1323546

SMITH, BRENDA HALE

AVIAN HABITAT SELECTION IN A MIXED CREOSOTEBUSH-GRASSLAND COMMUNITY

THE UNIVERSITY OF ARIZONA M.S. 1984

University
Microfilms
International 300 N. Zeeb Road, Ann Arbor, MI 48106

AVIAN HABITAT SELECTION IN A
MIXED CREOSOTEBUSH-GRASSLAND COMMUNITY

by

Brenda Hale Smith

A Thesis Submitted to the Faculty of the

SCHOOL OF RENEWABLE NATURAL RESOURCES

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE
WITH A MAJOR IN WILDLIFE ECOLOGY

In the Graduate College

THE UNIVERSITY OF ARIZONA

1 9 8 4

STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole of in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: Brenda Hale Smith

APPROVAL BY THESIS COMMITTEE

This thesis has been approved on the date shown below:

Norman S. Smith
N. S. Smith, Thesis Director
Assistant Cooperative Wildlife Unit Leader
Professor of Wildlife Ecology

12 June 84
Date

Paul R. Krausman
P. R. Krausman
Associate Professor of Wildlife Ecology

12 June 1984
Date

Stephen M. Russell
S. M. Russell
Associate Professor of
Ecology and Evolutionary Biology

14 June 1984
Date

PREFACE

This thesis was prepared in the form of two manuscripts written in a format which would facilitate immediate submission to a scientific journal for publication. Both manuscripts were written according to the format specifications of THE SOUTHWESTERN NATURALIST.

Approval for presenting the thesis in this format was based upon (1) approval by the Graduate College, and (2) my graduate committee's agreement.

I am especially grateful to Dr. Norm S. Smith, major advisor, for his advice and guidance through all phases of this study. I also thank Drs. Paul R. Krausman and Stephen M. Russell, who served as committee members and critically reviewed the manuscript.

I gratefully acknowledge Alicia Melgoza and Betty Travis for assistance with vegetation work, and Brian A. Maurer for advice on statistical analysis.

Special thanks go to my husband, Dave, for his assistance, support, and patience during this study.

I also thank Dr. Howard L. Morton of the Agricultural Research Service (ARS) for technical assistance. Financial support was provided by the ARS, U. S. Department of Agriculture.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

ABSTRACT

Black-throated sparrow (Amphispiza bilineata) use of an altered creosotebush (Larrea tridentata) community was examined on the Santa Rita Experimental Range, south of Tucson, Arizona, from October 1981 to December 1982. The community was treated with tebuthiuron, was mechanically crushed, or both in 1976 and 1977. Densities of all bird species varied seasonally and were generally highest on tebuthiuron-treated plots, reaching 11 birds/ha during fall 1982. Five Cassin's sparrow (Aimophila cassinii) nests were found on tebuthiuron-treated plots. Black-throated sparrows used a variety of shrubs and grasses with eight of 45 nests in live creosotebush and nine in dead creosotebush. Black-throated sparrow nests were generally built in areas with higher creosotebush cover or density and lower succulent and grass densities than average values on the plots for these vegetation types. The combination of tebuthiuron and mechanical treatments opened small areas in the creosotebush community and provided nesting areas for Cassin's sparrows during summer and feeding areas for granivorous flocks during the non-breeding season.

INTRODUCTION

The structure of avian communities in desert scrub is significantly influenced by the structural diversity of the vegetation (Dixon, 1959; Raitt and Maze, 1968; Tomoff, 1974). As avian habitats become more complex, birds increase in density and species composition, nesting, and foraging niches increase in diversity (Tomoff, 1974). Range management practices which alter the vegetative structure of an area may also change the bird community. Brush control with the herbicide tebuthiuron has been studied extensively during the last 10 years (e.g. Ford et al., 1974; Scifres and Mutz, 1978; Scifres et al., 1979; Britton and Sneva, 1981). Tebuthiuron rapidly changes shrublands to grasslands by defoliating and killing woody plants. Efforts to control creosotebush (*Larrea tridentata*) with tebuthiuron and various mechanical treatments are being studied in the southwestern U.S. and northern Mexico (H. L. Morton, in litt.). Because tebuthiuron may become a land management tool, it is important to determine the herbicide's effects on wildlife communities. The objective of this study is to examine the density of the bird community and the nest-site selection of black-throated sparrows on an altered creosotebush community. The foraging behavior of four bird species on the study area is described in Appendix 1.

STUDY AREA

The study was conducted on the Santa Rita Experimental Range, 50 km S Tucson, Arizona. The area is a gently sloping plain at an elevation of 975 m. Vegetation is southwestern desert scrub of the Lower Sonoran Life Zone (Lowe, 1964). The dominant species is creosotebush, with velvet mesquite (*Prosopis juliflora*), catclaw (*Acacia greggii*), and other shrubs common along washes. Precipitation is biseasonal with approximately half falling in localized heavy thunderstorms from July to September. April, May, and June are the driest months. Rainfall on the study area totalled 36 cm during 1982.

In 1976 three 100 by 800 m areas were treated with 0.3, 0.5, or 1.2 kg/ha tebuthiuron. A control area of equal size was left adjacent to each treated strip. The following year a land imprinter was used to mechanically treat 61 m strips of land at 61 m intervals perpendicular to the tebuthiuron treatments. This machine crushes above-ground vegetation, textures the soil, and plants grass seed. These treatments formed a grid arrangement of 72 61 by 100 m plots, which were of four types: 1) imprinting only (mechanical treatment), 2) tebuthiuron treatment only, 3) both imprinting and tebuthiuron treatments, and 4) control.

METHODS

Birds were counted along 800 m transects located in each tebuthiuron-treated and untreated strip. Only birds within the census strip were recorded. I censused each transect twice a month from October 1981 to December 1982; censuses began within 30 min after sunrise. Bird densities were estimated for each treatment using coefficients of detectability calculated for each species (Emlen, 1971).

I located black-throated sparrow (Amphispiza bilineata) and Cassin's sparrow (Aimophila cassinii) nests in 1982 by observing territorial pairs. The plot treatment, nest height, and plant species in which each nest was built were recorded.

I sampled vegetation on nine 30 m transects and 18 10 m^2 circular plots located in each tebuthiuron-treated strip and in one untreated strip. Shrub canopy cover was measured with the line intercept method (Canfield, 1941), herbaceous plant cover in a 30 m by 30 cm belt transect, and shrub density and mean height in the circular plots. Nest vegetation was sampled similarly along four 5 m transects radiating from the nest site at 90° intervals, and in one 10 m^2 circular plot centered at the nest site.

I divided plant species into seven categories based on physiognomic characteristics (Whittaker, 1970): 1) evergreen sclerophyll (creosotebush), 2) spinescent or thorn-shrub, 3) stem succulent, 4) perennial semishrub, 5) grass, 6) forb, and 7) dead shrub

(Appendix 2). Cover, density, and height of plot vegetation were analyzed with multivariate analysis of variance. I compared nest and plot vegetation for each vegetation category with three-way analysis of variance. The Statistical Package for the Social Sciences (SPSS) software was used for these analyses (Nie et al., 1975; Hull and Nie, 1981).

RESULTS

Bird Densities.--I observed 53 bird species during the study (Appendix 3). In 1982 11 species nested on the study area.

Bird densities varied by treatment and season (Table 1). Tebuthiuron-treated plots were combined because I found no significant differences ($P < 0.05$) between vegetation on plots treated with tebuthiuron. Bird densities were highest on all areas during fall and were lowest during winter (Fig. 1). The plots treated only with tebuthiuron had the highest densities during all seasons and use remained highest throughout the study on these plots. Except for periodic increases during winter and spring of 1981 to 1982, densities were generally lowest on plots treated only with imprinting.

Plot Vegetation.--Cover, density, and height of vegetation on tebuthiuron-treated plots differed significantly from that on control plots in several vegetation categories.

All tebuthiuron treatment rates significantly lowered creosotebush ($F = 3.95950$, $df = 3$, $P = 0.027$) and semishrub cover ($F = 12.40960$, $df = 3$, $P < 0.001$). Grass cover was higher on tebuthiuron-treated plots than on untreated areas ($F = 5.88050$, $df = 3$, $P = 0.007$). There were no significant differences in cover between tebuthiuron treatment rates or between imprinted and unimprinted areas.

Creosotebush density was lower on tebuthiuron-treated areas than on control plots ($F = 6.74417$, $df = 3$, $P = 0.004$) with no significant differences between the three rates. Grass density was highest on areas treated with 0.3 or 1.2 kg/ha tebuthiuron and lowest on untreated plots. Grass densities at all tebuthiuron treatment rates differed significantly from those on untreated areas ($F = 7.95501$, df = 3, $P = 0.002$). The density of dead shrubs on plots treated only with tebuthiuron was significantly greater than on control plots; the highest density was on plots treated with 1.2 kg/ha tebuthiuron ($F = 4.54129$, df = 3, $P = 0.017$). There were no significant differences in densities of dead shrubs on imprinted and unimprinted areas.

Creosotebush was significantly taller on unimprinted plots than on imprinted plots ($F = 15.44996$, df = 1, $P = 0.001$). There were no differences in height due to tebuthiuron treatment effects and no differences in other vegetation categories.

Nest Selection.--I located 45 black-throated sparrow and five Cassin's sparrow nests from March to September 1982 (Table 2). The small sample of Cassin's sparrow nests precludes a statistical comparison of nest sites. Nests of both species on unimprinted plots were most commonly built in creosotebush and were often located on the lower dead branches of the plant. On tebuthiuron-treated plots, nests were often surrounded by a dense growth of bush muhly (*Muhlenbergia porteri*).

Vegetation within 5 m of black-throated sparrow nests was compared to vegetation measured within plot transects or circles. I compared the effects of tebuthiuron treatment, imprinting, and location of vegetation on the cover, density, and height of vegetation. Analysis of variance revealed significant differences in cover and density of creosotebush, spinescents, and semishrubs, and in height of creosotebush and semishrubs between vegetation locations (Table 3).

Creosotebush and semishrub cover around nests were greater than cover on plots on unimprinted areas (Table 4). Around nests, semishrub cover was greater than cover on plots at all tebuthiuron rates but was lower on control areas. Spinescent cover around nests was higher than on plots in areas treated with imprinting only or with imprinting and 0.3 kg/ha tebuthiuron (Table 4). Spinescent and semishrub densities were higher around nests in areas treated with imprinting only or with imprinting and 0.3 kg/ha tebuthiuron (Table 4). Vegetation around nests was characterized by lower densities of succulents and grasses than in plot vegetation.

Creosotebush around nests was taller than average on control plots and on plots treated with 0.3 kg/ha tebuthiuron. Semishrubs were taller than average around nests on areas treated with 0.3 kg/ha tebuthiuron and were shorter on control plots.

DISCUSSION

Creosotebush is common throughout the southwestern desert scrub (Lowe, 1964) and forms the Larrea-Ambrosia community of the Sonoran Desert. Overgrazing and fire suppression have resulted in replacement of desert grassland by scrub communities (Gardner, 1951; Lowe, 1964). Creosotebush on the Santa Rita Experimental Range increased 73 times between 1904 and 1954 (Humphrey and Mehrhoff, 1958). As creosotebush invades an area and becomes dominant, surface soil erodes, herbaceous species are excluded, forage production becomes negligible, and a desert pavement develops (Gardner, 1951). Grasses and forbs are poor competitors with shrubs and grassland reestablishment is prevented (Brown, 1950).

Tebuthiuron is an effective means of controlling shallow-rooted species such as creosotebush, whitethorn (Acacia constricta), and burroweed (Haplopappus tenuisectus) at rates from 0.56 to 1.12 kg/ha (McNeill et al., 1977; Morton et al., 1978). Scifres and Mutz (1978) found that rates lower than 2.24 kg/ha did not generally increase grass production in South Texas. Forb production and diversity decreased at rates higher than 1 kg/ha for one to two years after application but recovered after three years. In southern Arizona forage production increased at rates of 1.12 kg/ha or greater when compared to untreated plots over a three year period; species composition was reduced when treated with 2.24 kg/ha or more herbicide (Morton, 1979). Persistence of tebuthiuron in the soil depends on rainfall and soil type (Bovey et al., 1978). The effectiveness of tebuthiuron in different areas is partly due to these conditions.

In my study shrub cover decreased and grass cover increased at all tebuthiuron treatment rates when compared to untreated plots. Creosotebush and spinescent densities decreased and grass density increased on all tebuthiuron treatments. Tebuthiuron was less effective on semishrubs.

Imprinting did not decrease shrub cover or density nor increase grass cover or density significantly ($\underline{P} < 0.05$). However, imprinting reduced creosotebush height 20 to 50 cm compared to plants on unimprinted plots.

One result of imprinting on tebuthiuron-treated plots was the crushing of shrubs killed by tebuthiuron. On unimprinted plots these dead shrubs, mainly creosotebush, were surrounded by dense growths of grasses, particularly bush muhly. Nine of 16 black-throated sparrow nests and three of five Cassin's sparrow nests were built in these bush muhly clumps and supported by dead creosotebush branches.

Cassin's sparrows generally occupy open grasslands with scattered shrubs necessary for song perches (Bent et al., 1968). My treatment plots provided an adequate grassland habitat to support a breeding population. During the breeding season, Cassin's sparrow densities were higher on tebuthiuron-treated plots than on untreated plots with the same mechanical treatment. I found no nests on untreated areas; although I did not locate all Cassin's sparrow nests on the study area, the activity centers of other males observed were always on the tebuthiuron-treated plots.

Creosotebush is of minor importance to most avian species. Several investigators (Hensley, 1954; Dixon, 1959; Austin, 1970; Tomoff, 1974; Hill, 1980) failed to find any birds nesting in creosotebush and Anderson and Anderson (1946) located only one black-tailed gnatcatcher (Polioptila melanura) nesting in the shrub. However, black-throated sparrows will nest extensively in creosotebush (Raitt and Maze, 1968). I found 13 black-throated sparrow nests built in live creosotebush during this study; eight of nine nests in untreated plots were in this shrub.

When compared with averages for the plot vegetation, black-throated sparrows generally chose nest sites in areas with higher creosotebush cover on unimprinted plots. On plots treated only with tebuthiuron, they nested in areas with higher creosotebush density. On imprinted plots nests were located in areas with higher spinescent cover. On control plots they nested where semishrub cover and densities of semishrubs and spinescents were higher. On all treatments there were generally fewer succulents and grasses around nests.

Black-throated sparrows were found on all plots and were the most common breeding birds on the study area. I found 29 of 45 nests on plots treated only with tebuthiuron. Black-throated sparrows use a wider variety of habitats than other desert-dwelling birds (Bent et al., 1968; Raitt and Maze, 1968; Tomoff, 1974). Although the presence of other desert bird species is highly correlated with the occurrence of particular plant forms (Tomoff, 1974), black-throated sparrows are generalists and do not appear to be restricted by any specific physiognomic elements.

There are striking differences in the seasonal use of desert scrub and grasslands by birds (Raitt and Pimm, 1976). A desert grassland site was heavily used by seed-eaters during the non-breeding season; breeding season densities were much lower. A creosotebush-mixed scrub community showed less seasonal variation. Breeding season densities were higher with insectivores an important component during summer and fall. Winter densities were lower; resident species were relatively important and large granivorous flocks were absent from this area.

My data correspond to these findings. The tebuthiuron-treated plots, which correspond to desert grassland habitat, were used heavily by granivores, particularly Brewer's (Spizella breweri) and black-throated sparrows, in the non-breeding season. These areas had higher grass densities and presumably higher seed production. On unimprinted plots I often observed birds perched on dead creosotebush branches feeding on grass seed heads. Because dead shrubs were on these plots, this behavior gave birds more accessibility to the food resource than they otherwise may have had. Densities during the breeding season were lower and were only slightly greater than densities on untreated areas.

Untreated plots, the creosotebush-mixed scrub community, also varied less throughout the year. Insectivores generally used these plots more than grassland plots, but there were no large differences in use between the various treatments or between seasons. Granivores rarely used the untreated plots; I saw large flocks only on tebuthiuron-treated plots, particularly on those treated with 1.2 kg/ha tebuthiuron.

The combination of tebuthiuron and imprinting treatments served to open areas in the dominantly creosotebush community. It provided habitat for a few typically grassland bird species and, during certain seasons, provided feeding areas for granivorous sparrows. The test of these treatments was on a small scale. If treatments are restricted to small areas and vegetation along washes is not removed, the bird community will not be adversely affected and the densities of some species and the number of species supported may increase.

LITERATURE CITED

Anderson, A. H., and A. Anderson. 1946. Notes on the use of creosotebush by birds. Condor, 48:179.

Austin, G. T. 1970. Breeding birds of desert riparian habitat in southern Nevada. Condor, 72:431-436.

Bent, A. C., et al. 1968. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. Dover Publ., Inc., New York. 1248 pp.

Bovey, R. W., et al. 1978. Persistence of tebuthiuron in surface runoff water, soil, and vegetation in the Texas Blacklands Prairie. J. Environ. Qual., 7:233-236.

Britton, C. M., and F. A. Sneva. 1981. Effects of tebuthiuron on western juniper. J. Range Mgmt., 34:30-32.

Brown, A. L. 1950. Shrub invasion of southern Arizona desert grassland. J. Range Mgmt., 3:172-177.

Canfield, R. H. 1941. Application of the line interception method in sampling range vegetation. J. Forestry, 39:388-394.

Dixon, K. L. 1959. Ecological and distributional relations of desert scrub birds of western Texas. Condor, 61:397-409.

Emlen, J. T. 1971. Population densities of birds derived from transect counts. Auk, 88:323-342.

Ford, D. H., F. O. Colbert, and L. C. Warner. 1974. Tebuthiuron for noncropland vegetation control. Proc. West. Soc. Weed Sci., 27:21-22.

Gardner, J. L. 1951. Vegetation of the creosotebush area of the Rio Grande Valley in New Mexico. Ecol. Monogr., 21:379-403.

Hensley, M. M. 1954. Ecological relations of the breeding bird population of the desert biome in Arizona. Ecol. Monogr., 24:185-207.

Hill, H. O. 1980. Breeding birds in a desert scrub community in southern Nevada. Southwestern Nat., 25:173-180.

Hull, C. H., and N. H. Nie. 1981. SPSS update 7-9--new procedures and facilities for releases 7-9. McGraw Hill Book Co., New York. 402 pp.

Humphrey, R. R., and L. A. Mehrhoff. 1958. Vegetation changes on a southern Arizona grassland range. Ecology, 39:720-726.

Lowe, C. H. 1964. Arizona landscapes and habitat. Pp. 3-132, _in_ The vertebrates of Arizona (C. H. Lowe, ed.). Univ. Ariz. Press, Tucson. 270 pp.

McNeill, K. E., et al. 1977. Tebuthiuron for rangeland brush control. Proc. South. Weed Sci. Soc., 30:229-230.

Morton, H. L. 1979. Effects of soil applied herbicides on forage production and botanical composition in southern Arizona rangelands. Proc. West. Soc. Weed Sci., 32:78-79.

Morton, H. L., H. M. Hull, R. D. Martin, and T. M. Wright. 1978. Control of creosotebush with tebuthiuron and karbutilate. Proc. West. Soc. Weed Sci., 31:74.

Nie, N. H., et al. 1975. Statistical package for the social sciences. Second ed. McGraw Hill Book Co., New York. 675 pp.

Raitt, R. J., and R. L. Maze. 1968. Densities and species composition of breeding birds of a creosotebush community in southern New Mexico. Condor, 70:193-205.

______________, and S. L. Pimm. 1976. Dynamics of bird communities in the Chihuahuan Desert, New Mexico. Condor, 78:427-442.

Scifres, C. J., and J. L. Mutz. 1978. Herbaceous vegetation changes following applications of tebuthiuron for brush control. J. Range Mgmt., 31:375-378.

______________, ______________, and W. T. Hamilton. 1979. Control of mixed brush with tebuthiuron. J. Range Mgmt., 32:155-158.

Tomoff, C. S. 1974. Avian species diversity in desert scrub. Ecology, 55:396-403.

Whittaker, R. H. 1970. Communities and ecosystems. Second ed. MacMillan Publ. Co., Inc., New York. 385 pp.

Table 1.--Seasonal bird densities ($\overline{X}$/10 ha) and number of species on four plot treatments, December 1981 to November 1982, Santa Rita Experimental Range, Arizona.

	Winter (12/81-2/82)		Spring (3/82-5/82)		Summer (6/82-8/82)		Fall (9/82-11/82)	
Treatment	No./10 ha	No. spp.	No./10 ha	No. spp.	No./10 ha	No. spp.	No./10 ha	No. spp.
Tebuthiuron-Imprinted	14	11	22	19	21	19	57	20
Tebuthiuron Only	44	19	24	22	31	16	107	22
Imprinted Only	14	10	20	17	15	9	22	14
Control	14	11	15	18	23	17	45	21

Table 2.--Black-throated sparrow and Cassin's sparrow nests on four plot treatments, 1982, Santa Rita Experimental Range, Arizona.

	Black-throated sparrows		Cassin's sparrows	
Treatment and Plant Species	No. nests	$\bar{X}$ nest ht. (cm)	No. nests	$\bar{X}$ nest ht. (cm)
TEBUTHIURON-IMPRINTED				
Acacia greggii	2	85		
Haplopappus tenuisectus	5	17		
Larrea tridentata	3	23	2	30
Pappophorum mucronulatum	2	12	2	18
Prosopis juliflora	1	20		
TEBUTHIURON ONLY				
Atriplex canescens	1	60		
Haplopappus tenuisectus	1	15		
Larrea tridentata	9	27	1	44
Pappophorum mucronulatum	2	28		
Prosopis juliflora	3	29		
IMPRINTED ONLY				
Acacia greggii	2	80		
Haploppapus tenuisectus	1	13		
Larrea tridentata	2	5		
Lycium andersonii	1	15		
Pappophorum mucronulatum	1	30		
CONTROL				
Larrea tridentata	8	31		
Prosopis juliflora	1	21		

Table 3.--Significant interactions between three effects tested with analysis of variance on cover, density, and height of vegetation, 1982, Santa Rita Experimental Range, Arizona.

VEGETATION CHARACTERISTICS AND INTERACTIONS		SIGNIFICANCE LEVELS F	df	P
CREOSOTEBUSH				
Cover:	Location[1] X Imprinting	7.959	1	0.006
Density:	Location X Tebuthiuron	2.874	3	0.038
Height:	Location X Tebuthiuron	3.625	3	0.013
SPINESCENTS				
Cover:	Location X Tebuthiuron X Imprinting	3.462	3	0.019
Density:	Location X Tebuthiuron X Imprinting	7.577	3	0.001
SEMISHRUBS				
Cover:	Location X Tebuthiuron	3.485	3	0.019
	Location X Imprinting	5.778	1	0.018
Density:	Location X Tebuthiuron X Imprinting	5.301	3	0.002
Height:	Location X Tebuthiuron	8.131	3	0.001
SUCCULENTS				
Density:	Location	4.457	1	0.036
GRASSES				
Density:	Location	10.292	1	0.002

[1] Location of vegetation within 5 m of nests or away from nests.

Table 4.--Mean cover (cm/30 m transect) of vegetation measured around nests (Nest Cover) or on plots (Plot Cover) for all treatments, 1982, Santa Rita Experimental Range, Arizona.

		Tebuthiuron Treatment (kg/ha)			
		1.2	0.5	0.3	Control
CREOSOTEBUSH					
IMPRINTED					
Cover	Nest[1]	0(0,5)[2]	172(89,7)	201(0,1)	310(123,7)
	Plot	7(6,9)	125(46,9)	33(26,9)	303(48,9)
UNIMPRINTED					
Cover	Nest	259(222,4)	903(292,5)	663(176,7)	1178(166,9)
	Plot	14(12,9)	210(51,9)	262(75,9)	684(217,9)
SPINESCENT					
IMPRINTED					
Cover	Nest	188(188,5)	0(0,7)	1060(0,1)	375(217,7)
	Plot	0(0,9)	0(0,9)	113(63,9)	30(20,9)
UNIMPRINTED					
Cover	Nest	0(0,4)	0(0,5)	60(33,7)	69(39,9)
	Plot	0(0,9)	175(69,9)	131(70,9)	236(95,9)
SEMISHRUB					
IMPRINTED					
Cover	Nest	88(39,5)	115(55,7)	236(0,1)	155(58,7)
	Plot	4(4,9)	7(5,9)	21(11,9)	164(40,9)
UNIMPRINTED					
Cover	Nest	47(47,4)	2(2,5)	105(42,7)	93(32,9)
	Plot	24(14,9)	16(14,9)	22(8,9)	132(26,9)

[1] Vegetation cover in cm/30 m transect.

[2] Values given are $\overline{X}$(SE of $\overline{X}$, n).

Table 5.--Mean density (no./100 m^2) of vegetation measured around nests (Nest Density) or on plots (Plot Density) for all treatments, 1982, Santa Rita Experimental Range, Arizona.

		Tebuthiuron Treatment (kg/ha)			
		1.2	0.5	0.3	Control
CREOSOTEBUSH					
IMPRINTED Density	Nest[1]	1.2(1.2,5)[2]	6.3(0.9,7)	3.0(0,1)	6.0(1.8,7)
	Plot	0.6(0.2,18)	4.8(1.2,18)	3.1(0.6,18)	12.1(1.8,18)
UNIMPRINTED Density	Nest	4.2(3.6,4)	14.4(1.0,5)	5.9(1.5,7)	14.6(2.0,9)
	Plot	0.3(0.1,18)	8.2(1.4,18)	6.1(1.0,18)	15.2(2.8,18)
SPINESCENT					
IMPRINTED Density	Nest	1.0(1.0,5)	0(0,7)	11.0(0,1)	2.3(1.4,7)
	Plot	0.1(0.1,18)	1.3(0.4,18)	1.1(0.6,18)	1.4(0.3,18)
UNIMPRINTED Density	Nest	0.2(0.2,4)	0.2(0.2,5)	0.6(0.2,7)	1.0(0.3,9)
	Plot	0.2(0.1,18)	1.1(0.7,18)	1.1(0.4,18)	1.3(0.5,18)
SEMISHRUB					
IMPRINTED Density	Nest	1.8(0.7,5)	1.3(0.8,7)	4.0(0,1)	14.9(8.6,7)
	Plot	0.8(0.2,18)	1.5(0.4,18)	1.3(0.4,18)	0.6(0.3,18)
UNIMPRINTED Density	Nest	1.8(0.9,4)	0.4(0.2,5)	0.9(0.6,7)	0.7(0.5,9)
	Plot	1.6(0.5,18)	0.4(0.1,18)	2.3(0.7,18)	0.8(0.3,18)

[1] Vegetation density in no./100 m^2.

[2] Values given are $\overline{X}$(SE of $\overline{X}$, n).

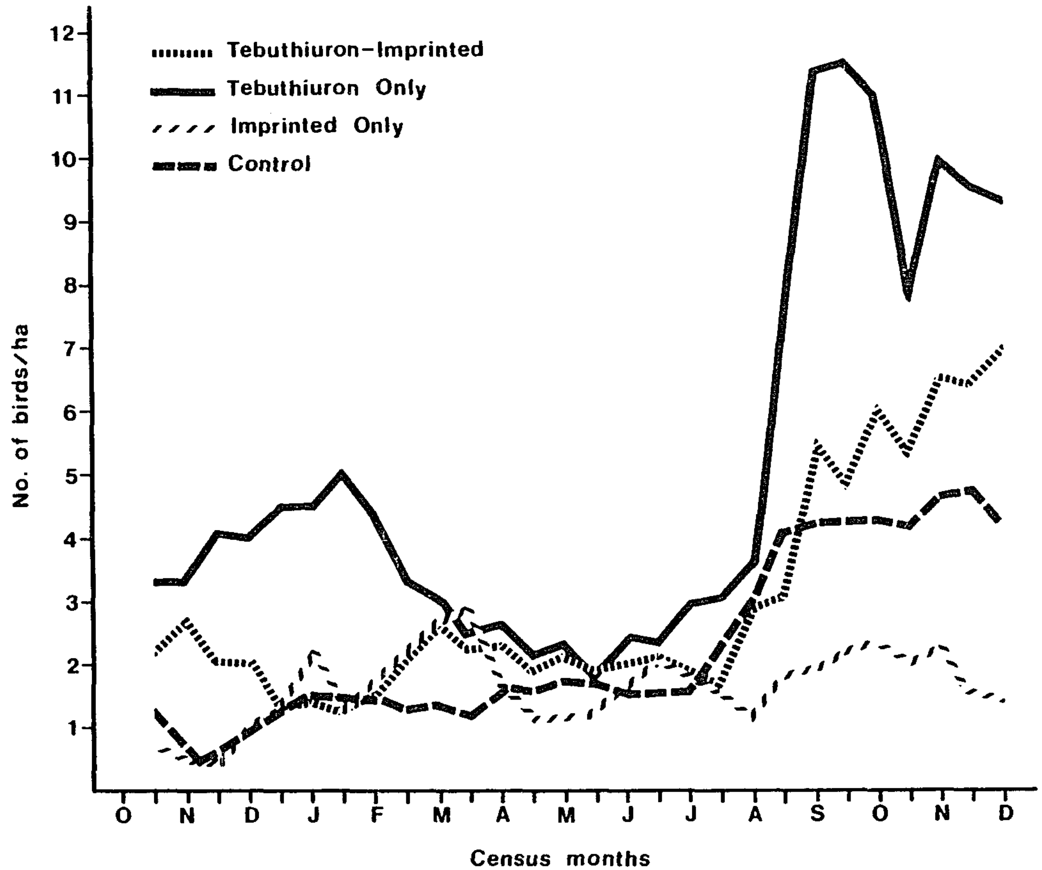

Fig. 1.--Average densities ($\overline{X}$ of three consecutive censuses) of all birds, October to December 1982, Santa Rita Experimental Range, Arizona.

APPENDIX 1

FORAGING BEHAVIOR OF FOUR BIRD SPECIES

IN A MIXED CREOSOTEBUSH-GRASSLAND COMMUNITY

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Foraging behavior of verdins (Auriparus flaviceps) and black-throated (Amphispiza bilineata), Brewer's (Spizella breweri), and vesper sparrows (Pooecetes gramineus) was examined on an altered creosotebush (Larrea tridentata) community on the Santa Rita Experimental Range, south of Tucson, Arizona, from July 1981 to December 1982. The community was treated with tebuthiuron, was mechanically crushed, or both in 1976 and 1977. Foraging method, foraging location, foraging height, and use of cover by the four species varied among the treatments. Black-throated and Brewer's sparrows foraged opportunistically, verdins avoided crushed plots, and vesper sparrows avoided control plots. Birds did not alter their foraging methods between treatments, but altered their use of treated plots or use of vegetation on the plots.

INTRODUCTION

Foraging behavior of forest birds may change in response to alterations in habitat structure (Grubb, 1979; Szaro and Balda, 1979) and resource distribution (Maurer and Whitmore, 1981; Franzreb, 1983). Changes in vegetation structure resulted in changes in bird densities and nest-site selection for some species in a desert scrub community (see pages 1-20). These changes may also lead to differences in foraging behavior on plots treated with the herbicide tebuthiuron or imprinting. The objective of this study is to examine the foraging behavior of four bird species on an altered creosotebush (*Larrea tridentata*) community.

STUDY AREA

The study was conducted on the Santa Rita Experimental Range, 50 km S Tucson, Arizona. The area is a gently sloping plain at an elevation of 975 m. Vegetation is southwestern desert scrub of the Lower Sonoran Life Zone (Lowe, 1964). The dominant species is creosotebush, with velvet mesquite (*Prosopis juliflora*), catclaw (*Acacia greggii*), and other shrubs common along washes. Precipitation is bi-seasonal with approximately half falling in localized heavy thunderstorms from July to September. April, May, and June are the driest months. Rainfall on the study area totalled 36 cm during 1982.

In 1976 three 100 by 800 m areas were treated with 0.3, 0.5, or 1.2 kg/ha tebuthiuron. A control area of equal size was left adjacent to each treated strip. The following year a land imprinter was used to mechanically treat 61 m strips of land at 61 m intervals perpendicular to the tebuthiuron treatments. This machine crushes above-ground vegetation, textures the soil, and plants grass seed. These treatments formed a grid arrangement of 72 61 by 100 m plots, which were of four types: 1) imprinting only (mechanical treatment), 2) tebuthiuron treatment only, 3) both imprinting and tebuthiuron treatments, and 4) control.

METHODS

I recorded data on activity behavior of verdins (*Auriparus flaviceps*) and black-throated (*Amphispiza bilineata*), Brewer's (*Spizella breweri*), and vesper sparrows (*Pooecetes gramineus*) after bird censuses. These species represent a resident insectivore, resident granivore, and two wintering granivores, respectively, which were relatively abundant on the study area. Data on both sexes were combined because field differentiation between sexes is difficult for these species. I recorded observations of an individual every 15 sec for 5 min (Wiens et al., 1970). Most observations were collected between 0600 and 1100. Data recorded included species, plot treatment, foraging method (gleaning insects or gleaning seeds), foraging location (ground, creosotebush, spinescent, semishrub, or dead shrub), foraging height (at 0.5 m intervals), and use of cover (in the open, under shrub canopy, in a dense grass clump, on the outer branches of a shrub, or on the inner branches).

I used chi-square analysis and contingency tables to test the effects of tebuthiuron treatment (treated or untreated), mechanical treatment (imprinted or unimprinted), and season (spring, March-May; summer, June-August; or winter, September-February) on the foraging behavior of the four bird species. I analyzed observations of 2292 black-throated sparrows, 754 Brewer's sparrows, 295 verdins, and 176 vesper sparrows.

RESULTS

Foraging Method.--The foraging method of black-throated sparrows varied by plot treatment and by season ($X^2 = 35.46$, df = 6, $P < 0.001$) (Table 6). They primarily ground-gleaned seeds during spring and winter on all plots. During summer, they commonly foliage-gleaned insects, especially on the control plots.

Verdins were strictly foliage-gleaning insectivores during all seasons. The proportion of foraging observations varied by plot treatment ($X^2 = 83.74$, df = 1, $P < 0.001$). I rarely observed verdins foraging on plots which were imprinted only; other plots were used equally.

Brewer's and vesper sparrows were present on the study area only during winter. They gleaned seeds on the ground or from standing grass. I never observed vesper sparrows foraging on control plots. Brewer's sparrows used all plots.

Foraging Location.--Foraging locations of black-throated sparrows varied by season and plot treatment ($X^2 = 26.49$, df = 6, $P < 0.001$) (Table 7). Birds were usually on the ground. However, during summer on control plots, black-throated sparrows usually foraged from creosotebush.

Foraging locations of verdins varied by plot treatment ($X^2 = 11.47$, df = 1, $P < 0.001$) (Table 8). They foraged in creosotebush exclusively on plots which were imprinted only. I usually found verdins in spinescents on tebuthiuron-treated, imprinted plots and on control plots.

Foraging locations of Brewer's sparrows varied between tebuthiuron treatments ($X^2 = 47.37$, df = 3, $P < 0.001$) and imprinting ($X^2 = 114.55$, df = 3, $P < 0.001$). Approximately 60% of locations in all plots were on the ground. They used creosotebush more often on control plots, spinescents on imprinted plots, and dead shrubs on tebuthiuron-treated plots.

Foraging locations of vesper sparrows varied between imprinted and unimprinted plots ($X^2 = 6.68$, df = 1, $P = 0.0098$). On imprinted plots 95% of the observations involved birds on the ground; on unimprinted plots 83% were of birds on the ground with the remainder in creosotebush.

Foraging Height.—The foraging height of black-throated sparrows varied between plot treatments ($X^2 = 29.07$, df = 5, $P < 0.001$). Most foraging was from 0-1 m. Black-throated sparrows foraged higher on control plots, but all were observed at 3 m or less.

Verdins generally foraged higher than black-throated sparrows. The foraging height of verdins also varied between plot treatments ($X^2 = 28.43$, df = 5, $P < 0.001$). Although verdins foraged up to 6 m, most activity occurred at 2 m or less on all plots. I never observed verdins at heights over 1 m on plots treated only with imprinting. They foraged highest on control plots, but most were observed below 4 m.

The foraging height of Brewer's sparrows varied between plot treatments ($X^2 = 8.94$, df = 3, $P = 0.0301$). They foraged lower on control plots than on other areas with most activity occurring below 0.5 m. Brewer's sparrows foraged up to 2 m on other areas.

The foraging height of vesper sparrows varied between imprinted and unimprinted areas (X^2 = 17.64, df = 1, P < 0.001). On imprinted plots they foraged on the ground. On unimprinted plots they used heights up to 1.5 m.

Use of Cover.--Cover use by black-throated sparrows varied between season and tebuthiuron treatment (X^2 = 66.23, df = 6, P < 0.001) and between season and imprinting (X^2 = 43.81, df = 6, P < 0.001). Except during spring on control plots, black-throated sparrows foraged in open areas on the ground more often than under a shrub canopy and were always found on the outer branches of a shrub more than on the inner branches. They used open areas on the ground the most during summer on tebuthiuron-treated plots and during winter on imprinted plots.

Cover use by verdins varied only by season (X^2 = 10.67, df = 1, P = 0.0011). They were always on the outer branches of a shrub more than on the inner branches. They seldom used inner branches during winter.

Cover use by Brewer's sparrows varied between tebuthiuron treatments (X^2 = 42.07, df=4, P < 0.001) and imprinting (X^2 = 25.13, df = 4, P < 0.001). Brewer's sparrows always foraged in open areas more than under a shrub canopy and used the outer branches of a shrub more than the inner branches. Brewer's sparrows also foraged in dense grass clumps on tebuthiuron-treated plots and on unimprinted plots. They rarely used dense grasses on other plots.

Cover use by vesper sparrows varied between tebuthiuron treatments ($X^2 = 9.15$, df = 3, $\underline{P} = 0.0274$) and imprinting ($X^2 = 40.52$, df = 4, $\underline{P} < 0.001$). On control plots I found vesper sparrows only in the open. On imprinted plots they foraged in areas in the open and in dense grass clumps and never used the inner branches of shrubs.

DISCUSSION

The differences in vegetation structure between the four plots affected all species to some extent. The changes included avoidance of certain areas by verdins and vesper sparrows and an opportunistic use of some plots by black-throated and Brewer's sparrows.

Black-throated sparrows altered their behavior to the extent that the habitat structures of the plots necessitated a change. Foliage-gleaning by black-throated sparrows is common during periods of high insect abundance (Tomoff, 1974); this activity was most common on control plots because these areas had the highest cover and density of creosotebush (Tables 4 and 5). They foraged in dead shrubs most often on tebuthiuron-treated plots where dead shrubs were densest (Table 5).

Brewer's sparrows were also opportunistic, using creosotebush, dead shrubs, and dense grasses in areas where these plants were available. They often foraged from the lower dead branches of creosotebush on tebuthiuron-treated plots. Grasses appeared taller on these plots, and foraging from higher levels may have allowed a greater use of the resource on these plots.

Verdins appeared to avoid plots treated with imprinting only. Of the four species studied, verdins foraged highest and were the only birds which were exclusively foliage-gleaners. Plots treated with imprinting only were characterized by vegetation less than 1 m tall and perhaps did not provide an adequate resource for verdins. They also seemed to prefer foraging in spinescents and used creosotebush more only in areas where spinescent cover was lowest (Table 4).

Vesper sparrows avoided control plots. They did not forage from low branches of creosotebush and remained on the ground in all areas when foraging. They remained strictly ground-gleaning granivores.

This study shows that some desert birds will change their foraging behavior in response to an altered habitat structure and resource distribution. However, because the treatments on the study area were small, vesper sparrows and verdins could forage in preferred habitat and did not need to use other areas.

LITERATURE CITED

Franzreb, K. E. 1983. A comparison of avian foraging behavior in unlogged and logged mixed-coniferous forest. Wilson Bull., 95:60-76.

Grubb, T. C. 1979. Factors controlling foraging strategies of insectivorous birds. Pp. 119-135, in The role of insectivorous birds in forest ecosystems (J. G. Dickson, R. N. Conner, R. R. Fleet, J. A. Jackson, and J. C. Kroll, eds.). Academic Press, New York, New York.

Maurer, B. A., and R. C. Whitmore. 1981. Foraging of five bird species in two forests with different vegetation structure. Wilson Bull., 93:478-490.

Szaro, R. C., and R. P. Balda. 1979. Bird community dynamics in a ponderosa pine forest. Studies in Avian Biol., 3:1-66.

Tomoff, C. S. 1974. Avian species diversity in desert scrub. Ecology, 55:396-403.

Wiens, J. A., S. G. Martin, W. R. Holthaus, and F. A. Iwen. 1970. Metronome timing in behavioral ecology studies. Ecology, 51:350-352.

Table 6.--Foraging methods of black-throated sparrows (% observations) on all treatments, 1981-1982, Santa Rita Experimental Range, Arizona.

FORAGING METHOD	SEASON	% OBSERVATIONS ON PLOT TREATMENTS[1] Teb.-Impr.	Teb. Only	Impr. Only	Control
Gleaning Insects	Spring	13	3	24	8
	Summer	22	17	25	38
	Winter	1			
Gleaning Seeds	Spring	61	80	62	70
	Summer	71	29	47	24
	Winter	94	78	85	79

[1] Sample sizes are: spring, n = 654; summer, n = 500; winter, n = 1138.

Table 7.--Foraging locations of black-throated sparrows (% observations) on all treatments, 1981-1982, Santa Rita Experimental Range, Arizona.

FORAGING LOCATION	SEASON	% OBSERVATIONS ON PLOT TREATMENTS[1] Teb.-Impr.	Teb. Only	Impr. Only	Control
Ground	Spring	67	78	68	75
	Summer	76	43	56	25
	Winter	85	59	80	66
Creosotebush	Spring	8	10	12	22
	Summer	2	17	30	50
	Winter	14	15	12	26
Spinescents	Spring	43	1	19	3
	Summer	12	5	12	23
	Winter	1	4	6	7
Dead Shrubs	Spring	1	11	1	
	Summer	10	35	2	3
	Winter	1	22	3	1

[1] Sample sizes are: spring, n = 652; summer, n = 483; winter, n = 1082.

Table 8.--Foraging locations of verdins (% observations) on all treatments in all seasons, 1981-1982, Santa Rita Experimental Range, Arizona.

FORAGING LOCATION	% OBSERVATIONS ON PLOT TREATMENTS[1] Teb.-Impr.	Teb. Only	Impr. Only	Control
Ground	1			
Creosotebush	13	21	100	21
Spinescents	73	48		59
Semishrubs	11	28		
Dead Shrubs	2	4		20

[1] Sample size n = 295.

APPENDIX 2

PLANT SPECIES INCLUDED IN VEGETATION CATEGORIES

1. Evergreen Sclerophyll

   Larrea tridentata

2. Spinescent

   Acacia constricta
   Acacia greggii
   Calliandra eriophylla
   Condalia lycioides
   Cercidium floridum
   Lycium andersonii
   Prosopis juliflora

3. Stem succelent

   Echinocereus fasiculatus
   Ferocactus wislizeni
   Mammillaria grahamii
   Opuntia engelmannii
   Opuntia fulgida
   Opuntia leptocaulis
   Opuntia versicolor
   Peniocereus greggii

4. Semishrubs

   Aloysia lycioides
   Atriplex canescens
   Baccharis sarothroides
   Coldenia canescens
   Ephedra trifurca
   Fouquieria splendens
   Galium sp.
   Haplopappus tenuisectus
   Hyptis emoryi
   Parthenium incanum
   Psilostrophe cooperi
   Yucca elata
   Zinnia pumila

5. Grasses

   Andropogon gerardi
   Aristida glabrata
   Aristida sp.
   Bouteloua curtipendula
   Bouteloua eriopoda
   Eragrostis chloromelas
   Eragrostis lehmanniana
   Heteropogon contortus
   Muhlenbergia porteri
   Panicum antidotale
   Pappophorum mucronulatum
   Setaria macrostachya
   Sporobolus sp.
   Trichachne californica
   Tridens muticus
   Tridens pulchellus

6. Forbs

   Allionia incarnata
   Ambrosia sp.
   Aphanostephus humilis
   Bahia absinthifolia
   Baileya multiradiata
   Brassica sp.
   Clematis sp.
   Croton sp.
   Cryptantha micrantha
   Ditaxis sp.
   Dyssodia acerosa
   Erigeron divergens
   Euphorbia melanadenia
   Gilia sp.
   Haplopappus gracilis
   Hibiscus denudatus
   Lepidium thurberi
   Lesquerella gordoni
   Lupinus sparsiflorus

(6. Forbs, cont.)

Lygodesmia _exigua_
Nama _hispidum_
Perezia _nana_
Phacelia _crenulata_
Physalis sp.
Plantago _insularis_
Salsola _kali_
Salvia _columbariae_
Senecio _monoensis_
Sida sp.

7. Dead Shrubs

Acacia _constricta_
Acacia _greggii_
Baccharis _sarothroides_
Fouquieria _splendens_
Galium sp.
Larrea _tridentata_
Prosopis _juliflora_

APPENDIX 3

BIRD DENSITIES (NO./10 HA), DECEMBER 1981-NOVEMBER 1982,

SANTA RITA EXPERIMENTAL RANGE, ARIZONA

COMMON AND SCIENTIFIC NAMES	PLOT TREATMENT AND BIRD DENSITY (No./10 ha)			
	Teb.-Impr.	Teb. Only	Impr. Only	Control
American kestrel (*Falco sparverius*)	0.4[1]	0.1	< 0.1	< 0.1
Scaled quail (*Callipepla squamata*)	0.4	0.4	0.2	0.1
Gambel's quail (*Callipepla gambelii*)	< 0.1	0.1		
White-winged dove (*Zenaida asiatica*)	< 0.1			
Mourning dove (*Zenaida macroura*)	1.3	0.4	0.4	0.8
Lesser nighthawk (*Chordeiles acutipennis*)			0.1	
Gila woodpecker (*Melanerpes uropygialis*)		< 0.1		
Ladder-backed woodpecker (*Picoides scalaris*)	< 0.1	< 0.1		
Northern flicker (*Colaptes auratus*)	0.8	0.5	0.1	0.5
Western flycatcher (*Empidonax difficilis*)	0.1			< 0.1
Say's phoebe (*Sayornis saya*)	< 0.1	< 0.1	0.2	< 0.1
Ash-throated flycatcher (*Myiarchus cinerascens*)	0.4	0.6	0.4	0.2
Western kingbird (*Tyrannus verticalis*)		< 0.1		
Verdin (*Auriparus flaviceps*)	1.6	1.2	1.3	2.6
Cactus wren (*Campylorhynchus brunneicapillus*)		1.5	< 0.1	0.7

[1] Values represent average density/census during the period December 1981-November 1982

	Teb.-Impr.	Teb. Only	Impr. Only	Control
Rock wren (*Salpinctes obsoletus*)	0.1			0.2
Bewick's wren (*Thryomanes bewickii*)	< 0.1		0.4	< 0.1
Ruby-crowned kinglet (*Regulus calendula*)	< 0.1	< 0.1		
Black-tailed gnatcatcher (*Polioptila melanura*)	0.2	0.2	0.4	0.5
Northern mockingbird (*Mimus polyglottos*)				< 0.1
Sage thrasher (*Oreoscoptes montanus*)				< 0.1
Bendire's thrasher (*Toxostoma bendirei*)		0.1		
Curve-billed thrasher (*Toxostoma curvirostre*)	< 0.1	0.2	0.2	0.3
Crissal thrasher (*Toxostoma dorsale*)		< 0.1		< 0.1
Loggerhead shrike (*Lanius ludovicianus*)	< 0.1	0.3	0.3	0.2
European starling (*Sturnus vulgaris*)				< 0.1
Orange-crowned warbler (*Vermivora celata*)				< 0.1
Lucy's warbler (*Vermivora luciae*)				0.1
Yellow-rumped warbler (*Dendroica coronata*)				< 0.1
Common yellowthroat (*Geothlypis trichas*)				< 0.1
Wilson's warbler (*Wilsonia pusilla*)	0.1			< 0.1
Western tanager (*Piranga ludoviciana*)	< 0.1			
Pyrrhuloxia (*Cardinalis sinuatus*)	< 0.1			< 0.1
Black-headed grosbeak (*Pheucticus melaocephalus*)	0.1	< 0.1		
Lazuli bunting (*Passerina amoena*)		0.2		
Green-tailed towhee (*Pipilo chlorurus*)	0.2	0.2	0.1	0.1
Brown towhee (*Pipilo fuscus*	1.4	1.1	0.6	1.0
Botteri's sparrow (*Aimophila botterii*)	0.1	< 0.1		

	Teb.- Impr.	Teb. Only	Impr. Only	Control
Cassin's sparrow (*Aimophila cassinii*)	1.1	3.0	0.5	1.0
Chipping sparrow (*Spizella passerina*)				< 0.1
Brewer's sparrow (*Spizella breweri*)	6.7	20.7	5.1	5.1
Black-chinned sparrow (*Spizella atrogularis*)		< 0.1		
Vesper sparrow (*Pooecetes gramineus*)	3.8	1.7	0.2	< 0.1
Lark sparrow (*Chondestes grammacus*)	0.4	0.4	0.1	0.2
Black-throated sparrow (*Amphispiza bilineata*)	5.6	16.9	6.7	5.5
Sage sparrow (*Amphispiza belli*)	0.1	0.1	0.2	0.1
Lark bunting (*Calamospiza melanocorys*)	0.4	0.1		
Grasshopper sparrow (*Ammodramus savannarum*)		< 0.1		
White-crowned sparrow (*Zonotrichia leucophrys*)	< 0.1	0.1		
Western meadowlark (*Sturnella neglecta*)	0.2	0.3	< 0.1	
Brown-headed cowbird (*Molothrus ater*)	0.1	0.1		< 0.1
Northern oriole (*Icterus galbula*)		< 0.1		
Scott's oriole (*Icterus parisorum*)	< 0.1	0.1	< 0.1	< 0.1