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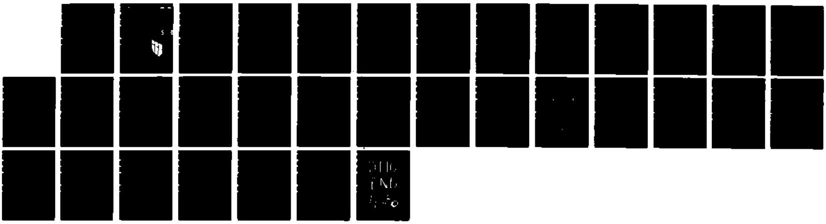

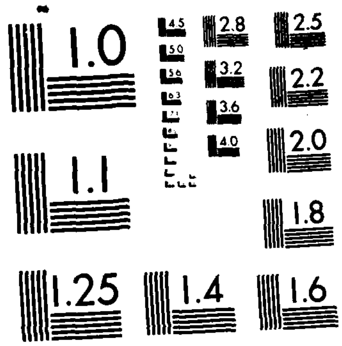

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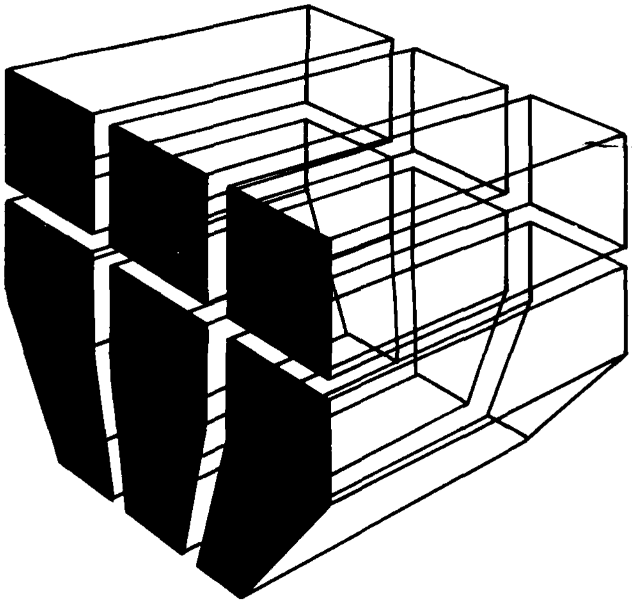
INTERIM REPORT N-86/02
December 1985

Annual Variation in Populations of Birds and Small Mammals on an Army Installation

by
David J. Tazik
William D. Severinghaus
Victor E. Diersing



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The prairie sites showed little change in bird populations or guilds between years. However, variation between years on the woodland site was significant for two bird species and one guild. The cause of this difference is not obvious, but is probably not related to habitat disturbance from training activities. There was no significant change between years in the numbers of most small nocturnal mammals collected on the prairie and pinyon-juniper sites. However, on both sites, there was a significant decrease in the number of harvest mice and a significant increase in the number of brush mice collected. There was also a significant increase in the number of pinyon mice in the pinyon-juniper woodland site. It appears that annual population fluctuations of mammal species generally occur across habitats, at least locally. The cause of these differences is unknown, but is probably not related to training activities.

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Field studies were conducted at Fort Carson, CO, and compared to results obtained from similar studies conducted during the previous year. The results were used to determine annual variation in bird and small mammal populations and to assess this data's usefulness in indicating habitat disturbance caused by Army training activities. Data were collected on shortgrass prairie and pinyon-juniper woodland study sites.

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The prairie site showed little change in bird populations or guilds between years. However, variation between years on the woodland site was significant for two bird species and one guild. The cause of this difference is not obvious, but is probably not related to habitat disturbance from training activities. There was no significant change between years in the numbers of most small nocturnal mammals collected on the prairie and pinyon-juniper sites. However, on both sites, there was a significant decrease in the number of harvest mice and a significant increase in the number of brush mice collected. There was also a significant increase in the number of pinyon mice in the pinyon-juniper woodland site. It appears that annual population fluctuations of mammal species generally occur across habitats, at least locally. The cause of these differences is unknown, but is probably not related to training activities.

FOREWORD

This investigation was performed for the Office of the Assistant Chief of Engineers (ACE) by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (USA-CERL). The work was performed under Project 4A162720A896, "Environmental Quality Technology"; Task A, "Installation Environmental Management Strategy"; Work Unit 030, "Guild Based Training Area Maintenance." The ACE Technical Monitor was Mr. Donald Bandel, DAEN-ZCF-B.

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Dr. R. K. Jain is Chief of USA-CERL-EN. COL Paul J. Theuer is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

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ANNUAL VARIATION IN POPULATIONS OF BIRDS AND SMALL MAMMALS ON AN ARMY INSTALLATION

1 INTRODUCTION

Background

A primary goal of military land area management is to maintain realistic training conditions on Army installations. The law also requires that "...consideration of environmental factors be integrated into existing Army procedures..."[1] Consequently, the response of the environment's biological and structural components to Army training exercises must be monitored. Several recent studies by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) have examined the impact of tactical vehicle activity on the land, fauna, and flora at various installations.[2] Another USA-CERL study provided a preimpact analysis of a maneuver site not yet subject to training exercises.[3] Each study took censuses of the test and control sites over 1 year to compare wildlife, vegetation, and other data. The data will be used to predict the effects of training on installation flora and fauna and to help planners generate ways to preserve the environment while maintaining a viable training program.

Objective

The objective of this report is to compare bird and mammal survey data obtained in 1983 and 1984 for prairie and pinyon-juniper control sites on the Fort Carson military reservation to help determine their utility in finely assessing habitat quality.

Approach

The field surveys conducted in 1983[4] at Fort Carson were repeated in 1984. The extent and direction of changes in birds and mammals were then quantified.

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[1] R. K. Jain, L. V. Urban, and G. S. Stacey, *Handbook for Environmental Impact Analysis*, Technical Report E-59/ADA006241 (U.S. Army Construction Engineering Research Laboratory [USA-CERL], 1974, p 13).

[2] W. D. Severinghaus, R. E. Riggins, and W. D. Goran, *Effects of Tracked Vehicle Activity on Terrestrial Mammals, Birds, and Vegetation at Fort Knox, KY*, Special Report N-77/ADA073782 (USA-CERL, 1979), pp 1-64; W. D. Severinghaus and W. D. Goran, *Effects of Tactical Vehicle Activity on the Mammals, Birds, and Vegetation at Fort Hood, TX*, Technical Report N-113/ADA109646 (USA-CERL, 1981), pp 1-22; W. D. Severinghaus and W. D. Goran, *Effects of Tactical Vehicle Activity on the Mammals, Birds, and Vegetation at Fort Lewis, Washington*, Technical Report N-116/ADA111201 (USA-CERL, 1981), pp 1-45; V. E. Diersing and W. D. Severinghaus, *The Effects of Tactical Vehicle Training on the Lands of Fort Carson, Colorado: An Ecological Assessment*, Technical Report N-85/03/ADA152142 (USA-CERL, 1984).

[3] V. E. Diersing and W. D. Severinghaus, *Ecological Baseline—Pinon Canyon Maneuver Site, Colorado*, Technical Report N-85/02/ADA152811 (USA-CERL, 1984).

[4] USA-CERL Technical Report N-85/03.

Mode of Technology Transfer

It is recommended that the results of this study be used as part of a long-term monitoring program of Fort Carson's training areas to contribute to further refinement of an environmental monitoring program for this installation and others and that subsequent surveys be used to fine-tune training area maintenance databases. It is also recommended that this data eventually be used to develop predictive algorithms and to determine confidence limits.

2 SITE DESCRIPTION

Fort Carson encompasses 55,785 ha along the eastern front of the Rocky Mountains. Most of the installation is located in El Paso County, with parts in Pueblo and Fremont Counties. Elevation ranges from 1560 to 2121 m. Average annual temperature is 9°C, average annual humidity 54 percent, and mean annual precipitation is 380 mm. Most precipitation occurs between April and September.

The pinyon-juniper (PJ) woodland and shortgrass prairie sites had been set up as control sites in the 1983 study. The PJ site is located just west of Road 11, 4 km north of Camp Red Devil. Pinyon pine (Pinus edulis) is the dominant woody vegetation, accompanied by mountain-mahogany (Cercocarpus montanus), one-seed juniper (Juniperus monosperma), rocky mountain juniper (J. scopolarum), gambel oak (Quercus gambelii), and skunk bush sumac (Rhus trilobata). Tactical vehicle activity had been evident on 19 percent of the area in 1983.

The shortgrass prairie site was located in Sullivan Park 1 km east of Camp Red Devil. Blue grama grass (Bouteloua gracilis) is the predominant ground cover. Disturbance resulting from tactical vehicle activity had been recorded on only 8 percent of the area in 1983.

USA-CERL Technical Report N-85/03 provides more detailed information about the study site.

3 METHODS

Birds

Birds were censused between 23 May and 1 June in 1983 and 1984, using a hybrid transect method.[5] Two parallel transects were established at each site. The transects were 250 m apart and 1000 m long on the prairie site and 150 m apart and 400 m long on the PJ site. Transects were walked on each of 10 mornings beginning at sunrise, and the location of all birds seen or heard on either side of each transect was recorded. Absolute densities were estimated by averaging the daily number of individuals of each species observed by each researcher. Only birds falling within the researcher's effective observation range were counted. This range was determined based on the distribution of observations in 5-m intervals to each side of the transects. For each day, the count used was the highest number of observations in one of the following categories: singing male observations x 2, all other observations, or total observations.[6]

To remove the variability resulting from different researchers, data for both sites were classified by both researcher and year. Prairie data for horned larks and meadowlarks were also subdivided by transect. This method could also detect any effect that a burn which had occurred during the spring of 1984 and covered 50 to 60 percent of the west transect would have had on the bird population. Individual species data were analyzed using a three-way analysis of variance (ANOVA) for prairie data, and a two-way ANOVA for PJ data. Fixed classifications for prairies were year ($n = 2$), researcher ($n = 2$), and transect ($n = 2$), and for PJ, year and researcher. The variates used were square root transformations of the daily observations for each species corrected for differences in area covered by different observers.

A guild classification system developed by USA-CERL[7] was used to analyze these data. This classification places within the same guild species using similar resources in a like manner. Biomass values were based on bird weights compiled by J. B. Dunning.[8]

Mammals

Small mammals were censused over the same 10-day period as birds. One trapline was set out at each site over the length of and parallel to the bird transects; each one consisted of 100 evenly spaced traps (eight rat traps interspersed with 92 museum special (ms) snap traps). The trapline at each site was set for two consecutive nights at five

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[5] J. T. Emlen, "Population Densities of Birds Derived from Transect Counts," *Auk*, Vol. 8 (1971), pp 323-342; J. T. Emlen, "Estimating Breeding Bird Densities from Transect Counts," *Auk*, Vol. 94 (1977), pp 455-468; W. D. Severinghaus, *Guidelines for Terrestrial Ecosystem Survey*, Technical Report N-89/ADA086526 (USA-CERL, 1980); M. H. Balph, L. C. Stoddart, and D. F. Balph, "A Simple Technique for Analyzing Bird Transect Counts," *Auk*, Vol. 94 (1977), pp 606-607.

[6] K. E. Franzreb, "Comparison of Variable Strip Transect and Spot-map Methods for Censusing Avian Populations in a Mixed-Coniferous Forest," *Condor*, Vol. 78 (1976), pp 260-262.

[7] W. D. Severinghaus, "Guild Theory Development as a Mechanism for Assessing Environmental Impact," *Journal of Environmental Management*, Vol. 5, (1981), pp 187-190.

[8] J. B. Dunning, Jr., *Body Weights of 686 Species of North American Birds* (1984 Western Bird Banding Association, Monograph No. 1, 1984).

locations. Two locations were 50 m to the outside of the bird transects, two coincided with the transects, and one was positioned between them. Trapnights per site totaled 1000.

Traps were baited with a mixture of rolled oats and peanut butter, set early in the evening, and checked each morning immediately after the bird counts. All captures were placed in plastic bags and labeled by date and capture site. In 1983, these specimens were frozen and subsequently prepared for scientific study. In 1984, only selected individuals were saved for later preparation. The rest were refrigerated until information on species identification, sex, weight, and reproductive condition (see Appendix A) could be recorded, usually within 48 hours.

4 RESULTS

Birds

Prairie

Total avian density and biomass were virtually the same for both years at Sullivan Park (Table 1). Western meadowlarks and horned larks accounted for about 95 percent of the numbers and biomass in both years, although horned larks were 1.6 times more numerous than meadowlarks. Lark sparrows and mourning doves were also observed. Individual species showed no significant differences between years.

Four guilds occupied the prairie site, each corresponding to one of the four species observed (Table 2). There was little change in the distribution of biomass among guilds.

ANOVA revealed a significant difference in the density of both horned larks and meadowlarks among researchers and between transects (Appendix B). In both 1983 and 1984, researcher A, who participated in both surveys, obtained a lower density for each species than researcher B (different persons in each year). Densities of both species

Table 1

Avian Species — Densities and Biomass on Sullivan Park Prairie Control Site

Species	1983		1984		Guild*
	No./100 ha	g/100 ha	No./100 ha	g/100 ha	
Western meadowlark	29.3	2863	29.0	2833	28
Horned lark	47.5	1489	46.9	1470	la
Lark sparrow	5.0	145	1.5	44	1b
Mourning dove	0.5	60	1.0	19	8
Total	82.3	4557	78.4	4466	

*See Table 2.

Table 2

Bird Guilds on Sullivan Park Prairie Control Site

Guild No.	Primary Guild Characteristics	Biomass (g/100 ha) 1983	Biomass (g/100 ha) 1984	Percent 1983	Percent 1984	Percent* Change
la	Seedeating, bare ground	1489	1470	32.7	32.9	-1.2
1b	Seedeating, open field	145	44	3.2	1.0	-69.7
8	Mast/grain, brush/field	60	119	1.3	2.7	98.3
28	Omnivorous, open field	2863	2833	62.8	63.4	-1.0
Total		4557	4466			-2.0

* $\frac{(1984\ \text{biomass} - 1983\ \text{biomass})}{1983\ \text{biomass}}$

were consistently higher on the east transect, except for the meadowlark densities obtained by researcher B in 1983. Also, for meadowlarks, the year x researcher x transect interaction was significant ($p = 0.035$). This resulted from the difference in direction of change for each transect between years recorded by the different researchers.

The analyses did not clearly detect whether the burn on the west transect had any impact on the prairie bird community.

Pinyon-Juniper Woodland

There was a 60 percent increase in total avian biomass and a 44 percent increase in total numbers between years on the PJ site (116 percent and 46 percent, respectively, if crows and magpies are excluded, as discussed below).

Twenty-two species were observed on this site during the 2 years of the study (Table 3). Of the 16 recorded in 1983, 15 were observed again the following year. Seven additional species were observed in 1984, each in relatively low numbers. Six species

Table 3

Avian Species—Densities and Biomass on Pinyon-Juniper Control Site

Species List	1983		1984		Guild*
	No./100 ha	g/100 ha	No./100 ha	g/100 ha	
Rufous-sided towhee**	30.0	1215	37.5	1518	3
Black-headed grosbeak	10.0	445	8.8	389	2
Scrub jay	2.5	440	22.5	3960	30
Chipping sparrow	28.8	374	25.0	325	1b
Mountain bluebird**	10.0	284	18.8	533	12
Ash-throated flycatcher**	10.0	272	2.5	68	13
Plain titmouse***	15.0	255	28.8	488	5
Brown-headed cowbird	5.0	220	1.3	55	30
Gray flycatcher	13.8	179	20.0	260	13
Common flicker	1.3	156	1.3	156	29
Lark sparrow	2.5	73	10.0	290	1b
Solitary vireo	2.5	42	5.0	83	14
Western tanager	1.3	35	1.3	35	2
Red-breasted nuthatch	2.5	25	3.8	37	15
Warbling vireo	1.3	15	--	--	14
American crow	5.0	2240	2.5	1120	30
Blue-gray gnatcatcher	--	--	1.3	8	15
Broad-tailed hummingbird	--	--	3.8	13	6
Lazuli bunting	--	--	1.3	19	3
Lesser goldfinch	--	--	2.5	24	3
Black-billed magpie	--	--	1.3	222	14
Mourning dove	--	--	3.8	446	8
Total	141.5	6270	203.1	10049	
(exluding American crow and Black-billed magpie)	136.5	4030	199.3	8707	

* See Table 4.

** Difference in density between years nearly significant at $0.05 < p \leq 0.10$.

*** Difference in density between years significant at $p \leq 0.05$.

with densities greater than 5.0 per 100 ha accounted for 83 percent of total numbers and 75 percent of total biomass in 1983: rufous-sided towhee, chipping sparrow, plain titmouse, gray flycatcher, black-headed grosbeak, mountain bluebird, and ash-throated flycatcher. In 1984, eight species made up 84 percent of avian numbers and 89 percent of the biomass, with the scrub jay and lark sparrow replacing the ash-throated flycatcher.

Only two species showed a statistically significant change in numbers between years. In 1984, scrub jays increased nine-fold, while plain titmice were nearly twice as abundant. Apparent increases in numbers of bluebirds and towhees and a decline in ash-throated flycatchers in 1984 were nearly statistically significant.

The American crow and black-billed magpie were excluded from the guild analysis used in this study. Since this technique combines species that use similar resources into one group, changes which occur are assumed to reflect alteration in the species' common resource base. The utility of this approach depends on monitoring species that use habitats relative to the scale of the survey being conducted. The American crow is a large, conspicuous species that uses an area much larger than the area censused here. It was obvious that the only magpie observed was not residing on or in the immediate vicinity of the study area. The extreme edge effect of a narrow census tract tends to assign undue importance to large-bodied, wide-ranging individuals that contact it.

The most notable change in guilds between years was in the omnivorous, mixed, nonground guild 30 (Table 4). This guild accounted for nearly half the total avian biomass in 1984, due mainly to an increase in scrub jays (Table 3). Large changes in absolute

Table 4

Bird Guilds on Pinyon-Juniper Control Site

Guild No.	Primary Characteristics	Biomass (g/100 ha) 1983	Biomass (g/100 ha) 1984	Percent 1983	Percent 1984	Percent*** Change
1b	Seedeating, open field	447	615	11.1	7.1	37.6
2	Seedeating, woodland	480	424	11.9	4.9	-11.7
3	Seedeating, edge	1215	1561	30.2	17.9	28.5
5	Fruit/seed, woods edge	255	489	6.3	5.6	91.8
6	Nectar	--	13	--	0.1	∞
8	Mast/grain, brush/field	--	446	--	5.1	∞
12	Insectivorous, sallying, open	284	533	7.0	6.1	87.7
13	Insectivorous, sallying, woodland	451	328	11.2	3.8	-27.3
14*	Insectivorous, gleaner, large	57	83	1.4	1.0	45.6
15	Insectivorous, gleaner, small	25	44	0.6	0.5	76.0
29	Omnivorous, ground	156	156	3.9	1.8	0.0
30**	Omnivorous, mixed nonground	660	4015	16.4	46.1	508.3
	Total	4030	8707			116.1

* Excluding black-billed magpie.

** Excluding American crow.

*** $\frac{\text{(1984 biomass - 1983 biomass)}}{\text{1983 biomass}}$

∞ undefined.

biomass in several other guilds can also be tied to single species (guild 5--plain titmouse; guild 6--broad-tailed hummingbird; guild 8--mourning dove; guild 12--mountain bluebird; guild 14--solitary vireo; and guild 15--red-breasted nuthatch).

The change in biomass of guild 30 obviously has a dramatic effect on the percent distribution of biomass among guilds. To examine such a relationship among these other guilds, percentages were calculated based on total biomass of just these guilds; i.e., excluding guild 30. Figure 1 shows the results. Variation between years is not particularly dramatic, although there is a slight decline among woodland guilds (2 and 13), accompanied by increases in several edge and open area guilds (5, 8, and 12). However, the two guilds that are most representative of edge species (1b and 3) together show little change between years. Figure 2 compares this edge group (guilds 1b and 3) and the woodland guild set.

Differences in density estimates among researchers were significant for the chipping sparrow, gray flycatcher, plain titmouse, rufous-sided towhee, scrub jay, and solitary vireo (Appendix B). In each case, the density estimates of researcher A were lower. A significant year-by-researcher interaction was detected for the american crow and solitary vireo, which resulted from differences in observed direction of change in densities between years among researchers (Appendix B).

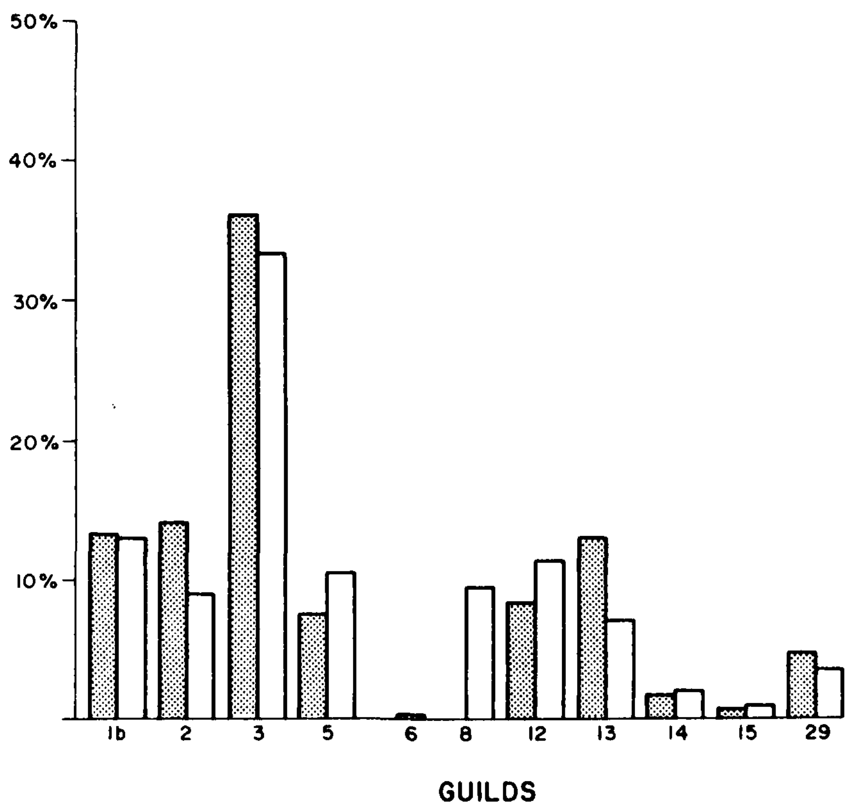

Figure 1. Percent distribution of avian biomass among guilds, excluding guild 30, in pinyon-juniper woodland in 1983 (shaded) and 1984 (open).

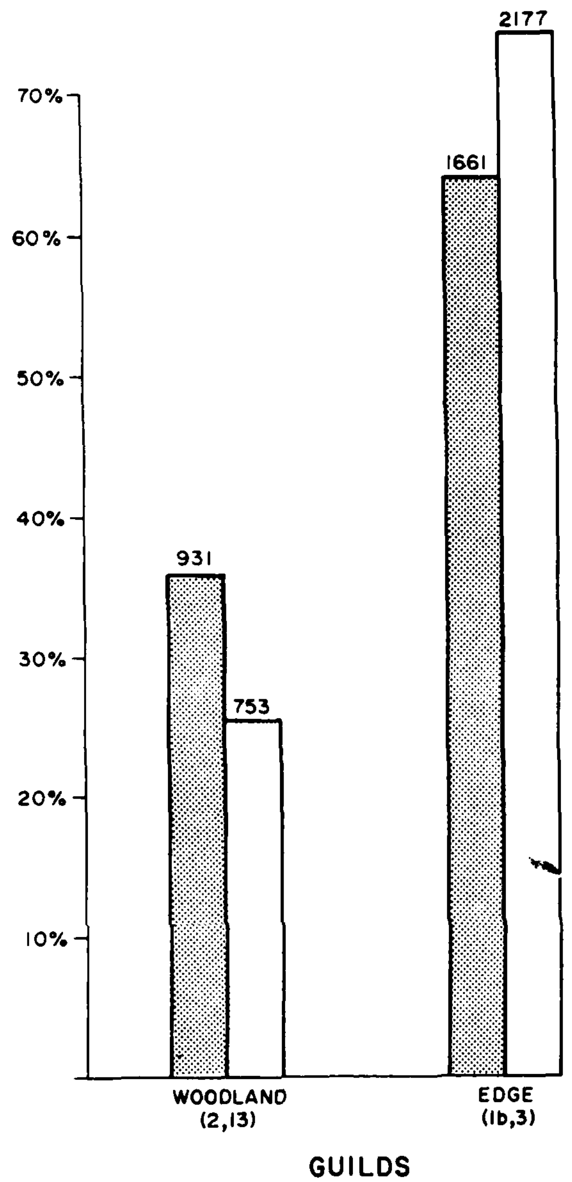

Figure 2. **Percent distribution of biomass among woodland and edge guilds in pinyon-juniper woodland in 1983 (shaded) and 1984 (open). Absolute biomass at top of bars. (See Table 4 for guild numbers.)**

Mammals

Prairie

Eight species were collected in each year, with seven common to both years. A total of nine species were collected over both years. The plains harvest mouse (Reithrodontomys montanus) was collected only in 1983 (one individual), and the brush mouse (Peromyscus boylii) was collected only in 1984 (six individuals). The total individuals for all species collected was 102 in 1983 and 108 in 1984 (no significant difference [Table 5]). Ord's kangaroo rat (Dipodomys ordii) and the deer mouse (Peromyscus maniculatus) accounted for 51 percent of all individuals collected in 1983, and 53 percent of those obtained in 1984.

Table 5

Mammal Capture Data—Shortgrass Prairie

Species (Scientific Name)	1983	1984	Significance Between Years
Dipodomys ordii	27	29	None
Perognathus flavus	10	5	None
Reithrodontomys megalotis	18	7	<0.05*
Reithrodontomys montanus	1	0	None
Onychomys leucogaster	9	10	None
Peromyscus leucopus	9	7	None
Peromyscus maniculatus	25	28	None
Peromyscus boylii	-	6	<0.025*
Peromyscus truei	1	1	None
Total individuals/year	102	108	None

*Statistically significant difference between years (0.05 level and above).

Of the nine species collected, two significantly increased or decreased from 1983 to 1984. Eighteen western harvest mice (Reithrodontomys megalotis) were collected in 1983, but only seven in 1984 ($p < 0.05$, significant decrease). No brush mice were collected in 1983, but six were captured in 1984 ($p < 0.025$, significant increase). Numbers of the other seven species did not change significantly from 1983 to 1984 (Ord's kangaroo rat, pocket mouse (Perognathus flavus), plains harvest mouse, grasshopper mouse (Onychomys leucogaster), white-footed mouse (Peromyscus leucopus), deer mouse, and pinyon mouse (Peromyscus truei).

Pinyon-Juniper Woodland

Ten species of small nocturnal mammals were collected over 1983 and 1984 combined, but only seven species were common to both years. The pocket mouse and white-throated woodrat (Neotoma albigula) were collected only in 1983, and the bush mouse only in 1984. The total number of individuals of all species collected was 87 in 1983 and 84 in 1984 (no significant difference [Table 6]). The western harvest mouse, deermouse, and pinyon mouse accounted for 72 percent of all individuals collected in 1983 and 73 percent in 1984.

Of the 10 species collected, three showed a significant increase or decrease in numbers collected from 1983 to 1984. The western harvest mouse was represented by 19 individuals in 1983 and seven individuals in 1984 ($p < 0.025$, significant decrease). The brush mouse increased from zero individuals in 1983 to four individuals in 1984 ($p < 0.05$). The pinyon mouse increased from 14 individuals collected in 1983 to 29 specimens in 1984 ($p < 0.025$). The other seven species did not show a significant change in numbers collected from 1983 to 1984 (Ord's kangaroo rat, pocket mouse, grasshopper mouse, white-footed mouse, deer mouse, white-throated woodrat, and mexican woodrat, [Neotoma mexicana]).

Table 6

Mammal Capture Data—Pinyon-Juniper Woodland

Species (Scientific Name)	1983	1984	Significance Between Years
Dipodomys ordii	3	3	None
Perognathus flavus	2	-	None
Reithrodontomys megalotis	19	7	<0.025*
Onychomys leucogaster	4	1	None
Peromyscus leucopus	7	5	None
Peromyscus maniculatus	30	25	None
Peromycus boylii	-	4	<0.05*
Peromyscus truei	14	29	<0.025*
Neotoma albigula	3	-	None
Neotoma mexicana	1	1	None
Total individuals/year	87	84	None

*Statistically significant differences between years (0.05 level and above).

5 DISCUSSION

Birds

Researcher Variability

Bird density estimates differed greatly among researchers for two of four species on the prairie site and six of 22 species on the PJ site. Differences in density estimates among researchers are not unexpected given the potential individual variation in accuracy of distance estimation, visual and aural acuity, and walking speed. However, the magnitude of differences is often substantial (Appendix B). Estimates of total avian density differed among researchers by 87 percent in 1983 and by 106 percent in 1984 on the PJ site and by 34 percent and 73 percent on the prairie site. No matter what the reasons for these differences are, it is certain that more attention must be paid to standardizing census procedures to diminish the effect of individual variability. Thus, the start of censusing should be alternated between transects to overcome potential bias due to temporal variation in avian activity levels. In so doing, variation among transects can be measured more accurately.

Prairie

The presence of few species and the dominance of only two in structurally homogeneous shortgrass prairie is common.[9] Horned larks and western meadowlarks made up more than 90 percent of the numbers and biomass of birds at Sullivan Park in each year. The remarkably similar patterns of species density and guild structure between years suggest there has been little change in relative proportions of grass cover and bare ground at this site.

The difference between transects in the densities of both horned larks and meadowlarks may be explained partly by the fact that the east transect, on which densities were usually higher, was censused first 14 out of 20 times. If more birds were active earlier, then a difference between transects would be expected. It is not clear how important this fact is; however, it is interesting to note that four of the six times the west transect was sampled first were in 1983 by researcher B. This is the only case in which meadowlark density appears higher on the east transect (Appendix B). However, researcher A obtained similar density estimates for meadowlarks for both transects in 1984, despite having sampled the west transect first on four of five occasions.

Pinyon-Juniper Woodland

Total density ranged from 142 to 203 birds per 100 ha over the 2 years. These are well below the 95 pairs per 40 ha (475 birds/100 ha) considered average by Balda and

[9] J. A. Wiens and M. I. Dyer, "Rangeland Avifaunas: Their Composition, Energetics, and Role in the Ecosystem," *Proceedings of the Symposium on Management of Forest of Range Habitats for Nongame Birds* (U.S. Department of Agriculture [USDA], Forest Service, 1975), pp 146-182.

Masters, but within the range of densities reported by several authors.[10] The number of species encountered in each year (16 to 21) also agrees with these studies.

Annual fluctuations in bird density (44 percent) and species richness (27 percent) of the magnitude encountered at Fort Carson in PJ woodland are not uncommon. Balda and Masters cited annual density changes of 28 to 70 percent and fluctuations in species numbers ranging from 8 to 26 percent.[11] McCollum, et al., found a 56 percent density increase in 1 year (352 to 550 birds per 100 ha) followed by an 87 percent decline the next year (to 294 birds per 100 ha) in a PJ-ponderosa pine ecotone.[12] The latter decline was accompanied by a decrease in number of species from 19 to 15. Blake reported a 44 percent increase in density (about 250 to 360 birds per 100 ha) and no change in the number of breeding species (16) between years in a southern Nevada PJ woodland.[13]

Such variation may be attributed to a number of factors, including annual fluctuations in precipitation and pinyon pine cone production,[14] winter weather,[15] and habitat disturbance. Figures 3 through 6 present climatic data averaged for Colorado Springs and Pueblo, CO. Precipitation was above normal during several months prior to and during the months in which censuses were conducted in 1983, but far below normal in May and June of 1984. However, snowfall was higher than normal in 1983-84 during November through January and in March and April and also higher than in 1982-83 for those months. Total precipitation from January to June 1984 was lower than precipitation in 1982 (8.3 in.), which was above normal, and also lower than normal (5.2 in. vs. 6.3 in.). Based on these figures, avian density and species richness might have been expected to decline in 1984.

Winter weather in 1983-84 was somewhat more severe compared to both the previous year and average conditions. Snowfall was higher, average temperature was lower in December and January, and heating degree days were higher from January through March. Again, an increase in avian density in 1984 is contrary to expectations under these conditions.

No data on changes in food resource availability were collected for this study.

The census site was used for tactical vehicle training between 1983 and 1984. However, vegetation data were not collected in 1984 to determine the extent of habitat damage that may have occurred. Consequently, there is no direct evidence to suggest that changes in the PJ bird community are related to habitat disturbance. However, an increase in scrub jays and in the omnivorous, mixed nonground guild would not have been

[10] R. P. Balda and N. Masters, "Avian Communities in the Pinyon-Juniper Woodland: A Descriptive Analysis, *Management of Western Forests and Grasslands for Nongame Birds*, General Technical Report INT-86 (USDA, Forest Service, 1980), pp 146-167; USA-CERL Technical Report N-85/02.
[11] R. P. Balda and N. Masters, pp 146-167.
[12] D. A. McCollum, S. R. Buchsbaum, and J. J. Price, "Breeding Bird Census No. 104--Pinyon-Juniper-Ponderosa Pine Ecotone," *Amer. Birds*, Vol. 32 (1978), p 39; D. A. McCollum, "Breeding Bird Census No. 112--Pinyon-Juniper- Ponderosa Pine Ecotone," *Amer. Birds*, Vol. 33 (1979), p 85; D. A. McCollum, "Breeding Bird Census No. 128--Pinyon-Juniper-Ponderosa Pine Ecotone," *Amer. Birds*, Vol. 34 (1980), pp 75-76.
[13] J. G. Blake, "A Seasonal Analysis of Bird Communities in Southern Nevada," *Southwest Nat.*, Vol. 29 (1984), pp 463-474.
[14] R. P. Balda and N. Masters, pp 146-167.
[15] D. A. McCollum (1980), pp 75-76.

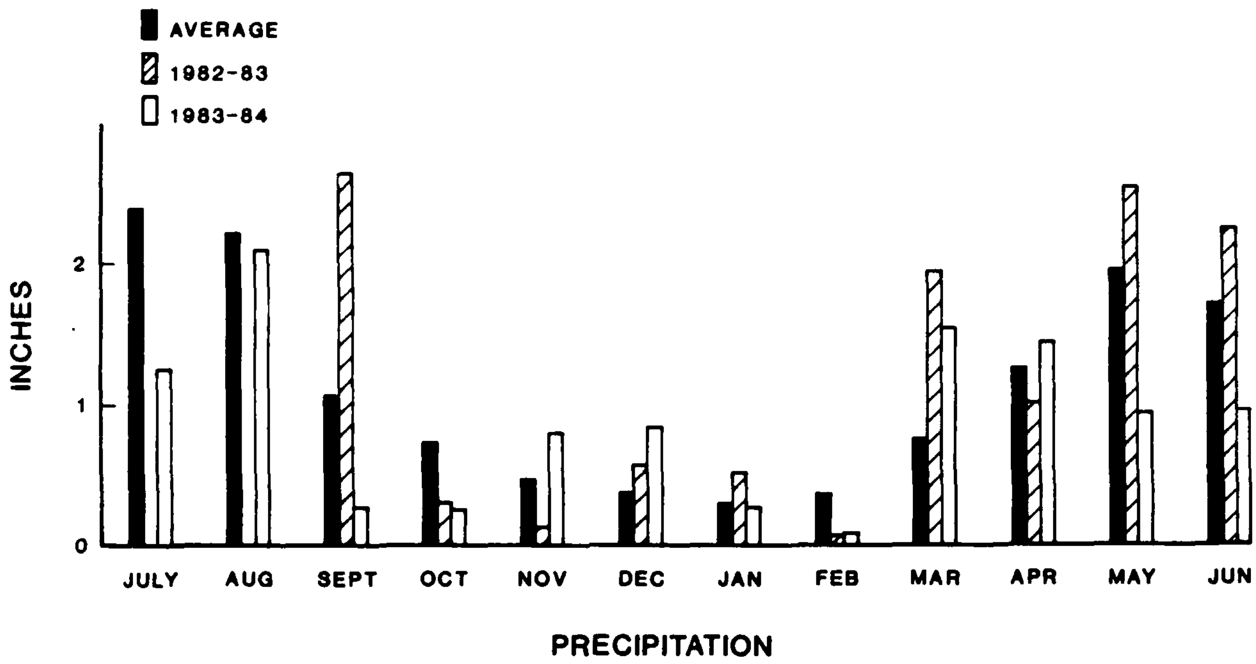

Figure 3. Monthly precipitation averaged for Pueblo and Colorado Springs, CO.

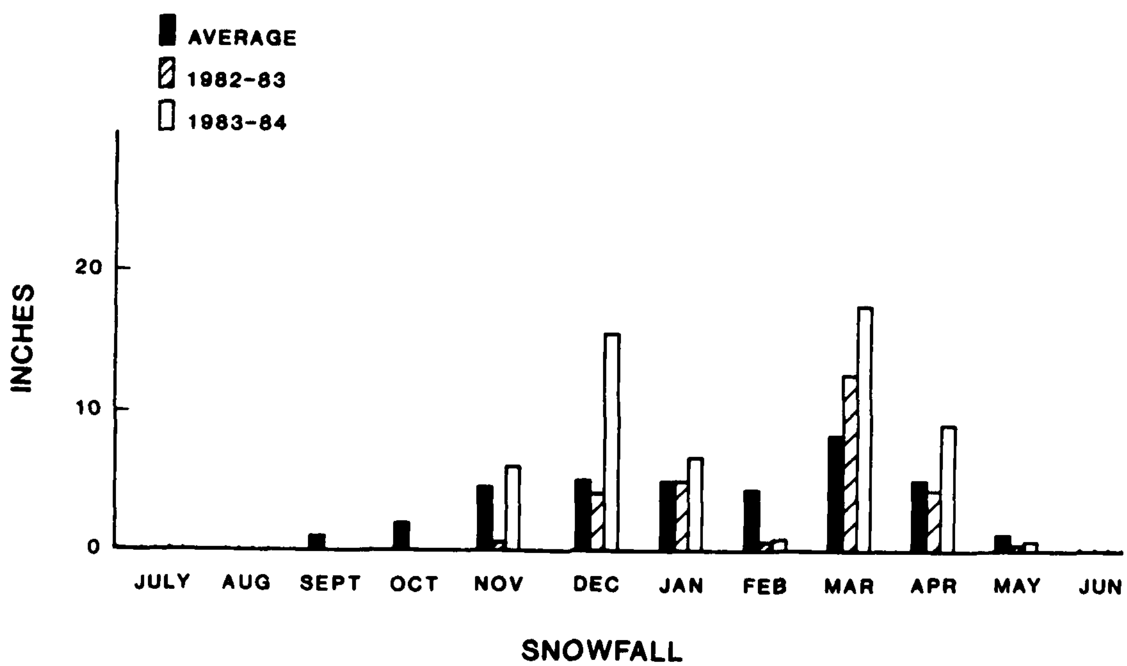

Figure 4. Monthly snowfall averaged for Pueblo and Colorado Springs, CO.

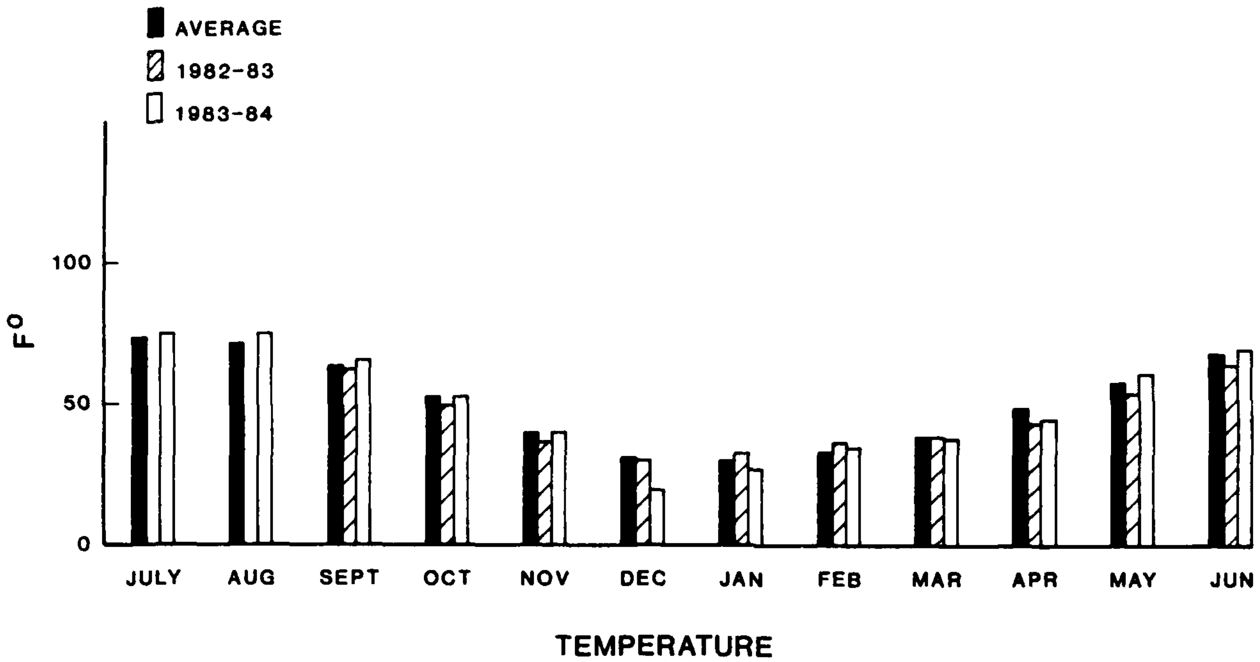

Figure 5. Mean monthly temperature averaged for Pueblo and Colorado Springs, CO.

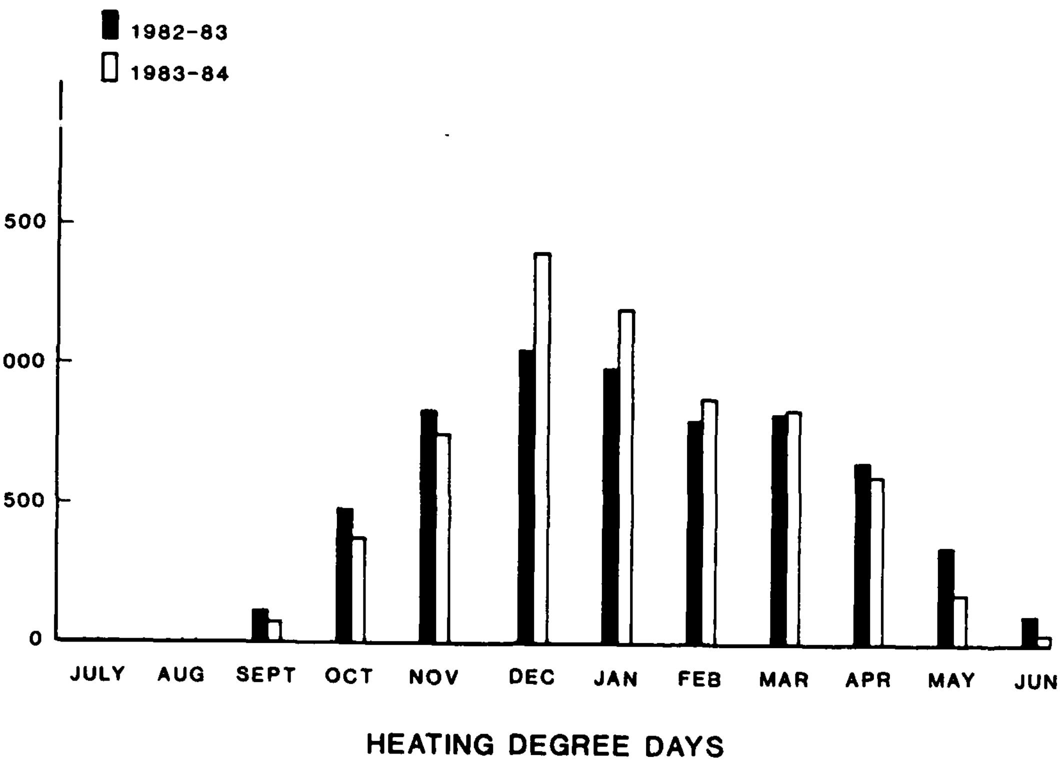

Figure 6. Heating degree days averaged for Pueblo and Colorado Springs, CO.

expected to result from habitat disturbance. Scrub jays prefer brush-covered terrain in the breeding season,[16] and this brush cover declines in response to training activity.[17]

Mammals

Mammal density and species composition differed little between sites and between years. Over 1983 and 1984, nine species of small nocturnal mammals were collected from the shortgrass prairie, and 10 species were taken from the pinyon-juniper woodland. Eight species were common to both sites, with the plains harvest mouse recorded only from the shortgrass prairie (one individual in 1983) and the white-throated and mexican woodrats collected only from the pinyon-juniper woodland site (total of five percent individuals).

It is interesting to note that the brush mouse was not collected at either site in 1983, but was collected on both sites in 1984 (six in the prairie and four in the pinyon-juniper woodland). Also, the western harvest mouse was abundant on both sites in 1983 (18 in the prairie and 19 in the pinyon-juniper woodland), but uncommon on both sites in 1984 (seven collected on each site). It appears, at least in a local region, that species population changes typically occur across habitats. It is not known what factors influence these population changes. Predation, lack of food, disease, social pressure, and interspecific competition could all be responsible, but these changes are obviously not in response to training effects. However, not all population changes within a species are synchronous across habitats. The pinyon mouse, a species characteristic of the pinyon-juniper woodland and rare on the prairie, was more than twice as abundant on the pinyon-juniper site in 1984 than in 1983; however, only one was collected on the prairie in 1983 and one in 1984.

The high between-years variation in numbers shown by mammals and the low between-years variation exhibited by birds suggest that bird data may be more useful for assessing habitat quality and evaluating changes caused by training.

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[16] A. M. Bailey and C. J. Nedrach, *Birds of Colorado*, 2 Vols. (Denver Museum of Natural History, 1965).

[17] USA-CERL Technical Reports N-85/02 and N-85/03.

6 CONCLUSIONS

This report has examined annual variation in bird and small mammal populations in pinyon-juniper woodland and shortgrass prairie sites on the lands of Fort Carson. Little change was noted in the density and biomass of avian species and guilds on the prairie site, suggesting that little habitat disturbance from training activity has occurred there between the springs of 1983 and 1984. Statistically significant differences between years were observed for two species and for one avian guild on the pinyon-juniper site. The causes of these differences were not certain, but probably do not relate to training activities. Variability in density estimates obtained by different researchers indicated that more effort should be made to standardize individual census techniques.

There were significant changes in three of the 10 species of mammals collected on the pinyon-juniper site from 1983 to 1984 (compared to two of 24 species for birds). Two of these species exhibited concurrent changes in density in both habitats between years (brush mice increased in numbers and western harvest mice decreased). The pinyon mouse demonstrated a significant increase in numbers on the pinyon-juniper site. It is unlikely that these population fluctuations are attributable to training. Results of this study suggest that bird data may be better suited than small mammal data for assessing habitat quality and changes due to maneuver training. However, several years of data are required to obtain a satisfactory measure of annual variation in bird and small mammal populations before a conclusive statement can be made.

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APPENDIX A:

STATISTICAL ANALYSIS OF MAMMAL DATA

Body Weights of Small Mammals Captured on Fort Carson, Colorado—1984

Species	Sex	N	Mean (g)	Std. Error
Dipodomys ordii	M	11	56.1	4.913
	F	21	54.1	2.669
Perognathus flavus	M&F	5	7.2	0.313
Spermophilus spilosoma	M	6	127.0	5.44
	F	9	114.4	6.49
Eutamias quadrivittatus	M	4	42.3	5.573
	F	4	34.0	0.816
Onychomys leucogaster	M	4	27.0	3.320
	F	7	26.3	4.628
Riethrodontomys megalotis	M	8	10.9	0.515
	F	6	10.5	0.885
Peromyscus boylii	M&F	4	20.3	0.250
Peromyscus leucopus	M	3	21.0	3.606
	F	7	23.7	2.598
Peromyscus maniculatus	M	33	18.8	0.755
	F	18	17.8	1.382
Peromyscus truei	M	19	20.8	1.015
	F	10	22.5	0.885
Neotoma mexicana	M	1	96.0	

APPENDIX B:

STATISTICAL ANALYSIS OF BIRD DATA

Table B1

Prairie Bird Densities (per 100 ha) by Year, Researcher, and Transect

		1983			1984		
Species	Researcher	Transect East	Transect West	Comb.	Transect East	Transect West	Comb.
Western*	A	15.7	30.0	22.9	20.0	22.9	21.5
Meadowlark	B	36.7	34.5	35.6	25 7	47.1	36.4
	Comb.	26.2	32.3	29.3	22.9	35.0	29.0
Horned**	A	27.5	57.5	42.5	27.5	40.0	33.8
Lark	B	45.0	60.0	52.5	50.0	70.0	60.0
	Comb.	36.3	58.8	47.5	38.8	55.0	46.9
Lark	A			5.0			1.0
Sparrow	B			5.0			2.0
	Comb.			5.0			1.5
Mourning	A			0.0			1.0
Dove	B			1.0			1.0
	Comb.			0.5			1.0

* Significant difference among researchers ($p = 0.008$) and among transects ($p = 0.022$); year x researcher x transect interaction significant at $p = 0.035$.

** Significant difference among researchers ($p = 0.002$) and among transects ($p = 0.003$).

Table B2

Pinyon-Juniper Bird Densities (per 100 ha) by Year, Researcher, and Transect

Species	Researchers	1983	1984	Species	Researchers	1983	1984
Rufous-sided*	A	15.0	32.5	Black-headed	A	10.0	7.5
Towhee	B	45.0	42.5	Grosbeak	B	10.0	10.0
	Comb.	30.0	37.5		Comb.	10.0	8.8
Scrub**	A	0.0	12.5	Chipping++	A	17.5	7.5
Jay	B	5.0	32.5	Sparrow	B	40.0	42.5
	Comb.	2.5	22.5		Comb.	28.8	25.0
Mountain	A	10.0	12.5	Ash-throated	A	2.5	2.5
Bluebird	B	10.0	25.0	Flycatcher	B	17.5	2.5
	Comb.	10.0	18.8		Comb.	10.0	2.5
Plain***	A	10.0	17.5	Brown-headed	A	5.0	2.5
Titmouse	B	20.0	40.0	Cowbird	B	5.0	0.0
	Comb.	15.0	28.8		Comb.	5.0	1.3
Gray+	A	7.5	7.5	Common	A	2.5	0.0
Flycatcher	B	20.0	32.5	Flicker	B	0.0	2.5
	Comb.	13.8	20.0		Comb.	1.3	1.3
Lark	A	5.0	5.0	Solitary+++	A	2.5	0.0
Sparrow	B	0.0	15.0	Vireo	B	2.5	10.0
	Comb.	2.5	10.0		Comb.	2.5	5.0
Western	A	2.5	0.0	Red-breasted	A	2.5	5.0
Tanager	B	0.0	2.5	Nuthatch	B	2.5	2.5
	Comb.	1.3	1.3		Comb.	2.5	3.8
Warbling	A	2.5	0.0	American‡	A	0.0	5.0
Vireo	B	0.0	0.0	Crow	B	10.0	0.0
	Comb.	1.3	0.0		Comb.	5.0	2.5
Blue-grey	A	0.0	0.0	Broad-tailed	A	0.0	2.5
Gnatcatcher	B	0.0	2.5	Hummingbird	B	0.0	5.0
	Comb.	0.0	1.3		Comb.	0.0	3.8
Lazuli	A	0.0	2.5	Lesser	A	0.0	2.5
Bunting	B	0.0	0.0	Goldfinch	B	0.0	2.5
	Comb.	0.0	1.3		Comb.	0.0	2.5
Black-billed	A	0.0	0.0	Mourning	A	0.0	7.5
Magpie	B	0.0	2.5	Dove	B	0.0	0.0
	Comb.	0.0	1.3		Comb.	0.0	3.8

* Significant difference among researchers ($p = 0.01$).

** Significant difference among years ($p = 0.001$) and among researchers ($p = 0.03$).

*** Significant difference among years ($p = 0.044$) and among researchers ($p = 0.033$).

\+ Significant difference among researchers ($p = 0.007$).

++ Significant difference among researchers ($p = 0.001$).

+++ Significant difference among researchers ($p = 0.035$); year by researcher interaction significant ($p = 0.035$).

‡ Year by researcher interaction significant ($p = 0.04$).

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