SPOTLIGHTING DEER FOR DETERMINATION OF POPULATION TRENDS IN OKLAHOMA

By

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PREFACE

The objective of this study was to evaluate roadside counts of white-tailed deer at night with the aid of spotlights for the determination of populations trends and sex and age ratios in Oklahoma. The study was conducted with the goal of making recommendations to the Oklahoma Department of Wildlife Conservation concerning the feasibility of using the spotlight technique and the application of the technique in the field. The thesis is in the format and style of the Journal of Wildlife Management.

Funds for the study were provided by Federal Aid to Wildlife Restoration, Pittman-Robertson Project W-130-R, Oklahoma Department of Wildlife Conservation, U. S. Fish and Wildlife Service, and Oklahoma State University, cooperating.

I thank my adviser, Dr. Paul A. Vohs, for his assistance and support throughout the study and preparation of the thesis. I also thank Dr. John A. Bissonette, Dr. Fritz L. Knopf, Dr. Thomas A. Gavin, and Dr. William A. Warde for serving on my graduate committee at various times. Dr. Warde provided many long hours of computer programming and statistical advice. J. Hammond Eve, formerly of the Oklahoma Department of Wildlife Conservation, aided in the initiation of the project. The assistance and cooperation of game rangers and area managers of the Oklahoma Department of Wildlife Conservation and the tolerance of people residing near the spotlight routes were appreciated.

Many OSU students participated in field work. I particularly

thank Mike Ahrnsbrak, Jim Brinton, Dan Biby, Rick Deffenbaugh, Dave Gordon, Ray Hedrick, and Dale Rollins. Rick Nummy provided invaluable assistance during the most difficult part of the study.

I express my deepest appreciation to my wife, Laem, for her support and for putting up with my irregular hours during this study.

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Abstract: Counting white-tailed deer (Odocoileus virginianus) illuminated by spotlights at night for the determination of population trends and sex and age ratios was evaluated in the Cross Timbers and Oak-Hickory habitat types in Oklahoma from December 1977 through August 1979. Significantly more observations of deer were made in the Oak-Hickory (502 total observations in 1,526 miles) than in the Cross Timbers (212 in 1,905 miles) habitat type. Weather factors, traffic, and moonlit nights did not measurably affect numbers of deer observed. The sum of all observations of deer on 4 30-mile routes in locations selected for the probability of observing deer in each habitat type during spring or late summer may approach a level of precision adequate for the determination of population trends. Late summer appeared optimum to obtain information on sex and age structure. Counting deer with aid of spotlights was superior to Hahn transect and deer drive counts conducted in the same areas.

Key Words: Odocoileus virginianus, Oklahoma, population trends, sex and age ratios, spotlight counts, white-tailed deer

[1]Contribution of the Oklahoma Cooperative Wildlife Research Unit, Oklahoma State University, Oklahoma Department of Wildlife Conservation, U. S. Fish and Wildlife Service, and Wildlife Management Institute, cooperating. Funded by Pittman-Robertson Project W-130-R, Oklahoma Department of Wildlife Conservation, U. S. Fish and Wildlife Service, and Oklahoma State University.

Information on population trends and sex and age ratios is basic to assessing management strategies. My purpose was to evaluate counting deer at night with the aid of spotlights as a technique for determining population trends and sex and age ratios for white-tailed deer in the Cross Timbers and Oak-Hickory habitat types of Oklahoma. The technique has been used or tested for determining population trends for deer in Texas (Cook 1973; Barron 1977, Unpubl. manuscript, Texas Parks and Wildl. Dept.), South Dakota (Progulske and Duerre 1964, Kranz 1974), Alberta and Saskatchewan (Gunson 1979), North Dakota (Johnson 1977), Iowa (Rybarczyk 1978), and Oregon (Dealy 1966). Advantages include simplicity in obtaining data, applications over a wide area, and minimum disturbance of the deer (Dealy 1966). Variability and low reliability are disadvantages in areas of low population density, mountainous terrain, dense foliage, or high human populations.

Varied effectiveness of the technique necessitated evaluation of spotlight counts in habitat types available in Oklahoma. The Cross Timbers (CT) and Oak-Hickory (OH) types were selected. The CT is the most extensive habitat type for deer in Oklahoma. The OH type in the northeast was representative of rough terrain and forest vegetation. The technique was tested by repeatedly surveying 4 routes in each habitat type and comparing results with data obtained using Hahn transects (Hahn 1949) and deer drives in related areas.

I thank P. A. Vohs, J. A. Bissonette, F. L. Knopf, T. A. Gavin, and W. D. Warde for their assistance. J. H. Eve, Oklahoma Department of Wildlife Conservation (ODWC), aided in initiation of the project. Many Oklahoma State University students participated in the field work, particularly M. Ahrnsbrak, J. Brinton, D. Biby, R. Deffenbaugh, D.

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METHODS AND MATERIALS

Study Areas

Location of the CT and OH habitat types was defined by Duck and Fletcher (1943). Vegetation was described by Bruner (1931), Rice and Penfound (1959), Dwyer and Santelman (1964), and Risser and Rice (1971).

The CT is predominantly post oak (Quercus stellata) - blackjack oak (Q. marilandica) forest of eastcentral Oklahoma and northcentral Texas (Dyksterhuis 1948) and lies within the Central Redbed Plains and Eastern Sandstone Cuesta Plains physiographic regions (Curtis and Ham 1957). Rainfall ranges from 75 to 100 cm per year. The area is characterized by rolling terrain ranging from 200 to 335 m in elevation. Post oak-blackjack oak forests occur on upland sites; low lying areas are covered by more mesic forest. Natural and cleared openings are devoted largely to agricultural uses, including wheat, peanuts, feed crops, and livestock grazing. Petroleum and natural gas operations are common locally.

The OH habitat type occurs primarily in the Boston Mountains and Ozark Plateau regions in northeastern Oklahoma. Rainfall ranges from 100 to 115 cm per year. Elevations range from 200 to 500 m, and terrain is rugged and hilly. Plateaus occur in the northern and westcentral portions of the study area. Much of the region contains oak-hickory forest. Extensive cleared areas are used for hay and livestock.

Greater densities of deer and larger annual harvest occur in the

OH habitat type. The 1978 deer harvest ranged from 0.24 to 0.33 deer per km^2 and averaged 0.29 per km^2 for the 4 counties in the OH (R. Umber, personal communication). Harvest varied from 0.01 to 0.12 deer per km^2 and averaged 0.08 per km^2 for the 6 counties in the CT.

Spotlight Counts

Four 40-mile spotlight routes were established in each habitat type in locations selected at random from among locations determined to be suitable. Gravelled and lightly-used paved roads that formed a closed or nearly closed configuration were identified using county road maps. The closed configuration was desired to enclose locations of drives and Hahn transects. Residents in the vicinity of each spotlight route were informed of the project either in person or by mail prior to the 1st survey on each route. Routes were surveyed monthly, conditions permitting, from December 1977 through June 1978 for CT routes and February through June 1978 for OH routes.

One OH route was discontinued after June 1978, and 3 CT routes were reduced to 10 miles in length in August and September 1978, then discontinued because no deer were observed. Four new 30-mile replacement routes were located in areas believed to contain at least moderate deer densities and surveyed for the 1st time in October 1978. The 4 remaining original routes were reduced to 30 miles in length by deleting the 10-mile segment with the fewest deer observations and were surveyed monthly from August to October 1978. The 8 final spotlight routes were surveyed March through August (CT) and April through August 1979 (OH).

Spotlight surveys were scheduled to occur within the period 1 week

either side of the new moon. Counting during rain, snow storms, or heavy fog was avoided to reduce variability introduced by possible changes in deer activity and visibility and to avoid impassable roads. Difficulties with weather, roads, equipment, and personnel schedules often prevented the single crew from completing all 8 spotlight surveys as scheduled monthly. Postponed surveys were rescheduled later in the month, but 5 surveys had to be completed during the subsequent month, 1 in a later month, and 5 (4 OH and 1 CT) were never completed. Surveys were not rescheduled if they were more than ½ completed on the original date. Differences in the number of miles completed per survey and the number of surveys per month necessitated the use of the number of observations of deer per mile of spotlighting in evaluating the counts.

Spotlight counts began 1 hour after sunset and were conducted at a speed of 8 to 10 mph from a prominently marked Oklahoma State University pickup truck. Two 4-inch aircraft landing lights mounted in Clorox bottles and powered from the pickup battery served as spotlights. The effective range of the lights for observing deer was 250 m. Spotlights were operated continuously on both sides of the road.

Three or 2-person crews were used. Two observers standing behind the cab were used when 3 persons were available. The driver served as an observer and received assistance from the observer behind the cab in the 2-person crews.

Deer were recorded as bucks, does, fawns, or unknown. Time, mile number, and type of vegetative cover were recorded for each observation. Activity of deer when 1st observed was recorded as standing, running, bedded, or unknown. If 1 or more deer in a group was standing, the entire group was recorded as standing.

Weather conditions during daylight hours prior to spotlighting and the phase of the lunar cycle were noted for each survey. Temperature, relative humidity, wind speed and direction, and cloud cover were recorded at the start of each survey and at the end of each 10-mile segment. Snow cover, precipitation, and the number of vehicles encountered on the road were recorded for each 10-mile segment.

An estimate of the area of visibility adjacent to the road in which deer could be observed during spotlighting was accomplished once for each route during summer. The perpendicular distance from the road bed to the nearest obscuring vegetation on each side of the road or 250 m (whichever was least) was measured at each 0.1 mile along the routes. The mean distance was then extrapolated to provide the estimate of the area of visibility. The percentage of vegetative cover types along 1 OH and 2 CT routes selected for comparison of areas with high and low counts was estimated using aerial photographs and field examination.

Personnel of the ODWC made 2 spotlight counts on 10-mile routes in each of 7 state game management areas during May 1979, and reported the results on forms provided by the project. Five areas were either in the CT or contained post oak-blackjack oak forest, and 2 were in the OH habitat type.

Hahn Transects and Deer Drives

One 2-mile transect was established adjacent to each of the 4 original CT routes and on 2 public hunting areas adjacent to routes in the OH during summer, 1978. The counts were made by walking along a pre-marked line during the last hour of daylight and visually searching for deer. Hahn transect counts were conducted once monthly in June,

August, and September 1978 (CT) and August and September 1978 (OH). Hahn transect counts were conducted adjacent to 1 original and 1 new CT route in 1979. The Hahn transects bisected a 53 ha and a 65 ha area, respectively, where deer drives were conducted. One Hahn transect on the Cherokee Public Hunting Area bisected a 259 ha area where a deer drive was conducted. Deer drives were conducted according to the method described by McCain (1939). Deer drives on the CT areas were held on 17 February 1979 with 31 participants, and the Hahn transects were surveyed monthly in March and May through July 1979. The deer drive in the OH area was held on 7 April 1979 with 28 participants, and the Hahn transects were surveyed monthly from May through July 1979.

RESULTS

Spotlight Surveys

Observations totaled 212 in 1,905 miles and 502 in 1,526 miles for CT and OH spotlight routes, respectively (Table 1). Significantly more deer per mile per survey were observed on OH routes ($t = 4.72$, $P < 0.001$). Few or no deer were counted on 4 of the original routes from December 1977 through June 1978. No deer were observed on 10-mile surveys on 3 of these (Lincoln, Okfuskee, and Seminole) conducted in August and September 1978. Three of 4 replacement routes produced an average of 0.21 observations per mile, compared with 0.02 per mile on the 4 discontinued routes. The replacement route in eastern Lincoln County average 0.03 deer per mile. There was no significant difference in the number of observations of deer per survey for 40-mile routes (11.57 per survey) and 30-mile routes (11.03 per survey) for the 4 routes surveyed throughout the study ($t = 0.21$, $P > 0.5$).

Parts of 3 of the 4 original routes on which deer were consistently observed (Creek, Cherokee, and Delaware) occurred on state game management areas. Deer were stocked previously on these areas and current management emphasizes deer.

Surveys on the 4 routes in each habitat type did not provide an adequate measure of the variability of spotlight counts within a month. Population levels and effects of weather within months could be assumed constant, but 15- to 35-fold differences in magnitude of the counts occurred among the routes. The coefficients of variation calculated for surveys within each month ranged from 61 to 200% and averaged 134% for the CT, and ranged from 31 to 164% and average 93% for the OH habitat types. Coefficients of variation obtained from the 2 spotlight counts on each of the 2 state game management areas during May 1979 ranged from 17 to 141% and averaged 61% (Table 2). A trend toward the association of smaller coefficients of variation with larger numbers of deer seen per count occurred.

The precision of the technique as measured by the coefficient of variation was increased by using the average number of deer observed per mile for all surveys within each habitat type during each month as the sampling unit. The coefficient of variation of this measurement was obtained for each pair of successive months (Table 3). Coefficients of variation ranged from 16 to 107% and averaged 38% for the CT, and ranged from 10 to 50% and averaged 28% for the OH habitat types. Differences in the number of routes surveyed per month contributed to the variability.

The mean number of deer per mile per month was calculated for the 4 original routes surveyed throughout the study if at least 3 of the

routes were surveyed (Table 4). This provided the most consistent comparison of the number of observations among months. The number of observations of deer per mile was highest in May and September 1978 and May and August 1979.

The 1st new fawns were observed during May, but fawns were not observed frequently until August (Table 5). No attempt was made to distinguish fawns of the previous year during winter and spring. Bucks were most commonly observed from July through October.

Crew Size

There was no difference in the deer counts between 8 surveys with 3-person crews (0.20 deer per mile) and 6 surveys with 2-person crews (0.27 deer per mile) on the Creek route ($t = -0.93$, $P > 0.3$).

Traffic

Vehicular traffic encountered during spotlighting did not affect deer counts. Cars and pickup trucks passed the observers on several occasions while deer were "holding" under the spotlight beam. The numbers of deer and the amount of traffic observed per 10-mile segment throughout the study were not correlated for any route and were correlated only during June ($r = 0.47$, $P < 0.01$).

The rankings of spotlight routes in ascending order by the amount of traffic encountered per 10-mile segment and in descending order by the number of deer observed per 10-mile segment were independent (Spearman rank correlation coefficient, $r_s = -0.08$, $P > 0.1$).

Weather

Effect of weather on observations of deer was not definitive. Combined data were grouped by month to avoid seasonal differences. Simple correlation coefficients were calculated for numbers of observations of deer with the nearest observation of temperature, relative humidity, wind speed, and cloud cover for each 5-mile segment of the spotlight surveys. Relative humidity in April and wind speed in May exhibited small but significant negative correlations with observations of deer (Table 6), but, in general, evaluations of the data were inconclusive.

Lunar Phase

Scheduling difficulties forced some surveys to be conducted on bright, moonlit nights, contrary to the recommendations of Progulske and Duerre (1964). Surveys useful for comparison occurred on 13 moonlit nights and 45 dark nights on the Creek, Payne, Delaware, Cherokee, and Adair-Sequoyah routes. There was no difference between the 2 groups in the mean number of observations of deer per mile ($t = 1.23$, $P > 0.2$).

Time of Night

Observations of deer in the CT habitat type were evenly distributed throughout 1-hour intervals since sunset (Table 7), except for the December-February-March and June-July periods, when more deer than expected were observed during the late intervals. More observations of deer than expected occurred during the early intervals in the OH during all but the February-March and August-September-

October periods. Progulske and Duerre (1964) noted 79% of 25,808 observations of deer during night-long spotlight surveys occurred within a 4-hour period beginning 1 hour after sunset. The apparent tendency toward an increase in observations later in the surveys in the CT habitat type may be an artifact of small sample size and/or the inability to completely randomize the opportunity for observations along the routes.

Activity

The activity of deer within the study area during the spotlighting period may have affected their visibility. Deer were recorded as standing during 69% (CT) and 73% (OH) of the initial observations (Table 8). Some deer bedded within range of the spotlights may have been missed during the surveys. Bedded but unobserved deer often stood and became visible during observation of other deer. The mean group size for groups with at least 1 deer standing (2.25 per group) was significantly different from the mean group size for groups with all deer bedded (1.67 per group) in the OH ($\underline{t} = 2.14$, $\underline{P} < 0.05$). No statistically significant difference was seen in the CT (2.45 deer per group standing, 1.68 per group bedded, $\underline{t} = 1.80$, $\underline{P} > 0.05$). There was no difference in the average time since sunset for observations of standing and bedded groups ($\underline{t} = 0.41$, CT; $\underline{t} = 0.32$, OH; $P > 0.5$), and no correlation occurred between group size and time of observation for bedded or standing groups in either habitat ($\underline{P} > 0.1$).

Deer were running in only 2% of the initial observations and only ½ of these disappeared from view. Activities most often encountered initially were standing or bedding. I assume these to indicate that approach of the vehicle did not frighten the deer.

Habitat

Observations of deer on the Creek and Cherokee routes were not distributed among vegetative cover types as would be expected from the frequency of occurrence of the cover types (x^2 = 39.68 and 208.47 for Creek and Cherokee, $P < 0.005$), but were weighted toward the brush type (Table 9). About 90% of observations of deer on the Creek route were in the relatively open grass-hay and brush cover types, but deer on the 2nd ½ of the Cherokee route were observed in forest types in percentages roughly equal to availability of the forest types.

The mean number of observations of deer per mile and the total area of visibility on each route were not correlated ($r = 0.31$, $P > 0.1$). Highest numbers of observations were not associated with routes with the greatest area of visibility or with routes having the least area of visibility.

Hahn Transects and Deer Drives

One deer was observed during 18 Hahn transect counts, and no deer were observed during 2 small-scale deer drives held in the CT area (Table 10). Deer were observed within the area of the drive and Hahn transect on the Payne area during 7 of 8 spotlight counts. Deer were observed during 4 of 14 spotlight counts on the area of the Creek deer drive and Hahn transect, including 11 on 14 March 1979.

A mean of 2.0 observations of deer occurred during 5 counts on the Delaware Hahn transect in 1978 and 1979 (Table 10). Only 1 deer was observed during spotlighting along the road adjacent to the area of the Hahn transect. Visibility was limited by heavy forest cover near the road. A mean of 6.0 observations of deer per night occurred during

spotlighting the 10-mile segment nearest the Hahn transect. A mean of 2.4 deer was observed during the Hahn transect counts on the Cherokee area compared with a mean of 1.7 per night observed while spotlighting the area adjacent to the transect. The count of 18 deer from the Cherokee deer drive was believed to underestimate the density.

DISCUSSION

Spotlighting was the only technique of the 3 employed that consistently produced observations of deer in the CT habitat type. A long route could be covered by 2 people in a night, and eyeshine allowed detection of deer even in heavy cover. A larger number of deer could be observed while spotlighting a long route than could be observed on Hahn transects in the OH area.

Variability inherent in spotlight counts is a function of density of deer and visibility of deer. Bergerud (1968) proposed that the 95% confidence interval for population estimates used in determining biomass and productivity of large herbivores be within 20% of the mean. The limited density and visibility of the deer populations in the CT and OH necessitate acceptance of slightly lower standards of precision if the counts are used to determine changes in population trends from year to year.

Small numbers of observations of deer on many routes, wide differences in observations of deer in counts among routes within each habitat type, and differences in the number of surveys between months increased variability. Combining observations on all surveys made during a month within each habitat type reduced overall variability, but masked variability among individual routes. Lowest coefficients of

variation among routes were associated with highest average counts. More observations of deer were made when routes were purposefully selected to pass through areas where observations were likely, but ability to expand results to the habitat type was lost.

Placement of routes in selected locations did not negate evaluation of trends in population numbers within the areas covered by the routes. The 30-mile routes traversed sufficient terrain to evaluate diversity of the selected areas and to record expansion and contraction of populations related to areas of "high" density. Thirty-mile routes in selected locations allowed the opportunity to count a sufficient sample of deer, to complete the survey within 5 hours after sunset, and to maintain observer efficiency. Shorter routes seemed inappropriate with current density of deer.

May (and possibily April in the CT) and August-September were considered optimum for maximizing counts. Wheat fields apparently attracted deer in the CT in April. Late summer was optimum for counting bucks and fawns, although the differential visibility of sex and age classes at that time of year (Downing et al. 1977) did not allow use of data for determining sex and age ratios.

The effects of weather on deer counts were difficult to identify because of the small numbers of observations of deer and lack of repeated surveys on similar routes under differing weather conditions. However, normal variations in weather had no measurable effect on spotlight counts made during a single month in either habitat type.

CONCLUSIONS AND RECOMMENDATIONS

Spotlight counts were judged better than deer drives or Hahn transects for determining gross population trends of deer in the CT and OH habitat types. Spotlight counts were more precise at the population levels present in the OH habitat type, despite rough terrain and dense vegetation. Repetitions of counts on the same routes within the April-May or August-September periods would be necessary to determine the exact number of 30-mile routes and repetitions necessary for the desired precision in each habitat type. The OH will require fewer routes and repetitions than the CT. None of the techniques appeared useful to estimate the density in either habitat type.

Under densities of deer present in Oklahoma, the initial sampling unit for spotlighting should consist of 4 30-mile routes selected in areas where observations of deer are likely. Changes in land use from year to year along the routes should be monitored. Counts in April (CT) or May (OH) would provide information prior to setting of harvest regulations. Late summer counts appeared optimum to obtain information on sex and age distribution. Determination of population trends requires that established routes be counted during dark lunar phase of the same month from year to year. Repetitive counts on each route during the selected month will provide a better estimator of trend. Surveys should be completed in the desired time despite vagaries of weather. Heavy rain, fog, and unseasonable weather should be avoided, and sufficient crews should be available to accomplish postponed surveys as soon as possible.

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Table 1. Summary of spotlight surveys of deer 10 or more miles in length, December 1977 through August 1979. Routes were named after county in which they were located.

Habitat type and route	No. surveys	Miles surveyed	Obs. of deer	Deer/ mile/ survey	Standard error of mean	CV (%)
Cross Timbers						
Lincoln[a]	8	260	4	0.02	0.01	182
Okfuskee[a]	8	244	9	0.04	0.01	84
Seminole[a]	10	292	0	0	0	-
Creek[b]	14	480	107	0.23	0.04	64
E. Lincoln[c]	7	195	5	0.02	0.01	156
Payne[c]	8	225	61	0.27	0.06	59
Pawnee[c]	8	209	26	0.12	0.04	86
Total	63	1,905	212	0.12	0.02	121
Oak-Hickory						
N. Adair[a]	5	200	4	0.02	0.01	163
Delaware[b]	13	430	139	0.33	0.07	74
Cherokee[b]	12	388	261	0.71	0.10	48
Adair-Sequoyah[b]	11	358	62	0.18	0.04	69
N. Delaware[c]	5	150	36	0.24	0.07	67
Total	46	1,526	502	0.36	0.05	97

[a]Original routes discontinued summer, 1978.

[b]Routes surveyed throughout the study.

[c]New routes added October 1978.

Table 2. Number of deer seen on 10-mile spotlight surveys conducted on state game management areas during the last week of May 1979. Five of the areas were located either in the Cross Timbers (CT) habitat type or contained post oak-black jack oak forest (POBJ).

Habitat type and area	Count 1	Count 2	$\bar{X}$	SD	CV (%)
CT and POBJ					
Canton	20	14	17.0	4.24	25
Keystone	2	0	1.0	1.41	141
Hulah	11	2	6.5	6.36	98
Okmulgee	1	3	2.0	1.41	71
Lexington	3	2	2.5	0.71	28
Oak-Hickory					
Fort Gibson	10	5	7.5	3.54	47
Cookson Hills	49	62	55.5	9.19	17

Table 3. Means and coefficients of variation of the total number of observations of deer per mile during each month in each habitat type for pairs of successive months.

Months	Cross Timbers		Oak-Hickory	
	Mean	CV (%)	Mean	CV (%)
Feb-Mar 78	0.08	107	0.32	50
Mar-Apr 78	0.09	57	0.22	10
Apr-May 78	0.08	24	0.29	27
May-Jun 78	0.08	16	0.30	21
Aug-Sep 78	0.15	63	0.46	21
Sep-Oct 78	0.11	16	0.41	38
Mar-Apr 79	0.18	20		
Apr-May 79	0.15	54	0.43	41
May-Jun 79	0.11	24	0.43	45
Jun-Jul 79	0.16	22	0.27	11
Jul-Aug 79	0.21	17	0.29	20

Table 4. The number of miles and mean number of observations of deer per mile by month with at least 3 surveys for the 4 original routes surveyed throughout the study.

Month	1978		1979	
	No. miles	Deer/ mile	No. miles	Deer/ mile
Mar	188	0.27		
Apr	160	0.28	78	0.32
May	150	0.41	120	0.64
Jun	150	0.31	120	0.28
Jul			90	0.24
Aug	120	0.40	150	0.31
Sep	120	0.43		

Table 5. Buck, doe, fawn, and unknown deer observed by month during spotlight surveys in both habitat types. Figures in parentheses are percentages of monthly totals.

Month	No. surveys	Bucks	Does	Fawns	Unknown	Total
Dec 77	4	0	1 (25)	0	3 (75)	4
Feb 78	6	0	15 (45)	0	18 (55)	33
Mar 78	8	3 (6)	42 (78)	0	9 (16)	54
Apr 78	8	1 (2)	27 (58)	0	19 (40)	47
May 78	8	1 (2)	39 (60)	1 (2)	24 (37)	65
Jun 78	9	4 (8)	29 (56)	1 (2)	18 (35)	52
Aug 78	4	10 (21)	26 (54)	9 (19)	3 (6)	48
Sep 78	4	4 (8)	35 (67)	9 (17)	4 (8)	52
Oct 78	6	10 (29)	13 (38)	4 (12)	7 (21)	34
Mar 79	4	0	19(100)	0	0	19
Apr 79	7	0	14 (30)	0	32 (70)	46
May 79	8	0	50 (55)	1 (1)	40 (44)	91
Jun 79	9	6 (12)	35 (67)	1 (2)	10 (19)	52
Jul 79	7	8 (19)	24 (57)	3 (7)	7 (17)	42
Aug 79	9	14 (18)	39 (52)	11 (15)	11 (15)	75
Total	101	61 (9)	408 (57)	40 (6)	205 (29)	714

Table 6. Simple correlation coefficients for deer counts with temperature, relative humidity, wind speed, and cloud cover recorded for each 5 miles surveyed during both years and with both habitat types combined.

Month	Temperature	Relative humidity	Wind speed	Cloud cover
Feb	0.104	0.204	-0.184	0.158
Mar	-0.163	-0.060	-0.017	0.087
Apr	0.075	-0.197[a]	0.060	0.031
May	-0.102	0.093	-0.223[a]	-0.113
Jun	0.185	-0.095	0.059	0.146
Jul	0.213	-0.009	-0.102	0.108
Aug	0.063	-0.191	0.167	0.133
Sep	0.339	-0.025	0.219	-0.029
Oct	0.107	-0.087	0.213	0.011

[a] $P < 0.05$

Table 7. Number of observations of deer in 1-hour intervals since sunset with the number of observations expected based on the percentage of survey time spent within each interval in parentheses, for selected survey periods, both years combined. Discrepancies in totals of expected observations result from rounding off.

Survey period	Hours since sunset					Chi-square
	1 - 2	2 - 3	3 - 4	4 - 5	5+	
Cross Timbers						
Dec-Feb-Mar	10 (9)	2 (10)	1 (10)	15 (8)	14 (5)	32.54[a]
Apr-May	16 (13)	16 (13)	16 (13)	5 (11)	0 (3)	7.60
Jun-Jul	7 (16)	11 (15)	23 (15)	14 (10)	3 (4)	12.42[b]
Aug-Sep-Oct	12 (13)	19 (17)	16 (16)	8 (11)	4 (2)	2.10
All months	45 (51)	48 (53)	56 (53)	42 (40)	21 (17)	2.34
Oak-Hickory						
Feb-Mar	18 (12)	4 (15)	5 (15)	18 (15)	23 (11)	31.49[a]
Apr-May	55 (33)	50 (41)	31 (47)	47 (45)	13 (29)	30.71[a]
Jun-Jul	31 (16)	29 (23)	19 (23)	8 (18)	1 (9)	29.66[a]
Aug-Sep-Oct	35 (23)	40 (41)	35 (41)	29 (34)	11 (12)	8.66
All months	139 (85)	123(120)	90(126)	102(110)	48 (65)	49.03[a]

[a] $P < 0.005$

[b] $P < 0.025$

Table 8. Number and percentage of observations of deer as recorded in each activity when 1st observed.

Activity	Cross Timbers		Oak-Hickory	
	No. deer	%	No. deer	%
Standing	146	68.9	364	72.5
Bedding	53	25.0	87	17.3
Running	3	1.4	12	2.4
Unknown	10	4.7	39	7.8

Table 9. Percentage composition of vegetative cover types within the area of visibility along 3 spotlight routes with the percentage of deer observed in each cover type in parentheses. Total area is in hectares with the total number of observations of deer on each route in parentheses.

Vegetative cover type	Routes			
	Lincoln	Creek	Cherokee 1st ½	Cherokee 2nd ½
Grass-hay	75.9 (100)	62.3 (63.6)	71.5 (0)	53.4 (23.8)
Brush	3.7 (0)	10.7 (27.1)	8.8 (0)	9.3 (33.3)
Bottomland forest	3.0 (0)	3.9 (2.8)	2.5 (0)	3.0 (4.2)
Post oak-blackjack oak	12.8 (0)	23.1 (6.5)	5.7 (0)	14.1 (17.6)
Oak-hickory forest	0 (0)	0 (0)	10.8 (0)	20.2 (21.1)
Crops	4.5 (0)	0 (0)	0.7 (0)	0 (0)
Totals	1,227 (4)	739 (107)	428 (0)	325 (261)

Table 10. Results of Hahn transect and deer drive counts associated with deer spotlight routes in 1978 and 1979.

Habitat type and spotlight route	Area of visibility (ha)	Year	N	Total deer	$\bar{X}$	SD	Deer drives Area (ha)	Deer drives No. deer
Cross Timbers								
Creek	36.8	1978	3	0	0	0		
		1979	4	1	0.3	0.5	53	0
Lincoln	57.8	1978	3	0	0	0		
Okfuskee	26.7	1978	2	0	0	0		
Seminole	33.2	1978	2	0	0	0		
Payne	50.0	1979	4	0	0	0	65	0
Oak-Hickory								
Delaware	17.4	1978	2	8	4.0	0		
		1979	3	2	0.7	0.9		
Cherokee	10.5	1978	2	4	2.0	0		
		1979	3	8	2.7	2.5	259	18

VITA 2

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Master of Science

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