COMPARISON OF COVER SELECTION BY NORTHERN BOBWHITES AND HUNTERS IN WESTERN OKLAHOMA

By

JOSHUA LEE RICHARDSON

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Thesis Approved

Dr. Fred S. Guthery
Thesis Advisor

Dr. Samuel D. Fuhlendorf

Dr. Timothy J O'Connell

Dr. Gordon Emslie
Dean of the Graduate College

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INTRODUCTION

For at least a century, northern bobwhites (*Colinus virginianus*) have been popular with sportsmen and researchers. This popularity has led to an abundance of research on bobwhites. Early studies (Stoddard 1931) were conducted to learn more about the life history of bobwhites. More recent studies have focused on the population decline that is occurring throughout much of the bobwhite's range (Klimstra 1982, Brennan 1991, Brady et al. 1998). As more has been learned about bobwhites, the methods for managing them have evolved as well.

Wildlife management began as man's attempt to benefit wildlife species. As such, ideas such as predator removal, restricted hunting seasons and bag limits, and habitat creation, especially edge (Leopold 1933), attained prominence through the years. As it has grown, however, wildlife management has looked more to science for new methods to benefit wildlife species (Peek 1986:10-12). As management shifted to a more scientific basis, new approaches to the integration of game management and hunting were studied and proposed. One such approach in bobwhite management has been the hunter-covey interface (HCI). This model incorporates the velocity of hunters and the area they effectively cover with the adaptability of bobwhite to predation pressure to yield an average daily harvest (Radomski and Guthery 2000). This information can be used to set season limits to achieve specific goals (i.e. spring breeding density). To effectively implement a model such as this, base statistics such as the average rate of hunter movement and the amount and type of cover hunted needs to be established for each method of hunting.

While much is known of the life history and ecology of bobwhites, few studies have examined bobwhite hunters as a means of controlled predation. The productivity of a site, which can be thought of as bobwhites seen per unit effort, often influences hunters' choices of which areas to hunt or not hunt (Hardin et al. 2005). However, the effects of hunting are not spread homogenously over a state or area (Roseberry 1979, Lehmann 1984, Lyon and Burcham 1998). It should follow, then, that areas experiencing high hunting pressures would have high bobwhite densities. Few would argue that this holds true, although no study has examined this. If this assumption was invalid, I would expect a discrepancy in habitat selection between bobwhites and hunters. This would indicate that there are other likely factors that influence the selection of area hunted, but few studies have quantified use by humans, and none have attempted to compare habitat selection between bobwhites and hunters.

My objective was to better understand the selection of cover by bobwhites and bobwhite hunters and to further explore the demographics of hunters and their perspective regarding changes in management practices. I predicted that hunters would choose similar habitat to bobwhites to maximize their productivity during a hunt. Along with this I also quantitatively described the movement of bobwhite hunters hunting on foot. This information, combined with the use of the HCI, may improve biologists' abilities to achieve a specific outcome from harvest management, such as spring breeding density of bobwhites or maximizing recreational opportunity for sportsmen. To characterize the sample of hunters participating in this study I used a questionnaire which provided information on the general level of hunter skill and their attitudes regarding bobwhite management.

STUDY AREA

This study was conducted on the Packsaddle Wildlife Management Area (WMA). Packsaddle WMA consisted of 6,070 ha in the southern portion of Ellis County in western Oklahoma. The area consisted mainly of mixed grasses and shinnery oak (*Quercus havardii*) in uplands and cottonwood (*Populus deltoides*), elm (*Ulmus* spp.), and hackberry (*Celtis* spp.) in bottomlands. The area experienced an average annual precipitation of 64.4 cm, with a mean average daily temperature of 13.9 C˚, as recorded by the National Climate Data Center station in Arnett, Oklahoma, from 1974 through 2004. In November through February, which corresponds to Oklahoma's quail season, the mean average daily temperature was 3.0 C˚.

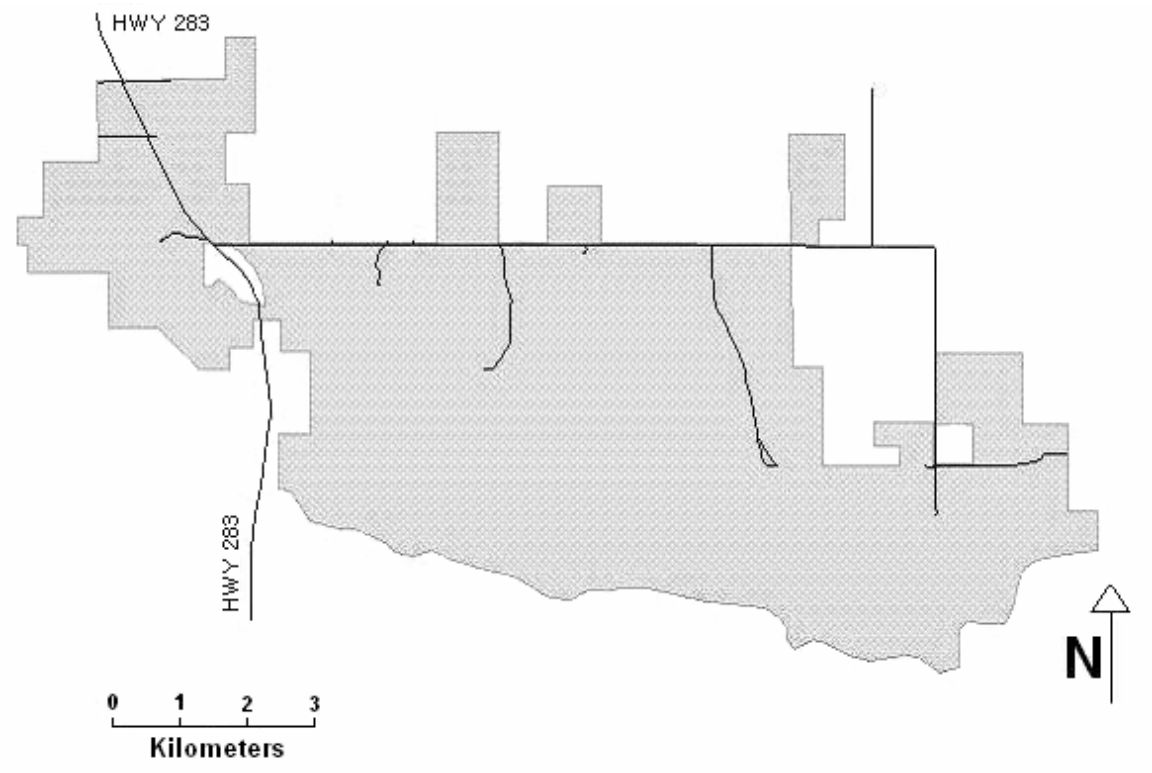
Vehicular access was mainly limited to the northern edge of the area with access to the interior available by foot (Figure 1). The Oklahoma Department of Wildlife Conservation (ODWC) conducted various habitat management practices including limited grazing, controlled burning, and food plots on the management area.

LITERATURE REVIEW

Hunting as a Method of Wildlife Management.

It is a fundamental task of wildlife managers to limit and regulate hunting methods to maintain sustainable populations of the species being managed (Robinson and Bolen 1984:2-3). Hunting as a managed form of predation is used in many states for management of various wildlife species (Decker and Connelly 1989, Giles and Findlay 2004). Harvest rates, population estimates, and survival probabilities are basic information that can assist in setting practical harvest limits (Rosene 1969). With

Figure 1. Packsaddle Wildlife Management Area, Ellis County, Oklahoma, boundary (shaded area) and accessible public roads (dark lines) during the 2004 and 2005 bobwhite hunting seasons.



bobwhite management, however, most regulations are set liberally to maximize recreational opportunity (Guthery et al. 2005*a*).

Hunters, as with any consumers, will preferentially choose quality areas, or those areas that maximize the rate of return while minimizing foraging time (Emlen 1966, MacArthur and Pianka 1966, Schoener 1971, Charnov 1976). This preferential choice of areas creates sanctuaries that remain comparatively unaffected by hunting pressures (Clayton et. al. 1997, Broseth and Pederson 2000), thereby reducing the influence of hunting pressure on populations in large areas. By better understanding hunter movement patterns and the pressure exerted on a wildlife community, bobwhite management can progress in a scientific fashion.

Geographic Information Systems and Global Positioning Systems

The use of radio-tracking in wildlife management has been around since the early 1960s and has since been used to study many physiological and biological aspects of wildlife (Mech and Barber 2002). Recent developments in other technologies have further enhanced the application of the data obtained through radio-tracking. One of these developments is the Geographic Information System (GIS), which allows the joining and manipulation of spatial and processed data. Data received from radio-tracking devices can be combined with various spatial data, including elevation, land-use, cover types, and maps. Often used along with a GIS are Global Positioning Systems (GPS), which allow for the collection of spatial data in the field.

While GPS, GIS, and radio-tracking have been used extensively in recent years to monitor various aspects of wildlife populations, only 4 known studies have used telemetry data to monitor humans and human interaction in relation to these wildlife populations (Broseth and Pederson 2000, Lyon and Burcham 1998, Stedman et al. 2004, Hardin et al. 2005). Other studies have investigated hunter demographics and attitudes (Decker and Connelly 1989, Crews and DeMaso 2000) and explored the spatial relationships and effects of hunters on prey species (Sparrowe and Springer 1970, Root et al. 1988, Robinette and Doerr 1993, Millspaugh et al. 2000, Suchy and Munkel 2000).

Cover Selection

One would expect the most successful hunters will be those who choose hunting locations in the same areas that bobwhites choose for cover. However, the survival of the prey species depends on their ability to not only select cover that provides food, water, and protection, but also to select cover that decreases the probability of encountering a

predator. The ability of bobwhites to elude hunters has been recorded both in studies (Sisson et al. 2000, Hardin 2003) and in anecdotal accounts.

Quantifying differential selection of habitats has been of particular interest to the wildlife profession throughout conservation history. To accomplish this, several methods of calculating selection ratios and testing hypotheses have been proposed (Alldredge et al. 1998). No one method is suitable for all studies of habitat selection due to "problems of sampling level, unit-sum constraint, differential use, and definition of availability" (Aebischer et al. 1993: 1321). The chi-square goodness-of-fit test is recommended when relocations are pooled and selection is generalized for populations (Alldredge et. al. 1998). Despite these difficulties, the ability to categorize habitat as selected or avoided is still of considerable interest.

Bobwhites are known to preferentially select areas with woody cover, which they use for escape and resting cover (Davis 1964, Roseberry and Klimstra 1984, Williams et al. 2000). When woody cover is limited, this preferential selection does not always increase survival, especially through the hunting season, as it can lead to bobwhite concentrations in areas that experience higher hunting pressure (Roseberry 1979, Williams et al. 2000). In areas saturated with usable space (Guthery 1997), including woody cover, the concentrating effect of habitat may be removed. In these cases, hunting pressure may be spread throughout the area, with some areas being highly pressured and others lightly pressured (Broseth and Pederson 2000). By using a selection ratio, categorizing the selected or avoided areas for both bobwhites and hunters would allow for a comparison between the two.

METHODS

Data Collection

To facilitate habitat and cover selection analysis, I obtained geographic data for both bobwhite hunters and bobwhites. The Oklahoma Department of Wildlife Conservation conducted a 10-year study from 1991 to 2001 on the Packsaddle WMA in which >100,000 radio locations from >3,000 bobwhites were collected (DeMaso et al. 1997, Cox et al. 2004). These data provided both date of location and universal transverse mercator (UTM) coordinates of the radio-collared bobwhites. I removed telemetry locations that fell outside the Packsaddle boundary.

I created vegetation maps using ArcView 3.3 and ArcDesktop GIS (Environmental Systems Research Institute Redlands, California, USA). Vegetation types were visually delineated and categorized using 2003 National Agriculture Imagery Program color ortho-quarter-quad images. I followed the vegetation classification pattern of and used associations included in Hoagland (2000). Classifications were verified on site by visual inspection and consultation with local authorities. In addition to vegetation types, slope and distances from roads were used to further partition cover classes. Roads were defined as those areas publicly accessible by motor vehicle. Four distance categories were established, <500 m, 500–<1,500 m, 1,500–<2,500 m, and ≥2,500 m. Slope was defined by 2 categories, level (slope ≤3%) and steep (slope >3%), which partitioned the management area roughly in half. The combination of vegetation, distance from road, and slope defined cover types within the Packsaddle area. Cover types with areas <1% of the total area were combined to form rare cover types that maintained their distance and slope categories (Table 1).

I obtained spatial data on hunting parties using Garmin's Foretrex 201 GPS (Garmin International, Olathe, KS, USA). GPS units were given to hunting parties that came to the Packsaddle WMA. When contact with a hunting party was made, I asked them to participate in the study. GPS units and questionnaires were presented to hunting parties that were willing to participate. This continued throughout the day. The Foretrex 201 units marked the paths of hunters by automatically recording the hunter's position every 7 seconds. Several members of the hunting party, including dogs, carried GPS units.

I provided the questionnaire to characterize the sample of hunters. Questions regarding hunter skill provided information on how long participants had been hunting and influences on when and where they hunt. Attitudes toward management changes were addressed by questions relating to changes in bag limits, season lengths, and general satisfaction with a bobwhite hunting experience. Hunters from both years were asked to rate the importance of each of the following elements: seeing several coveys per outing, plenty of shooting, attaining a bag limit, being out in nature, watching the dogs work, and going into the field with friends. Responses were given as values from 1 to 5, with 1 indicating no importance and 5 indicating extreme importance. I also asked hunters to report on personal limitations that they used while in the field. Marked choices indicated an exercise of that limitation. If a choice was not marked, it was considered as a "no" response.

Data Analysis

After the hunters returned, I downloaded data from each GPS unit into a text file on a computer using DNRGarmin. These text files contained all raw data for every hunt.

Data from these text files were then cleaned and saved within a database file. This cleaning removed excess data points such as those recorded while hunters were at their vehicles, either before leaving to hunt or after returning from hunting, and while traveling, and erroneous points within the hunt route due to GPS error or loss of signal. I identified these points by plotting the recorded path. Data for parties with multiple units was obtained from the unit that best maintained its satellite connection and had the fewest number of removed points within a hunt. Each of these database files were then transformed into an ESRI shape file using ArcView 3.3, and used for analysis of cover selection.

Hunter Movement.— To obtain information about hunting party movement, I combined the data for each hunting party. Distance between subsequent locations was calculated using the distance formula. I determined hunter velocity in m/sec by dividing the distance between recorded points by 7 seconds. Values for pairs of locations with time intervals different than 7 seconds were removed from calculations. Values for average velocity and average distance for each hunting party in each season were grouped and average values for each season were calculated from these.

Survey Response.— I evaluated the questionnaire data using descriptive statistics. Responses for multiple choice questions were entered as numerical values (1 for the first option, 2 for the second, and so on). Means were calculated for questions requiring a numerical answer. Both means and frequencies were calculated for questions regarding the importance of factors relating to bobwhite hunting enjoyment. Frequencies were calculated for multiple-choice questions

Cover Selection.— Selection values required information on available and used cover types. Issues of independence or correlation were present in both bobwhite and hunter data. These correlations were only significant in the theoretical realm of selection. Selection values are the ratio of the probability of use of certain available habitats and the proportion of available habitats. In theory, uncorrelated (independent) relocations, which often define use when calculating selection, would be temporally spaced such that an organism has the ability to reach any of the available cover types. However, in practical and applied uses of selection values, this may not be true and may even be impractical or inappropriate. For instance, in this study hunter use was non-independent because hunters began and ended their hunts at their vehicles, which were parked near roads. This would bias selection for cover types that are near roads. Trying to achieve independence within the hunter data would yield results that had little implication for practical management. However, in the statistical sense, this non-independence may result in a greater Type I error due to a reduced estimate of variability. Given these conditions, significant findings should be judged not only by *P*-values but by logic. Because I was interested only in comparing use by bobwhites and hunters on the Packsaddle area, the Packsaddle boundary defined the area of availability; the cover type map provided a census of cover types on the area. The telemetry locations and recorded GPS tracks determined use of cover types. I pooled bobwhite relocations across the hunting season (Oct–Feb) for each year's telemetry data and the combined relocations of all 10 years were used to define use for the population. The selection ratio for bobwhites was calculated using the proportion of use to availability $w_i = o_i/\pi_i$, where π_i is the proportion of available i^{th} habitat within a defined boundary, o_i is the proportion of use,

and w_i is the selection value for the i^{th} habitat (Savage 1931, Manly et al. 1993). Values of $w_i = 1$ indicate the habitat use is equal to that expected under random use, while values >1 and <1 indicate higher or lower use than expected by random use, respectively.

I defined proportional cover use for hunters as the ratio of segment length within a cover type to total length of the hunt instead of using point data. By using the segment length within a habitat type instead of time or velocity, the effects of pauses or breaks within a habitat type were reduced. To determine a selection value for cover types within the population of hunters I used selection values estimated from the sample of hunters. The mean values from this group of estimates were used as the selection value for the hunter population. Confidence intervals were computed as with any population sample.

Cover types were considered selected by hunters when the selection ratio was >1 and the lower 95% confidence interval for the selection ratio did not contain 1. Cover types were considered selected by bobwhites when the lower 95% confidence limit of the proportion of use within a cover type was greater than the available proportion of that cover type. The Pearson product moment correlation coefficient, *r*, was computed to compare hunter and bobwhite selection values. I also graphically compared selection values by plotting bobwhite selection values against hunter selection values.

RESULTS

Hunter Movement

Data for 28 separate hunts were obtained in the 2004 season, while the 2005 season produced data for 42 hunts. The hunter tracks from 2004 provided 55,262 useable 7-second periods, while the 2005 season yielded 65,219 periods. The average velocity of hunters in 2004 was 0.73 m/sec (SE = 0.07) while hunters moved an average of 5.09 m

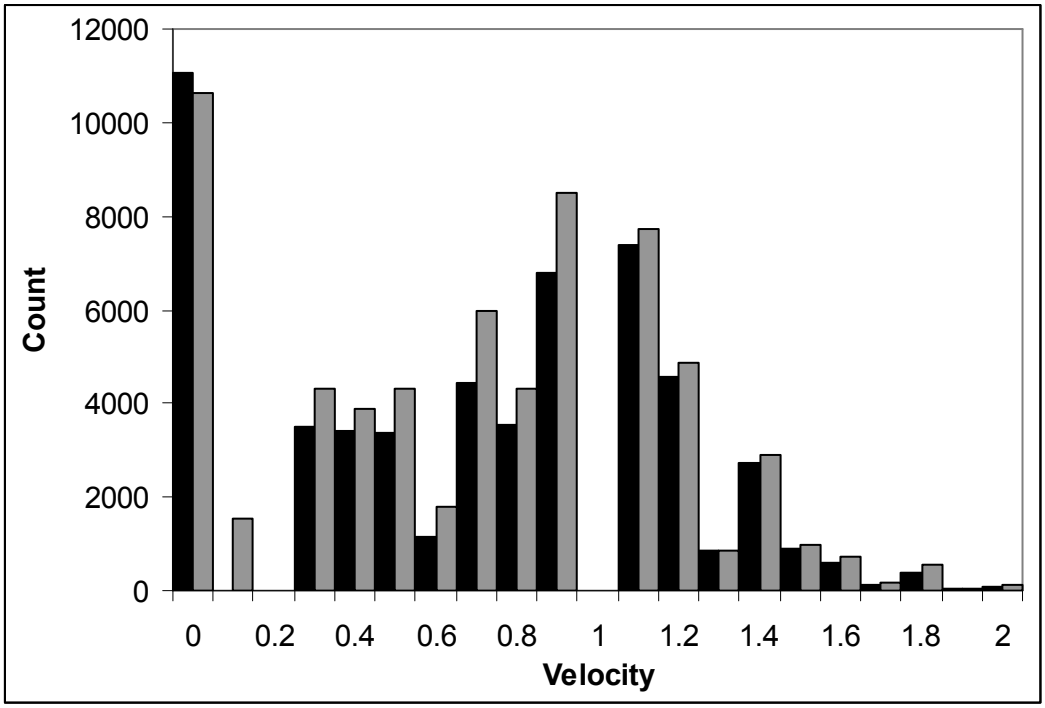
(SE = 0.14) per 7-second period. In 2005 the average velocity of hunting parties was 0.77 m/sec (SE = 0.17) with an average distance of 5.37 m (SE = 0.33) traveled per 7-second period (Figure 2). Average route length was 6,290.0 m (SE = 849.4) for 2004 and 6,686.6m (SE = 744.2) for 2005.

Survey Response

The bobwhite hunter survey showed several interesting tendencies. Of the 31 respondents in 2004, 30 (97%) were male and 1 (3%) was female, with 58% reporting income ≥ $60,000. The average hunter hunted 21.2 (SE = 2.53) days a year and had had 25.7 (SE = 2.49) years of bobwhite hunting experience (n = 31). Besides bobwhite hunting, hunters spent an average of 42.3 (SE = 11.72, n =31) days in the field participating in other activities. The ages of hunters in the survey ranged from 19 to 73 years with an average of 46.6 years (SE = 2.25). The average lowest bag limit at which respondents would still hunt was 6.1 (SE = 0.44, range = 1–10, n = 31).

The 2 factors most influential on the area hunted were the type of vegetation (43.3%, SE = 9.05) and previous success in the same area (33.3%, SE = 8.61). The preferred months of hunting were November and December (30.0%, SE = 8.37 and 46.7%, SE = 9.11, respectively). If bag limits were raised to 13 or lowered to 7, most respondents would hunt the same amount (93.6%, SE = 4.41 if raised and 83.9%, SE = 6.61 if lowered). A 4-month season was preferred by 58.1% (SE = 8.86) of hunters. Respondents were slightly in favor of regulations that were the same statewide (61.3%

Figure 2. Distribution of bobwhite hunting parties' velocity (m/sec) measured through the 2004 (black) and 2005 (grey) seasons at Packsaddle Wildlife Management Area, Ellis County, Oklahoma.



SE = 8.75) and overwhelmingly in favor of regulations that remained constant from year to year (89.3%, SE = 5.84).

Results from 2005 departed slightly from 2004. All respondents (n = 25) were male, with 38.1% reporting income of ≥$60,000 and 33.3% reporting income of $40,000–$59,999 (n = 21). Respondents reported spending fewer days bobwhite hunting (19.9, SE = 3.05) and had fewer years of experience (24.1, SE = 2.92). However, hunters in 2005 reported spending more days in the field not bobwhite hunting (65.5, SE = 17.7, n = 25). Average age of hunters remained nearly constant at 46.4 and ranged from 14 to 73 (SE = 2.67). The lowest acceptable bag limit for respondents in 2005 was 5.0 (SE = 0.72, range = 0–10, n = 24).

Previous success in the same area was the greatest factor influencing the choice of hunting area (65.2%, SE = 9.93) for hunters in 2005. November (41.7%, SE = 10.06) and

December (33.3%, SE = 9.62) remained the preferred months of hunting. Most hunters claimed they would hunt the same amount regardless of a rise or drop of 3 birds in the bag limit (96.0%, SE = 3.52 and 84.0%, SE = 6.58 SE, respectively). Preference for season length was similar to 2004, with 3-, and 4-month seasons being nearly equally favored (44.0%, SE = 9.93 and 36.0%, SE = 9.60 respectively). Most respondents in 2005 were in favor of regulations that remained the same from year to year (64.0%, SE = 9.60) and across the state (76.0%, SE = 8.54). Most hunters rated the social aspects of hunting higher than the harvest aspects less important (Tables 2 and 3 and Figure 3).

Cover Selection

Hunters.— Four cover types were selected by hunters (Table 4). Seventeen cover types were used at random. The selection values for 11 of these cover types by hunters were >1; however, the lower confidence interval was <1, while 6 cover types had selection values <1 with upper confidence intervals >1. Eleven cover types were avoided, with confidence intervals that did not include 1. Hunters selected all sand sagebrush and little bluestem cover types <1,500 m from roads, with level sand sagebrush and little bluestem <500 m from roads having the highest selection value (Table 4). Level shinnery oak and little bluestem close to roads was used by 48.6% (SE = 5.97) of hunting parties, while 14 other cover types were used by >25% of hunting parties. Comparison of proportional use of cover types by hunters between the 2 years showed a significant correlation ($r = 0.702$, $P = 0.0002$, $n = 32$).

Bobwhites.— The chi-square statistic testing the random selection of cover types by bobwhites was highly significant with a value of 39,996.47 and 49 df, indicating selective use or avoidance of >1 cover type. I expected this outcome based on the large sample

Table 1. Importance of several elements of bobwhite hunting on Packsaddle Wildlife Management Area, Ellis County, Oklahoma, to hunters during the 2004 (n = 31) and 2005 bobwhite seasons (n = 25).

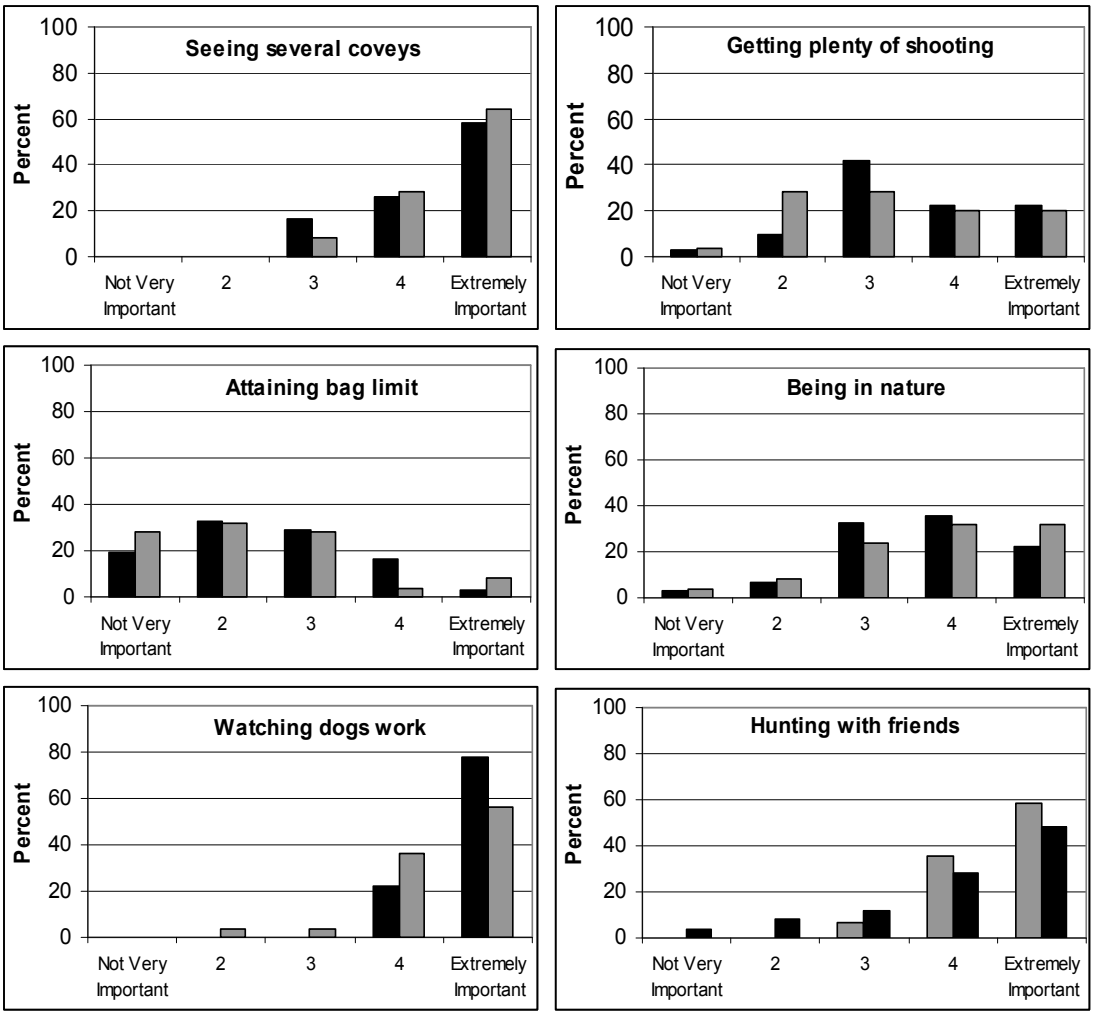
Year	Aspect	$\bar{x}$	SE	Min	Max
2004	Seeing several coveys	4.4	0.14	3	5
	Plenty of shooting	3.5	0.19	1	5
	Attaining bag limit	2.5	0.20	1	5
	Being in nature	3.7	0.18	1	5
	Watching dogs work	4.8	0.08	4	5
	Being with friends	4.5	0.11	3	5
2005	Seeing several coveys	4.6	0.13	3	5
	Plenty of shooting	3.2	0.24	1	5
	Attaining bag limit	2.3	0.24	1	5
	Being in nature	3.8	0.22	1	5
	Watching dogs work	4.4	0.15	2	5
	Being with friends	4.1	0.23	1	5

Table 2. Percentage of respondents that imposed personal restrictions on themselves while bobwhite hunting at Packsaddle Wildlife Management Area, Ellis County, Oklahoma, during the 2004 (n = 24) and 2005 bobwhite season (n = 21).

Year	Personal limitations while bobwhite hunting	Yes	No	SE
2004	Shoot only at coveys, not singles	15.6	84.4	8.29
	Do not shoot at small coveys	56.3	43.8	9.88
	Limit shots taken at coveys	53.1	46.9	10.06
	Lower personal bag limit	9.4	90.6	4.08
	Other	43.8	56.3	4.08
2005	Shoot only at coveys, not singles	13.6	86.4	7.32
	Do not shoot at small coveys	31.8	68.2	9.93
	Limit shots taken at coveys	50.0	50.0	10.66
	Lower personal bag limit	9.1	90.9	6.13
	Other	22.7	77.3	8.93

size (n = 30,021). Lower confidence intervals of the proportion of use for level and steep sand sagebrush and little bluestem <1,500 m from roads and steep shinnery oak and little bluestem 500–<1,500 m from roads were greater than the proportion of those cover types available, indicating selection of these cover types (Table 4). The selection values of level disturbed areas <500 m from roads and level shinnery oak and little bluestem <500 m from roads had confidence intervals that contained the value of the available proportion of those cover types, indicating random use of these cover types. Twenty-five other cover types were avoided, with upper confidence intervals less than the available

Figure 3. Distribution of the importance of several factors of bobwhite hunting from responses by hunters at Packsaddle Wildlife Management Area, Ellis County, Oklahoma, during the 2004 (black, *n* = 31) and 2005 bobwhite seasons (grey, *n* = 25).



proportions of those cover types. The highest selection occurred for level sand sagebrush and little bluestem <500 m from roads, followed closely by level sand sagebrush and little bluestem 500–<1,500 m from roads and steep sand sagebrush and little bluestem 500–<1,500 m from roads.

Correlation analysis revealed a weak linear relationship between bobwhite and hunter selection values ($r = 0.44$, $P = 0.01$, $n = 32$) (Figures 4 and 5). Sixteen cover types were avoided and 4 cover types were selected by both quail and hunters. Eleven other

Table 3. Bobwhite (n = 30,021) and hunter (n = 70) proportions of use (o_i) and selection values (w_i) for corresponding cover types within Packsaddle Wildlife Management Area, Ellis County, Oklahoma, during the 2004 and 2005 bobwhite seasons.

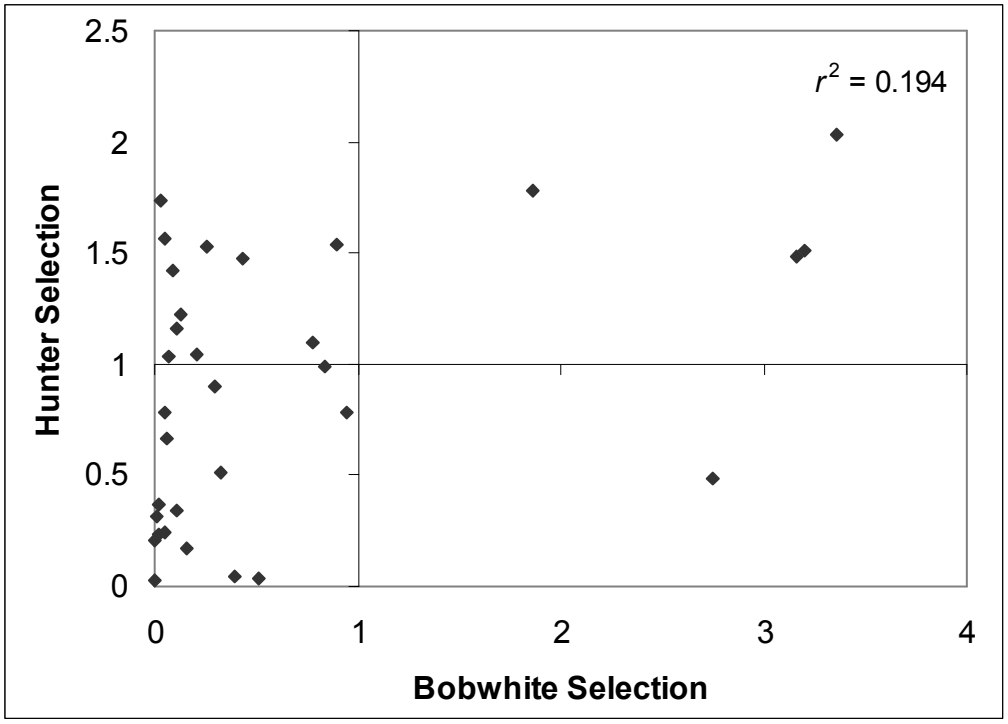
Slope and distance		Bobwhites				Hunters			
Hoagland classification	π_i[a]	o_i	w_i	SE	Use[b]	o_i	w_i	SE	Use
Level[c], <500 m[d]									
Agriculture and oil field	0.0138	0.012	0.90	0.046	-	0.021	1.54	0.441	o
Little bluestem and switchgrass	0.0481	0.004	0.07	0.007	-	0.050	1.04	0.317	o
Shinnery oak and little bluestem	0.0926	0.072	0.77	0.016	-	0.101	1.10	0.230	o
Sand sagebrush and little bluestem	0.0338	0.114	3.36	0.054	+	0.069	2.04	0.356	+
Rare vegetation	0.0191	0.001	0.06	0.010	-	0.013	0.66	0.191	o
Level, 500-<1,500 m									
Agriculture and oil field	0.0183	0.003	0.15	0.017	-	0.003	0.17	0.087	-
Little bluestem and switchgrass	0.0201	0.000	0.02	0.005	-	0.007	0.37	0.207	-
Sideoats grama prairie	0.0208	0.002	0.09	0.012	-	0.030	1.42	0.287	o
Shinnery oak and little bluestem	0.0641	0.061	0.95	0.022	-	0.050	0.79	0.238	o
Sand sagebrush and little bluestem	0.0404	0.129	3.20	0.048	+	0.061	1.51	0.229	+
Wetland	0.0215	0.000	0.01	0.004	-	0.007	0.31	0.226	-
Rare vegetation	0.0025	0.001	0.25	0.058	-	0.004	1.53	0.713	o

Level, 1,500-<2,500 m									
Sideoats grama prairie	0.0127	0.003	0.21	0.023	-	0.013	1.04	0.351	o
Shinnery oak and little bluestem	0.0138	0.007	0.52	0.035	-	0.001	0.04	0.037	-
Wetland	0.0415	0.002	0.05	0.006	-	0.010	0.24	0.113	-
Rare vegetation	0.0040	0.000	0.11	0.030	-	0.005	1.16	0.446	o
Level, ≥2,500 m									
Wetland	0.0117	0.000	0.02	0.007	-	0.003	0.23	0.162	-
Rare vegetation	0.0019	0.000	0.10	0.043	-	0.001	0.35	0.334	o
Steep[c], <500 m									
Little bluestem and switchgrass	0.0115	0.000	0.03	0.009	-	0.020	1.74	0.855	o
Sideoats grama prairie	0.0198	0.001	0.05	0.009	-	0.031	1.56	0.423	o
Shinnery oak and little bluestem	0.0300	0.025	0.83	0.030	-	0.030	0.99	0.247	o
Sand sagebrush and little bluestem	0.0414	0.077	1.87	0.037	+	0.074	1.78	0.338	+
Rare vegetation	0.0079	0.003	0.32	0.037	-	0.004	0.52	0.180	-
Steep, 500-<1,500 m									
Sideoats grama prairie	0.1175	0.015	0.13	0.006	-	0.144	1.22	0.228	o
Shinnery oak and little bluestem	0.0649	0.178	2.74	0.034	+	0.031	0.48	0.154	-
Sand sagebrush and little bluestem	0.0797	0.252	3.16	0.031	+	0.119	1.49	0.246	+

Rare vegetation	0.0195	0.001	0.05	0.009	-	0.015	0.78	0.237	o
Steep, 1,500-<2,500 m									
Sideoats grama prairie	0.0645	0.019	0.29	0.012	-	0.058	0.90	0.221	o
Shinnery oak and little bluestem	0.0260	0.010	0.39	0.022	-	0.001	0.04	0.034	-
Rare vegetation	0.0166	0.007	0.44	0.029	-	0.024	1.47	0.411	o
Steep, ≥2,500 m									
Sideoats grama prairie	0.0139	0.000	0.00	0.000	-	0.000	0.02	0.023	-
Rare vegetation	0.0061	0.000	0.00	0.000	-	0.001	0.20	0.142	-

[a]Available proportion of cover types.
[b]"-" indicates avoidance, "o" indicates random use, and "+" indicates selective use.
[c]Level indicates ≤3% slope.
[d]Distance measured to nearest road.
[e]Steep indicates >3% slope.

Figure 4. Relationship between hunter and bobwhite selection values (n = 32) at Packsaddle Wildlife Management Area, Ellis County, Oklahoma, during the 2004 and 2005 bobwhite seasons. Points indicate hunter and bobwhite selection values for each cover type.



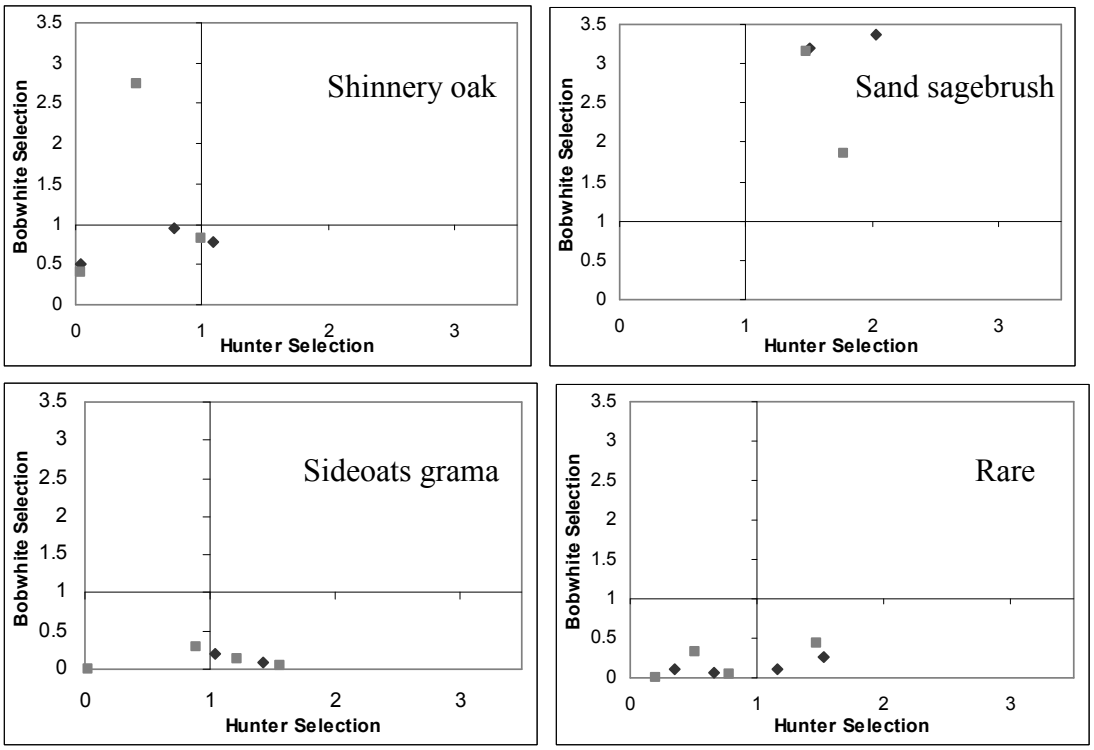
cover types were avoided by quail but had average hunter selection values >1. However, lower confidence intervals for hunter selection values in these cover types were <1, indicating random use of these cover types by hunters. One cover type, steep shinnery oak and little bluestem 500-<1,500 m from roads, was selected by quail but avoided by hunters.

DISCUSSION

Hunter Movement

From this study, it appears that the average rate of hunter movement is especially consistent, differing only 4 cm/sec between the 2 years of this study. The average length of hunting routes was also reasonably constant, with considerable overlap of confidence intervals between the 2 years. By combining this value with an estimate for effective width one could derive a reasonable value for area effectively covered during a hunt. To

Figure 5. Comparison of hunter and bobwhite selection values (n = 32) within shinnery oak, sand sagebrush, sideoats grama, and rare cover types at Packsaddle Wildlife Management Area, Ellis County, Oklahoma, during the 2004 and 2005 bobwhite season. (diamonds = ≤3%, squares = slope >3%)



effectively implement a model such as the HCI, more information on the effective width covered by hunting parties using their particular method of hunting would be needed to better determine the area covered by hunting groups.

Survey Response

Bobwhite hunting on the Packsaddle Wildlife Management Area appears to be a male-dominated sport, with mostly middle-aged, affluent participants. Hunters only used approximately 20 days of a nearly 3-month season, or roughly 22% of the available time. Crews and DeMaso (2000) found a similar distribution with regards to demographics, but hunters questioned in their study spent fewer days (13–14 days less) bobwhite hunting. Previous success in the same area appears to be a primary motive for choosing hunting

areas. Although this result is not astonishing (Frey et al. 2003, Hardin et al. 2005), it is likely that each individual measures their success differently.

Even though most respondents preferred regulations that remained relatively constant throughout time and across the state, it is likely that managers could make occasional alterations to hunting regulations without decreasing hunter enjoyment or participation. Although most respondents were amenable to a reduction in season length, down to 2 months, I would suggest the months of November and December should remain a part of the season as these months were favored by most hunters. Also while most hunters rated attaining a bag limit of low to moderate importance, the average lowest acceptable bag limit was only approximately half (5 – 6 birds) of the current bag limit. The most important factors for those surveyed were seeing several coveys, being in nature, hunting with friends, and watching the dogs work. Similar responses were found by Hayeslette et al. (2001) and Frey et al. (2003), where hunters' satisfaction appeared to be influenced greatest by things other than bag limits or shooting. This would indicate that managers may be able to increase hunter satisfaction by changing the focus of their management from increasing harvest rates to improving the overall hunting experience.

Cover Selection

Hunters.— As might be expected with human data, variance within the hunter sample was large within most cover types. As seen by looking at the selection index values (Table 4), level sand sagebrush and little bluestem <500 m from roads was the most preferred with 3 other sand sagebrush and little bluestem cover types showing selection as well. Level shinnery oak and little bluestem <1,500 m from roads, steep shinnery oak and little bluestem <500 m from roads, and level sand sagebrush and little

bluestem <500 m from roads had average selection values >1 and were used by nearly 50% of hunting parties. This would seem to indicate that these cover types also provided some desirable attribute to attract bobwhite hunting parties.

Bobwhites.— The significant chi-squared value indicates that selection was occurring for ≥1 of the cover types. This result was expected due to the large sample size (n = 30,021). When looking at the selected cover types from bobwhite data, only 2 vegetation types were preferred, the shinnery oak and little bluestem cover type and the sand sagebrush and little bluestem cover type. Five vegetation types were avoided across all distance and slope categories, the cottonwood forest cover type little bluestem and switchgrass cover type, the old world bluestem cover type, the sideoats grama cover type, and wetland areas. This is in keeping with other studies of habitat selection by bobwhites (Guthery et al. 2005*b*, Guthery et al. 2005*c*, Hiller et al. 2007). It should be noted that cover types avoided or neutrally used by bobwhites are not necessarily unimportant. Some of these avoided or neutrally used cover types may provide valuable resources to bobwhites (Hiller et al. 2007).

Correlation of Selection Values

If cover selection between bobwhites and hunters was perfectly matched, one would expect to find a perfectly linear relationship when plotting hunter selection values against bobwhite selection values. However, this was not the case (Figure 5). Although the Pearson's r value was significant, the correlation was very weak, signifying that hunters are not accurately choosing hunting areas that are selected by quail. Eleven cover types had hunter selection values >1 and bobwhite selection values <1. The four cover types with hunter selection values >1 were also selected by quail and the 5 cover types

selected by quail were used by 30–48% of hunting parties. This would indicate that hunters are not actually selecting the wrong cover types to hunt in, but they are selecting extra cover types that quail are avoiding. This inconsistency would likely have a considerable effect on the probability of the average hunting party encountering and flushing bobwhites during a hunt. However, because both years of this study occurred during periods of relatively high bobwhite densities, the average skill of the hunters sampled could have been correspondingly lower. Guthery et al. (2005*a*) found that, while hunter abundance did decline with declining bobwhite populations, the efficiency of hunters seemed to increase as bobwhite populations declined. This led to the deduction that the hunter during bobwhite population lows were "more dedicated and experienced and perhaps hunts in better habitat." (Guthery et al. 2005*a*:1101). Further study on cover selection by hunters during low bobwhite populations is needed to determine the validity of this assumption.

Caveats

This study was conducted with no replicates and hunting parties were not randomly selected, and as such the results obtained may be unique to the Packsaddle area. However, my results may provide reliable estimates and show general trends that are robust enough to hold with similar hunting parties in the Southern Great Plains.

The selection values calculated in this study provided an average value for multiple years of data collection. In essence 10 seasons of data were collapsed into a single point value. While this can produce biased estimates of selection values (Schooly 1994) that would interfere with specific habitat studies, I felt that this would not interfere with the objective of my study. By pooling relocations across 10 years, I could capture

the full extent of bobwhite habitat selection while still retaining good estimates for selection values. In a similar fashion, hunter data were pooled across the 2 years of collection. However, both years were reported by the Oklahoma Department of Wildlife Conservation as above average years for bobwhite production and recruitment. Movement behavior of hunters and proportional use of habitats were also similar between the 2 years. For these reasons I believe that my choice to pool my hunter data was affirmed.

MANAGEMENT IMPLICATIONS

Frequently managers cannot manage specifically for the benefit of wildlife species; they must also consider the human users of an area. On public hunting areas, the desires of hunters are of great importance to the areas' managers. While many aspects of hunting excursions are outside the realm of wildlife managers, one important factor, the sighting of several coveys, tenders itself to management in several ways. While managers cannot conjure quail to fill the whim of hunters, they can provide habitats that are favorable to quail survival. These habitats vary throughout the bobwhite's range and have been studied by others previously. Another method to increase hunter-bobwhite encounters is to further educate hunters about quail-preferred habitats. When hunting parties choose habitats that quail avoid, or avoid habitats quail prefer they are likely reducing their probability of encountering bobwhites, and thus reducing their overall satisfaction with a hunt on an area. Also, the typical walking hunting party moves at an average rate of .73 to .77 m/sec and travels 6.2 to 6.8 km. This would indicate that managed areas containing regions >3 km from a vehicular access point are not fully

useable by the average "on foot" hunting party. Managers would need to open new roads granting access to these areas in order to increase hunter-quail encounters.

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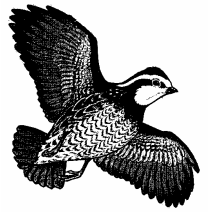
Appendix A.



Oklahoma State University

Quail Hunter Survey

Your answers to the following questions will help improve quail management in Oklahoma.

1. Approximately how many **days** each year do you hunt bobwhite quail? _____ day

2. Approximately how many **years** have you hunted bobwhite quail? _____ years

3. Approximately how many days do you spend in the field **not** hunting quail each year?

   (For example, scouting, hunting other seasons, camping, hiking, etc.) _____ days

4. What **most** influences your choice of hunting locations when quail hunting? **Choose one.**

☐ Type of vegetation
☐ Recommendation by others
☐ Previous success in same location
☐ Other: _____

5. Which month do you **most** enjoy quail hunting in Oklahoma? **Choose one.**

☐ November
☐ December
☐ January
☐ February

   5a. Approximately what percentage of your quail hunting occurs during that month? _____%

The next questions concern daily bag limits for quail and season length preferences. Currently, Oklahoma's limit for quail is 10 birds per day and the season spans three months.

6. If the daily bag limit for quail was lowered from 10 to 7 birds per day, would you:

☐ Hunt more often
☐ Hunt the same amount
☐ Hunt less often
☐ Quit quail hunting

7. If the daily bag limit for quail was increased from 10 to 13 birds per day, would you:

☐ Hunt more often
☐ Hunt the same amount
☐ Hunt less often
☐ Quit quail hunting

8. What is the lowest daily bag limit at which you would still hunt quail? _____ quail per day

9. What is the highest daily bag limit at which you would still hunt quail? _____ quail per day

10. If the quail season length were changed, which of the following would you prefer?
☐ 1-month season
☐ 2-month season
☐ 3-month season
☐ 4-month season

11. Which type of quail hunting regulations do you prefer:
☐ Regulations that are the **same statewide**
☐ Regulations that **vary by region** according to local quail abundance

12. Which type of quail hunting regulations do you prefer:
☐ Regulations that remain the **same from year to year**
☐ Regulations that **vary from year to year** according to quail abundance

13. How important are the following factors in your quail hunting experience? (Circle one)

	Not at all Important				**Extremely Important**
Seeing several coveys in an outing:	1	2	3	4	5
Getting plenty of shooting:	1	2	3	4	5
Attaining a bag limit:	1	2	3	4	5
Just being out in nature:	1	2	3	4	5
Watching the dogs work:	1	2	3	4	5
Going into the field with friends:	1	2	3	4	5

14. Do you impose any of the following self-limiting regulations on yourself?
Check all that apply:
☐ I only shoot when I flush a covey, not when one or two birds fly
☐ I don't shoot when coveys are small
☐ I limit the number of shots taken at a covey
☐ I set a personal daily bag limit lower than the legal limit of 10
☐ Other: _____

15. Gender: ☐ Female ☐ Male

16. State and county of residence: _____ (County), _____ (State)

17. Age: _____ years

18. What was your annual household income, before taxes, in 2003?
☐ <$25,000
☐ $25,000-39,999
☐ $40,000-59,999
☐ ≥$60,000

Thank you for your cooperation!
Please return your completed survey to the Packsaddle WMA Headquarters

Appendix B

Oklahoma State University Institutional Review Board

Date:	Monday, October 11, 2004
IRB Application No	AS0523
Proposal Title:	Comparison of Cover Selection by Bobwhite Quail and Quail Hunters in Western Oklahoma
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 10/10/2005

Principal Investigator(s

Joshua Lee Richardson
2425 W. Lakeview #27
Stillwater, OK 74075

Fred S. Guthery
303F Ag Hall
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

[X] The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact me in 415 Whitehurst (phone: 405-744-1676, colson@okstate.edu).

Sincerely,

Carol Olson

Carol Olson, Chair
Institutional Review Board

VITA

Joshua Lee Richardson

Candidate for the Degree of

Master of Science

Thesis: COMPARISON OF COVER SELECTION BY NORTHERN BOBWHITES AND HUNTERS IN WESTERN OKLAHOMA

Major Field: Wildlife and Fisheries Ecology

Biographical:

Education: Graduated from Corn Bible Academy High School, Corn, Oklahoma in May, 2000; received Bachelor of Science degree in Environmental Studies from Southern Nazarene University, Bethany, Oklahoma in May 2004. Completed the requirements for the Master of Science degree with a major in Wildlife and Fisheries Ecology at Oklahoma State University, Stillwater, Oklahoma in December 2006.

Experience: Raised on a farm in Sheridan Lake, Colorado and employed as a farm laborer; employed as a biologist intern with the Oklahoma Department of Wildlife; employed by Southern Nazarene University, Department of Biology as an undergraduate lab assistant; employed by Oklahoma State University, Department of Agriculture Science and Natural Resources as a graduate research assistant.

Professional Memberships: Student Chapter of The Wildlife Society