AVIAN POPULATIONS OF FOUR HERBACEOUS COMMUNITIES IN SOUTHEASTERN WYOMING

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Many studies have been made of bird populations in North America, but most of these have been carried out in forested areas. Avian ecology on grassland and similar herbaceous communities has virtually been ignored. It was the aim of this study to ascertain the bird populations of four herbaceous communities at various elevations. It was desired to evaluate the density, composition, and seasonal variations of these populations.

The study was started in the summer of 1958 and field work was terminated in the summer of 1960. Research localities were selected on the basis of their accessibility, relatively slight disturbance by man, and representation of the surrounding community.

DESCRIPTION OF THE AREAS STUDIED

Within a 40-mile radius of Laramie, Wyoming, are four rather distinct physiographic features. These are the Laramie Basin, the Medicine Bow Mountains, the Laramie Mountains, and the Great Plains. The two mountain ranges are part of the Southern Rocky Mountain Province and result from the division of the Front Range into two ranges. The Laramie Range trends almost due north, and the Medicine Bow Range trends northwest and terminates approximately 50 miles north of the Colorado-Wyoming state line. Between the two is the Laramie Basin. East of the Laramie Range lies the Great Plains Province (Fenneman, 1931). One study area was located in each of these physiographic types.

The lowest area, occurring on the Great Plains, was located seven miles west of the city of Cheyenne in Laramie County (T. 13 N./R. 68 W./S. 12) at an elevation of 6400 feet above sea level. This 40-acre Cheyenne Plains area was flat for the most part, with several gentle slopes in the east and north portions. A few small depressions which occasionally contained water during the spring were located in the lower places. Such depressions, prevalent on the plains area, are commonly called "buffalo wallows" or "blow-outs." As is true in all four areas, climate on the Cheyenne Plains is rather severe. The average annual precipitation is 14.7 inches at Cheyenne and is quite variable from year to year. The mean annual temperature is approximately 45° F. (United States Department of Commerce, Climatological data for 1871–1960). The coldest month is January and the warmest is July, the monthly averages being 26° F. and 68° F., respectively. Wind velocities are high, especially during the winter and spring months, as they also are on the other three areas. The vegetation is a short-grass association, the predominant grass species being blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*). The per cent cover of the vegetation was estimated as 35.7 based on point quadrat samples. Of this total, grasses, sedges, and rushes composed 29.1 per cent, forbs composed 4.6 per cent, and lower plants provided the remaining 2.0 per cent. The most numerous breeding birds are the Horned Lark (*Eremophila alpestris*) and the McCown Longspur (*Rhynchophanes mccownii*). Common mammals include the white-tailed jackrabbit (*Lepus townsendii*), the thirteen-lined ground squirrel (*Citellus tridecemlineatus*), and the deer mouse (*Peromyscus maniculatus*). Economic uses of this area are grazing of sheep and cattle and drilling for oil.

The second area, located in the Laramie Basin, is ten miles west of the city of Laramie in Albany County (T. 16 N./R. 75 W./S. 26) at an elevation of 7350 feet above sea level. The 40-acre study area in the Laramie Basin was topographically the most

uniform of the four areas, being flat and without any noticeable important irregularities. This area had the lowest precipitation of the four areas, with an average of only 11.2 inches annually. The mean annual temperature is 41.6° F. The lowest monthly average occurs in January and is 22.4° F. The warmest month is July, with an average of 64.0° F. (Climatological data for 1869–1960). Since the most prevalent grasses are needlegrass (*Stipa comata*) and blue grama, this could be called a mixed-grass association. Other common flowering plants are phlox (*Phlox hoodii*), fringed sagebrush (*Artemisia frigida*), and winterfat (*Eurotia lanata*). Grasses, sedges, and rushes formed 13.6 per cent of the cover. Forbs provided 9.2 per cent and lower plants 8.4 per cent. The estimate of vegetational cover was thus 31.2 per cent. Species composing the breeding bird population are the same as those on the Cheyenne Plains, Horned Larks and McCown Longspurs being the principal residents. The pronghorn (*Antilocapra americana*) is a common mammal, as well as the white-tailed jackrabbit, thirteen-lined ground squirrel, and the deer mouse. Horses graze the area lightly all year, and cattle use it heavily in the late summer and early fall.

The third area is located in the Laramie Range, which separates the two plains regions. It is three miles east of the summit of United States highway 30, Albany County (T. 14 N./R. 72 W./S. 11), at an elevation of 8500 feet above sea level. This location is within the Pole Mountain Game Refuge of the Medicine Bow National Forest. The study area was located on one of the gently rolling segments of the Laramie Mountains. There were no extensive flat areas present. On the hilltops small outcrops of granite were evident and the ground surface was covered with granitic gravel. Judging from scanty weather bureau data from a nearby station, average annual precipitation is approximately 17.6 inches and average temperature is 37° F. January, the coldest month, has an average of 18° F., whereas July, the warmest, has an average of 59.6°F. (Climatological data for 1931–1949). Snow, which is present most of the winter, persists into April. Along with topographic variations, vegetation shows much diversity in this area. The presence of a few scattered limber pines (*Pinus flexilis*), groves of quaking aspen (*Populus tremuloides*), and fairly extensive stands of big sagebrush (*Artemisia tridentata*) indicate that the community is beginning the transition from grassland to a coniferous type. The most abundant grass species are slimstem muhly (*Muhlenbergia filiculmis*), bluebunch wheatgrass (*Agropyron spicatum*), and needlegrass. Grasses, sedges, and rushes provided 7.0 per cent cover. Trees and shrubs composed 1.7 per cent, while forbs furnished 10.3 per cent and lower plants 6.9 per cent for an estimate of 25.9 per cent vegetational cover for the area. Commonest breeding birds are the Horned Lark and Vesper Sparrow (*Pooecetes gramineus*). Some of the mammals that frequent the area include the pronghorn, mule deer (*Odocoileus hemionus*), and the deer mouse. Cattle and horses occasionally graze on the area.

Libby Flats in the Snowy Range is the highest and farthest west of the areas studied. It is three-fourths of a mile southeast of the summit of Wyoming highway 130 as the road crosses the Snowy Range within the Medicine Bow National Forest. The exact location is T. 16 N./R. 79 W./S. 21, and the elevation is 10,500 feet above sea level. The Libby Flats area is located on one of the highest portions of the plateau at the head of the Libby Creek drainage. The specific site studied slopes gradually downward to the north and includes a small stream and a pond. The ground appears to be almost completely covered with vegetation, with the exception of a few large, scattered boulders. Long-term averages for climatological conditions are nonexistent for alpine communities of the Medicine Bow Mountains. General observations suggest that the climate is very severe. Libby Flats is usually snow free only from mid-June until October or

November. Snow banks persist in the gullies into July, and snow storms can occur at any time of the year. The highly eroded wave-like surface of the snow crust on Libby Flats gives evidence of high wind velocities during the winter months. Summer temperatures during the investigation rarely approached 80° F., and the winter minimum was −30° F. Afternoon thunderstorms are common in June and July. Plant communities vary along a north-south moisture gradient. On drier sites alpine avens (*Geum rossii*) and clover (*Trifolium parryi*) are very common and grade into wet communities of sedge (*Carex*) and willow (*Salix*). Small clumps of low conifers composed of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) dot the area, indicating that Libby Flats is transitional between the spruce-fir forest and a true alpine tundra. Nevertheless, the area assumes more of the characteristics of an alpine community probably because high wind velocities and ice abrasion prohibit the invasion of more trees. Plant sampling indicated a cover estimate of 53.6 per cent. The composition of this was 0.7 per cent for trees and shrubs; 10.2 per cent for grasses, sedges, and rushes; 41.7 per cent for forbs; and 1.0 per cent for lower plants. The Horned Lark, Water Pipit (*Anthus spinoletta*), and White-crowned Sparrow (*Zonotrichia leucophrys*) are breeding birds on the area. The most common mammals are the northern pocket gopher (*Thomomys talpoides*), deer mouse, vole (*Microtus* sp.), and red fox (*Vulpes fulva*). The area is grazed by sheep during July and August.

METHODS

At each of the four localities, two 20-acre plots were staked out and subdivided into acre blocks. A 20-acre plot then consisted of a rectangle made up of four rows of five one-acre blocks. The four rows, or the long axis of the rectangle, were oriented north and south. A rectangular five-acre neutral strip separated the two plots.

Bird censuses were conducted from July 6, 1958, through August 4, 1960, on a year-round basis on all areas when the weather permitted and travel was possible. A total of 176 censuses was taken during the entire period. Distribution of these was Cheyenne, 47; Laramie, 57; Pole Mountain, 48; Libby Flats, 24. The procedure followed in conducting a census consisted of walking along the north-south lines of each 20-acre plot until the entire area was covered. A map, as described by Kendeigh (1944), was employed for recording the results of each census. A new map was used for each census, and the location of all birds seen and heard was recorded on it. Other information recorded included behavioral notes, direction of flight if the bird flushed, and sex if this was discerned.

During the breeding season a variation of this method was employed in which a rope, the length of which was equal to one side of one one-acre plot, was dragged up and down the strips by two persons. If a bird flushed close to the rope, the rope was dropped and a search was made for the nest. Otherwise, the same procedures were used in the rope census as in the census utilizing only one observer. Rope censuses provided a check to determine the number of birds missed in regular censusing, as well as to assist in the location of nests. For population estimates during the nonbreeding seasons, totals for each 20-acre plot were divided by the number of censuses taken during the season to give an average number of birds on the area during that season. Breeding population density estimates required different procedures. A composite map was made for each species on which all observations of that bird during the season were plotted. A different symbol was used for each census. Sex and behavior, especially singing, were also noted. All of the breeding birds maintained a "type A" territory (Nice, 1941), that is, the defended area was used for mating, nesting, and feeding of adults and young. The

observations were clustered into groups representing the general limits of a territory of one pair of birds. By counting these territories an estimate of the number of pairs of the species residing on the area was obtained.

In addition to the birds which used the areas for nesting, a number of species utilized the study sites for other purposes, mainly feeding. These were called "visitors," and estimates were made of their density by dividing the total number seen during a season by the number of censuses during that period of time.

Birds were collected for study and analysis of food habits. During the time that censusing was being done, all birds were collected at least one-half mile from the study areas. Measurements were taken, the gizzards were removed, and birds were dried and placed in the Department of Zoology Museum at the University of Wyoming.

THE PREBREEDING SEASON

Some species of birds begin breeding activities as soon as they arrive on the breeding grounds in early spring. Others do not exhibit breeding behavior on arrival but wait several weeks or longer. This period between arrival and breeding activity is considered the prebreeding season in this study.

A few Horned Larks wintered in the vicinity of every area except Libby Flats. However, most Horned Larks were only summer residents even though large flocks wintered as near as 60 miles southeast of Laramie in the wheat area of northern Colorado. Horned Larks became noticeably more numerous in mid-February. At this time the birds were in flocks concentrated on roadsides. The early flocks observed in Wyoming were composed largely of males. The ratio commonly was six or more males to one female. Pickwell (1931) states that the first Horned Larks to arrive on the breeding grounds at Evanston, Illinois, and Ithaca, New York, were resident males. Loomis (1887) found a large proportion of the Horned Larks wintering in South Carolina to be females. Flocks continued to increase in size on the three lower areas through the middle of March. At this time if the ground was not covered with snow and the daytime temperatures were relatively warm, approximately 40° F. or above, some of the birds dispersed over the plains and began breeding activities.

Males could be heard singing and could be seen fighting over territorial boundaries. The full complement of Horned Larks was not usually present until the end of the first week in April on the Cheyenne, Pole Mountain, and Laramie areas. Measurement of the testes taken from 40 male larks indicated that the period of most rapid recrudescence occurred from mid-March to mid-April. Due to the indefinite shape of the avian ovary, it was difficult to take meaningful linear measurements on female gonads. On the basis of general observations of 14 female Horned Larks, it was observed that the ovary increased rapidly in size during March. Enlarged follicles were present from April through June. However, no conclusions could be drawn on the basis of only 14 specimens. The earliest spring date that Horned Larks were observed on Libby Flats was May 15, 1960. At that time only 20 per cent of Libby Flats was free of snow, and the several pairs of larks present were located on these bare places. Some fighting between males was observed, but whether or not territories had been established could not be determined. When the next census was taken on June 1, 1960, the Horned Larks were not defending these areas.

McCown Longspurs arrived on the Cheyenne area by the end of the first week in April in both 1959 and 1960. Some of these birds displayed territorial behavior when first observed, whereas others remained in flocks until as late as May 17, 1960. Since the same flock stayed in the vicinity until mid-May, the birds were not thought to be

migrants. Not enough information was available for an adequate explanation of this wide behavioral variation within a single population. Measurement of the testis size of several longspurs suggests that the time of gonadal recrudescence was highly variable. Arrival time of McCown Longspurs on the Laramie Plains census area was approximately the last week in April. No late flocks similar to those seen on the Cheyenne Plains were observed near the Laramie area. Other species of breeding birds were on territories the first census after their arrival and therefore were not considered in the prebreeding period.

BREEDING SEASON

Cheyenne area.—Three species of birds, the Horned Lark, Mountain Plover (*Eupoda montana*), and McCown Longspur, utilized the censused area on the Cheyenne Plains for breeding (table 1). Eleven species of visitors were recorded during the breeding season (table 2). Of these, the Rock Wren (*Salpinctes obsoletus*) was probably the only migrant. Birds of prey utilized the study area for hunting, as did the Cliff

TABLE 1

PAIRS OF BREEDING BIRDS

Species	1958* Plot A	1958* Plot B	1958* Pairs per 100 acres	1959* Plot A	1959* Plot B	1959* Pairs per 100 acres	1960* Plot A	1960* Plot B	1960* Pairs per 100 acres
Cheyenne Plains Area, 1959 and 1960									
Mountain plover				0	1.0	2.5	0	1	2.5
Horned lark				8	10.0	45.0	12.5	12	61.0
McCown longspur				9	11.5	51.0	10.5	10	51.0
Total pairs				17	22.5	98.5	23.0	23	114.5
Laramie Plains Area, 1958, 1959, and 1960									
Mountain plover	....	1	2.5	....	....	....	0.5	0.5	2.5
Horned lark	7	5	30.0	8	12.0	50.0	6.5	6.0	31.0
McCown longspur	7	7	35.0	8	5.5	34.0	5.0	4.5	24.0
Total pairs	14	13	67.5	16	17.5	84.0	12.0	11.0	57.5
Pole Mountain Area, 1958, 1959, and 1960									
Horned lark	2.0	2.0	10.0	3.5	2.5	15.0	2.0	2.5	11.5
Robin	....	....	....	1.0	....	2.5	....	....	....
Vesper sparrow	1.0	2.0	7.5	1.0	3.0	10.0	1.5	1.5	7.5
White-crowned sparrow	....	....	....	0.5	....	2.5	....	....	....
Total pairs	3.0	4.0	17.5	6.0	5.5	30.0	3.5	4.0	19.0
Libby Flats Area, 1959 and 1960									
Horned lark				0.0	1.0	2.5	0.5	0.0	1.0
Water pipit				1.5	1.5	7.5	2.0	2.0	10.0
White-crowned sparrow				2.0	0.0	5.0	2.0	0.5	6.0
Total pairs				3.5	2.5	15.0	4.5	2.5	17.0

* Breeding season considered—
Cheyenne Plains Area: 1959, April 6–July 29 (7 censuses); 1960, April 5–July 11 (14 censuses).
Laramie Plains Area: 1958, July 6–July 26 (4 censuses); 1959, May 2–July 17 (7 censuses); 1960, May 26–July 9 (7 censuses).
Pole Mountain Area: 1958, July 8–July 29 (3 censuses); 1959, May 1–July 29 (6 censuses); 1960, April 9–July 21 (12 censuses).
Libby Flats Area: 1959, May 30–August 10 (7 censuses); 1960, June 1–August 4 (6 censuses).

Swallow (*Petrochelidon pyrrhonota*), which could have come from nesting sites within a mile of the census area. Aerial invertebrates were also consumed by Common Nighthawks (*Chordeiles minor*), but these birds were observed at times other than during censusing. Nesting sites were available within several miles for the Killdeer (*Charadrius vociferus*) and Lark Bunting (*Calamospiza melanocorys*), which preferred either a more moist situation or taller vegetation than existed on the study area. The Western Meadowlark (*Sturnella neglecta*) nested within 300 feet of the census area along a fence and occasionally moved onto the census area to feed. A single Vesper Sparrow was observed once in 1960 on the census area. The same individual appeared to have moved about one-half mile northwest where it was seen for several weeks.

TABLE 2

VISITORS ON THE LARAMIE PLAINS AREA DURING THE BREEDING SEASON, 1959 AND 1960

	1959*			1960*		
Species	No. days observed	Total no. per 40 acres	Av. no. per census	No. days observed	Total no. per 40 acres	Av. no. per census
Turkey vulture	....	....	....	1	1	.07
Red-tailed hawk	....	....	....	2	2	.14
Ferruginous hawk	....	....	....	1	1	.07
Marsh hawk	....	....	....	4	4	.29
Sparrow hawk	1	1	.14	4	4	.29
Killdeer	1	1	.14	2	2	.14
Cliff swallow	....	....	....	2	2	.14
Rock wren	1	1	.14	....	....	....
Western meadowlark	....	....	....	2	2	.14
Lark bunting	2	3	.43	....	....	....
Vesper sparrow	....	....	....	1	1	.07
Total individuals		6	.86		19	1.36

* Breeding season considered: 1959, April 6–July 29 (7 censuses); 1960, April 5–July 11 (14 censuses).

The breeding season censuses in 1959 included three censuses taken in the morning and four in the afternoon. The census of April 6 was the first one in which Horned Larks and McCown Longspurs were dispersed over the census plots and were exhibiting territorial behavior. Juvenal Horned Larks and McCown Longspurs were first observed on June 9, 1959. The total counts gradually declined as mortality and emigration apparently occurred. By July 29, 1959, only a few Horned Larks and McCown Longspurs remained on territories, since many had already united into flocks. In several instances the flocks were made up of both adults and juveniles. Within several days after this census the birds formed into large flocks of mixed Horned Larks and McCown Longspurs.

Horned Larks and McCown Longspurs exhibited territorial behavior on April 5, 1960, although some individuals of both species were still in flocks. Actually some larks had been setting up territories prior to this time. From the latter part of June to the first of August, lark and longspur populations gradually declined. By August 1 most birds had gathered into large mixed flocks.

Laramie area.—Species composition of breeding birds on the Laramie Plains area was identical to that of the Cheyenne area (table 1). The visitors, however, included only six species (table 3). One of these, the Mountain Plover, was a breeding bird on the 40 acres two of the three years censused and a visitor for the other year. Of the other visitors, the Common Nighthawk, Barn Swallow (*Hirundo rustica*), and Cliff Swallow

fed on airborne invertebrate fauna over the areas, whereas the Marsh Hawk (*Circus cyaneus*) and California Gull (*Larus californicus*) searched for food items that were located on the ground. The California Gulls were known to nest in colonies from five to ten miles from the study area and commonly were observed flying slowly over the plains a few feet above the ground. The abundance of thirteen-lined ground squirrel remains found in the gull colonies suggests that these low level flights may have been rodent-hunting forays.

TABLE 3

VISITORS ON THE LARAMIE PLAINS AREA DURING THE BREEDING SEASON 1958, 1959, AND 1960

Species	1958*			1959*			1960*		
	No. days observed	Total no. per 40 acres	Av. no. per census	No. days observed	Total no. per 40 acres	Av. no. per census	No. days observed	Total no. per 40 acres	Av. no. per census
Marsh hawk	2	2.0	0.5	1	1.0	0.14	1	1.0	0.14
Mountain plover	....	....	....	2	4.0	0.57	....	....	....
California gull	1	3.0	0.75	5	18.0	2.6	3	22.0	3.1
Common nighthawk	....	....	....	....	....	....	1	1.0	0.14
Barn swallow	....	....	....	....	....	....	1	1.0	0.14
Cliff swallow	2	5.0	1.25	....	....	....	1	2.0	0.29
Total individuals		10.0	2.50		23.0	3.31		27.0	3.81

* Breeding season considered: 1958, July 6-July 26 (4 censuses); 1959, May 2-July 17 (7 censuses); 1960, May 26-July 9 (7 censuses).

Censusing was begun on the Laramie area on July 6, 1958. Mixed flocks of Horned Larks and McCown Longspurs had begun to form by July 30, 1958. Population numbers fluctuated tremendously during April and early May on the Laramie Plains. Weather was primarily responsible. With the onset of warm weather the Horned Larks exhibited breeding behavior in late March, and the McCown Longspurs did so in late April. If several inches of snow fell on the area and remained at least one day, the birds would desert their territories, band into large flocks, and move out in search of snow-free ground. The plains would be reinhabited with birds only after the snow had melted and warmer weather again prevailed. Whether or not the same individuals returned to their originally established territories is not known. This behavior occurred on the Cheyenne and Pole Mountain areas as well as on the Laramie Plains. An outstanding example of this was evident in the Laramie area in the spring of 1959. There was a complete blanket of snow on March 29, 1959. In the course of this census when no birds were observed on the ground, 428 Horned Larks were counted flying over the 40-acre plot in a southeasterly direction. Prior to this time, the larks had been dispersed and exhibiting territorial behavior. The birds were back on the census area by April 5. Males were observed fighting and singing. Many birds were paired. Another snowstorm occurred on April 7. The following morning 1251 Horned Larks were counted flying over the area. All were moving east or southeast, and no birds were observed on the ground. During a census on April 19, conducted in a snow storm, all Horned Larks were in flocks and flying south. The earliest census when populations appeared to be stablized was on May 2. This was the earliest census used to determine the size of the breeding population. The first flocking in the area was observed on July 31 in 1959. Nesting was disturbed in 1960 by snowstorms until as late as May 19 when the last heavy snow fell. By July 22, flocks of transient birds had begun moving through the area.

Pole Mountain area.—Of four species of birds nesting on the Pole Mountain area,

only the Horned Lark and Vesper Sparrow were present during all three years (table 1). The White-crowned Sparrow was present only one summer. Thirteen species of visitors were recorded during the breeding season (table 4). Of these, the Robin (*Turdus migratorius*) was a breeding bird during 1959. Most of the visitors very likely nested near the study area. Those birds which required trees and dense thickets for nesting sites could have found suitable localities within a mile of the censused area.

TABLE 4

VISITORS ON THE POLE MOUNTAIN AREA DURING THE BREEDING SEASON, 1958, 1959, AND 1960

Species	1958*			1959*			1960*		
	No. days observed	Total no. per 40 acres	Av. no. per census	No. days observed	Total no. per 40 acres	Av. no. per census	No. days observed	Total no. per 40 acres	Av. no. per census
Turkey vulture	....	....	....	....	....	....	4	7.0	0.6
Red-tailed hawk	2	2.0	0.7	2	2.0	0.3	3	3.0	0.25
Marsh hawk	....	....	....	....	....	....	1	1.0	0.08
Unidentified hawk	....	....	....	1	1.0	0.2	1	1.0	0.08
Sparrow hawk	....	....	....	....	....	....	8	9.0	0.75
Hummingbird	....	....	....	....	....	....	1	1.0	0.08
Violet-green swallow	....	....	....	1	1.0	0.2	1	2.0	0.16
Cliff swallow	....	....	....	....	....	....	1	2.0	0.16
Black-billed magpie	1	1.0	0.3	....	....	....	....	....	....
Clark nutcracker	2	5.0	1.7	....	....	....	....	....	....
Robin	1	1.0	0.3	....	....	....	3	3.0	0.25
Mountain bluebird	2	5.0	1.7	1	1.0	0.2	1	1.0	0.08
Brewer blackbird	1	3.0	1.0	3	64.0	10.7	4	25.0	2.1
Lark bunting	....	....	....	1	2.0	0.3	....	....	....
Total individuals		17.0	5.67		71.0	11.83		55.0	4.58

* Breeding season considered: 1958, July 8–July 29 (3 censuses); 1959, May 1–July 29 (6 censuses); 1960, April 9–July 21 (12 censuses).

Censusing was started on July 8, 1958, allowing only three counts to be taken during the breeding season. The density estimates included only late nesters and thus are not comparable to densities found in 1959 and 1960. Horned Larks had begun to flock by July 29 in 1958. Horned Larks were present and somewhat dispersed during April, 1959. By May 1 most male Horned Larks were observed singing. Vesper Sparrows moved onto the area during May. Both the White-crowned Sparrow and Robin nested near the edge of the censused area in an aspen grove. On April 9, 1960, larks were paired. By May 10, 1960, Vesper Sparrows were established on territories.

Libby Flats area.—Censusing on Libby Flats was started on July 21, 1958, during the latter part of the breeding season. Since only three censuses could be considered within the breeding season, no estimation of breeding density by territory mapping techniques was attempted. Breeding species present were the Horned Lark and the White-crowned Sparrow. Notably absent was the Water Pipit. During July the meadow became very dry, a possible reason for abandonment by Water Pipits.

Of the Libby Flats visitors cited in table 5, the Sharp-shinned Hawk (*Accipiter striatus*), Mountain Chickadee (*Parus gambeli*), Robin, Audubon Warbler (*Dendroica auduboni*), Pine Grosbeak (*Pinicola enucleator*), Pine Siskin (*Spinus pinus*), and Gray-headed Junco (*Junco caniceps*) have been found to nest in the coniferous forests of Wyoming (McCreary, 1937). Observations of Marsh Hawks were made in August during the postbreeding period for the species. It is unlikely that Marsh Hawks nested at

this elevation. An observation of a Killdeer on June 1, 1960, was somewhat unusual for this elevation. This species is found largely below 9000 feet in Wyoming, according to McCreary (1937). Violet-green Swallows (*Tachycineta thalassina*) might have found rock crevices suitable for nesting near Libby Flats. The Mountain Bluebird (*Sialia currucoides*) is a cavity nester and apparently found suitable sites in the burned-over area just north of the meadow, where hollow tree trunks were common. It would not be surprising to find Vesper Sparrows nesting in brushy, open areas above timberline, since the species occurs over a wide elevational range.

TABLE 5

VISITORS ON THE LIBBY FLATS AREA DURING THE BREEDING SEASON, 1958, 1959, AND 1960

Species	1958*			1959*			1960*		
	No. days observed	Total no. per 40 acres	Av. no. per census	No. days observed	Total no. per 40 acres	Av. no. per census	No. days observed	Total no. per 40 acres	Av. no. per census
Sharp-shinned hawk	....	....	....	1	1.0	0.14	....	....	....
Marsh hawk	1	2.0	0.67	1	1.0	0.14	....	....	....
Unidentified hawk	....	....	....	1	1.0	0.14	....	....	....
Killdeer	....	....	....	....	....	....	1	2.0	0.33
Violet-green swallow	....	....	....	1	2.0	0.29	1	1.0	0.17
Unidentified swallow	....	....	....	....	....	....	1	1.0	0.17
Mountain chickadee	....	....	....	....	....	....	1	2.0	0.33
Robin	2	6.0	2.0	3	6.0	0.86	3	10.0	1.67
Mountain bluebird	....	....	....	4	7.0	1.0	3	6.0	1.0
Audubon warbler	....	....	....	1	7.0	1.0	....	....	....
Pine grosbeak	1	1.0	0.33	....	....	....	....	....	....
Pine siskin	....	....	....	1	9.0	1.29	....	....	....
Vesper sparrow	1	1.0	0.33	....	....	....	....	....	....
Gray-headed junco	1	1.0	0.33	....	....	....	....	....	....
Total individuals		11.0	3.67		34.0	4.86		22.0	3.67

* Breeding season considered: 1958, July 21–August 7 (3 censuses); 1959, May 30–August 10 (7 censuses); 1960, June 1–August 4 (6 censuses).

A snowshoe trip was made to Libby Flats on April 4, 1959. The area was entirely snow covered, with the exception of a small knoll where the weather station was located. No birds were present. Censusing on a regular basis began on May 30 (table 1). Water Pipits and White-crowned Sparrows were the only breeding species present during June. Horned Larks were first seen on the area on July 1, but they were observed just outside the 40 acres in June. Water Pipits left the area in early August. Territorial behavior of birds on June 1, 1960, was evident in spite of a 50 per cent snow cover. Most birds had abandoned territories by August 4.

Comparison of breeding populations.—When densities of breeding bird populations of the four areas are compared, it is obvious that the number of pairs of birds decreases with increasing elevation. The number of species composing the total population increases generally with elevation and with increasing vegetational complexity. Yearly changes in abundance of birds show little consistent similarity from one area to another. Only one species of breeding bird, the Horned Lark, nested on all four areas.

Visitor density was greatest on the two mountain areas. This was not surprising since the areas were somewhat transitional, so that birds both of the open areas and of the coniferous forests occasionally were present. Visitor density on the two plains areas was very comparable if the California Gulls, present because of the close proximity to

breeding colonies, are omitted from the Laramie Plains area. Low counts of visitors would be expected in areas of great topographic and vegetational uniformity, such as the Laramie and Cheyenne plains. The Marsh Hawk was the only visitor present on all four areas.

TABLE 6

DIFFERENCES BETWEEN AVERAGE NUMBER OF PAIRS OF BREEDING BIRDS PER 100 ACRES ON THE STUDY AREAS FOR 1958 TO 1960

Species	Cheyenne	Laramie	Diff. Ch.-La.	Pole Mt.	Diff. P.-Ch.	Diff. P.-La.	Libby Flats	Diff. Libb.-Ch.	Diff. Libb.-La.	Diff. Libb.-P.
Mountain plover	2.5	1.3	1.2	....	2.5	1.3	....	2.5	1.3	0.0
Horned lark	53.0	40.5	12.5	12.2	40.8	28.3	1.8	51.2	39.7	10.4
Robin	....	....	0.0	0.8	0.8	0.8	....	0.0	0.0	0.8
Water pipit	....	....	0.0	....	0.0	0.0	8.7	8.7	8.7	8.7
Vesper sparrow	....	....	0.0	8.3	8.3	8.3	....	0.0	0.0	8.3
White-crowned sparrow	....	....	0.0	0.8	0.8	0.8	5.5	5.5	5.5	4.7
McCown longspur	51.0	29.0	22.0	....	51.0	29.0	....	51.0	29.0	0.0
Total pairs	106.5	70.8	35.7	22.1	104.2	68.5	16.0	118.9	84.2	32.9

One method of comparing bird populations is by means of percentage differences (Odum, 1950). The difference in density (in pairs per 100 acres) for each species occupying the two areas being compared is determined. If species one has 20 pairs in plot A and ten pairs in plot B, the difference is ten pairs; or if species one has ten pairs in plot A and none in plot B, the difference is also ten pairs (table 6). All of these differences are added and the total is divided by the total number of pairs on both areas to determine the percentage of difference between the two populations. The percentage difference is a rough index of the difference in species composition and density. Comparison by this procedure yields the following percentages:

Cheyenne–Laramie $\frac{\text{Ch.–La. diff.}}{\text{Ch. La.}} = \frac{35.7}{177.3} \times 100 = 20.1$ per cent

Cheyenne–Pole Mountain $\frac{\text{Ch.–P. diff.}}{\text{Ch. P.}} = \frac{104.2}{128.6} \times 100 = 81.0$ per cent

Cheyenne–Libby Flats $\frac{\text{Ch.–Libb. diff.}}{\text{Ch. Libb.}} = \frac{118.9}{122.5} \times 100 = 97.1$ per cent

Laramie–Pole Mountain $\frac{\text{La.–P. diff.}}{\text{La. P.}} = \frac{68.5}{92.9} \times 100 = 73.7$ per cent

Laramie–Libby Flats $\frac{\text{La.–Libb. diff.}}{\text{La. Libb.}} = \frac{84.2}{86.8} \times 100 = 97.0$ per cent

Pole Mountain–Libby Flats $\frac{\text{P.–Libb. diff.}}{\text{P. Libb.}} = \frac{32.9}{38.1} \times 100 = 86.4$ per cent

The two plots most alike are Cheyenne and Laramie; those most dissimilar are Libby Flats and the two plains areas.

THE POSTBREEDING SEASON

The postbreeding season is designated as that period between the time when the last brood of young becomes independent of its parents and only winter residents remain on a given area. The time considered in this period is subjective as are the other seasonal divisions of this study. Nevertheless, differences in composition of bird populations is pronounced and can be described on a species basis.

The most obvious feature of the postbreeding season in prairie birds is flocking behavior. This begins in late July for many birds. The flocks become very elusive, as they rapidly move from place to place. Census counts during this period give only gen-

TABLE 7

BIRDS PRESENT DURING THE POSTBREEDING SEASON

Species	1958* No. days observed	1958* Total no. per 40 acres	1958* Av. no. per census	1959* No. days observed	1959* Total no. per 40 acres	1959* Av. no. per census
		Cheyenne Plains Area				
Marsh hawk	2	2	0.7	1	1	0.2
Prairie falcon	....	....	....	1	3	0.6
Unidentified swallow	....	....	....	1	1	0.2
Horned lark	3	29	9.7	5	36	7.2
Rock wren	....	....	....	1	1	0.2
Unidentified shrike	1	1	0.3	....	....	....
Lark bunting	1	1	0.3	2	4	0.8
McCown longspur	2	23	7.7	5	97	19.4
Unidentified	2	7	2.3	3	96	19.2
Total individuals		63	21.0		239	47.8
		Laramie Plains Area				
Turkey vulture	....	....	....	1	1	0.13
Ferruginous hawk	1	1	0.25	1	2	0.25
Marsh hawk	1	1	0.25	1	1	0.13
Cliff swallow	1	1	0.25	2	50	6.25
Mountain plover	....	....	....	1	1	0.13
Horned lark	4	155	38.75	8	84	10.5
McCown longspur	3	82	20.5	7	48	6.0
Unidentified	3	12	3.0	1	4	0.5
Total individuals		252	63.00		191	23.89

* Season considered—
Cheyenne Plains Area: 1958, August 18–September 20 (3 censuses); 1959, August 6–September 18 (5 censuses).
Laramie Plains Area: 1958, July 30–September 19 (5 censuses); 1959, July 25–September 26 (8 censuses).

eral estimates of avian populations. Tables 7, 8, and 9 summarize the results of postbreeding counts. Movements are diverse. Some species immediately begin a southward migration singly or in flocks. Some wander locally from place to place until weather becomes severe or food supplies are depleted. A few birds move northward, and some in the vicinity of mountains move to higher elevations before starting the southward migration (Fitch, MS). Species observed to wander locally in flocks before leaving included Horned Lark, Water Pipit, Vesper Sparrow, and McCown Longspur. The Marsh Hawk and Sparrow Hawk (*Falco sparverius*) only appeared on Libby Flats in early August after their normal breeding season, obviously a postbreeding or postnatal

move to higher elevation. Lark Buntings were recorded on the Pole Mountain area in August, after having moved uphill from breeding sites on the plains. Packard (1946) observed the same sort of movement in these latter three species in Rocky Mountain National Park in Colorado.

TABLE 8

BIRDS ON THE POLE MOUNTAIN AREA DURING THE POSTBREEDING SEASON, 1958 AND 1959

Species	1958* No. days observed	1958* Total no. per 40 acres	1958* Av. no. per census	1959* No. days observed	1959* Total no. per 40 acres	1959* Av. no. per census
Turkey vulture	1	1	.25	....	....	....
Marsh hawk	2	2	.50	2	2	.4
Sparrow hawk	3	5	1.25	....	....	....
Red-shafted flicker	3	5	1.25	....	....	....
Horned lark	4	9	2.25	5	33	6.6
Black-billed magpie	1	1	.25	....	....	....
Clark nutcracker	1	5	1.25	....	....	....
House wren	1	1	.25	....	....	....
Vesper sparrow	2	2	.50	4	34	6.8
Gray-headed junco	....	....	....	2	3	.6
Chipping sparrow	....	....	....	1	1	.2
White-crowned sparrow	....	....	....	1	1	.2
Song sparrow	1	3	.75	....	....	....
Unidentified sparrow	....	....	....	1	2	.4
Unidentified	1	3	.75	2	13	2.6
Total individuals		37	9.25		89	17.8

* Season considered: 1958, August 6–September 16 (4 censuses); 1959, August 6–September 18 (5 censuses).

TABLE 9

BIRDS ON THE LIBBY FLATS AREA DURING THE POSTBREEDING SEASON, 1958 AND 1959

Species	1958* No. days observed	1958* Total no. per 40 acres	1958* Av. no. per census	1959* No. days observed	1959* Total no. per 40 acres	1959* Av. no. per census
Marsh hawk	5	9	1.29	1	1	0.33
Sparrow hawk	4	8	1.14	1	1	0.33
Horned lark	2	3	0.43	1	2	0.67
Mountain bluebird	....	....	....	1	3	1.00
Pine siskin	....	....	....	1	3	1.00
Vesper sparrow	1	4	0.57	....	....	....
White-crowned sparrow	1	1	0.14	1	1	0.33
Unidentified	3	6	0.86	1	1	0.33
Total individuals		31	4.43		12	4.00

* Season considered: 1958, August 14–November 2 (7 censuses); 1959, August 17–September 20 (3 censuses).

THE WINTER SEASON

Bird populations on the Cheyenne, Laramie, and Pole Mountain areas were low during both winters of censusing. No birds were observed wintering on Libby Flats during the four winter trips made to that area. The Horned Lark was the most com-

monly observed bird on the three other areas. It was most often present during the beginning and end of the winter season, that is, during October, early November, late February, and March. Densities on the three lower areas were quite similar (table 10). Since all of these birds moved about very much during the winter, densities are expressed as the average number of birds seen on each census of 40 acres.

The Pole Mountain population was composed of the greatest number of species. Two of these species, the Common Crow (*Corvus brachyrhynchos*) and the Black-billed Magpie (*Pica pica*), reflect the presence of trees nearby. The forested areas nearby supported a greater number of species as well as higher densities of birds during the winter. Actually, the Golden Eagle (*Aquila chrysaëtos*) and Rough-legged Hawk (*Buteo lagopus*) hunted the Laramie as well as the Cheyenne Plains. Low densities can account

TABLE 10

BIRDS PRESENT DURING THE WINTER SEASON

Species	1958–1959* No. days observed	Total no. per 40 acres	Av. no. per census	Av. no. per 100 acres	1959–1960* No. days observed	Total no. per 40 acres	Av. no. per census	Av. no. per 100 acres
Cheyenne Plains Area								
Rough-legged hawk	....	....	....	....	1	1	.11	.28
Golden eagle	....	....	....	....	1	1	.11	.28
Horned lark	3	15	3	7.5	1	13	1.44	3.61
Unidentified	....	....	....	....	1	1	.11	.28
Total individuals		15	3	7.5		16	1.78	4.45
Laramie Plains Area								
Horned lark	2	6	2	6	3	17	1.7	4.2
Pole Mountain Area								
Rough-legged hawk	....	....	....	....	1	1	.1	.25
Horned lark	2	9	1.8	4.5	4	38	4.2	10.5
Black-billed magpie	....	....	....	....	1	1	.1	.25
Common crow	1	1	.2	.5	1	1	.1	.25
Total individuals		10	2.0	5.0		41	4.5	11.3

* Season considered—
Cheyenne Plains Area: 1958–59, November 15, 1958–March 28, 1959 (5 censuses); 1959–60, October 11, 1958–March 12, 1960 (9 censuses).
Laramie Plains Area: 1958–59, November 9, 1958–March 1, 1959 (3 censuses); 1959–60, October 12, 1959–March 10, 1960 (10 censuses).
Pole Mountain Area: 1958–59, November 15, 1958–March 28, 1959 (5 censuses); 1959–60, October 11, 1959–March 13, 1960 (9 censuses).

for their not having been observed during censusing. Four trips were made to Libby Flats during the winter season, these being taken in October, December, January, and April. No birds were observed during any of these visits. The area was found to be nearly covered with hard-crusted snow when the December and January trips were made. Several inches of soft snow covered the area in October, and several feet of soft snow were present in April. Although areas within one mile of the census area remained snow-free all winter, these localities were also without wintering birds.

ACKNOWLEDGMENTS

I would like to express my appreciation to Dr. Kenneth L. Diem, Miss V. June Wetherell, and Dr. C. L. Porter for their assistance with this study. I am indebted to the National Science Foundation for Cooperative Fellowships for the years 1959–1960 and 1960–1961. The Wyoming Chapter of the Society of the Sigma Xi provided a grant-in-aid, and the National Association of the Society of the Sigma Xi supported this research project with a grant from the Sigma Xi–RESA Research Fund. This is a portion of a thesis submitted as partial fulfillment of requirements for the Ph.D. to the University of Wyoming, Laramie, Wyoming.

SUMMARY

A study of bird populations in four open areas in southeastern Wyoming was carried out from the summer of 1958 through the summer of 1960. The Cheyenne area, a slightly rolling short-grass plains, was at an elevation of 6400 feet. The Laramie area was mixed-grass prairie at an elevation of 7350 feet. The Pole Mountain area, located on a dissected plateau, was 8500 feet in elevation and was transitional between plains and coniferous forest. Libby Flats, an alpine meadow on a high plateau, was 10,500 feet in elevation.

On each of the four areas, two 20-acre plots were staked out in acre blocks. Bird censuses were conducted by use of a plot census method. Densities were expressed as average numbers of individual birds present per census and pairs per 100 acres during the breeding season. Bird populations were considered in terms of prebreeding, breeding, postbreeding, and winter seasons, with main emphasis being placed on the species of birds that were residents on the four areas.

Although a few Horned Larks wintered on or near the three lower areas, flocks of Horned Larks became more numerous in mid-February, males arriving first. After mid-March, whenever several days of warm weather prevailed, these birds dispersed over the study areas and exhibited breeding behavior. Frequently, complete snow cover that persisted as long as one day forced the larks back into nomadic flocks which moved to any open areas available for feeding. McCown Longspurs arrived approximately one week later on the Laramie Plains than on the Cheyenne area. Most longspurs set up territories immediately after arrival in April, but they did not begin nesting until May. They, too, were driven back into flocks by late snow storms.

Estimates of average densities in pairs per 100 acres during the breeding season were as follows: Cheyenne, 106.5; Laramie, 70.8; Pole Mountain, 22.1; Libby Flats, 16.0. The Horned Lark was the only species that nested on all four areas and was also the most numerous breeding bird on all areas except Libby Flats. McCown Longspurs and Mountain Plovers were the only other breeding birds on the Cheyenne and Laramie areas. The Robin, Vesper Sparrow, and White-crowned Sparrow, in addition to the Horned Lark, nested on the Pole Mountain area, but the Robin and the White-crowned Sparrow were present during only one of the three summers when censusing was conducted. Breeding species on Libby Flats, in addition to Horned Larks, included the Water Pipit and White-crowned Sparrow. Eleven species of visitors were observed on the Cheyenne area during the breeding seasons, six on the Laramie area, 12 on the Pole Mountain area, and 14 on the Libby Flats area. In order of decreasing similarity of avian breeding populations, the area index combinations were Cheyenne-Laramie, Laramie-Pole Mountain, Cheyenne-Pole Mountain, Pole Mountain-Libby Flats, Laramie-Libby Flats, Cheyenne-Libby Flats.

Generally, on all areas the postbreeding period began the first of August and con-

tinued until October. Horned Larks, McCown Longspurs, and Water Pipits formed large flocks during this period. No birds were found wintering on Libby Flats, and population densities were very low on the other three areas. The Horned Lark was the only species of breeding bird present during the winter.

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