparison to aid in determination of population fluctuations.

Table 3. Summary of vegetative types on 50-stop, 24.5 mile roadside count, Central Plains Experimental Range and Pawnee National Grassland, Weld County, Colorado.

Category	Number of Stops		
	Dominant	Incidental	Total
Shortgrass	41	6	47
Shortgrass with brush	12	2	14
Tall grass	4	5	9
Tall grass with brush	-	1	1
Agricultural field crops	2	7	9
Windbreak	2	-	2
Wet area	-	2	2
Buildings	1	4	5
Total	62*	27	89*

*Some stops were dominated equally by two types of vegetation, hence totals are greater than 50.

CHAPTER III

METHODS AND MATERIALS

The primary techniques used by former investigators in grasslands have been the strip-census method described by Dice (1930), Breckenridge (1935), and Logan (1961); a plot count method described by Kendeigh (1944) and Finzel (1962); and various roadside counts described by Howell (1951) and Robbins and VanVelzen (1967). Miscellaneous studies have used mist-netting and the Lincoln index (Stamm et al. 1960), "intensive search" (Raitt and Maze 1968), and territory determinations (Wiens 1969).

Methods used to determine the populations and biomass of birds on the CPER and adjacent Pawnee National Grassland were plot counts, roadside counts, nest searches, territory determinations, and specimen collections. Observations were made using 7X35 binoculars and (on the roadside count) a 20X spotting scope. Notes and numbers were recorded on standardized field forms (Appendices B and C).

Plot Count Method

Each plot was censused weekly during the spring and early summer (April 15-August 15) and biweekly the remainder of the year. Counts were made by walking transects through the plot, making short

detours to search hard-to-see areas or to identify individuals. Since the plot counts were an attempt to determine the actual number of birds using the plot, a careful search was necessary to avoid missing birds as well as to avoid duplications. The routes traveled placed all points within 200 feet of the observer at some time during the count.

The location of each bird when first seen was recorded on a standard form (Appendix B) in 1969. Later I realized that location alone did not tell enough about the birds on the plot. Therefore, in 1970, I recorded certain movements of each bird as well (see symbols at bottom-left of Appendix B). In this manner I could determine if a bird was territorial, simply foraging, or flying over the plot. Each plot was censused in 25-40 minutes, a rate of 69-107 linear feet (21.0-32.6 m) per minute. Counts were normally made between 0730 and 1330 (MST). Since a careful search of each plot was made, it was not thought necessary to start counts at sunrise or during major activity peaks.

Numbers of each species observed on the plots were combined with nest searches in 1969 to determine the number of nesting pairs utilizing each plot. In 1970, these techniques were combined with a technique of determining individual territories (discussed later) to derive a more accurate estimate of the population.

Since not all birds using each plot nested there, and not all birds nesting there restricted their activities entirely within the plot

boundaries, a second measure of bird use was needed. "Bird-use days," a parameter used by the national wildlife refuge system to measure waterfowl utilization, was computed. The numbers of each species seen on two consecutive counts were averaged and multiplied by the number of days between counts to determine use days for the period. These values were grouped into breeding season, post-breeding, and winter season categories.

Nest Search Methods

Several techniques were used in 1969 to find nests on the plots. Most methods were unsuccessfl because nests were well-camouflaged. A method of dragging a rope or light chain between two observers was attempted. I found that most birds, horned larks in particular, flushed at great distance from the observers. The rope constantly became entangled in cactus and shrubs. This method was abandoned in favor of using extended periods of observation to locate adults feeding young, carrying nesting material, or returning to the nest to incubate. Interestingly, I found more nests in 1970 during the weekly plot counts than in 1969, while trying several methods of searching for nests.

Territory Determination

Territory sizes and locations of individual nesting pairs were determined in May and June, 1970, by plotting the locations of a

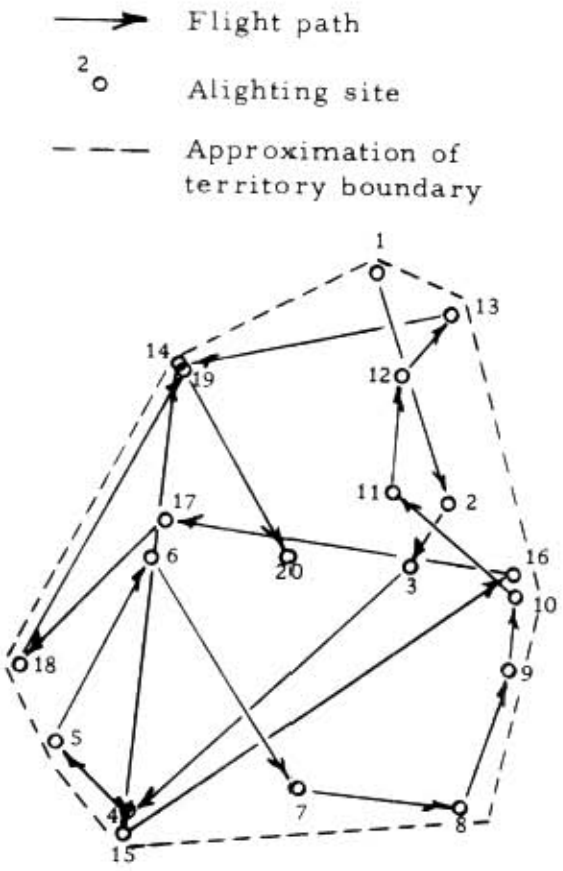
series of flushings as described by Wiens (1969). Territorial males were flushed 20 times and their direction of flight and point of landing were noted. By sketching perimeters around these points, a picture of the territory of the individual emerged (Fig. 17).

Intraspecific interaction often occurred at territorial boundaries among horned lark males, western meadowlark males, and McCown's longspur males. Little or no recognizable interaction was noted among lark bunting males and among Brewer's sparrow males. The technique described worked best for horned larks. Western meadowlark territories were generally too large for accurate plotting. Brewer's sparrows and McCown's longspurs flushed well when not pursued too forcefully. I suspect that lark bunting territories are not as well defined as those of other species. An abundance of unmated displaying males confused the situation, and often several lark bunting males would display within the confines of the suspected territory of another male. Other observers (Wiens, personal communication) have had better success than I with this species.

Roadside Count Method

Techniques used on the roadside counts were established and described by Robbins and VanVelzen (1967). The results were used to determine relative abundance of each species and to detect changes in these rankings.

Fig. 17.--Diagramatic example of the flushing method used to determine territories on the study plots. From a mapping of a horned lark territory made on June 13, 1970.



Territory size approximately 3.54 acres

Fifty stops, one-half mile (0.8 km) apart, were made along a permanently designated route. All birds seen or heard within a one-quarter-mile radius of each stop were recorded during a three-minute period. Each stop was timed with an automatic timer. Counts were started at sunrise (one-half hour before sunrise for each of the Last Chance, Abarr, and Briggsdale counts) during April-November. During winter, counts were started between 0800 and 0900 (MST). I found that most birds did not become active in winter until the sun had warmed the birds and their surroundings. Each count took 4 to 5 hours to complete (average was 4 hours, 20 minutes).

Roadside counts were made weekly during April 15-August 15, and biweekly the remainder of the year. Rain, wind velocities of 14 miles per hour or greater, and deep snow drifts on the road caused cancellation of several counts.

Weight Measurements

Birds (primarily horned larks and lark buntings) were collected weekly during March, 1969-April, 1970, by me, and from May through July, 1970, by Dr. P. H. Baldwin, Department of Zoology, Colorado State University. Birds were weighed to the nearest 0.1 gram in the laboratory by undergraduate technicians.

Biases

Several biases were encountered during my study. Weather conditions influenced results. High winds and rain restricted

movements of birds and made it difficult to hear their calls. Extremely cold mornings delayed the start of their daily activities. Snow and low relative humidity allowed greater visibility and audibility, respectively.

The time of day influenced results of the roadside counts. For example, fewer meadowlark calls were noted toward the end of most roadside routes. However, this was a constant bias and should have had little effect on yearly population trends. Plots were generally counted in a regular order beginning with 23E and ending with 10S. Reversing the order had little effect on results.

During the first year of study, few investigators were present on the study area. However, by the 1970 breeding season, over 50 investigators and their equipment were present. Four buildings and a shed and corral were constructed. Shortly afterward, Say's phoebes appeared, nesting on a ledge in the shed. Barn swallows also appeared, but no nests were found. The total disturbance by men and machines was not measured, but probably has some effect on the avian population.

Experience was a bias. As I became familiar with each species and its characteristics, I could more readily find individuals. One might expect then that second year figures would be higher than the first year. This was not the case.

Conspicuousness of each species varied and was the most important bias of the study. Species such as the lark bunting and

McCown's longspur, with loud aerial displays and/or distinctive plumage, were more easily seen than the camouflaged mountain plover and horned lark. This bias was partially compensated by the latter two species' choice of sparse cover for most of their activities.

I feel the above factors influenced results of the roadside counts more than the plot counts. By carefully searching each plot most individuals were flushed, seen, or heard. However, some birds (especially incubating females) were certainly overlooked, and others were counted twice. Hopefully, these biases cancelled each other.

Standardization of techniques used on both systems of counts helped to minimize biases caused by weather, human disturbance, time, and experience.

CHAPTER IV

RESULTS

Thirty-two species of birds were observed on or over the plots from July, 1968 to July 31, 1970 (Table 4 and Appendix A). Most species were migrant visitors (Table 4). Eight species accounted for over 95% of the total year-round activity on the plots. Approximate arrival and departure dates of these primary species are shown in Fig. 18. One species, the horned lark, was present year-round. Six species were breeding season residents; another was a winter resident only.

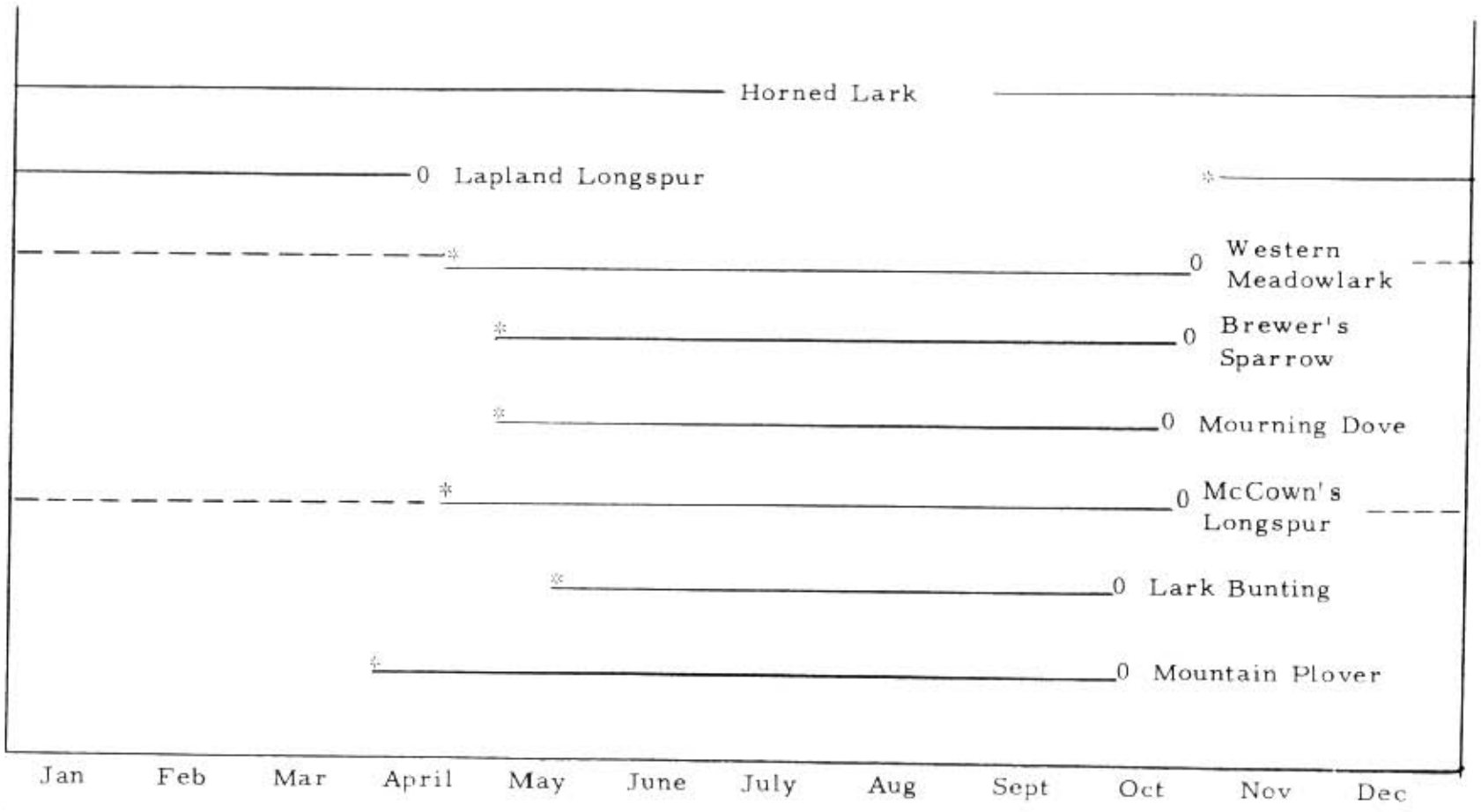
Eighty-four species were noted on the roadside count during the study (Appendix A). Eighteen to 28 of these species were commonly seen during spring, summer, and fall counts (average was 22 species). These included the eight primary species (Table 7), several raptors (Swainson's hawk, golden eagle, marsh hawk, and sparrow hawk), eastern and western kingbirds, barn swallow, loggerhead shrike, and starling. Species seen in winter were the rough-legged hawk, ferruginous hawk, golden eagle, marsh hawk, horned lark, and Lapland longspur. The latter two species were virtually the only species on the plots in winter. An average of 10 species was seen on each roadside count in winter.

Table 4. Summary of species seen on six, 20-acre plots from July 1, 1968-July 31, 1970, IBP Intensive Site, Central Plains Experimental Range.

Species	Plot					
	23E	23W	22E	15E	15W	10S
Swainson's hawk	T	T	T	T	T	T
Rough-legged hawk	B	B	B	B	B	B
Ferruginous hawk	TB	TB	TB	TB	TB	TB
Golden eagle	TB	TB	TB	TB	TB	TB
Marsh hawk	TB	TB	TB	TB	TB	TB
Prairie falcon	TB	TB	TB	TB	TB	TB
Pigeon hawk						B
Sparrow hawk	T	T	T	T	T	
Killdeer			Pn	Pn	Pn	
Mountain plover	N			N		
Long-billed curlew		T				
Whimbrel		T				
Rock dove			F	F	Pn	
Mourning dove	FPn	FPn	FPn	FPn	FPn	N
Burrowing owl	T	FPn	T	T		
Poor-will						B
Common nighthawk	T		FPn	T		
Say's pheobe					T	
Horned lark	NW	NW	NW	NW	NW	NW
Barn swallow		T				
Cliff swallow					T	T
Sage thrasher			T		T	
Loggerhead shrike						T
Western meadowlark	F	N	N	N	N	N
Red-winged blackbird			T		T	
Lark bunting	F	N	N	N	N	N
Vesper sparrow		T	T			T
Chipping sparrow			T			
Brewer's sparrow		T	N	T	N	N
McCown's longspur	N	N	FPn	FPn	N	F
Lapland longspur	W	W	W	W	B	B
Chestnut-collared longspur	F	N	F	N	FPn	

Key to symbols:
N = Nested and foraged on plot.
Pn = Nested in pasture but not on plot.
F = Foraged on plot.
T = Temporary visitor in spring or summer.
W = Winter season resident.
B = Brief visitor in fall or winter.

Fig. 18.--Approximate arrival and departure dates of eight principal species.



* - Arrival

0 - Departure

– – – – Present, but numbers reduced and restricted

Species on the checklist but not noted on the plot or roadside counts had been reported in the literature or were observed along streams, brush areas, farms, and ponds on and near the CPER and Pawnee National Grassland.

Since large seasonal differences in the avifauna occurred, the findings of my study are presented by seasons of use---breeding, post-breeding, and winter.

Breeding Season, April 15-July 21, 1969 and 1970

Five species provided most of the nesting on the plots (Table 5). Horned larks and lark buntings together accounted for 64% and 59% of all nesting in 1969 and 1970, respectively. Western meadowlarks, McCown's longspurs, and Brewer's sparrows contributed a combined total of 32% and 36%, respectively. Mountain plovers, mourning doves, and chestnut-collared longspurs were less abundant, each being restricted to one or two plots. Common nighthawks, killdeers, and rock doves nested within pasture boundaries, but not within the plots, during one or both years. Their contributions to the total population were insignificant.

Most species showed fluctuations within and among the various plots. Density of nesting populations of each species commonly reached a peak early in the breeding season (Fig. 19) and declined slightly as the birds dispersed to begin nesting activities. As broods fledged, populations again increased.

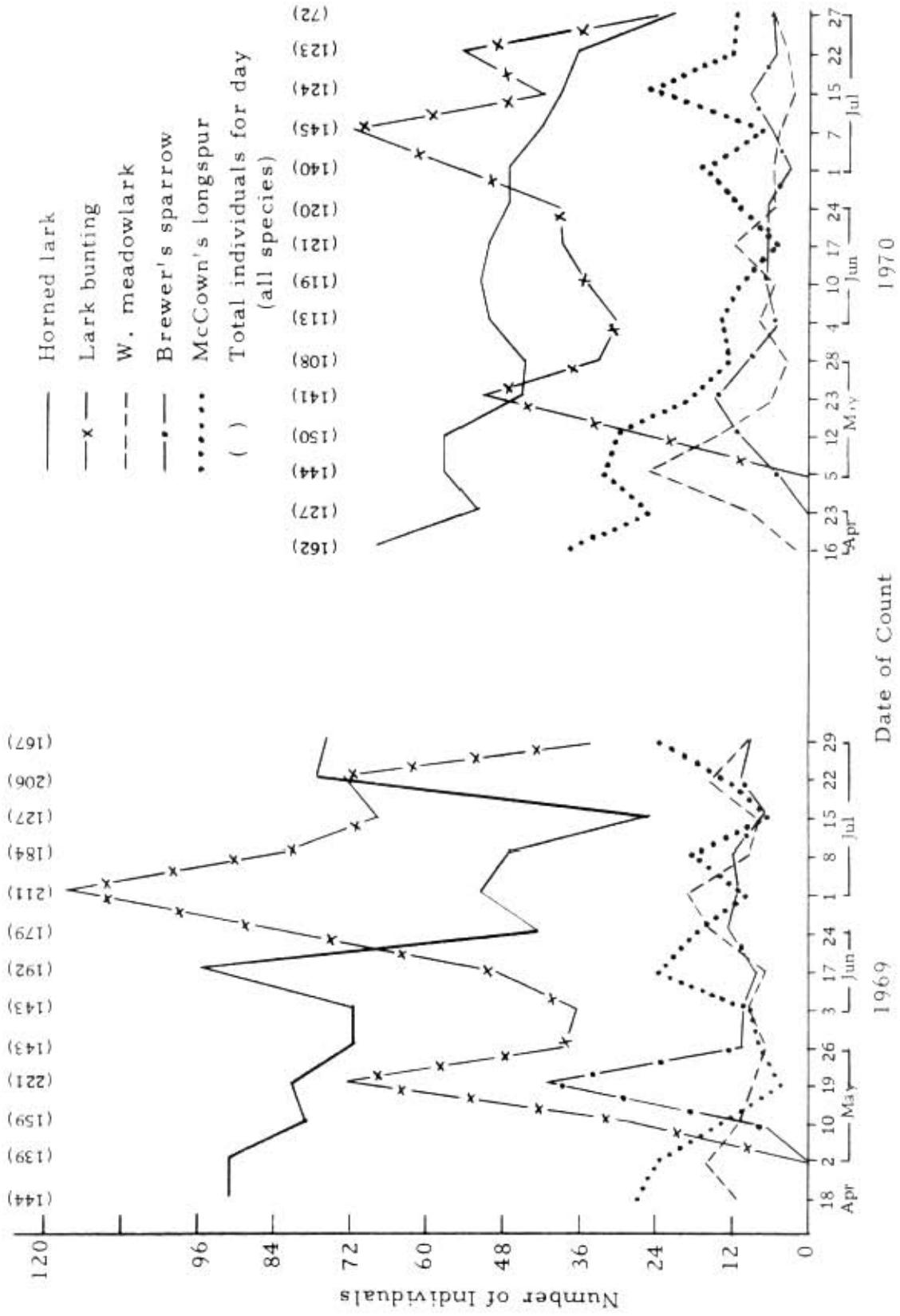
Table 5. Breeding pairs of birds on six 20-acre plots, 1969 and 1970 (densities in pairs/100 acres in parenthesis).

Species	Plot Number 23E	23W	22E	15E	15W	10S	Pairs/100 acres
1969							
Horned lark	10.1 (50.5)	2.6 (13.0)	3.7 (18.5)	6.5 (32.5)	4.6 (23.0)	3.1 (15.5)	(25.5)
Lark bunting	0 0	5.8 (29.0)	3.9 (19.5)	3.0 (15.0)	3.9 (19.5)	3.0 (15.0)	(16.3)
Western meadowlark	0 0	1.4 (7.0)	1.6 (8.0)	1.9 (9.5)	1.3 (6.5)	3.1 (15.5)	(7.8)
McCown's longspur	3.8 (19.0)	1.1 (5.5)	0 0	0 0	0.8 (4.0)	0 0	(4.7)
Brewer's sparrow	0 0	0 0	3.0 (15.0)	0 0	3.8 (19.0)	3.6 (18.0)	(8.7)
Mountain plover	2.0 (10.0)	0 0	0 0	0 0	0 0	0 0	(1.7)
Mourning dove	0 0	0 0	0 0	0 0	0 0	1.0 (5.0)	(0.8)
Total	15.9 (79.5)	10.9 (54.5)	12.2 (61.0)	11.4 (57.0)	14.4 (72.0)	13.8 (69.0)	(65.5)

Table 5. (Continued)

Species	Plot Number 23E	23W	22E	15E	15W	10S	Pairs/100 acres
1970							
Horned lark	4.5 (22.5)	2.3 (11.5)	2.7 (13.5)	2.4 (12.0)	3.2 (16.0)	2.5 (12.5)	(14.7)
Lark bunting	0 0	4.8 (24.0)	2.8 (14.0)	3.1 (15.5)	2.9 (14.5)	3.0 (15.0)	(13.8)
Western meadowlark	0 0	1.2 (6.0)	1.1 (5.5)	1.5 (7.5)	2.0 (10.0)	2.0 (10.0)	(6.5)
McCown's longspur	3.3 (16.5)	3.3 (16.5)	0 0	0 0	0.4 (2.0)	0 0	(5.8)
Brewer's sparrow	0 0	0 0	1.0 (5.0)	0 0	2.9 (14.5)	2.3 (11.5)	(5.2)
Mountain plover	1.5 (7.5)	0 0	0 0	0 0	0 0	0 0	(1.2)
Chestnut collared longspur	0 0	0.5 (2.5)	0 0	1.0 (5.0)	0 0	0 0	(1.2)
Total	9.3 (46.5)	12.1 (60.5)	7.6 (38.0)	8.0 (40.0)	11.4 (57.0)	9.8 (49.0)	(48.4)

Fig. 19.--Trends of populations on plots (all plots combined) during 1969 and 1970 breeding seasons.


Horned lark
Lark bunting
W. meadowlark
Brewer's sparrow
McCown's longspur
Total individuals for day (all species)
Number of Individuals
Date of Count
1969
1970
Apr
May
Jun
Jul

A decline in total breeding population from 1969 to 1970 was noted on the roadside counts as well as on the plots (Table 6). All primary species except the McCown's longspur and mourning dove showed declines on both roadside and plot counts. Of these latter two species, only the McCown's longspur was represented by enough individuals on the plot counts for the change to be significant. Most counts showed similar declines or increases for each particular species. Important deviations from the trends were noted for lark buntings on the Last Chance count, western meadowlarks and mountain plovers on the CPER-Pawnee count, and mourning doves which varied erratically on all counts. However, average increases and decreases of the roadside counts correspond well with those of the plot counts.

Not all birds using the plots during the breeding season were breeding individuals. For this reason, average total populations were computed from plot counts during each breeding season (Table 7). Four of the 5 major breeding species declined in total population in 1970. McCown's longspurs increased as did three minor species. Breeding pair populations and average total populations were similar in total individuals/100 acres (131.0 and 96.8 breeding birds/100 acres in 1969 and 1970; 143.7 and 105.4 birds/100 acres for the average total population in the 2 years). However, differences in rankings did occur among species.

Table 6. Summary of trends of species on roadside and plot counts, 1969 and 1970 breeding seasons.

Species Count Name	Number Observed 1969	1970	Percent of Species' Increase/Decrease
Horned lark			
Briggsdale	210	130	-38
Last Chance	293	195	-33
Abarr	290	240	-17
CPER-Pawnee*	199	152	-24
Average/count	248	179	-28
Plot count avg. (May-July)	65	37	-44
Lark bunting			
Briggsdale	506	395	-22
Last Chance	262	320	+22
Abarr	265	58	-78
CPER-Pawnee	320	247	-23
Average/count	338	255	-25
Plot count avg. (May-July)	60	48	-19
Western meadowlark			
Briggsdale	94	68	-28
Last Chance	155	138	-11
Abarr	291	239	-18
CPER-Pawnee	131	153	+17
Average/count	168	150	-11
Plot count avg. (May-July)	11	8	-27
McCown's longspur			
Briggsdale	1	0	-100
Last Chance	0	0	--
Abarr	0	0	--
CPER-Pawnee	32	36	+13
Average/count	8	9	+ 9
Plot count avg. (May-July)	13	16	+24

Table 6. (Continued)

Species Count Name	Number Observed 1969	1970	Percent of Species' Increase/Decrease
Brewer's sparrow			
Briggsdale	5	2	-60
Last Chance	1	1	--
Abarr	55	39	-29
CPER-Pawnee	26	26	--
Average/count	22	17	-22
Plot count avg. (May-July)	13	9	-33
Mourning dove			
Briggsdale	62	58	-6
Last Chance	39	47	+21
Abarr	92	45	-51
CPER-Pawnee	22	31	+41
Average/count	54	45	-16
Plot count avg. (May-July)	.33	.69	+109
Mountain plover			
Briggsdale	27	3	-89
Last Chance	5	2	-60
Abarr	0	0	--
CPER-Pawnee	2	3	+50
Average/count	9	2	-76
Plot count avg. (May-July)	4	4	--
Total individuals			
Briggsdale	1032	807	-22
Last Chance	856	581	-32
Abarr	1253	832	-34
CPER-Pawnee	781	706	-10
Average/count	981	732	-31
Number of species			
Briggsdale	25	27	+8
Last Chance	22	23	+5
Abarr	31	33	+6
CPER-Pawnee	20	21	+5
Average/count	25	26	+6

*CPER-Pawnee roadside count was the weekly roadside count nearest the date of the other roadside counts, generally the last week in June.

Table 7. Average total bird population present on six 20-acre plots (birds/100 acres in parenthesis) on CPER during 1969 (13 counts) and 1970 (15 counts) breeding seasons.

Year & Species	Plot Number 23E	23W	22E	15E	15W	10S	100 Acre Average of All Plots
1969							
Horned lark	26.1	9.2	7.2	13.7	10.3	6.2	(60.5)
Lark bunting	1.2	13.8	10.7	9.4	9.5	7.3	(43.2)
Western meadowlark	0.5	2.2	1.2	2.3	2.5	2.8	(9.5)
McCown's longspur	10.8	3.2	0	1.5	0.2	0	(13.1)
Brewer's sparrow	0	0.7	2.5	0.6	2.9	5.2	(10.0)
Mountain plover	3.4	0	0	0.3	0.1	0	(3.2)
Mourning dove	0.1	0	0	0.2	0	0.1	(0.3)
Chestnut-collared longspur	0	0.8	0.1	0.7	0	0	(1.6)
Others	0.3	0.5	1.7	0.2	0.2	0.1	(2.5)
Total	42.4 (212.0)	30.4 (152.0)	23.4 (117.0)	28.9 (144.5)	25.7 (128.5)	21.7 (108.5)	(143.7)

Table 7. (Continued)

Year & Species	Plot Number 23E	23W	22E	15E	15W	10S	100 Acre Average of All Plots
1970							
Horned lark	14.6	4.6	5.7	8.7	6.7	7.0	(39.4)
Lark bunting	1.6	8.1	8.1	5.1	6.3	4.9	(28.4)
Western meadowlark	0.2	1.4	1.3	0.9	2.3	1.5	(6.3)
McCown's longspur	9.9	7.1	0	0.5	0.7	0.1	(15.2)
Brewer's sparrow	0	0	1.6	0	2.7	3.0	(6.1)
Mountain plover	4.3	0	0	0.1	0	0	(3.7)
Mourning dove	0.1	0.1	0.1	0	0	0.3	(0.5)
Chestnut-collared longspur	0.1	4.3	0	0.7	0.3	0	(4.5)
Others	0.3	0.1	0.3	0.2	0.3	0.3	(1.2)
Total	31.1 (155.5)	25.7 (128.5)	17.1 (85.5)	16.2 (81.0)	19.3 (96.5)	17.1 (85.5)	(105.4)

In order to determine avian standing crop biomass (hereafter referred to as SCB) collected individuals were weighed and summarized by season (Table 8). Weights of 822 individuals of nine species were obtained. For some species (chestnut-collared longspur, Lapland longspur, mountain plover, and mourning dove) the number of specimens was very low. Breeding-pair SCB (Table 9) was computed using weights from Table 8 and numbers of breeding pairs from Table 5. Even though horned larks were the most numerous species in both years, they provided the greatest breeding-pair SCB in 1969 only. In 1970 their SCB was exceeded by that of lark buntings and meadowlarks. These three species provided 82% and 83% of the total breeding SCB in 1969 and 1970, respectively. Due to their large size, SCB of mountain plovers exceeded that of the more numerous McCown's longspurs. Variations in rankings by SCB among plots were noted yearly, due to changes in the nesting population.

Average total SCB (Table 10) was computed for each species using weights from Table 8 and number of individuals from Table 7. Average total SCB was similar to breeding pair SCB in both years. However, SCB provided by individual species often varied considerably between total and breeding-pair computations. Horned larks, lark buntings, and western meadowlarks provided a combined total of 80% and 75% of the total average SCB in 1969 and 1970, respectively. Horned larks provided the greatest SCB for any species in both years.

Table 8. Weights of birds collected on the Central Plains Experimental Range and Pawnee National Grassland, July, 1968-July, 1970.

Species & Season	Weights (grams)							
	Male		Female		Sex Unknown		Totals	
Horned lark	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.
Breeding	69	33.2	61	31.8			130	32.3
Post-breeding	46	33.0	22	31.0	15	33.4	83	32.5
Winter	210	35.5	62	34.5	5	34.9	277	35.3
Total	325	34.7	145	32.7	20	33.8	490	34.0
Lark bunting								
Breeding	84	38.3	41	36.8	3	30.5	128	37.6
Post-breeding	3	36.0	22	32.2	31	32.4	56	32.5
Total	87	38.2	63	35.2	34	32.3	184	36.1
Western meadowlark								
Breeding	3	103.8			9	105.1	12	104.8
Post-breeding					20	90.2	20	90.2
Winter	9	103.5	1	125.0			10	105.6
Total	12	103.5	1	125.0	29	94.8	42	98.0
McCown's longspur								
Breeding	21	25.4	14	25.0	2	23.6	37	25.1
Post-breeding	3	25.5			5	25.2	8	25.3
Winter	6	26.3	1	25.5			7	26.2
Total	30	25.6	15	25.0	7	24.7	52	25.3

Table 8. (Continued)

Species & Season	Weights (grams)							
	Male		Female		Sex Unknown		Totals	
Brewer's sparrow	No.	Avg.	No.	Avg.	No.	Avg.	No.	Avg.
Breeding	4	10.8	3	10.5	10	11.6	17	11.2
Post-breeding					23	11.2	23	11.2
Total	4	10.8	3	10.5	33	11.3	40	11.2
Mountain plover								
Breeding					2	103.6	2	103.6
Mourning dove								
Post-breeding	2	125.2	1	119.0			3	123.1
Lapland longspur								
Winter	1	27.6	3	23.9			4	24.8
Chestnut-collared longspur								
Breeding	4	18.4	1	20.4			5	18.8

Table 9. Breeding-pair standing crop biomass in grams/100 acres and grams/square meter on CPER during 1969 and 1970 breeding seasons.*

Year & Species	Plot Number 23E	23W	22E	15E	15W	10S	Average of All Plots
1969							
Horned lark	3262.5	840.0	1195.0	2099.5	1486.0	1001.5	1647.4
	.008	.002	.003	.005	.004	.002	.004
Lark bunting	0	2181.0	1466.5	1128.0	1466.5	1128.0	1228.3
	0	.005	.004	.003	.004	.003	.003
Western meadowlark	0	1467.0	1677.0	1991.0	1362.5	3249.0	1624.4
	0	.004	.004	.005	.003	.008	.004
McCown's longspur	954.0	276.0	0	0	201.0	0	238.5
	.002	.001	0	0	Trace	0	Trace
Brewer's sparrow	0	0	336.0	0	425.5	403.0	199.9
	0	0	.001	0	.001	Trace	Trace
Mountain plover	2072.0	0	0	0	0	0	352.2
	.005	0	0	0	0	0	.001
Mourning dove	0	0	0	0	0	1231.0	197.0
	0	0	0	0	0	.003	Trace
Total	6288.5	4764.0	4674.5	5218.5	4941.5	7012.5	5487.7
	.016	.012	.012	.013	.012	.017	.014

Table 9. (Continued)

Year & Species	Plot Number 23E	23W	22E	15E	15W	10S	Average of All Plots
1970							
Horned lark	1453.5	743.0	872.0	775.0	1033.5	807.5	947.4
	.004	.002	.002	.002	.003	.002	.002
Lark bunting	0	1805.0	1053.0	1165.5	1090.5	1128.0	1044.3
	0	.004	.003	.003	.003	.003	.003
Western meadowlark	0	1257.5	1153.0	1572.0	2096.0	2096.0	1362.4
	0	.003	.003	.004	.005	.005	.003
McCown's longspur	828.5	828.5	0	0	0	100.5	292.9
	.002	.002	0	0	0	Trace	.001
Brewer's sparrow	0	0	112.0	0	325.0	257.5	115.7
	0	0	Trace	0	.001	.001	Trace
Mountain plover	1554.0	0	0	0	0	0	248.6
	.004	0	0	0	0	0	.001
Chestnut-collared longspur	0	94.0	0	188.0	0	0	45.1
	0	Trace	0	Trace	0	0	Trace
Total	3836.0	4728.0	3190.0	3700.5	4545.0	4389.5	4056.4
	.009	.012	.008	.009	.011	.011	.010

*Trace = amounts of .000499 gm/m^2 or less, but greater than 0.0.

Table 10. Average total standing crop biomass of eight principal species in grams/100 acres and grams/square meter on CPER during 1969 and 1970 breeding seasons.[a]

Year & Species	Plot Number 23E	23W	22E	15E	15W	10S	Average of All Plots
1969							
Horned lark	4215.2	1485.8	1162.8	2212.6	1663.5	1001.3	1956.9
	.010	.004	.003	.005	.004	.002	.005
Lark bunting	225.6	2594.4	2011.6	1767.2	1786.0	1372.4	1626.2
	.001	.006	.005	.004	.004	.003	.004
Western meadowlark	262.0	1152.8	628.8	1205.2	1310.0	1467.2	1004.3
	.001	.003	.002	.003	.003	.004	.002
McCown's longspur	1355.4	401.6	0	188.3	25.1	0	930.1
	.003	.001	0	Trace	Trace	0	.002
Brewer's sparrow	0	39.2	140.0	33.6	162.4	291.2	111.1
	0	Trace	Trace	Trace	Trace	.001	Trace
Mountain plover	176.1	0	0	155.4	51.8	0	63.9
	Trace	0	0	Trace	Trace	0	Trace
Mourning dove	61.6	0	0	123.1	0	61.6	41.1
	Trace	0	0	Trace	0	Trace	Trace
Chestnut-collared longspur	0	75.2	9.4	65.8	0	0	25.1
	0	Trace	Trace	Trace	0	0	Trace
Total	6295.9	5749.0	3952.6	5751.2	4998.8	4193.7	5758.7
	.016	.014	.010	.014	.012	.010	.014

Table 10. (Continued)

Year & Species	Plot Number 23E	23W	22E	15E	15W	10S	Average of All Plots
1970							
Horned lark	2357.9	742.9	920.6	1405.1	1082.1	1130.5	1273.2
	.006	.002	.003	.003	.003	.003	.003
Lark bunting	300.8	1522.8	1522.8	958.8	1184.4	921.2	1068.5
	.001	.004	.004	.002	.003	.002	.003
Western meadowlark	10.5	733.6	681.2	471.6	1205.2	786.0	648.0
	Trace	.002	.002	.001	.003	.002	.002
McCown's longspur	1242.5	891.1	0	62.8	87.9	12.6	382.8
	.003	.002	0	Trace	Trace	Trace	.001
Brewer's sparrow	0	0	89.6	0	151.2	168.0	68.1
	0	0	Trace	0	Trace	Trace	Trace
Mountain plover	2227.4	0	51.8	0	0	0	379.9
	.006	0	Trace	0	0	0	.001
Mourning dove	61.6	61.6	61.6	0	0	184.7	61.6
	Trace	Trace	Trace	0	0	Trace	Trace
Chestnut-collared longspur	9.4	404.2	0	65.8	27.9	0	84.6
	Trace	.001	0	Trace	Trace	0	Trace
Total	6210.1	4356.2	3327.6	2964.1	3738.7	3203.0	3966.7
	.015	.011	.008	.007	.009	.008	.010

*Trace = amounts of 0.000499 gm/m^2 or less, but greater than 0.0.

Considerable variation was noted in total average SCB among pasture types, pasture 23E providing the greatest SCB both years. Rankings among other plots varied yearly.

Bird-use days were computed for both breeding seasons (Tables 11 and 12). Total use declined 23% in 1970 from 1969 levels. McCown's longspur use increased in 1970; their use of plot 23W more than doubled. Horned larks and lark buntings together provided 72% and 62% of the total use days in 1969 and 1970, respectively. Again, rankings of the various plots changed yearly except for plot 23E which maintained the most use days both years.

Post-breeding Season, August 1-October 15, 1969

During the post-breeding season horned larks and McCown's longspurs gathered into large flocks. They provided a greater portion of the total population during this period than they did during the breeding season. Lark bunting numbers declined 88%. They left the plots, gathered in flocks along roadside ditches, and then migrated to wintering areas. No concentrations of Brewer's sparrows were noted before they departed in October.

Average populations for the post-breeding season (Table 13) were computed from data from six counts. These average figures reflect individuals present for the entire period as well as those individuals of species which migrated and were only present for a portion of the season. Horned larks and McCown's longspurs

Table 11. Bird-use days-1969 breeding season (use days/100 acres in parenthesis).

Species	Plot Number 23E	23W	22E	15E	15W	10S	Total
All Species							
Apr 15-May 15	1164	511	684	1063	496	565	4483
May 16-Jun. 15	1072	854	863	904	869	837	5399
Jun. 16-Jul. 15	1264	1012	839	780	884	680	5459
Jul. 16-31	786	516	351	388	496	204	2741
Total	4286	2893	2737	3135	2745	2286	18,082
							(15,068)
				use days/100 acres/week			977
Horned Lark							
Apr 15-May 15	713	159	409	670	355	282	2598
May 16-Jun. 15	804	307	299	514	446	249	2919
Jun. 16-Jul. 15	727	118	114	282	238	103	1582
Jul. 16-31	489	143	61	113	174	64	1044
Total	2733	727	883	1579	1213	708	7843
							(6536)
				use days/100 acres/week			424
Lark Bunting							
Apr. 15-May 15	0	85	65	38	72	63	323
May 16-Jun. 15	0	351	366	270	243	256	1486
Jun. 16-Jul. 15	89	650	567	432	432	310	2480
Jul. 16-31	7	275	177	205	196	83	943
Total	96	1361	1175	945	943	712	5232
							(4360)
				use days/100 acres/week			283

Table 11. (Continued)

Species	Plot Number 23E	23W	22E	15E	15W	10S	Total
Western Meadowlark							
Apr. 15-May 15	0	104	126	76	32	95	433
May 16-Jun. 15	26	48	61	29	66	268	498
Jun. 16-Jul. 15	8	51	18	65	102	148	392
Jul. 16-31	0	32	27	68	52	29	208
Total	34	235	232	238	252	540	1531
							(1276)
				use days/100 acres/week			83
McCown's Longspur							
Apr. 15-May 15	417	28	2	170	0	0	617
May 16-Jun. 15	197	87	0	0	8	0	292
Jun. 16-Jul. 15	308	175	0	0	14	0	497
Jul. 16-31	196	59	0	0	0	0	255
Total	1118	349	2	170	22	0	1661
							(1384)
				use days/100 acres/week			90
Brewer's Sparrow							
Apr. 15-May 15	0	60	8	24	28	110	230
May 16-Jun. 15	0	21	101	41	99	53	315
Jun. 16-Jul. 15	0	0	98	0	86	119	303
Jul. 16-31	0	0	58	2	73	28	161
Total	0	81	265	67	286	310	1009
							(841)
				use days/100 acres/week			55

Table 12. Bird-use days-1970 breeding season (use days/100 acres in parenthesis).

Species	Plot Number 23E	23W	22E	15E	15W	10S	Total
All Species							
Apr. 15-May 15	1099	1097	358	443	570	700	4267
May 16-Jun. 15	897	642	516	596	592	582	3825
Jun 16-Jul. 15	938	667	885	597	545	504	4136
Jul. 16-31	389	278	272	120	423	156	1638
Total	3323	2684	2031	1756	2130	1942	13,866
							(11,555)
				use days/100 acres/week			749
Horned Lark							
Apr. 15-May 15	469	189	182	274	249	345	1708
May 16-Jun. 15	429	166	164	309	204	262	1534
Jun. 16-Jul. 15	495	60	196	272	199	155	1377
Jul. 16-31	166	59	68	87	94	29	503
Total	1559	474	610	942	746	791	5122
							(4268)
				use days/100 acres/week			277
Lark Bunting							
Apr. 15-May 15	22	39	45	46	27	55	234
May 16-Jun. 15	107	236	222	187	177	160	1089
Jun. 16-Jul. 15	51	396	392	271	212	223	1545
Jul. 16-31	0	116	174	33	225	79	627
Total	180	787	833	537	641	517	3495
							(2912)
				use days/100 acres/week			189

Table 12. (Continued)

Species	Plot Number 23E	23W	22E	15E	15W	10S	Total
Western Meadowlark							
Apr. 15-May 15	10	74	93	63	107	158	505
May 16-Mun. 15	12	49	40	29	56	94	280
Jun. 16-Jul. 15	0	54	16	24	52	44	190
Jul. 16-31	0	10	10	0	51	0	71
Total	22	187	159	116	266	296	1046
							(872)
				use days/100 acres/week			57
McCown's Longspur							
Apr. 15-May 15	391	390	0	22	83	20	906
May 16-Jun. 15	258	187	0	29	19	0	493
Jun. 16-Jul. 15	228	150	0	0	0	0	378
Jul. 16-31	170	74	0	0	0	0	244
Total	1047	801	0	51	102	20	2021
							(1684)
				use days/100 acres/week			109
Brewer's Sparrow							
Apr. 15-May 15	0	10	25	0	38	158	231
May 16-Jun. 15	0	0	76	0	128	94	298
Jun. 16-Jul. 15	0	0	56	0	75	62	193
Jul. 16-31	0	0	20	0	53	38	111
Total	0	10	177	0	294	352	833
							(694)
				use days/100 acres/week			45

Table 13. Average population (6 counts) of birds on six, 20-acre plots (birds/100 acres in parenthesis) on CPER during the 1969 post-breeding season.

Species	S H 23E	S L 23W	W H 22E	S M 15E	W M 15W	W L 10S	Total/ 100 acres
			Plot Number				
Horned lark	42.3	9.7	8.2	17.2	9.0	6.2	(77.2)
Lark bunting	0	0.5	1.7	2.3	1.2	0.8	(5.4)
Western meadowlark	0.2	0.7	1.7	0.8	1.5	0.7	(4.7)
McCown's longspur	17.0	6.3	3.3	4.5	2.5	0.5	(28.4)
Brewer's sparrow	0	0	0.3	0.3	2.5	1.3	(3.7)
Others*	0.8	0.5	0.3	0.3	0.7	0	(2.2)
Total	60.3 (301.5)	17.7 (88.5)	15.5 (77.5)	25.4 (127.0)	17.4 (87.0)	9.5 (47.5)	(121.6)

*Includes 5 marsh hawks, 3 killdeers, 1 mourning dove, 4 burrowing owls, 1 common nighthawk, 1 barn swallow, 1 cliff swallow, and 2 vesper sparrows during 6 counts.

accounted for 87% of the post-breeding population. Plot 23E had the greatest population density (41% of the total for all plots).

Average SCB for the post-breeding season (Table 14) was computed using weights from Table 8 and numbers of birds from Table 13. Post-breeding SCB was 67% of breeding SCB. Sixty-five percent of the total SCB was provided by horned larks which increased 28% from breeding season levels. Plot 23E (heavily-grazed, summer-use) again had the greatest SCB of all pasture types (39% of the total). Plot 10S (lightly-grazed, winter-use) had the least SCB (7% of the total).

Total use days for the $2\frac{1}{2}$-month post-breeding season was 10,703 (Table 15). Weekly use decreased from 1969 breeding season levels during the post-breeding season, but remained higher than the subsequent 1970 breeding season level (Tables 11, 12, and 15). Horned larks provided 63% of total use; McCown's longspurs provided 24%. Lapland longspurs arrived near the end of the period and replaced the McCown's later in the year. In winter plumage these two species were easily confused. It is possible that a portion of the build-up of McCown's in September and October was actually the arrival of the Lapland species. However, McCown's longspurs have been reported wintering in northeastern Colorado (Krause 1968). Total use days reflect the departure of lark buntings, Brewer's sparrows, and western meadowlarks in September and early October.

Table 14. Average standing crop biomass in grams/100 acres and grams/square meter on CPER during the 1969 post-breeding season.

Species	Plot Number 23E	23W	22E	15E	15W	10S	Average of All Plots
Horned lark	6873.8	1576.3	1332.5	2795.0	1462.5	1007.5	2507.9
	.017	.004	.003	.007	.004	.002	.006
Lark bunting	0	81.3	276.3	373.8	195.0	130.0	175.5
	0	Trace	.001	.001	Trace	Trace	Trace
Western meadowlark	90.2	315.7	766.7	360.8	676.5	315.7	423.9
	Trace	.001	.002	.001	.002	.001	.001
McCown's longspur	2150.5	797.0	417.5	569.3	316.3	63.3	718.5
	.005	.002	.001	.001	.001	Trace	.002
Brewer's sparrow	0	0	18.5	18.5	140.0	72.8	41.4
	0	0	Trace	Trace	Trace	Trace	Trace
Total	9114.5	2770.3	2811.5	4117.4	2790.3	1589.3	3867.2
	.023	.003	.007	.010	.007	.004	.010

Trace = amounts of 0.000499 gm/m^2 or less, but greater than 0.0.

Table 15. Bird-use days-1969 post-breeding season (use days/100 acres in parenthesis).

Species	Plot Number 1	2	3	4	5	6	Total
All Species							
Aug. 1-Aug. 14	659	165	151	289	340	81	1685
Aug. 15-Sep. 15	2019	570	285	1073	248	337	4532
Sep. 16-Oct. 15	2122	686	561	520	440	157	4486
Total	4800	1421	997	1882	1028	575	10,703
							(8919)
					use days/100 acres/week		821
Horned Lark							
Aug. 1-Aug. 14	389	108	66	145	189	23	920
Aug. 15-Sept. 15	1448	305	199	992	110	231	3285
Sep. 16-Oct. 15	1385	307	295	217	209	82	2495
Total	3222	720	560	1354	508	336	6700
							(5583)
					use days/100 acres/week		514
Lark Bunting							
Aug. 1-14	0	17	52	96	22	37	224
Aug. 15-Sep. 15	0	0	0	4	32	2	38
Sep. 16-Oct. 15	0	0	0	0	0	0	0
Total	0	17	52	100	54	39	262
							(218)
					use days/100 acres/week		20

Table 15. (Continued)

Species	Plot Number 1	2	3	4	5	6	Total
Western Meadowlark							
Aug. 1-14	5	18	26	29	30	2	110
Aug. 15-Sep. 15	2	32	43	4	50	27	158
Sep. 16-Oct. 15	0	0	12	0	14	5	31
Total	7	50	81	33	94	34	299
							(249)
				use days/100 acres/week			23
McCown's Longspur							
Aug. 1-14	227	22	0	0	0	0	249
Aug. 15-Sep. 15	523	229	24	61	0	14	851
Sep 16-Oct. 15	469	281	237	303	203	29	1522
Total	1219	532	261	364	203	43	2622
							(2185)
				use days/100 acres/week			201
Brewer's Sparrow							
Aug. 1-14	0	0	8	12	81	19	120
Aug. 15-Sep. 15	0	0	0	0	42	57	99
Sep. 16-Oct. 15	0	0	0	0	14	19	33
Total	0	0	8	12	137	95	252
							(210)
				use days/100 acres/week			19

Table 15. (Continued)

Species	Plot Number 1	2	3	4	5	6	Total
Lapland Longspur							
Aug. 1-14	0	0	0	0	0	0	0
Aug. 15-Sep. 15	0	0	0	0	0	0	0
Sep. 16-Oct. 15	267	85	0	0	0	0	352
Total	267	85	0	0	0	0	352
							(293)
				use days/100 acres/week			27

Two early snowstorms in October may have driven many of the birds south before their normal departure dates. Noticeable differences in the avifauna were noted following these storms.

Winter Season, October 16, 1969-April 14, 1970

Declines in populations of all summer residents were noted during winter. The average population (Table 16) declined 62% from post-breeding levels. It was composed almost entirely of horned larks and Lapland longspurs which provided 78% and 16%, respectively of the total. Chestnut-collared longspurs and most McCown's longspurs departed. Meadowlarks were present only at the beginning and end of winter. Lark buntings and Brewer's sparrows were absent. Three species of raptors (ferruginous hawk, marsh hawk, and sparrow hawk) were seen occasionally during 11 counts.

Winter SCB (Table 17) was computed using weights from Table 8 and numbers of birds from Table 16. Winter SCB was 39% of the post-breeding level. Lower numbers of individuals and the departure of lark buntings and meadowlarks accounted for most of the decline. Biomass provided by these two species declined from a combined breeding biomass of 2630.5 grams per 100 acres during 1969 to 26.4 grams during winter. Even though horned lark SCB declined 50% from post-breeding levels this species provided 83% of the total SCB in winter. Lapland longspurs contributed 12%. Plot 23E had the greatest SCB (six times greater than the plot with least SCB, 15E).

Table 17. Average standing crop biomass (excluding incidental species*) in grams/100 acres and grams/square meter on CPER during the 1969/70 winter season.**

Species	Plot Number 23E	23W	22E	15E	15W	10S	Average of All Plots
Horned lark	2859.3	1359.1	931.9	494.2	1341.4	529.5	1252.6
	.007	.003	.002	.001	.003	.001	.003
Western meadowlark	0	0	0	0	0	158.4	26.4
	0	0	0	0	0	Trace	Trace
McCown's longspur	196.5	78.6	0	0	0	13.1	48.0
	Trace	Trace	0	0	0	Trace	Trace
Lapland longspur	520.8	409.2	62.0	62.0	12.4	12.4	179.8
	.001	.001	Trace	Trace	Trace	Trace	Trace
Total	3576.6	1846.9	993.9	556.2	1353.8	713.4	1506.8
	.009	.005	.002	.001	.003	.002	.004

*Includes 2 ferruginous hawks, 4 marsh hawks, 1 sparrow hawk, 1 killdeer, and 6 mountain plovers seen briefly on 11 counts during winter.

**Trace = amounts of 0.000499 gm/m^2 or less, but greater than 0.0.

Total use days (Table 18) for the 6 months were 9227. Weekly use days declined for all species except the Lapland longspur. Horned larks and Lapland longspurs provided 78% and 15% respectively of the total. Final departure of McCown's longspurs, meadowlarks, and Brewer's sparrows was reflected in the totals as was the subsequent rearrival of McCown's and meadowlarks near the end of winter. Lapland longspurs reached peak populations early in the winter period, but by the end of winter they had departed for their nesting grounds. Plot 23E had the greatest use in winter; plot 10S had the least use.

Table 18. Bird-use days-1969/70 winter season (use days/100 acres in parenthesis).

Species	Plot Number 1	2	3	4	5	6	Total
All Species							
Oct. 16-Dec. 15	1758	509	186	106	215	66	2840
Dec. 16-Feb. 14	493	475	298	86	327	113	1792
Feb. 15-Apr. 14	1429	961	687	435	721	362	4595
Total	3680	1945	1171	627	1263	541	9227
							(7689)
				use days/100 acres/week			297
Horned Lark							
Oct. 16-Dec. 15	1224	242	126	42	125	54	1813
Dec. 16-Feb. 14	491	321	258	48	308	112	1538
Feb. 15-Apr. 14	1138	724	594	367	691	325	3839
Total	2853	1287	978	457	1124	491	7190
							(5991)
				use days/100 acres/week			232
Western Meadowlark							
Oct. 16-Dec. 15	0	0	0	0	4	0	4
Dec. 16-Feb. 14	0	0	0	0	0	0	0
Feb. 15-Apr. 14	0	4	0	0	4	18	26
Total	0	4	0	0	8	18	30
							(25)
				use days/100 acres/week			1

Table 18. (Continued)

Species	Plot Number 1	2	3	4	5	6	Total
McCown's Longspur							
Oct. 16-Dec. 15	56	16	60	64	60	8	264
Dec. 16-Feb. 14	0	0	0	0	0	0	0
Feb. 15-Apr. 14	169	0	0	4	0	6	179
Total	225	16	60	68	60	14	443
							(369)
				use days/100 acres/week			14
Brewer's Sparrow							
Oct. 16-Dec. 15	0	0	0	0	4	0	4
Dec. 16-Feb. 14	0	0	0	0	0	0	0
Feb. 15-Apr. 14	0	0	0	0	0	0	0
Total	0	0	0	0	4	0	4
							(3)
				use days/100 acres/week			Tr
Lapland Longspur							
Oct. 16-Dec. 15	478	263	0	0	0	0	741
Dec. 16-Feb. 14	2	154	40	38	19	1	254
Feb. 15-Apr. 14	35	233	51	64	6	13	402
Total	515	650	91	102	25	14	1397
							(1164)
				use days/100 acres/week			45

CHAPTER V

DISCUSSION

Comparison with Other Studies

Several investigators have described avian breeding populations in grasslands. Cassel (1952) censused several plots in Weld County, Colorado in 1948. He found 60 breeding pairs of three species (horned larks and McCown's longspurs were dominant) per 100 acres in a blue grama community. A saltbush-blue grama community had four species (lark buntings and Brewer's sparrows were dominant) and 58 pairs per 100 acres.

Logan (1961) compared populations of birds in two areas of Weld County, Pierce and Nelson's, by using the strip-transect method of census described by Breckenridge (1935). He used several transects in each study area. Grassland transects in the Pierce area contained 43.6-237.0 birds per 100 acres in 1959, and 26.2-86.7 in 1960. Nelson's study area contained 275.1-378.1 birds per 100 acres in 1959 and 316.1-442.6 in 1960. Standing crop biomass for Pierce was 4749-15,590 grams per 100 acres (0.011735-0.038524 grams/square meter) in 1959, and 4489-5706 grams per 100 acres (0.011093-0.014100 grams/square meter) in 1960. Comparable figures for

Nelson's area in 1959 and 1960 were 8800-13,257 (0.021746-0.032759) and 10,000-12,725 (0.024711-0.031445), respectively.

Finzel (1962) studied populations of birds on prairies similar to the CPER near Cheyenne and Laramie, Wyoming from 1958-1960. Horned larks and McCown's longspurs were dominant on both areas. Breeding densities in pairs per 100 acres for Cheyenne in 1959 were 45 pairs of horned larks, 51 pairs of McCown's longspurs, and 2.5 pairs of mountain plovers. In 1960, densities were 61, 51, and 2.5, respectively. Near Laramie densities were 30, 35, and 2.5 pairs, respectively in 1958; 50, 34, and 0 in 1959; and 31, 24, and 2.5 pairs, respectively in 1960. A few lark buntings and other species were noted on her plots.

Cody (1966b) found a population of birds on the CPER of 8 pairs of lark buntings, 4 pairs of horned larks, $7\frac{1}{2}$ pairs of McCown's longspurs, and $1\frac{1}{2}$ pairs of western meadowlarks nesting in an area of unspecified size. Other censuses during the same study revealed 11 to 23 pairs nesting in areas of unspecified sizes on 13 North and South American grasslands.

Prairie populations were estimated for the IBP Matador Site near Matador, Saskatchewan from 1967 through 1969 by Maher (1970). Populations on 3 plots totalling 127.68 acres (pairs/100 acres in parenthesis) in ungrazed pastures were 53.5 pairs (41.1 pairs) of 11 species in 1967. The 1968 population of these same plots was 60.5

pairs (47.4 pairs) of 8 species. A fourth plot of 42.56 acres in 1968 had 37 pairs (86.9 pairs/100 acres). The 1969 census of the above 4 plots (170.24 acres) was 115 pairs (67.6 pairs/100 acres) of 9 species. Census of 2 grazed plots in 1969 revealed 64.0 pairs of 7 species per 85.12 acres (75.2 pairs/100 acres). Primary species were the horned lark, Sprague's pipit, western meadowlark, Baird's sparrow, vesper sparrow, and chestnut-collared longspur. McCown's longspurs nested only in the grazed plots.

J. A. Wiens (personal communication) conducted counts in pastures 23E and 22E in 1968. Utilizing the forementioned flushing technique he found the population of pasture 23E to be 44.7 McCown's longspurs, 27.1 horned larks, and 10.5 lark butings (82.3 individuals) per 100 acres. Pasture 22E had 59.9 lark buntings, 14.4 horned larks, 9.2 western meadowlarks, 5.7 grasshopper sparrows, and 4.4 Brewer's sparrows (93.6 individuals) per 100 acres. Standing crop Biomass per 100 acres of pasture 23E was 2772 grams (.006850 grams/square meter). Biomass per 100 acres of pasture 22E was 4025 grams (.009946 grams/square meter).

Wintering populations during previous studies in northern grasslands contained fewer species and individuals than breeding populations. Finzel (1962) noted that horned larks were the only birds present in winter on her study area. She observed 1.7-2.0 birds/40 acres (4.25-5.00/100 acres) at Laramie Plains, and 1.44-3.00 (3.6-7.5) at Cheyenne. Rosenbaum et al. (1950) recorded four

horned larks and 0.1 marsh hawks per 100 acres of prairie in Jefferson County, Colorado.

Breeding populations I obtained for the CPER (65.5 and 48.4 pairs/100 acres in 1969 and 1970) were similar to Cassel's 60 and 58 pairs for Weld County. They were generally lower than Finzel's populations for Wyoming. Total populations (average of all plots) of 143.7 and 105.4 birds per 100 acres during my study were higher than those obtained by Wiens for pastures 23E and 22E (82.3 and 93.6, respectively). Considerable variation was also noted between his figures and those I obtained for the same pastures in later years (Table 19).

Table 19. Average total breeding season populations on two pastures of CPER.

Investigator	(Year)	Birds per 100 Acres		All Plot Avg./100 acres
		Plot 23E	Plot 22E	
Wiens	(1968)	83.3	93.6	88.5
Giezentanner	(1969)	212.0	117.0	143.7
"	(1970)	155.5	85.5	105.4

Data obtained by Logan (1961) showed much variability yearly and among transects. The populations I studied did not reach the extremes of density of his study, remaining instead within the lower limits of his determined populations. Average SCB I obtained was

similar to that determined by Wiens, and also corresponds well with the lower range of Logan's determinations.

I found similarities among all studies in the number of primary breeding species utilizing each area, but there was wide variability in the density of breeding pairs of each species.

Cody (1966b) in summarizing several counts in grasslands concluded that similarities in number of species and number of pairs utilizing grasslands indicated that the habitat had reached a saturation point. It appears that such a point for the Colorado shortgrass prairie would be seven to eight species and 40-65 nesting pairs/100 acres. Biomass varies from approximately 2772-6295 grams per 100 acres, depending on the number of individuals and the particular species inhabiting the area.

Winter populations reflected lower numbers of species and individuals than breeding populations. Several plot counts on which no birds were seen were made during winter. Normally, however, one to three species and an average of 45.8 individuals per 100 acres were seen. This population was considerably higher than Finzel's one species (horned lark) and 3.6-7.5 birds/100 acres near Cheyenne, and the two species and 4.1 individuals reported by Rosenbaum (1950) in winter. However, birds were extremely nomadic during winter. My average of 11 counts during this period would more likely reflect the true population than would the one or two trips of other investigators.

Characteristics of the Avifauna of the Prairie

Prairies provide few niches for nesting species, but each type of niche is widespread and allows for use by many individuals. Therefore, avifaunas of prairies have few nesting species, but many individuals of each species. In this way prairies closely resemble the Arctic biomes in contrast to forest or tropical ecosystems.

Little vertical stratification occurs on the true prairie. All species except the Brewer's sparrows are ground nesters. Instead, division of resources depends upon the quality and quantity of vegetation (discussed in a later section) and upon differences in niche exploitation. Lark buntings and western meadowlarks appear to share the same vegetative types. They have different feeding niches; meadowlarks consume larger insects than do lark buntings (Phillip Creighton, personal communication). Similar separations were noted between horned larks and mountain plovers.

Some overlap in niche utilization was eliminated by temporal separation. In a few areas horned larks occupied territories in sparse cover early in the nesting and growing season. Later in the spring, as the vegetation became denser and larks completed first nesting attempts, they were replaced by lark buntings and meadowlarks.

Where artificialy diverse niches occurred (windbreaks, abandoned buildings, bridges, and farmland) different species appeared

and exploited them. Eastern and western kingbirds, loggerhead shrikes, and mourning doves nested in windbreaks. Barn swallows, rock doves, and Say's phoebes nested in abandoned buildings and under bridges.

The harsh winters of the CPER also influenced species' distribution. Most of the nesting species were insectivorous during the breeding season and omnivorous the rest of the year. This fact required them to migrate to wintering areas with more insects. The remaining passerines (horned lark and Lapland longspur) were granivorous in winter, foraging widely over the prairie and adjacent wheat fields. The insectivorous Swainson's hawk was replaced in winter by the rodent-eating rough-legged hawk. The loggerhead shrike was similarly replaced by the larger northern shrike.

Migrant species arrived and departed with sudden regularity. Most species quickly reached peak populations upon spring arrival (Fig. 18) and just as suddenly disappeared in the fall. The species which remained declined steadily from late fall through winter as the birds moved to wheat fields to forage. Upon arrival in spring, most birds quickly dispersed and began nesting activities. Ground nests were vulnerable to weather and predation; therefore, hatching and fledging success was low. Often two or more nesting attempts requiring several months were necessary to fledge a single brood. Time was critical.

Thus the prairie exhibits spatial and temporal separation of species and individuals in an environment lacking in vertical stratification and abundant niche types.

Effects of Grazing on Avian Distribution

Dramatic differences in the composition of plant cover on the plots occurred as a result of the varied grazing intensities and seasonal use. As a result of these differences, noticeable changes in the avifauna occurred, especially during the breeding season. In most cases the plot with least plant SCB (23E) received the greatest use for nesting and foraging. The plot with greatest SCB (10S) received the least total use (Tables 2 and 5).

Horned larks, McCown's longspurs, and mountain plovers showed definite preferences for semi-bare areas provided by plot 23E (Table 5) and the hilltops of plot 23W. Although horned larks used all plots, a noticeable concentration of this species occurred in all seasons in plot 23E. Pairs were distributed rather uniformly over hills and low areas, showing little preference for either type of terrain. McCown's longspurs preferred heavily-grazed hilltops which they used for aerial displays and nesting. Mountain plovers exhibited the opposite preference for terrain, nesting and foraging in heavily-grazed low areas. Western meadowlarks and lark buntings preferred plots with denser vegetation than did horned larks and McCown's longspurs. The former two species used all plots except 23E,

showing a slight preference for the lightly-grazed pastures (23W and 10S) for nesting.

DuBois (1935) reported the preference of chestnut-collared longspurs for low, moist situations with tall, thick grass. I noted this preferences also, and found these longspurs nesting in dense cover on plots 23W and 15E.

Brewer's sparrows were restricted almost entirely to winter use pastures, as this was where fourwing saltbush occurred. All Brewer's nests found were built in this species of shrub.

Mourning doves nested on the ground in dense and sparse cover types. No vegetational preference was noted for this species.

I attempted to relate each year's breeding season bird-use days to the SCB of plants remaining in October prior to the next year's breeding season. My hypotheses were that:

(1) Usage by western meadowlarks, lark buntings, chestnut-collared longspurs, and Brewer's sparrows is positively correlated with increasing plant biomass.

(2) Usage by horned larks, McCown's longspurs, and mountain plovers is negatively correlated with increasing plant biomass.

(3) Usage by Brewer's sparrows is positively correlated with the abundance of fourwing saltbush (present in winter use pastures), hence Brewer's sparrow use is positively correlated with winter use pastures.

If one studies Tables 2, 11, and 12 the hypotheses appear to be correct. Obvious differences occur in both plant cover and bird-use days for each of the plots. An analysis of covariance using plant SCB (Table 2) and bird-use days (Tables 11 and 12) was performed. The results are summarized in Table 20. As shown, the only correlation provided by this test was a positive relationship between plant biomass and western meadowlark use. These results may or may not be significant, as I do not feel the volume of data was sufficient to perform an adequate statistical analysis. More years of study will be necessary to confirm or refute my hypotheses. However, I do feel definite trends exist which support them.

Table 20. Results of analysis of covariance--standing crop biomass of plants remaining on six, 20-acre plots on CPER in October versus bird-use days for 1969 and 1970 breeding seasons.

Species	Regression Coefficient	Computed T value	F (1,7)
Horned lark	-.09383	-1.25359	1.57148
Lark bunting	.07938	.64262	.41296
Western meadowlark	.70573	2.22912	4.96898
McCown's longspur	-.12052	-.95334	.90885
Brewer's sparrow	.39610	1.18471	1.40353

Horned larks maintained their preference for the sparse vegetation of plot 23E through the post-breeding and winter seasons. They

were joined by Lapland longspurs during this time. One explanation for this preference in winter could be that the areas of sparse vegetation were kept free of snow by the wind, whereas other plots with more vegetation retained the occasional snow cover longer.

CHAPTER VI

CONCLUSIONS

Similarities in results obtained during my study and those obtained by other investigators in grasslands allowed me to draw several conclusions about the birds of the CPER:

(1) Avian populations determined in this study for the northern Colorado shortgrass prairie compare favorably in numbers of species and numbers of individuals found in similar studies in Colorado and Wyoming.

(2) Numerical density of birds on the CPER varies from year to year.

(3) Since the CPER grassland provided few different niches for nesting, the breeding population was composed of only a few (8) species. Most of the nesting was provided by individuals of five of these species, with the remaining species contributing minor amounts.

(4) Dominance of a species by numbers and by standing crop biomass may vary from year to year in grasslands.

(5) Species that dominate according to numbers may be different from those species that dominate according to standing crop biomass.

(6) The "saturation point" (Cody 1966b) for the shortgrass prairie of northern Colorado was seven to eight species and 40-65 nesting pairs per 100 acres.

(7) The distribution of avian populations is influenced by conditions of the vegetation resulting from different grazing intensities and seasonal use.

(8) Horned larks, McCown's longspurs, and mountain plovers prefer heavily-grazed areas with sparse vegetation; lark buntings, western meadowlarks, and chestnut-collared longspurs prefer moderate or lightly-grazed areas with taller, denser grass cover. Brewer's sparrows are restricted to areas having abundant fourwing saltbush.

(9) Bird-use days is a valid measure of the utilization of prairies, and allows for subsequent incorporation into consumer studies to determine the feeding impact of birds on the prairie.

(10) More years of study will be necessary to totally analyze the effects of grazing on the distribution of the nesting population.

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APPENDICES

APPENDIX A

APPENDIX A

Checklist of birds of the CPER and Pawnee National Grassland compiled by Ryder and Cobb, 1969.[1]

AOU Number	Common Name	Scientific Name
004	Eared Grebe	Podiceps caspicus
001	Western Grebe	Aechmophorus occidentalis
006	Pied-billed Grebe	Podilymbus podiceps
120	Double-crested Cormorant	Phalacrocorax auritus
194	Great Blue Heron	Ardea herodias
202	Black-crowned Night Heron	Nycticorax nycticorax
203	Yellow-crowned Night Heron	Nyctanassa violacea
+172	Canada Goose	Branta canadensis
+132	Mallard	Anas platyrhynchos
+135	Gadwall	Anas strepera
+143	Pintail	Anas acuta
139	Green-winged Teal	Anas carolinensis
140	Blue-winged Teal	Anas discors
141	Cinnamon Teal	Anas cyanoptera
137	American Widgeon	Mareca americana
142	Shoveler	Spatula clypeata
146	Redhead	Aythya americana
147	Canvasback	Aythya valisineria
148	Greater Scaup	Aythya marila
149	Lesser Scaup	Aythya affinis
151	Common Goldeneye	Bucephala clangula
153	Bufflehead	Bucephala albeola
167	Ruddy Duck	Oxyura jamaicensis

APPENDIX A (Continued)

129	Common Merganser	Mergus merganser
+325	Turkey Vulture	Cathartes aura
332	Sharp-shinned Hawk	Accipiter striatus
333	Cooper's Hawk	Accipiter cooperii
+337	Red-tailed Hawk	Buteo jamaicensis
*+342	Swainson's Hawk	Buteo swainsoni
*+347	Rough-legged Hawk	Buteo lagopus
*+348	Ferruginous Hawk	Buteo regalis
*+349	Golden eagle	Aquila chrysaetos
352	Bald Eagle	Haliaeetus leucocephalus
*+331	Marsh Hawk	Circus cyaneus
354	Gyrfalcon	Falco rusticolus
*+355	Prairie Falcon	Falco mexicanus
+356	Peregrine Falcon	Falco peregrinus
*+357	Pigeon Hawk	Falco columbarius
*+360	Sparrow Hawk	Falco sparverius
293	Scaled Quail	Callipepla squamata
+309	Ring-necked Pheasant	Phasianus colchicus
206	Sandhill Crane	Grus canadensis
214	Sora	Porzana carolina
221	American Coot	Fulica americana
*+273	Killdeer	Charadrius vociferus
*+281	Mountain Plover	Eupoda montana
229	Common Snipe	Capella gallinago
*+264	Long-billed Curlew	Numenius americanus
*265	Whimbrel	Numenius phaeopus
+261	Upland Plover	Bartramia longicauda
263	Spotted Sandpiper	Actitis macularia
256	Solitary Sandpiper	Tringa solitaria
258	Willet	Catoptrophorus semipalmatus

APPENDIX A. (Continued)

254	Greater Yellowlegs	Totanus melanoleucus
255	Lesser Yellowlegs	Totanus flavipes
239	Pectoral Sandpiper	Erolia melanotos
241	Baird's Sandpiper	Erolia bairdii
242	Least Sandpiper	Erolia minutilla
232	Long-billed Dowitcher	Limnodromus scolopaceus
249	Marbled Godwit	Limosa fedoa
251	Hudsonian Godwit	Limosa haemastica
+225	American Avocet	Recurvirostra americana
224	Wilson's Phalarope	Steganopus tricolor
223	Northern Phalarope	Lobipes lobatus
+053	California Gull	Larus californicus
054	Ring-billed Gull	Larus delawarensis
+059	Franklin's Gull	Larus pipixcan
069	Forster's Tern	Sterna forsteri
077	Black Tern	Chlidonias niger
*+313.1	Rock Dove	Columba liva
*+316	Mourning Dove	Zenaidura macroura
387	Yellow-billed Cuckoo	Coccyzus americanus
365	Barn Owl	Tyto alba
+375	Great Horned Owl	Bubo virginianus
*+378	Burrowing Owl	Speotyto cunicularia
366	Long-eared Owl	Asio otus
*+367	Short-eared Owl	Asio flammeus
*+418	Poor-will	Phalaenoptilus nuttallii
*+420	Common Nighthawk	Chordeiles minor
432	Broad-tailed Hummingbird	Selasporus platycercus
390	Belted Kingfisher	Megaceryle alcyon
+413	Red-shafted Flicker	Colaptes cafer
+406	Red-headed Woodpecker	Melanerpes erythrocephalus

APPENDIX A. (Continued)

393	Hairy Woodpecker	Dendrocopos villosus
+394	Downy Woodpecker	Dendrocopos pubescens
+444	Eastern Kingbird	Tyrannus tyrannus
+447	Western Kingbird	Tyrannus verticalis
448	Cassin's Kingbird	Tyrannus vociferans
*+457	Say's Pheobe	Sayornis saya
464	Western Flycatcher	Empidonax difficilis
+462	Western Wood Pewee	Contopus sordidulus
459	Olive-sided Flycatcher	Nuttallornis borealis
*+474	Horned Lark	Eremophila alpestris
614	Tree Swallow	Iridoprocne bicolor
+617	Rough-winged Swallow	Stelgidopteryx ruficollis
*+613	Barn Swallow	Hirundo rustica
*+612	Cliff Swallow	Petrochelidon pyrrhonota
+611	Purple Martin	Progne subis
477	Bluejay	Cyanocitta cristata
+475	Black-billed Magpie	Pica pica
+488	Common Crow	Corvus brachyrhynchos
735	Black-capped Chickadee	Parus atricapillus
738	Mountain Chickadee	Parus gambeli
728	Red-breasted Nuthatch	Sitta canadensis
721	House Wren	Troglodytes aedon
+715	Rock Wren	Salpinctes obsoletus
+703	Mockingbird	Mimus ploy glottos
704	Catbird	Dumetalla carolinensis
+705	Brown Thrasher	Toxostoma rufum
*+702	Sage Thrasher	Oreoscoptes montanus
+761	Robin	Turdus migratorius
759	Hermit Thrush	Hylocichla guttata
+758	Swainson's Thrush	Hylocichla ustulata

APPENDIX A. (Continued)

+768	Mountain Bluebird	Sialia currucoides
+754	Townsend's Solitaire	Myadestes townsendi
700	Sprague's pipit	Anthus spragueii
618	Bohemian Waxwing	Bombycilla garrula
619	Cedar Waxwing	Bombycilla cedrorum
+621	Northern Shrike	Lanius excubitor
*+622	Loggerhead Shrike	Lanius ludovicianus
+493	Starling	Sturnus vulgaris
624	Red-eyed Vireo	Vireo olivaceus
646	Orange-crowned Warbler	Vermivora celata
644	Virginia's Warbler	Vermivora virginiae
+652	Yellow Warbler	Dendroica petechia
655	Myrtle Warbler	Dendroica coronata
656	Audubon's Warbler	Dendroica auduboni
668	Townsend's Warbler	Dendroica townsendi
659	Chestnut-sided Warbler	Dendroica pensylvanica
661	Blackpoll Warbler	Dendroica striata
675	Northern Waterthrush	Seiurus noveboracensis
680	MacGillivray's Warbler	Opornis tolmiei
681	Yellowthroat	Geothlypis trichas
+685	Wilson's Warbler	Wilsonia pusilla
686	Canada Warbler	Wilsonia canadensis
687	American Redstart	Setophaga ruticilla
+688.2	House Sparrow	Passer domesticus
494	Bobolink	Dolichonyx oryzivorus
*+501.1	Western Meadowlark	Sturnella neglecta
+497	Yellow-headed Blackbird	Xanthocephalus xanthocephalus
*+498	Red-winged Blackbird	Agelaius phoeniceus
506	Orchard Oriole	Icterus spurius
507	Baltimore Oriole	Icterus galbula

APPENDIX A. (Continued)

508	Bullock's Oriole	Icterus bullockii
+510	Brewer's Blackbird	Euphagus cyanocephalus
511	Common Grackle	Quiscalus quiscula
+495	Brown-headed Cowbird	Molothrus ater
+596	Black-headed Grosbeak	Pheucticus melanocephalus
597	Blue Grosbeak	Guiraca caerulea
599	Lazuli Bunting	Passerina amoena
604	Dickcissel	Spiza americana
519	House Finch	Carpodacus mexicanus
+524	Gray-crowned Rosy Finch	Leucosticte tephrocotis
525	Black Rosy Finch	Leucosticte atrata
+528	Common Redpoll	Acanthis flammea
+533	Pine Siskin	Spinus pinus
+529	American Goldfinch	Spinus tristis
521	Red Crossbill	Loxia curvirostra
592.1	Green-tailed Towhee	Chlorura chlorura
+587	Rufous-sided Towhee	Pipilo erythrophthalmus
*+605	Lark Bunting	Calamospiza melanocorys
+542	Savannah Sparrow	Passerculus sandwichensis
+546	Grasshopper Sparrow	Ammodramus savannarum
+545	Baird's Sparrow	Ammodramus bairdii
*+540	Vesper Sparrow	Pooecetes gramineus
+552	Lark Sparrow	Chondestes grammacus
578	Cassin's Sparrow	Aimophila cassinii
573	Black-throated Sparrow	Amphispiza bilineata
574	Sage Sparrow	Amphispiza belli
567	Slate-colored Junco	Junco hyemalis
+567.9	Oregon Junco	Junco oreganus
570.8	Gray-headed Junco	Junco caniceps
+559	Tree Sparrow	Spizella arborea

APPENDIX A. (Continued)

*+560	Chipping Sparrow	Spizella passerina
+561	Clay-colored Sparrow	Spizella pallida
*+562	Brewer's Sparrow	Spizella breweri
553	Harris' Sparrow	Zonotrichia querula
+554	White-crowned Sparrow	Zonotrichia leucophrys
581	Song Sparrow	Melospiza melodia
*+539	McCown's Longspur	Rhynchophanes mccownii
*+536	Lapland Longspur	Calcarius lapponicus
*+538	Chestnut-collared Longspur	Calcarius ornatus

[1]Several species were observed and added by me after the list was compiled.

*Observed on the six, 20-acre study plots on the Central Plains Experimental Range.

+Observed on the $24\frac{1}{2}$ mile, 50-stop roadside count.

APPENDIX B

PLOT COUNTS

Section _____

Date _____

Time _____ to _____

Observer _____

Weather
Wind _____
Temp _____
Sky _____
Other _____

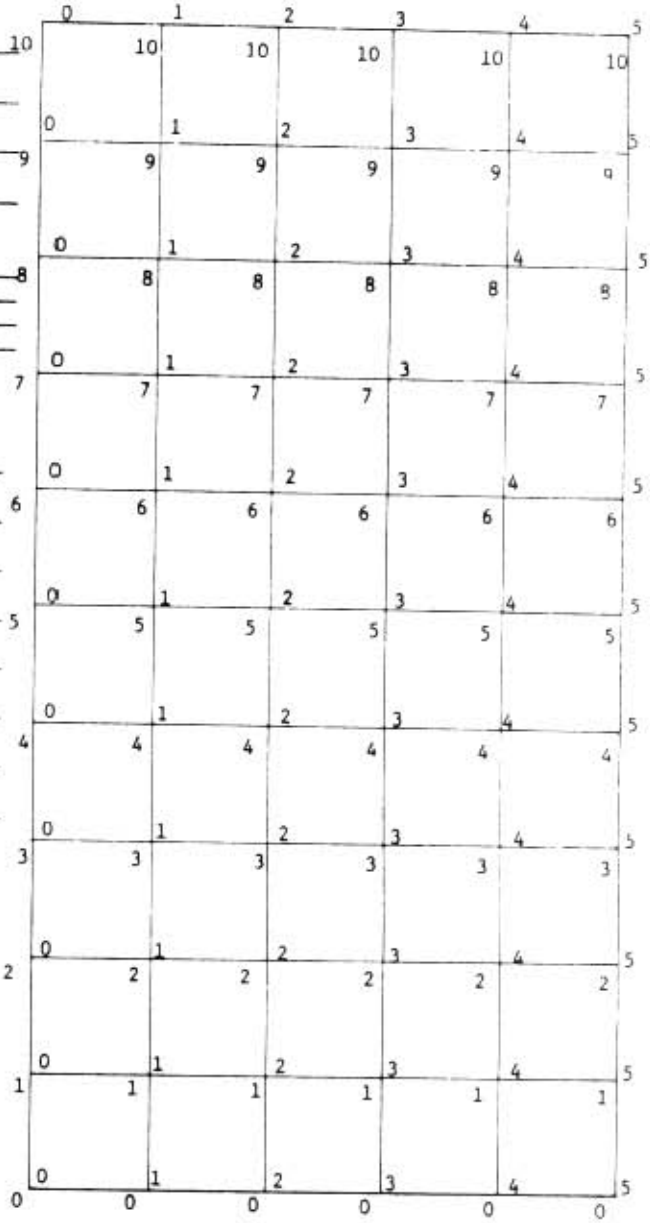
Species	Number

Key:
X = Lark Bunting ♂
X = Lark Bunting ♀
O = Horned Lark
W = Western Meadowlark
H = McCown's Longspur
B = Brewer's Sparrow

→O→ = Flew over plot, did not land

→O = Flew on to plot and landed

O→ = Flushed on plot and flew off of plot



APPENDIX C

IBP

GRASSLAND BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

FIELD DATA SHEET - AVIAN ROAD COUNT

	GROUP	GENUS	SPECIES	SEX	STATIONS 1 2 3 4 5 6 7 8 9 0	STATIONS 1 2 3 4 5 6 7 8 9 0

GROUP
0 Waterfowl
1 Falconiform
2 Galli- and Gruiform
3 Charadriiform
4 Doves, owls, nighthawks, woodpeckers
5 Flycatchers, swallows, jays, titmice, wrens
6 Thrashers, bluebirds, gnatcatchers, pipits
7 Shrikes, starlings, vireos
8 Icterids
9 Fringillids

SEX
0 Unknown
1 Male
2 Female

IBP

GRASSLAND BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

FIELD DATA SHEET - AVIAN ROAD COUNT SUMMARY

DATA TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	GROUP	GENUS	SPECIES	SEX	PAGE TOTALS					NO. STOPS	
			Day	Mo	Yr								1	2	3	4	5		
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-19	21	23-24	26-27	29	31-32	34-35	37-38	40-41	43-44	46-48	

DATA TYPE
01 Aboveground Biomass
02 Litter
03 Belowground Biomass
10 Vertebrate - Live Trapping
11 Vertebrate - Snap Trapping
12 Vertebrate - Collection
20 Avian Flush Census
21 Avian Road Count
22 Avian Road Count Summary
23 Avian Collection - Internal
24 Avian Collection - External
25 Avian Collection - Plumage
30 Invertebrate
40 Microbiology - Decomposition
41 Microbiology - Nitrogen
42 Microbiology - Biomass
43 Microbiology - Root Decomposition
44 Microbiology - Respiration

SITE
01 Ale
02 Bison
03 Bridger
04 Cottonwood
05 Dickinson
06 Hays
07 Hopland
08 Jornada
09 Osage
10 Pantex
11 Pawnee

TREATMENT
1 Ungrazed
2 Lightly grazed
3 Moderately grazed
4 Heavily grazed
5 Grazed 1969, ungrazed 1970
6
7
8
9

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