

Technical Report No. 171
AVIAN POPULATION STUDIES
ON THE PAWNEE SITE, 1968-1971

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GRASSLAND BIOME
U.S. International Biological Program

November 1972

TABLE OF CONTENTS

	Page
Title Page	i
Table of Contents	ii
Abstract	iii
Introduction	1
Objectives	1
Personnel	2
Locations	3
Methods	3
Plot and Roadside Counts	7
North American Breeding Bird Survey	7
Raptor Counts	10
Nesting Studies	11
Food Habits Studies	11
Movement Studies	13
Results	13
Plot and Roadside Counts	13
North American Breeding Bird Counts	15
Raptor Counts	23
Nesting Studies	36
Food Habits Studies	44
Movement Studies	48
Acknowledgment	53
Literature Cited	54
Appendix I. Field Data	58

ABSTRACT

The numbers and biomass of the dominant birds have been studied on and around the Pawnee Site since July 1968. Counts were made at approximately weekly intervals (April 15 to August 15) in six 20-acre (8.1 ha) plots and along a 50-stop, 24½ mile (39.4 km) roadside route. The remainder of the year, counts were less frequent, usually every 2 weeks in 1968-70 but only monthly in 1971. Raptors were counted in a 56-sq mile (145 km²) study area and along various roadside routes. Counts from the Pawnee Site are compared to those from seven other 50-stop routes in Colorado which are part of the North American Breeding Bird Survey.

In 1971 the total number of breeding pairs (59.0) on the six 20-acre plots was approximately the same as that observed in 1970 (58.2). However, a decrease was noted in Horned Larks and an increase in McCown's Longspurs and Western Meadowlarks. Lark Bunting, Brewer's Sparrow, and Mountain Plover populations remained about constant both years. Overall, breeding bird densities on the plots in 1971 were below those noted in 1969, but above those noted in 1968. In general, the IBP 50-stop roadside count findings were comparable to those noted on five other routes in Colorado for the years 1968-71.

Raptor numbers noted in the fall of 1969 and 1971 were quite similar, although the migration was somewhat later in 1969. Wintering populations for three winters, however, differed considerably. Although Golden Eagles were the most abundant all three winters and Rough-legged Hawks second in abundance, the latter species was much less common in 1969-70 than in 1968-69 or 1970-71. Golden Eagles were unusually abundant in 1969-70.

The productivity of the large birds of prey in 1971 was analyzed and compared with data in 1970. Prairie Falcons produced the most young per nest (4.00 in 1971) and Swainson's Hawk the least (0.64 in 1970). Food habits

for Golden Eagles and Great Horned Owls are described. Both rely heavily upon lagomorphs.

Since 1961, over 3,000 birds representing 60 species have been banded at the Pawnee Site. Comparatively fewer distant recoveries have been reported than for the birds of prey. In contrast, a number of local returns have been noted for various passerines.

INTRODUCTION

The numbers and biomass of the dominant birds of the Pawnee Site have been studied since July 1968 at various seasons of the year in an effort to determine the standing crop biomass in pastures subjected to various intensities and seasons of grazing, to estimate avian productivity, to determine movements, and to study the food habits of certain species. These studies have been reported in part in earlier Technical Reports by Giezentanner and Ryder (1969), Ryder (1969), Marti (1969), Giezentanner (1970), and Strong and Ryder (1971). Data in these reports have been used in modelling efforts reported by Swartzman (1969) and Harris and Swartzman (1971). The findings reported herein supplement and complement those of other avian studies of the Grassland Biome reported by Baldwin (1970, 1971a,b,c); Baldwin, Butterfield, and Creighton (1969); Baldwin, Creighton, and Kissel (1971); Creighton (1971a,b); and Wiens (1970a,b, 1971a,b).

OBJECTIVES

In 1971 the primary objectives of these studies were:

1. To determine, primarily at six periods of the year, the number and biomass of the dominant birds on the 320 A pastures subjected to light, moderate, and heavy grazing.
2. To determine the avian productivity (clutch size, nesting success, and nestling growth) of the dominant nesting birds.
3. To determine movements in and out of the study area of the main migrants and summer and winter residents.

PERSONNEL

Field data in 1968 were gathered primarily by D. A. Cobb and R. A. Ryder (Ryder and Cobb, 1969); in 1969 by J. B. Giezentanner and Ryder (Giezentanner and Ryder, 1970); in 1970 by Mark A. Strong, Ryder, and Giezentanner; and in 1971 by Strong and Ryder (1971). Master of Science theses in wildlife biology based on these data were completed by Giezentanner in 1970 (converted to Technical Report No. 62, 1970) and by Strong (1971). C. D. Marti (1969^{a,b,c}, 1970) gathered data pertaining to owls in 1966-70 and in 1970 completed a Doctor of Philosophy degree in wildlife biology based on his fieldwork. In addition, W. R. Marion conducted field counts of diurnal raptors in 1969-70 and wrote an M.S. thesis on his studies in 1970 (see also Marion and Ryder, 1970). More recently, G. R. Craig, an M.S. candidate in wildlife biology, and R. R. Olendorff, a post-doctoral fellow of the American Museum of Natural History at CSU, have been studying the ecology of birds of prey, particularly in 1970-71. Undergraduate students who also gathered raptor data include: R. E. Baker, D. L. Coven, M. N. Good, L. R. Grater, C. M. McCord, R. G. Minor, T. D. Ray, J. E. Seale, and M. J. Williams. Allegra Collister has banded many birds at the Pawnee Site, and Nancy Hurley has censused birds on the Pawnee National Grassland at approximately 2-week intervals since January 1969. W. D. Gaul (1971), a Ph.D. candidate at the University of Minnesota, has gathered considerable data on Mountain Plovers in 1969-71. D. C. Zumeta conducted a special study of Horned Lark migration and habitat preferences of migrating and wintering flocks commencing in September 1971. Information related to all of these studies is included in this report.

LOCATIONS

The primary study area was the IBP intensive site on the Central Plains Experimental Range (CPER) where six 20-acre (8.1 ha) plots were established in July 1968 (Fig. 1). Specific locations and differences in topography, vegetation, and grazing use of these plots were discussed by Giezentanner (1970). Also, a 50-stop roadside census route, $24\frac{1}{2}$ miles (39.4 km) long, was laid out through the CPER and into the Pawnee National Grassland (Fig. 1). Again, details regarding the route and the stops involved were discussed by Giezentanner (1970).

An additional 56-sq mile (145 km^2) study area centered on the CPER was established in January 1969, and a 50-mile (80.5 km) route was marked through it for raptor censusing (Fig. 2).

Additional areas on the Crow Valley Unit of the Pawnee National Grassland were utilized as nesting study areas by Strong (1971) for passerines, by Marti (1970) for owls, and by Olendorff and Craig (Olendorff, 1972) for all birds of prey. W. D. Gaul has primarily utilized areas in the Pawnee Butte Unit of the National Grassland, particularly near Keota, for his Mountain Plover studies.

Census data from North American Breeding Bird Surveys (Robbins and Van Velzen, 1969) at seven locations in Colorado (Fig. 3) were used for comparative purposes.

METHODS

Various census methods were employed in conjunction with routine nest searches; banding and marking; and regular collections of birds for biomass determination, measurements of gonads, and gatherings of material for food habits studies.

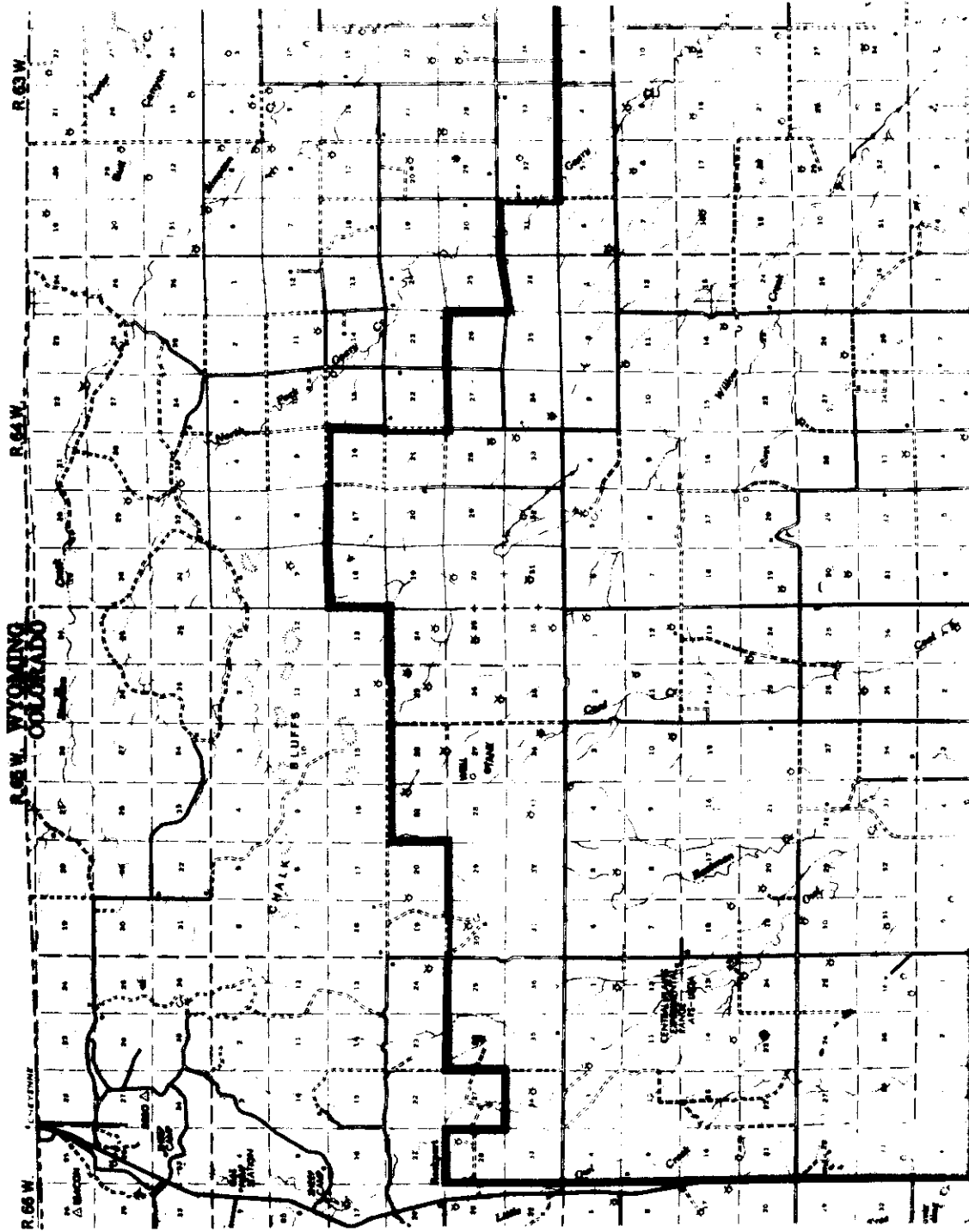


Fig. 1. Locations of plots and roadside count route of R. A. Ryder et al. (1969).

BREEDING BIRD SURVEY ROUTES COLORADO

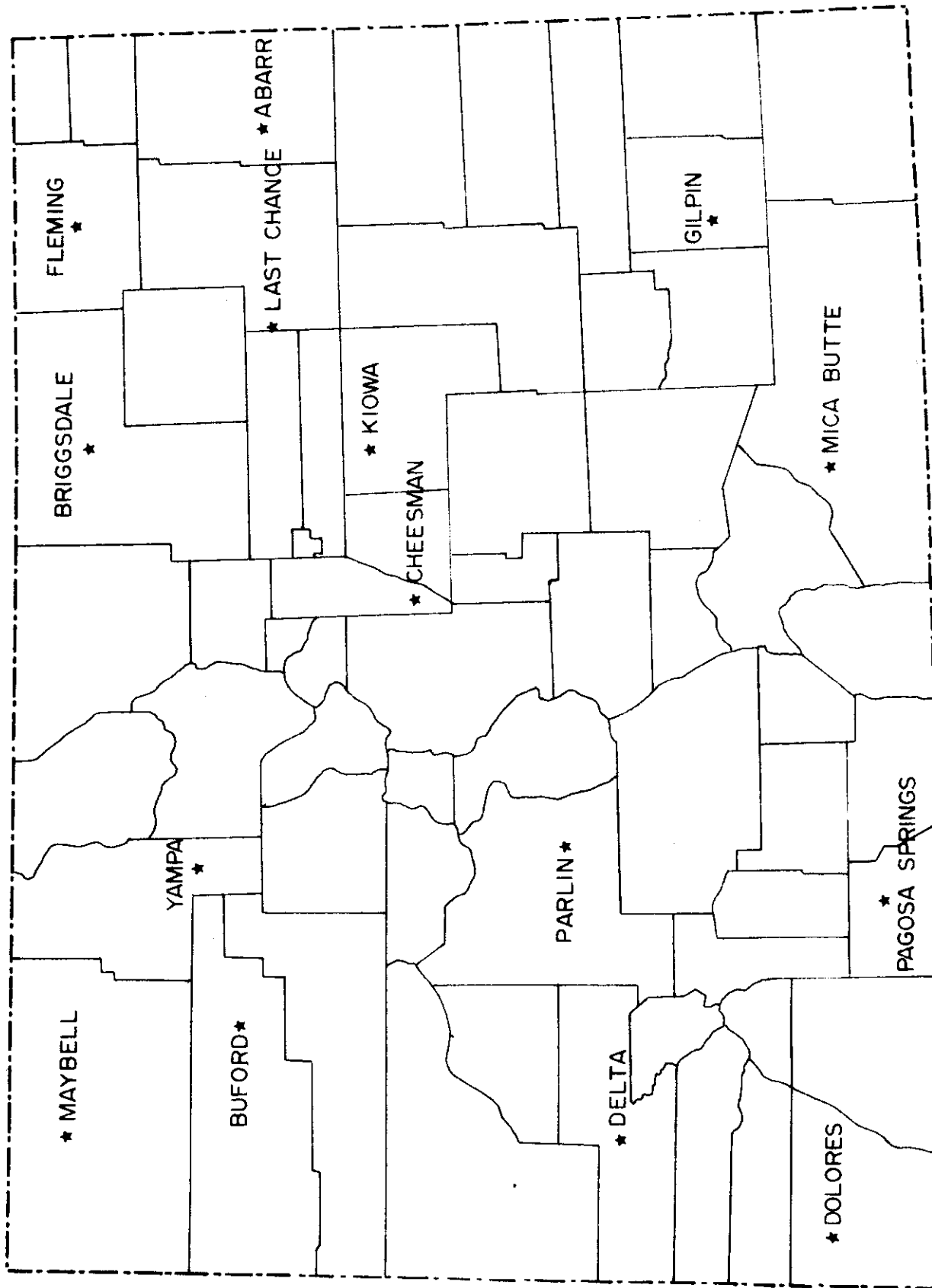


Fig. 3. North American Breeding Bird Survey routes in Colorado.

0 10 20 30 40 50
SCALE OF MILES

Plot and Roadside Counts

Since July 1968, each of the six 20-acre plots was censused weekly from April 15 to August 15. The remainder of the year, counts were less frequent, usually every 2 weeks 1968-70 but only monthly in 1971. Normally all six plots were covered in 1 day. The roadside route was covered at approximately the same frequency, but not on the same days that the plots were counted. Thus, in 1971, both the plots and the roadside route were counted on (or within 5 days) of the assigned sampling dates: March 25, May 1, June 25, August 20, and October 15. Also, counts will be made on or about December 15, 1971. The specific details of these counts were described by Giezantanner (1970), and the total number of counts made from 1968 through 1971 are summarized in Table 1.

North American Breeding Bird Survey

Since 1968, from 9 to 16 roadside routes have been covered annually by volunteer observers elsewhere in Colorado as part of the North American Breeding Bird Survey as described by Ryder (1970), Robbins and Van Velzen (1967 and 1969), and Van Velzen and Robbins (1971). Seven of these routes are in eastern Colorado (Fig. 3) and thus have been compared to findings of the IBP roadside route. All of these routes are of the same length (50 stops, 24½ miles), are covered at approximately the same time each year (normally in mid-June), and are in accordance with the same instructions. R. A. Ryder has been the state coordinator of these counts all four years. The observers who conducted the counts of the grassland routes in Colorado are summarized in Table 2.

Table 1. Numbers of plot and roadside counts of birds conducted at the Pawnee Site 1968-71.

Year	Plot Counts		Roadside Counts
	Total	Breeding Season ^{a/}	
1968	14	3 ^{b/}	17
1969	31	12	34
1970	30	14	27
1971	22	13	13
Totals	97	42	91

^{a/} Mid-April to August 1.

^{b/} Counts not started until July 1968.

Table 2. Observers on North American Breeding Bird Survey Routes in Eastern Colorado, 1968-71.^{a/}

Route	Observers			
	1968	1969	1970	1971
IBP--Pawnee Site ^{b/}	Cobb	Giezentanner	Giezentanner	Strong
Briggsdale	Ryder	Ryder	Ryder	Ryder
Last Chance	Cobb	Giezentanner	Giezentanner	McEwen
Abarr	Cobb	Giezentanner	Giezentanner	McEwen
Fleming	Braun	Braun	Braun	Braun
Kiowa	Beidleman	Beidleman	Beidleman	Beidleman
Gilpin	N. C.	N. C.	Julian	Julian
Mica Butte	Janes	N. C.	N. C.	Griffiths

^{a/} See Fig. 3 for locations.

^{b/} Not an officially designated route, but censused in the same manner as the others.

N. C. = Not covered.

Raptor Counts

Although birds of prey are frequently counted on the 50-stop roadside counts and occasionally on the 20-acre plots, more stress has been placed on counts in the 56-sq mile study area (Ryder, 1969) as well as upon various other routes through the Pawnee National Grassland and adjacent areas.

One of these, hereafter referred to as the 90-mile count, consisted of 53 miles of shortgrass prairie and 37 miles of cultivated wheat land. The route passed through 22.5 miles of the Pawnee National Grassland in the northeastern portion of the state near Nunn, Colorado. The western topography tends to be rolling and the eastern is flat. Cottonwood trees are scattered throughout both areas. Although most of the route was restricted to sparsely-traveled dirt roads, it passed over 24 miles of heavily-used paved roads. In general, the region is lightly populated with one occupied house to every 2.5 miles. The route was restricted to this region because the shier hawks will not tolerate close proximity to human activity.

The area was scanned by one observer and occasionally two, who traveled the route in a vehicle at speeds of 25 to 45 mph. Raptors were counted at almost any distance from the road because of the openness of the land. Periodically, the vehicle was stopped and likely sites were scanned with binoculars. Raptors were sighted with the naked eye from the moving vehicle; then identification was made with 7 x 50 binoculars and a 15-60X spotting scope after the vehicle was stopped. The location of the raptor; its direction of flight or behavior; and, when possible, the sex and age were recorded on a map and a special data card. The route was driven once a week, and if the weather interfered (due to winds above 15 mph or limited vision), the count was delayed until the weather cleared. In order to keep them consistent, the counts were made in the early morning ($\frac{1}{2}$ to $1\frac{1}{2}$ hr after sunrise) and lasted

about 4 hr. The time was flexible to allow pauses for trapping, banding, and marking raptors encountered along the census route.

Still other raptor count data were compiled by Nancy Hurley, who covered the same general area in the Pawnee National Grassland approximately every 2 weeks 1969-71 for a total of 49 counts (as of December 1, 1971). The exact route varied, depending on the weather and road conditions, but averaged about 80 miles. Olendorff established a route southeast of Briggsdale in 1971 to the 56-sq mile count around the CPER. The count was designed to study fall migration of raptors across a large block of agricultural land adjacent to the Pawnee National Grassland.

Nesting Studies

Nest search techniques and methods used in studying growth of passerine nestlings are described in a separate Technical Report by Strong (1971) and are similar to those reported earlier by Strong and Ryder (1971) and Giezantanner and Ryder (1969). In addition, Gaul (1971) located 80 Mountain Plover nests in 1969, 12 in 1970, and 19 in 1971. Gaul will discuss his nesting studies in his PH.D. thesis. Olendorff and Craig searched a 2,000-sq mile area of northern Weld County, including all the Pawnee National Grassland, for raptor nests in 1970 and 1971. They compiled routine data regarding nest site details; numbers of eggs and their fates, and numbers of young fledged as well as noting food items brought to the nests (Olendorff, 1972). Marti (1970) previously reported on owl nests that he followed.

Food Habits Studies

Prey items in and under raptor nests were identified during nest visits by Olendorff and Craig (Olendorff, 1972). These data were supplemented

by items identified after forced regurgitation of the crop contents of young hawks and owls.

Time-lapse filming was incorporated into a study of Great Horned Owls to obtain more detailed information about feeding habits, prey, activity patterns, and behavior of young and adult owls. Two camera recorders were mounted at Great Horned Owl nests just after the eggs had hatched, and filming progressed until the young fledged. The first owl nest was located on shortgrass prairie habitat in a cottonwood tree windbreak approximately $3\frac{1}{2}$ miles east of the IBP headquarters. The second nest was representative of creek-bottom habitat and was located in the cottonwoods along Crow Creek about $7\frac{1}{2}$ miles north and $1\frac{1}{4}$ miles east of Briggsdale, Colorado. The second nest was adjacent to a cultivated wheat field.

The camera recorder consisted of a super 8 movie camera that automatically made exposures at one-minute intervals. An electronic flash was added to the system for night filming. It was apparent that the flash had no effect upon the behavior or activity of the owls when it was in operation. This is also confirmed by the findings of Truslow (1966), Pearson (1959), and Nielson (1957), who believed that the illumination was of too short a duration (less than one thousandth of a second) to be detected. A photoelectric relay turned the strobe on at sunset and off at dawn. The entire recorder operated for six to eight days on two 12-volt and one 6-volt automobile batteries. A spring driven 8-day clock and a dial thermometer were mounted in camera range to record the time of exposure and the temperature.

Visits were made to the nests every 48 hr to change the film and replace the batteries when necessary. During each of these visits, the prey items in the nest were recorded, and the young were weighed and measured. Also, owl pellets were periodically collected and dated.

Movement Studies

Most of the nestlings followed in nest and growth studies were banded, as were a number of adults captured in mist nets at nests and water holes. In 1969 and 1970 a number of passerines were captured in small mammal live traps. Some hawks were color-marked with plastic streamers placed on their legs; many passerines were marked with plastic, colored leg bands.

A questionnaire was devised and mailed to approximately 200 observers in the Great Plains, requesting arrival and departure dates for certain key species of birds believed to migrate through their regions. Standard ornithological journals, regional check lists, and local bird club newsletters were searched for additional migration data.

Additional fall migration data were collected at the Pawnee Site by D. C. Zumeta, who made frequent plot counts and regular observations of flight direction, flock size, and time of passage, primarily of Horned Lark flocks.

RESULTS

Plot and Roadside Counts

As in past years, the minimal avian biomass production on the six 20-acre plots was calculated based upon breeding pair estimates and nesting studies (see also Giezantanner and Ryder, 1969; Strong and Ryder, 1971). In 1971 the total number of breeding pairs (59.0) on the 120 acres was approximately the same as that calculated in 1970 (58.2). However, a decrease was noted in Horned Larks and an increase in McCown's Longspurs and Western Meadowlarks (Table 3). Lark Bunting, Brewer's Sparrow, and Mountain Plover populations remained about constant both years. Overall, breeding bird densities in 1971

Table 3. Minimal avian biomass production on 120 acres at Pawnee, 1970 and 1971.^{a/}

Statistics	Horned Lark	McGown's Longspur	Western Meadowlark	Lark Bunting	Brewer's Sparrow	Mountain Plover	Chestnut-collared Longspur	Totals
Breeding Pairs	1971 15.8	9.4	8.7	16.6	6.9	1.5	--	59.0
	1970 17.6	7.0	7.8	16.6	6.2	1.5	1.5	58.2
Mean	1971 3.0	3.1	4.6	4.0	4.0	3.0	--	--
Clutch	1970 2.8	3.2	4.9	4.0	3.6	3.0	4.0	--
Total Eggs	1971 53.0	29	40	66	28	5	--	221
	1970 49	22	38	66	22	5	6	208
Total Wt Eggs (g)	1971 143	67	234	211	32	77	--	764
	1970 132	51	222	211	25	77	14	732
Estimated Young	1971 18	12	17	37	17	4	--	105
	1970 15	8	8	28	8	4	2	73
Total Fledgling Wt (g)	1971 409	210	893	983	170	400	--	2,955
	1970 341	140	420	661	80	400	30	2,072
Total Fledgling Wt (10 ⁻⁶ g/m ²)	1971 842	432	1,837	1,796	350	823	--	6,080
	1970 702	288	864	1,360	165	823	62	4,264

^{a/} Mean clutch size, nesting and fledging successes as well as fledgling weights from Strong (1971).

were below those noted in 1969, but above those in 1968 (Fig. 4). Our calculated breeding population densities were generally less than those reported by Finzel (1964) near Cheyenne and within the range of those reported by Mickey (1939, 1941, 1942) near Laramie, Wyoming. Cassel (1952) observed breeding densities at Pawnee in 1951 that were about as high as our 1969 observations (Fig. 4). Wiens (1971b) observed lower densities each year on his plot, which was subjected to heavy summer grazing by cattle, than we noted on our nearby plot in the same pasture (Table 4). In contrast, our estimates of the breeding population in the heavy winter-grazed pasture were consistently less than those Wiens noted. Although we had plots in the same pasture as Wiens, our plots did not overlap his. Also, our population estimates were based on slightly different methods (see Giezentanner, 1970) and included more counts over a longer period of time each season.

North American Breeding Bird Counts

The IBP 50-stop roadside counts for 1971 were similar to those for 1970, both for peaks and total individuals seen, but in general were greater than those peak numbers seen in 1968, although less than those noted in 1969 (Fig. 5). Total species seen at various seasons of the year were similar for all 4 years (Fig. 6), ranging from as few as five species on some winter counts to 29 in spring or fall migrations. Normally about 23 species were noted during the summer.

The seasonal flux in populations as determined by the roadside count indicated that Horned Lark numbers peak in the winter, Lark Buntings peak in midsummer (Fig. 7 and 8), and Western Meadowlarks are most numerous in the spring and fall migrations (Fig. 9). In general these findings agree with those reported by Giezentanner (1970) for plot counts.

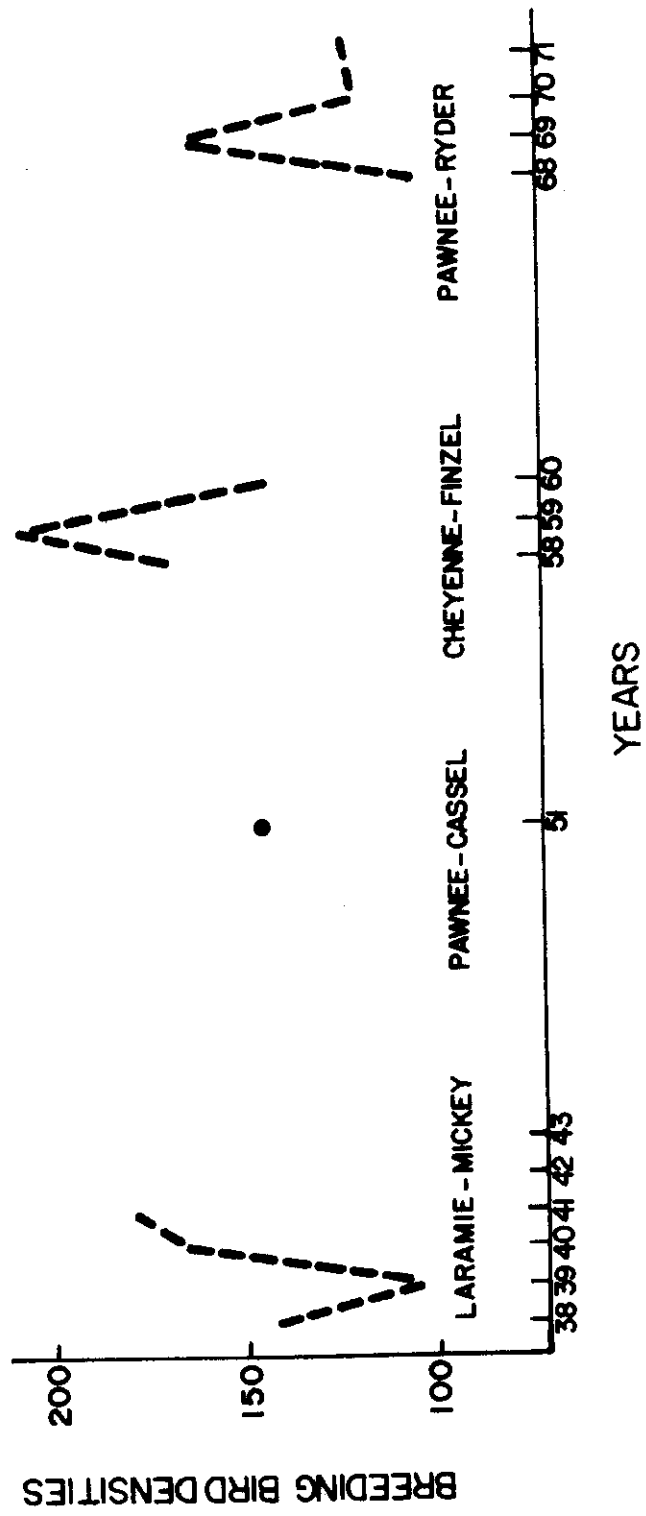


Fig. 4. Breeding bird densities (pairs/100 ha).

Table 4. Comparison of Wiens' and Ryder et al.'s plot censuses, Pawnee Site, 1968-71--breeding populations.

Years	Birds/100 ha	
	Wiens	Ryder et al.
<i>Heavy Summer Grazing</i>		
1968	203.3	219.8
1969	260.7	392.6
1970	269.6	298.8
1971	226.3	249.4
<i>Heavy Winter Grazing</i>		
1968	231.3	185.2
1969	332.5	301.2
1970	277.1	187.7
1971	339.6	234.6

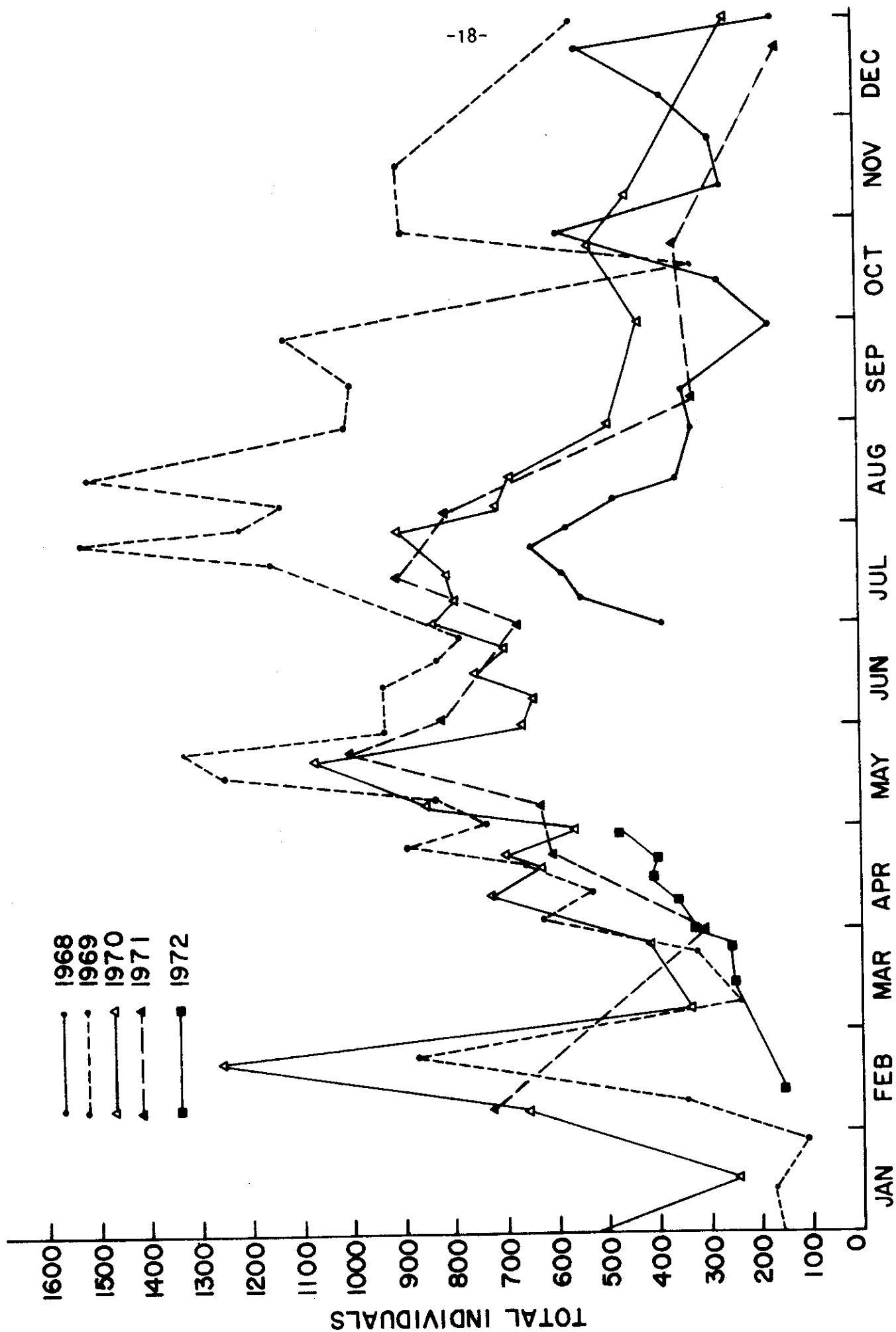


Fig. 5. IBP roadside bird survey--total individuals.

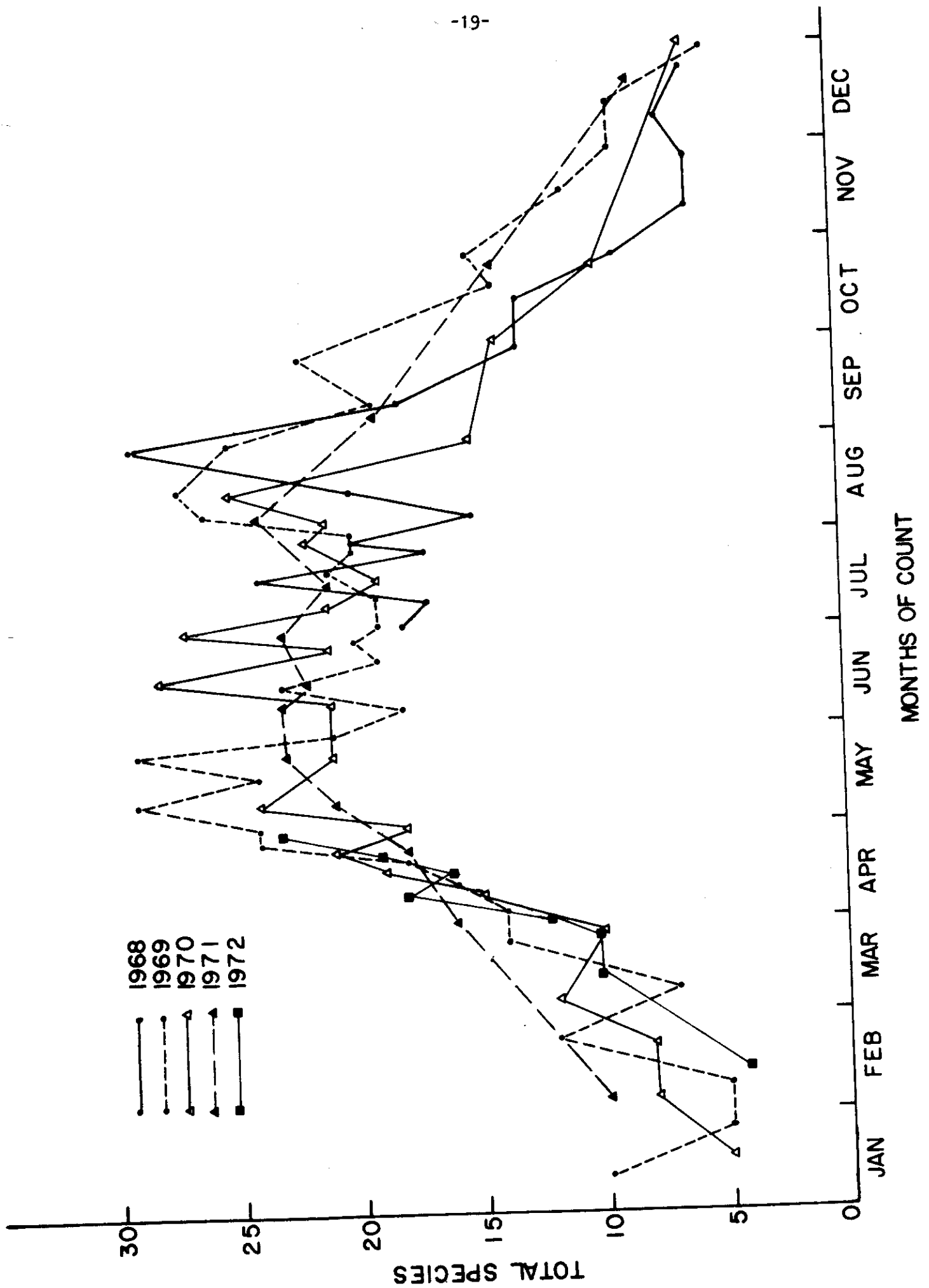


Fig. 6. IBP roadside bird survey--total species.

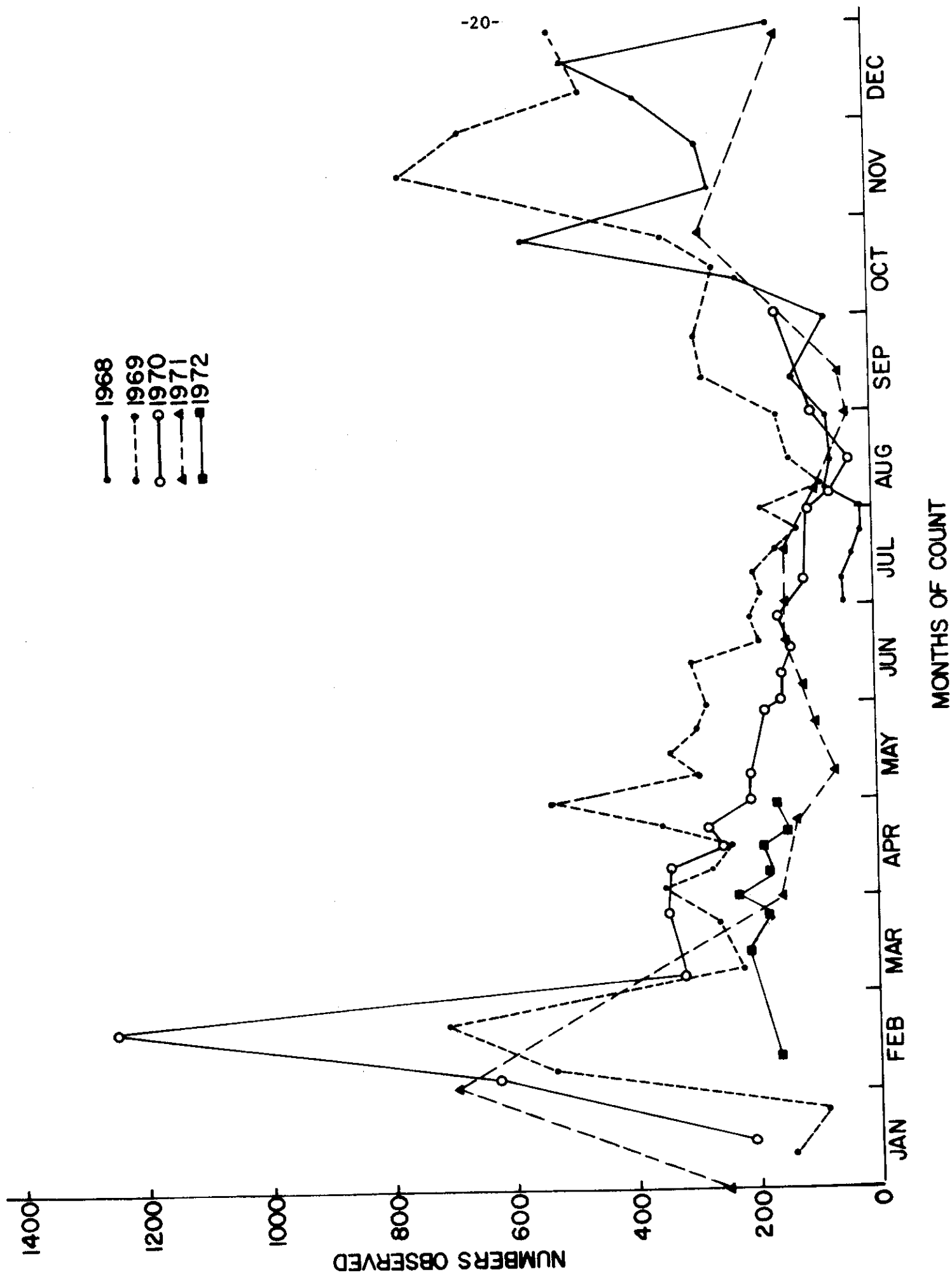


Fig. 7. IBP roadside counts--Horned Larks.

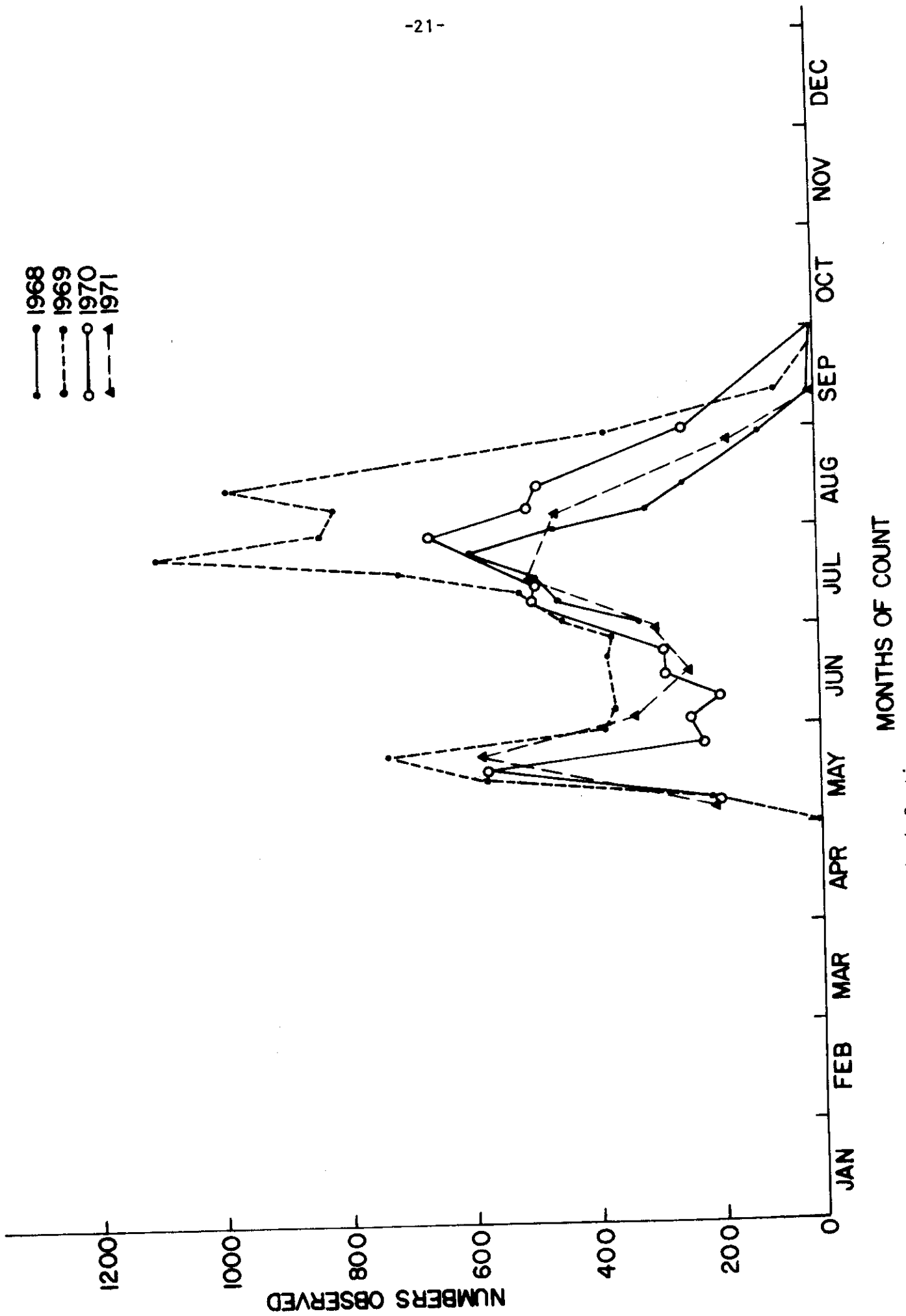
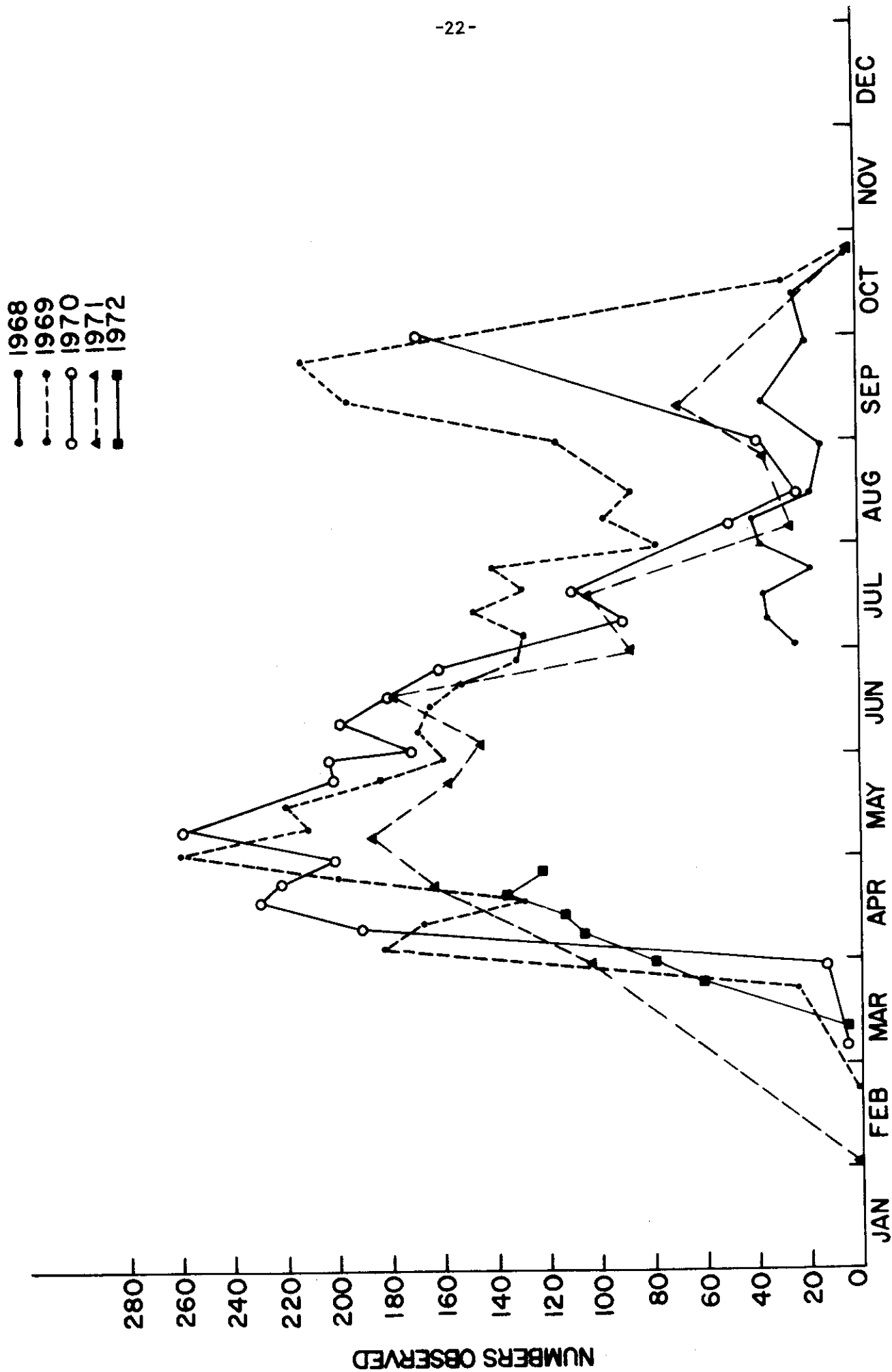


Fig. 8. 1BP roadside counts--Lark Bunting.



MONTHS OF COUNT

Fig. 9. IBP roadside count--Western Meadowlark.

North American Breeding Bird Surveys conducted at seven other locations in the Colorado plains generally showed similar trends to the IBP roadside findings. Most counts indicated that peak totals of birds occurred in 1969 (Table 5). In all, four years of data were available from five routes in addition to the IBP route at Pawnee. All but Pawnee indicated an increase in Horned Lark breeding populations in 1971 compared to 1970 (Table 5 and Fig. 10). Lark Bunting breeding populations (Fig. 11) were highest in 1969 on five of the six routes (including the Pawnee IBP route), but were highest in 1970 on one route (Last Chance).

The breeding populations as determined for 1968-71 on these eight roadside counts (Table 5) were most diverse (36 to 42 species) on the Kiowa Route, which is closest to the mountains, and least diverse on the Pawnee Route (18 to 22 species). The greatest number of individual birds were observed each year on the Fleming Route, which extends through better wheat country as well as grasslands. It appears that the Pawnee Site had one of the better populations of Lark Buntings and Western Meadowlarks in 1971, but fewer Horned Larks than five of the other seven routes.

Raptor Counts

The diurnal birds of prey encountered during the spring and fall study periods were mainly: Golden Eagle (*Aquila chrysaetos*), Swainson's Hawk (*Buteo swainsonii*), Rough-legged Hawk (*Buteo lagopus*), Ferruginous Hawk (*Buteo regalis*), Red-tailed Hawk (*Buteo jamaicensis*), Marsh Hawk (*Circus cyaneus*), Prairie Falcon (*Falco mexicanus*), Sparrow Hawk (*Falco sparverius*), Sharp-winged Hawk (*Acipiter striatus*), and Turkey Vulture (*Cathartes aura*). The Golden Eagle, Red-tailed Hawk, Ferruginous Hawk, Marsh Hawk, and Prairie

Table 5. Roadside counts of breeding birds at various locations in Colorado, 1968-71.

Species & Routes	1968	1969	1970	1971
<i>Horned Lark</i>				
IBP	(41) ^{a/}	199	152	128
Briggsdale	95	210	130	222
Last Chance	205	203	195	245
Abarr	166	290	240	224
Fleming	196	236	169	190
Kiowa	33	27	26	31
Gilpin	--	--	127	147
Mica Butte	243	--	--	92
<i>Lark Bunting</i>				
IBP	282	320	247	248
Briggsdale	387	506	395	309
Last Chance	242	262	320	233
Abarr	17	265	58	136
Fleming	114	188	120	55
Kiowa	68	98	69	6
Gilpin	--	--	33	28
Mica Butte	13	--	--	8
<i>Western Meadowlark</i>				
IBP	(25)	131	153	177
Briggsdale	40	94	68	117

Table 5. Roadside counts of breeding birds at various locations in Colorado, 1968-71 (continued).

Species & Routes	1968	1969	1970	1971
<i>Western Meadowlark</i>				
Last Chance	43	155	138	139
Abarr	141	291	239	175
Fleming	215	268	174	144
Kiowa	163	243	194	185
Gilpin	--	--	144	162
Mica Butte	46	--	--	95
<i>Mourning Dove</i>				
IBP	(9)	22	31	42
Briggsdale	20	62	58	77
Last Chance	27	39	47	77
Abarr	80	92	45	64
Fleming	37	65	67	74
Kiowa	85	72	54	75
Gilpin	--	--	28	31
Mica Butte	15	--	--	20
<i>All Species Total Individuals</i>				
IBP	(385)	781	706	746
Briggsdale	646	1032	785	899
Last Chance	579	856	895	899
Abarr	501	1253	832	852

Table 5. Roadside counts of breeding birds at various locations in Colorado, 1968-71 (continued).

Species and Routes	1968	1969	1970	1971
<i>All Species Total Individuals</i>				
Fleming	1342	1904	1496	1333
Kiowa	653	677	634	524
Gilpin	--	--	540	610
Mica Butte	438	--	--	386
<i>Total Number of Species</i>				
IBP	(18)	20	21	22
Briggsdale	29	25	27	28
Last Chance	21	22	23	28
Abarr	26	31	33	34
Fleming	27	27	28	26
Kiowa	36	37	42	38
Gilpin	--	--	25	26
Mica Butte	23	--	--	36

a/ Numbers in parentheses believed underestimations due to lateness in season for 1968 IBP roadside count.

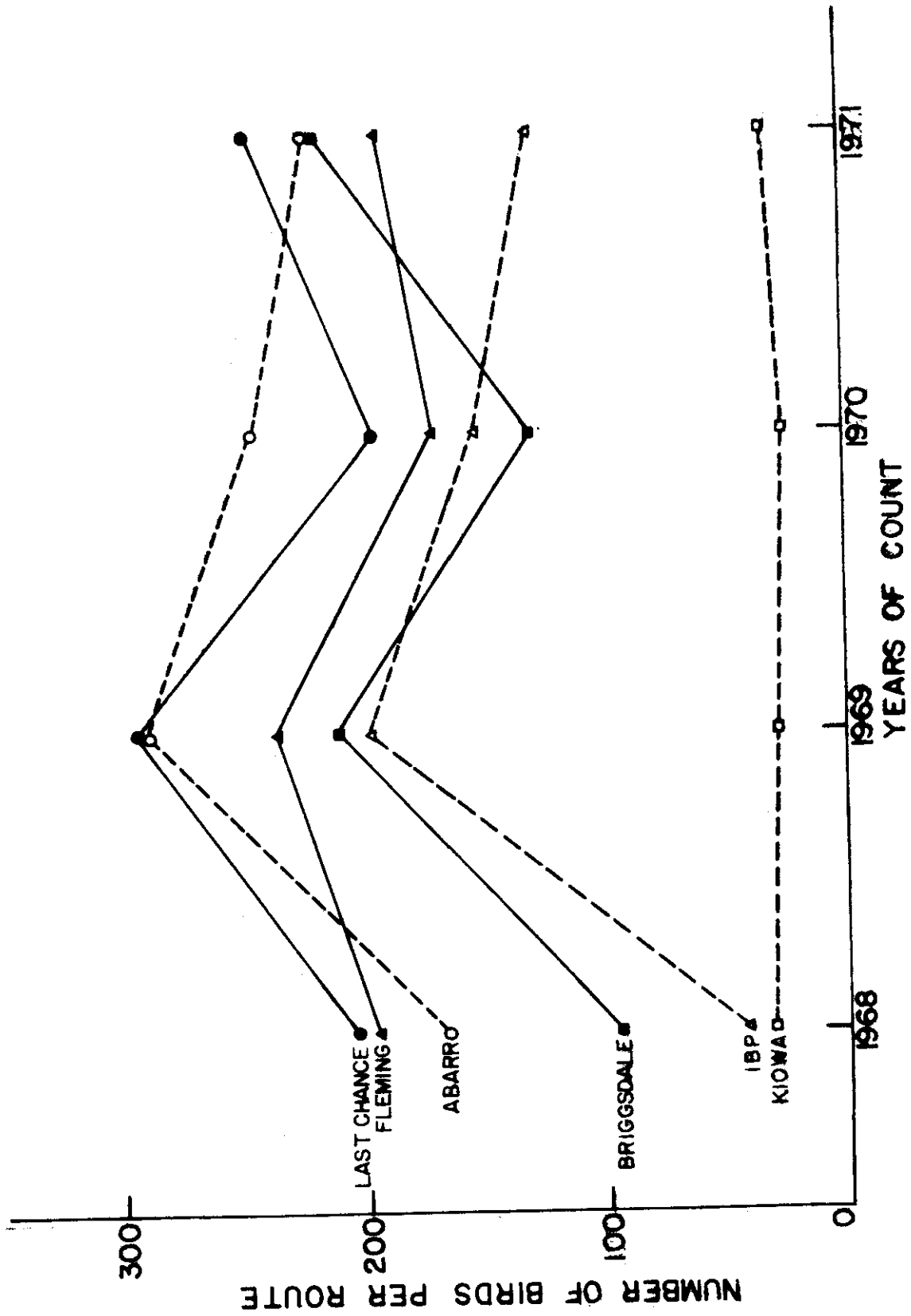


Fig. 10. Trends in Horned Lark numbers on six roadside-count routes in eastern Colorado, 1968-71.

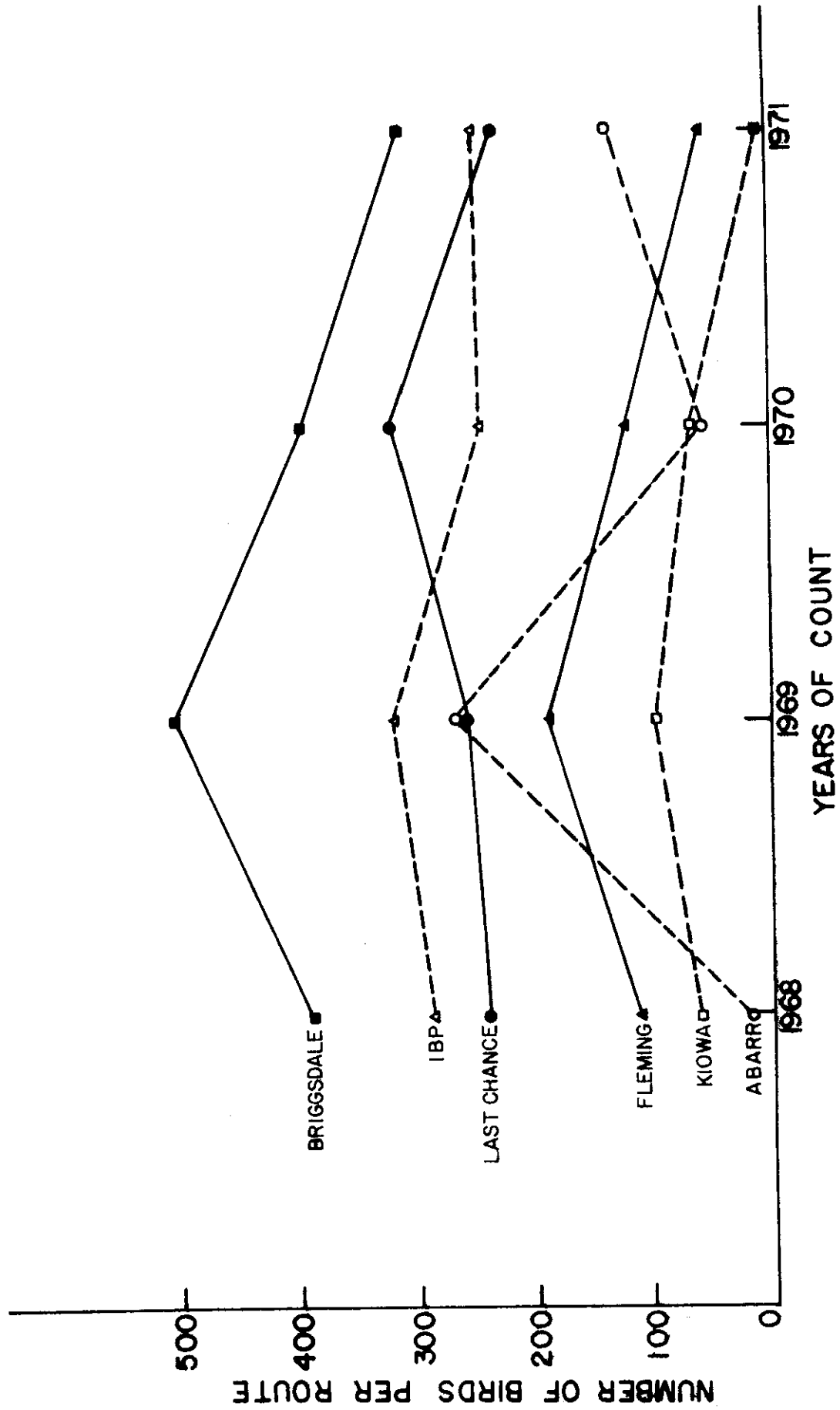


Fig. 11. Trends in Lark Bunting numbers on six roadside-count routes in eastern Colorado, 1968-71.

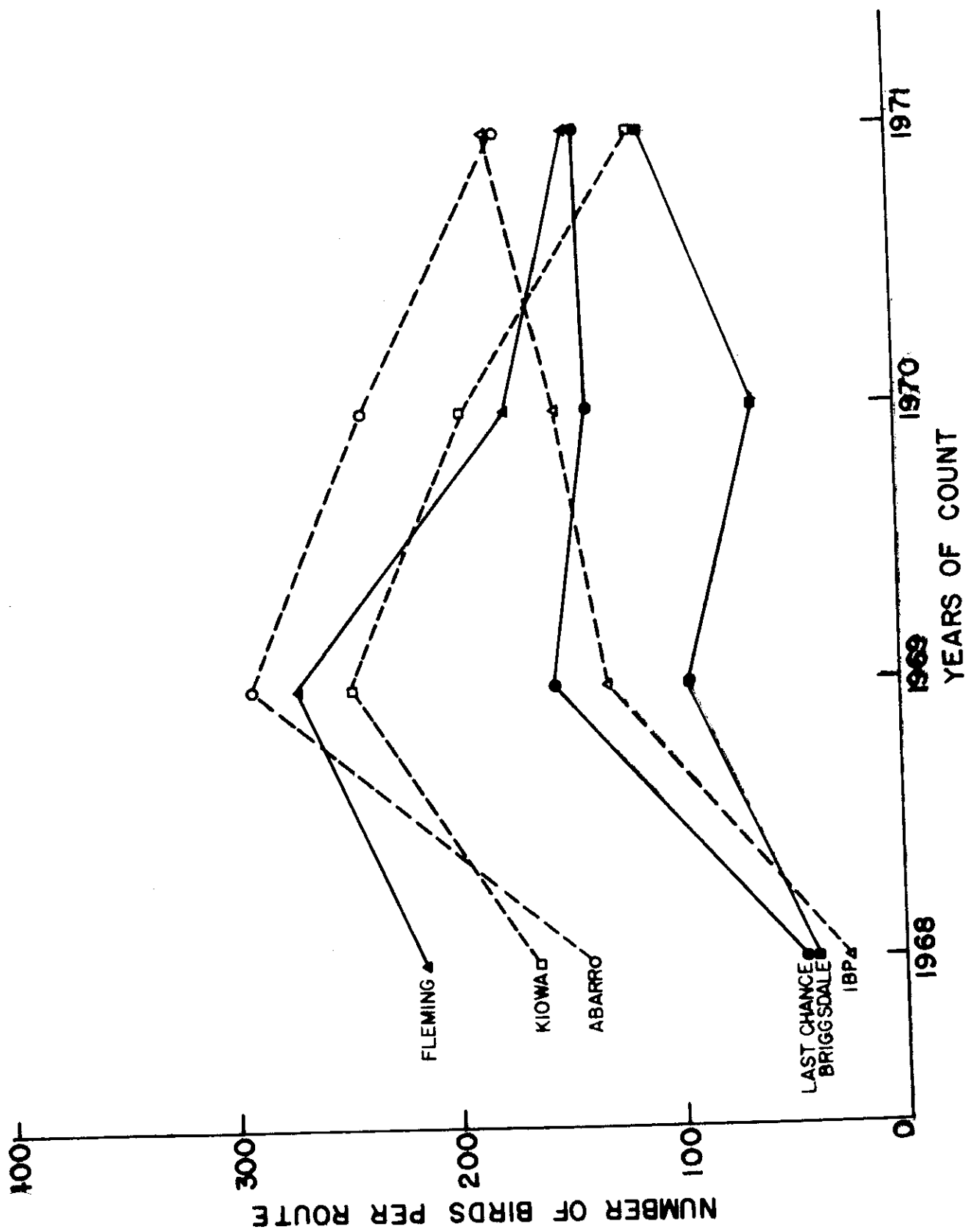


Fig. 12. Trends in Western Meadowlark numbers on six roadside-count routes in eastern Colorado, 1968-71.

Falcon are residents throughout the year. The Rough-legged Hawk is strictly a winter resident, and the Swainson's Hawk and Sparrow Hawk are summer residents.

A total of 925 raptors were recorded during the fall and spring migration periods of 1969-70. The fall migration accounted for a little less than two-thirds of the total raptor observations, even though more time was spent observing the spring movement (Tables 6 and 7).

Those species which showed well-defined peaks in both spring and fall were the Sparrow Hawk, Swainson's Hawk, and, to a lesser extent, the Golden Eagle. Those species which showed increased but no well-defined peaks were the Marsh Hawk and the Red-tailed Hawk. The Prairie Falcon and the Rough-legged Hawk showed increases in the fall, remained high during the winter, then declined during the spring (Fig. 13 and 14).

In general the fall migration was characterized by a mass movement of hawks in a short time of $1\frac{1}{2}$ months. The birds tended to migrate with the peaks of individual species falling within a range of 21 days from August 13 to September 17. The spring migration was generally more drawn out, lasting from late February until the end of April. The different species of hawks moved through in a staggered fashion with peaks occurring at different times. Though the spring raptor movement lasted longer than the fall migration, the duration of each species' spring movement was shorter than in fall. Olendorff counted 329 diurnal birds of prey in five fall counts along essentially the same route in 1971 (Table 8). Sparrow Hawks peaked almost 2 weeks later in 1971 than in 1969. Swainson's Hawks were still building in numbers on September 23, 1971, but the peak did not occur until 2 to 6 days later (Olendorff, 1972). No definite peak occurred for Marsh Hawks, but they were common throughout the study period..

Table 6. Numbers of raptors observed at the Pawnee National Grassland in the fall of 1969.

Species	Aug. 6	Aug. 13	Aug. 20	Aug. 27	Aug. 29	Sept. 3	Sept. 10	Sept. 17	Total	% of Total
Sparrow Hawk	13	7	17	32	43	66	70	23	271	47.8
Swainson's Hawk	8	7	14	12	17	34	35	24	151	26.7
Marsh Hawk	2	4	9	4	9	11	6	5	50	8.8
Ferruginous Hawk	--	2	3	1	1	3	3	5	18	3.2
Red-tailed Hawk	2	1	2	4	2	3	3	1	18	3.2
Prairie Falcon	--	2	2	--	3	4	2	1	14	2.5
Golden Eagle	--	1	1	1	2	1	--	--	6	1.1
Sharp-shinned Hawk	--	--	--	--	--	1	--	--	1	0.5
Turkey Vulture	--	--	--	--	--	--	--	--	0	0.0
Unidentified Hawk	1	1	3	3	17 ^{a/}	2	3	7	37	6.5
Totals	26	25	51	57	94	125	122	66	566	100.0
Miles Covered	113	113	113	113	113	113	113	113	904	
Raptors/ 100 Miles	23.0	22.1	45.1	50.1	83.3	110.6	107.0	58.4	62.4	

^{a/} The increase in unidentified hawks reflects the lack of a spotting scope which was used in making identification on other days.

Table 7. Numbers of raptors observed at the Pawnee National Grassland in the spring of 1970.

Species	Feb. 21	Mar. 7	Mar. 14	Mar. 25	Apr. 2	Apr. 7	Apr. 11	Apr. 21	Apr. 25	May 2	Total	% of Total
Sparrow Hawk	--	--	--	--	4	5	15	31	31	10	96	26.8
Marsh Hawk	--	4	10	5	12	10	10	14	10	2	77	21.5
Rough-legged Hawk	13	13	11	12	11	6	1	2	--	--	69	19.2
Golden Eagle	2	12	1	5	3	6	3	3	3	4	42	11.7
Swainson's Hawk	--	--	--	--	--	--	--	4	10	14	28	7.8
Ferruginous Hawk	2	1	1	9	4	--	2	1	1	2	23	6.4
Prairie Falcon	4	2	1	--	2	--	--	--	--	--	9	2.5
Red-tailed Hawk	--	1	1	1	1	--	--	--	--	1	5	1.4
Turkey Vulture	--	--	--	--	--	--	--	1	--	--	1	0.3
Sharp-shinned Hawk	--	--	--	--	--	--	--	--	--	--	0	0.0
Unidentified Hawk	1	1	2	3	1	1	--	--	--	--	9	2.5
Totals	22	34	27	35	38	28	31	56	55	33	359	100.0
Miles Covered	90	90	90	90	90	90	90	90	90	90	900	
Raptors/ 100 Miles	24.9	37.7	30.0	38.8	42.2	31.1	34.4	62.2	61.1	36.6	39.8	

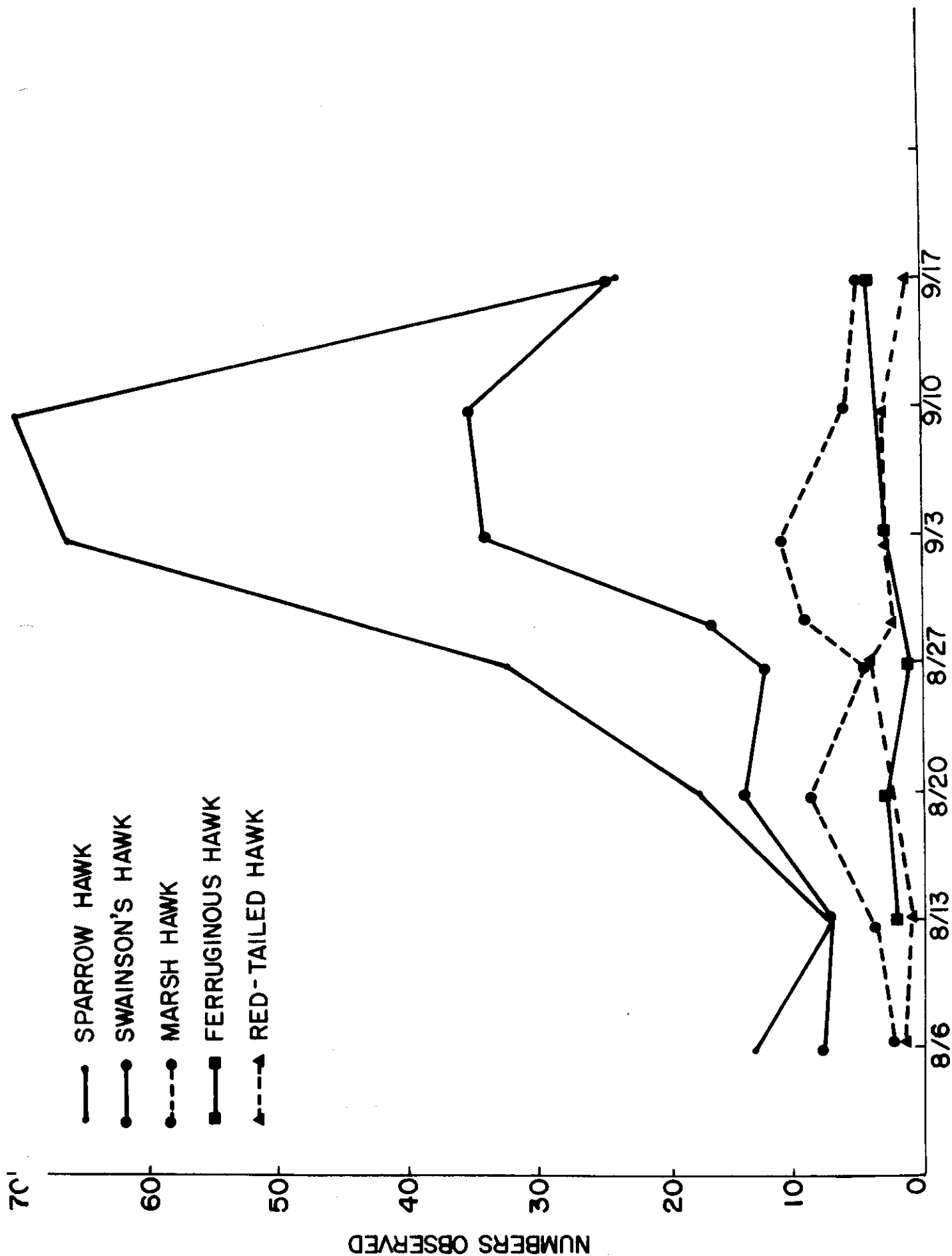


Fig. 13. Numbers of raptors observed at the Pawnee National Grassland in the fall of 1969.

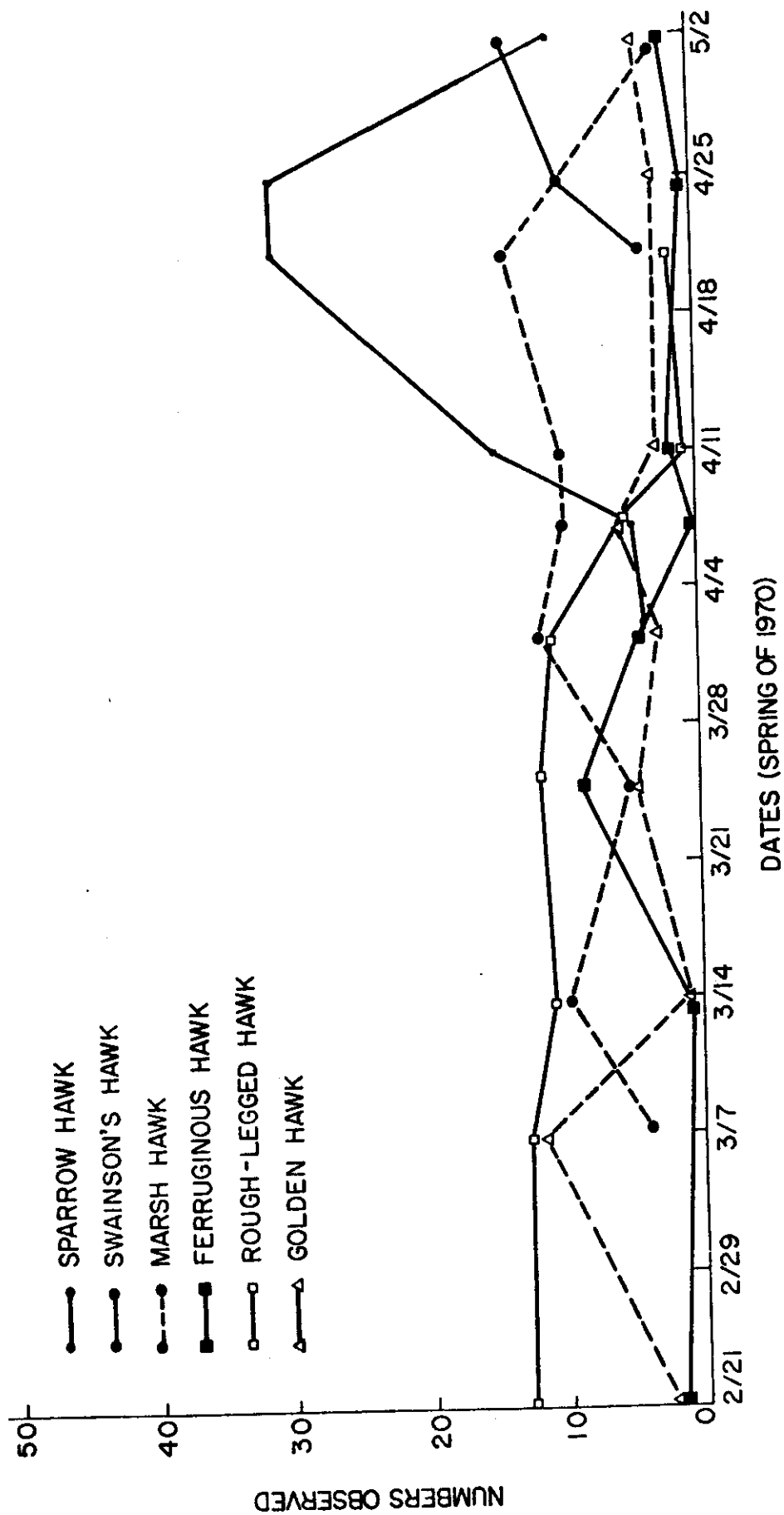


Fig. 14. Numbers of raptors observed at the Pawnee National Grasslands in the spring of 1970.

Table 8. Numbers of raptors observed at the Pawnee National Grassland in the fall of 1971.

Species	Aug. 27	Sept. 3	Sept. 10	Sept. 19	Sept. 23	Total	% of Total
Sparrow Hawk	40	20	6	36	61	163	49.6
Swainson's Hawk	8	9	3	27	35	82	24.9
Marsh Hawk	7	9	3	9	7	35	10.6
Ferruginous Hawk	2	1	1	3	5	12	3.7
Red-tailed Hawk	1	2	1	4	3	11	3.3
Prairie Falcon	--	--	--	3	2	6	1.8
Golden Eagle	3	2	2	4	1	12	3.7
Sharp-shinned Hawk	--	--	--	1	1	2	0.6
Turkey Vulture	--	--	--	--	--	--	--
Burrowing Owl	--	--	--	1	1	2	0.6
Unidentified Hawk	--	--	--	1	3	4	1.2
Totals	61	44	16	89	119	329	100.0
Miles Covered	88	88	88	88	88	440	
Raptors/ 100 Miles	53.6	38.7	14.0	78.3	104.7	74.7	

The percent of total column shows nearly the same percentages in 1971 as in 1969. The major exception is the Golden Eagle, which was three times more common in 1971 than in 1969. The figures for raptors/100 miles are only slightly higher in 1971 than in 1969, the averages being 74.7 and 62.4, respectively. In general, migrant populations appear stable, although there is some evidence that the migration was later in 1971 than in 1969.

Further information regarding seasonal fluctuations in diurnal raptor populations can be gained from Nancy Hurley's roadside counts. Miss Hurley's counts, covering practically 3 years (1969-71), indicate fall peaks in raptor numbers (Fig. 15) similar to those noted by Olendorff in 1969 and 1971 (Tables 6 and 8).

Wintering populations of diurnal raptors are best typified by the 3 years of data from the 56-sq mile study area which includes the CPER (Table 9). The first 2 years of these data were analyzed and discussed in detail by McCord (1969), Minor (1969), Marion (1970), and Marion and Ryder (1970). In all three winters, Golden Eagles were the most abundant raptor, and the Rough-legged Hawks were second in abundance (Table 9 and Fig. 16 and 17).

Nesting Studies

The results from nest visits (clutch size, hatch, and fledging success) and growth of nestling passerines are reported by Strong (1971).

The productivity of the large birds of prey of northern Weld County, Colorado, in 1971 was analyzed and compared with data obtained in 1970 (Table 10). The data cannot be considered in terms of raptors produced per square mile, since much of the study area was not adequately covered. Such a consideration will be made by Olendorff (1972).

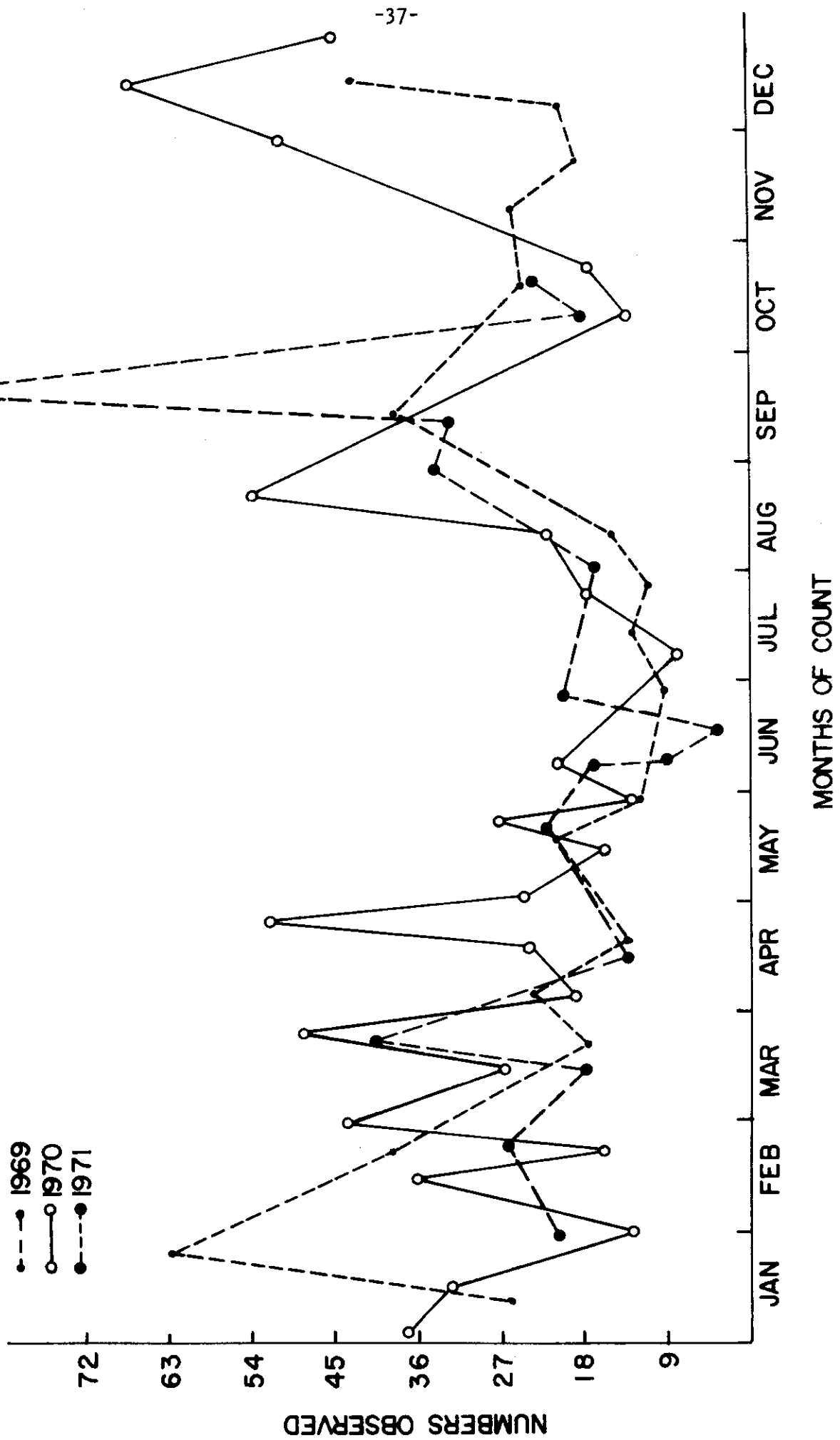


Fig. 15. Diurnal raptors per 100 miles observed by Nancy Hurley.

Table 9. Diurnal raptors observed on a 56-sq mile study area, September 29 to April 4, each year.

Species	1968-69 ^{a/} (4 counts)		1969-70 (16 counts)		1970-71 (10 counts)	
	No.	Percent	No.	Percent	No.	Percent
Golden Eagle	22	33.3	76	43.5	33	35.9
Rough-legged Hawk	25	38.4	34	19.4	29	31.5
Marsh Hawk	9	13.6	23	13.1	10	10.9
Ferruginous Hawk	7	10.6	16	9.1	9	9.8
Prairie Falcon	1	1.5	9	5.2	5	5.4
Red-tailed Hawk	--	0.0	2	1.1	4	4.3
Sparrow Hawk	--	0.0	--	0.0	2	2.2
Unidentified Hawk	2	3.0	15	8.6	0	0.0
Total	66		175		92	

^{a/} Data begin on January 25.

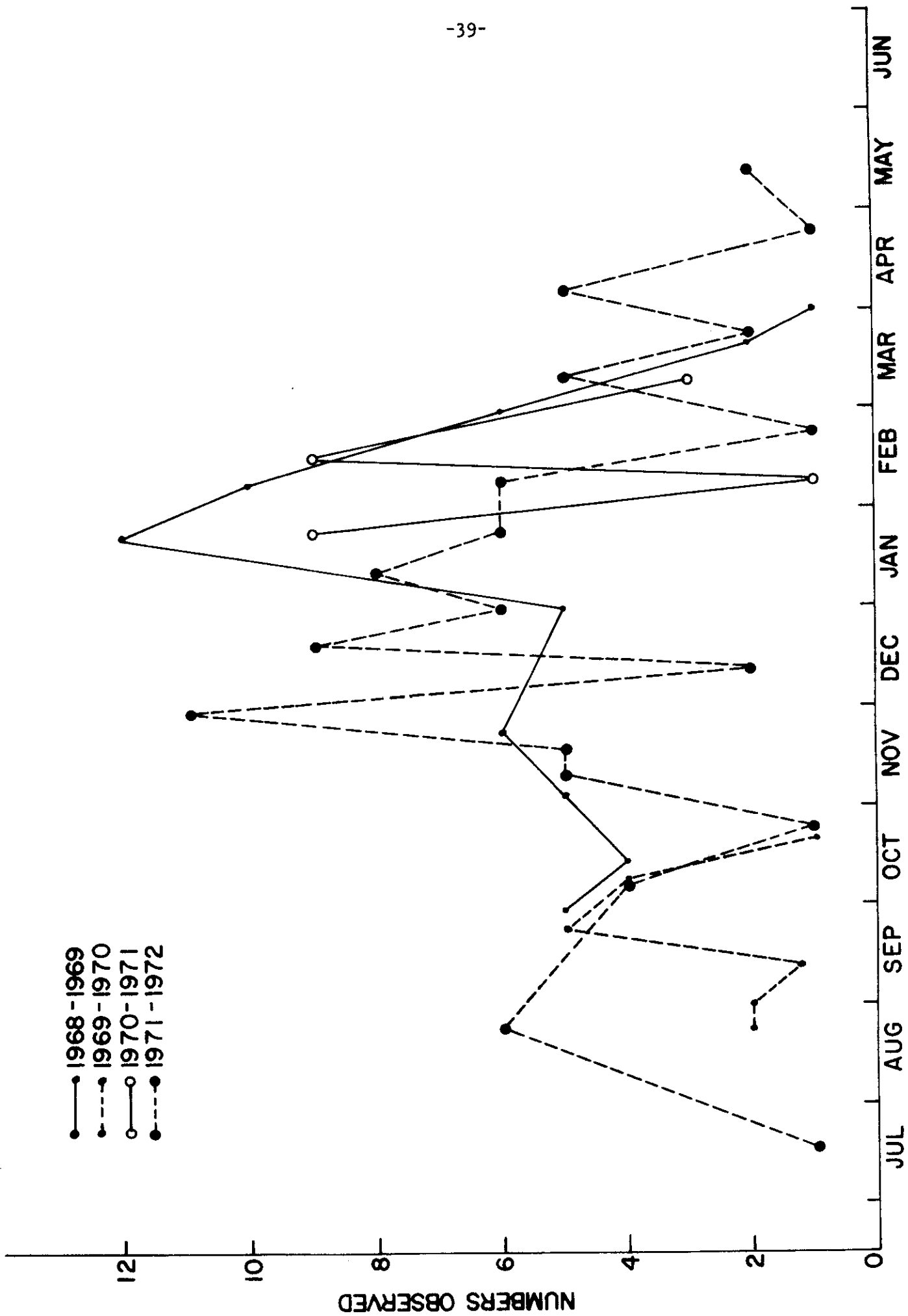


Fig. 16. Golden Eagles seen on 56-sq mile study area.

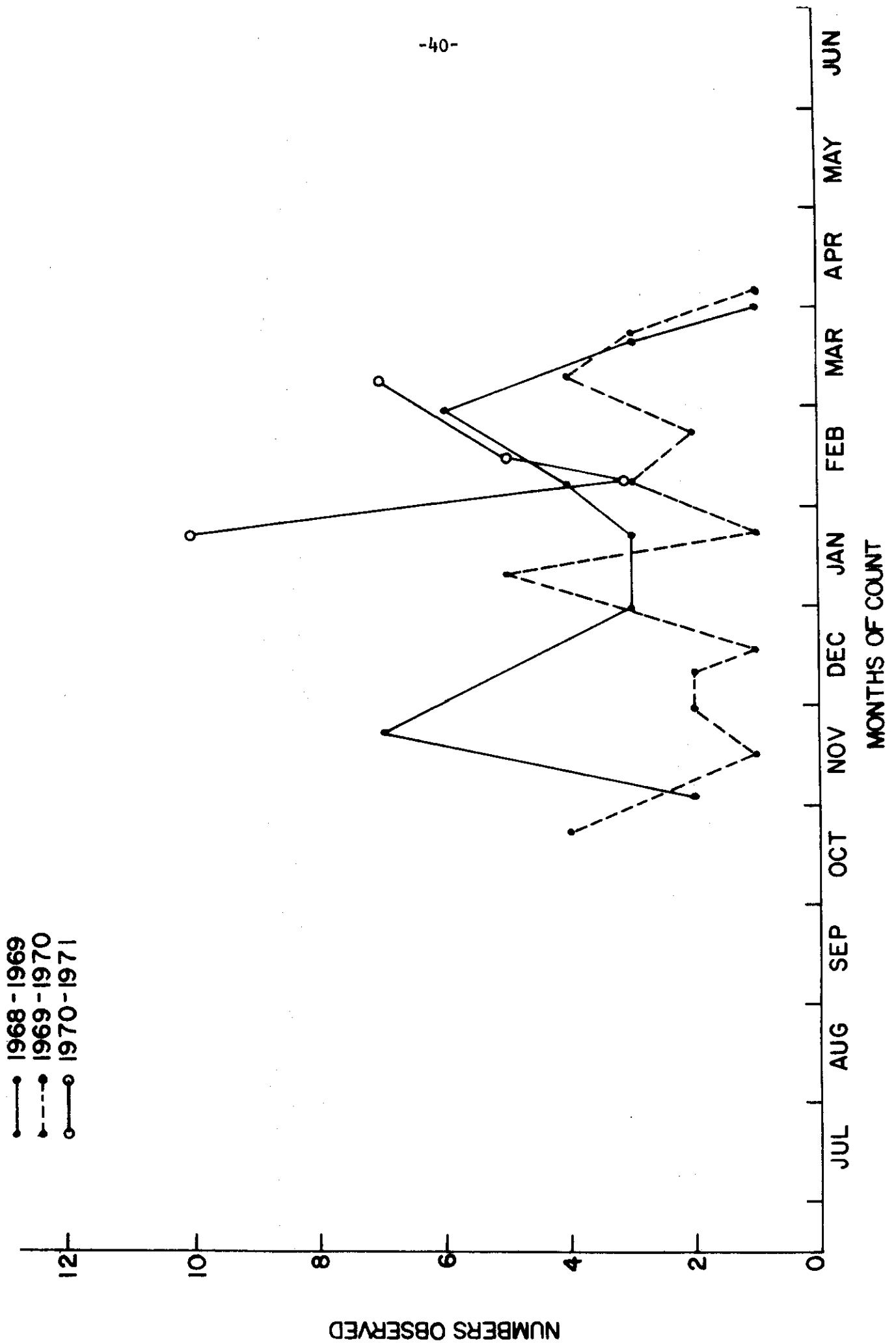


Fig. 17. Rough-legged Hawks seen on the 56-sq mile study area.

Table 10. Productivity of the large birds of prey of northern Weld County, Colorado, in 1970 and 1971. Percentages are given in parentheses.

Species	Nests		Nests Abandoned		Young per Successful Nest		Young per Nest	
	1970	1971	1970	1971	1970	1971	1970	1971
Ferruginous Hawk	10	15	6 (60)	4 (27)	2.00	2.45	0.80	1.80
Swainson's Hawk	28	38	19 (68)	23 (61)	2.00	2.40	0.64	0.95
Golden Eagle	11	20	1 (9)	7 (35)	1.70	1.61	1.55	1.05
Prairie Falcon	<u>7^{a/}</u>	8	3 (43) ^{a/}	0 (0)	4.25	4.00	2.43 ^{a/}	4.00
Great Horned Owl	8	14	1 (13)	3 (21)	1.86	2.00	1.63	1.57

^{a/} Data of L. R. Grater. Abandonment caused by disappearance of eggs and large nestlings from nests.

Fifteen ferruginous hawk nests were located in 1971, of which four (27%) were abandoned. An abandonment rate of 60% was noted in 1970. Ferruginous Hawk nests were not climbed during the egg period in 1971, but were in 1970. Weather was also a factor causing abandonment of Ferruginous Hawk nests in 1970. Young produced per successful Ferruginous Hawk nest was up in 1971. Thus, the increase in the number of young produced per nest found was the result of higher productivity per successful pair and a decrease in the rate of abandonment.

Productivity of Swainson's Hawks also was up in 1971 relative to 1970 as the result of a lower rate of abandonment and a higher fledging rate in successful nests. The lower fledging rate per occupied nest of Swainson's Hawks follows the high desertion rate of Swainson's Hawks (more than twice as high as Ferruginous Hawks). Data for young produced per successful nest show parallel increases from 1970 to 1971 for both species of hawks.

Golden Eagle production was down slightly in 1971 as the result of a higher rate of abandonment. This decreased production is believed to be an artifact of data acquisition. Since the observers were in the field early in the 1971 nesting season, several instances of creek-bank nests being destroyed by heavy rains and continued erosion were noted. Similar early abandonments would not have been detected in 1970. The suggestion is that there are more floating pairs of Golden Eagles during the summer months than originally expected. No renesting of Golden Eagles was observed.

Data from six specific Golden Eagle nesting sites are available from the years 1964-71 (Table 11). The number of young known to have been fledged has varied from two to six for these sites.

Table 11. Golden Eagles fledged on the Pawnee Site (Rockport to Hereford) 1964-1971. Data courtesy of T. Ray (1964-69), R. R. Olendorff, and G. Craig (1970-71).

Year	Nest Sites (F. & W. S. Numbers) ^{a/}						Total
	53	54	54A	55	56	57	
1964	?	-	?	?	2	1	3
1965	0	-	?	2	1	0	3
1966	1	-	?	1	-	2	4
1967	2	A	?	-	-	1	3
1968	-	A	?	2	-	-	2
1969	-	1	1	2	-	2	6
1970	-	2	?	?	?	0	2
1971	-	2	-	A	?	1	3

^{a/} F. & W. S. Numbers = Fish and Wildlife Service.

? = No data available.

- = Nest checked, but was inactive.

0 = Eagles nested, but failed to fledge any young.

A = Nest active, but fate unknown.

Prairie Falcons were not studied by Olendorff in 1970. Data from Grater (1970) were used for year-to-year comparisons. No Prairie Falcons or eggs were taken from the study area in 1971. The productivity remained at a high level.

Abandonment of Great Horned Owl nests was slightly higher in 1971, but productivity data are comparable for the two years. Fourteen nests fledged 1.57 young per nest.

Food Habits Studies

In 1971, 60 Horned Larks and 60 Lark Buntings were collected for weights and other morphological data. The visceral contents of these birds were frozen for later analysis by Baldwin and his students. Their findings will be reported in separate Technical Reports.

Food habits of owls were studied intensively from 1967 to 1970 and have been previously reported (Marti, 1969a,c, 1970; Marti and Ryder, 1969).

Winter and spring food habits of Golden Eagles were studied by Good (1970) on the 56-sq mile raptor count area from December 18 to May 19, 1970. Pellets from four perches and one tree-nest site were analyzed. Data derived from these 50 pellets, 25 from winter and 25 from spring, indicated that the Golden Eagles studied relied upon lagomorphs (species and genera not distinguishable) for the majority of their food. All pellets consisted primarily of rabbit fur. Ground squirrels (most likely *Citellus tridecemlineatus*) were present only in the spring pellets and were not abundant, probably because of inclement weather during the spring of 1970 which delayed emergence of ground squirrels. Other species of prey identified from hair or feathers in pellets included weasel, *Mustela* spp.; possibly raccoon, *Procyon lotor*; and fox, most

likely *Vulpes fulva*; an unidentified passerine; and several unidentified small mammals.

Field observations of Golden Eagle feeding behavior and prey availability were made during the same period by Baker (1970). He noted that Golden Eagles were most active in the mornings which had moderate breezes, when they hunted by soaring about 100 ft above the ground. Later in the day, as winds increased, the eagles were more likely to perch on windmills or on telephone poles. Baker noted that the eagles seemed to have more or less well-defined feeding territories. Sixty-three percent of the observations he made of hunting eagles were in open shrub vegetation rather than in continuous shortgrass prairie. Jackrabbits, the main eagle prey, were most abundant in the shrub type. Although both Good (1970) and Baker (1970) reported that some rabbits were undoubtedly taken as carrion, and Baker found 22 road-kills or 1.4 dead lagomorphs per square mile, neither thought this source of food was particularly abundant during their studies. Heugly (1970), summarizing 15 separate studies of Golden Eagle food habits conducted over a 47-year period in 20 states, also concluded that lagomorphs were the most important prey of the Golden Eagle.

This study on the Pawnee supported the findings in previous studies, in that lagomorphs were found in every pellet and made up over 90% of every pellet examined from both winter and spring collections. It could not be determined whether jackrabbits or cottontails were most abundant. Even so, with the trend shown by other investigations and by prey availability on the Pawnee National Grassland, *Lepus* is surely the most commonly-taken prey.

Prey availability findings on the Pawnee National Grassland show that black-tail jackrabbits (*Lepus californicus*), with a density of 12.3 per square mile, made up 74% of all lagomorphs present in the 1970 study. White-tail jackrabbits (*Lepus townsendi*) made up 18% of the total, and density was

2.2 per square mile. Cottontails were least abundant, making up only 8% of the total and found in densities of 1.2 per square mile. In general, lagomorphs were fairly abundant on the Pawnee, with overall densities of 15.7 per square mile (Baker, 1970).

A total of eighteen 50-foot rolls of movie film (representing approximately 60,000 frames) have been collected, but to date have not been analyzed. Although the varieties and numbers of prey items will be ascertained predominantly from these films, information gathered from the castings and prey items present during nest visits will also be used to support the films. Table 12 represents the prey items present at the nests when the film was changed. These data alone are not reliable for making any sound judgments due to the following biases:

1. The visits were not frequent enough to obtain a true picture of prey preference--even daily visits would not be truly representative.
2. The data are biased toward large prey items that are not easily consumed at one feeding.
3. The amount of unconsumed prey decreased as the owlets developed and ate more voraciously. In fact, no items were present on either of the last two visits before the young fledged.

Despite these biases, this table may be used to roughly compare the two nests since the same data were collected in the same manner. The following comparisons have been made:

1. While both pairs took about the same amount of total biomass, the shortgrass prairie pair had to capture more individuals to make up the total. This indicates that large prey was not as abundant on the shortgrass prairie as on the riparian habitat.

Table 12. Food habits of Great Horned Owls based upon items found in the two nests followed by Craig in 1971.

Prey Item	Nest 1			Nest 2			Both Nests Combined		
	No.	%	Biomass	No.	%	Biomass	No.	%	Biomass
Lagomorphs									
<i>Sylvilagus</i>	5	16.6	4,712	7	34.5	8,700	12	24.0	13,412
<i>Lepus</i>	2	6.6	2,713	2	10.0	3,370	4	8.0	6,083
Rodents									
<i>Thomomys</i>	20	66.6	6,000	1	5.0	300	21	42.0	6,300
<i>Dipodomys</i>	2	6.6	130	2	10.0	130	4	8.0	260
<i>Onychomys</i>	--	--	--	1	5.0	38	1	2.0	38
<i>Peromyscus</i>	--	--	--	1	5.0	25	1	2.0	25
Birds									
<i>Phasianus</i>	--	--	--	1	5.0	1,293	1	2.0	1,293
<i>Anas</i>	--	--	--	2	10.0	726	2	4.0	726
<i>Bucephala</i>	--	--	--	2	10.0	680	2	4.0	680
<i>Zenaidura</i>	1	3.3	120	--	--	--	1	2.0	120
<i>Sturnella</i>	--	--	--	1	5.0	105	1	2.0	105
Total	30	100.0	13,675	20	100.0	15,367	50	100.0	29,042

2. The greater variety of prey species available to the creek-bottom pair is reflected by a prey species list nearly twice that of the shortgrass owls.
3. *Thomomys* accounted for the majority of prey numbers and biomass of the shortgrass pair, indicating a large population in the vicinity. It is also interesting to note that every pocket gopher at the nest was a male. This is due to the greater vulnerability of the males to predation when they come above ground during their breeding season.

Movement Studies

Since 1961 over 3,000 birds representing 60 species have been banded at the Pawnee Site, mostly since 1968 (Table 13). Comparatively few recoveries have been reported other than for the birds of prey. Most of the recoveries were within 25 miles of the banding sites, although a Sparrow Hawk and a Mockingbird were recovered in Texas; a Mourning Dove in New Mexico; a Golden Eagle near Kimball, Nebraska; a Ferruginous Hawk in Mexico; and a Swainson's Hawk in Argentina. Returns were more common than recoveries. Six of 15 adult Horned Larks color-marked in the intensive study pastures in 1969 were retrapped there in 1970. This is believed to represent territorial birds returning to the area of nesting. Although some Horned Larks have been recorded in the pastures in all months since July 1968, it is not clear whether those Horned Larks nesting at the Pawnee Site also winter there. A total of 261 Horned Lark specimens were submitted to the U.S. National Museum for subspecific determinations. As of November 4, 1971, all specimens so far examined (summer and winter) have been identified as *Eremophila alpestris enthyia* (Richard C. Banks, personal communication). A preponderance of males

Table 13. Birds banded at the Pawnee Site, 1961-1971^{a/}.

Species	1961-1967	1968	1969	1970	1971	Total
Swainson's Hawk	11	0	3	13	28	55
Ferruginous Hawk	2	0	3	7	24	36
Golden Eagle	28	0	0	15	14	57
Prairie Falcon	8	0	1	35	27	71
Sparrow Hawk	0	0	2	0	11	13
Killdeer	1	3	2	6	2	14
Mountain Plover	20	15	179	25	137	376
Mourning Dove	8	10	37	134	66	255
Great Horned Owl	9	11	20	8	17	65
Western Kingbird	2	0	13	9	9	33
Say's Phoebe	2	3	13	16	25	59
Horned Lark	53	11	72	91	131	358
Barn Swallow	2	1	5	6	9	23
Cliff Swallow	0	0	0	2	8	10
Sage Thrasher	1	2	2	0	0	15
Loggerhead Shrike	17	6	68	39	45	175
Western Meadowlark	20	8	15	54	27	124
Lark Bunting	143	60	155	216	269	843
Brewer's Sparrow	15	14	20	5	21	75

Table 13. Birds banded at the Pawnee Site, 1961-1971 (continued).

Species	1961-1967	1968	1969	1970	1971	Total
McCown's Longspur	45	8	43	34	92	222
Chestnut-collared Longspur	2	0	7	13	8	30
Others (39 species) ^{b/}	25	19	26	38	22	130
Totals	414	171	686	766	992	3,029

^{a/} Includes bandings of P. Baldwin, D. Cobb, A. Collister, G. Craig, P. Creighton, W. Gaul, C. Marti, R. Olendorff, T. Rutter, R. Ryder, M. Strong, and M. Williams.

^{b/} Includes Mallard, Red-tailed Hawk, Rough-legged Hawk, Long-billed Curlew, Barn Owl, Burrowing Owl, Common Nighthawk, Red-shafted Flicker, Eastern Kingbird, Traill's Flycatcher, Western Wood Pewee, Rough-winged Swallow, Black-billed Magpie, Mockingbird, Northern Shrike, Starling, Red-eyed Vireo, Yellow Warbler, Northern Water-thrush, MacGillivray's Warbler, Wilson's Warbler, House Sparrow, Red-winged Blackbird, Baltimore Oriole, Bullock's Oriole, Brewer's Blackbird, Brown-headed Cowbird, Black-headed Grosbeak, Blue Grosbeak, Pine Siskin, American Goldfinch, Red Crossbill, Savannah Sparrow, Grasshopper Sparrow, Vesper Sparrow, Lark Sparrow, Sage Sparrow, Chipping Sparrow, and Day-colored Sparrow.

is noted in the winter flocks which may indicate that the females migrate farther south.

Two Lark Bunting returns were taken in 1970 mist netting at a water hole. The birds had been banded the previous year at the same location. Creighton (personal communication) reports that a pair of Chestnut-collared Longspurs (male and female) banded in 1970 homed to their same territory in 1971, two male Horned Larks banded in 1970 homed to their same territories in 1971, and two male McCown's Longspurs banded in 1970 returned to the same pasture (although different territories) in 1971. A female Lark Bunting banded in 1969 was seen again in 1970 and 1971 within a $\frac{1}{2}$ mile of where she was initially banded.

Approximately 50 usable replies were received from questionnaires mailed to over 200 observers in the Great Plains requesting arrival and departure dates for certain key species of birds. Only the data for the 1971 spring migration have been analyzed and these for only part of the 16 species in question. An example of spring arrival dates at various locations are presented in Fig. 18.

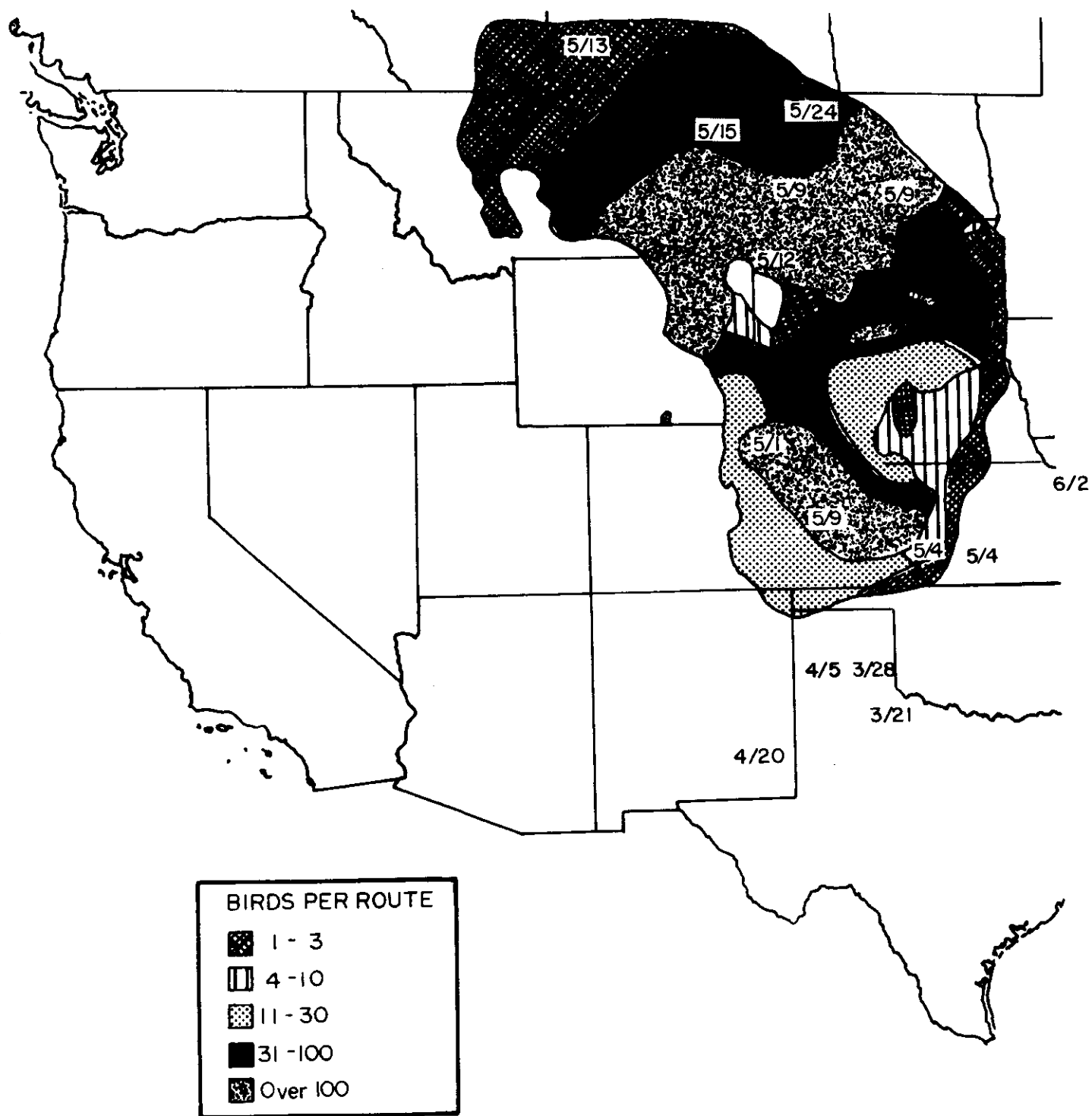


Fig. 18. Spring arrival dates (month and day) for 1971 based upon replies to a mail questionnaire. (Base map of breeding densities for 1969 provided by U.S. Fish and Wildlife Service).

ACKNOWLEDGMENT

The assistance of numerous students and cooperators listed under personnel is greatly appreciated. Portions of this report dealing with raptors were contributed by G. R. Craig and R. M. Olendorff.

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APPENDIX I

FIELD DATA

Avian Permanent Plot Data

The Pawnee Site avian permanent plot count data collected from 1968 through 1971 is Grassland Biome data set number A2U208B. A description of these data follow, along with a listing of the 1971 data from one permanent plot.

Data Description: There are four types of cards for each permanent plot on each date:

	<i>Columns</i>	<i>Information</i>
A. Header card (one)	3 - 5	Pasture number in which plot is located
	16 - 20	Grazing treatment on that pasture
	26 - 33	Date (mo-da-yr)
	35 - 38	Time count started (hours and minutes)
	40 - 43	Time count ended
	45 - 56	Name of observer
B. Commentary card (one)--gives method of taking transect, wind speed and direction, temperature, and cloudiness.		
C. Birds counted (one card for each species as needed).		

<i>Columns</i>	<i>Information</i>
1 - 5	AOU number of species--left justified
6 - 7	Number of birds counted
10	Used for AOU number 605 (Lark Bunting) only Sex--M or F

D. Trailer card indicating end of data for that date (one).

Columns

Information

1 - 5

\$\$\$\$\$

1	2	3	4	5	6	7	8
1234567890123456789012345678901234567890123456789012345678901234567890							
23EHEAVY SUMMER WALKED TRANSECT \$\$\$\$\$	01-21-71 0815 0830 STRONG WIND SSE 10-14 MPH TEMP. 32 SKY 0					NORTH TO LEFT	
23E WALKED TRANSECT 474 03 \$\$\$\$\$	02-02-71 1235 1250 STRONG WIND ESE 6-8 TEMP. 56 F9 SKY 1					NORTH TO LEFT	
23EHEAVY SUMMER WALKED TRANSECT 474 14 539 02 \$\$\$\$\$	03-29-71 1215 1235 STRONG WIND 8-10 MPH SW. TEMP. 66, /					NORTH TO LEFT	
23EHEAVY SUMMER WALKED TRANSECT 357 01 281 01 331 01 474 12 539 25 501.101 \$\$\$\$\$	04-13-71 0835 0855 STRONG WIND, SW 3-5 MPH TEMP. 46 SKY 1					NORTH TO LEFT	
23EHEAVY SUMMER WALKED TRANSECT 281 01 474 11 539 08 \$\$\$\$\$	04-21-71 1305 1325 STRONG WIND WSW 8-10 MPH, TEMP. 55, SKY 2, SPRINKLE					NORTH TO LEFT	
23EHEAVY SUMMER WALKED TRANSECT 281 03 474 12 539 15 \$\$\$\$\$	04-29-71 0840 0900 STRONG WIND, N. 4-6 TEMP. 48 SKY 2					NORTH TO LEFT	
23EHEAVY SUMMER WALKED TRANSECT 474 07 539 13 281 04 \$\$\$\$\$	05-06-71 1300 1325 STRONG WIND, NNE 3-4 MPH, TEMP 52 SKY 2 L.SPRINKLE					NORTH TO LEFT	
23EHEAVY SUMMER WALKED TRANSECT 474 19 539 15 605 39 281 02 \$\$\$\$\$	05-13-71 0830 0900 STRONG WIND, CALM TEMP. 61 SKY 0					NORTH TO LEFT	
23EHEAVY SUMMER WALKED TRANSECT 474 20 539 13 501.102 281 04 \$\$\$\$\$	05-25-71 0815 0845 STRONG WIND, SW 3-4 TEMP. 62 SKY 1					NORTH TO LEFT	

23EHEAVY SUMMER	06-05-71 0810 0835 STRONG	
WALKED TRANSECT	WIND WSW 6-7 MPH TEMP 64 SKY 0	NORTH TO LEFT
474 08		
539 13		
605 06 M		
281 01		
613 01		
SSSSS		
23EHEAVY SUMMER	06-11-71 0850 0905 STRONG	
WALKED TRANSECT	WIND SW 4-5 MPH TEMP. 69 SKY 0	NORTH TO LEFT
474 16		
539 10		
281 04		
605 02 M		
501.102		
SSSSS		
23EHEAVY SUMMER	06-17-71 0815 0830 STRONG	
WALKED TRANSECT	NNW 4-5 TEMP 74 SKY 0	NORTH TO LEFT
474 23		
539 13		
501.103		
281 02		
316 01		
SSSSS		
23EHEAVY SUMMER	06-24-71 0820 0840 STRONG	
WALKED TRANSECT	WIND NNE 6-8 TEMP. 80 SKY 1	NORTH TO LEFT
474 17		
539 14		
501.102		
281 02		
SSSSS		
23EHEAVY SUMMER	07-01-71 0820 0840 STRONG	
WALKED TRANSECT	WIND SE 8-10 TEMP 57 SKY 2	NORTH TO LEFT
474 18		
539 08		
281 04		
613 01		
501.101		
316 01		
SSSSS		
23EHEAVY SUMMER	07-08-71 0815 0835 STRONG	
WALKED TRANSECT	WIND CALM TEMP. 73 SKY 1	NORTH TO LEFT
474 08		
539 07		
281 04		
501.101		
605 01 M		
SSSSS		
23EHEAVY SUMMER	07-15-71 0830 0850 STRONG	
WALKED TRANSECT	WIND ESE 4-5 TEMP 74 SKY 0	NORTH TO LEFT
474 05		
539 08		
605 01 F		
281 05		
501.101		
SSSSS		
23EHEAVY SUMMER	07-28-71 0830 0845 STRONG	
WALKED TRANSECT	ESE 7-8. TEMP 61. SKY 0	NORTH TO LEFT
474 03		
539 02		
SSSSS		

23EHEAVY SUMMER	08-03-71 0950 1010 STRONG	
WALKED TRANSECT	SSE 4-5 69, SKY 0	NORTH TO LEFT
474 02		
539 05		
SSSSS		
23EHEAVY SUMMER	08-11-71 0830 0850 STRONG	
WALKED TRANSECT	WIND CALM TEMP. 69 SKY 0	NORTH TO LEFT
348 01		
331 01		
281 02		
474 03		
539 06		
SSSSS		
23WHEAVY SUMMER	08-24-71 0840 0855 STRONG	
WALKED TRANSECT	ESE 4-5, TEMP 64, SKY 0	NORTH TO LEFT
613 02		
331 01		
SSSSS		
23EHEAVY SUMMER	09-15-71 0825 0905 ZUMETA	
WALKED TRANSECT	10 MPH-S, TEMP 42-50 SKY P.C.	NORTH TO LEFT
613 09		
474 02		
539 23		
SSSSS		
23EHEAVY SUMMER	10-19-71 0850 0904 ZUMETA	
WALKED TRANSECT	WNW, 8-10, TEMP 45, SKY CLEAR, 0	NORTH TO LEFT
474 06		
536 01		
SSSSS		