LARGE-SCALE VEGETATION FEATURES AFFECTING THE DISTRIBUTION AND ABUNDANCE OF GRASSLAND BIRDS

by

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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 AND FISHERIES SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

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ACKNOWLEDGMENTS

This study was funded by the United States Fish and Wildlife Service in cooperation with the University of Arizona under FWS Agreement No. 1448-00002-95-0850. I thank the entire staff of the Buenos Aires National Wildlife Refuge, and in particular William P. Kuvlesky, Jr. and Thea Ulen for providing logistical support and assistance.

I also extend my gratitude and thanks to Chris Kirkpatrick for providing outstanding field assistance and advice. His competence, dedication, and friendship were critical to the success of my fieldwork.

Thanks also to my family who, although they have not done anything for me lately, deserve some credit for supporting me for the first 22 years of my life. Who knows where I would have ended up had they not invested countless hours reading to me as a child.

Much thanks to committee member Larry Howery, who provided an objective voice and valuable criticism. Finally, the utmost of thanks to my advisors Bill Mannan and Steve DeStefano, who made my time here enjoyable and taught me by example what it means to be a good scientist. Though my name alone appears on the title page, I can not emphasize enough that what follows would not have been possible without their help.

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ABSTRACT

I predicted the likely effects of fire on the abundance of grassland birds by determining which vegetal features influenced the distribution and abundance of grassland birds at the Buenos Aires National Wildlife Refuge, Arizona. Abundance of pyrrhuloxia (Cardinalis sinuatus) (r^2 = 0.363), Lucy's warbler (Vermivora luciae) (r^2 = 0.348), and total abundance of birds (r^2 = 0.358) was positively correlated with increasing density of mesquite (Prosopis velutina), whereas abundance of cactus wren (Campylorhynchus brunneicappillus) (r^2 = 0.452) was negatively correlated with increasing mesquite density. Abundance of loggerhead shrikes (Lanius ludovicianus) (r^2 = 0.693) was positively correlated with increasing environmental patchiness. Fire is likely to reduce the density of mesquite, thus I predict that those species positively correlated with mesquite density will decline following fire whereas species negatively correlated with mesquite density will benefit.

INTRODUCTION

Grassland birds have declined more rapidly in the past 25 years than any other avian guild (Knopf 1995), and results from the Breeding Bird Survey indicate that fewer than 30% of grassland species monitored show increasing trends (Sauer et al. 1995). Habitat destruction, primarily the conversion of native grassland to agricultural land, is often implicated in these changes (Sauer et al. 1995). In southeastern Arizona, most grasslands are grazed by livestock, which may result in unsuitable conditions for some species of grassland birds (Bock and Webb 1984). Buenos Aires National Wildlife Refuge, in southeastern Arizona, is the largest ungrazed grassland in the state and as such represents a potentially important source of habitat for grassland birds. However, the exclusion of fire, the invasion of introduced Lehmann lovegrass (Eragrostis lehmanniana), and the encroachment of woody shrub species such as mesquite (Prosopis velutina) all have contributed to the degradation of the ecosystem.

Historical records indicate that woody shrub species were largely absent from these grasslands, and Brown and Archer (1989) speculated that the introduction of livestock coupled with the exclusion of fire facilitated the lateral spread of mesquite out of riparian areas. Efforts to enhance grass production for cattle also led to the introduction of Lehmann lovegrass, which has been able to outcompete native grasses and form large, nearly monotypic stands on upland areas at the Refuge. Bock et al. (1986) reported that stands of Lehmann lovegrass support a reduced abundance of grassland birds, but it appears that this effect is dependent upon the fire history of the area. Recently burned stands of Lehmann lovegrass support bird abundances similar to those found on native grass stands but significantly greater than those found on unburned stands of Lehmann lovegrass (Bock and Bock 1992b). Bock and Bock (1992b) speculated that the thick layers of dead litter which build up in unburned Lehmann lovegrass stands may inhibit foraging of some birds and that fire may ameliorate this condition by reducing the amount of litter. Although Lehmann lovegrass may support fewer individuals, it does not appear to influence the species composition of bird communities. Mesquite, however, does appear to influence bird species richness and based on the habitat needs of grassland birds, it is likely that much of the Refuge now supports a very different bird community than was historically present, primarily as a result of shrub encroachment.

One of the main goals of Refuge managers is the restoration of a native grassland ecosystem similar to one which would have existed before the large-scale conversion of land to cattle production. A return to historical conditions will result in an increase in the dominance of native perennial grasses at the expense of exotic grasses and mesquite trees. The primary tool used to achieve these goals at the Refuge has been prescribed fire, although controversy exists about the effectiveness of fire in reducing Lehmann lovegrass (Ruyle et al. 1988). It is presumed that this restoration project will benefit grassland birds, but it is still unclear exactly how different members of the bird community will respond. Although fire appears to increase the abundance of wintering birds in southeastern Arizona grasslands (Bock et al. 1976; Bock and Bock 1988, 1992b), the effects on breeding birds are more ambiguous. Previous studies in similar grasslands indicate that some species will benefit whereas others will decline in abundance following fire (Bock and Bock 1992b). In addition, little is known about the impacts of mesquite elimination on non-game grassland birds. In the present study, I predicted the effects of fire on grassland birds by identifying relationships between bird abundance and components of the vegetal community that are likely to be affected by fire.

STUDY AREA

This study was conducted on the Buenos Aires National Wildlife Refuge, located in the Altar Valley of south central Pima County, Arizona. Elevations on the Refuge range from 912 to 1460 m. Lehmann lovegrass and mesquite dominate most of the upland areas, whereas native grasses are most abundant in floodplain areas where Lehmann lovegrass occurs in low densities.

The climate of the area is semi-arid, with an average annual rainfall of 40.5 cm. Precipitation follows the pattern typical of the southwestern United States, with 60% falling in July and August and most of the remainder occurring during winter. Temperatures on the Refuge range from -11° C in the winter to 41° C in the summer, with an average monthly mean of 17° C.

METHODS

During the autumn of 1995, I randomly placed 12 25-ha plots (1000 x 250 m) in areas dominated by the Lehmann lovegrass / mesquite cover type, and then bisected each with a 1-km transect. All transects were ≥200-m from the nearest road to minimize disturbance and any edge effect, and all transects were separated by ≥500-m to maintain independence.

During the spring and summer of 1996 I sampled vegetation along the 12 transects to determine percent cover by species, density of mesquite trees, and average size of mesquite trees. To measure percent cover, I divided each of the 1-km transects into a series of 20-m segments of which a subset of 6 was randomly selected for sampling. I measured percent cover by species along these segments using the line-intercept method of Canfield (1941). As suggested by Canfield (1941), I measured grass and herbaceous cover basally and shrub cover at the crown-spread intercept.

I sampled mesquite in 10 10-m radius plots on each transect. The plots were established every 100-m at a random distance (≤60m) perpendicular to each transect. Within each plot, I measured the height and width of all trees which were taller than the grasses. I found that height and width were directly related ($r = 0.949$, $P < .001$), so I arbitrarily chose height as a representative measure of size.

Bird surveys were conducted on each of the 12 1-km transects from April 1996 to August 1996. Each transect was visited 6 times by 2 different observers, with each visit lasting between 15 and 25 minutes. Surveys were postponed or canceled in the event of rain or high winds. To minimize observer-based bias, the observer alternated visits so that each observer made 3 non-consecutive visits to each transect. The order in which the transects were surveyed was determined randomly at the beginning of the study. We used a fixed-width transect method, counting all birds heard or seen within 125-m of either side of the transect. Because I could not assume that every individual was counted in this strip, values reported are for abundance rather than density.

At least 3 important vegetal characteristics are likely to change significantly following fire: percent cover of grasses, density of mesquite, and average size of mesquite (Cable 1967, Bock et al. 1976, Bock and Bock 1992a). I compared the mean values of these variables with the abundance of all bird species with >20 observations using simple linear regression. In addition, I assessed the effect of environmental patchiness by comparing bird abundances with the coefficient of variation of mesquite density.

RESULTS

Vegetation

Mesquite densities on the study plots ranged from 2,785 to 6,366 trees / 25 ha, and average tree height ranged from 1.3 to 3.1 m (Table 2). Using a GIS database, I determined that 76% of the Refuge supports a similar range of mesquite densities. Regression analysis revealed a positive relationship between average tree height and mesquite density ($r = 0.768$, $P = 0.004$) (Figure 5). Percent cover of grasses was uniformly low across all plots and Lehmann lovegrass was the dominant grass species (Table 3). All of the plots were characterized by a lack of low ground cover (grasses or herbs) with moderate shrub cover and abundant areas consisting of either bare ground or dead litter (Table 4). In addition, mesquite was the dominant shrub species (Table 4), although snakeweed (Gutierrezia sp.). and burroweed (Isocoma tenuisecta) were also common and often formed large, unbroken stands together.

Habitat Relationships

I detected 857 individuals of 29 species of birds between April and August 1996, which I defined as the breeding season (Table 1). I found 4 significant relationships between bird abundance and mesquite density. Total abundance of birds and the abundance of Lucy's warbler (Vermivora luciae) and pyrrhuloxia (Cardinalis sinuatus) were positively correlated with an increase in the density of mesquite (Figs. 1, 2, 3). Conversely, the abundance of cactus wrens (Campylorhynchus brunneicapillus) was negatively correlated with an increase in the density of mesquite (Figure 4). Neither Cassin's sparrow (Aimophila cassinii) (r = -0.03, P = 0.921) nor Botteri's sparrow (A. botterii) (r = 0.241, P = 0.442), both of which are species of management concern (USFWS 1995), exhibited a significant relationship with any of the vegetation variables I measured.

The data for cactus wren abundance contained one outlying value which resulted from a series of observations of a family group consistently occurring directly adjacent to the transect for several weeks. Because I felt this resulted in a biased estimate of abundance, I excluded this study plot prior to analysis and thus results for cactus wren are based on data from 11 plots rather than 12. Inclusion of these data, however, did not affect the significance of the test although it did result in a lower r-value.

Finally, I found that loggerhead shrike abundance was positively correlated with an increase in environmental patchiness, measured as the coefficient of variation of mesquite density (Figure 6). The coefficient of variation measures the degree of variability among the estimates of mesquite density, giving an indication of the patchiness of mesquite distribution. Thus, areas with a high value for this coefficient were characterized by scattered stands of mesquite interspersed with areas of open grassland.

DISCUSSION

Habitat Relationships

Density of mesquite appears to be an important factor in determining the distribution of grassland birds on the Refuge. I found that pyrrhuloxia and Lucy's warblers were more abundant in areas of relatively dense mesquite, whereas cactus wrens were less abundant in these areas. These trends fit well with previous descriptions of breeding habitat for these species. Pyrrhuloxia are considered to be a species of shrubby edges, often building their nests in mesquite trees (Bent 1968). Lucy's warbler, one of two cavity-nesting North American warblers, is likely dependent on mesquite for both nesting and foraging sites (Ehrlich et al. 1988). Although little is published about the habitat requirements of the cactus wren, they appear to prefer nesting in cholla cacti (Opuntia sp.) (McGee 1985, Farley and Stuart 1994), which were absent from areas with high densities of mesquite.

Loggerhead shrikes were more abundant on plots with a patchy distribution of mesquite trees. Given their ecological requirements, this is not surprising. Loggerhead shrikes rely upon elevated perches in open areas from which to hunt their prey, and thus would benefit from a mix of open grassland and scattered mesquite (Ehrlich et al. 1988). In addition to providing hunting perches, shrikes on the study area probably also rely upon mesquite as a nesting substrate (Ehrlich et al. 1988, J. Lloyd pers. obs.).

Effects of Fire on Mesquite

Previous research in the semi-desert grasslands of southeastern Arizona indicates that fire temporarily reduces shrub density, including mesquite (Humphrey 1958, Cable 1967, Bock and Bock 1992a,b). Bock and Bock (1992a) reported a 1 year reduction in density of as much as 64% for some shrub species, whereas Cable (1967) reported 1 year reductions in mesquite density ranging from 5 - 31%. Blydenstein (1957) reported that 52% of mesquite trees <0.5 inches in diameter died following a summer fire but that mortality of trees >0.5 inches in diameter was only 8 - 15%. It is clear that smaller mesquite individuals are more susceptible to fire mortality, thus the effect of fire on mesquite will depend both on fire conditions and on the size of individuals. Top-killed mesquite resprout quickly from their root crowns, although they may only regain 50% of their original height within the next three years (Bock and Bock 1992b). Thus, fire is capable of effecting relatively dramatic, albeit temporary, changes in the structure of shrubby grasslands. In addition, it is possible that repeated burning would result in a more permanent reduction in mesquite density, especially if smaller, resprouting individuals were subjected to fire (Martin 1983). However, my data indicate that the most dense stands of mesquite on the Refuge are made up of relatively large and invulnerable individuals which are less likely to be killed by fire. Therefore, in the absence of a relatively intense fire, or perhaps even a series of intense fires, mesquite densities are not likely to change significantly across my study area.

Predictions

Based on the previously reported effects of fire on mesquite, it appears that fire is more likely to top-kill and defoliate trees rather than kill them outright. The defoliated husks of wood which are left aboveground following a fire are unlikely to provide suitable sites for nest-building. Because of this, breeding birds are unlikely to differentiate between top-killed and dead mesquite until resprouting occurs. Thus, although fire may not reduce the density of mesquite per se, it does reduce the effective density of mesquite by changing the structure and reducing the amount of nesting cover for breeding birds. Combining this with the observed habitat relationships, I predict that fire will result in a reduction in the abundance of pyrrhuloxia and Lucy's warbler as well as in total bird abundance. Cactus wrens, preferring areas of low mesquite density, are predicted to increase in abundance following fire, dependent on presence or growth of cacti. The degree of change which occurs in abundance of any species will likely depend on the extent of mesquite mortality and, in the absence of additional burning, will be temporary.

The response of loggerhead shrikes to fire is likely to be strongly dependent on the extent and intensity of the burn. I found that shrikes were more abundant in areas with a mixture of open grassland and scattered mesquite, thus I predict that they would benefit from fires which created patchy openings but, because of their dependence on shrubs, would decline following a fire intense enough to cause widespread mesquite mortality. However, given that such fires are rare at the Refuge, it seems likely that loggerhead shrikes will benefit from the increased patchiness which often follows prescribed burning.

In assessing the accuracy of the predictions, it is important to consider the causes underlying the observed relationships. Correlative tests, such as those I used, do not necessarily identify the biologically important variables (Martin 1989). Therefore, the habitat features which I have identified as important may only be correlated with the actual features influencing distribution and abundance. Despite this, pyrrhuloxia and Lucy's warblers both seem likely to comply with my predictions due to their local dependence on mesquite for breeding habitat. Similarly, loggerhead shrikes are apt to conform to my predictions given their dependence on scattered mesquite for both nesting and foraging. The accuracy of this prediction will hinge, however, on the extent and intensity of the fire. In addition, other birds dependent on mesquite for nesting and foraging, such as blue grosbeaks (Guiraca caerulea) and ash-throated flycatchers (Myiarchus cinerascens) also are apt to decline when mesquite becomes less dense. The loss of this shrub-dependent bird community likely will diminish the overall bird abundance and species richness throughout the study area. The prediction that cactus wrens will increase in abundance, however, is more tenuous. Study plots with the highest densities of mesquite supported few cacti. Thus, their absence may be only an indirect result of increased mesquite density, and if so then fire will have little immediate effect on cactus wren populations in the area.

Although the results suggest that mesquite density is an important structural feature determining the distribution of birds in these grasslands, we await post-burn results with which to evaluate the predictions. Based on information about the range of mesquite densities on the Refuge and the areal extent of the Lehmann lovegrass / mesquite cover type, I believe that my study areas are representative of conditions across most of the Refuge. However, further research is needed across a broader range of conditions to both increase the sphere of inference and to elucidate any further relationships which may exist. This study, due to the limited physiognomic diversity of the Refuge, was conducted on only a relatively narrow range of mesquite densities yet still yielded several significant relationships. This leads me to believe that more extensive studies, ranging from areas of no mesquite cover to areas of dense mesquite growth, would reveal that the distribution and abundance of many of the Refuge's bird species is influenced by the density of mesquite. The abundance of a number of species in the present study had a positive, but non-significant, relationship with mesquite density, further supporting this contention.

Though this model does not investigate the processes underlying changes in distribution and abundance of grassland birds following fire, it may prove to be an effective tool for generating predictions. In particular, it may provide a new avenue for managers needing efficient methods for evaluating the impacts of changing vegetation structure on grassland birds. The information necessary to generate predictions is relatively easy to obtain, and could be obtained during monitoring projects which are becoming increasingly common on public lands. However, the results obtained here should not be used as the sole basis for evaluating habitat quality, for I gathered no information on reproductive success. As Van Horne (1983) and Vickery et al. (1992) have pointed out, relying on numbers alone is a poor way to evaluate habitat quality.

MANAGEMENT IMPLICATIONS

The recent spread of mesquite out of riparian areas and into uplands at the Refuge has allowed shrub-dependent bird species to expand into areas that they were unlikely to have inhabited historically. Although this physiognomic shift has benefited some species, it also appears to have created unsuitable conditions for others. Grassland-obligate birds such as grasshopper and lark sparrows (Chondestes grammacus) were absent from the study area during the breeding season, and Botteri's sparrow occurred only in low numbers. These species are considered to be sensitive to the encroachment of woody shrubs (Bent 1968, Ehrlich et al. 1988) and were likely excluded from those areas where mesquite density is highest.

Because of the influence it has on the upland bird community, the reduction of mesquite may be one of the most important outcomes of prescribed burning. It is likely that fire will have strong impacts on bird community composition, with open grassland species and species benefiting from increased heterogeneity favored over those species characteristic of mixed shrub grasslands. Because of the dominance of shrub-dependent species on my study area, this shift will likely result in an overall decline in bird abundance and species richness, although the magnitude of the change will be dependent on fire intensity and the ability of open grassland species to colonize newly created and ephemeral habitat. Many of the birds likely to decline or disappear locally as a result of lowered mesquite densities are probably only recent invaders of the converted grassland, and thus should be of less concern than species historically native to the area. Rather, it is probably more important to focus on fire-related impacts to particular species, particularly those of management concern such as Cassin's or Botteri's sparrow. Although my data do not indicate a significant relationship between abundance of either species and density of mesquite, both species are reported to prefer nesting in open grassland with scattered shrubs or small trees and avoid areas of dense brush (Bent 1968). Based on this information, it is likely that both Cassin's sparrow and Botteri's sparrow will benefit from a reduction in the density of mesquite. Given the potentially sensitive status of populations of both species, monitoring their response to fire should be an integral part of any plan to use prescribed burning in the restoration of a native grassland ecosystem on the Refuge. Finally, this study indicates that fire is likely to be an important part of any effort to restore native bird communities on the Refuge. Although there is currently much debate about the efficacy of using prescribed burning to eliminate Lehmann lovegrass, the continued use of fire is likely to reduce the density of mesquite on the Refuge and in doing so allow for the return of historical grassland bird communities. At this point, the benefits to grassland birds of removing mesquite appear to outweigh any negative effects of increasing the density of Lehmann lovegrass. Thus, I encourage managers to continue experimenting with fire as a part of the larger, overall attempt to restore native Sonoran savanna.

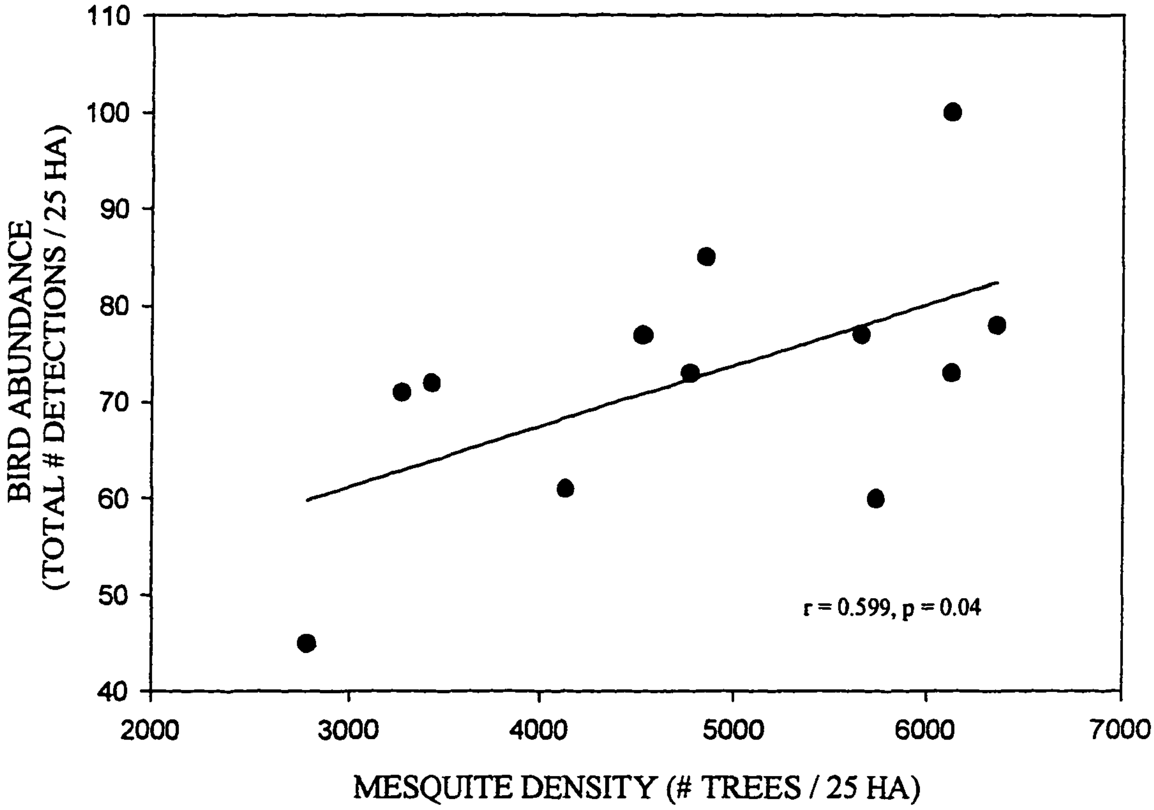

Figure 1. The relationship between overall bird abundance and mesquite density on the Buenos Aires National Wildlife Refuge, Arizona between April and August 1996.

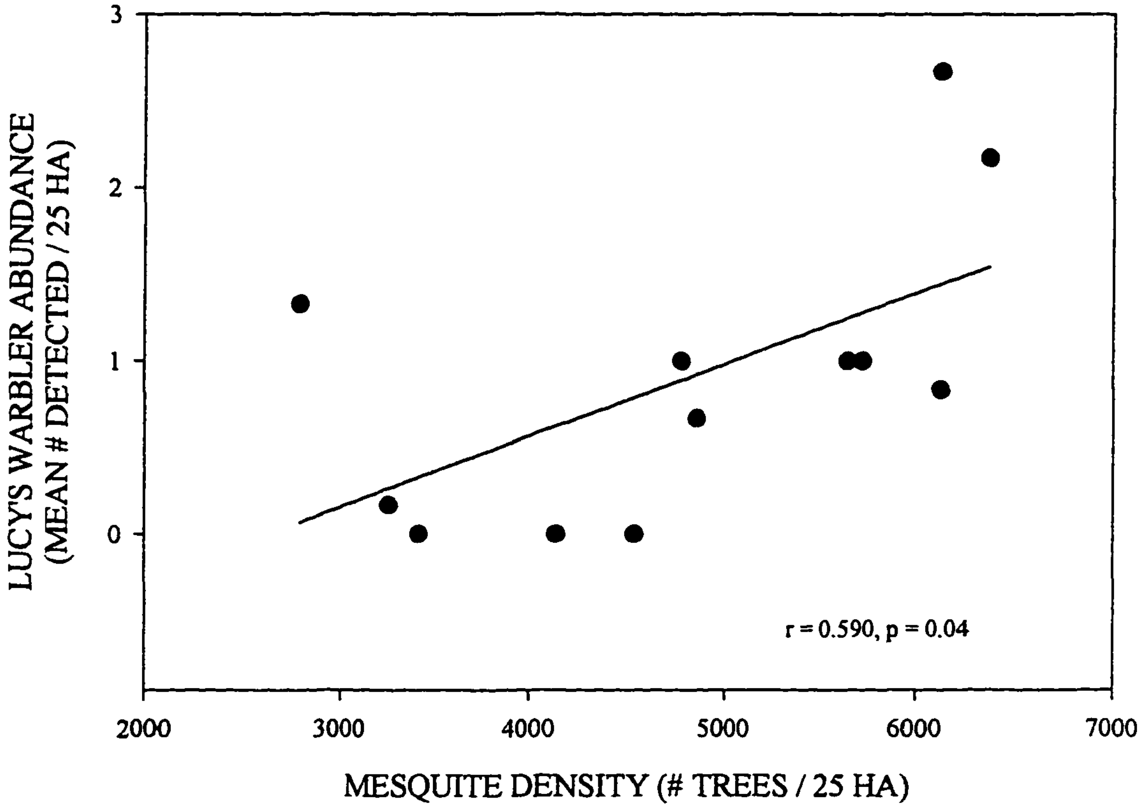

Figure 2. The relationship between Lucy's warbler abundance and mesquite density on the Buenos Aires National Wildlife Refuge, Arizona between April and August 1996.

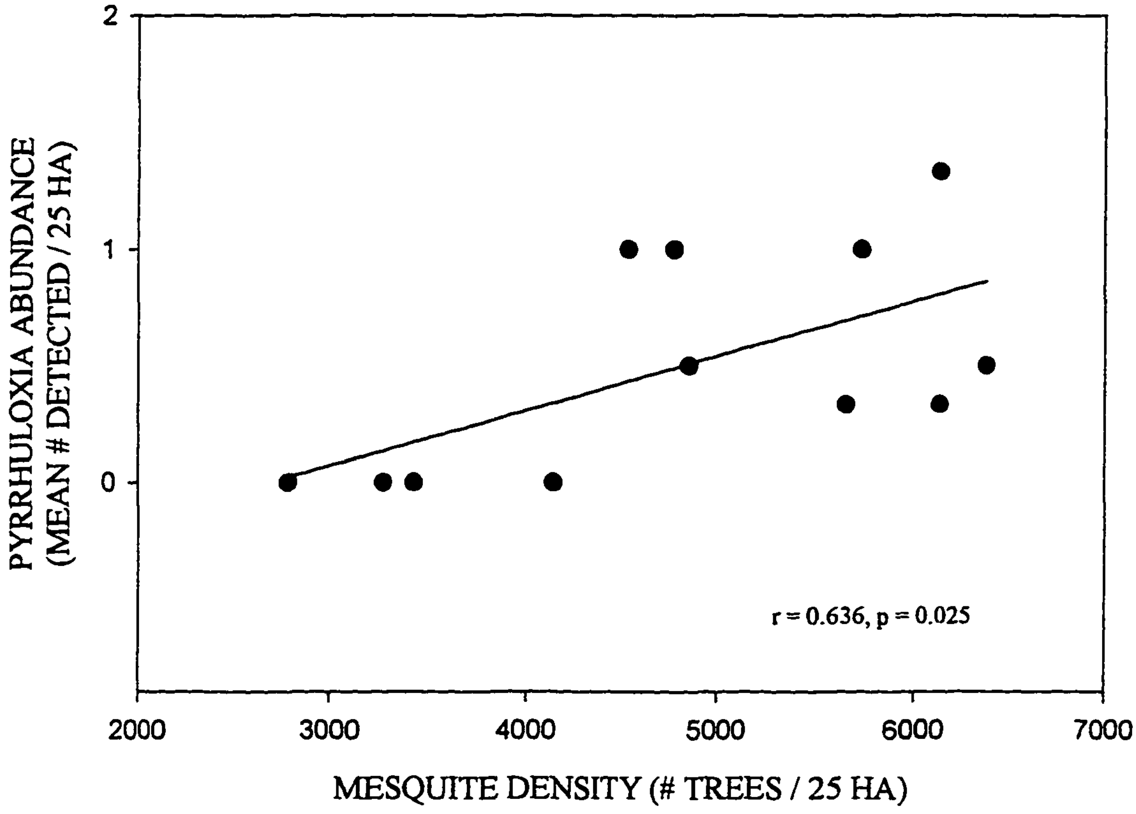

Figure 3. Relationship between pyrrhuloxia abundance and mesquite density on the Buenos Aires National Wildlife Refuge, Arizona between April and August 1996.

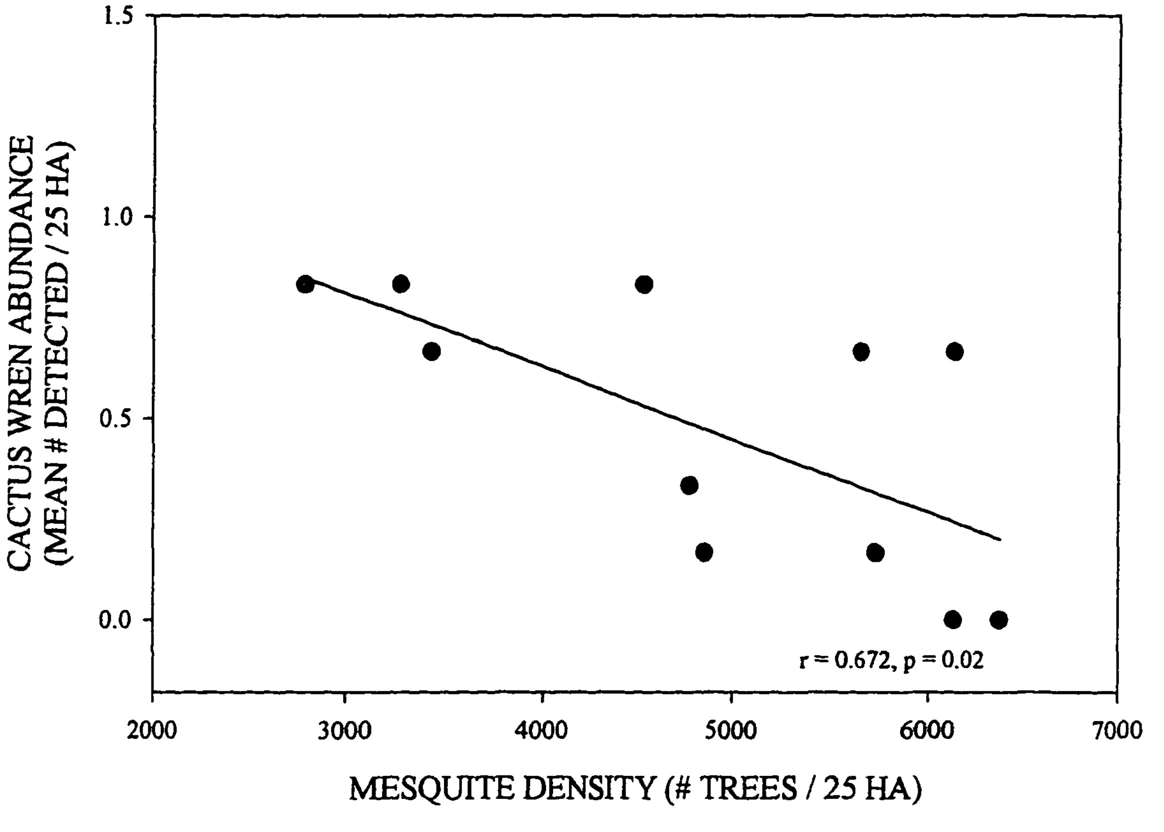

Figure 4. The relationship between cactus wren abundance and mesquite density on the Buenos Aires National Wildlife Refuge, between April and August 1996.

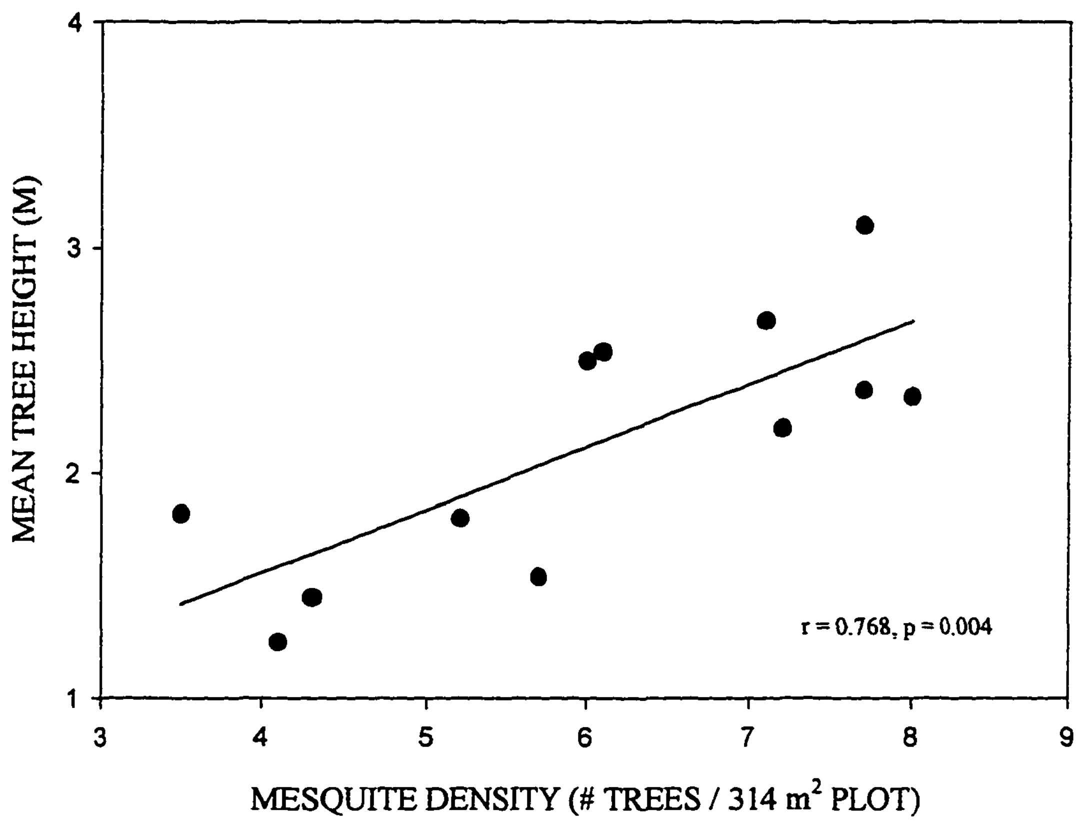

Figure 5. Relationship between mean height of mesquite trees and mean mesquite density per 314 m^2 plot on the Buenos Aires National Wildlife Refuge, Arizona in July 1996.

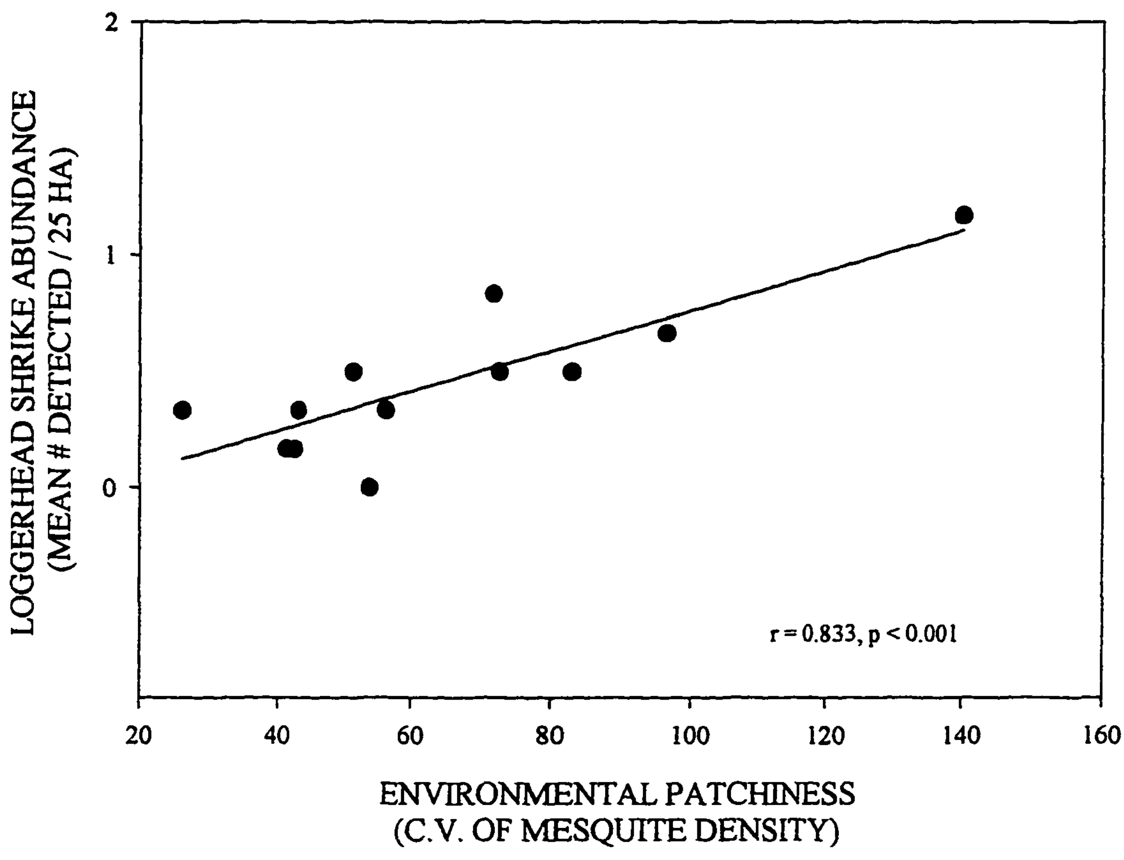

Figure 6. The relationship between loggerhead shrike abundance and environmental patchiness, measured by the coefficient of variation of mesquite density.

Table 1. Total bird detections from 6 visits to 12 1-km transects at the Buenos Aires National Wildlife Refuge, Arizona, April to August 1996.

Species	Total number detected
black-throated sparrow (Amphispiza bilineata)	251
Eastern meadowlark (Sturnella magna)	101
Lucy's warbler (Vermivora luciae)	65
Cassin's sparrow (Aimophila cassinii)	57
cactus wren (Campylorhynchus brunneicappillus)	46
ash-throated flycatcher (Myiarchus cinerascens)	46
Northern mockingbird (Mimus polyglottos)	45
pyrrhuloxia (Cardinalis sinuatus)	36
loggerhead shrike (Lanius ludovicianus)	33
mourning dove (Zenaida macroura)	23
blue grosbeak (Guiraca caerulea)	21
Botteri's sparrow (Aimophila botterii)	17
Western kingbird (Tyrannus verticalis)	14
brown-headed cowbird (Molothrus ater)	14
horned lark (Eremophila alpestris)	14
Bullock's oriole (Icterus bullocki)	11
canyon towhee (Pipilio fuscus)	11
verdin (Auriparus flaviceps)	10
white-winged dove (Zenaida asiatica)	7
Bell's vireo (Vireo bellii)	7
Bewick's wren (Thryomanes bewickii)	5
black-tailed gnatcatcher (Polioptila melanura)	4
rufous-crowned sparrow (Aimophila ruficeps)	4
Northern cardinal (Cardinalis cardinalis)	4
phainopepla (Phainopepla nitens)	3
lesser nighthawk (Chordeiles acutipennis)	3
western flycatcher (Empidonax difficilis)	3
vermilion flycatcher (Pyrocephalus rubinus)	1
ladder-backed woodpecker (Picoides scalaris)	1

Table 2. Mean mesquite density and tree height on 12 25-ha study plots sampled during June and July 1996 at the Buenos Aires National Wildlife Refuge, Arizona.

Plot	Density (Trees / 25 ha)	SE	Average height (m)	SE
01	4,138	541.0	1.8	0.16
02	3,421	557.1	1.5	0.19
03	4,536	1192.5	1.5	0.24
04	3,263	945.0	1.3	0.16
05	6,127	1027.0	3.1	0.19
06	5,650	1302.0	2.7	0.21
07	2,785	379.8	1.8	0.13
08	6,127	1393.8	2.4	0.10
09	5,730	2538.8	2.2	0.14
10	4,854	2070.1	2.5	0.18
11	4,775	813.3	2.5	0.26
12	6,366	1665.1	2.3	0.15

Table 3. Percent cover of grasses at the Buenos Aires National Wildlife Refuge, Arizona sampled during March and April 1996.

Species	Percent Cover
Plot 01	
Aristida sp.	0.42
Digitaria californica	0.46
Bouteloua sp.	1.46
Bothriochloa barbinodis	0.25
Eragrostis intermedia	3.17
Eragrostis lehmanniana	3.29
Plot 02	
D. californica	0.83
Bouteloua sp.	0.25
B. barbinodis	0.96
E. intermedia	1.17
E. lehmanniana	5.42
Plot 03	
D. californica	0.29
Bouteloua sp.	0.33
E. lehmanniana	8.42
Plot 04	
Aristida sp.	0.50
D. californica	0.88
Bouteloua sp.	0.67
B. barbinodis	0.54
E. intermedia	0.42
E. lehmanniana	5.54
Plot 05	
D. californica	1.08
E. intermedia	0.25
E. lehmanniana	12.08

Table 3. Continued

Species	Percent Cover
Plot 06	
Aristida sp.	0.38
D. californica	0.42
B. barbinodis	0.88
E. intermedia	0.42
Heteropogon contortus	0.17
E. lehmanniana	6.79
Plot 07	
Aristida sp.	0.04
D. californica	0.83
B. barbinodis	0.17
E. intermedia	9.79
H. contortus	0.25
E. lehmanniana	5.00
Plot 08	
D. californica	0.13
E. intermedia	0.54
H. contortus	0.25
E. lehmanniana	9.54
Plot 09	
Aristida sp.	1.20
D. californica	0.63
B. barbinodis	0.25
E. intermedia	0.38
E. lehmanniana	2.38
Plot 10	
Aristida sp.	0.29
D. californica	0.67
E. intermedia	0.42
E. lehmanniana	4.88

Table 3. Continued.

Species	Percent Cover
Plot 11	
Aristida sp.	0.54
D. californica	0.21
E. intermedia	0.50
H. contortus	0.83
E. lehmanniana	6.13
Plot 12	
Aristida sp.	0.38
D. californica	0.46
Bouteloua sp.	1.08
E. intermedia	0.21
H. contortus	0.17
E. lehmanniana	4.33

Table 4. Percent cover of shrubs and bare ground / litter on 12 study plots sampled during March and April 1996 at the Buenos Aires National Wildlife Refuge, Arizona.

Species		Percent Cover
	Plot 01	
Prosopis velutina		6.08
Gutierrezia sp.		0.24
bare ground / litter		85.46
	Plot 02	
P. velutina		3.08
bare ground / litter		87.91
	Plot 03	
P. velutina		9.83
bare ground / litter		83.79
	Plot 04	
bare ground / litter		90.79
	Plot 05	
P. velutina		4.17
Gutierrezia sp.		7.00
Isocoma tenuisecta		12.41
bare ground / litter		60.75
	Plot 06	
P. velutina		10.80
Gutierrezia sp.		8.13
I. tenuisecta		0.88
bare ground / litter		72.42
	Plot 07	
P. velutina		4.91
Gutierrezia sp.		1.58
I. tenuisecta		1.41
bare ground / litter		76.67

Table 4. Continued.

Species		Percent Cover
	Plot 08	
P. velutina		9.75
Gutierrezia sp.		4.16
I. tenuisecta		2.08
bare ground / litter		72.91
	Plot 09	
P. velutina		10.16
Gutierrezia sp.		8.13
I. tenuisecta		8.33
bare ground / litter		71.00
	Plot 10	
P. velutina		5.33
Gutierrezia sp.		8.96
I. tenuisecta		9.13
bare ground / litter		71.45
	Plot 11	
P. velutina		18.08
Gutierrezia sp.		9.20
I. tenuisecta		3.45
bare ground / litter		65.33
	Plot 12	
P. velutina		7.16
Gutierrezia sp.		4.75
I. tenuisecta		8.75
bare ground / litter		74.38

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