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Home range, habitat use, and movements of reintroduced masked bobwhite

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HOME RANGE, HABITAT USE, AND MOVEMENTS OF REINTRODUCED MASKED BOBWHITE

by

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TABLE OF CONTENTS

LIST OF TABLES

Table Page

LIST OF ILLUSTRATIONS

ABSTRACT

Home range, habitat use, and movements of reintroduced masked bobwhite (Colinus virginianus ridgewayi) were studied during 1986-88 on the Buenos Aires National Wildlife Refuge in southern Arizona. Home ranges averaged 10.9 ha (5.2-14.6 ha), and core areas averaged 1.1 ha (0.2-2.7 ha). Core areas had significantly higher visual obstruction by vegetation from 0-1 dm, aerial and basal grass cover, and significantly lower bare ground, litter, half-shrub cover, half shrub density, and visual obstruction by vegetation from 5-20 dm than non-core areas. The majority of the masked bobwhite moved less than 1 km between their release location and the site of first trapping. However, some long distance movements occurred. Once home ranges were established, masked bobwhite seldom left the boundaries. Key habitat components are identified for masked bobwhite on the Buenos Aires National Wildlife Refuge.

INTRODUCTION

Herbert Brown first described the masked bobwhite (Colinus virginianus ridgwayi) in Arizona in 1884. Its historic range in Sonora, Mexico extended south to Guaymas, east to the Sierra Madre foothills, west to within 42 kilometers of the Gulf of California, and north to the U.S./Mexican border. In the U.S., the masked bobwhite occurred in the Altar and Santa Cruz valleys of Arizona (Brewster 1887, Brown 1904, Ligon 1952). A combination of overgrazing and severe drought in the early 1900s destroyed masked bobwhite habitat and extirpated it from Arizona (Brown 1904, Gallizioli et al. 1967). The masked bobwhite is now listed as an endangered species by the U.S. Fish and Wildlife Service (1975). Only remnant populations of masked bobwhite remain in Sonora, Mexico where overgrazing, shrub intrusion, and creation of buffel grass (Pennisetum ciliare) monocultures are destroying the remaining habitat (Gallizioli et al. 1967, Tomlinson 1972, Mills and Reichenbacher 1982)

Little is known about the historic habitats occupied by masked bobwhite except in general terms. Brown (1885) described masked bobwhites as occurring in the grassy plains and mesas of the Altar Valley and as absent in the brushy canyons. Stephens (1885) found bobwhites in the "best grass seen on route" during his travels in southern Arizona. Due to overgrazing and drought, the vegetative composition of historic masked bobwhite range has changed markedly since the turn of the century. Remnant populations of masked bobwhite in Sonora have been associated with dense grass-forb habitat (Ligon 1952) and dense stands of perennial grasses (Gallizioli et al. 1967). Tomlinson (1972) reported that masked bobwhite in Sonora prefer grassland habitat with some mesquite (*Prosopis*) and "edge" areas where brush and trees abut open grassland. Limited data on masked bobwhite reintroduced into the Altar valley of Arizona from 1975-80 indicated that they preferred areas with high plant diversity such as occur in bottomlands and "edges" where mesquite-lined washes adjoin open grass-forb sites (Goodwin and Hungerford 1977).

Home range sizes and seasonal movements have not been investigated for the masked bobwhite. Knowledge of these factors as well as a more detailed understanding of habitat requirements are important criteria in the ongoing reintroduction and management activities for masked bobwhite on the Buenos Aires National Wildlife Refuge. The objectives of this study were to (1) determine sizes of masked bobwhite home ranges and core areas, (2) describe habitat within home ranges and core areas, (3) compare habitat characteristics between core and non-core areas in masked bobwhite home ranges, (4) compare habitat characteristics between masked bobwhite home ranges and representative sites on the refuge, and (4) examine seasonal movements for the reintroduced masked bobwhites.

STUDY AREA

The study area was located on the southern portion of the Buenos Aires National Wildlife Refuge. The refuge is 45,325 hectares and is located in the Altar Valley, southeast of Tucson, in Pima County, Arizona (Figure 1).

The climate of the area is characterized by low precipitation, low humidity, and high summer temperatures. Annual precipitation averages 40 centimeters with approximately 40% occurring during July and August. The mean annual temperature is approximately 15 C, and temperatures range from lows of -11 C in winter to 41 C in summer (U.S. Fish and Wildlife 1985).

Elevations within the study area range from 910 to 1070 meters. Soils in the lowland areas belong to the White House Bernardino-Caralampi Association which encompasses soils greater than 175 centimeters in depth. Upland areas include rock outcrops with interspersed shallow to very shallow soils of the Rock Outcrop Lampshire Cellar Association (U.S. Fish and Wildlife 1985).

The refuge is predominately semi-desert grassland with small remnant areas of Sonora Savannah grassland. Land-use practices in the past have dramatically changed this area of the Altar valley. Native perennial grasses have been reduced and in some cases probably extirpated. Mesquite has become widespread and is no longer confined to bottomland sites.

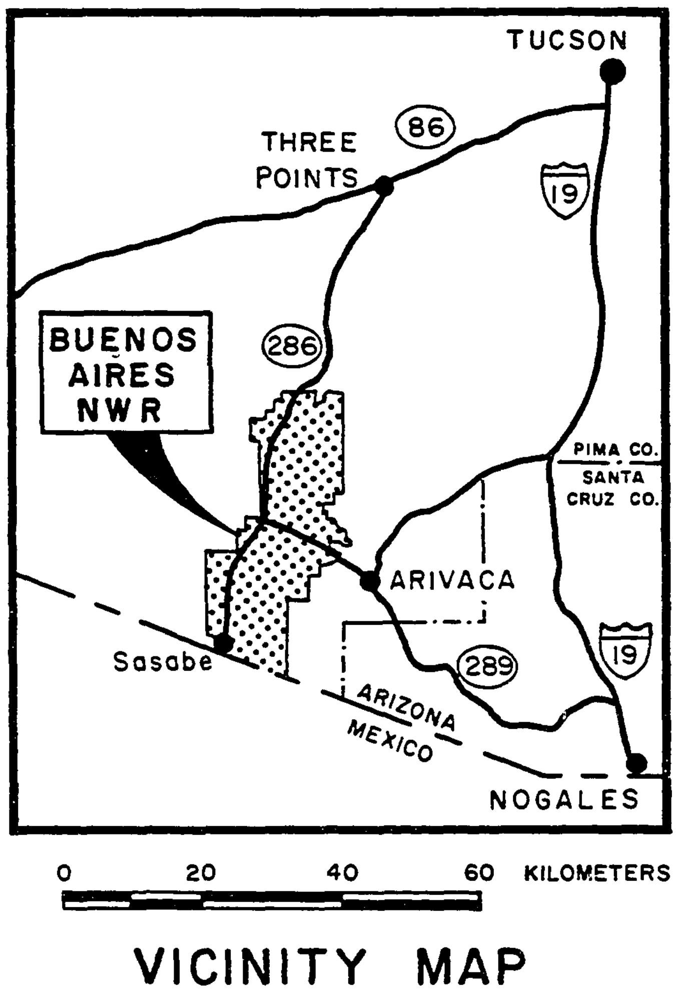

Figure 1: Vicinity map of the Buenos Aires National Wildlife Refuge.

Upland sites in many areas are dominated by the weedy halfshrubs, snakeweed (_Gutierrezia sarothrae_) and burroweed (_Aplopappus tenuisectus_) and by the introduced Lehmann's lovegrass (_Eragrostis lehmanniana_). Many bottomland sites are dominated by the introduced Johnsongrass (_Sorghum halepense_) and others have been cleared, irrigated and planted with other introduced grasses. Native grasses such as the grammas, (_Bouteloua_ spp.), the dropseeds (_Sporobolus_ spp.) and some species of three-awns (_Aristida_ spp.) still persist in many sites on the refuge, particularly in bottomland areas.

The refuge is home to a wide variety of wildlife including 2 other species of quail: Gambels quail (_Callipepla gambelii_) and scaled quail (_Callipepla squamata_). Possible predators of the bobwhite include a number of species of resident and migratory raptors, coyotes (_Canis latrans_), badger (_Taxidea taxus_), and striped and spotted skunks (_Mephitis mephitis_) and (_Spilogale gracilis_).

METHODS

Release Technique

Since 1985, masked bobwhite have been released on the Buenos Aires National Wildlife Refuge during June-September of each year by refuge personnel. The chicks were pen-reared at Patuxent Wildlife Research Center in Maryland and were shipped to the refuge at 3-4 weeks of age. Groups of 15 chicks on the average were then adopted to and released with vasectomized Texas bobwhite (*Colinus virginianus texanum*) males (Ellis et al. 1978). Release locations were selected by the refuge manager and biologist. All birds released were toe-clipped and sequentially numbered with a metal patagial marker (Monel metal animal ear tag #1, Gey Band and Tag Company, Norristown, Pennsylvania).

Radio Telemetry

I located reintroduced bobwhite using bird dogs, quail drives, and incidental observations. I trapped 70 masked bobwhite using Stoddard (1931) standard quail traps and tunnel traps baited with chicken scratch. I outfitted 49 masked bobwhite (25 males and 24 females) with radio transmitters (Wildlife Materials, Carbondale Illinois) which were attached bib-style to each bird (Amstrup 1980). The transmitter outfit weighed between 4.5 and 5.0 grams. I attempted to locate each bird a minimum of 4 times per week at random time periods throughout the daylight hours. I obtained the locations by triangulating from a minimum distance of 30-40 meters and from flushing the birds once a week.

Home Range Calculations

I plotted the bobwhite locations on acetate overlays on aerial photos of the refuge (1986, scale 1:4500). Once I obtained a minimum of 15 relocations to delineate a home range, I overlaid a grid on the aerial photo and assigned an x,y coordinate to each location. I used the minimum convex polygon method (Mohr 1947) on McPaal software (Smithsonian, version 2.1) to calculate the outer boundaries and area of each home range. I used the harmonic mean method (Dixon and Chapman 1980) on McPaal software to calculate core areas based on 50% contour lines.

Based on my observations of when bobwhites were first seen in pairs and then in coveys, I divided the year into a non-breeding season (mid-October to early May) and a breeding season (mid-May to early October). I calculated 8 home ranges for masked bobwhite based on relocation data from radio-tagged birds. The Middle Mormon (MM), Lake (LK), and Shop (SH) home ranges were determined during the 1986-87 non-breeding season. The Burnt Corral 1 (BC1), Burnt Corral 2 (BC2), and Showbarn (SB) home ranges were determined during the 1987 breeding season. The Mormon Corral (MC) and Garcia (G) home ranges were determined during the 1987-88 non-breeding season. Six of the 8 home ranges had enough relocations to enable me to calculate core areas. The number of relocations used to calculate home range boundaries varied from 17 to 51. Home range data for individual home ranges is summarized in Appendix A: Table A-1.

Vegetation Sampling

After I calculated home range and core area boundaries, I established temporary 30 meter transects within each home range to sample vegetation. The transects were located within each home range using stratified random sampling. The number of transects placed in masked bobwhite home ranges varied from 8 to 40 and represented an average of 3 transects/ha. The number of transects placed in masked bobwhite core areas varied from 3 to 9 and represented between 13 and 23 percent of the total number of transects within each home range. The remainder of the home range transects were placed in the non-core areas of the home ranges. I overlaid a grid on each home range and selected random starting coordinates and a random direction for each transect. I established the transects so that they did not cross home range or core area boundaries or each other.

I sampled 240 vegetation transects in masked bobwhite home ranges. Vegetation transects in home ranges calculated for the 1986-87 non-breeding season were sampled during May and June of 1987. Vegetation transects in home ranges calculated for the 1987 breeding season were sampled during

July to September of 1987. Vegetation transects in home ranges calculated for the 1987-88 non-breeding season were sampled during March of 1988. Vegetation transect data is summarized for the individual home ranges in Appendix A: Table A-2.

The refuge range conservationist also established 27 permanent 30 meter transects in representative areas throughout the refuge. Sixteen of the transects were placed in upland sites and 11 were placed in bottomland sites. Sites were defined by elevation and soil type. These transects provided a source of comparison for vegetation data obtained from the home range transects as both were sampled using the same methods. The representative transects were sampled in September 1987.

I sampled percent cover, by species, of trees, shrubs, half-shrubs, and grasses along each 30 meter transect using Canfield's (1941) line-interception method. All individual plants of these vegetation forms were measured if any part of the plant intercepted the vertical plane of the 30 meter transect. Measurements were of aerial cover (centimeters of the transect covered by an aerial projection of the crown on the ground). Basal cover was also measured for perennial grasses. I recorded heights for all trees, shrubs, and half-shrubs which intercepted the transect.

I estimated aerial cover of forbs and cover of litter and bare ground using 0.2 x 0.5 meter Daubenmire (1959) plots. Ten Daubenmire plots were located along each 30 meter transect, 1 every 3 meters, beginning at the 3 meter mark. The plots were oriented lengthwise to the transect and were alternated on each side of the tape. The percent cover of grasses, forbs, bare ground, and litter was recorded by species in 1 of 6 categories: 0-5%, 6-25%, 26-50%, 51-75%, 76-95%, and 96-100%. Only plants with greater than 50 percent of their base rooted within the plot were included in the estimate.

I sampled the density of half-shrubs in a 120 meter square plot which encompassed a 2 meter wide strip along each side of the 30 meter transect. Within this plot, I counted all standing half-shrubs, by species, whether dead or alive. I obtained densities of trees and shrubs from direct counts in the home ranges.

I sampled the vertical structure of vegetation using a range-pole technique based on that of Robel et al. (1970). A 2 meter steel range pole was divided into decimeter (dm) increments by alternating color bands. Beginning at the 3 meter mark, the pole was alternately placed 1 dm to the right and then the left of the tape every 3 meters. Sections of the pole obscured by vegetation were recorded to the nearest 0.5 dm, and the form of obstructing vegetation also was recorded. At each of the 10 locations, the pole was read from both sides of the transect at a perpendicular distance of 4 meters and a height of 1 meter. This procedure provided 20 readings per transect. The definition of vegetation form (tree, shrub, half-shrub, grass, forb) was by species and not by size class. Scientific names of forbs, half-shrubs, shrubs, and trees were obtained from Kearney and Peebles (1964). Scientific names of grasses were obtained from Gould (1981).

Movements

Three sources of information were used to examine seasonal movements. Movements of radio-tagged quail were determined with radio telemetry. Incidental observations of quail provided information on the timing of pair and covey formation. Trapping returns of marked birds enabled me to identify distances moved from release locations.

Statistical Analysis

I tested for differences in vegetation between core and non-core areas within each home range using Mann-Whitney U-Wilcoxon Rank-Sum W tests. The variables examined included percent ground cover of grasses (aerial and basal), forbs, half-shrubs, trees/shrubs, bare ground, and litter; vertical structure of grasses, trees, and all vegetation in 10 dm height intervals; and density of half-shrubs. Small sample sizes did not permit testing for differences in percent cover or densities of individual vegetation species between core and non-core areas. I chose the Mann-Whitney test due to the small sample sizes involved in these comparisons. A T-test was used to compare density of trees in 3 height classes between core areas and non-core areas.

To increase the sample size available for statistical tests of percent ground cover, density of half-shrubs, and vertical structure of vegetation between core and non-core areas, I combined transects from all home ranges. I then tested for differences with the Mann-Whitney U-Wilcoxon Rank Sum W test and the T-test.

I tested for significant differences in vegetation characteristics among the 8 home ranges and representative transects in upland and bottomland sites using an analysis of variance and Scheffes test. The variables tested were percent ground cover of all grasses (aerial and basal), *Bouteloua* aerial cover, *Aristida* aerial cover, *Eragrostis* aerial cover, *Sporobolus* aerial cover, half-shrub cover, tree cover, densities of half-shrubs, cactus and trees, and vertical structure of grasses, trees, and all vegetation forms combined.

I analyzed the data using SPSS-X software on the University of Arizona's ARVAX mainframe computer.

All significances are reported at the $P<0.05$ level. In some instances differences in absolute values of variables are also reported to illustrate trends although these differences are not statistically significant.

RESULTS

Trapping And Telemetry

Trapping success was highest during the non-breeding season when the bobwhites were in coveys and lowest during the breeding season when the bobwhites were paired.

The length of monitoring of each radio-tagged bobwhite ranged from 1 day to 151 days with a mean of 28 days. The wide range of monitoring was due to mortalities, failed transmitters and lost signals. Due to the differential trapping success between breeding and non-breeding seasons and the short transmitter life, I was unable to follow any single radio-tagged bobwhite during both seasons.

Home Range Sizes and Locations

The mean area for the 8 masked bobwhite home ranges (Figure 2) was 10.9 hectares (5.2 to 14.6 ha). The mean core area was 1.1 hectares (0.2 to 2.7 ha). During the breeding season the mean home range area was 10.0 hectares, and the mean core area was 0.6 hectares. During the non-breeding seasons the mean home range area was 11.4 hectares, and the mean core area was 1.3 hectares. Home range areas and core areas were not significantly different between the breeding and non-breeding seasons (Table 1).

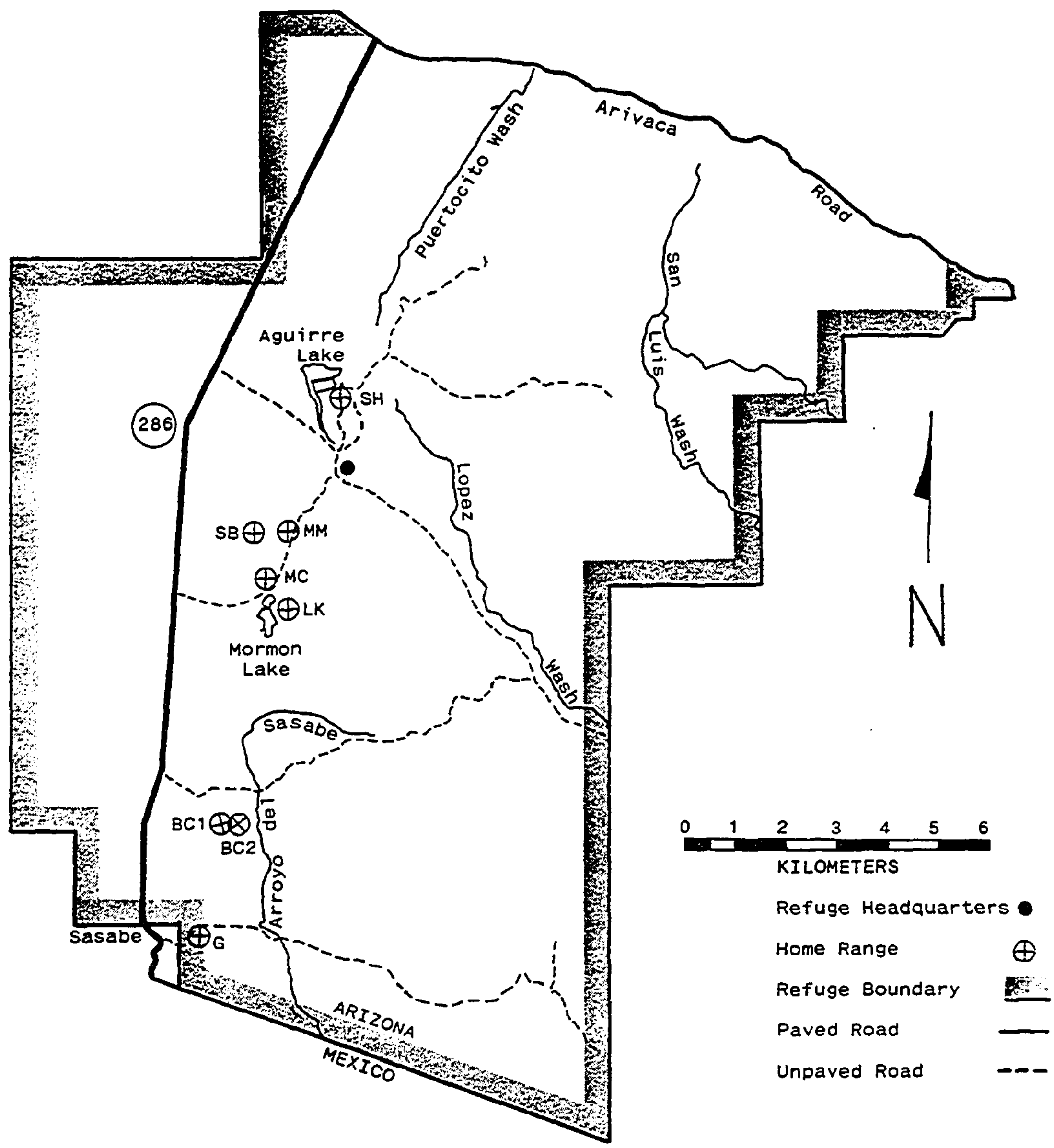

Figure 2: Study area on the Buenos Aires National Wildlife Refuge with locations of masked bobwhite home ranges.

Table 1

Mean sizes (ha) of breeding and non-breeding season masked bobwhite home ranges and core areas on the Buenos Aires National Wildlife Refuge compared by T-test.

	Breeding			Non-breeding			T	prob	Sig?
	$\bar{x}$	SE	n	$\bar{x}$	SE	n			@P<0.05
Total Area	10.0	1.8	3	11.4	1.7	5	0.55	0.31	N
Core Area	0.6	0.4	2	1.3	0.6	4	0.82	0.23	N

Home Range Vegetation Descriptions

Six of the eight masked bobwhite home ranges were located predominately in bottomland areas, and the remaining 2 were located predominately in upland areas. (Appendix A: Figures A-1 to A-8).

Species Richness

The mean number of vegetation species in the eight home ranges was 14 (10-17) grasses, 17 (10-23) forbs, and 3 (1-7) trees and shrubs. The number of half-shrub species present on the 8 home ranges varied from 0 to 2 species. During the non-breeding season the mean number of grasses was 14 (10-17), and the mean number of forbs was 13 (10-20) on the 5 home ranges. During the breeding season the mean number of grasses was 15 (10-17), and the mean number of forbs was 16 (11-23) on the 3 home ranges. The mean number of trees and shrubs was 3 on home ranges during both the breeding and non-breeding seasons (Table 2).

Frequency of Occurrence

The most frequent grass species over all home ranges (based on frequency of occurrence on line-intercepts) were three-awns (*Aristida* spp.), drop-seeds (*Sporobolus* spp.), grammas (*Bouteloua* spp.), Arizona cottontop (*Trichachne californica*), Rothrock gramma (*Bouteloua Rothrockii*), cane

Table 2

Numbers of species of different vegetation forms within masked bobwhite home ranges on the Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Home Range	Grasses	Forbs	Half-Shrubs	Trees	Cactus
MM	12	17	2	1	0
SH	13	18	2	3	0
LK	10	10	2	3	0
BC1	17	23	0	5	1
BC2	17	15	1	3	0
SB	10	11	2	1	0
MC	17	20	2	2	1
G	17	18	2	7	1

beardgrass (*Andropogon barbinodis*), vine mesquite (*Panicum obtusum*), and lovegrass (*Eragrostis* spp.). The most frequent forb species over all home ranges (based on frequency of occurrence on Daubenmire plots) were ragweed (*Ambrosia confertiflora*), Russian thistle (*Salsola kali*), Thurber's peppergrass (*Lepidium thurberi*), annual goldeneye (*Viguiera annua*), lambs-quarters (*Chenopodium album*), careless weed (*Amaranthus Palmeri*), *Atriplex elegans*, and red-maids (*Calandrinia ciliata*). The most frequent tree species over all home ranges (based on frequency of occurrence on line-intercepts) were mesquite (*Prosopis juliflora*) and Mexican paloverde (*Parkinsonia aculeata*). Snakeweed (*Gutierrezia sarothrae*) and burroweed (*Aplopappus tenuisectus*) were the only half-shrubs described on masked bobwhite home ranges (Table 3).

The frequency of occurrence of forbs, grasses, and half-shrubs, shrubs, and trees for individual home ranges are summarized in Appendix A: Tables A-3 through A-5.

Ground Cover

The mean aerial grass cover for all home ranges was 38.1% (28.6% to 55.9%). The mean basal grass cover for all home ranges was 16.3% (6.4% to 28.6%). For the 5 non-breeding home ranges the mean aerial grass cover was 35.2% (28.6% to 43.3%), and the mean basal grass cover was 16.8% (12.3% to 17.9%). For the 3 breeding season home ranges the

Table 3

Frequency of occurrence (%) and constancy of occurrence of most common vegetation species on transects in masked bobwhite home ranges, Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-1988.

FORBS	Freq. (%) (N=204 transects)	Constancy (%) (N=8 home ranges)
Ambrosia confertiflora	69.6	100.0
Salsola kali	40.8	100.0
Lepidium thurberi	35.0	100.0
Viguiera annua	32.9	100.0
Chenopodium album	20.4	75.0
Amaranthus palmeri	19.2	50.0
Atriplex elegans	15.4	75.0
GRASSES		
Aristida spp.	66.7	100.0
Sporobolus spp.	51.3	100.0
Bouteloua spp.	35.4	62.5
Trichachne californica	35.0	87.5
Bouteloua rothrockii	31.7	75.0
Andropogon barbinodis	28.8	100.0
Panicum obtusum	25.0	87.5
HALF-SHRUBS		
Gutierrezia sarothrae	16.7	87.5
Aplopappus tenuisectus	8.3	75.0
TREES/SHRUBS		
Prosopis juliflora	44.6	100.0
Parkinsonia aculeata	2.9	50.0

mean aerial grass cover was 43.0% (32.6% to 55.6%), and the mean basal grass cover was 15.5% (12.3% to 17.8%). The mean forb cover for all home ranges was 11.4% (2.7% to 21.8%). Forb cover in the home ranges averaged 10.6% (2.7% to 17.8%) during the non-breeding season and 12.8% (3.6% to 21.2%) during the breeding season. The mean half-shrub cover for all home ranges was 2.3% (0% to 10.2%). The mean half-shrub cover was 3.4% (0.3% to 10.2%) for non-breeding season home ranges, and 0.5% (0% to 1.5%) for breeding season home ranges.

The mean tree/shrub cover for all home ranges was 8.3% (4.5% to 14.7%). Tree/shrub cover averaged 8.3% (4.5% to 14.7%) on home ranges during the non-breeding season and 8.2% (5.3% to 11.4%) on home ranges during the breeding season.

The mean bare ground for all home ranges was 29.5% (17.9% to 40.6%), and the mean litter cover was 29.8% (19.7% to 36.6%). During the non-breeding season, home ranges averaged 27.2% (17.9% to 35.6%) bare ground and 34.1% (30.0% to 36.6%) litter cover. During the breeding season, the home ranges averaged 33.2% (29.3% to 40.6%) bare ground and 22.8% (19.7% to 25.0%) litter cover.

The percent cover of grasses (aerial and basal), forbs, half-shrubs and trees is summarized for the individual home ranges in Appendix A: Table A-6. The percent cover of litter and bare ground for the individual home ranges is summarized in Appendix A: Table A-7.

The mean percent ground cover for the most frequent forbs and grasses over all home ranges are presented for the individual home ranges in Appendix A: Tables A-8 and A-9.

Heights of Woody Species

The mean height of trees on all home ranges was 3.0 meters with a range in heights of 0.2 to 12.0 meters. The mean height of trees was 3.2 meters on non-breeding season home ranges and 2.7 meters on breeding season home ranges. Half-shrubs averaged 0.35 meters on all home ranges during both the breeding and non-breeding seasons.

Density of Woody Species

The density of trees on masked bobwhite home ranges averaged 12.3 trees per ha in the 0-1 meter height class, 40.3 trees per ha in the 1-5 meter height class and 3.3 trees per ha in the greater than 5 meter height class. The mean density of half-shrubs for masked bobwhite home ranges was 2612/ha (5 to 7490/ha).(Appendix A: Table A-10).

Vertical Structure Of Vegetation

The vertical structure of vegetation (percent visual obstruction) for all home ranges combined is illustrated in Figure 3. Vertical vegetation structure is divided into 4 categories: forbs, grasses, half-shrubs and trees. The

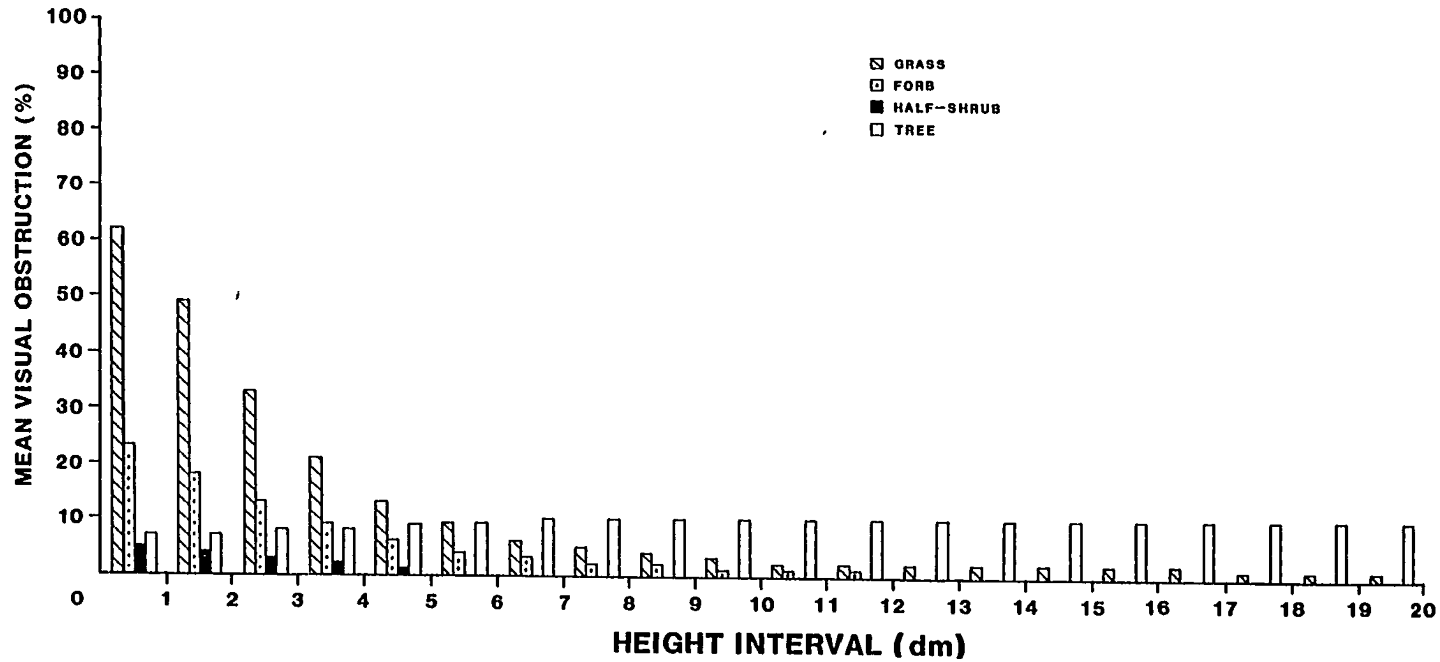

Figure 3: Visual obstruction by vegetation (forbs, grasses, half-shrubs, and trees) in masked bobwhite home ranges.

mean visual obstruction is given in dm intervals from 0 to 20 dm. The vegetation structure data for individual home ranges is summarized in Appendix A: Tables A-11 through A-18.

Core vs Non-core Comparisons For Individual Home Ranges

Four of the six core areas included a higher percentage of bottomland-grass and bottomland-tree/shrub habitats than was found in the total home ranges. Upland tree/shrub habitat and disturbed areas (roads etc.) were included less in core areas than their availability in the home ranges (Table 4).

Ground Cover

Aerial grass cover was higher ($P<0.05$) in core areas than in non-core areas for 3 of the 6 home ranges. In 2 of the remaining 3 home ranges, mean aerial grass cover was higher, but not significantly, in the core areas compared to the non-core areas. Basal grass cover was higher ($P<0.05$) in core areas than in non-core areas of 2 of the 6 home ranges and was higher, but not significantly, in core areas compared to non-core areas in the remaining 4 home ranges. Forb cover was not significantly different between core and non-core areas of any of the home ranges. Forb cover was lower, but not significantly, in core areas than in non-core

Table 4

Percent occurrence of habitat categories within masked bobwhite home ranges and core areas on the Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Home Range	Bottom grass		Bottom tree/shrub		Upland grass		Upland tree/shrub		Other (Roads) (etc.)	
	Tot.	Core	Tot.	Core	Tot.	Core	Tot.	Core	Tot.	Core
MM	53	64	7	8	40	28	0	0	0	0
SH	42	68	15	26	12	0	18	0	13	6
LK	6	-	29	-	37	-	28	-	0	-
BC1	39	67	61	33	0	0	0	0	0	0
BC2	57	0	43	100	0	0	0	0	0	0
SB	0	-	24	-	48	-	21	-	7	-
MC	53	67	4	12	0	0	35	18	8	3
G	47	0	36	0	17	100	0	0	0	0

areas of 4 home ranges and was higher, but not significantly, in core areas than in non-core areas of 2 home ranges. Half-shrubs were present in such low numbers in core areas that half-shrub cover was not detected during sampling. Half-shrub cover was present in small quantities in non-core areas of 5 of the 6 home ranges. Tree/shrub cover was lower ($P<0.05$) in the core area than the non-core area of 1 home range and was lower, but not significantly, in core areas compared to non-core areas of 3 of the home ranges. Percent bare ground was lower ($P<0.05$) in core areas compared to non-core areas in 4 of the 6 home ranges. In the core areas of the remaining 2 home ranges, percent bare ground was higher, but not significantly, in one and lower, but not significantly, in the other when compared to non-core areas. Percent litter cover was lower, but not significantly, in core areas compared to non-core areas of 5 of the 6 home ranges. In the remaining home range, litter cover was higher, but not significantly, in the core area compared to the non-core area. The results of the core versus non-core comparisons of percent ground cover for the home ranges are summarized in Table 5. More detailed information about the core versus non-core comparisons for the individual home ranges is reported in Appendix A: Tables A-19 through A-24.

Table 5

Differences in percent ground cover of vegetation, bare ground and litter between core and non-core areas of individual masked bobwhite home ranges and with all home range transects combined (H=higher absolute value in core area, L=lower absolute value in core area, *=significant (P<0.05), ND=no difference in absolute values).

Home Range	Tree/Shrub Cover	Half-Shrub Cover	Grass Cover (aer.)	Grass Cover (bas.)	Forb Cover	Bare Ground	Litter
MM	H	L	*H	*H	L	*L	L
SH	*L	L	H	H	H	*L	L
BC1	L	ND	H	H	L	H	H
BC2	H	ND	ND	H	L	*L	L
G	L	L	*H	H	H	L	L
MC	L	L	*H	*H	L	*L	L
All H.R.[a] Combined	L	*L	*H	*H	L	*L	*L

[a] Results of T-test analysis.

Density of Woody Species

Half-shrubs were present on the 120 meter square plots in both core and non-core areas of 3 of the 6 home ranges. The half-shrub density was low in both core and non-core areas for three home ranges. Half shrubs were absent in the core areas of the other three home ranges and were present in low densities in the non-core areas (Table 6).

The density of trees in the less than 1 meter height class was higher in core areas than in non-core areas in the 5 home ranges sampled. The density of trees in the 1-5 meter height class was higher in core areas than in non-core areas for 4 of the 5 home ranges sampled (Table 7).

Vertical Structure Of Vegetation

The mean percent visual obstruction by forbs was variable between core and non-core areas and no patterns were evident among the home ranges (Table 8).

The mean percent visual obstruction by grasses was higher ($P<0.05$) in core areas than in non-core areas at the 0 to 1 dm level for 4 of the 6 home ranges. In the remaining two home ranges, visual obstruction by grasses at the 0 to 1 dm level was higher, but not significantly, in one core area and lower, but not significantly, in the other when compared to non-core areas. Above the 1 dm level there was variability in the visual obstruction by grasses and no significant differences were found at $P<0.05$ (Table 9).

Table 6

Half-shrub densities (hs. dens.) in core and non-core areas of masked bobwhite home ranges compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

Home Range		CORE AREA hs. dens. (#/ha) $\bar{x}$	SE	NON-CORE AREA hs. dens. (#/ha) $\bar{x}$	SE	2-tail prob	Sig?@ P<0.05
MM	40	0.0	0.0	2817.5	1359.5	--	-
SH	29	0.0	0.0	3941.7	1935.4	--	-
BC1	40	9.2	9.2	3.3	3.0	0.4251	N
BC2	24	0.0	0.0	26.7	21.1	-	-
G	34	104.2	93.0	446.7	199.4	0.6699	N
MC	40	42.0	26.4	5047.5	1651.5	0.4252	N

Table 7

Tree/shrub densities (#/ha) in 3 height classes within core and non-core areas of masked bobwhite home ranges.

Home Range	CORE AREA <1m	1-5m	>5m	NON-CORE AREA <1m	1-5m	>5m
SH	20.0	21.2	0.6	13.1	62.2	4.7
BC1	53.3	103.3	10.0	4.1	38.0	3.0
BC2	185.0	185.0	0.0	14.0	40.4	2.6
MC	32.0	32.0	0.0	0.3	29.4	4.9
G	62.5	55.0	2.5	20.6	28.3	1.8

Half-shrub cover was insufficient in any of the home ranges to test for differences in visual obstruction between ore and non-core areas. Mean percent visual obstruction by trees was not significantly different among core areas and non-core areas of any home range for any height interval tested (Table 10).

When all vegetation forms were combined, differences in mean percent visual obstruction were not significant between core and non-core areas for 5 of the 6 home ranges. The mean visual obstruction by vegetation was lower ($P<0.05$) in the core area than in the non-core area of the MC home range for each of the intervals between 3 and 15 dm and also for the intervals from 16 to 20 dm. Visual obstruction by vegetation was higher, but not significantly, for all home ranges from 0-1 dm (Table 11).

Core versus Non-core comparisons With Home Ranges Combined

Ground Cover

The results of this analysis are consistent with the results of the within home range core vs non-core comparisons. Generally, the results of the Student T-test and the Mann-Whitney test were consistent. Aerial and basal grass cover was ($P<0.05$) higher in core areas than in non-core areas. Bare ground and litter were lower ($P<0.05$) in core areas than in non-core areas. Half-shrub cover was

Table 8

Mean visual obstruction by forbs in core and non-core areas of masked bobwhite home ranges (H=higher absolute value in core area, L=lower absolute value in core area, *=significant (P<0.05)).

Height Class (dm)	MM	SH	BC1	BC2	MC	G
0-1	L	H	L	H	L	L
1-2	H	H	L	H	L	*L
2-3	L	H	L	H	L	*L
3-4	L	H	*L	H	L	*L
4-5	L	H	L	H	L	*L
5-6	L	H	L	*H	*L	*L
6-7	L	H	L	*H	L	L
7-8		H	L	L	L	L
8-9		H	L	L	L	L
9-10		H	L	L	L	L
10-11		H			L	L
11-12		H			L	L
12-13		H			L	L
13-14		H			L	L
14-15		H			L	L
15-16		L			L	L
16-17		L			L	L
17-18		L			L	L
18-19		L			L	L
19-20		L			L	L

Table 9

Mean visual obstruction by grasses in core and non-core areas of masked bobwhite home ranges (H=higher absolute value in core area, L=lower absolute value in core area, *=significant (P<0.05)).

Height Class (dm)	MM	SH	BC1	BC2	MC	G	Combined[1]
0-1	*H	H	*H	L	*H	*H	*H
1-2	H	L	*H	L	H	H	H
2-3	H	L	H	H	L	H	L
3-4	L	L	H	H	L	H	L
4-5	L	L	H	L	L	H	L
5-6	H	L	H	H	L	H	L
6-7	H	L	H	L	L	H	L
7-8	L	L	H	H	L	H	L
8-9		L	H	H	L	H	L
9-10		L	H	H	L	L	*L
10-11		L	H	H	L	L	*L
11-12		L	H	L	L	L	*L
12-13		L	L		L	L	*L
13-14		L			L	L	*L
14-15		L			L		*L
15-16		L			L		*L
16-17					L		*L
17-18					L		*L
18-19					L		*L
19-20					L		*L

1 Results of core vs. non-core T-test analysis for all home range transects combined.

Table 10

Mean visual obstruction by trees in core and non-core areas of masked bobwhite home ranges (H=higher absolute value in core area, L=lower absolute value in core area, *=significant ($P<0.05$), ND=no difference in absolute values).

Height Class (dm)	MM	SH	BC1	BC2	MC	G	Combined[1]
0-1	ND	L	L	H	L	L	L
1-2	H	L	L	H	L	L	L
2-3	H	L	L	H	L	L	L
3-4	H	L	L	H	L	L	L
4-5	H	L	L	H	L	L	L
5-6	H	L	L	H	L	L	L
6-7	H	L	L	H	L	L	L
7-8	H	L	L	H	L	L	L
8-9	H	L	L	L	L	L	L
9-10	H	L	L	L	L	L	L
10-11	H	L	L	L	L	L	*L
11-12	H	L	L	L	L	L	*L
12-13	H	L	L	L	L	L	*L
13-14	H	L	L	L	L	L	*L
14-15	H	L	L	L	L	L	*L
15-16	H	L	L	H	L	L	L
16-17	H	L	L	H	L	L	L
17-18	H	L	L	H	L	L	L
18-19	H	L	L	H	L	L	L
19-20	H	L	L	H	L	L	L

1 Results of core vs. non-core T-test analysis for all home range transects combined.

Table 11

Mean visual obstruction by all vegetation forms in core and non-core areas of masked bobwhite home ranges (H=higher absolute value in core area, L=lower absolute value in core area, *=significant (P<0.05).

Height Class (dm)	MM	SH	BC1	BC2	MC	G	Combined[1]
0-1	H	H	H	H	H	H	*H
1-2	H	L	H	H	L	H	L
2-3	H	H	H	H	*L	L	L
3-4	L	L	L	H	*L	L	L
4-5	H	L	L	H	*L	L	L
5-6	H	L	L	H	*L	L	*L
6-7	H	L	L	H	*L	H	*L
7-8	H	L	L	H	*L	H	*L
8-9	H	L	L	H	*L	H	*L
9-10	H	L	L	H	*L	L	*L
10-11	H	L	L	L	*L	L	*L
11-12	H	L	L	L	*L	L	*L
12-13	H	L	L	L	*L	L	*L
13-14	H	L	L	L	*L	L	*L
14-15	H	L	L	L	*L	L	*L
15-16	H	L	L	H	L	L	*L
16-17	H	L	L	H	*L	L	*L
17-18	H	L	L	H	*L	L	*L
18-19	H	L	L	H	*L	L	*L
19-20	H	L	L	H	*L	L	*L

1 Results of core vs. non-core T-test analysis for all home range transects combined.

present in such low quantities in core areas that it was not detected during sampling. Forb cover was not significantly different between core and non-core areas. Tree cover was not significantly different between core and non-core areas based on the T-test results, but was lower ($P<0.05$) in core areas than in non-core areas based on the Mann-Whitney results.

The results of the core versus non-core comparisons for percent ground cover with home range transects combined are summarized in Table 5. More detailed information is available in Appendix A: Tables A-25 and A-26.

Density of Woody Species

When all transects were combined, half-shrub density was ($P<0.05$) higher in non-core areas. Cactus density was not significantly different between core and non-core areas (Tables 12-13).

Tree densities were higher ($P<0.05$) in the core areas compared to non-core areas for the 0-1 meter height class. Tree densities were higher, but not significantly, in core areas compared to non-core areas for the 1-5 meter height class (Table 14).

Vertical Structure Of Vegetation

Visual obstruction by grasses was higher ($P<0.05$) in core areas at the 0-1 dm interval and was higher, but not

Table 12

Density (#/ha) of half-shrubs and cactus in core and non-core areas of masked bobwhite home ranges (all transects combined) compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

Veg Type	CORE AREA (N=24) $\bar{x}$	SE	NON-CORE AREA (N=136) $\bar{x}$	SE	2-Tail Prob.	Sig? @ $P<0.05$
Half-Shrub	25.0	17.0	1875.0	534.9	0.0306	Y
Cactus	8.3	5.1	8.3	5.1	0.4327	N

Table 13

Density (#/ha) of half-shrubs and cactus in core and non-core areas of masked bobwhite home ranges (all transects combined) compared by T-test.

Veg Type	CORE AREA (N=24) $\bar{x}$	SE	NON-CORE AREA (N=136) $\bar{x}$	SE	2-Tail prob.	Sig? @ P<0.05
Half-Shrub	25.0	17.0	1875.0	534.9	0.001	Y
Cactus	8.3	5.1	8.3	5.1	0.704	N

Table 14

Mean densities (#/ha) of trees/shrubs in 3 height classes on non-core and core areas of masked bobwhite home ranges compared by T-test.

Size Class	NON-CORE (N=5) tree/shrub dens. (#/ha) $\bar{x}$	SE	CORE (N=5) tree/shrub dens. (#/ha) $\bar{x}$	SE	T	2-tail prob.	Sig? @ P<0.05
<1m	10.4	3.7	70.6	29.5	-2.02	0.034	Y
1-5m	39.7	6.1	79.0	30.2	-1.28	0.225	N
>5m	3.4	0.6	2.6	1.9	-0.40	0.297	N

significantly, in the core areas at the 1-2 dm interval. Visual obstruction by grasses was lower ($P<0.05$) in core areas than in non-core areas for the 11 intervals between 9 and 20 dm when the T-test was used but not when the Mann-Whitney test was used. Visual obstruction by trees was lower ($P<0.05$) in core areas than in non-core areas for the 0-1, 1-2 and 2-3 dm intervals using the Mann-Whitney test and was lower ($P<0.05$) in the core areas than the non-core areas for the 10-11, 11-12, 12-13 and 14-15 dm intervals when the T-test was used. When all forms of vegetation were combined, the visual obstruction by vegetation was higher ($P<0.05$) in the core areas for the 0-1 dm interval. Visual obstruction by vegetation was lower ($P<0.05$) in core areas for the 15 intervals between 5 and 20 dm when the T-test was used and for the 3-4 and 5-6 dm intervals, for the intervals between 10 and 17 dm, and for the 18-19 and 19-20 dm intervals when the Mann-Whitney test was used.

The comparison of percent visual obstruction by grasses, trees and all vegetation forms between core and non-core areas for the combined transects is summarized in Tables 9-11. More detailed information is provided in Appendix A: Tables A-27 through A-32. The vertical structure of vegetation including grasses, trees, and all vegetation forms is illustrated for the core and non-core areas in Figures 4-6.

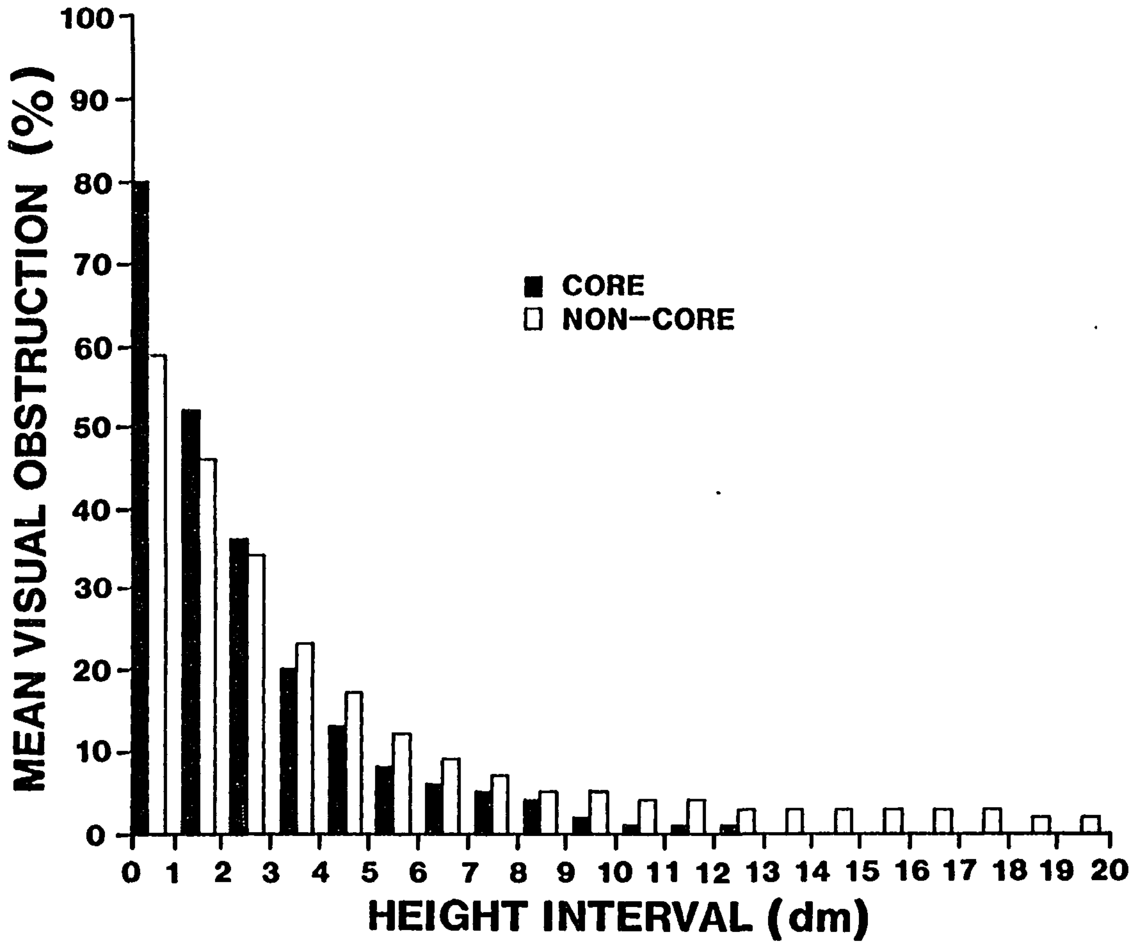

Figure 4: Visual obstruction by grasses in core and non-core areas of masked bobwhite home ranges.

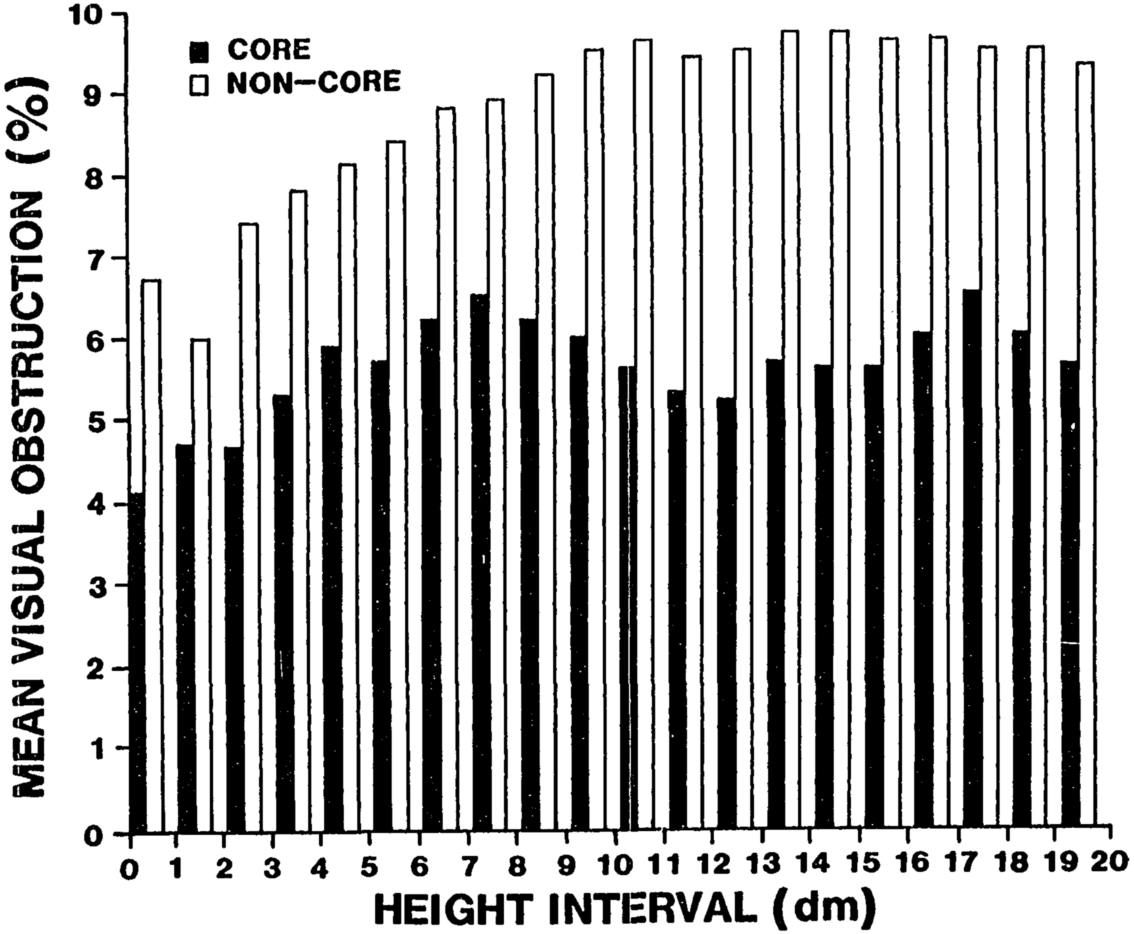

Figure 5: Visual obstruction by trees in core and non-core areas of masked bobwhite home ranges.

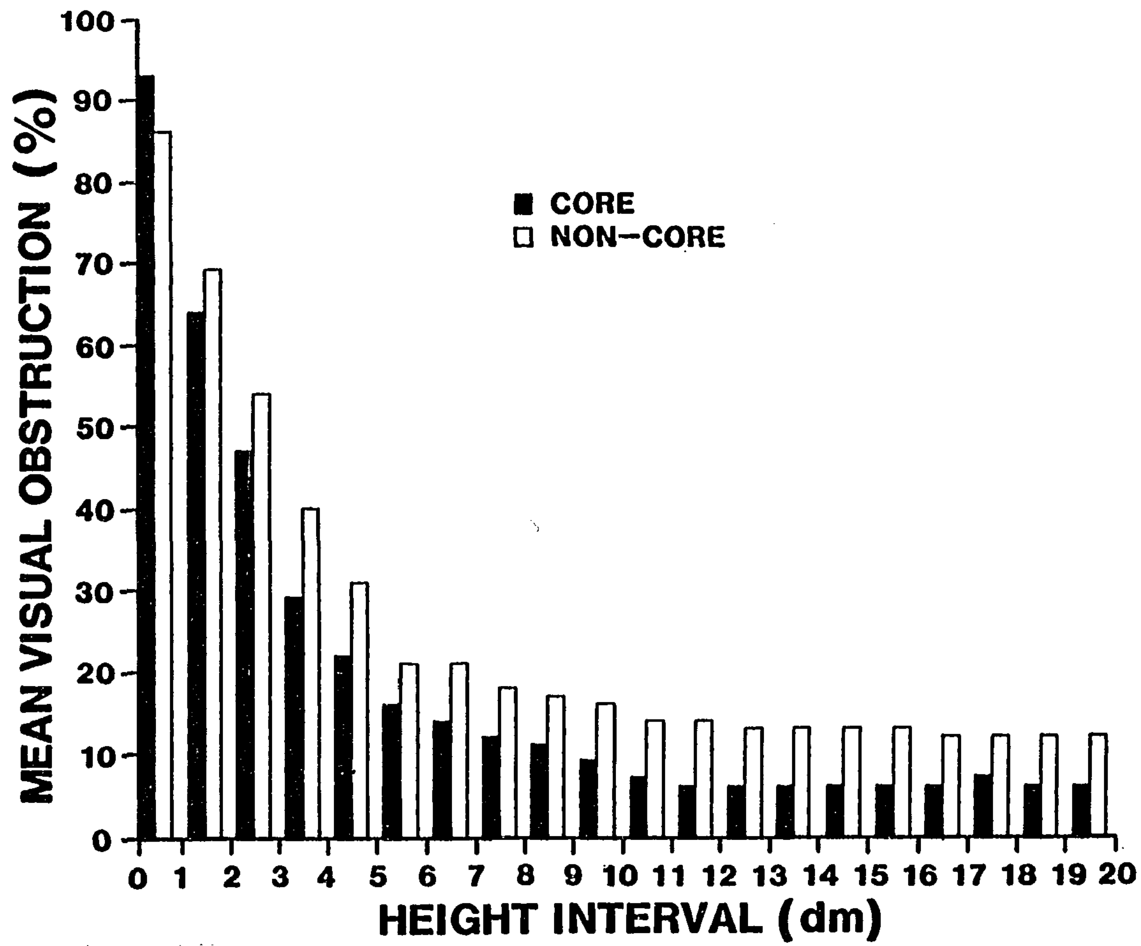

Figure 6: Visual obstruction by all vegetation forms in core and non-core areas of masked bobwhite home ranges.

Comparison Of Representative Transects And Home Ranges

There were significant differences ($P<0.05$) for aerial grass cover, half-shrub cover, *Bouteloua* aerial cover, *Eragrostis* aerial cover, *Aristida* aerial cover, *Sporobolus* aerial cover and densities of half-shrubs and cactus among some of the home ranges and representative upland and bottomland sites on the refuge (Table 15). There were also significant differences among some home ranges and upland and bottomland sites for the percent visual obstruction by grasses, trees, and all vegetation forms at various height intervals (Appendix A: Tables A-33 and A-34).

Ground Cover

The BC2 home range was higher ($P<0.05$) in aerial grass cover than the bottomland sites, the G home range, the SB home range and the MM home range. *Bouteloua* aerial cover was higher ($P<0.05$) in the MM home range than the SH, G, and MC home ranges and was higher ($P<0.05$) in the SB home range than in the SH home range. *Eragrostis* aerial cover was higher ($P<0.05$) in the upland sites than in all the home ranges and the bottomland sites. *Aristida* cover was higher ($P<0.05$) in the BC1 and BC2 home ranges than in the MM, SH, MC, G, and SB home ranges and the upland and bottomland

Table 15

Analysis of variance on percent ground cover and densities of vegetation among each of 8 masked bobwhite home ranges and representative transects in upland and bottomland areas on the Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Variable Tested	F Ratio	F Prob.	Sig? @ P=0.05
Grass cover (aerial)	5.34	0.0000	Y
Bouteloua spp. (aerial cover)	6.76	0.0000	Y
Eragrostis spp. (aerial cover)	9.09	0.0000	Y
Aristida spp. (aerial cover)	15.50	0.0000	Y
Sporobolus spp. (aerial cover)	4.54	0.0000	Y
cactus cover	1.71	0.0871	N
half-shrub cov.	10.45	0.0000	Y
tree cover	1.60	0.1152	N
cactus density	4.55	0.0000	Y
half-shrub dens.	4.49	0.0000	Y

sites. Aristida cover was also higher ($P<0.05$) in the BC2 home range than in the LK home range. Sporobolus aerial cover was higher ($P<0.05$) in the SH home range than in the upland sites and the SB, MC, G, and BC1 home ranges. Half-shrub cover was higher ($P<0.05$) in the upland sites than in the bottomland sites and all home ranges except LK. The LK home range was higher ($P<0.05$) in half-shrub cover than all other home ranges and the bottomland sites.

Density of Woody Species

The density of half-shrubs was greater ($P<0.05$) in upland sites than in the BC1 and BC2 home ranges and was greater, but not significantly, than all other home ranges except LK. Cactus density was higher ($P<0.05$) in upland sites than all home ranges except LK and was higher, but not significantly, in upland sites compared to bottomland sites.

Vertical Structure Of Vegetation

No significant differences ($P<0.05$) were found in percent visual obstruction by grasses at the 0-1 dm level. The visual obstruction by grasses was lower ($P<0.05$) in the MM home range than upland sites for the 1-5 dm intervals and than 3-5 home ranges for the 1-6 dm intervals. The visual obstruction by grasses was higher ($P<0.05$) in the MC home range than upland sites for the 7-11 dm intervals and the 14-20 dm intervals and than 4-6 home ranges for the 6-20 dm intervals.

The percent visual obstruction by trees was higher ($P<0.05$) in the BC2 home range than the MM home range at all height intervals and than the SH home range at the 4-5 dm interval. The percent visual obstruction by trees was higher ($P<0.05$) in the BC1 home range than the MM home range at the 9-10 dm level.

Similar patterns were evident when percent visual obstruction by all vegetation forms was analyzed. The visual obstruction by vegetation was lower ($P<0.05$) in the MM home range than upland sites for the 0-5 dm intervals, than bottomland sites for the 0-8 dm intervals, and than 2-5 home ranges for the 0-7 dm intervals. The visual obstruction by vegetation was higher ($P<0.05$) in the MC home range than at least 2 home ranges for every interval from 3 to 20 dm.

Movements

Radio-tagged masked bobwhite remained within the boundaries of their home ranges which had an average maximum dimension of 586 (491-662) meters. One exception was a pair that travelled 2.4 km from its home range and returned the following day.

Based on trapping data from marked bobwhites, the straight line distance between the initial release locations and the sites of the first trappings averaged 3014 meters

(64 m-23.7 km) for bobwhite without calculated home ranges and 1593 meters (74 m-12.2 km) for bobwhite with calculated home ranges (Figures 7 and 8). For bobwhite with calculated home ranges, the straight line distance between the initial release location and the center of the home range (center of the core area) averaged 1722 meters (83 m-12.2 km) (Figure 9).

Sixty-one percent of all bobwhites trapped moved less than 1.0 kilometer between their initial release location and the site of first trapping. Thirty-three percent moved between 1.5 and 4.0 kilometers, and six percent moved more than 10 kilometers.

Seventy-two percent of birds with calculated home ranges moved less than 1.0 kilometer between their release location and the center of their home range. Twenty-two percent moved between 1.5 and 4.0 kilometers, and six percent (2 birds) moved greater than 10 kilometers.

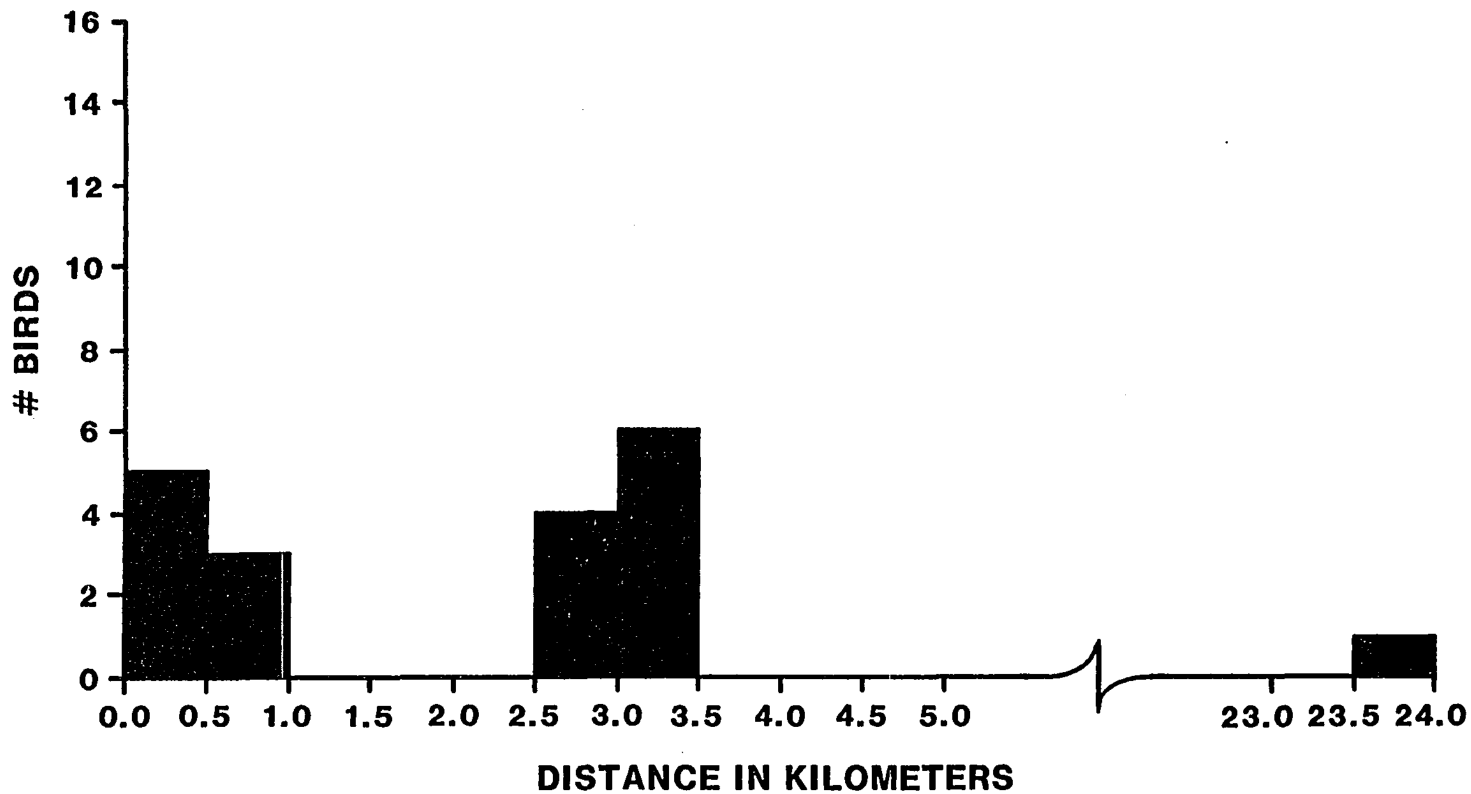

Figure 7: Distance, in kilometers, between release site and site of first trapping for reintroduced masked bobwhite without calculated home ranges.

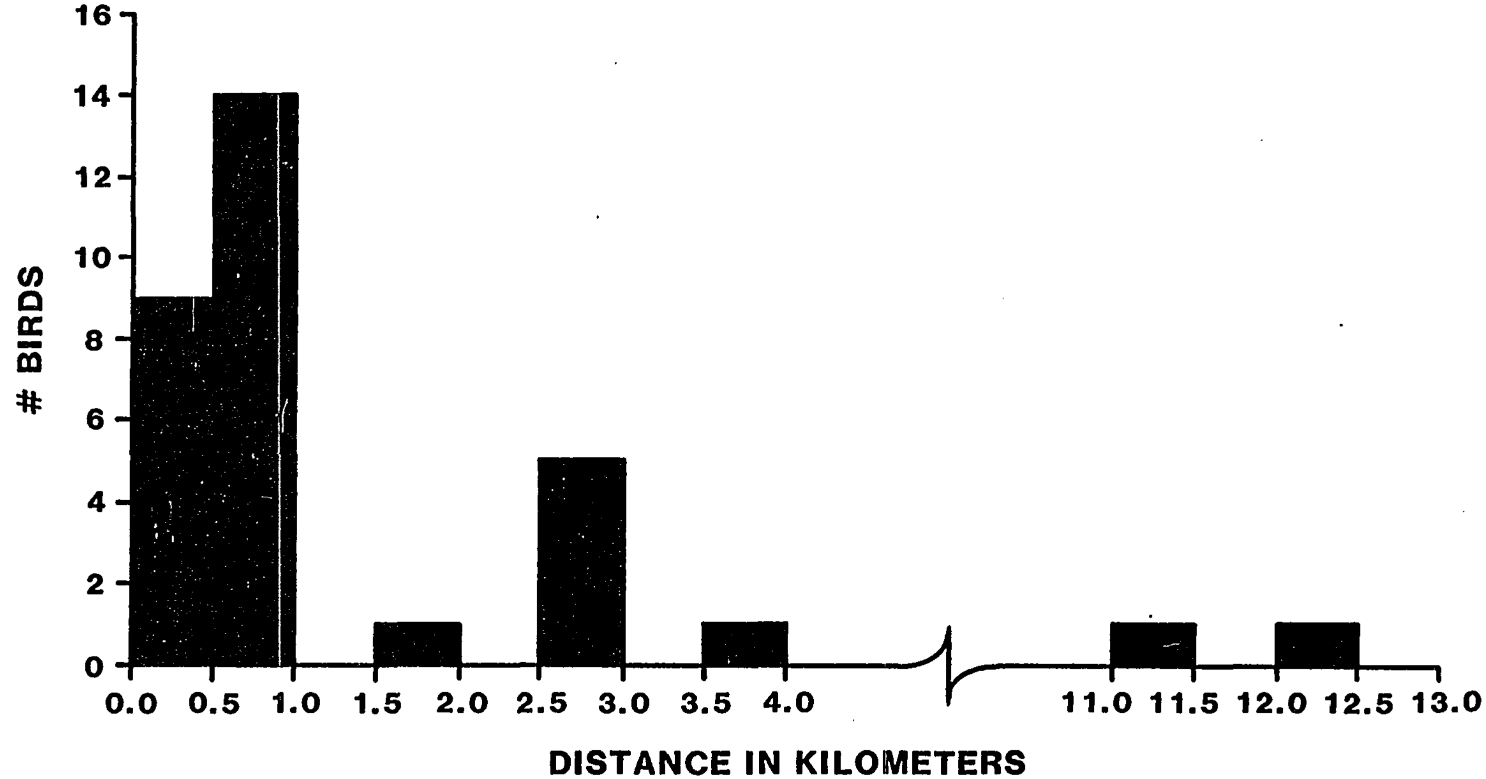

Figure 8: Distance, in kilometers, between release site and site of first trapping for reintroduced masked bobwhite with calculated home ranges.

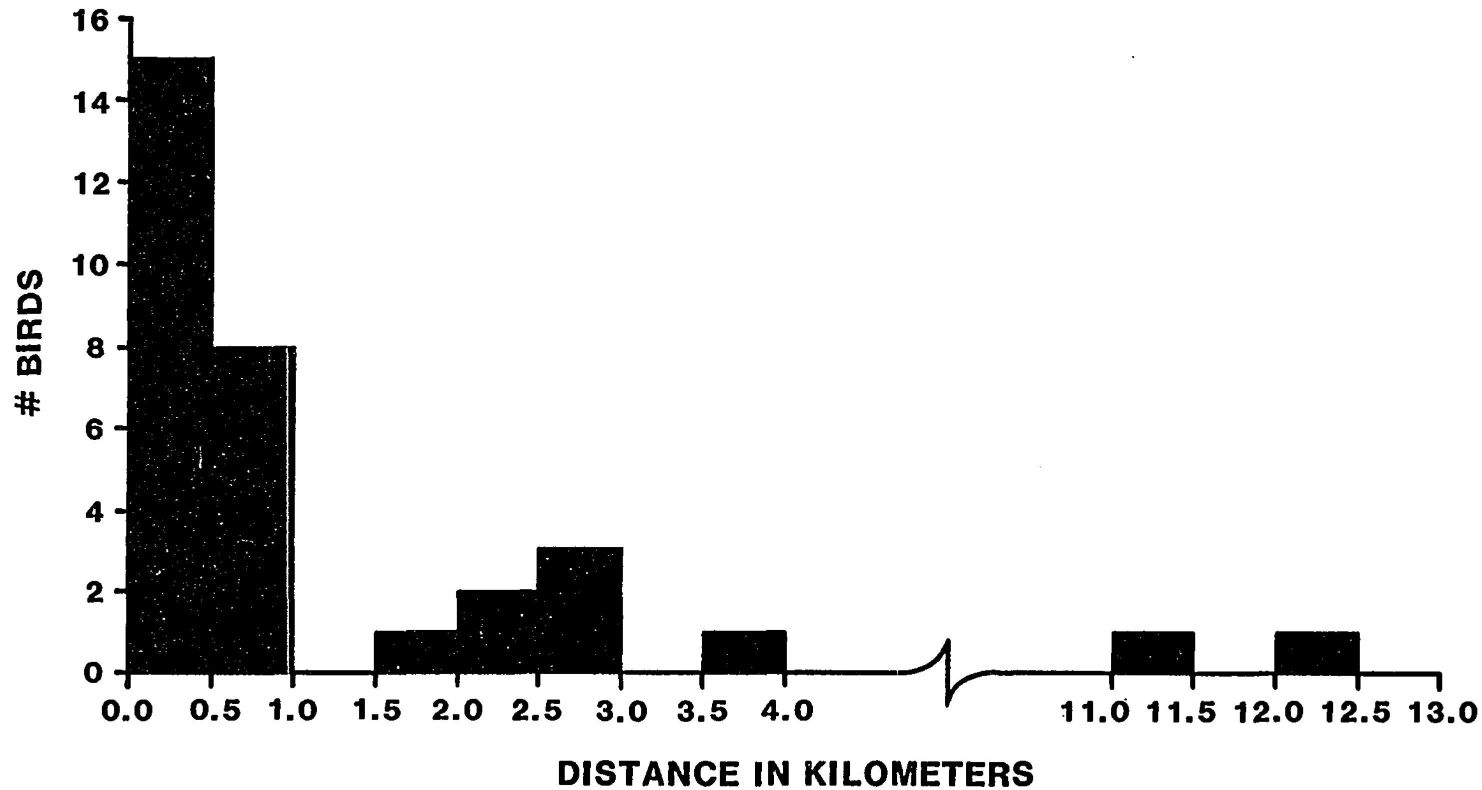

Figure 9: Distance, in kilometers, between release site and centers of core areas in home ranges of reintroduced masked bobwhite.

DISCUSSION

Home Range Size

The mean home range size of 10.9 ha (5.2-14.6 ha) for masked bobwhite is consistent with home range sizes reported for other subspecies of bobwhite, but a wide range of home range sizes has been reported. Yoho and Dimmick (1972a) reported a mean home range size of 6.7 ha (4.0-11.7 ha) for bobwhite coveys in southwestern Tennessee. The mean home range size for bobwhite coveys in Illinois was 8.6 ha (5.7-11.4 ha) (Roseberry 1964). Also in Illinois, Urban (1972) calculated a mean home range size of 10.0 ha (6.4-16.7 ha) for bobwhite coveys and pairs. The mean home range size for bobwhite in southern Iowa was 18.8 ha (2.4-38.0 ha) during the breeding season (Crim and Seitz 1972). Wiseman and Lewis (1981) reported a mean home range size of 4.4 ha (3.6-5.1 ha) for bobwhite coveys in northeastern Oklahoma.

Factors which may influence home range size for bobwhite include weather (Roseberry 1964), season (Urban 1972), population density (Wiseman and Lewis 1981, Urban 1972), and availability of food (Wiseman and Lewis 1981, Schemnitz 1961). Roseberry (1964) reported a general shrinking of home range size when snow covered vegetation. Urban (1972) found that home range sizes for nesting female bobwhites were smaller than those for post-nesting females and home ranges for unmated males were significantly larger than those for mated males. The nesting female bobwhite in my study restricted her activity to about 2 % of the total home range while nesting. I did not find a significant difference among the sizes of the masked bobwhite breeding season and non-breeding season home ranges. Urban (1972) also found no significant difference between general breeding and non-breeding season home ranges. Urban (1972) reported that covey ranges increased in the fall when population numbers were low, but they may not have increased during times of high population density. Schemnitz (1961) found that scaled quail home ranges with supplemental food were 24 percent smaller than those without supplemental food. Although many factors may contribute to differences in home range sizes, the most important one is probably the method of home range analysis. The minimum convex polygon method, for instance, is frequently modified and is also sensitive to sample size (Anderson 1982). The smaller home ranges reported by Wiseman and Lewis (1981) may be attributed to higher population densities or availability of supplemental food, but the most apparent reason is that when they calculated home ranges they excluded habitat not believed to be used by bobwhite. Unfortunately, many researchers did not explicitly state the method used to calculate home range boundaries; thus limiting the value of home range size comparisons.

Two of the masked bobwhite home ranges (BC1 and BC2) overlapped, including their core areas. The BC2 masked bobwhite pair was nesting in a core area which overlapped with the BC1 core area. Overlap of home ranges is apparently common with other subspecies of bobwhite. Murphy and Baskett (1952) reported both home ranges of coveys and pairs overlapping in Missouri bobwhites. Lehmann (1946a) also reported overlap of covey ranges in Texas. Yoho and Dimmick (1972b) reported overlap of covey ranges in Tennessee bobwhite which they attributed to high quail densities. However, it is unlikely that home range overlap in my study was related to high densities of bobwhite since the masked bobwhite are being reintroduced to the area and are present in very low numbers. The overlap of masked bobwhite core areas which included a nest site may be uncommon. However, core area overlap has not been investigated in other bobwhite studies.

Home Range Vegetation Descriptions

The association of reintroduced masked bobwhite with areas having an interspersion of grass, grass-forb, and shrub cover is consistent with the general descriptions of masked bobwhite habitat in Sonora, Mexico (Tomlinson 1972) and with requirements for other subspecies of bobwhite (Stoddard 1931, Casey 1966, Wiseman and Lewis 1981, Wilson and Crawford 1987).

As part of a status survey of masked bobwhite in Sonora, Mills and Reichenbacher (1982) sampled vegetation at Rancho Grande, the area of the remaining natural masked bobwhite population. The vegetation measurement techniques were similar to ours. The two main habitat types in the Rancho Grande area were described as "modified" vegetation, cleared and planted to buffel grass (*Pennisetum ciliare*) and "natural" vegetation which was a mixture of shrubs and trees with annual grasses and forbs for understory and which lacked buffel grass. The masked bobwhite at Rancho Grande were primarily found in the buffel grass pastures which had many similar vegetative characteristics to the masked bobwhite home ranges in my study. The buffel grass habitat at Rancho Grande averaged 6 grass species and 15 forb species compared to an average of 14 grass species and 17 forb species in the masked bobwhite home ranges in my study area. The average percent grass cover in the Rancho Grande buffel grass habitat (63%) was higher than the percent grass cover in the masked bobwhite home ranges (38%) but was similar to the percent grass cover (52%) in core areas. Most of the grass cover at Rancho Grande was introduced buffel grass rather than native perennial grasses. Rothrock gramma was the most prevalent of the native grasses which were present in some of the buffel grass pastures. Rothrock gramma was also one of the most common grasses on the masked bobwhite home ranges in my study. Forb cover in the Rancho

Grande buffel grass habitat was the same (11%) as in my masked bobwhite home ranges. Shrub cover in the Rancho Grande buffel grass habitat (11%) was higher than in my masked bobwhite home ranges (8%) and included a greater variety of trees and shrubs. The vertical structure of vegetation in the buffel grass habitats also appeared to be similar to that of my masked bobwhite home ranges although different methods were used to measure this characteristic. In the buffel grass habitats the majority of vegetation volume was contained within the first meter and was primarily buffel grass. In the masked bobwhite home ranges in my study, the majority of vegetation within the first 60 dm was grass. Tree/shrub structure was fairly uniform throughout all height intervals and in all home ranges in my study. The "native" shrubby habitat at Rancho Grande averaged 4 grass species, 11 forb species, 1% perennial grass cover, 1% perennial forb cover and 33% tree/shrub cover. The paucity of perennial grasses and forbs was probably a result of grazing practices. Considerably less vegetation volume was found in the first meter in the "natural" habitat. More of the vegetation was 1-2 meter shrubs than 0.5-1 meter grasses. Although the "natural" shrubby habitat at Rancho Grande appeared different than the buffel grass habitat and the masked bobwhite home ranges in my study, Mills and Reichenbacher found a few masked bobwhite associated with it. The "natural" shrubby habitat may provide some of the masked bobwhites' requirements in Sonora.

The vegetative characteristics of masked bobwhite home ranges in my study are also similar to those of bottomland areas where Goodwin (1982) located reintroduced masked bobwhite and sampled vegetation on the Buenos Aires Ranch. The areas sampled by Goodwin averaged 8 grass species and 7 forb species, 14 % grass cover, 12 % forb cover and 12 % tree/shrub cover. The lower percent of grass cover in his study was probably because of cattle grazing on the ranch at that time.

The Sonoran Savanna Grassland habitat was once widely distributed in central Sonora and in parts of south central Arizona. This habitat was characterized by perennial grasses such as three-awns, grammas, and *Heteropogon* interspersed with trees such as mesquite (Brown et al. 1979). Sonora Savannah Grassland was probably the historic habitat occupied by masked bobwhite. The most common grasses on the masked bobwhite home ranges in my study included three-awns, grammas, and other native perennials such as dropseeds and Arizona cottontop. These grasses were interspersed with scattered mesquite and other shrubs. Therefore, the vegetation in my study of masked bobwhite home ranges resembles Sonora Savanna Grassland. However, the habitat described at Rancho Grande in Sonora does not resemble the description of Sonora Savannah Grassland (Mills and Reichenbacher 1982). Areas on the Buenos Aires Refuge may more closely resemble the historic masked bobwhite habitat than the remaining masked bobwhite areas in Sonora.

Core Areas

I calculated core areas for the masked bobwhite home ranges with the harmonic mean method. Although this method has not been used for quail home ranges before, Spencer and Barrett (1984) found that it accurately represented core areas as the most used portions of carnivore home ranges and always included den sites in the calculated core areas. My results indicated that the method accurately depicted bobwhite core areas. The only masked bobwhite nest located in my study was included in a core area, and core areas were located in the most used portions of the bobwhite home ranges.

Although core areas have not been specifically calculated in other bobwhite studies, the concept of a covey "headquarters" area has been discussed and a size of 42 square meters or less suggested (Stoddard 1931, Casey 1966, Yoho and Dimmick 1972a). These "headquarters" areas are substantially smaller than my masked bobwhite core areas which averaged 1.1 ha (0.2-2.7 ha). The "headquarters" areas, however, were described as brushy coverts or brushpiles which provided escape cover but did not include other cover types.

Core areas, by definition, are the areas of highest use within the home range and therefore would be expected to meet the bobwhites requirements for escape, nesting, and foraging cover. My analysis indicates that masked bobwhite core areas include more ground cover of grass and more cover of grass from 0-1 dm than is available in the total home ranges. Possibly the higher density of grass is important escape cover in core areas. Grass is also important nesting cover for bobwhite (Stoddard 1931, Lehmann 1946b).

My analysis indicates that masked bobwhite use areas with a higher density of small mesquites and an absence of half-shrub cover for core areas. Bobwhites require shrub cover for protection from predators and weather, but seem to prefer the more open canopy of small mesquites which allow grass and forb growth underneath rather than the more compact growth form of half-shrubs and the barren ground between half-shrubs. Half-shrubs probably provide undesirable foraging cover because their seeds are small and airborne.

My analysis indicates that masked bobwhite use forb and tree/shrub cover in proportion to their availability on the home ranges. There was a significantly greater vertical tree/shrub cover between 5 and 20 dm in non-core areas and a greater, but not significantly, tree/shrub ground cover in 4 of the 6 non-core areas. However, there was a higher density of small shrubs/trees in all bobwhite core areas. The smaller shrubs and trees would have less canopy coverage than larger trees at the same density and would tend to have more vegetation near the ground than larger trees. The shrub/tree ground cover in masked bobwhite habitat in Sonora (Mills and Reichenbacher 1982) and on the Buenos Aires Ranch in 1982 (Goodwin 1982) was greater than tree/shrub ground cover on masked bobwhite home ranges in this study. Goodwin (1982) thought that the most limiting component of bobwhite habitat on the Buenos Aires Ranch was the proper size and distribution of overstory cover. He did not find bobwhite in areas with less than 8% shrub cover and reported that they preferred areas with 15-30 % overstory cover. Possibly a lesser amount of tree/shrub cover is acceptable when the associated grass cover is taller and denser and provides more cover as in the masked bobwhite home ranges in this study.

Bobwhites in Oklahoma preferred tall and short shrub habitat and used woody habitat in proportion to its availability (Wiseman and Lewis 1981). Bobwhites in Iowa (Crim and Seitz 1972) slightly preferred wooded draws and dense shrubs. In Texas, bobwhites used woody cover slightly less than was available (Wilson and Crawford 1987). This would suggest that differences in bobwhite use of woody cover may be related to the type and distribution of woody cover and the quality of other available cover types.

Comparison Of Representative Transects And Home Ranges

Vegetation characteristics were highly variable both within and between home ranges. The MC home range was unique in having large areas of Johnson grass up to 2 meters in height. The Johnson grass cover was probably responsible for the significantly higher vertical grass cover and vertical vegetation cover in this home range compared to the other home ranges and representative sites. The MM home range had large areas of short perennial grasses which were generally less than 2 dm in height. These shorter grasses were probably responsible for the significantly lower vertical grass cover and vertical vegetation cover above 1 dm in this home range. The LK home range was unique in having a greater density of half-shrubs than the other home ranges. Vegetation characteristics were also highly variable in upland and bottomland sites on the refuge and between those sites and the home ranges.

Representative upland sites on the refuge had higher half-shrub cover, cactus density, and *Eragrostis* cover than home ranges and bottomland sites. The majority of the *Eragrostis* cover was Lehmann's lovegrass, an introduced perennial, which covers large portions of many upland areas. Goodwin (1982) found that half-shrub cover was significantly correlated with upland sites and negatively correlated with bottomland sites on the Buenos Aires Ranch. Apparently *Eragrostis* cover was not correlated strongly with either type of site in his study. Mills and Reichenbacher (1982) found that masked bobwhite in Sonora did not use extensive monocultures of introduced buffel grass but used areas where buffel grass was mixed with other grasses and forbs. The high density of half-shrubs and large expanses of Lehmann's lovegrass in upland areas on the Buenos Aires National Wildlife Refuge probably make these areas less desirable than bottomland sites to the masked bobwhite.

Representative bottomland areas had less grass cover and higher tree cover than home ranges and upland areas. Although these differences weren't significant, they do indicate that not all bottomland areas on the refuge are similar in vegetative characteristics to the masked bobwhite home ranges. Despite the variability in vegetation on the refuge, masked bobwhite seem to prefer certain vegetative characteristics, and both bottomland and upland areas could be managed to meet some of the masked bobwhites requirements.

<u>Movements</u>

My analysis indicated that masked bobwhite use their entire home range in a season and are capable of crossing the widest dimension of their home range within 1 or 2 days. I was not able to follow any radio-tagged bobwhite during both the breeding and non-breeding seasons due to short transmitter life and mortalities. I was, thus, unable to determine whether masked bobwhite use approximately the same ranges during both seasons. I trapped one female masked bobwhite in the winter of 1986-87 and again in the winter of 1987-88. She was a member of a different covey each winter and although the home range boundaries of these coveys did not overlap, there was no more than 100 meters between the two ranges. In Missouri, the ranges of bobwhite families overlapped or were within 800 meters of their ultimate winter covey ranges (Murphy and Baskett 1952, Agee 1957).

Reintroduced masked bobwhite were generally sedentary. The majority of masked bobwhite remained and established home ranges within 1.0 kilometer of their release locations. A movement of 1.0 kilometer is less than twice the average maximum home range dimension of 586 meters. Radio-tagged bobwhite did not appear to leave their home range boundaries. However, 1 pair of masked bobwhite travelled approximately 2.4 kilometers from its home range and then returned the following day. Other bobwhite subspecies are also sedentary. Stoddard (1931) believed that southeastern bobwhites remained within a 1600 meter radius of their birthplace. Murphy and Baskett (1952) reported that the majority of bobwhites in Missouri also remained within 1600 meters of their birthplace and that at least 50 percent remained within 800 meters. Lehmann (1946a), however, studied the movements of bobwhites in Texas and concluded that although some moved only short distances from their home ranges for periods as long as 2 years, more than 50 percent of the bobwhites that he studied moved more than 0.7 kilometer from their birthplace and were capable of travelling extended distances. These studies suggest that bobwhite are generally sedentary but are capable of travelling long distances.

Periods of localized movements are not considered uncommon for bobwhites. These "shuffle" periods of increased movement and covey interchange generally occur during the early fall and early spring and may facilitate the maintenance of advantageous group size and the equalization of sex ratios prior to pairing up in spring (Stoddard 1931, Lehmann 1984). I observed periods of increased movement among radio-tagged masked bobwhite during mid-October and bobwhites, in general, were more visible on the study area. This difference may have been indicative of the "fall-shuffle". After mid to late May, I began to find masked bobwhite in trios and pairs which indicated that coveys were disbanding.

Long-distance movements in bobwhite are less common. Maximum movements reported for bobwhite were 4026 meters in Missouri (Murphy and Baskett 1952), 5636 meters in Iowa (Boehnke 1954), and 9661 meters in Texas (Lehmann 1946a). None of these approach the maximum movement of 23.7 kilometers for a masked bobwhite in my study. Long-distance movements by bobwhite have been attributed to overpopulation (Lehmann 1946a) and seasonal changes in habitat quality

(Duck 1943, Urban 1972, Lehmann 1984). Masked bobwhite may move long distances because of inadequate habitat conditions at certain release locations on the refuge; however I do not have data to substantiate this. Another possible cause for the long distance movements is social. Masked bobwhites may have become separated from their foster parents and broods after release due to mortalities, pursuit by a predator, or some disturbance. They may have then travelled in search of another brood or covey to join. Due to the low density of bobwhites on the refuge, this attempt to join a covey could have entailed travelling a considerable distance. Similarly, single bobwhites may have travelled considerable distances in search of a mate at the onset of the breeding season. Possible evidence for the social aspect of bobwhite movements includes the one day "visit" of a pair of radio-tagged bobwhite to the refuge headquarters area where pens of captive bobwhites are kept, the appearance at refuge headquarters of masked bobwhite from 8 separate releases made in areas from 750 meters to 23.7 kilometers away, and the appearance of a masked bobwhite at a pen of captive bobwhites near the town of Arivaca which is approximately 23 kilometers from refuge headquarters. Long distance movements by masked bobwhite on the refuge could be related to habitat conditions or to their social behavior, but ultimately these probably relate to the low population density and to the reintroduction procedure.

My data on movements are somewhat biased as I concentrated my trapping activities and research in areas where the bobwhites were released. Because of this, I was less likely to document long distance movements. Radio telemetry is also limited as a tool for studying movements. At times, I could not get a signal on radio-tagged birds in the vicinity of their home ranges. Sometimes this was temporary and other times I never relocated the bird. Unfortunately, due to the limited range of the transmitters I was unable to determine if signals were lost because of equipment faults or movements of the birds. The comparisons which can be made between movements of reintroduced masked bobwhite and bobwhite in a natural state are limited because of the unnatural situations which are probably created by the reintroduction procedure.

MANAGEMENT RECOMMENDATIONS

My analysis of the home range and habitat data indicates the following habitat requirements for masked bobwhite:

(1) Approximately 11 hectares per covey or pair of masked bobwhite.

(2) An interspersion of grass, grass-forb, and shrub habitat.

(3) Diversity of grasses and forbs (10 species of each).

(4) 150 trees or shrubs per ha in the 0-5 meter height class.

(5) 90% visual obstruction by vegetation at the 0-1 dm height interval.

(6) 50 % aerial grass cover.

(7) 30 % basal grass cover.

(8) 15 % forb cover.

(9) 10 % tree/shrub cover.

(10) absence of half-shrubs.

(11) absence of Lehmann's lovegrass.

The bottomland habitat where I concentrated my research appears to be in good condition and to have many of the components of the Sonora Savannah grassland which was probably historic masked bobwhite habitat. Comparison of bottomland areas containing home ranges with other representative bottomland sites on the refuge indicate that not all are in similar condition. Apparently an increase in grass cover would be beneficial in some bottomland areas. Bobwhites included some upland areas in their home ranges. Potentially more upland areas could become suitable habitat for masked bobwhite if half-shrubs and Lehmann's lovegrass were reduced and if there was increased growth of native grasses and forbs in these areas. An increase in the density of small mesquites and shrubs would probably be beneficial in some upland and bottomland areas. Management activities which promote these features are encouraged.

The conclusions which can be made from comparisons of masked bobwhite home ranges and representative areas on the refuge are limited because of the small number of permanent representative transects (27/45300 ha) and the high variability of vegetation. At least 100 permanent representative transects should be established on the refuge to monitor the condition of vegetation in actual or potential masked bobwhite habitat areas.

Releases of masked bobwhite should continue to be made in concentrated groups until the population is increased substantially. Probably a minimum of 5 groups of masked bobwhite should be released in any 11 hectare area to ensure an adequate number of birds to form the winter covey. Additional surveys for masked bobwhite using bird dogs, quail drives, or listening for calling birds are recommended. These surveyed areas should include peripheral areas away from areas of concentrated releases to detect long distance movements. Radio-tagging or visibly marking all members of a few adjacent coveys may allow for a better understanding of social behavior and movements between coveys.

APPENDIX A

SUPPLEMENTAL DATA

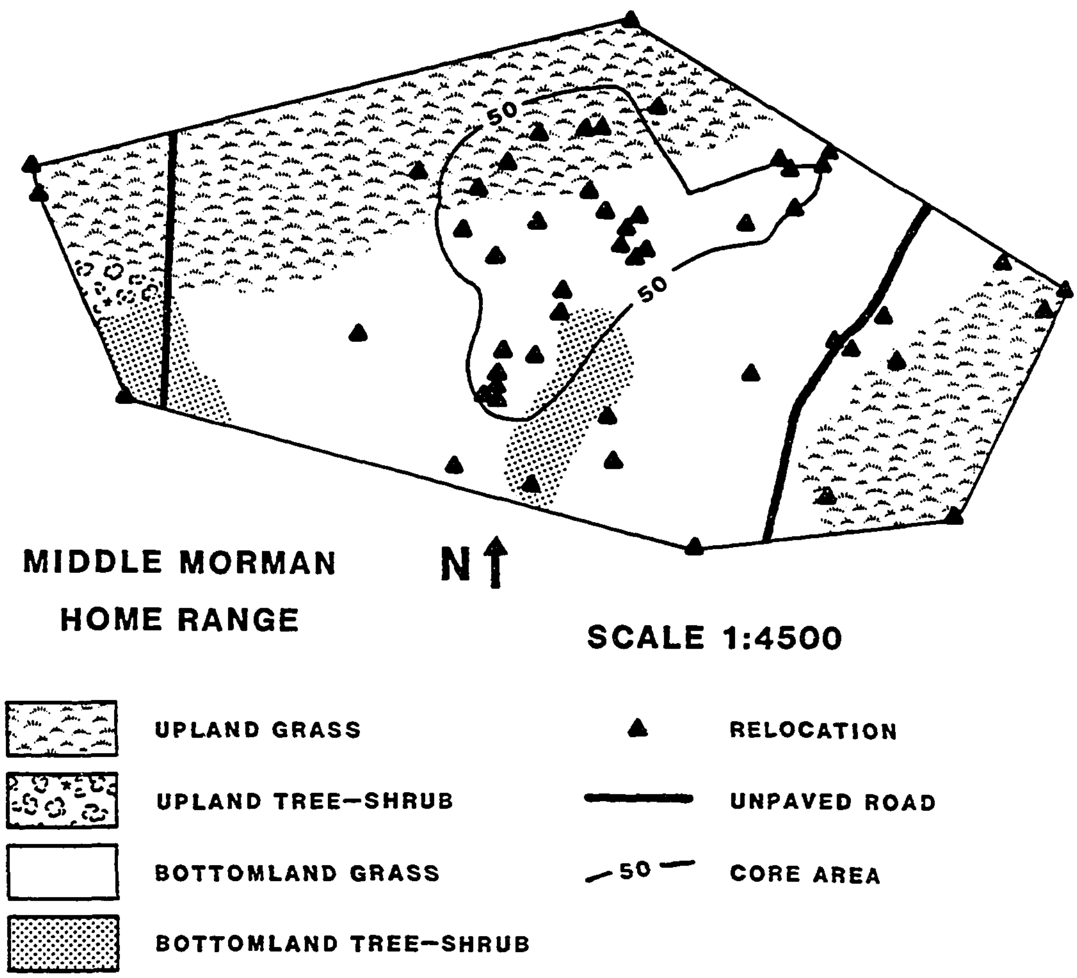

Figure A-1: Middle Mormon masked bobwhite home range.

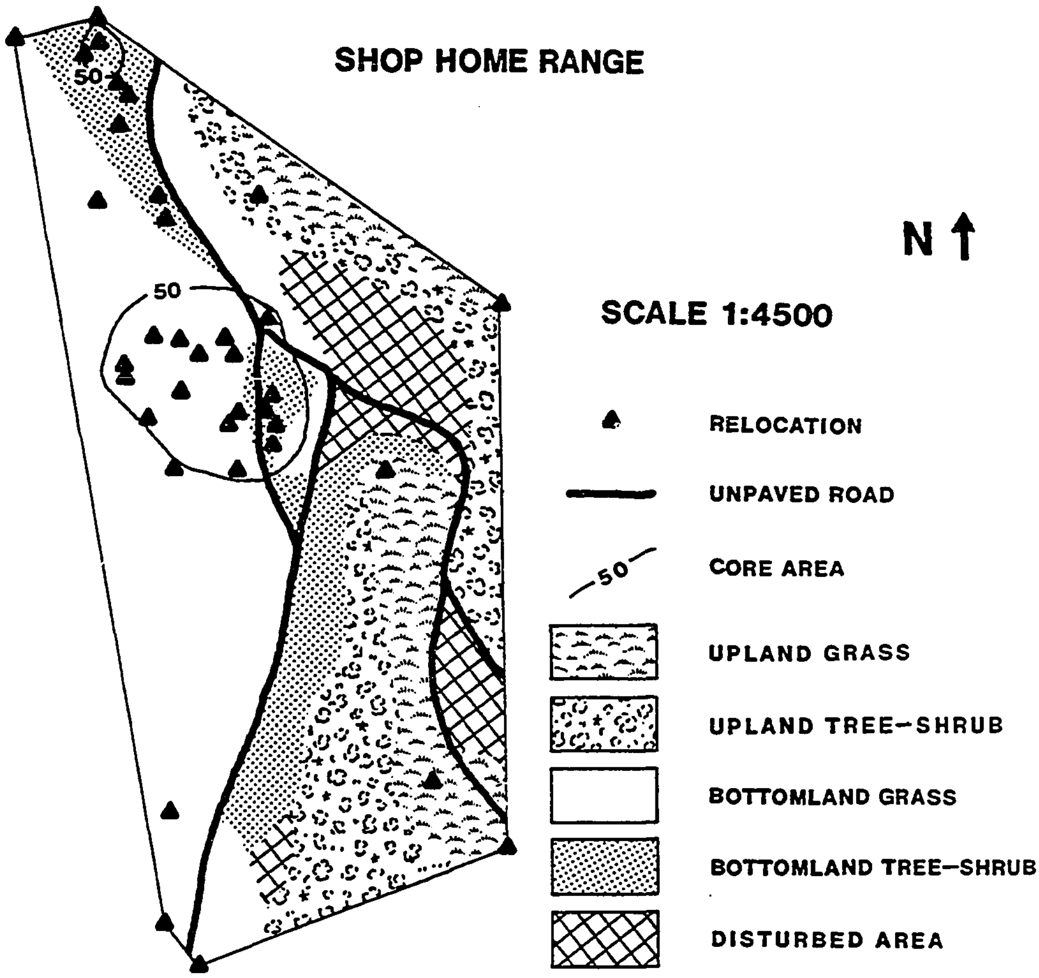

Figure A-2: Shop masked bobwhite home range.

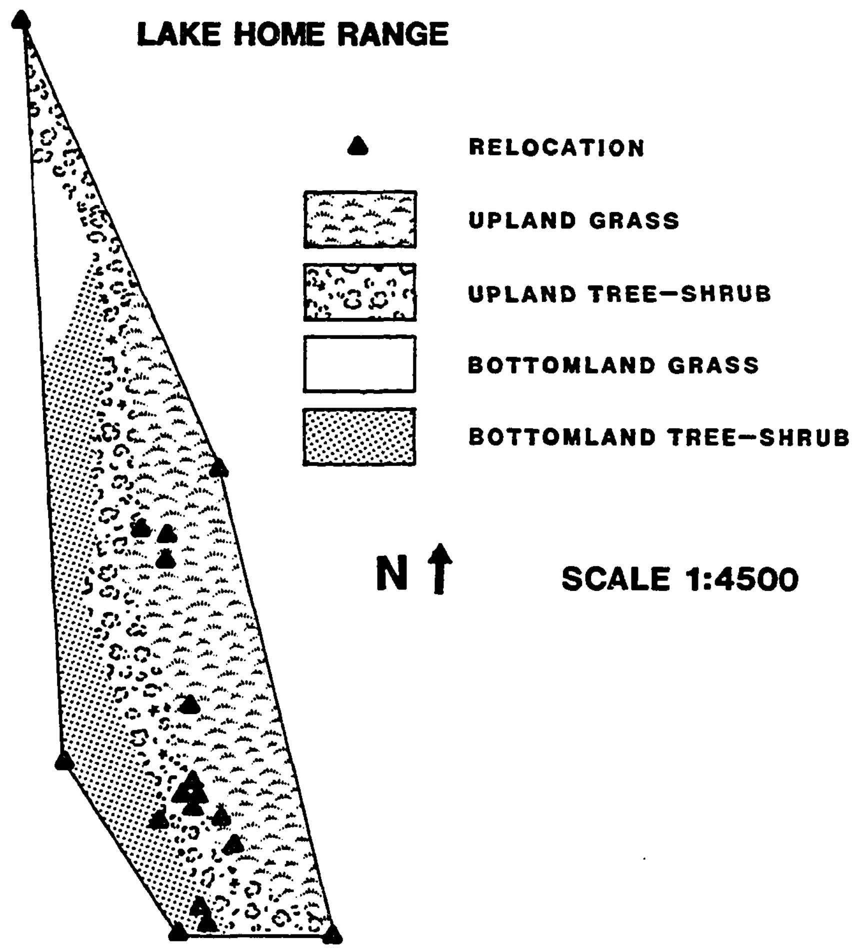

Figure A-3: Lake masked bobwhite home range.

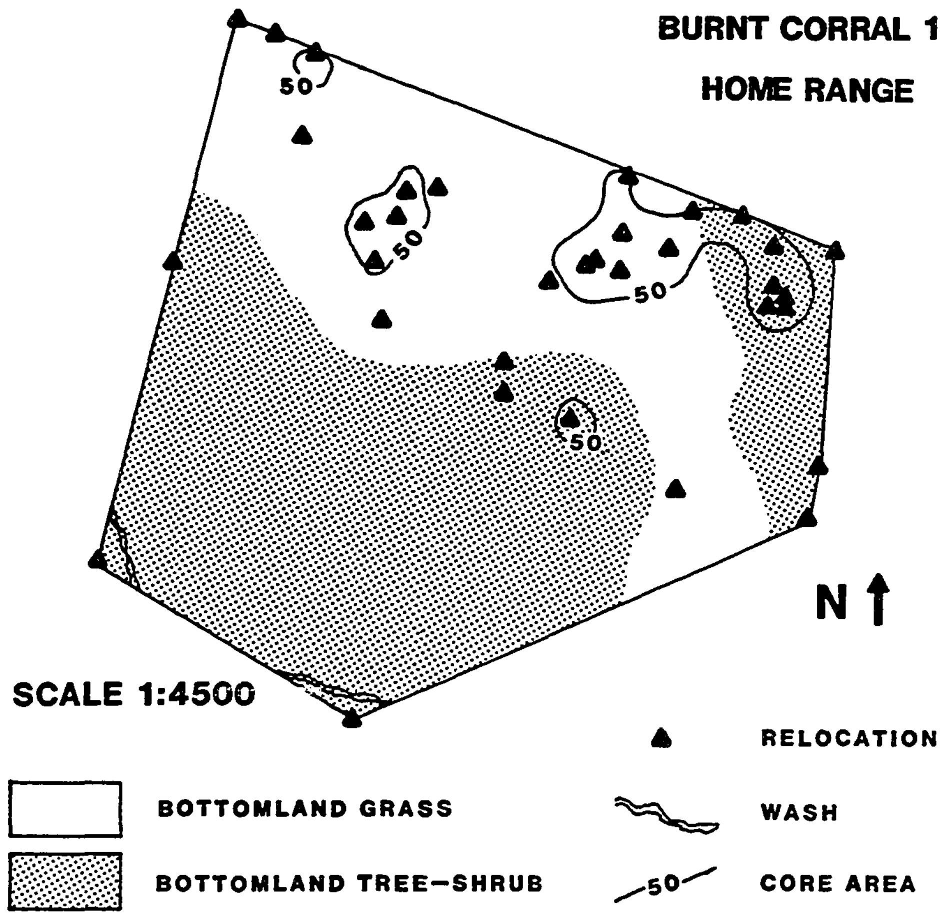

Figure A-4: Burnt Corral 1 masked bobwhite home range.

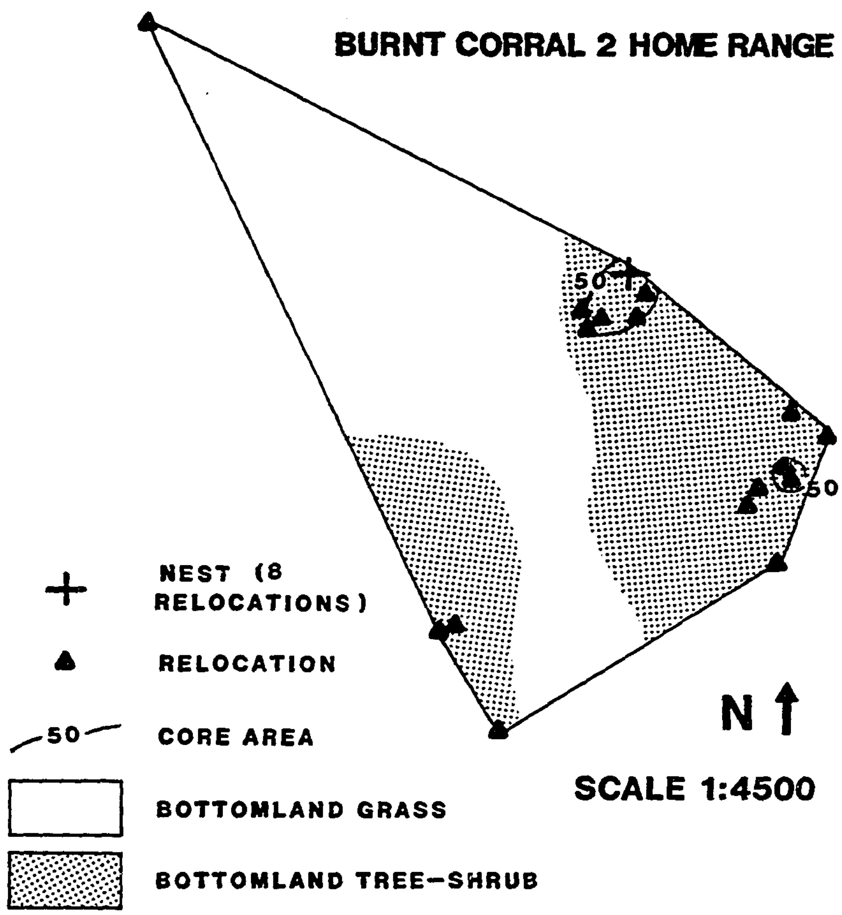

Figure A-5: Burnt Corral 2 masked bobwhite home range.

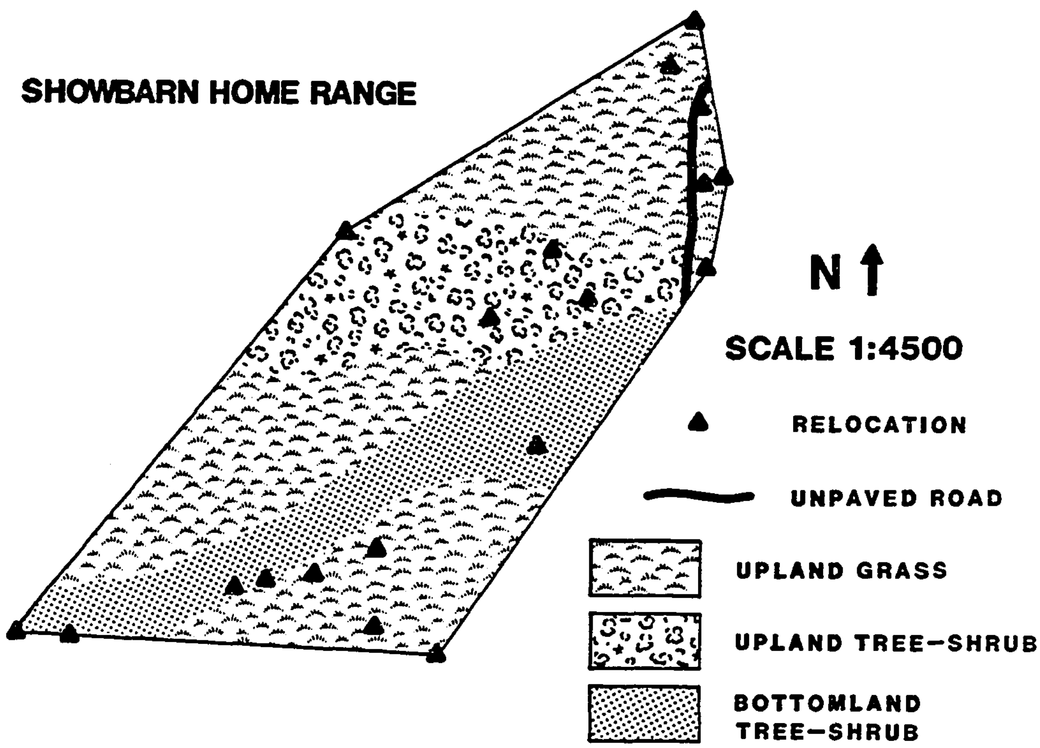

Figure A-6: Showbarn masked bobwhite home range.

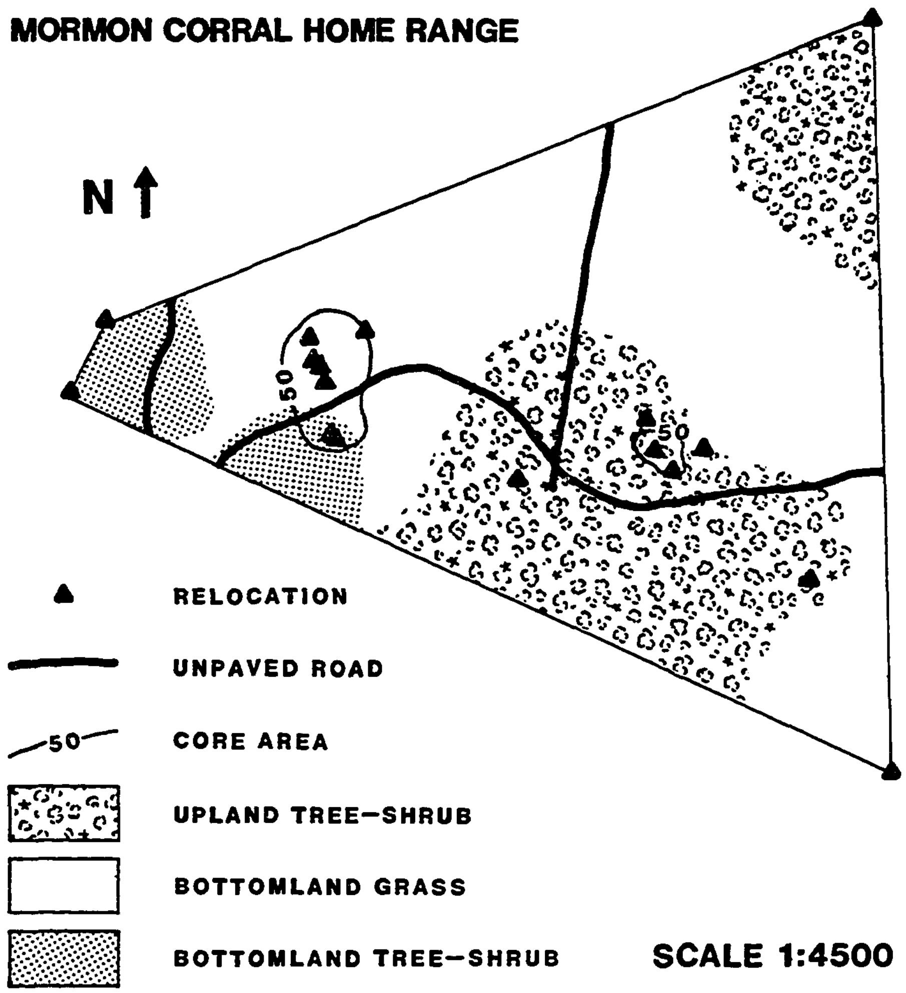

Figure A-7: Mormon Corral masked bobwhite home range.

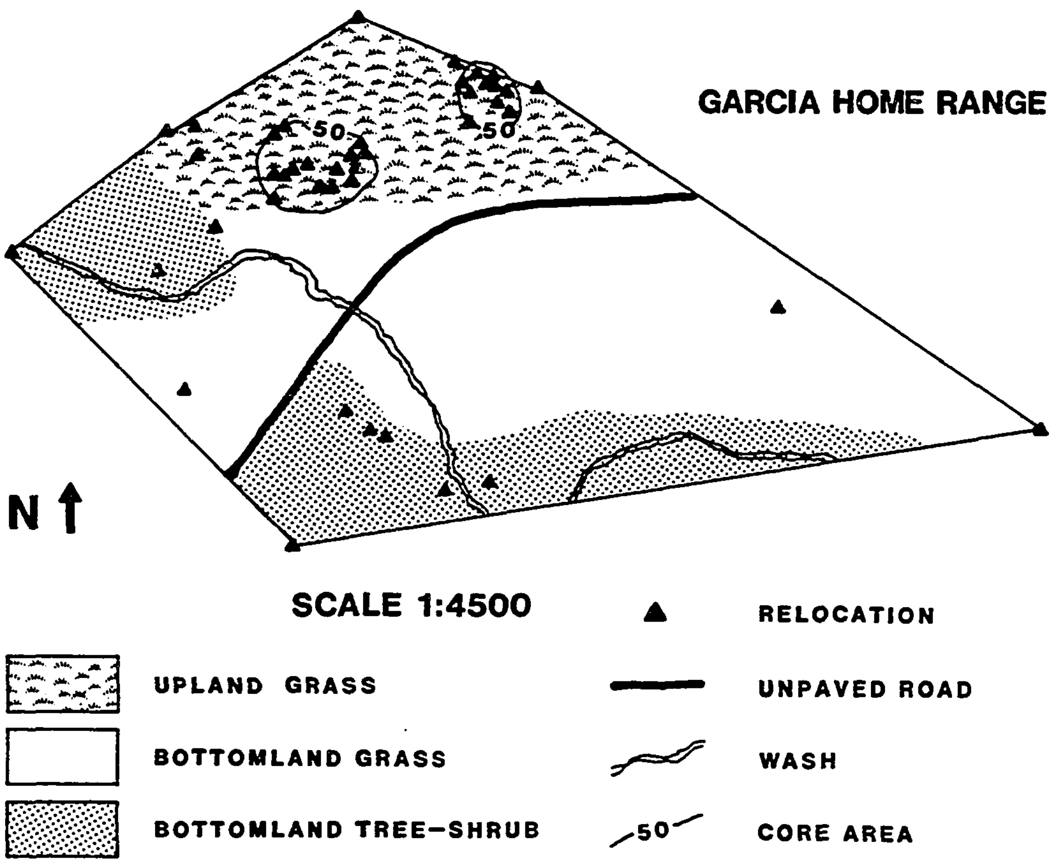

Figure A-8: Garcia masked bobwhite home range.

Table A-1

Masked bobwhite home ranges on the Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Home Range	Season[1]	Total Area (ha)	Core Area (ha)	Total # relocs.	# Core relocs.	# Non-core relocs.	sampled (period)	# birds radioed
MM	NB	14.6	2.7	51	27	24	(11/22/86-4/4/87)	4
SH	NB	12.8	1.7	36	19	17	(12/5/86-4/23/87)	5
LK	NB	5.2	-	18	-	-	(11/20/86-2/20/87)	3
BC1	BR	13.6	0.9	34	18	16	(5/25/87-7/24/87)	2
BC2	BR	8.2	0.2	24	13	11	(5/25/87-7/24/87)	1
SB	BR	8.3	-	19	-	-	(5/19/87-7/14/87)	2
MC	NB	13.3	0.5	17	9	8	(12/19/87-2/7/88)	5
G	NB	11.2	0.4	43	25	18	(12/14/87-2/29/88)	3

[1] Non-breeding season=NB, Breeding season=BR

Table A-2

Vegetation transects in masked bobwhite home ranges on the Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Home Range	Season	Total area	Core area (ha)	Total # trans. (ha)	# Core trans.	# Non-Core trans.	Transects/ha Total	Transects/ha Core
MM	NB	14.6	2.7	40	8	32	2.7	3.0
SH	NB	12.8	1.7	29	5	24	2.3	3.0
LK	NB	5.2	-	8	-	-	1.5	-
BC1	BR	13.6	0.9	40	9	31	2.9	10.0
BC2	BR	8.2	0.2	24	3	21	2.9	15.0
SB	BR	8.3	-	25	-	-	3.0	-
MC	NB	13.3	0.5	40	5	35	3.0	10.0
G	NB	11.2	0.4	34	5	29	3.0	10.0

Table A-3
Frequency of occurrence (%) of forbs on Daubenmire plots within masked bobwhite home ranges, Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-1988.

SPECIES	MM	SH	LK	BC1	BC2	SB	MC	G
Ambrosia confertiflora	73	14	38	95	92	80	58	82
Amaranthus palmeri	-	-	-	38	38	-	48	9
Androsace occidentalis	-	-	-	-	-	-	3	-
Asclepias subulata	-	-	-	3	-	-	5	-
Atriplex elegans	43	7	50	20	13	12	-	-
Boerhaavia coccinea	-	7	-	50	46	4	-	-
Bowlesia incana	-	-	-	-	-	-	28	24
Calandrinia ciliata	-	-	-	-	-	-	50	50
Chenopodium album	3	-	-	33	33	4	20	53
Chenopodium spp.	-	-	-	8	-	-	-	-
Convolvulus incanus	23	-	-	-	8	-	-	-
Convolvulus spp.	5	14	-	5	-	-	-	-
Cucurbita digitata	-	3	-	10	-	-	-	-
Descurainia pinnata	-	-	-	-	-	-	35	35
Eriogonum albertianum	-	-	-	3	13	-	-	-
Erigeron canadensis	3	7	-	3	4	-	-	-
Erodium cicutarium	18	14	-	-	-	4	-	6
Eriogonum deflexum	-	-	-	-	-	-	13	15
Eriastrum diffusum	18	-	25	-	-	1	5	9
Erigeron divergens	-	-	-	-	-	1	-	-
Euphorbia albomarginata	3	-	-	10	17	-	3	12
Euphorbia florida	-	-	-	35	63	-	-	-
Gaura parviflora	-	-	-	3	-	-	-	-
Gnaphalium leucocephalum	-	-	-	3	-	-	-	-
Gnaphalium spp.	3	10	-	-	-	-	-	-
Kallstroemia grandiflora	-	-	-	18	42	-	-	6
Lactuca serriola	-	17	-	-	-	-	-	-
Lepidium thurberi	45	35	50	53	42	56	5	15
Lomatium nevadense	-	-	-	-	-	-	3	-
Lupinus spp.	3	-	13	8	-	-	3	12
Marsilea vestita	-	-	-	-	-	-	5	-
Mentzelia albicaulis	-	-	-	-	-	-	-	3
Oenothera albicaulis	-	-	-	-	-	-	-	9
Oenothera flava	-	-	-	-	-	-	10	-

TABLE A-3
CONTINUED

SPECIES	MM	SH	LK	BC1	BC2	SB	MC	G
Phacelia arizonica	-	-	-	-	-	-	18	-
Phyla cuneifolia	-	7	-	-	-	-	-	-
Plantago purshii	33	35	13	3	-	16	10	-
Rumex crispus	-	1	-	-	-	-	-	6
Salsola kali	33	69	25	28	17	4	55	74
Sida spp.	-	10	-	-	-	-	-	-
Solanum elaeagnifolium	-	-	-	-	8	-	-	-
Solanum spp.	3	7	-	3	-	-	-	-
Trianthema portulacastrum	3	-	50	7	-	4	-	-
unknown forbs	68	21	50	70	75	40	65	35
Veronica peregrina	10	10	38	7	-	-	-	-
Viguiera annua	65	45	13	15	17	20	10	59
(Number of plots)	(400	290	80	400	240	250	400	340)

Table A-4

Frequency of occurrence of grasses (%) on 30 meter transects in masked bobwhite home ranges, Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Species	MM	SH	LK	BC1	BC2	SB	MC	G
Andropogon barbinodis	20	7	13	43	71	12	10	50
Aristida spp.	45	31	100	90	100	88	48	68
Bouteloua aristidoides	-	-	-	15	25	-	-	-
Bouteloua curtipendulata	3	3	-	30	29	4	8	53
Bouteloua gracilis	18	-	-	23	33	-	25	-
Bouteloua hirsuta	-	-	-	-	8	-	-	-
Bouteloua radicosa	-	-	-	-	4	-	-	-
Bouteloua rothrockii	8	-	50	45	75	-	33	56
Bouteloua spp.	80	21	88	38	-	100	-	-
Bromus catharticus	-	7	-	-	-	-	-	-
Chloris virgata	18	10	50	10	17	8	18	38
Cynodon dactylon	-	62	-	-	-	-	5	12
Eriochloa lemmoni	-	-	-	15	21	-	13	-
Eragrostis intermedia	-	-	13	13	88	4	13	38
Eragrostis lemmoni	-	-	-	5	-	8	18	50
Eragrostis megastachya	-	3	-	-	-	-	3	-
Eragrostis spp.	25	7	63	33	17	80	3	9
Festuca octoflora	-	-	-	-	-	-	-	12
Hilaria belangeri	5	10	-	3	-	44	3	12
Hordeum murinum	8	34	-	-	-	-	-	-
Leptochloa dubia	3	41	13	8	21	-	3	18
Lycurus phleoides	-	-	-	-	-	-	-	29
Mulenbergia rigens	-	-	-	-	-	-	-	3
Panicum obtusum	58	-	13	15	17	16	53	3
Setaria macrostachya	-	-	-	3	33	-	-	-
Sorghum halepense	10	55	-	8	-	-	33	24
Sporobolus airoides	-	-	-	-	4	-	-	-
Sporobolus contractus	-	-	-	13	-	-	-	-
Sporobolus spp.	50	55	75	50	75	16	45	62
Trichachne californica	-	3	63	78	92	8	15	47
unknown grasses	80	38	63	85	75	32	18	32
(Number of Transects)	(40	29	8	40	24	25	40	34)

Table A-5

Frequency of occurrence (%) of half-shrubs, shrubs, and trees on line-intercept transects in masked bobwhite home ranges, Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Species	MM	SH	LK	BC1	BC2	SB	MC	G
Acacia angustissima	-	-	13	-	-	-	-	-
Acacia constricta	-	-	-	3	4	-	-	9
Acacia greggii	-	-	-	13	4	-	-	-
Anisacanthus thurberi	-	-	-	-	-	-	-	15
Aplopappus tenuisectus	10	7	50	-	-	16	10	6
Baccharis glutinosa	-	3	-	-	-	-	-	-
Baccharis sarothroides	-	-	-	-	-	-	-	6
Celtis pallida	-	-	13	-	-	-	-	9
Chilopsis linearis	-	-	-	-	-	-	-	9
Gutierrezia sarothrae	13	17	100	-	4	36	20	12
Mimosa spp.	-	-	-	3	-	-	-	-
Parkinsonia aculeata	-	7	25	5	-	-	3	-
Prosopis juliflora	38	45	38	58	58	64	38	24
unknown shrub	-	-	-	-	-	4	5	3
(Number of transects)	(40	29	8	40	24	25	0	34)

Table A-6

Percent ground cover ($\bar{x}$ and standard error, SE) by vegetation form in masked bobwhite home ranges on the Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Home Range	Season[1] &Year	N	Tree/Shrub Cover $\bar{x}$	Tree/Shrub Cover SE	Half-shrub Cover $\bar{x}$	Half-shrub Cover SE	Grass Cover aerial $\bar{x}$	Grass Cover aerial SE	Grass Cover basal $\bar{x}$	Grass Cover basal SE	Forb Cover $\bar{x}$	Forb Cover SE
MM	NB,86-7	40	4.6	1.6	1.8	1.0	33.1	2.8	16.5	1.7	6.9	0.7
SH	NB,86-7	29	9.5	3.4	2.3	1.1	40.2	4.4	28.6	4.8	11.0	2.2
LK	NB,86-7	08	14.7	7.3	10.2	3.0	30.8	3.1	6.4	1.0	2.7	1.1
BC1	BR,87	40	11.4	2.3	-	-	40.6	2.5	12.3	1.3	21.8	1.6
BC2	BR,87	24	7.9	2.1	0.1	0.0	55.9	2.2	17.8	1.3	13.0	1.2
SB	BR,87	25	5.3	1.4	1.5	0.6	32.6	1.2	16.3	1.5	3.6	1.1
MC	NB,87-8	40	8.3	2.4	2.3	1.0	43.3	4.9	23.4	3.9	14.6	2.1
G	NB,87-8	34	4.7	1.3	0.3	0.2	28.6	2.6	8.5	1.3	17.8	1.7

1 NB=non-breeding season
BR=breeding season

Table A-7

Percent ground cover of litter and bare ground in masked bobwhite home ranges on the Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Home Range	Season	Year	N	Litter $\bar{x}$	Litter SE	Bare Ground $\bar{x}$	Bare Ground SE
MM	NB	86-87	40	30.0	2.2	31.1	2.5
SH	NB	86-87	29	35.9	3.0	20.6	3.5
LK	NB	86-87	08	32.4	6.4	35.6	5.4
BC1	BR	87	40	19.7	1.9	29.3	2.4
BC2	BR	87	24	25.1	2.6	29.7	2.5
SB	BR	87	25	23.6	2.8	40.6	3.2
MC	NB	87-88	40	36.6	2.6	17.9	2.2
G	NB	87-88	34	35.5	2.3	31.0	2.6

Table A-8

Percent ground cover ($\bar{x}$ and SE) of most frequent forbs on individual masked bobwhite home ranges, Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Home Range	N	AMCO[1] $\bar{x}$	AMCO[1] SE	SAKA[2] $\bar{x}$	SAKA[2] SE	LETH[3] $\bar{x}$	LETH[3] SE	VIAN[4] $\bar{x}$	VIAN[4] SE	CHAL[5] $\bar{x}$	CHAL[5] SE	AMPA[6] $\bar{x}$	AMPA[6] SE
MM	40	1.8	0.4	0.8	0.4	0.3	0.1	1.4	0.4	0.1	0.1	0.0	0.0
SH	29	0.1	0.1	3.3	0.7	0.9	0.5	0.6	0.3	0.0	0.0	0.0	0.0
LK	08	0.5	0.3	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
BC1	40	11.5	1.3	0.6	0.3	1.1	0.3	0.1	0.1	1.1	0.4	1.3	0.4
BC2	24	6.5	1.2	0.5	0.3	0.6	0.2	0.4	0.2	0.4	0.2	1.0	0.6
SB	25	1.6	0.5	0.1	0.1	0.6	0.2	0.7	0.5	0.0	0.0	0.0	0.0
MC	40	1.4	0.4	4.7	1.6	0.1	0.1	0.5	0.3	0.5	0.2	1.4	0.4
G	34	9.0	1.7	3.3	0.9	0.2	0.1	0.8	0.2	0.6	0.2	0.0	0.0

1 AMCO=*Ambrosia confertiflora* 2 SAKA=*Salsola kali* 3 LETH=*Lepidium thurberi*
4 VIAN=*Viguiera annua* 5 CHAL=*Chenopodium album*
6 AMPA=*Amaranthus palmeri*

Table A-9

Percent ground cover (aerial) of most frequent grasses on individual masked bobwhite home ranges, Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88

Home Range		ARSP[1] $\bar{x}$	SE	SPSP[2] $\bar{x}$	SE	BOSP[3] $\bar{x}$	SE	TRCA[4] $\bar{x}$	SE	BORO[5] $\bar{x}$	SE	ANBA[6] $\bar{x}$	SE
MM	40	2.0	0.6	1.5	0.4	18.8	2.9	0.0	0.0	0.1	0.1	0.2	0.1
SH	29	2.1	0.9	5.0	1.6	0.9	0.5	0.0	0.0	0.0	0.0	0.1	0.1
LK	08	5.9	1.3	4.3	2.6	12.0	2.6	5.1	1.6	1.8	0.8	0.1	0.1
BC1	40	10.5	1.1	1.0	0.2	2.5	0.7	9.8	1.7	2.9	0.8	2.2	0.6
BC2	24	13.3	1.6	2.6	0.6	0.0	0.0	13.9	1.9	7.0	1.6	3.4	0.8
SB	25	3.9	0.8	0.2	0.1	18.1	1.8	0.0	0.0	0.3	0.2	2.1	1.0
MC	40	2.4	0.7	1.2	0.3	0.0	0.0	0.3	0.1	4.1	1.9	0.4	0.2
G	34	2.8	0.7	1.3	0.3	0.0	0.0	1.6	0.5	2.6	0.7	0.8	0.2

1 ARSP=*Aristida* spp.
2 SPSP=*Sporobolus* spp.
3 BOSP=*Bouteloua* spp.
4 TRCA=*Trichachne californica*
5 BORO=*Bouteloua Rothrockii*
6 ANBA=*Andropogon barbinodis*

Table A-10

Density of trees and half-shrubs (#/ha) in masked bobwhite home ranges, Buenos Aires National Wildlife Refuge, Pima County, Arizona, 1986-88.

Home Range	half-shrub (#/ha)[1] $\bar{x}$	SE	tree/shrub (#/ha)[2] <1m	tree/shrub (#/ha) 1-5m	tree/shrub (#/ha) >5m
MM	2363	1124	29.7	61.2	1.4
SH	3711	1710	14.0	56.4	4.2
LK	7490	1659	5.0	140.2	8.9
BC1	5	3	7.3	42.5	3.3
BC2	23	18	17.8	43.9	2.5
SB	2287	799	15.1	38.0	0.1
G	403	160	22.1	29.4	1.8
MC	4613	1618	0.5	29.5	4.7

[1] Density estimated by counts within 120 m^2 plots
Number of plots= 40 for MM, 29 for SH, 8 for LK, 40 for BC1, 24 for BC2, 34 for G, 40 for MC

[2] Density from total counts within home ranges

Table A-11

Mean and standard error of 40 vertical vegetation structure transects for Middle Mormon masked bobwhite home range, Buenos Aires National Wildlife Refuge.

Height Intvl. (dm)	Mean Visual Obstruction (%)							
	Grass		Forb		Half-shrub		Tree/Shrub	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
0-1	60.6	4.4	9.7	1.6	3.2	1.7	2.5	0.6
1-2	19.9	2.5	5.9	1.4	2.1	1.2	3.0	0.8
2-3	7.8	1.3	2.9	0.8	1.1	0.6	2.9	0.7
3-4	2.5	0.7	0.5	0.2	0.5	0.4	3.3	0.8
4-5	1.1	0.5	0.1	0.1	0.1	0.1	3.1	0.8
5-6	0.5	0.2	0.1	0.1			3.0	0.8
6-7	0.4	0.2	0.1	0.1			3.1	0.8
7-8	0.1	0.1					3.5	0.9
8-9							4.0	0.9
9-10							3.6	0.9
10-11							3.1	0.8
11-12							3.1	0.8
12-13							3.0	0.7
13-14							3.1	0.8
14-15							3.4	0.8
15-16							3.6	0.8
16-17							3.6	0.9
17-18							3.8	0.9
18-19							3.8	1.0
19-20							3.5	0.9

Table A-12

Mean and standard error of 29 vertical vegetation structure transects for Shop masked bobwhite home range, Buenos Aires National Wildlife Refuge.

Height Intvl. (dm)	Mean Visual Obstruction (%) Grass $\bar{x}$	Grass SE	Forb $\bar{x}$	Forb SE	Half-shrub $\bar{x}$	Half-shrub SE	Tree/Shrub $\bar{x}$	Tree/Shrub SE
0-1	70.5	4.8	34.8	5.4	5.0	2.6	4.1	1.3
1-2	54.8	4.7	27.4	5.2	4.5	2.3	4.0	1.3
2-3	42.6	4.3	22.2	4.3	3.8	1.9	4.0	1.3
3-4	26.0	4.1	15.7	3.9	1.4	0.6	4.3	1.4
4-5	20.3	3.6	12.7	3.4	0.5	0.3	4.3	1.3
5-6	16.0	3.2	8.4	2.3	0.3	0.2	5.0	1.7
6-7	11.2	2.6	6.0	2.0	0.3	0.2	5.2	1.6
7-8	7.9	1.9	3.4	1.1	0.3	0.2	5.3	1.7
8-9	5.0	1.3	2.1	0.7	0.2	0.2	5.3	1.7
9-10	3.8	1.0	1.0	0.5			5.5	1.8
10-11	1.9	0.6	0.7	0.3			5.7	1.9
11-12	1.9	0.6	0.5	0.3			5.2	1.8
12-13	1.6	0.6	0.5	0.3			5.3	1.9
13-14	1.4	0.5	0.5	0.3			5.7	1.9
14-15	1.0	0.5	0.5	0.3			5.9	2.0
15-16	0.5	0.3	0.3	0.2			5.5	1.9
16-17	0.5	0.3	0.3	0.2			5.2	1.8
17-18	0.3	0.2	0.2	0.2			5.2	1.8
18-19	0.3	0.2	0.2	0.2			5.5	1.9
19-20	0.5	0.4	0.2	0.2			5.7	2.0

Table A-13

Mean and standard error for 8 vertical vegetation structure transects for Lake masked bobwhite home range, Buenos Aires National Wildlife Refuge.

Height Intvl. (dm)	Mean Visual Obstruction (%)							
	Grass		Forb		Half-shrub		Tree/Shrub	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
0-1	46.9	6.8	3.1	1.9	22.5	6.9	8.8	4.5
1-2	24.4	4.3	1.3	0.8	17.5	6.5	9.4	4.9
2-3	13.1	2.5	0.6	0.6	13.8	5.1	10.6	5.4
3-4	5.0	1.6			8.8	3.5	10.6	5.4
4-5	1.9	0.9			3.1	1.6	13.1	6.9
5-6	0.6	0.6			1.9	0.9	13.1	7.2
6-7	0.6	0.6					12.5	6.5
7-8							11.3	5.8
8-9							12.5	6.4
9-10							12.5	6.5
10-11							12.5	6.5
11-12							11.9	5.9
12-13							13.1	6.7
13-14							13.8	7.1
14-15							15.0	7.8
15-16							15.6	8.2
16-17							15.0	7.7
17-18							15.6	8.1
18-19							16.3	8.5
19-20							16.3	8.5

Table A-14

Mean and standard error of 40 vertical vegetation structure transects for Burnt Corral 1 masked bobwhite home range, Buenos Aires National Wildlife Refuge.

Height Intvl. (dm)	Mean Visual Obstruction (%)							
	Grass		Forb		Half-shrub		Tree/Shrub	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
0-1	61.9	3.6	40.4	3.7			8.9	1.6
1-2	55.5	3.6	33.3	3.6			9.5	1.6
2-3	40.5	3.3	22.0	2.9			10.1	1.7
3-4	23.3	2.3	11.5	2.1			10.8	1.8
4-5	11.8	1.6	5.3	1.3			11.4	1.9
5-6	6.0	1.1	3.1	0.9			11.5	1.9
6-7	3.1	0.9	1.4	0.5			12.7	2.1
7-8	2.3	0.7	0.9	0.4			13.2	2.1
8-9	1.4	0.5	0.3	0.2			13.6	2.3
9-10	1.3	0.5	0.3	0.2			14.6	2.3
10-11	0.5	0.2					14.8	2.2
11-12	0.3	0.2					14.8	2.3
12-13	0.1	0.1					14.8	2.3
13-14							15.5	2.3
14-15							15.4	2.3
15-16							15.3	2.3
16-17							15.6	2.3
17-18							15.1	2.3
18-19							14.6	2.3
19-20							14.0	2.3

Table A-15

Mean and standard error of 24 vertical vegetation structure transects for Burnt Corral 2 masked bobwhite home range, Buenos Aires National Wildlife Refuge.

Height Intvl. (dm)	Mean Visual Obstruction (%)							
	Grass		Forb		Half-shrub		Tree/Shrub	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	-	SE
0-1	71.5	3.7	30.7	3.4			10.2	1.9
1-2	65.0	3.3	25.7	3.0			11.1	2.1
2-3	44.6	3.5	13.7	2.2			13.7	2.2
3-4	25.2	3.2	4.8	1.3			14.6	2.1
4-5	11.7	2.8	2.2	0.8			16.1	2.5
5-6	4.1	1.1	1.1	0.4			16.7	2.5
6-7	1.5	0.6	0.9	0.4			16.7	2.7
7-8	0.9	0.5	0.2	0.2			17.2	2.9
8-9	0.9	0.5	0.2	0.2			17.6	3.0
9-10	0.7	0.5	0.2	0.2			17.2	3.1
10-11							17.8	3.3
11-12							17.0	3.0
12-13							17.0	3.0
13-14							17.0	3.1
14-15							17.0	3.0
15-16							17.2	3.1
16-17							17.2	3.2
17-18							17.8	3.3
18-19							17.2	3.0
19-20							16.1	3.1

Table A-16

Mean and standard error of 25 vertical vegetation structure transects for Showbarn masked bobwhite home range, Buenos Aires National Wildlife Refuge.

Height Intvl. (dm)	Mean Visual Obstruction (%)							
	Grass		Forb		Half-shrub		Tree/Shrub	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
0-1	70.0	3.9	8.0	2.7	4.4	1.4	9.2	1.8
1-2	52.0	5.2	5.4	1.8	4.0	1.4	9.4	1.7
2-3	34.4	4.6	3.0	1.0	2.2	0.9	9.4	1.8
3-4	22.2	3.3	1.4	0.5	0.6	0.4	9.8	1.8
4-5	7.8	1.8	0.2	0.2	0.2	0.2	10.2	1.9
5-6	3.2	1.1	0.2	0.2			10.0	2.1
6-7	1.2	0.5	0.2	0.2			11.2	2.2
7-8	1.0	0.5					10.2	2.0
8-9	0.8	0.5					10.2	2.0
9-10	0.4	0.3					10.2	2.0
10-11	0.2	0.2					9.6	1.9
11-12	0.2	0.2					10.4	1.9
12-13							9.0	2.0
13-14							9.2	2.1
14-15							9.0	2.0
15-16							8.8	2.1
16-17							8.6	2.0
17-18							8.6	2.1
18-19							8.0	2.1
19-20							7.6	2.1

Table A-17

Mean and standard error of 40 vertical vegetation structure transects for Mormon Corral masked bobwhite home range, Buenos Aires National Wildlife Refuge.

Height Intvl. (dm)	Mean Visual Obstruction (%)							
	Grass		Forb		Half-shrub		Tree/Shrub	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
0-1	54.4	5.0	33.8	4.3	4.8	2.4	4.8	1.2
1-2	44.9	4.9	30.4	4.1	4.4	2.3	4.8	1.2
2-3	37.0	4.9	28.3	3.9	2.3	1.2	4.9	1.2
3-4	29.6	4.8	24.6	3.7	1.3	0.8	5.1	1.3
4-5	24.8	4.6	20.8	3.4	0.6	0.4	5.4	1.3
5-6	20.4	4.3	17.1	3.1	0.1	0.1	5.8	1.3
6-7	18.6	4.2	14.6	2.8	0.1	0.1	6.3	1.5
7-8	16.4	4.1	11.5	2.5			6.1	1.5
8-9	15.5	4.1	8.9	2.1			6.5	1.5
9-10	13.6	3.8	5.6	1.5			6.9	1.6
10-11	12.0	3.5	3.8	1.1			7.3	1.6
11-12	11.9	3.6	3.0	1.0			7.4	1.7
12-13	11.1	3.5	2.3	0.8			7.5	1.7
13-14	10.9	3.4	1.6	0.6			7.8	1.8
14-15	10.9	3.3	1.4	0.6			8.0	1.9
15-16	10.5	3.2	1.0	0.5			7.9	1.9
16-17	9.6	3.0	0.9	0.5			8.0	1.9
17-18	9.1	2.9	0.8	0.5			8.4	2.0
18-19	8.6	2.7	0.6	0.4			8.5	2.0
19-20	7.8	2.4	0.6	0.4			8.8	2.1

Table A-18

Mean and standard error of 34 vertical vegetation structure transects for Garcia masked bobwhite home range, Buenos Aires National Wildlife Refuge.

Height Intvl. (dm)	Mean Visual Obstruction (%) (N=34)							
	Grass		Forb		Half-shrub		Tree/shrub	
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
0-1	60.3	4.2	22.4	3.3	0.3	0.2	8.4	2.1
1-2	49.6	4.1	16.9	3.4	0.3	0.2	8.5	2.1
2-3	42.1	4.1	12.9	2.7	0.3	0.2	8.4	2.1
3-4	34.0	3.8	10.0	2.2	0.3	0.2	8.8	2.0
4-5	27.2	3.6	7.5	1.7			9.0	2.2
5-6	20.1	3.0	5.0	1.2			8.8	2.1
6-7	12.5	2.2	4.0	1.1			8.8	2.0
7-8	8.7	2.0	2.6	1.0			8.5	2.1
8-9	6.0	1.6	1.5	0.9			8.2	2.1
9-10	4.9	1.4	1.2	0.8			8.2	2.0
10-11	3.2	1.2	0.6	0.5			7.8	2.0
11-12	2.9	1.1	0.6	0.5			7.2	1.9
12-13	2.5	1.0	0.3	0.3			7.2	1.9
13-14	2.2	0.9	0.3	0.3			6.8	1.8
14-15	2.1	0.8	0.3	0.3			6.8	1.8
15-16	2.1	0.8	0.3	0.3			6.5	1.7
16-17	2.1	0.8	0.3	0.3			6.3	1.7
17-18	2.1	0.8	0.3	0.3			6.2	1.7
18-19	1.9	0.8	0.3	0.3			6.2	1.7
19-20	1.9	0.8	0.3	0.3			6.2	1.7

Table A-19

Percent ground cover in core and non-core areas of MIDDLE MORMON masked bobwhite home range compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

Cover Type	CORE AREA (N=8) Mean Cover(%)	SE	NON-CORE AREA (N=32) Mean Cover(%)	SE	2-Tailed Prob.	Sig? @ P<0.05
Grass (aerial)	48.3	4.6	29.3	2.9	0.0072	Y
Grass (basal)	22.8	3.3	15.0	1.8	0.0425	Y
Forb	4.5	0.8	7.6	0.7	0.0539	N
Half-Shrub	0.0	-	2.3	1.2	-	-
Tree/Shrub	5.1	2.4	4.4	1.9	0.1502	N
Bare Ground	19.3	3.4	35.2	2.7	0.0088	Y
Litter	25.6	5.8	31.5	2.4	0.2060	N

Table A-20

Percent ground cover in core and non-core areas of SHOP masked bobwhite home range compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

	CORE AREA (N=5)		NON-CORE AREA (N=24)			
Cover Type	Mean Cover(%)	SE	Mean Cover(%)	SE	2-Tailed Prob.	Sig? @ P<0.05
Grass (aerial)	54.9	15.5	37.2	4.2	0.4529	N
Grass (basal)	46.9	18.3	24.8	4.2	0.3865	N
Forb	18.5	6.0	9.4	2.3	0.0884	N
Half-Shrub	0.0	0.0	2.8	1.3	-	-
Tree/ Shrub	0.0	0.0	11.4	4.0	0.0397	Y
Bare Ground	10.5	10.5	22.7	3.7	0.0402	Y
Litter	22.3	8.0	38.7	3.0	0.0832	N

Table A-21

Percent ground cover in core and non-core areas of BURNT CORRAL 1 masked bobwhite home range compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

	CORE AREA (N=9)		NON-CORE AREA (N=31)			
Cover Type	Mean Cover(%)	SE	Mean Cover(%)	SE	2-Tailed Prob.	Sig? @ P<0.05
Grass (aerial)	46.5	4.0	38.9	3.0	0.1687	N
Grass (basal)	15.1	2.5	11.4	1.5	0.1278	N
Forb	18.7	4.5	22.7	1.6	0.4964	N
Half-Shrub	0.0	0.0	0.0	0.0	1.0000	N
Tree/Shrub	7.6	4.9	12.5	2.6	0.1887	N
Bare Ground	32.2	6.7	28.5	2.4	0.6502	N
Litter	20.3	3.8	19.5	2.2	0.8206	N

Table A-22

Percent ground cover in core and non-core areas of BURNT CORRAL 2 masked bobwhite home range compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

Cover Type	CORE AREA (N=3) Mean Cover(%)	SE	NON-CORE AREA (N=21) Mean Cover(%)	SE	2-Tailed Prob.	Sig? @ P<0.05
Grass (aerial)	55.7	7.6	55.9	2.3	0.7600	N
Grass (basal)	18.6	1.2	17.7	1.5	0.6312	N
Forb	9.5	1.6	13.5	1.3	0.2053	N
Half-Shrub	0.0	0.0	0.0	0.0	1.0000	N
Tree/Shrub	17.3	9.1	6.5	1.9	0.3279	N
Bare Ground	16.3	0.9	31.6	2.6	0.0207	Y
Litter	22.9	5.8	25.4	2.8	0.9304	N

Table A-23

Percent ground cover in core and non-core areas of GARCIA masked bobwhite home range compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

	CORE AREA (N=5)		NON-CORE AREA (N=29)			
Cover Type	Mean Cover(%)	SE	Mean Cover(%)	SE	2-Tailed Prob.	Sig? @ P<0.05
Grass (aerial)	43.1	8.2	26.1	2.5	0.0305	Y
Grass (basal)	12.0	3.5	7.9	1.3	0.0800	N
Forb	24.7	4.6	16.7	1.8	0.1514	N
Half-Shrub	0.0	0.0	0.4	0.2	-	-
Tree/Shrub	0.4	0.4	5.4	1.5	0.1202	N
Bare Ground	25.2	4.3	32.0	2.9	0.3682	N
Litter	29.3	3.0	36.6	2.6	0.3813	N

Table A-24

Percent ground cover in core and non-core areas of MORMON CORRAL masked bobwhite home range compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

	CORE AREA (N=5)		NON-CORE AREA (N=35)			
Cover Type	Mean Cover(%)	SE	Mean Cover(%)	SE	2-Tailed Prob.	Sig? @ P<0.05
Grass (aerial)	71.9	6.9	39.3	5.2	0.0389	Y
Grass (basal)	59.0	12.3	18.9	3.4	0.0045	Y
Forb	7.3	3.0	15.6	2.3	0.2121	N
Half-Shrub	0.0	0.0	2.6	1.1	-	-
Tree/Shrub	0.0	0.0	9.5	2.6	0.0535	N
Bare Ground	6.6	3.1	19.6	2.3	0.0389	Y
Litter	28.4	6.2	37.8	2.8	0.2438	N

Table A-25

Percent ground cover in core and non-core areas of masked bobwhite home ranges (all transects combined) compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

	CORE AREA (N=35)		NON-CORE AREA (N=172)			
Cover Type	Mean Cover(%)	SE	Mean Cover(%)	SE	2-Tailed Prob.	Sig? @ P<0.05
Grass (aerial)	52.0	3.3	36.9	1.6	0.0001	Y
Grass (basal)	27.5	4.2	15.6	1.1	0.0009	Y
Forb	13.8	2.0	14.5	0.8	0.5166	N
Half-Shrub	0.0	0.0	1.4	0.4	-	-
Tree/ Shrub	4.7	1.7	8.3	1.0	0.0490	Y
Bare Ground	20.1	2.8	27.7	1.2	0.0050	Y
Litter	24.5	2.2	31.7	1.2	0.0144	Y

Table A-26

Percent ground cover in core and non-core areas of masked bobwhite home ranges (all transects combined) compared by T-Test.

Cover Type	CORE AREA (N=35) Mean Cover(%)	SE	NON-CORE AREA (N=172) Mean Cover(%)	SE	2-Tailed Prob.	Sig? @ P<0.05
Grass (aerial)	52.0	3.3	36.9	1.6	0.000	Y
Grass (basal)	27.5	4.2	15.6	1.1	0.009	Y
Forb	13.8	2.0	14.5	0.8	0.765	N
Half-Shrub	0.0	0.0	1.4	0.4	-	-
Tree/Shrub	4.7	1.7	8.3	1.0	0.071	N
Bare Ground	20.1	2.8	27.7	1.2	0.011	Y
Litter	24.5	2.2	31.7	1.2	0.011	Y

Table A-27

Percent visual obstruction of grasses in 20 height intervals in core and non-core areas (all transects combined) of masked bobwhite home ranges compared by Mann-Whitney U-Wilcoxon Rank Sum W Test.

Ht. Int. (dm)	CORE AREA (N=34) $\bar{x}$	SE	NON-CORE AREA (N=1[illegible]) $\bar{x}$	SE	2-tailed prob.	Sig? @ P<0.05
0-1	80.0	3.2	58.9	2.2	0.0000	Y
1-2	51.8	4.9	45.5	2.1	[illegible]150	N
2-3	35.7	4.7	34.2	1.9	0.[illegible]3	N
3-4	20.2	3.9	23.4	1.7	0.2[illegible]	N
4-5	13.1	3.0	16.5	1.6	0.482[illegible]	N
5-6	8.2	2.3	11.9	1.4	0.4718	N
6-7	6.3	1.8	8.5	1.3	0.9107	N
7-8	4.7	1.5	6.6	1.1	0.8562	N
8-9	3.8	1.1	5.3	1.1	0.6311	N
9-10	2.2	0.7	4.7	1.0	0.7487	N
10-11	1.0	0.4	3.7	0.9	0.8360	N
11-12	0.9	0.4	3.6	1.0	0.7265	N
12-13	0.6	0.3	3.3	0.9	0.5423	N
13-14	0.4	0.2	3.1	0.9	0.3460	N
14-15	0.4	0.2	3.0	0.9	0.4321	N
15-16	0.3	0.2	2.9	0.8	0.2494	N
16-17	0.3	0.2	2.7	0.8	0.2518	N
17-18	0.3	0.2	2.5	0.7	0.3224	N
18-19	0.3	0.2	2.4	0.7	0.3254	N
19-20	0.3	0.2	2.2	0.6	0.3240	N

Table A-28

Percent visual obstruction of grasses in 20 height intervals in core and non-core areas (all transects combined) of masked bobwhite home ranges compared by T-test.

Ht. Int. (dm)	CORE AREA (N=34) $\bar{x}$	SE	NON-CORE AREA (N=172) $\bar{x}$	SE	2-tailed prob.	Sig? @ P<0.05
0-1	80.0	3.2	58.9	2.2	0.000	Y
1-2	51.8	4.9	45.5	2.1	0.218	N
2-3	35.7	4.7	34.2	1.9	0.751	N
3-4	20.2	3.9	23.4	1.7	0.446	N
4-5	13.1	3.0	16.5	1.6	0.414	N
5-6	8.2	2.3	11.9	1.4	0.178	N
6-7	6.3	1.8	8.5	1.3	0.334	N
7-8	4.7	1.5	6.6	1.1	0.323	N
8-9	3.8	1.1	5.3	1.1	0.346	N
9-10	2.2	0.7	4.7	1.0	0.044	Y
10-11	1.0	0.4	3.7	0.9	0.010	Y
11-12	0.9	0.4	3.6	1.0	0.010	Y
12-13	0.6	0.3	3.3	0.9	0.005	Y
13-14	0.4	0.2	3.1	0.9	0.003	Y
14-15	0.4	0.2	3.0	0.9	0.004	Y
15-16	0.3	0.2	2.9	0.8	0.003	Y
16-17	0.3	0.2	2.7	0.8	0.003	Y
17-18	0.3	0.2	2.5	0.7	0.004	Y
18-19	0.3	0.2	2.4	0.7	0.004	Y
19-20	0.3	0.2	2.2	0.6	0.004	Y

Table A-29

Visual obstruction of trees in 20 height intervals between core and non-core areas (all transects combined) of masked bobwhite home ranges compared with Mann-Whitney U-Wilcoxon Rank Sum W Test.

Ht. Int. (dm)	CORE AREA (N=34) $\bar{x}$	SE	NON-CORE AREA (N=172) $\bar{x}$	SE	2-tailed prob.	Sig? @ P<0.05
0-1	4.1	1.3	6.7	0.7	0.0256	Y
1-2	4.7	1.5	6.0	0.7	0.0426	Y
2-3	4.7	1.5	7.4	0.7	0.0358	Y
3-4	5.3	1.5	7.8	0.8	0.1026	N
4-5	5.9	1.5	8.1	0.8	0.3200	N
5-6	5.7	1.5	8.4	0.8	0.2125	N
6-7	6.2	1.7	8.8	0.9	0.2657	N
7-8	6.5	1.7	8.9	0.9	0.3379	N
8-9	6.3	1.7	9.2	1.0	0.2010	N
9-10	6.0	1.6	9.5	1.0	0.1493	N
10-11	5.6	1.5	9.6	1.0	0.1193	N
11-12	5.3	1.5	9.4	1.0	0.0772	N
12-13	5.2	1.5	9.5	1.0	0.0559	N
13-14	5.7	1.7	9.7	1.0	0.0887	N
14-15	5.6	1.6	9.7	1.0	0.0929	N
15-16	5.6	1.6	9.6	1.0	0.0963	N
16-17	6.0	1.7	9.6	1.0	0.1557	N
17-18	6.5	1.8	9.5	1.0	0.1831	N
18-19	6.0	1.8	9.5	1.0	0.1217	N
19-20	5.6	1.7	9.3	1.0	0.1203	N

Table A-30

Visual obstruction of trees in 20 height intervals between core and non-core areas (all transects combined) of masked bobwhite home ranges compared with T-test.

Ht. Int. (dm)	CORE AREA (N=34) $\bar{x}$	SE	NON-CORE AREA (N=172) $\bar{x}$	SE	2-tailed prob.	Sig? @ P<0.05
0-1	4.1	1.3	6.7	0.7	0.128	N
1-2	4.7	1.5	6.0	0.7	0.199	N
2-3	4.7	1.5	7.4	0.7	0.141	N
3-4	5.3	1.5	7.8	0.8	0.170	N
4-5	5.9	1.5	8.1	0.8	0.256	N
5-6	5.7	1.5	8.4	0.8	0.183	N
6-7	6.2	1.7	8.8	0.9	0.215	N
7-8	6.5	1.7	8.9	0.9	0.263	N
8-9	6.3	1.7	9.2	1.0	0.198	N
9-10	6.0	1.6	9.5	1.0	0.067	N
10-11	5.6	1.5	9.6	1.0	0.029	Y
11-12	5.3	1.5	9.4	1.0	0.025	Y
12-13	5.2	1.5	9.5	1.0	0.018	Y
13-14	5.7	1.7	9.7	1.0	0.099	N
14-15	5.6	1.6	9.7	1.0	0.032	Y
15-16	5.6	1.6	9.6	1.0	0.081	N
16-17	6.0	1.7	9.6	1.0	0.130	N
17-18	6.5	1.8	9.5	1.0	0.199	N
18-19	6.0	1.8	9.5	1.0	0.135	N
19-20	5.6	1.7	9.3	1.0	0.109	N

Table A-31

Percent visual obstruction of all vegetation forms in 20 height intervals between core and non-core areas (all transects combined) of masked bobwhite home ranges compared with Mann-Whitney U-Wilcoxon Rank Sum W Test.

Ht. Int. (dm)	CORE AREA (N=34) $\bar{x}$	SE	NON-CORE AREA (N=172) $\bar{x}$	SE	2-tailed prob.	Sig? @ P<0.05
0-1	93.1	1.6	86.1	1.4	0.0385	Y
1-2	64.3	5.1	69.0	2.1	0.5133	N
2-3	46.5	5.0	54.4	2.1	0.1489	N
3-4	29.1	4.5	40.1	2.0	0.0259	Y
4-5	21.9	3.6	31.1	1.9	0.0580	N
5-6	16.0	2.8	25.1	1.8	0.0377	Y
6-7	14.4	2.5	20.9	1.6	0.1433	N
7-8	12.2	2.1	18.3	1.6	0.2394	N
8-9	10.6	1.9	16.6	1.5	0.2370	N
9-10	8.5	1.6	15.5	1.4	0.0923	N
10-11	6.8	1.5	14.0	1.3	0.0426	Y
11-12	6.2	1.5	13.5	1.3	0.0162	Y
12-13	5.7	1.5	13.1	1.2	0.0087	Y
13-14	6.2	1.6	12.9	1.2	0.0168	Y
14-15	6.0	1.6	12.9	1.2	0.0171	Y
15-16	5.9	1.6	12.6	1.2	0.0161	Y
16-17	6.3	1.6	12.3	1.2	0.0347	Y
17-18	6.8	1.8	12.1	1.2	0.0547	Y
18-19	6.3	1.6	11.9	1.1	0.0345	Y
19-20	5.9	1.7	11.6	1.1	0.0338	Y

Table A-32

Percent visual obstruction of all vegetation forms in 20 height intervals between core and non-core areas (all transects combined) of masked bobwhite home ranges compared with T-test.

Ht. Int. (dm)	CORE AREA (N=34) $\bar{x}$	SE	NON-CORE AREA (N=172) $\bar{x}$	SE	2-tailed prob.	Sig? @ P<0.05
0-1	93.1	1.6	86.1	1.4	0.002	Y
1-2	64.3	5.1	69.0	2.1	0.361	N
2-3	46.5	5.0	54.4	2.1	0.124	N
3-4	29.1	4.5	40.1	2.0	0.052	N
4-5	21.9	3.6	31.1	1.9	0.052	N
5-6	16.0	2.8	25.1	1.8	0.008	Y
6-7	14.4	2.5	20.9	1.6	0.034	Y
7-8	12.2	2.1	18.3	1.6	0.023	Y
8-9	10.6	1.9	16.6	1.5	0.015	Y
9-10	8.5	1.6	15.5	1.4	0.001	Y
10-11	6.8	1.5	14.0	1.3	0.000	Y
11-12	6.2	1.5	13.5	1.3	0.000	Y
12-13	5.7	1.5	13.1	1.2	0.000	Y
13-14	6.2	1.6	12.9	1.2	0.002	Y
14-15	6.0	1.6	12.9	1.2	0.001	Y
15-16	5.9	1.6	12.6	1.2	0.001	Y
16-17	6.3	1.6	12.3	1.2	0.004	Y
17-18	6.8	1.8	12.1	1.2	0.015	Y
18-19	6.3	1.6	11.9	1.1	0.010	Y
19-20	5.9	1.7	11.6	1.1	0.006	Y

Table A-33

Analysis of Variance and Scheffes test on percent visual obstruction of grasses by decimeter height interval for 8 masked bobwhite home ranges (MM, SH, LK, SB, BC1, BC2, MC, G) and representative upland (PTU) and bottomland (PTB) sites.

Height Interval (dm)	Sig. differences in percent vertical cover of grasses at P=0.05. (<= sig. lower; >=sig. higher)
0-1	none
1-2	MM < MC, G, SH, PTU, BC1, SB
2-3	MM < MC, G, SH, PTU, BC1, SB, BC2; LK < PTU
3-4	MM < MC, G, SH, PTU, BC1, BC2
4-5	MM < MC, G, SH, PTU
5-6	MM < MC, G, SH ; SB < MC, G ; BC1 < MC
6-7	MC > MM, BC2, BC1, SB
7-8	MC > MM, BC2, BC1, SB, PTU
8-9	MC > MM, BC2, BC1, SB, PTU
9-10	MC > MM, BC2, BC1, SB, PTU
10-11	MC > MM, BC2, BC1, SB, PTU, SH
11-12	MC > MM, BC2, BC1, SB, SH
12-13	MC > MM, BC2, BC1, SB, SH
13-14	MC > MM, BC2, BC1, SB, SH, G
14-15	MC > MM, BC2, BC1, SB, SH, G, PTU
15-16	MC > MM, BC2, BC1, SB, SH, G, PTU
16-17	MC > MM, BC2, BC1, SB, SH, G, PTU
17-18	MC > MM, BC2, BC1, SB, SH, PTU
18-19	MC > MM, BC2, BC1, SB, SH, PTU
19-20	MC > MM, BC2, BC1, SB, SH, PTU

Table A-34

Analysis of Variance and Scheffes Test on percent visual obstruction of all vegetation forms by decimeter height interval for 8 masked bobwhite home ranges (MM, SH, LK, SB, BC1, BC2, MC, G) and representative upland (PTU) and bottomland sites (PTB).

Height Interval (dm)	Sig. differences in percent vertical cover of all vegetation for P=0.05. (<= sig. lower; >= sig. higher)
0-1	MM < PTB,MC,BC1,SH,PTU,BC2
1-2	MM < PTB,MC,BC1,SH,PTU,BC2,G,SB ; LK < PTB, BC2
2-3	MM < PTB,MC,BC1,SH,PTU,BC2,G,SB ; PTB > LK, SB
3-4	MM < PTB,MC,BC1,SH,PTU,BC2,G,SB ; PTB > SB,BC1 ; MC > SB
4-5	MM < PTB,MC,BC1,SH,PTU,BC2,G ; PTB > SB,BC1 ; MC >SB,BC1
5-6	MM < PTB,MC,BC1,SH,G ; PTB > SB ; MC > SB, BC1
6-7	MM < PTB,MC,G ; MC > SB,BC1,PTU,SH
7-8	MM < PTB ; MC > SB,BC1,PTU,SH,MM
8-9	MC > SB,PTU,SH,MM
9-10	MC > MM,PTU
10-11	MC > MM
11-12	MC > MM
12-13	MC > MM
13-14	MC > MM
14-15	MC > MM
15-16	MC > MM
16-17	MC > MM
17-18	MC > MM
18-19	MC > MM
19-20	MC > MM

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