REPRODUCTIVE ECOLOGY OF RESIDENT AND TRANSLOCATED BOBWHITES ON SOUTH FLORIDA RANGELANDS

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
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Populations of northern bobwhite (*Colinus virginianus*) have been declining steadily over the last several decades throughout their range, probably due to changing land uses and habitat degradation. This decline has been observed in south Florida as well, where there is a lack of general knowledge about the reproductive ecology and nesting requirements for northern bobwhites that may be hindering conservation efforts. Similarly, translocation, another tool that may serve to restore northern bobwhite populations to their former level in south Florida, has not been well studied.

This study evaluated northern bobwhite nest habitat selection and success at several levels: microhabitat, home range, and landscape levels. I found that bobwhites selected for nest sites that had increased vegetative structure and visual obstruction at the microhabitat level, which was consistent with the characteristics of successful bobwhite nests. At a home range and landscape levels, bobwhites tended to select nests nearer to fencerows, further from canals, and further from habitat edge. Successful nests were further from most linear landscape features such as fencerows and canals that may be corridors for predators, but closer to habitat edge. I suggest managing for nest habitat that has taller, thicker herbaceous vegetation, interspersed with other types of habitat to increase edge, that is located away from fencerows and other linear

landscape features to increase nest success. Habitat should be managed similarly for both resident and translocated birds.

CHAPTER 1
INTRODUCTION

Populations of northern bobwhite (*Colinus virginianus*) have declined dramatically throughout their North American range, with declines in Florida averaging ~4.3%/year during the past several decades (Sauer et al. 2001, Giuliano et al. 2007). These declines are most likely due to loss and degradation of Florida's quail habitat, a result of changes in land use. This is particularly true in rangelands, where native range is frequently converted to "improved" pastures of Bahia grass (*Paspalum notatum*) and other sod-forming grasses, and both improved and native range are often overgrazed (Giuliano et al. 2007). Habitat restoration and translocation of wild bobwhites may be effective tools for restoring quail populations in Florida. However, a general lack of knowledge about quail ecology (including reproductive ecology) in Florida's rangelands, which are very different from anywhere else in the northern bobwhites range, and the effectiveness of translocating quail as a restoration tool, may hinder restoration efforts (FWC 2004, Hines 2004, Giuliano et al. 2007).

High reproductive potential of northern bobwhites is one of the main factors allowing bobwhite populations to exist with and recover from high annual mortality and catastrophic events (Suchy and Munkel 1993). A better understanding of northern bobwhite reproductive ecology in south Florida rangelands may provide insights into their management and facilitate population increases and restorations. Based on studies from other parts of the northern bobwhite's range, quail appear to prefer nesting in fields dominated by native, warm season bunchgrasses such as wiregrass (*Aristida stricta*) and various bluestems (*Andropogon spp.*), 0.3-0.7 m tall, with birds nesting near the base of grass clumps. Ideal nesting habitat has ~2.7, 30 cm diameter grass clumps/m^2 that is close to (within 15-25 m) shrubby escape cover (Giuliano et al. 2007). Several non-Florida studies have examined bobwhite nest site selection, and found at patch level, bobwhites selected nest sites with taller grass and woody cover, less bare ground, greater litter and grass cover, and more visual obstruction than associated random sites (Taylor et al. 1999, Townsend et al. 2001, Lusk et al. 2006). This type of nesting cover probably provides accessible nest site locations, with protection from predators. While these studies provide a general idea of bobwhite nest site selection, all occurred in western states (e.g., Oklahoma, Kansas, and Texas). There have been no such studies on the unique rangelands of south Florida, where quail nesting habitat requirements may differ from other parts of its range (Giuliano et al. 2007).

Another factor potentially limiting northern bobwhite conservation and population restoration is their poor dispersal ability, coupled with isolated, remnant populations throughout much of their range (Burger 2001, Giuliano et al. 2007). As a result, even when northern bobwhite habitat is restored, it may take decades, if ever, for birds to re-colonize restored areas. Translocating wild birds from source populations into restored habitats may be a viable means of restoring local bobwhite populations. However, there has not been extensive research to determine its effectiveness. Several studies have examined using translocation as a means of reintroducing the masked subspecies of bobwhite (Ellis et al. 1977, Smith 1987, Hernandez et al. 2006), and found that translocation had limited success, possibly due to the differences in habitat between source and restoration sites (Hernandez et al. 2006). There have been several recent studies looking at the effects of translocation on other subspecies of northern bobwhite. However, the primary focus of these studies was on the impact translocating bobwhites had on their home range size, movement patterns, and site fidelity (Liu et al. 2002, Terhune et al. 2006). Terhune et al. (2006) studied the impact relocating bobwhites had on reproduction, and found translocating bobwhites did not reduce reproductive output, and may serve to augment quail populations. However, the study did not examine the potential of relocating bobwhites to a restored habitat, or what effect moving bobwhites into restored habitat (which may differ from the habitat where they were trapped) has on nesting ecology. Terhune et al. (2006) monitored nest success and survival, but nest site use and selection were not determined, and these factors are an important part of bobwhite reproductive ecology (Giuliano et al. 2007). Further, these studies were not conducted on the unique Florida subspecies of bobwhite (*Colinus virginianus floridanus*) or in Florida rangelands.

Study Objectives

My primary objective was to examine nest site selection by resident and translocated northern bobwhites in the rangelands of south Florida at the microhabitat level (i.e., vegetation structure at the nest site), home range level, and at the landscape level. Additionally, I wanted to determine if bobwhite nest site selection in south Florida rangelands had an effect on nest success.

Study Area

The project took place in the North and South Prairies and surrounding areas of the Devil's Garden/Alico Ranch in Hendry County, FL (Township 45S, Range 31E, Sections 1 and 12; Township 45S, Range 32E, Sections 5, 6, 7, 8, 17, and 18). I collected data during the nesting seasons of 2007 and 2008 (approximately March through August). The study area encompassed ~800 ha, which could support a minimum viable population of 500-1000 birds (assuming one bird/0.81-1.62 ha; Giuliano et al. 2007). This area was chosen because it 1) was large enough to support a minimum viable population, 2) was easily accessible, 3) was improvable in terms of quail habitat and manipulating other activities (e.g., grazing), 4) had fair quail habitat, 5) habitat enhancement had already begun on the area (e.g., roller chopping and reduced grazing), 6) had relatively few birds at the time of the study, and 7) did not have quail hunting. Point counts (Bibby et al. 2000) during May and June, 2006 indicated that the area had a minimum population of 24 birds, and habitat evaluations indicated that there were ~100 ha of useable space in the area for quail.

CHAPTER 2
METHODS

Data Collection

Throughout the study, I captured, translocated, and released wild birds into the study area. All birds were banded with a standard metal leg-band (Monel Butt-End #7, National Band and Tag Company) and released into useable habitat within the study area. All trapped females that weighed ≥140 g were fitted with a 5 g necklace-style radio transmitter with a mortality sensor (Model AWE-QLL, American Wildlife Enterprises; weighing <3.5% of the birds body mass; Fuller et al. 2005). I trapped extensively throughout the study area prior to releasing translocated birds, and all captured resident hens over 140 g were fitted with radio collars. Translocation of wild birds into the study area began during the spring of 2007, and continued during the spring of 2008. I translocated quail into the restoration area from early spring until the nesting season had begun. Although it has been found that it takes several months for a bobwhite to become familiar with it's new habitat after translocation (Liu et al. 2002), birds moved into new habitat in winter resulted in extremely high mortality rates, and translocating birds during spring and summer increased their chance for survival through the breeding season. Wild birds were obtained for translocation from other portions of the Alico Ranch, where quail were found in habitat that potentially faced destruction or degradation (e.g., conversion to sugar cane production or water impoundment). I trapped birds in donor areas using standard wire funnel traps and bait (e.g., corn; Bookhout 1996, Braun 2005), checking traps after dark each day. Captured birds were transferred from traps to holding boxes, transported to a workroom where they were sexed and aged based on standard feather criteria (Giuliano et al. 2007), banded, weighed, females fitted with radio-transmitters, and released in appropriate cover. I released birds at locations where there was suitable warm season grass cover for nesting, shrubs to provide escape and thermal cover, and forb cover to provide foraging and brood rearing habitat in close proximity to one another. I trapped, handled, and released resident birds each year, using the same procedures as for translocated birds. Trapping, handling, and releasing of birds followed appropriate animal care and use protocols (e.g., AOU Ad Hoc Committee on the Use of Wild Birds in Research 1988). The project was reviewed and approved by the University of Florida/IFAS Non-Regulatory Animal Research Committee (003-008 WEC) and the Florida Fish and Wildlife Conservation Commission.

Once nesting season began each year, radio collared birds were radio-located daily (diurnally) by triangulation from three known receiving locations (White and Garrott 1990, Krebs 1999, Millspaugh and Marzluff 2001, Braun 2005). I established receiving locations at 0.40 km intervals, forming a grid throughout the study area. Once per week, birds were located using homing to determine whether they were nesting or not. When monitoring indicated that a female had initiated incubation (i.e., found repeatedly in the same location during the nesting season; March-August), nests were visually located and eggs counted. When visiting a nest, I took care not to disturb vegetation, with all disturbed vegetation returned to its original position after the visit. Nests were marked by placing a small piece of flagging on the nest vegetation clump, and location recorded using a global positioning system (GPS). I attempted to check nests every three days, when the hen was absent from the nest, to determine the status of the nest. When incubation ceased, as determined via radio telemetry and nest visits, I recorded the fate of the nest and number of eggs hatched. I considered all nests hatching ≥1 egg successful. Each nest site was paired with a location 100 m distant in a random compass direction for microhabitat evaluation.

At each nest and paired random location, vegetation composition and structure were examined in several strata (i.e., overstory, understory, shrub, herbaceous, and ground levels; Dueser and Shugart 1978), using a nested plot design (Figure 2-1). All overstory (woody vegetation ≥7.5 cm diameter at breast height [DBH]) and understory (woody vegetation <7.5 cm DBH, >2.0 m in height) plants were counted and DBH measured within a 0.03 ha circular plot to estimate density and basal area (individual species and all combined), species richness, and diversity (Krebs 1999). Overstory and understory canopy closure were estimated for each strata from 41 evenly spaced, vertical ocular tube sightings along 2 perpendicular 20 m transects centered in the 0.03 ha plot (James and Shugart 1971). Shrubs (woody vegetation ≤2.0 m in height) were counted, maximum height determined for each species, and horizontal shrub coverage measured along two perpendicular 20 m^2 (2x10 m) transects centered on the 0.03 ha plot to estimate horizontal shrub coverage, species richness, and diversity. Coverage (ocular estimate) and maximum height of each species of herbaceous plant were determined in a 1m^2 plot centered on the nest or random site and in four 1m^2 plots, one randomly located in each quadrant of the 0.03 ha plot. Coverage of bare ground (i.e., no herbaceous or shrub canopy cover) was also determined in all five 1m^2 plots. To assess vertical vegetation structure from 0-2 m above ground, a cover pole (Griffin and Youtie 1988) was centered on the 0.03 ha plot, with readings taken at 5 m and 10 m from each of the cardinal directions. The plant species most closely associated with the nest location (e.g., nest under wiregrass) was recorded, as well as the total number of red imported fire ant mounds present within the plot. All variables measures at nest sites and paired random sites are described in Table 2-1.

I plotted nest site locations in a Geographic Information System (GIS), and measured distances from nest sites to several landscape features including un-grazed areas, canals, habitat edge, wetlands, burned areas, fencerows, and roads using the ArcView 3.3 Nearest Feature extension. I created layers of the desired variables using GPS locations of variable vertices, digitized several from United States Geological Survey digital orthophoto quadrangles, and converted the Florida Fish and Wildlife Conservation Commission's Habitat and Landcover raster dataset to a vector layer. To analyze habitat selection at the home range level, I gave each nest site a 50 ha buffer using the Hawth's Tools extension in ArcGIS v. 9.3. Fifty hectares is an approximate mean home range size for both resident and translocated northern bobwhites during the nesting season (Liu et al. 2002). Fifty random points were then generated (using Hawth's Tools) within each buffer. I measured distances from the 50 random points to the same variables using the same methods as with nest sites. To compare nest habitat type use between resident and translocated bobwhites at this level, habitat type was determined at each nest site as well as all random sites using ArcGIS 9.0. I used habitat classifications outlined in the Florida Fish and Wildlife Conservation Commissions Comprehensive Wildlife Conservation Strategy (Florida Fish and Wildlife Conservation Commission 2005). Habitat classifications included agriculture, disturbed/transitional, dry prairie, freshwater marsh/wet prairie, grassland/improved pasture, hardwood hammock forest, mixed hardwood-pine forest, natural pineland, and shrub swamp. To analyze habitat selection at the landscape level, I generated1000 random points throughout the study area using the Hawth's Tools extension in ArcGIS 9.3. I calculated distances to the habitat variables measured for analysis at the home range level for nest sites and the 1000 random sites using the Nearest Feature extension for ArcView v. 3.3. To compare nest habitat type use between resident and translocated bobwhites at this level (i.e., landscape), habitat type was determined at each nest site as well as all random sites using ArcGIS 9.0.

Analyses

I used one-way blocked analysis of variance to compare nest habitat variables between nest sites and paired random sites at the microhabitat level, and to compare nest macrohabitat variables (i.e., distances to roads, habitat edge, etc.) at the home range level between nest sites and the mean distances of the 50 paired random points associated with each nest. One-way analysis of variance was used to compare microhabitat variables between resident and translocated nest sites, and between successful and unsuccessful nests. A one-way analysis of variance was also used to compare variables between nest and random sites (i.e., 1000 study area wide) at the landscape level.

I used discriminant function analysis (DFA) to determine which combination of variables best discriminated between nest and paired random sites, between resident and translocated nest sites, and between successful and unsuccessful nests at the microhabitat level. Discriminant function analysis was also used to discriminate between nest and paired random sites at the home range and landscape levels. I used methods described by Noon (1981) and McGarigal et al. (2000) to reduce multicolinearity problems and the number of variables considered in each DFA model. All DFA models were fit using a stepwise forward procedure with a tolerance of 0.001, F to enter = 0.15 and F to remove = 0.15. Since the order in which variables are entered into the model can effect final model selection, and there is no accepted method of determining the order of variable entry into a model (McGarigal et al. 2000, SYSTAT 2007), I entered variables into the model based on effect size (Cohen 1988) in one-way analysis of variance comparisons (i.e., the variable with the largest effect size was entered first and the variable with the smallest effect size was entered last). I assumed effect size was positively associated with biological importance, regardless of statistical significance. I assessed the relative importance of each variable in the final model by examining the standardized canonical discriminate functions

(SCDF). Variables with higher SCDF values made greater contributions to the discriminating power of the model (McGarigal et al. 2000).

Likelihood ratio analysis was used to examine dependence between nest vegetation use (i.e., what species of vegetation the nest was located in) and bird origin (i.e., resident or translocated), and to examine dependence between FWC landcover type and bird origin. At the home range level, likelihood ratio analysis was used to examine dependence between FWC landcover type at nest and paired random sites. The analysis was conducted once comparing nest sites to all 50 paired random sites, and once comparing nest sites to the majority cover type of all 50 random points combined within the buffer. At the landscape level, likelihood ratio analysis was used to examine dependence between nest sites and the 1000 random points throughout the study area. Likelihood ratio analysis was also used to examine dependence between nest success and FWC landcover type, grazing regime (i.e., grazed or un-grazed), and nest vegetation type.

I considered all tests significant at $P \leq 0.05$. If necessary, I used Fisher's least significant difference tests for post-hoc comparisons (SYSTAT 2007). All comparisons used all birds, translocated birds only, and resident birds only, where appropriate.

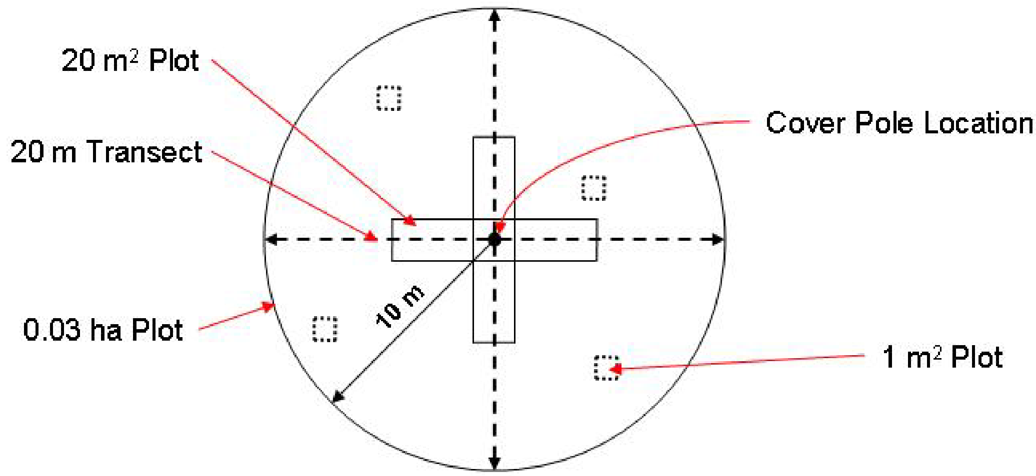

Figure 2-1. Nested plot design used to sample vegetation at quail nest and random sites in south Florida rangelands 2007-2008.

Table 2-1. Nest habitat characteristics examined for northern bobwhite in south Florida rangelands, 2007-2008.

Variable	Variable description
Nest_%forbs (%)	Forb coverage in 1m^2 plot at nest site
Nest_fb_max (cm)	Maximum height of forbs in 1m^2 plot at nest site
Nest_%gram (%)	Graminoid coverage in 1m^2 plot at nest site
Nest_gr_max (cm)	Maximum height of graminoids in 1m^2 plot at nest site
Nest_%bunch (%)	Bunchgrass coverage in 1m^2 plot at nest site
Nest_bn_max (cm)	Maximum height of bunchgrass in 1m^2 plot at nest site
Nest_%shrub (%)	Shrub coverage in 1m^2 plot at nest site
Nest_sh_max (cm)	Maximum height of shrubs in 1m^2 plot at nest site
Nest_%litter (%)	Litter cover in 1m^2 plot at nest site
Nest_%bare (%)	Bare ground in 1m^2 plot at nest site
Nest_Litt_depth (cm)	Mean litter depth at nest site taken from 4 readings
Nest_sp_rich (#)	Species present 1m^2 plot at nest site
Com_Sp._Rich (#)	Species present in all 5 1m^2 plots at sampling site
Com_%forbs (%)	Mean forb coverage from all 5 1m^2 plots at sampling site
Com_fb_max (cm)	Mean maximum height of forbs from all 5 1m^2 plots at sampling site
Com_%gram (%)	Mean graminoid coverage from all 5 1m^2 plots at sampling site
Com_gr_max (cm)	Mean maximum height of graminoids from all 5 1m^2 plots at sampling site
Com_%bunch (%)	Mean bunchgrasses coverage from all 5 1m^2 plots at sampling site
Com_bn_max (cm)	Mean maximum height of bunchgrasses from all 5 1m^2 plots at sampling site
Com_%shrub (%)	Mean shrub coverage from all 5 1m^2 plots at sampling site
Com_shrub_max (cm)	Mean maximum height of shrubs from all 5 1m^2 plots at sampling site
Com_%litter (%)	Mean litter cover from all 5 1m^2 plots at sampling site
Com_%bare (%)	Mean bare ground from all 5 1m^2 plots at sampling site

Table 2-1. Continued.

Variable	Variable description
Com_Litt_depth (cm)	Mean litter depth from all 5 1m^2 plots at sampling site
VO_%5m 0-50 (%)	Mean vertical obstruction from 5 m between 0 cm and 50 cm
VO_%5m 50-100 (%)	Mean vertical obstruction from 5 m between 50 cm and 100 cm
VO_%5m 100-150 (%)	Mean vertical obstruction from 5 m between 100 cm and 150 cm
VO_%5m 150-200 (%)	Mean vertical obstruction from 5 m between 150 cm and 200 cm
VO_%10m 0-50 (%)	Mean vertical obstruction from 10 m between 0 cm and 50 cm
VO_%10m 50-100 (%)	Mean vertical obstruction from 10 m between 50 cm and 100 cm
VO_%10m 100-150 (%)	Mean vertical obstruction from 10 m between 100 cm and 150 cm
VO_%10m 150-200 (%)	Mean vertical obstruction from 10 m between 150 cm and 200 cm
OV_SPEC_RICH (#)	Species present in overstory
OV_DEN_TOT (#/m^2)	Density of overstory plants in plot
OV_OCUL_% (%)	Ocular tube readings with overstory vegetation
UN_SPEC_RICH (#)	Species present in understory
UND_DEN_TOT (#/m^2)	Density of understory plants in plot
UN_OCUL_% (%)	Ocular tube readings with understory vegetation
SH_SP_RICH (#)	Species present in shrub layer
SH_DEN_TOT (#/m^2)	Density of shrubs in plot
SH_COV_% (%)	Cover tape obscured by woody vegetation along 4 10 meter transects
FIR_ANT_DEN (#/m^2)	Density of fire ant mounds
Distance to 50 acre plot (m)	Distance to nearest ungrazed area
Distance to canals (m)	Distance to nearest canal
Distance to habitat edge (m)	Distance to habitat edge
Distance to wetland (m)	Distance to nearest wetland
Distance to burned areas (m)	Distance to nearest burned area
Distance to fencerow (m)	Distance to nearest fencerow
Distance to roads (m)	Distance to nearest road

CHAPTER 3
RESULTS

Microhabitat Level Habitat Use and Selection

During the study, I trapped 288 wild quail, of which 103 were fitted with radio transmitters. Of these birds, 176 were translocated into the study area from other areas of the ranch. I found 40 nests; 15 of resident quail and 25 of translocated quail. At the microhabitat level, quail selected nest sites with taller forbs, greater horizontal visual obstruction, and a lower density of fire ant mounds than at paired random sites (Table 3-1). The best combination of variables that discriminated between nest and paired random sites, in order of importance, was vertical visual obstruction at 5 meters between 100 and 150 cm (SCDF = 0.700), overstory canopy closure (SCDF = 0.680), maximum height of bunchgrasses (SCDF = -0.644), maximum shrub height (SCDF = -0.608), cover of bare ground (SCDF = -0.510), distance to the nearest fencerow (SCDF = -0.439), and vertical obstruction at 10 m between 0 and 50 cm (SCDF = 0.360; 69% correct jackknifed classification rate; canonical correlation = 0.698; $P \leq 0.001$). Considering only translocated nests, nest sites had greater vertical obstruction at 5 m between 50 and 100 cm than at paired random sites (Table 3-2). The best combination of variables that discriminated between translocated nests and paired random sites, in order of importance, was distance to the nearest fencerow (SCDF = -1.101), distance to the nearest road (SCDF = 1.094), shrub cover (SCDF = -1.081), vertical obstruction at 5 m between 50 and 100 cm (SCDF = 0.907), litter depth (SCDF = 0.742), distance to the nearest canal (SCDF = -0.704), and cover of grass (SCDF = -0.544; 79% correct jackknifed classification rate; canonical correlation = 0.809; $P = 0.001$). Considering only resident quail nests, nests sites had taller maximum forb heights and greater vertical obstruction than paired random sites (Table 3-3). The best combination of variables to discriminate between resident quail nest sites and paired random sites, in order of importance, was maximum height of forbs (SCDF = 2.647), overstory canopy closure (SCDF = 2.362), vertical visual obstruction from 10 m between 0 and 50 cm (SCDF = -1.564), and distance to wetlands (SCDF = 1.345; 100% correct jackknifed classification rate; canonical correlation = 0.948; $P \leq 0.001$). Habitat type was independent of whether it was a nest or paired random site for all nests ($P = 0.664$), translocated nests only ($P = 0.972$), and resident nests only ($P = 0.117$).

Comparing nest site use between translocated and resident bobwhites, resident nest sites had taller maximum heights of forbs, greater overstory canopy closure, were further from un-grazed areas, and were closer to areas burned than translocated birds (Table 3-4). The best combination of variables that discriminated between resident and translocated bobwhite nests, in order of importance, was distance to burned areas (SCDF = 1.737), understory density (SCDF = 1.435), bunchgrass density (SCDF = -0.902), and vertical obstruction at 10 m between 100 and 150 cm (SCDF = -0.538; 96% correct jackknifed classification rate; canonical correlation = 0.905; $P \leq 0.001$). Considering only successful resident and translocated nest sites, resident nests had taller maximum heights of forbs, greater visual obstruction at 10 m between 100 and 150 cm, higher density of overstory plants, and were closer to burned areas than the nests of translocated bobwhites (Table 3-5). The best combination of variables to discriminate between successful translocated and resident nests, in order of importance, was maximum height of bunchgrasses (SCDF = 1.634), forb cover (SCDF = 1.205), maximum height of shrubs (SCDF = 0.993), cover of bunchgrasses (SCDF = 0.988), and vertical obstruction at 10 m between 100 and 150 cm (SCDF = 0.864; 86% correct jackknifed classification rate; canonical correlation = 0.931; $P = 0.002$). Nest vegetation use depended on whether quail were translocated or resident birds ($P = 0.009$). However, post hoc tests could not be performed due to small sample sizes. Habitat type at the nest was independent of whether it belonged to a resident or translocated bobwhite for all nests (P = 0.817) and successful nests only (P = 0.412).

Successful nests had greater coverage of forbs and taller bunchgrasses at the nest site than unsuccessful nests (Table 3-6). The best combination of variables that discriminated between successful and unsuccessful nests, in order of importance, was forb cover (SCDF = 0.963), overstory canopy closure (SCDF = -0.616), and distance to habitat edge (SCDF = -0.590; 75% correct jackknifed classification rate; canonical correlation = 0.709; P = 0.003). Considering translocated quail nests, successful nests were closer to roads than unsuccessful nests (Table 3-7). The best combination of variables discriminating between successful and unsuccessful translocated quail nests, in order of importance, was shrub density (SCDF = 0.971), distance to the nearest fencerow (SCDF = -0.934), distance to roads (SCDF = 0.745), litter depth (SCDF = -0.659), and bare ground coverage (SCDF = 0.539; 81% correct jackknifed classification rate; canonical correlation = 0.824; P = 0.002). Considering only resident bobwhite nests, successful nests had greater cover of forbs and taller maximum height of grasses (Table 3-8). The best combination of variables that discriminated between successful and unsuccessful resident bobwhite nests, in order of importance, was forb cover (SCDF = 0.963), overstory canopy closure (SCDF = -0.616), and distance to habitat edge (SCDF = -0.590; 75% correct jackknifed classification rate; canonical correlation = 0.709; P = 0.003). Whether a nest was successful or unsuccessful was independent of which habitat type the nest was located in for all nests (P = 0.394), translocated nests only (P = 0.918), and resident nests only (P = 0.140). Nest success did not depend on whether a nest was found in a grazed or un-grazed area for all nests (P = 0.959), translocated nests only (P = 0.831), or resident nests only (P = 0.999). Nest success was independent of what type of nest vegetation nests were located in for all nests (P = 0.875), translocated nests only (P = 0.361), and resident nests only (P = 0.282).

Home Range Level Habitat Use and Selection

At the home range level, nest sites were closer to un-grazed areas, further from canals, closer to burned areas, and closer to fencerows than at paired locations (Table 3-9). The best combination of variables that discriminated between nests and random sites was distance to fencerows and distance to habitat edge (49% correct jackknifed classification rate; canonical correlation = 0.272; P = 0.045), with distance to habitat edge being more important (SCDF = -0.760) than distance to fencerow (SCDF = 0.594). Considering only translocated quail nests, nest sites were closer to un-grazed areas, further from canals, and closer to fencerows than paired sites (Table 3-10). The best combination of variables to discriminate between nests and paired sites was distance to fencerows and distance to habitat edge (59% correct jackknifed classification rate; canonical correlation = 0.472; P ≤ 0.001), with distance to fencerow being more important (SCDF = 0.814) than distance to habitat edge (SCDF = -0.574). Considering only resident nest and paired sites, bobwhite nests were closer to burned areas than paired sites (Table 3-11). The best combination of variables included only distance to burned areas. Habitat type was independent of whether or not the site was a nest site or one of 50 paired sites for all nests (P = 0.447), translocated nests only (P = 0.886), or resident nests only (P = 0.966). However, when comparing nest sites to the majority cover type for the 50 paired points, cover type was dependent on whether the sites were a nest or paired site (P = 0.001). Quail selected dry prairie over freshwater marsh/wet prairie (P = 0.001) and dry prairie over grassland/improved pasture (P ≤ 0.005), but there was no effect when examining freshwater marsh/wet prairie relative to grasslands/improved pasture (P = 0.620). When examining translocated nest sites, cover type was dependent on whether a site was a nest or paired random site (P = 0.012). Translocated quail selected for dry prairie over freshwater marsh/wet prairie (P = 0.005) and dry prairie over grassland/improved pasture (P = 0.004), but there was no effect when considering freshwater marsh/wet prairie relative to grassland/improved pasture (P = 0.719). When examining resident nest sites, cover type was dependent on whether a site was a nest or paired random site (P = 0.003). Resident quail selected for dry prairie over freshwater marsh/wet prairie (P = 0.002) and dry prairie over grassland/improved pasture (P = 0.001), but there was no effect when considering freshwater marsh/wet prairie relative to grassland/improved pasture (P = 0.679).

When comparing successful and unsuccessful nest sites to landscape features, I did not find any significant differences in variables (Table 3-12). Considering only translocated successful and unsuccessful nest sites, successful nests were closer to roads than unsuccessful nests (Table 3-13). Considering only resident nests, there were no differences between successful and unsuccessful nests. Discriminant function analysis did not create models for all, translocated, or resident nests.

Landscape Level Habitat Use and Selection

At the landscape level, nest sites were further from habitat edge and burned areas than random points (Table 3-15). However, the best combination of variables to discriminate between nest and random sites, in order of importance, was distance to burned areas (SCDF = 0.746), distance to habitat edge (SCDF = 0.486), distance to fencerows (SCDF = -0.473), and distance to canals (SCDF = 0.309; 74% correct jackknifed classification rate; canonical correlation = 0.166; $P \leq 0.001$). Considering only translocated nest and random sites, nests were closer to un-grazed areas, further from habitat edge, further from burned areas, and closer to fencerows than random sites (Table 3-16). The combination of variables that discriminated best between nest sites and random sites, in order of importance, was distance to burned areas (SCDF

= 0.850), distance to habitat edge (SCDF = 0.282), distance to canals (SCDF = 0.280), distance to un-grazed areas (SCDF = -0.276), and distance to fencerows (SCDF = -0.258; 84% correct jackknifed classification rate; canonical correlation = 0.235; $P \leq 0.001$). Considering only resident quail nest and random sites, nest sites were further from un-grazed areas than randomly located points (Table 3-17). There was no combination of variables that best discriminated between resident quail nest and random sites. The habitat type a site was located in was independent of whether it was a nest or random point for all nests ($P = 0.175$), translocated nests only ($P = 0.617$), and resident nests only ($P = 0.889$).

Table 3-1. Microhabitat characteristics of bobwhite nest sites and paired random sites in south Florida rangelands, 2007-2008.

	Nest sites (n = 22)		Paired random sites (n = 27)		
Variable*	Mean	SE	Mean	SE	P
Nest_%forbs (%)	0.188	0.025	0.176	0.027	0.741
Nest_fb_max (cm)	62.000	5.962	45.757	4.225	0.029
Nest_%gram (%)	0.609	0.033	0.662	0.035	0.271
Nest_gr_max (cm)	109.351	4.465	113.000	4.612	0.574
Nest_%bunch (%)	0.378	0.043	0.359	0.034	0.608
Nest_bn_max (cm)	91.351	8.576	108.459	6.200	0.112
Nest_%shrub (%)	0.027	0.012	0.018	0.011	0.597
Nest_sh_max (cm)	14.432	5.939	10.595	3.581	0.583
Nest_%litter (%)	0.112	0.027	0.073	0.014	0.196
Nest_%bare (%)	0.041	0.009	0.057	0.016	0.349
Nest_Litt_depth (cm)	2.182	0.327	1.542	0.159	0.085
Nest_sp_rich (#)	5.351	0.341	5.514	0.321	0.725
Com_Sp._Rich (#)	11.000	0.564	10.919	0.488	0.914
Com_%forbs (%)	0.183	0.018	0.198	0.020	0.578
Com_fb_max (cm)	91.829	6.103	73.324	5.702	0.030
Com_%gram (%)	0.551	0.025	0.582	0.028	0.496
Com_gr_max (cm)	120.973	3.949	118.162	4.324	0.634
Com_%bunch (%)	0.210	0.022	0.155	0.017	0.051
Com_bn_max (cm)	107.703	7.511	117.000	4.578	0.297
Com_%shrub (%)	0.012	0.004	0.025	0.008	0.151
Com_shrub_max (cm)	31.361	7.478	30.972	6.505	0.970
Com_%litter (%)	0.136	0.022	0.097	0.010	0.095
Com_%bare (%)	0.075	0.015	0.069	0.015	0.749
Com_Litt_depth (cm)	1.852	0.246	1.580	0.158	0.352
VO_%5m 0-50 (%)	0.879	0.021	0.850	0.022	0.331
VO_%5m 50-100 (%)	0.294	0.043	0.163	0.032	0.015
VO_%5m 100-150 (%)	0.109	0.026	0.030	0.016	0.013
VO_%5m 150-200 (%)	0.072	0.024	0.016	0.010	0.030
VO_%10m 0-50 (%)	0.940	0.012	0.897	0.019	0.308
VO_%10m 50-100 (%)	0.465	0.045	0.293	0.039	0.005
VO_%10m 100-150 (%)	0.232	0.039	0.116	0.032	0.023
VO_%10m 150-200 (%)	0.143	0.031	0.084	0.028	0.165
OV_SPEC_RICH (#)	0.432	0.126	0.270	0.092	0.299
OV_DEN_TOT (#/m^2)	0.002	0.001	0.002	0.001	0.689
OV_OCUL_% (%)	0.045	0.016	0.015	0.006	0.071
UN_SPEC_RICH (#)	0.378	0.125	0.243	0.090	0.386
UND_DEN_TOT (#/m^2)	0.003	0.001	0.001	0.001	0.255
UN_OCUL_% (%)	0.030	0.013	0.019	0.009	0.491
SH_SP_RICH (#)	3.595	0.323	3.649	0.368	0.908
SH_DEN_TOT (#/m^2)	0.070	0.013	0.084	0.016	0.501
SH_COV_% (%)	0.057	0.012	0.054	0.011	0.875
FIR_ANT_DEN (#/m^2)	0.006	0.001	0.009	0.001	0.036
Distance to 50 acre plot (m)	249.820	52.271	244.562	53.166	0.887
Distance to canals (m)	428.771	41.384	415.057	44.674	0.868
Distance to habitat edge (m)	43.995	7.096	51.569	6.533	0.452
Distance to wetland (m)	62.271	7.185	73.716	7.205	0.283
Distance to burned areas (m)	1299.689	160.155	1249.368	162.316	0.637

Table 3-1. Continued.

Variable*	Nest sites (n = 22) Mean	SE	Paired random sites (n = 27) Mean	SE	P
Distance to fencerow (m)	113.558	18.426	119.186	15.447	0.620
Distance to roads (m)	342.007	33.591	316.291	36.766	0.616

*variable descriptions in Table 2-1.

Table 3-2. Microhabitat characteristics of translocated bobwhite nest sites and paired random sites in south Florida rangelands, 2007-2008.

Variable*	Nest sites (n = 14) Mean	SE	Paired random sites (n = 14) Mean	SE	P
Nest_%forbs (%)	0.169	0.035	0.182	0.039	0.805
Nest_fb_max (cm)	46.909	6.069	49.136	5.263	0.761
Nest_%gram (%)	0.634	0.042	0.661	0.043	0.643
Nest_gr_max (cm)	111.864	5.588	114.182	5.072	0.762
Nest_%bunch (%)	0.397	0.058	0.328	0.043	0.348
Nest_bn_max (cm)	90.409	11.760	110.136	7.170	0.157
Nest_%shrub (%)	0.020	0.011	0.005	0.002	0.176
Nest_sh_max (cm)	13.545	7.924	8.636	4.434	0.596
Nest_%litter (%)	0.095	0.023	0.057	0.013	0.170
Nest_%bare (%)	0.051	0.013	0.077	0.024	0.346
Nest_Litt_depth (cm)	2.023	0.221	1.614	0.217	0.199
Nest_sp_rich (#)	5.318	0.408	5.682	0.498	0.559
Com_Sp._Rich (#)	11.545	0.781	11.636	0.670	0.931
Com_%forbs (%)	0.180	0.020	0.194	0.026	0.664
Com_fb_max (cm)	87.727	8.598	82.182	7.808	0.636
Com_%gram (%)	0.540	0.031	0.576	0.038	0.444
Com_gr_max (cm)	123.364	4.070	121.409	4.550	0.753
Com_%bunch (%)	0.203	0.026	0.160	0.023	0.224
Com_bn_max (cm)	108.318	9.237	119.455	5.268	0.304
Com_%shrub (%)	0.013	0.005	0.021	0.009	0.432
Com_shrub_max (cm)	34.571	10.805	32.381	9.319	0.883
Com_%litter (%)	0.118	0.022	0.092	0.014	0.321
Com_%bare (%)	0.093	0.024	0.082	0.024	0.732
Com_Litt_depth (cm)	1.650	0.145	1.773	0.251	0.676
VO_%5m 0-50 (%)	0.882	0.023	0.850	0.030	0.396
VO_%5m 50-100 (%)	0.255	0.036	0.136	0.044	0.036
VO_%5m 100-150 (%)	0.095	0.034	0.039	0.025	0.187
VO_%5m 150-200 (%)	0.084	0.033	0.023	0.016	0.105
VO_%10m 0-50 (%)	.941	.013	0.902	0.022	0.323
VO_%10m 50-100 (%)	0.414	0.045	0.286	0.055	0.083
VO_%10m 100-150 (%)	0.180	0.041	0.123	0.044	0.349
VO_%10m 150-200 (%)	0.123	0.037	0.093	0.039	0.583
OV_SPEC_RICH (#)	0.318	0.166	0.273	0.117	0.819
OV_DEN_TOT (#/m^2)	0.002	0.001	0.002	0.001	0.860
OV_OCUL_% (%)	0.020	0.012	0.013	0.007	0.628
UN_SPEC_RICH (#)	0.364	0.155	0.227	0.113	0.485
UND_DEN_TOT (#/m^2)	0.003	0.001	0.001	0.001	0.172
UN_OCUL_% (%)	0.040	0.021	0.010	0.008	0.198

Table 3-2. Continued.

Variable*	Nest sites (n = 14)		Paired random sites (n = 14)		
	Mean	SE	Mean	SE	P
SH_SP_RICH (#)	3.591	0.398	3.864	0.467	0.645
SH_DEN_TOT (#/m^2)	0.066	0.020	0.076	0.013	0.695
SH_COV_% (%)	0.063	0.018	0.041	0.008	0.271
FIR_ANT_DEN (#/m^2)	0.006	0.001	0.009	0.001	0.056
Distance to 50 acre plot (m)	123.597	48.093	116.769	52.187	0.963
Distance to canals (m)	481.942	52.169	471.054	61.724	0.985
Distance to habitat edge (m)	46.901	63.908	53.662	8.373	0.582
Distance to wetland (m)	63.908	9.010	79.456	9.808	0.255
Distance to burned areas (m)	1856.559	164.226	1827.187	175.614	0.817
Distance to fencerow (m)	88.706	19.789	94.321	17.268	0.670
Distance to roads (m)	379.215	41.962	357.933	49.720	0.787

*variable descriptions in Table 2-1.

Table 3-3. Microhabitat characteristics of resident bobwhite nest sites and paired random sites in south Florida rangelands, 2007-2008.

Variable*	Nest sites (n = 10)		Paired random sites (n = 11)		
	Mean	SE	Mean	SE	P
Nest_%forbs (%)	0.215	0.037	0.167	0.037	0.370
Nest_fb_max (cm)	84.133	9.250	40.800	7.023	0.001
Nest_%gram (%)	0.572	0.053	0.663	0.062	0.245
Nest_gr_max (cm)	105.667	7.492	111.267	8.830	0.638
Nest_%bunch (%)	0.373	0.065	0.403	0.055	0.729
Nest_bn_max (cm)	92.733	12.727	106.000	11.401	0.434
Nest_%shrub (%)	0.037	0.026	0.038	0.026	0.965
Nest_sh_max (cm)	15.733	9.239	13.467	6.089	0.839
Nest_%litter (%)	0.137	0.057	0.095	0.026	0.472
Nest_%bare (%)	0.025	0.009	0.028	0.013	0.840
Nest_Litt_depth (cm)	2.417	0.750	1.429	0.234	0.224
Nest_sp_rich (#)	5.400	0.608	5.267	0.316	0.850
Com_Sp._Rich (#)	10.200	0.776	9.867	0.624	0.739
Com_%forbs (%)	0.188	0.035	0.204	0.033	0.735
Com_fb_max (cm)	98.000	8.333	60.333	7.200	0.002
Com_%gram (%)	0.567	0.045	0.591	0.041	0.888
Com_gr_max (cm)	117.467	7.811	113.400	8.385	0.729
Com_%bunch (%)	0.220	0.039	0.148	0.025	0.129
Com_bn_max (cm)	106.800	13.038	113.400	8.385	0.675
Com_%shrub (%)	0.011	0.006	0.031	0.015	0.238
Com_shrub_max (cm)	26.867	9.976	29.000	8.928	0.875
Com_%litter (%)	0.163	0.045	0.105	0.013	0.151
Com_%bare (%)	0.049	0.011	0.049	0.012	0.996
Com_Litt_depth (cm)	2.148	0.571	1.298	0.103	0.136
VO_%5m 0-50 (%)	0.875	0.045	0.850	0.031	0.657
VO_%5m 50-100 (%)	0.367	0.102	0.208	0.044	0.163
VO_%5m 100-150 (%)	0.133	0.044	0.015	0.009	0.014
VO_%5m 150-200 (%)	0.050	0.028	0.004	0.004	0.113
VO_%10m 0-50 (%)	0.937	0.025	0.888	0.035	0.284

Table 3-3. Continued.

Variable*	Nest sites (n = 10) Mean	SE	Paired random sites (n = 11) Mean	SE	P
VO_%10m 50-100 (%)	0.558	0.093	0.304	0.050	0.025
VO_%10m 100-150 (%)	0.329	0.077	0.104	0.044	0.015
VO_%10m 150-200 (%)	0.179	0.059	0.069	0.040	0.121
OV_SPEC_RICH (#)	0.600	0.190	0.267	0.153	0.190
OV_DEN_TOT (#/m^2)	0.003	0.001	0.001	0.001	0.198
OV_OCUL_% (%)	0.083	0.033	0.016	0.010	0.065
UN_SPEC_RICH (#)	0.400	0.214	0.267	0.153	0.614
UND_DEN_TOT (#/m^2)	0.001	0.001	0.002	0.001	0.860
UN_OCUL_% (%)	0.016	0.009	0.033	0.020	0.468
SH_SP_RICH (#)	3.600	0.559	3.333	0.607	0.737
SH_DEN_TOT (#/m^2)	0.074	0.016	0.095	0.036	0.591
SH_COV_% (%)	0.048	0.014	0.075	0.025	0.370
FIR_ANT_DEN (#/m^2)	0.006	0.002	0.008	0.001	0.345
Distance to 50 acre plot (m)	451.778	92.020	436.251	86.523	0.868
Distance to canals (m)	343.697	63.970	331.061	57.904	0.779
Distance to habitat edge (m)	39.344	12.565	48.654	10.775	0.627
Distance to wetland (m)	59.651	12.255	65.105	10.390	0.801
Distance to burned areas (m)	614.312	145.144	627.102	142.646	0.950
Distance to fencerow (m)	153.320	34.397	156.483	26.310	0.770
Distance to roads (m)	282.474	54.066	253.829	51.314	0.622

*variable descriptions in Table 2-1.

Table 3-4. Microhabitat characteristics of resident and translocated bobwhite nest sites in south Florida rangelands, 2007-2008.

Variable*	Resident nest sites (n = 15) Mean	SE	Tranlocated nest sites (n = 22) Mean	SE	P
Nest_%forbs (%)	0.215	0.037	0.169	0.035	0.384
Nest_fb_max (cm)	84.133	9.250	46.909	6.069	0.001
Nest_%gram (%)	0.572	0.053	0.634	0.042	0.355
Nest_gr_max (cm)	105.667	7.492	111.864	5.588	0.503
Nest_%bunch (%)	0.373	0.065	0.397	0.058	0.795
Nest_bn_max (cm)	92.733	12.727	90.409	11.760	0.896
Nest_%shrub (%)	0.037	0.026	0.020	0.011	0.528
Nest_sh_max (cm)	15.733	9.239	13.545	7.924	0.859
Nest_%litter (%)	0.137	0.057	0.095	0.023	0.454
Nest_%bare (%)	0.025	0.009	0.051	0.013	0.157
Nest_Litt_depth (cm)	2.417	0.750	2.023	0.221	0.561
Nest_sp_rich (#)	5.400	0.608	5.318	0.408	0.908
Com_Sp._Rich (#)	10.200	0.776	11.545	0.781	0.247
Com_%forbs (%)	0.188	0.035	0.180	0.020	0.830
Com_fb_max (cm)	98.000	8.333	87.727	8.598	0.416
Com_%gram (%)	0.567	0.045	0.540	0.031	0.602
Com_gr_max (cm)	117.467	7.811	123.364	4.070	0.471
Com_%bunch (%)	0.220	0.039	0.203	0.026	0.709
Com_bn_max (cm)	106.800	13.038	108.318	9.237	0.923
Com_%shrub (%)	0.011	0.006	0.013	0.005	0.814

Table 3-4. Continued.

Variable*	Resident nest sites (n = 15) Mean	SE	Tranlocated nest sites (n = 22) Mean	SE	P
Com_shrub_max (cm)	26.867	9.976	34.571	10.805	0.619
Com_%litter (%)	0.163	0.045	0.118	0.022	0.324
Com_%bare (%)	0.049	0.011	0.093	0.024	0.153
Com_Litt_depth (cm)	2.148	0.571	1.650	0.145	0.327
VO_%5m 0-50 (%)	0.875	0.045	0.882	0.023	0.881
VO_%5m 50-100 (%)	0.367	0.102	0.255	0.036	0.218
VO_%5m 100-150 (%)	0.133	0.044	0.095	0.034	0.503
VO_%5m 150-200 (%)	0.050	0.028	0.084	0.033	0.497
VO_%10m 0-50 (%)	0.937	0.025	0.941	0.013	0.897
VO_%10m 50-100 (%)	0.558	0.093	0.414	0.045	0.123
VO_%10m 100-150 (%)	0.329	0.077	0.180	0.041	0.066
VO_%10m 150-200 (%)	0.179	0.059	0.123	0.037	0.400
OV_SPEC_RICH (#)	0.600	0.190	0.318	0.166	0.277
OV_DEN_TOT (#/m^2)	0.003	0.001	0.002	0.001	0.636
OV_OCUL_% (%)	0.083	0.033	0.020	0.012	0.049
UN_SPEC_RICH (#)	0.400	0.214	0.364	0.155	0.888
UND_DEN_TOT (#/m^2)	0.001	0.001	0.003	0.001	0.329
UN_OCUL_% (%)	0.016	0.009	0.040	0.021	0.384
SH_SP_RICH (#)	3.600	0.559	3.591	0.398	0.989
SH_DEN_TOT (#/m^2)	0.074	0.016	0.066	0.020	0.770
SH_COV_% (%)	0.048	0.014	0.063	0.018	0.561
FIR_ANT_DEN (#/m^2)	0.006	0.002	0.006	0.001	0.791
Distance to 50 acre plot (m)	451.778	92.020	123.597	48.093	0.001
Distance to canals (m)	343.697	63.970	481.942	52.169	0.105
Distance to habitat edge (m)	39.344	12.565	46.901	63.908	0.611
Distance to wetland (m)	59.651	12.255	63.908	9.010	0.777
Distance to burned areas (m)	614.312	145.144	1856.559	164.226	0.000
Distance to fencerow (m)	153.320	34.397	88.706	19.789	0.088
Distance to roads (m)	282.474	54.066	379.215	41.962	0.164

*variable descriptions in Table 2-1.

Table 3-5. Microhabitat characteristics of successful resident and translocated bobwhite nest sites in south Florida rangelands, 2007-2008.

Variable*	Resident nest sites (n = 5) Mean	SE	Tranlocated nest sites (n = 10) Mean	SE	P
Nest_%forbs (%)	0.330	0.045	0.200	0.063	0.201
Nest_fb_max (cm)	90.000	13.704	44.900	9.943	0.020
Nest_%gram (%)	0.475	0.061	0.592	0.066	0.278
Nest_gr_max (cm)	107.200	17.878	114.200	5.603	0.639
Nest_%bunch (%)	0.385	0.079	0.365	0.092	0.891
Nest_bn_max (cm)	100.400	22.569	82.900	18.808	0.584
Nest_%shrub (%)	0.000	0.000	0.030	0.020	0.320
Nest_sh_max (cm)	0.000	0.000	23.600	16.204	0.331
Nest_%litter (%)	0.120	0.068	0.120	0.045	0.999
Nest_%bare (%)	0.020	0.005	0.040	0.019	0.475
Nest_Litt_depth (cm)	1.800	0.382	2.375	0.328	0.305

Table 3-5. Continued.

Variable*	Resident nest sites (n = 5) Mean	SE	Tranlocated nest sites (n = 10) Mean	SE	P
Nest_sp_rich (#)	6.400	1.030	5.100	0.690	0.305
Com_Sp._Rich (#)	11.400	0.927	11.300	0.955	0.948
Com_%forbs (%)	0.291	0.086	0.215	0.036	0.345
Com_fb_max (cm)	111.800	11.830	103.500	15.301	0.729
Com_%gram (%)	0.556	0.082	0.500	0.051	0.552
Com_gr_max (cm)	139.600	14.016	123.000	4.937	0.186
Com_%bunch (%)	0.268	0.040	0.193	0.025	0.117
Com_bn_max (cm)	139.600	14.016	116.100	8.564	0.156
Com_%shrub (%)	0.000	0.000	0.009	0.006	0.358
Com_shrub_max (cm)	0.000	0.000	27.556	18.991	0.309
Com_%litter (%)	0.109	0.048	0.140	0.042	0.659
Com_%bare (%)	0.029	0.009	0.056	0.010	0.112
Com_Litt_depth (cm)	1.390	0.227	1.695	0.168	0.308
VO_%5m 0-50 (%)	0.900	0.100	0.920	0.020	0.772
VO_%5m 50-100 (%)	0.550	0.185	0.265	0.051	0.059
VO_%5m 100-150 (%)	0.213	0.087	0.090	0.050	0.226
VO_%5m 150-200 (%)	0.025	0.025	0.050	0.033	0.663
VO_%10m 0-50 (%)	0.938	0.063	0.950	0.018	0.796
VO_%10m 50-100 (%)	0.700	0.162	0.435	0.076	0.114
VO_%10m 100-150 (%)	0.487	0.128	0.175	0.063	0.031
VO_%10m 150-200 (%)	0.212	0.075	0.100	0.054	0.275
OV_SPEC_RICH (#)	0.800	0.374	0.100	0.100	0.032
OV_DEN_TOT (#/m^2)	0.004	0.002	0.000	0.000	0.022
OV_OCUL_% (%)	0.078	0.061	0.000	0.000	0.084
UN_SPEC_RICH (#)	0.800	0.583	0.100	0.100	0.121
UND_DEN_TOT (#/m^2)	0.003	0.002	0.001	0.001	0.271
UN_OCUL_% (%)	0.024	0.011	0.005	0.005	0.078
SH_SP_RICH (#)	3.600	1.077	3.000	0.447	0.549
SH_DEN_TOT (#/m^2)	0.061	0.029	0.037	0.010	0.342
SH_COV_% (%)	0.034	0.010	0.029	0.013	0.808
FIR_ANT_DEN (#/m^2)	0.008	0.004	0.007	0.001	0.707
Distance to 50 acre plot (m)	482.110	135.099	235.214	102.293	0.179
Distance to canals (m)	267.278	74.497	381.872	81.264	0.385
Distance to habitat edge (m)	50.339	19.899	36.570	11.382	0.528
Distance to wetland (m)	67.295	16.812	57.468	12.611	0.655
Distance to burned areas (m)	900.062	297.508	1881.431	248.507	0.031
Distance to fencerow (m)	168.468	44.225	122.761	32.696	0.428
Distance to roads (m)	251.120	76.666	271.633	53.645	0.829

*variable descriptions in Table 2-1.

Table 3-6. Microhabitat characteristics of successful and unsuccessful bobwhite nest sites in south Florida rangelands, 2007-2008.

Variable*	Successful (n = 15) Mean	SE	Unsuccessful (n = 21) Mean	SE	P
Nest_%forbs (%)	0.243	0.047	0.150	0.028	0.077
Nest_fb_max (cm)	59.933	9.620	64.524	8.052	0.716

Table 3-6. Continued.

Variable*	Successful (n = 15) Mean	SE	Unsuccessful (n = 21) Mean	SE	P
Nest_%gram (%)	0.553	0.049	0.648	0.044	0.169
Nest_gr_max (cm)	111.867	6.684	105.095	5.780	0.451
Nest_%bunch (%)	0.372	0.065	0.392	0.061	0.827
Nest_bn_max (cm)	88.733	14.317	89.905	10.901	0.948
Nest_%shrub (%)	0.020	0.014	0.033	0.020	0.612
Nest_sh_max (cm)	15.733	11.017	14.190	7.114	0.903
Nest_%litter (%)	0.120	0.036	0.105	0.040	0.788
Nest_%bare (%)	0.033	0.013	0.046	0.013	0.493
Nest_Litt_depth (cm)	2.183	0.255	2.238	0.550	0.937
Nest_sp_rich (#)	5.533	0.576	5.238	0.447	0.684
Com_Sp._Rich (#)	11.333	0.688	10.810	0.875	0.662
Com_%forbs (%)	0.240	0.037	0.144	0.013	0.009
Com_fb_max (cm)	106.267	10.712	84.095	6.626	0.072
Com_%gram (%)	0.519	0.042	0.575	0.033	0.295
Com_gr_max (cm)	128.533	5.791	113.667	4.917	0.059
Com_%bunch (%)	0.218	0.022	0.198	0.035	0.664
Com_bn_max (cm)	132.933	7.675	93.571	11.104	0.046
Com_%shrub (%)	0.006	0.004	0.015	0.005	0.198
Com_shrub_max (cm)	17.714	12.493	39.381	9.459	0.170
Com_%litter (%)	0.130	0.031	0.141	0.033	0.809
Com_%bare (%)	0.047	0.008	0.095	0.025	0.120
Com_Litt_depth (cm)	1.593	0.136	2.032	0.422	0.400
VO_%5m 0-50 (%)	0.914	0.029	0.853	0.031	0.169
VO_%5m 50-100 (%)	0.346	0.069	0.266	0.057	0.372
VO_%5m 100-150 (%)	0.125	0.044	0.103	0.035	0.690
VO_%5m 150-200 (%)	0.043	0.025	0.097	0.038	0.271
VO_%10m 0-50 (%)	0.946	0.021	0.932	0.016	0.249
VO_%10m 50-100 (%)	0.511	0.075	0.445	0.057	0.480
VO_%10m 100-150 (%)	0.264	0.068	0.221	0.049	0.598
VO_%10m 150-200 (%)	0.132	0.045	0.158	0.046	0.699
OV_SPEC_RICH (#)	0.333	0.159	0.524	0.190	0.474
OV_DEN_TOT (#/m^2)	0.001	0.001	0.003	0.001	0.326
OV_OCUL_% (%)	0.026	0.021	0.062	0.023	0.285
UN_SPEC_RICH (#)	0.333	0.211	0.381	0.161	0.859
UND_DEN_TOT (#/m^2)	0.002	0.001	0.003	0.001	0.443
UN_OCUL_% (%)	0.011	0.005	0.045	0.023	0.220
SH_SP_RICH (#)	3.200	0.449	3.875	0.469	0.336
SH_DEN_TOT (#/m^2)	0.045	0.011	0.089	0.021	0.114
SH_COV_% (%)	0.031	0.009	0.074	0.020	0.088
FIR_ANT_DEN (#/m^2)	0.007	0.002	0.005	0.001	0.207
Distance to 50 acre plot (m)	317.513	84.796	213.139	69.014	0.347
Distance to canals (m)	343.674	59.726	470.301	55.122	0.139
Distance to habitat edge (m)	41.160	9.810	47.379	10.214	0.680
Distance to wetland (m)	60.744	9.829	64.293	10.477	0.817
Distance to burned areas (m)	1435.354	238.356	1216.783	215.812	0.518
Distance to fencerow (m)	137.997	26.031	99.160	26.145	0.322
Distance to roads (m)	264.795	42.424	390.231	47.651	0.075

*variable descriptions in Table 2-1.

Table 3-7. Microhabitat characteristics of successful and unsuccessful translocated bobwhite nest sites in south Florida rangelands, 2007-2008.

	Successful (n = 10)		Unsuccessful (n = 11)		
Variable*	Mean	SE	Mean	SE	P
Nest_%forbs (%)	0.200	0.063	0.143	0.039	0.447
Nest_fb_max (cm)	44.900	9.943	49.364	8.509	0.735
Nest_%gram (%)	0.592	0.066	0.673	0.058	0.372
Nest_gr_max (cm)	114.200	5.603	105.273	8.870	0.416
Nest_%bunch (%)	0.365	0.092	0.414	0.084	0.700
Nest_bn_max (cm)	82.900	18.808	90.818	15.523	0.747
Nest_%shrub (%)	0.030	0.020	0.014	0.014	0.500
Nest_sh_max (cm)	23.600	16.204	5.636	5.636	0.290
Nest_%litter (%)	0.120	0.045	0.068	0.020	0.293
Nest_%bare (%)	0.040	0.019	0.064	0.021	0.413
Nest_Litt_depth (cm)	2.375	0.328	1.795	0.303	0.209
Nest_sp_rich (#)	5.100	0.690	5.545	0.545	0.615
Com_Sp._Rich (#)	11.300	0.955	11.909	1.331	0.719
Com_%forbs (%)	0.215	0.036	0.150	0.020	0.129
Com_fb_max (cm)	103.500	15.301	77.727	8.061	0.142
Com_%gram (%)	0.500	0.051	0.577	0.039	0.240
Com_gr_max (cm)	123.000	4.937	120.273	5.982	0.732
Com_%bunch (%)	0.193	0.025	0.200	0.046	0.898
Com_bn_max (cm)	116.100	8.564	96.455	15.924	0.305
Com_%shrub (%)	0.009	0.006	0.015	0.007	0.572
Com_shrub_max (cm)	27.556	18.991	38.545	14.166	0.642
Com_%litter (%)	0.140	0.042	0.097	0.024	0.370
Com_%bare (%)	0.056	0.010	0.129	0.045	0.146
Com_Litt_depth (cm)	1.695	0.168	1.582	0.252	0.719
VO_%5m 0-50 (%)	0.920	0.020	0.845	0.041	0.128
VO_%5m 50-100 (%)	0.265	0.051	0.259	0.057	0.939
VO_%5m 100-150 (%)	0.090	0.050	0.109	0.051	0.792
VO_%5m 150-200 (%)	0.050	0.033	0.123	0.058	0.304
VO_%10m 0-50 (%)	0.950	0.018	0.927	0.021	0.304
VO_%10m 50-100 (%)	0.435	0.076	0.414	0.058	0.823
VO_%10m 100-150 (%)	0.175	0.063	0.200	0.057	0.772
VO_%10m 150-200 (%)	0.100	0.054	0.155	0.055	0.492
OV_SPEC_RICH (#)	0.100	0.100	0.545	0.312	0.208
OV_DEN_TOT (#/m^2)	0.000	0.000	0.004	0.002	0.145
OV_OCUL_% (%)	0.000	0.000	0.040	0.024	0.124
UN_SPEC_RICH (#)	0.100	0.100	0.545	0.282	0.168
UND_DEN_TOT (#/m^2)	0.001	0.001	0.005	0.003	0.137
UN_OCUL_% (%)	0.005	0.005	0.075	0.040	0.115
SH_SP_RICH (#)	3.000	0.447	4.091	0.667	0.199
SH_DEN_TOT (#/m^2)	0.037	0.010	0.096	0.037	0.160
SH_COV_% (%)	0.029	0.013	0.092	0.033	0.103
FIR_ANT_DEN (#/m^2)	0.007	0.001	0.005	0.002	0.378
Distance to 50 acre plot (m)	235.214	102.293	41.237	27.756	0.053
Distance to canals (m)	381.872	81.264	538.297	66.731	0.148

Table 3-7. Continued.

	Successful (n = 10)		Unsuccessful (n = 11)		
Variable*	Mean	SE	Mean	SE	P
Distance to habitat edge (m)	36.570	11.382	57.789	12.716	0.242
Distance to wetland (m)	57.468	12.611	70.804	13.593	0.492
Distance to burned areas (m)	1881.431	248.507	1841.635	226.426	0.911
Distance to fencerow (m)	122.761	32.696	63.325	25.302	0.158
Distance to roads (m)	271.633	53.645	461.062	57.177	0.028

*variable descriptions in Table 2-1.

Table 3-8. Microhabitat characteristics of successful and unsuccessful resident bobwhite nest sites in south Florida rangelands, 2007-2008.

	Successful (n = 5)		Unsuccessful (n = 10)		
Variable*	Mean	SE	Mean	SE	P
Nest_%forbs (%)	0.330	0.045	0.158	0.040	0.021
Nest_fb_max (cm)	90.000	13.704	81.200	12.452	0.671
Nest_%gram (%)	0.475	0.061	0.620	0.070	0.206
Nest_gr_max (cm)	107.200	17.878	104.900	7.729	0.891
Nest_%bunch (%)	0.385	0.079	0.367	0.092	0.905
Nest_bn_max (cm)	100.400	22.569	88.900	16.119	0.686
Nest_%shrub (%)	0.000	0.000	0.055	0.039	0.340
Nest_sh_max (cm)	0.000	0.000	23.600	13.363	0.242
Nest_%litter (%)	0.120	0.068	0.145	0.081	0.845
Nest_%bare (%)	0.020	0.005	0.028	0.014	0.723
Nest_Litt_depth (cm)	1.800	0.382	2.725	1.117	0.580
Nest_sp_rich (#)	6.400	1.030	4.900	0.737	0.259
Com_Sp._Rich (#)	11.400	0.927	9.600	1.046	0.290
Com_%forbs (%)	0.291	0.086	0.136	0.018	0.031
Com_fb_max (cm)	111.800	11.830	91.100	10.726	0.256
Com_%gram (%)	0.556	0.082	0.573	0.056	0.689
Com_gr_max (cm)	139.600	14.016	106.400	7.609	0.040
Com_%bunch (%)	0.268	0.040	0.196	0.055	0.409
Com_bn_max (cm)	139.600	14.016	90.400	16.227	0.073
Com_%shrub (%)	0.000	0.000	0.017	0.008	0.184
Com_shrub_max (cm)	0.000	0.000	40.300	13.117	0.053
Com_%litter (%)	0.109	0.048	0.190	0.062	0.411
Com_%bare (%)	0.029	0.009	0.059	0.014	0.190
Com_Litt_depth (cm)	1.390	0.227	2.526	0.837	0.367
VO_%5m 0-50 (%)	0.900	0.100	0.863	0.050	0.711
VO_%5m 50-100 (%)	0.550	0.185	0.275	0.116	0.218
VO_%5m 100-150 (%)	0.213	0.087	0.094	0.048	0.219
VO_%5m 150-200 (%)	0.025	0.025	0.063	0.041	0.556
VO_%10m 0-50 (%)	0.938	0.063	0.937	0.026	0.999
VO_%10m 50-100 (%)	0.700	0.162	0.488	0.113	0.304
VO_%10m 100-150 (%)	0.487	0.128	0.250	0.088	0.154
VO_%10m 150-200 (%)	0.212	0.075	0.163	0.082	0.707
OV_SPEC_RICH (#)	0.800	0.374	0.500	0.224	0.478
OV_DEN_TOT (#/m^2)	0.004	0.002	0.002	0.001	0.409
OV_OCUL_% (%)	0.085	0.041	0.078	0.061	0.921

Table 3-8. Continued.

	Successful (n = 5)		Unsuccessful (n = 10)		
Variable*	Mean	SE	Mean	SE	P
UN_SPEC_RICH (#)	0.800	0.583	0.200	0.133	0.196
UND_DEN_TOT (#/m^2)	0.003	0.002	0.001	0.000	0.113
UN_OCUL_% (%)	0.024	0.011	0.012	0.012	0.534
SH_SP_RICH (#)	3.600	1.077	3.600	0.686	0.999
SH_DEN_TOT (#/m^2)	0.061	0.029	0.081	0.019	0.573
SH_COV_% (%)	0.034	0.010	0.055	0.021	0.511
FIR_ANT_DEN (#/m^2)	0.008	0.004	0.005	0.002	0.376
Distance to 50 acre plot (m)	482.110	135.099	436.612	125.001	0.8250
Distance to canals (m)	267.278	74.497	381.906	88.478	0.418
Distance to habitat edge (m)	50.339	19.899	33.846	16.441	0.556
Distance to wetland (m)	67.295	16.812	55.828	16.815	0.676
Distance to burned areas (m)	900.062	297.508	435.718	123.402	0.123
Distance to fencerow (m)	168.468	44.225	145.747	48.031	0.768
Distance to roads (m)	251.120	76.666	298.152	73.707	0.697

*variable descriptions in Table 2-1.

Table 3-9. Home range level habitat characteristics of bobwhite nest and paired random sites for each nest in south Florida rangelands, 2007-2008.

	Nest site (n = 39)		Paired random sites (n = 39)		
Variable*	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	249.820	52.271	281.012	49.793	0.000
Distance to canals (m)	428.771	41.384	392.157	37.711	0.002
Distance to habitat edge (m)	43.995	7.096	34.859	1.469	0.190
Distance to wetland (m)	62.271	7.185	53.452	2.365	0.230
Distance to burned areas (m)	1299.689	160.155	1322.355	156.908	0.003
Distance to fencerow (m)	113.558	18.426	132.723	13.698	0.039
Distance to roads (m)	342.007	33.591	328.266	29.381	0.138

*variable descriptions in Table 2-1.

Table 3-10. Home range level habitat characteristics of translocated bobwhite nest and paired random sites for each nest in south Florida rangelands, 2007-2008.

	Nest site (n = 39)		Paired random sites (n = 39)		
Variable*	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	123.597	48.093	281.012	49.793	0.000
Distance to canals (m)	481.942	52.169	392.157	37.711	0.000
Distance to habitat edge (m)	46.901	8.613	34.859	1.469	0.238
Distance to wetland (m)	63.908	9.010	53.452	2.365	0.230
Distance to burned areas (m)	1856.559	164.226	1322.355	156.908	0.056
Distance to fencerow (m)	88.706	19.789	132.723	13.698	0.022
Distance to roads (m)	379.215	41.962	328.266	29.381	0.119

*variable descriptions in Table 2-1.

Table 3-11. Home range level habitat characteristics of resident bobwhite nest and paired random sites for each nest in south Florida rangelands, 2007-2008.

	Nest site (n = 39)		Paired random sites (n = 39)		
Variable*	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	451.778	92.020	281.012	49.793	0.064
Distance to canals (m)	343.697	63.970	392.157	37.711	0.503
Distance to habitat edge (m)	39.344	12.565	34.859	1.469	0.555
Distance to wetland (m)	59.651	12.255	53.452	2.365	0.682
Distance to burned areas (m)	614.312	145.144	1322.355	156.908	0.027
Distance to fencerow (m)	153.320	34.397	132.723	13.698	0.408
Distance to roads (m)	282.474	54.066	328.266	29.381	0.675

*variable descriptions in Table 2-1.

Table 3-12. Characteristics of successful and unsuccessful nest sites in south Florida rangelands, 2007-2008.

	Successful nests (n = 15)		Unsuccessful nests (n = 23)		
Variable	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	317.513	84.796	213.139	69.014	0.347
Distance to canals (m)	343.674	59.726	470.301	55.122	0.139
Distance to habitat edge (m)	41.160	9.810	47.379	10.214	0.680
Distance to wetland (m)	60.744	9.829	64.239	10.477	0.817
Distance to burned areas (m)	1435.354	238.356	1216.783	215.812	0.518
Distance to fencerow (m)	137.997	26.031	99.160	26.145	0.322
Distance to roads (m)	264.795	42.424	390.231	47.651	0.075

*variable descriptions in Table 2-1.

Table 3-13. Characteristics of successful and unsuccessful translocated nest sites in south Florida rangelands, 2007-2008.

	Successful nests (n = 10)		Unsuccessful nests (n = 13)		
Variable	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	235.214	102.293	41.237	27.756	0.053
Distance to canals (m)	381.872	81.264	538.297	66.731	0.148
Distance to habitat edge (m)	36.570	11.382	57.789	12.716	0.242
Distance to wetland (m)	57.468	12.611	70.804	13.593	0.492
Distance to burned areas (m)	1881.431	248.507	1841.635	226.426	0.991
Distance to fencerow (m)	122.761	32.696	63.325	25.302	0.158
Distance to roads (m)	271.633	53.645	461.062	57.177	0.028

*variable descriptions in Table 2-1.

Table 3-14. Characteristics of successful and unsuccessful resident nest sites in south Florida rangelands, 2007-2008.

	Successful nests (n = 5)		Unsuccessful nests (n = 10)		
Variable*	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	482.110	135.099	436.612	125.001	0.825
Distance to canals (m)	267.278	74.497	381.906	88.478	0.418
Distance to habitat edge (m)	50.339	19.899	33.846	16.441	0.556
Distance to wetland (m)	67.295	16.812	55.828	16.815	0.676
Distance to burned areas (m)	900.062	297.508	435.718	123.402	0.123
Distance to fencerow (m)	168.468	44.225	145.747	48.031	0.768
Distance to roads (m)	251.120	76.666	298.152	73.707	0.697

*variable descriptions in Table 2-1.

Table 3-15. Landscape level habitat characteristics of bobwhite nests and 1000 random sites in south Florida rangelands, 2007-2008.

	Nest sites (n = 39)		Random sites (n = 1000)		
Variable*	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	249.820	52.271	287.449	8.684	0.405
Distance to canals (m)	428.771	41.384	380.257	9.561	0.323
Distance to habitat edge (m)	43.995	7.096	31.869	1.003	0.021
Distance to wetland (m)	62.271	7.185	47.517	1.539	0.063
Distance to burned areas (m)	1299.689	160.155	782.975	22.068	0.000
Distance to fencerow (m)	113.558	18.426	149.611	3.977	0.078
Distance to roads (m)	342.007	33.591	379.939	8.700	0.395

*variable descriptions in Table 2-1.

Table 3-16. Landscape level habitat characteristics of translocated bobwhite nests and 1000 random sites in south Florida rangelands, 2007-2008.

	Nest sites (n = 22)		Random sites (n = 1000)		
Variable*	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	123.597	48.093	287.449	8.684	0.004
Distance to canals (m)	481.942	52.169	380.257	9.561	0.103
Distance to habitat edge (m)	46.901	8.613	31.869	1.003	0.023
Distance to wetland (m)	63.908	9.010	47.517	1.539	0.103
Distance to burned areas (m)	1856.559	164.226	782.975	22.068	0.000
Distance to fencerow (m)	88.706	19.789	149.611	3.977	0.019
Distance to roads (m)	379.215	41.962	379.939	8.700	0.990

*variable descriptions in Table 2-1.

Table 3-17. Landscape level habitat characteristics of resident bobwhite nests and 1000 random sites in south Florida rangelands, 2007-2008.

	Nest sites (n = 15)		Random sites (n = 1000)		
Variable*	Mean	SE	Mean	SE	P
Distance to 50 acre plot (m)	451.778	92.020	287.449	8.684	0.022
Distance to canals (m)	343.697	63.970	380.257	9.561	0.641
Distance to habitat edge (m)	39.344	12.565	31.869	1.003	0.369
Distance to wetland (m)	59.651	12.255	47.517	1.539	0.338
Distance to burned areas (m)	614.312	145.144	782.975	22.068	0.386
Distance to fencerow (m)	153.320	34.397	149.611	3.977	0.910
Distance to roads (m)	282.474	54.066	379.939	8.700	0.172

*variable descriptions in Table 2-1.

CHAPTER 4
DISCUSSION

Microhabitat Level Habitat Use and Selection

Most of the selected nest microhabitat variables can be associated with greater visual obstruction of the nest site, which probably serves to conceal the nest from predators and possibly provide thermal protection for incubating hens. This is consistent with previous findings on nest microhabitat selection (Taylor et al. 1999, Townsend et al. 2001, Arredondo et al. 2006) and use of habitats for thermal protection by bobwhites (Guthery et al. 2005). While I did not find any relation between vertical obstruction and nest success, Townsend et al. (2001) found that successful nests were concealed better than unsuccessful nests. Bobwhites selected for more overstory canopy closure and shorter bunchgrasses at the nest site, but I found that successful nests had less canopy coverage and taller bunchgrasses at the nest site than unsuccessful nests. The reason for this discrepancy is unclear. Arredondo et al. (2006) reported bobwhites selecting for taller bunchgrasses at the nest site than was available in the surrounding area, and both Taylor et al. (1999) and Lusk et al. (2006) found that successful nests were associated with taller vegetation than unsuccessful nests. My results may have differed from Arredondo et al. (2006) because average bunchgrass height at nest sites in south Florida (91.4 cm) was much greater than the average bunchgrass height of nest sites found in Texas (23.7 cm). This suggests that the habitat structure may be different in these two areas, causing bobwhites to select for different nest habitat characteristics, or that after some height threshold selection may no longer be associated with success, or may be associated with declining success. Bobwhites selected nest sites with less bare ground, which is consistent with the findings of Townsend et al. (2001) and may be to provide additional visual obstruction of the nest. While I did not find a relation between bare ground and nest success, Townsend et al. (2001) reported less bare ground at successful nest sites, while Lusk et al. (2006) found that successful nests were associated with higher levels of bare ground than random sites. Nest sites were located closer to fencerows, possibly because fencerows provide better escape and foraging cover than the surrounding habitats. Nest sites also had lower densities of fire ant mounds than random sites, possibly because bobwhites may be avoiding this predator of quail chicks. Lehman (1947) found several cases in which newly hatched chicks were killed at the nest by imported fire ants and Giuliano et al. (1996) found that exposure to fire ants can reduce chick survival, but Johnson (1961) found that fire ants did not have an influence on quail production.

I found less shrub cover surrounding translocated nest sites than was available, possibly because shrub cover blocks sunlight, which reduces the growth of herbaceous plants at lower levels, reducing visual obstruction at potential nest sites. Successful nests were found to have less shrub cover than unsuccessful nests by Taylor et al. (1999), while Lusk et al. (2006) found the opposite to be true. I did not find shrub cover to be a significant factor associated with nest success at the microhabitat level. Translocated bobwhites selected nest sites with deeper litter than paired random sites; successful translocated quail nests also had deeper litter than unsuccessful nests. Again, this is possibly because increased litter provides better nest concealment from predators. Translocated nests were associated with greater graminoid cover than random sites, which was consistent with the findings of several studies (Taylor et al. 1999, Townsend et al. 2001, Arredondo et al. 2006), but this was not found to be associated with nest success. Additionally, while translocated bobwhites selected nest sites that were further from roads and closer to fencerows than random sites, successful translocated nests were in fact closer to roads and further from fencerows than unsuccessful nest sites. While bobwhites use fencerows for cover and foraging, fencerows may also be corridors for nest predators. Selecting for closer proximity to fencerows may be placing nests at a higher risk for predation (Stanton 1944), and is supported by Hannon and Cotterill (1998) who found that overall predation of artificial nests in shrubs and on the ground was highest in fencerows when compared to other habitats. Baskett (1947) found that very few ring-necked pheasant nests in fencerows were successful.

The majority of important habitat characteristics at resident nest sites were associated with greater visual obstruction. This probably serves to hide the nest from potential predators, and is consistent with the findings of Taylor et al. (1999). While I did not find a connection between nest success and visual obstruction, both Taylor et al. (1999) and Lusk et al. (2006) found that successful nests were surrounded by taller herbaceous vegetation than unsuccessful nests. It is possible that due to my small sample size, I could not detect significant effects of vertical obstruction on nest success. Resident bobwhites selected for greater overstory canopy closure at nest sites, and successful resident nest sites were associated with greater overstory canopy closure than unsuccessful nest sites. Resident nests were also located closer to wetlands than random sites. This is probably because during the nesting season, the edges of these wetlands provide an abundance of forbs, bare ground, and overhead protection, which is characteristic of good bobwhite brood habitat (Giuliano et al. 2007).

Resident bobwhites selected nest sites with habitat characteristics that were closely associated with greater visual obstruction than at translocated nest sites. Taller vegetation at the nest site may lead to increased nest success (Taylor et al. 1999, Lusk et al. 2006), and greater visual obstruction of the nest site may lead to increased nest success (Townsend et al. 2001, Hernandez et al. 2003). This may suggest that resident bobwhites are selecting for nest sites that are more likely to be successful than translocated bobwhites. However, I did not find that nest success was dependent on whether a quail was resident or translocated, which is consistent with the findings of Terhune et al. (2006b). Resident bobwhites nested closer to burned areas than translocated bobwhites. Burned areas provided more bare ground and forb cover than unburned areas, and resident bobwhites may have been able to better select nest sites near these areas because they were more familiar with the habitat. Liu et al. (2002) determined that it required approximately 4 months for translocated bobwhites to become familiar with their new habitat. Being moved only a short time before the nesting season, translocated bobwhites may not have been able to find burned areas before making their nests. Translocated birds also nested closer to un-grazed areas than resident bobwhites, possibly because the thicker, un-grazed vegetation at these sites more closely resembled the habitat where they were trapped than the grazed habitats in the remainder of the study area.

When comparing successful resident and translocated nest sites, the important habitat characteristics again indicated that resident birds selected for greater visual obstruction than translocated birds. Resident nests were also closer to burned areas than translocated nests. Nest clump vegetation type was dependent on whether a bird was resident or translocated, but nests success did not depend on nest clump vegetation type.

Home Range Level Habitat Use and Selection

When comparing nest sites to 50 random nest sites within a home range sized buffer, the most important habitat characteristic was distance to fencerows, with nest sites being closer to fencerows than paired random sites. This could be because fencerows offer good escape and foraging cover. I did not find significant relationships between any habitat characteristic and nest success, however, Baskett (1947) found that ring-necked pheasants nesting in fencerows had poor nest success due to high levels of predation. Quail selected nest sites further from edge and canals, possibly to avoid nest predators, which may use these as travel corridors. Barding and

Nelson (2008) found that meso-predators such as raccoons tended to follow linear habitat features such as habitat edge and trails when foraging, and meso-predators incorporate more levees and roads into their home range than expected (Frey and Canover 2006). Nests were closer to burned areas than random sites, which may be because areas burned the winter before typically have abundant forbs and less litter, which would provide good brood habitat (Giuliano et al. 2007). Quail selected dry prairie for nests sites over both grassland/improved pasture and freshwater marsh/wet prairie habitats. This is possibly because meso-predators, particularly raccoons, forage selectively in wetland habitats (Barding and Nelson 2008).

When comparing translocated nests to random sites at the home range level, the most important habitat characteristic was distance to fencerows. This is consistent with our findings for all nests combined, and may have occurred for the same reasons. Nest sites were also closer to un-grazed areas, further from canals, and further from habitat edge than random sites. I did not find relationships between any of these characteristics and nest success. Translocated birds may have selected nest sites closer to un-grazed sites because they offered more cover than grazed areas, and many of the quail were translocated from areas with more cover than the habitat they were released into. Translocated birds may have avoided habitat edge and canals because they may be travel corridors for potential nest predators (Frey and Canover 2006, Barding and Nelson 2008). Translocated quail selected dry prairie habitat for nest sites over both grassland/improved pasture and freshwater marsh/wet prairie habitats, possibly because of the tendency for the study area to flood during nesting season.

When comparing resident nest sites to random sites at the home range level, the only significant variable was distance to burned areas. Nests were closer to burned areas than random sites. Resident birds may have selected nest sites closer to burned areas because they provide better brood habitat than elsewhere in the study area. I did not find a relationship between any nest characteristic and nest success for resident nests. Resident quail selected dry prairie over both grassland/improved pasture and freshwater marsh/wet prairie habitats for nest sites.

Landscape Level Habitat Use and Selection

When comparing nest sites to random points at a landscape level, the two most important habitat characteristics influencing nest site selection were distance to habitat edge and burned areas, with nest sites being further from both habitat edge and burned areas than random points. Quail may have avoided habitat edges for nest sites to avoid predation, but they were probably further from burned areas because there were so few burned areas in the study area. Other important variables included distance to fencerows and canals, with nest sites being closer to fencerows and further from canals than random sites, which may have been because fencerows offer good escape and foraging cover. They may have avoided canals because they are often used as travel corridors for possible predators (Frey and Canover 2006), however, this has also been shown to be true for fencerows (Barding and Nelson 2008). I did not find any significant relationship between habitat characteristics and nest success.

When comparing translocated nest sites to random sites, the most important variables were distance to un-grazed areas, habitat edge, burned areas, and fencerows. Nests were closer to fencerows and un-grazed areas, and further from habitat edge and burned areas. Translocated birds may have nested nearer to fencerows and un-grazed areas because of the denser vegetative cover available there, which may have been lacking in other areas of the study area. Distance to canals was also important but to a lesser degree, with nests being further from canals than random points. None of the habitat characteristics being selected for were related to nests success.

Resident nests were further from un-grazed areas than random points. No other habitat characteristics had a significant effect on nest site selection. Resident quail may have avoided un-grazed areas because the vegetation there is much denser, and may make it difficult to move and forage.

Summary

Management should be used to create microhabitat conditions with increased density and height of herbaceous nest vegetation. More litter and less bare ground should be provided at potential nesting sites, to create better visual obstruction for nests, which in turn should reduce nest predation. This could be achieved by burning habitat to stimulate growth of warm season grasses and forbs, and by using backing fires, which would leave some areas unburned. This would provide areas of thicker residual vegetation mixed with other habitats, which would be ideal for northern bobwhite nesting. Decreasing grazing rates during the nesting/growing season would allow for bunchgrasses and forbs, important to nesting, to grow taller and denser, and would improve nesting habitat. At the home range scale, habitat should be managed for increased heterogeneity of nesting vegetation, since nest success is improved by being closer to habitat edge. Again, this may be accomplished by periodic, slow backing fires that leave a patchy mix of burned and unburned habitat. Fencerows, roads, and canals may be potential linear travel corridors for predators (Barding and Nelson 2008) at the landscape level, and should be minimized in areas of suitable nesting habitat since bobwhites may select to nest near these features, resulting in a reduction of nest success. Translocated and resident bobwhites may select for slightly different nesting habitat, but none of these differences resulted in a difference in nest success between resident and translocated birds. Because they have similar nest success to resident birds, translocating birds may be a viable method for restoring populations of northern bobwhites in south Florida rangelands.

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BIOGRAPHICAL SKETCH

Brandon Schad was born in Stillwater, Minnesota. He graduated from the University of Minnesota in 2004 with a bachelor's degree in fisheries and wildlife, and since then has worked for a variety of organizations. He worked for the USDA Forest Service on habitat improvement projects in the Chequamegon-Nicolet National Forest, and worked later for Ducks Unlimited Inc. in both the sand hills of Nebraska and the Missouri coteau in North Dakota on several studies of upland nesting waterfowl nest selection and success. He moved to Florida in 2006 to work at the University of Florida researching northern bobwhites, and received his M.S. in wildlife ecology and conservation from the University of Florida in August, 2009. He is an avid hunter and angler, and loves spending his time outdoors.