VEGETATIONAL ANALYSIS OF BOBWHITE HABITAT ON NORTHEASTERN OKLAHOMA RANGELAND

by

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VEGETATIONAL ANALYSIS OF BOBWHITE HABITAT

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RANGELAND

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PREFACE

In order to facilitate submission of this thesis for publication, format specifications of THE JOURNAL OF WILDLIFE MANAGEMENT were followed. Information obtained during the course of study that was not suitable for publication is presented in appendices. Presentation of the thesis in this manner is based on the Graduate College's policy of accepting a thesis written in manuscript form and is subject to approval by the Graduate College of the thesis adviser's request for a waiver of the standard format in a letter dated 4 November, 1977.

I wish to express my sincere appreciation to Dr. Ronald J. Tyrl, my major adviser, for his suggestions, encouragement, interest, and wit during the preparation of this manuscript and throughout my graduate career. I am grateful to the members of my graduate committee, Dr. Jeff Powell and Dr. Paul Vohs, for their assistance and advice, and Dr. William Warde for his help with statistical analyses of the data.

Thanks are extended to Dr. James Lewis for his assistance during the initial phase of this project and to Mr. W. W. Ingersoll, without whose cooperation, this project could not have been conducted. I am grateful also to Dr. Barbara Reed for reviewing this manuscript. Very special thanks are given to my family, Mr. Berte and Mrs. Mary Collins, John, Joe, Diane, and Kellie, for their constant support of all my endeavors.

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VEGETATIONAL ANALYSIS OF BOBWHITE HABITAT ON NORTHEASTERN OKLAHOMA RANGELAND

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Abstract: A vegetational analysis of bobwhite habitat on northeastern Oklahoma tallgrass prairie rangeland was performed using a modified line transect method of sampling. Results indicate that bobwhites are not species specific with regard to tree cover. When cover requirements are met, species composition is unimportant. Tree species composition and percent cover varied among covey home ranges. _Cornus drummondii_, _Ulmus americana_, _Diospyros virginiana_, _Celtis_ spp., and _Salix nigra_ dominated the tree canopy. Draws were more wooded than slopes. _Rubus allagheniensis_, _Symphoricarpos orbiculatus_, and _Rhus copallina_ dominated the shrub canopy and occurred more frequently, with greater density, and provided more cover on slopes than in draws. Shrub frequency, density, and cover also varied among home ranges. Total tree cover, tree cover in draws, total shrub cover, shrub cover in draws, and shrub cover on slopes differed among pastures ($P<0.70$, $P<0.85$, $P<0.62$, $P<0.66$, $P<0.69$) indicating that differences were due to chance most often and were not biologically important to the quail. Total tree cover, tree cover in draws, tree cover on slopes, and shrub cover in draws differed among home ranges ($P<0.10$, $P<0.05$, $P<0.20$, $P<0.025$) and among home ranges within a pasture ($P<0.10$, $P<0.025$, $P<0.35$, $P<0.025$). Frequency data indicate that the most important food

plants consumed by bobwhites were common in all covey home ranges, occurring more frequently on grassland slopes than in draws.

The prevalent agicultural practice of monoculture does not favor the existence of bobwhite quail (Colinus virginianus). The apparently diverse habitats required by bobwhites have gradually diminished both in quantity and quality as larger tracts of land are devoted to monoculture. This practice has also resulted in drastically reduced quail populations on lands that formerly supported large numbers of birds (Rosene 1969).

However, approximately 50 percent of Oklahoma is rangeland, which supports much of the state's quail population. Quail biology in farmlands has been extensively studied (Burger and Linduska 1967, Ellis et al. 1969, Stoddard 1936). With the exception of studies in Kansas (Robel 1965, 1969) though, little research has been devoted to bobwhite biology in the tallgrass prairie.

In 1975, the Oklahoma Cooperative Wildlife Research Unit began a study of the population characteristics of bobwhite quail in relation to environmental conditions on a northeastern Oklahoma tallgrass prairie. Utilizing information generated by this study, and based on the premise that an understanding of the vegetation comprising quail habitat is important for proper interpretation of behavior patterns and in the development of land management practices favoring bobwhite production, the present project was conducted to describe and compare the vegetation comprising the winter home ranges of eight quail coveys in the tallgrass prairie.

STUDY SITE

The study area is the McFarlin-Ingersoll Ranch, located in southeastern Rogers County, Oklahoma, 3.2 km north of Inola on Oklahoma Highway 88 (Fig. 1). The majority of the 4,700 ha ranch is tallgrass prairie rangeland located on the Dennis-Bates-Collinsville soil association. Level to gently sloping prairies broken by escarpments characterize the area. The temperate, continental climate is characterized by moderate, sunny winters and long, hot summers (Polone 1966). Cold periods usually last only a few days while hot periods are moderated by cool nights and occasional local showers. Heaviest seasonal precipitation occurs in spring and fall (Table 1). Mean annual temperature and precipitation are 15.6°C and 96.5 cm, respectively.

The ranch is used primarily as a cow-calf operation (Wiseman 1977a). Stocking rate is approximately one cow (1 animal unit) per 2.8 ha with year-long grazing on all grazing units. The owner, in cooperation with several field trial clubs which sponsor field trials on the ranch, manages quail and their habitat. Present quail management practices include Sorghum almum food plots located as close to woody cover as possible and maintenance of feeders (Wiseman 1977a). Winter bobwhite quail diet is supplemented with maize or corn.

A comprehensive vegetational analysis of the two 250 ha study areas selected by Wiseman (1977a) for his study of quail home range and habitat use was performed. Study Area One, commonly called the South Big Walnut Pasture, is located 4 km northeast of the main ranch office complex (R17E T20N Secs. 10 and 15). It is dominated by extensive grassland with wooded areas along major drainage pathways. The soil associations present include Collinsville stony loam, Bates-

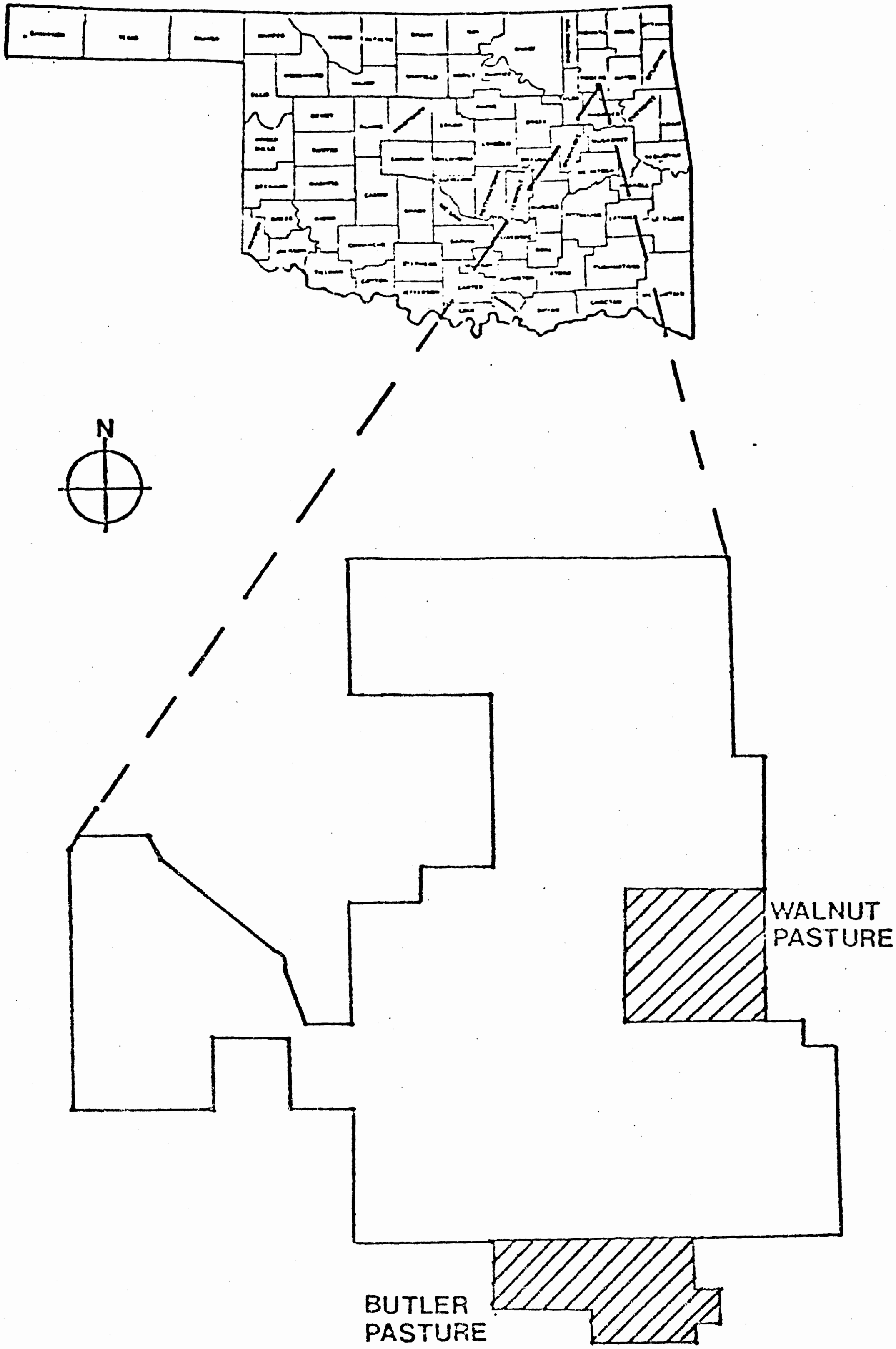


Fig. 1. Location of the McFarlin-Ingersoll Ranch and the two intensive study areas (crosshatched), Rogers County, Oklahoma.

Table 1. Temperature and precipitation at Claremore, Rogers County, Oklahoma for the years 1931 to 1960 (Polone 1966).

Month	Average Daily Maximum Temperature C	Average Daily Minimum Temperature C	Average Monthly Precipitation cm
January	9.30	-2.74	4.74
February	12.04	-0.90	4.80
March	16.69	2.97	6.51
April	22.51	9.18	10.13
May	26.10	14.11	14.15
June	31.58	19.15	12.59
July	34.61	21.22	8.10
August	34.83	20.72	7.77
September	30.86	15.96	9.97
October	24.86	9.91	8.62
November	16.13	2.63	5.67
December	10.92	-1.12	4.59
Year	22.51	9.24	97.64

Collinsville complex, Dennis-Bates complex, Breaks-Alluvial land complex, and Choteau silt loam (Fig. 2A). Study Area Two, commonly called the Butler Pasture, is located 4 km southeast of the main ranch complex (R17E T20N Secs. 27 and 28). It too, is characterized by tall-grass prairie slopes and wooded drainage pathways. The soil associations here are the same as are found in the South Big Walnut Pasture with the addition of Hector-Linker fine sandy loam, Hector stony sandy loam, and Linker fine loam (Fig. 2B). A brief description of each soil association (Polone 1966) is given below.

1. The Collinsville (lithic hapludoll) stony loam association is a steep to moderately sloping stony soil in upland prairies, formed from sandstone under tall prairie grasses. The dark, grayish-brown surface layer has moderate, medium, granular structure. The substratum of weathered sandstone is underlain by bedrock at a depth of about 25 cm. The soil is excessively drained and is susceptible to water erosion.

2. The soils of the Bates (typic argiudoll)-Collinsville complex are gently to strongly sloping on upland prairies. About 20% are Collinsville soils, which differ from the previous description by having thicker layers and fewer stones on the surface. The Bates series consists of a surface underlain by a subsoil about 36 cm thick. The upper part of the subsoil is strongly acidic heavy loam while the lower part is strongly acidic light clay loam. The substratum is weathered sandstone and shale underlain by bedrock. The Bates series of this complex differs from this description by having thinner layers.

3. The Breaks-Alluvial land complex consists of channels of intermittent streams 3 to 9 m wide, narrow valley floors 3 to 15 m in width, and sloping to steep valley sides 15 to 45 m. The soil is a mixture of mostly shallow Bates, Collinsville, and Dennis soils on the uplands and dominated by Vertigris soils on the bottomlands.

4. The Hector (lithic dystrochrept) stony loam is a shallow, sloping soil of forested uplands. Slopes range from 3 to 30% and are excessively drained and stony.

5. The Dennis (aquic paleudoll)-Bates complex is gently sloping, well-drained soils of upland prairies, composed of Dennis silt loam, Bates loam, Parsons silt loam, and Collinsville soils. The complex is subject to severe water erosion.

6. The Hector (lithic dystrochrept)-Linker (typic hapludult)

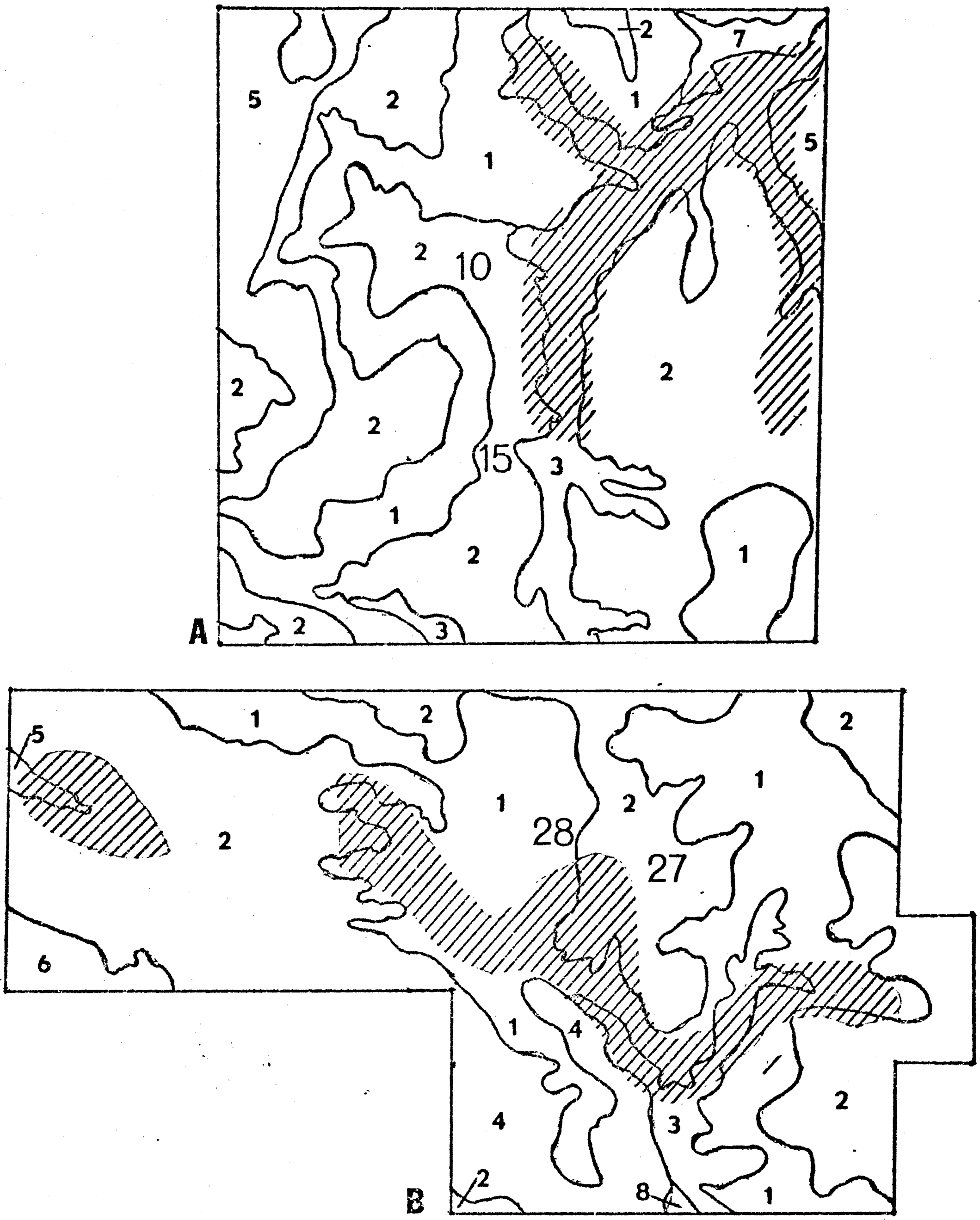


Fig. 2. Location of covey home ranges (crosshatched) (Wiseman 1976, personal communication) and soil associations present in intensive study areas, Rogers County, Oklahoma. (A). Walnut Pasture (B). Butler Pasture. 1=Collinsville stony loam; 2=Bates-Collinsville complex; 3=Breaks-Alluvial land complex; 4=Hector stony sandy loam; 5=Dennis-Bates complex; 6=Hector-Linker fine sandy loam; 7=Choteau silt loam; 8=Linker fine sandy loam (Polone 1966).

fine sandy loams are moderately sloping sandy soils that developed under hardwood trees in the uplands. The soil is sandy and prone to water erosion and loss of fertility.

7. Choteau (aquic paleudoll) silt loam is a deep, dark-colored, gently sloping upland soil. The strongly acidic silt loam surface layer is about 66 cm thick with medium granular structure. The very acid subsoil is heavy silt loam of fine granular structure. Mottled clay loam alluvium comprises the substratum.

8. A moderately sloping soil, Linker fine sandy loam developed in the uplands from sandstone under hardwood trees.

METHODS AND MATERIALS

The vegetation of the December 1975 - January 1976 home ranges of eight bobwhite quail coveys (Wiseman 1977b), three in the Walnut Pasture (Fig. 3) and five in the Butler Pasture (Fig. 4), was sampled. Sampling was performed during September and October, 1976, by means of a modified line transect. The line transect has been found to be a quick and easily performed method of sampling in forested areas (Bauer 1943). It has been adapted to sampling rangeland vegetation and has been found to yield reliable estimates of species composition, density, and ecological structure (Canfield 1941, Witman and Siggeirson 1954, Crockett 1963). Heterogeneous stands of vegetation are more accurately sampled by oblong or oval plots. The line transect develops length to the maximum, thus increasing the likelihood of encountering a greater number and diversity of individual plant species (Canfield 1941).

Several sampling units composed of two perpendicular line transects of unequal lengths were established within each home range by use of a cord marked at one m intervals with colored tape. The locations of sampling units were arbitrarily established along draws in each home range. In all cases, a 30 m transect crossed a draw at its midpoint at ? an angle of intersection acute enough to allow the line to more-or-less poor usage!

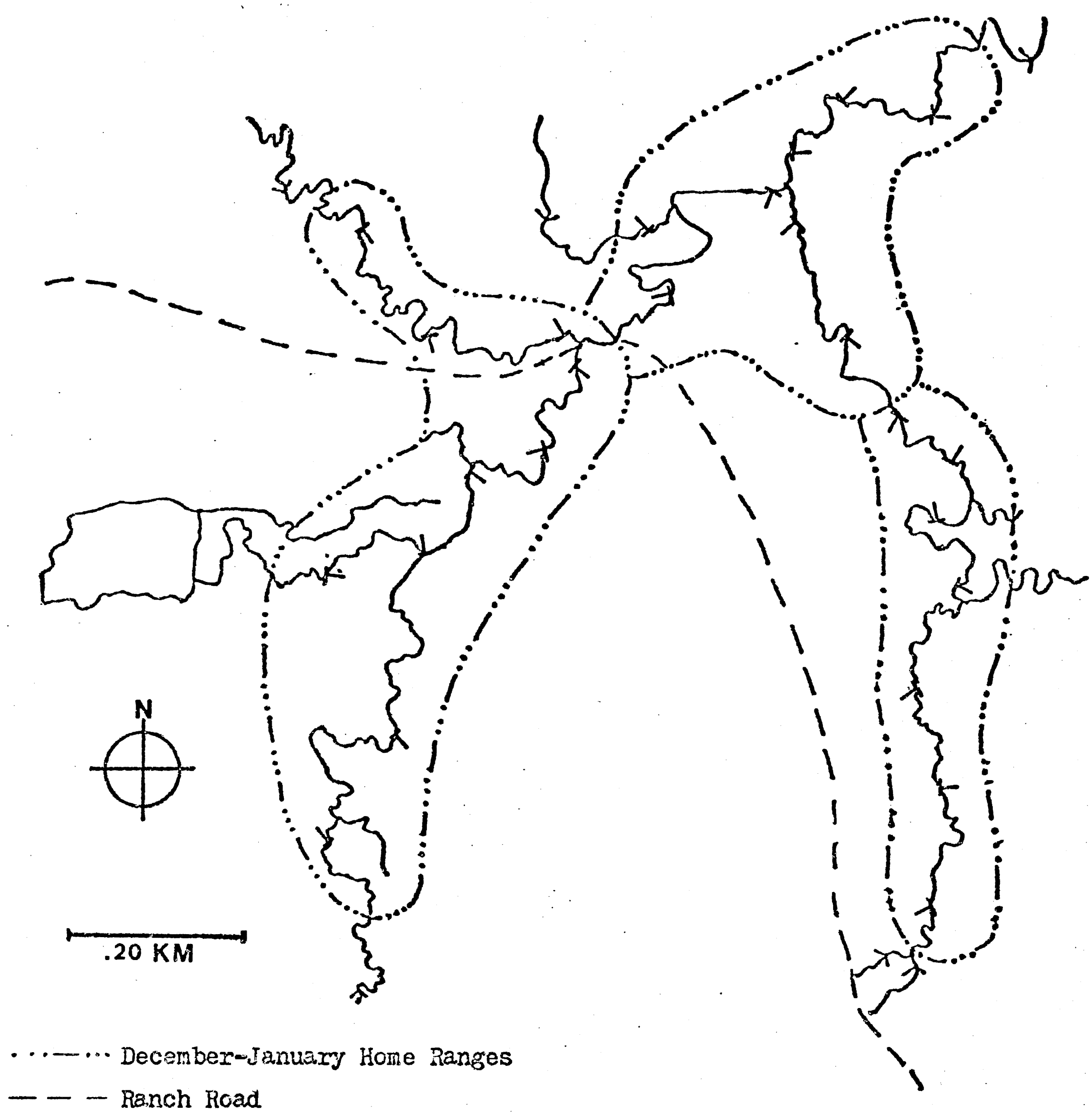
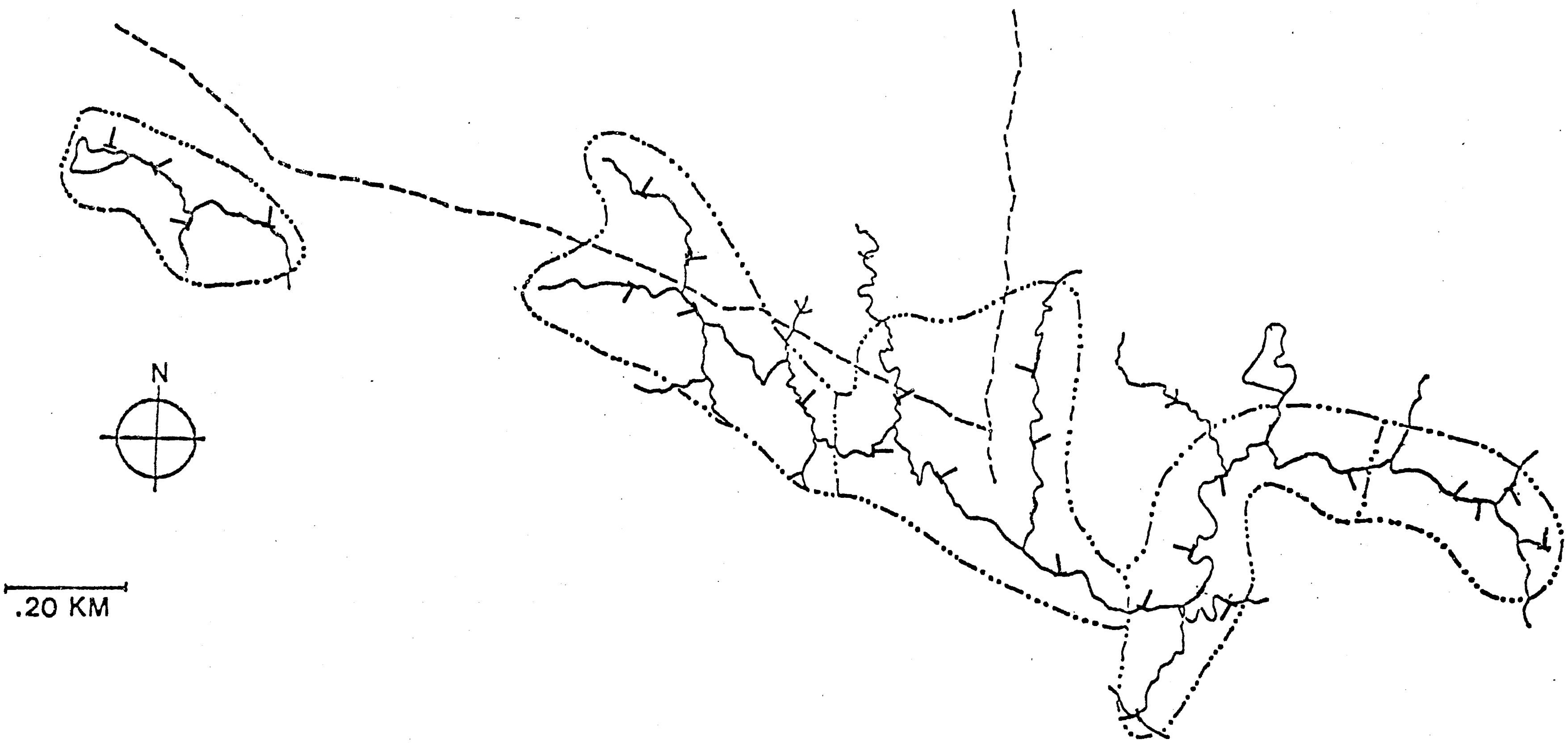


Fig. 3. Three bobwhite quail covey home ranges and twenty five sampling units (not drawn to scale), Walnut Pasture, Rogers County, Oklahoma (Wiseman 1976, personal communication).



····—··· December-January Home Ranges
— — — Ranch Road

Fig. 4. Five bobwhite quail covey home ranges and twenty five sampling units (not drawn to scale), Butler Pasture, Rogers County, Oklahoma (Wiseman 1976, personal communication).

parallel the draw. This insured intensive sampling of woodland areas occupied by quail. When the arbitrarily selected sampling site was located such that the transect line crossed the draw more than once or could not nearly parallel the draw, the nearest, most favorable location was used. A transect of 50 m in length was established perpendicular to the former at its midpoint and extended into grassland on one side of the draw, insuring intensive grassland sampling. In order to avoid bias, the direction in which each 30 m transect crossed a draw alternated. Grassland on both sides of a draw was sampled by alternating the direction of each 50 m transect.

The closest living taxon was recorded at each one m interval. Tree cover, shrub cover, and shrub density were also recorded for each transect. Total percent tree cover was determined by estimating the total transect length covered by tree canopy. Percent aerial cover per species was estimated according to the Braun-Blanquet method (Oosting 1956). Shrub cover was determined by estimating the total transect length covered by each individual species. The number of shrub stems per species within one m on either side of the transect line were counted. Density per m^2 was then calculated. Data was analyzed on an IBM computer using Statistical Analysis System (SAS) programs designed by Barr and Goodnight (1972).

Random plant collections were made every three to four weeks between April and October, 1976, in order to obtain a more complete floral inventory of both study areas. The mounted specimens were deposited in the Oklahoma State University Herbarium, Oklahoma.

RESULTS AND DISCUSSION

Trees

The role of woody vegetation in providing cover has long been recognized as a major factor influencing the distribution and carrying capacity of bobwhite quail (Baker 1940, Damon 1946, Parmalee 1953, Wiseman 1977b). Results of the present study indicate that bobwhites in northeastern Oklahoma tallgrass prairie rangeland do not require specific tree species for cover. Rather when cover requirements are met, species composition is unimportant.

Thirteen genera were sampled in the eight home ranges (Table 2). *Fraxinus*, *Bumelia*, and *Juglans* were sampled only in home ranges of the Walnut Pasture, while *Prunus*, *Crataegus*, and *Quercus* were sampled only in Butler Pasture home ranges. These six genera, however, were common to both pastures outside the sampling units. Although tree species composition of the home ranges varied, five genera (*Cornus*, *Ulmus*, *Diospyros*, *Celtis*, *Salix*) occurred most frequently along sampling units, dominating the canopy layer. While draws were generally more wooded than slopes, frequencies of the dominants both in draws and on slopes varied among home ranges (Fig. 5).

Percent aerial cover also varied among home ranges (Table 3). This variation was reflected in the analyses of variance of the total cover, cover in draws, and cover on slopes (Appendix A). Differences among pastures were not statistically significant at the traditionally-used 0.05 significance level. The high observed significance levels for total cover and cover in draws ($P<0.70$, $P<0.85$) reveal that differences among pastures were due to chance and were not biologically important to the quail. In contrast, significant differences among all eight

Table 2. Percent frequency of occurrence of trees encountered along sampling units, Rogers County, Oklahoma.

	% frequency of occurrence
Dogwood *Cornus drummondii*	50
Ulmus americana	48
Diospyros virginiana	28
Hackberry *Celtis laevigata*, *C. occidentalis*	24
Salix nigra	24
Quercus marilandica	14
Fraxinus pennsylvanica	10
Prunus hortulana, *P. munsoniana*, *P. serotina*	10
Honey Loc *Gleditsia triacanthos*	8
Mulberry *Morus rubra*	6
Crataegus mackenzii, *C. coccinioides*	6
Quercus palustris	4
Quercus stellata	2
Bumelia lanuginosa	2
Juglans nigra	2

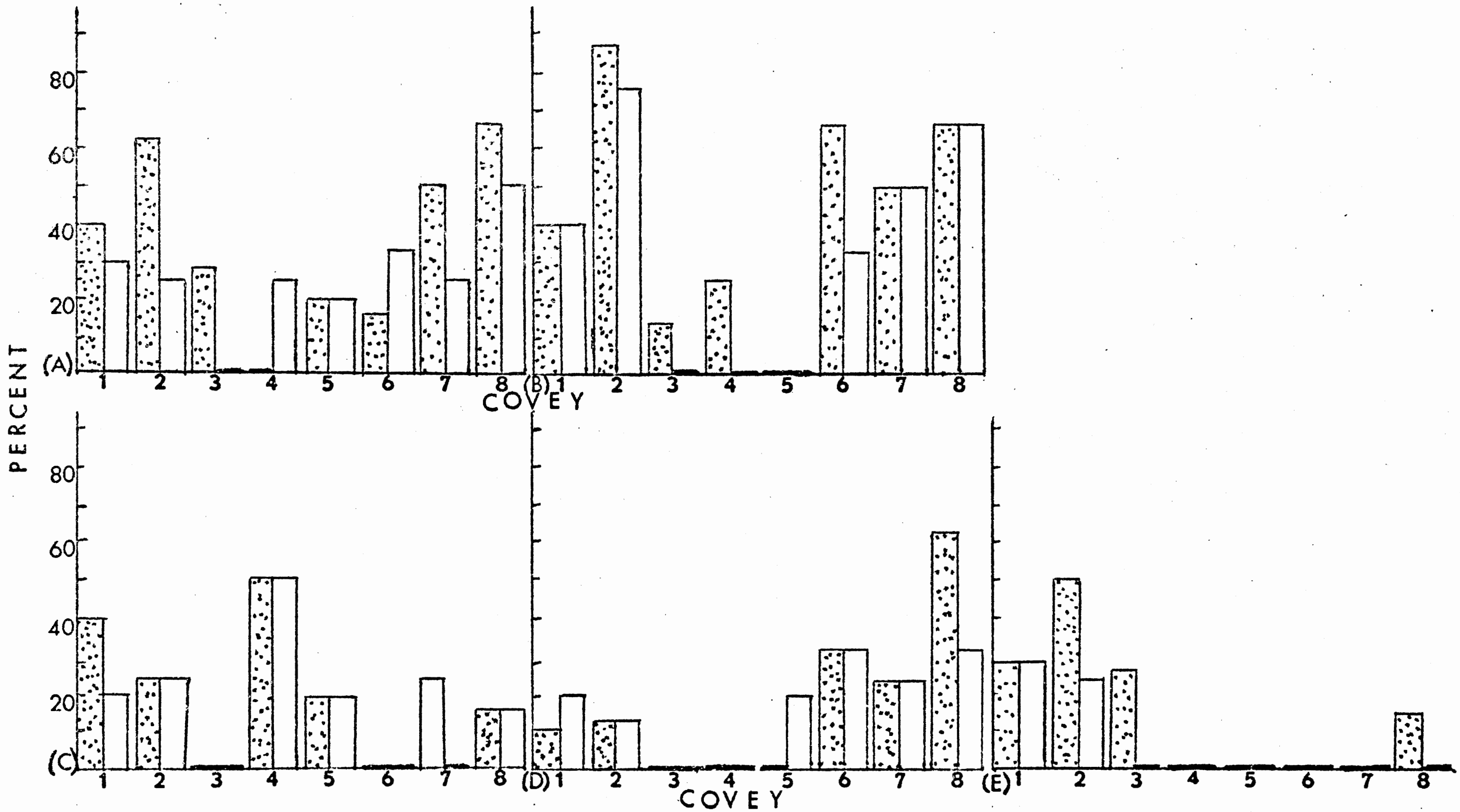


Fig. 5. Percent frequency of occurrence in draws (mottled) and on slopes per covey home range of the five dominant tree genera, Rogers County, Oklahoma. (A). Cornus (B). Ulmus (C). Diospyros (D). Celtis (E). Salix.

Table 3. Sample size, standard deviation, and mean aerial cover (%) per covey home range of sampling units, draws, and slopes, Rogers County, Oklahoma.

	Covey								
Location	1[a] n=10	2[a] n=8	3[a] n=7	4[b] n=4	5[b] n=5	6[b] n=6	7[b] n=4	8[b] n=6	Total Average n=50
Sampling unit	25.41 ±26.12	33.45 ±19.91	8.34 ±13.63	11.00 ±9.58	12.35 ±17.24	31.33 ±31.41	27.03 ±24.96	49.27 ±30.30	24.80 ±25.06
Draw	42.10 ±44.08	70.25 ±41.70	14.86 ±35.40	16.00 ±23.66	5.60 ±8.17	48.83 ±46.13	50.00 ±48.96	71.67 ±39.71	41.40 ±15.09
Slope	15.40 ±24.19	11.40 ±7.48	4.43 ±5.53	8.00 ±9.66	16.40 ±22.69	23.83 ±25.06	13.25 ±10.81	35.83 ±31.47	16.00 ±13.96

[a]Walnut Pasture

[b]Butler Pasture

home ranges were found at the 10, 5, and 20 percent significance levels, while differences among home ranges within a pasture were significant at the 10, 2.5, and 35 percent significance levels. This supports the conclusion that bobwhite quail on northeastern Oklahoma tallgrass prairie rangeland are adapted to variable amounts of tree cover.

Ulmus, Cornus, and Celtis contributed 50-100 percent of the total aerial cover more frequently in draws than on slopes (Fig. 6). Of these three species, Ulmus provided 50-100 percent of the total cover most frequently. This is explained by the species relatively large crown size and frequency of occurrence in draws and on slopes. While the differences between frequencies of Cornus and Ulmus were not great, crown size of the two species differed, with Ulmus owning the larger crown. Although the differences in crown size of Celtis and Ulmus were minor, the latter occurred on more than twice as many draws and slopes as the former.

Diospyros occurred more often in draws than on slopes, where unlike Cornus, it contributed less than 50 percent of the total cover most frequently. When encountered on slopes though, it tended to provide 75-100 percent of the total cover. Frequency and cover class frequency of these two species may be explained by their similar growth habit. Both habitually form thickets, with Diospyros tending to occupy more xeric sites than Cornus.

Although characteristically a bottomland tree species, Salix provided 75-100 percent of the total cover on slopes as frequently as in draws. However, it did not contribute as much cover to the slopes as the frequency of this cover class indicates. The small amount of total cover on one slope transect and the absence of tree species other than

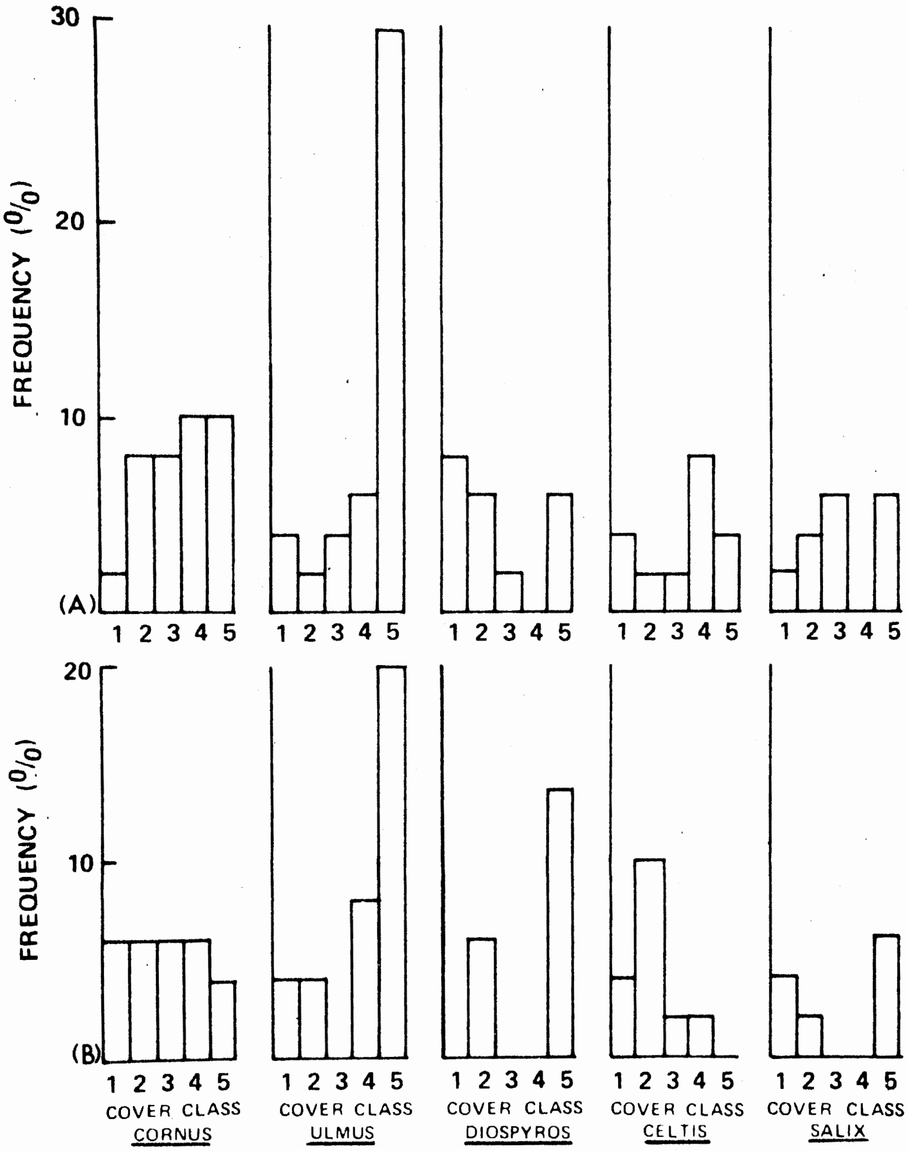


Fig. 6. Cover class frequencies of the five dominant tree genera, Rogers County, Oklahoma. (A). Draws (B). Slopes. 1= 0-5%; 2= 5-25%; 3=25-50%; 4= 50-75%; 5=75-100%.

Salix from the canopies of two other slope transects caused the species to appear to provide more cover on slopes than it actually did.

When cover class frequencies are averaged per covey home range and graphed (Fig. 7), the previously discussed differences between draws and slopes are accentuated. In addition, the variability of species composition and cover class frequencies of each species among home ranges is illustrated.

Shrubs

Of the five shrub species sampled, Rubus, Symphoricarpos, and Rhus copallina occurred most frequently (Table 4). Wiseman (1977b) reported Rubus and Symphoricarpos to comprise the short shrub habitat preferred by coveys during fall, winter, and spring. These two species were the only shrubs to occur in all eight home ranges, with Rubus occurring more frequently than any other shrub. On the average, all three dominants occurred more frequently on slopes than in draws (Table 5), and except for the frequency of Rubus on slopes, frequencies of the shrubs varied among covey home ranges (Fig. 8).

Density and cover values of shrubs in draws and on slopes varied among home ranges (Figs. 9, 10, 11). On the average, the dominant shrubs occurred with greatest density and provided the greatest amount of cover on slopes. As trees were more scarce on slopes than in draws, the role of shrubs in providing cover increased in importance. Rubus generally occurred more frequently and with greater density than the other shrubs. However, it provided less cover than Symphoricarpos and Rhus in draws and more cover than the latter two species on slopes. Although Rhus provided the least amount of cover of the three, it was one of the tall shrub species used in greater proportion than was

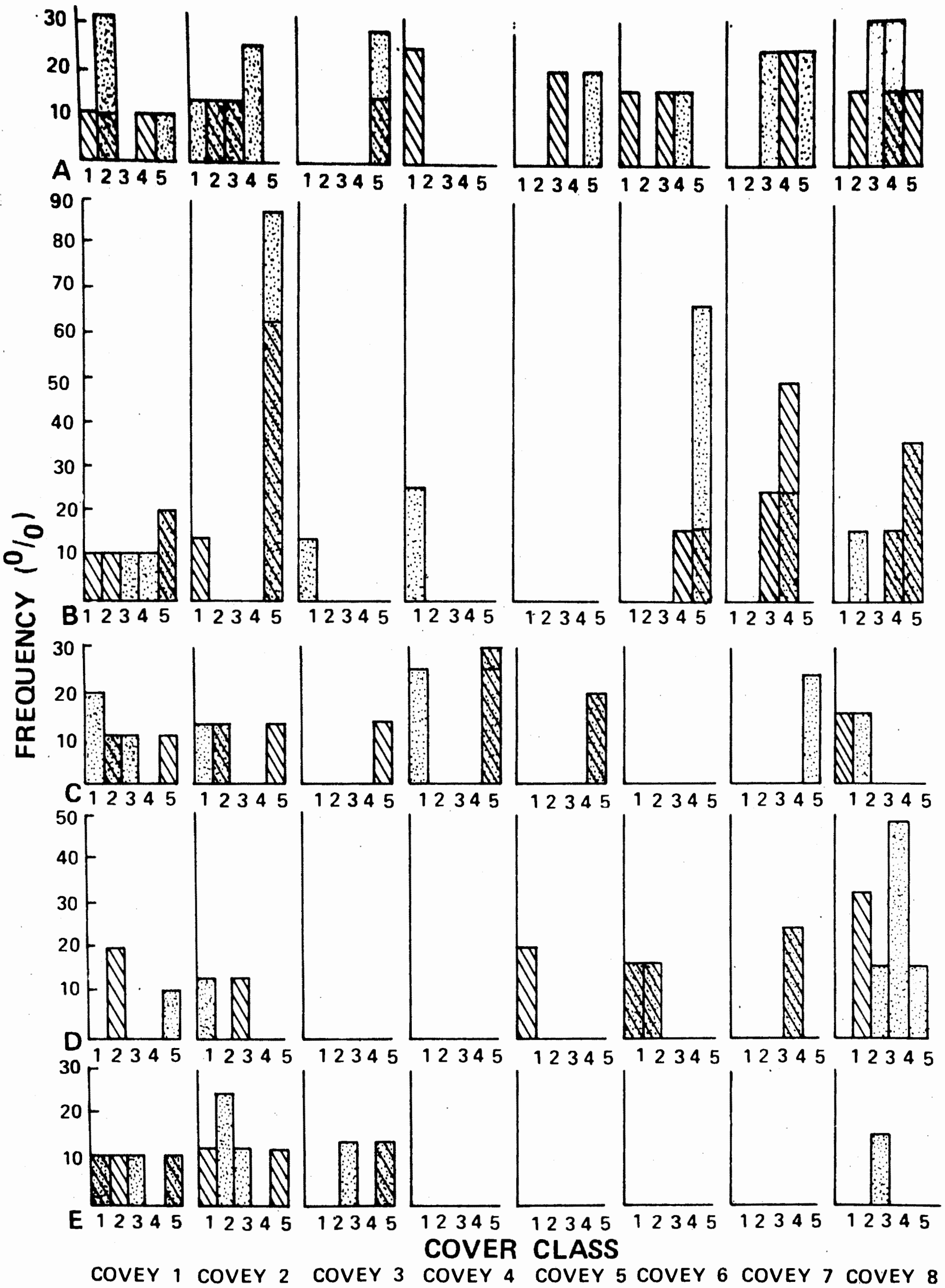


Fig. 7. Cover class frequencies in draws (mottled) and on slopes (crosshatched) per covey home range of the five dominant tree genera, Rogers County, Oklahoma. (A). Cornus (B). Ulmus (C). Diospyros (D). Celtis (E). Salix. 1=0-5%; 2=5-25%; 3=25-50%; 4=50-75%; 5=75-100%.

Table 4. Percent frequency of occurrence of the five shrub species encountered along sampling units, Rogers County, Oklahoma.

	% frequency of occurrence
Rubus allagheniensis	100
Symphoricarpos orbiculatus	90
Rhus copallina	36
Cephalanthus occidentalis	34
Rhus glabra	2

Table 5. Percent frequency of occurrence in draws and on slopes of the three dominant shrub species, Rogers County, Oklahoma.

Species	% frequency of occurrence	
	draw	slope
Rubus allagheniensis	90	100
Symphoricarpos orbiculatus	72	82
Rhus copallina	18	32

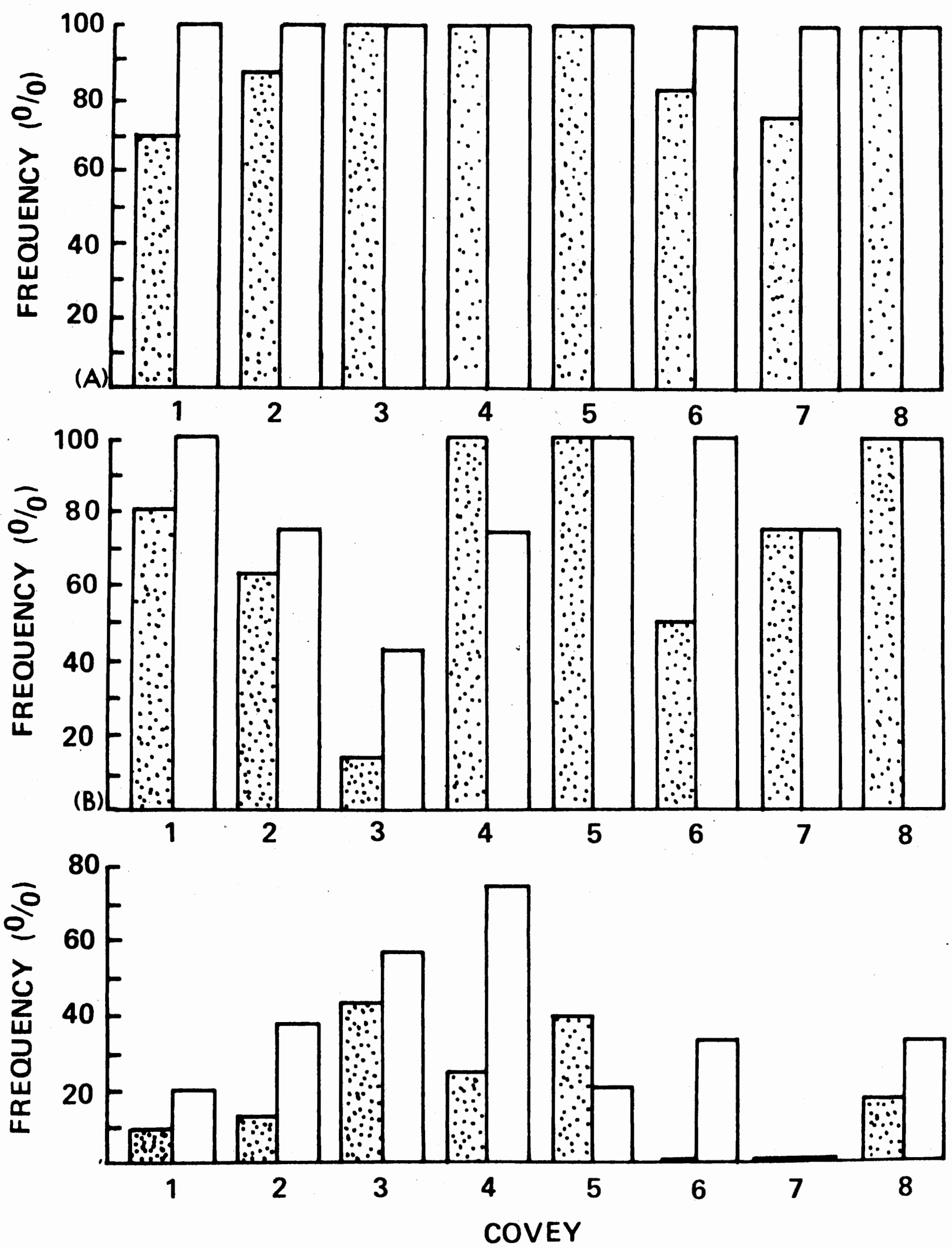


Fig. 8. Percent frequency of occurrence in draws (mottled) and on slopes per covey home range of the three dominant shrub species, Rogers County, Oklahoma. (A). Rubus (B). Symphoricarpos (C). Rhus copallina.

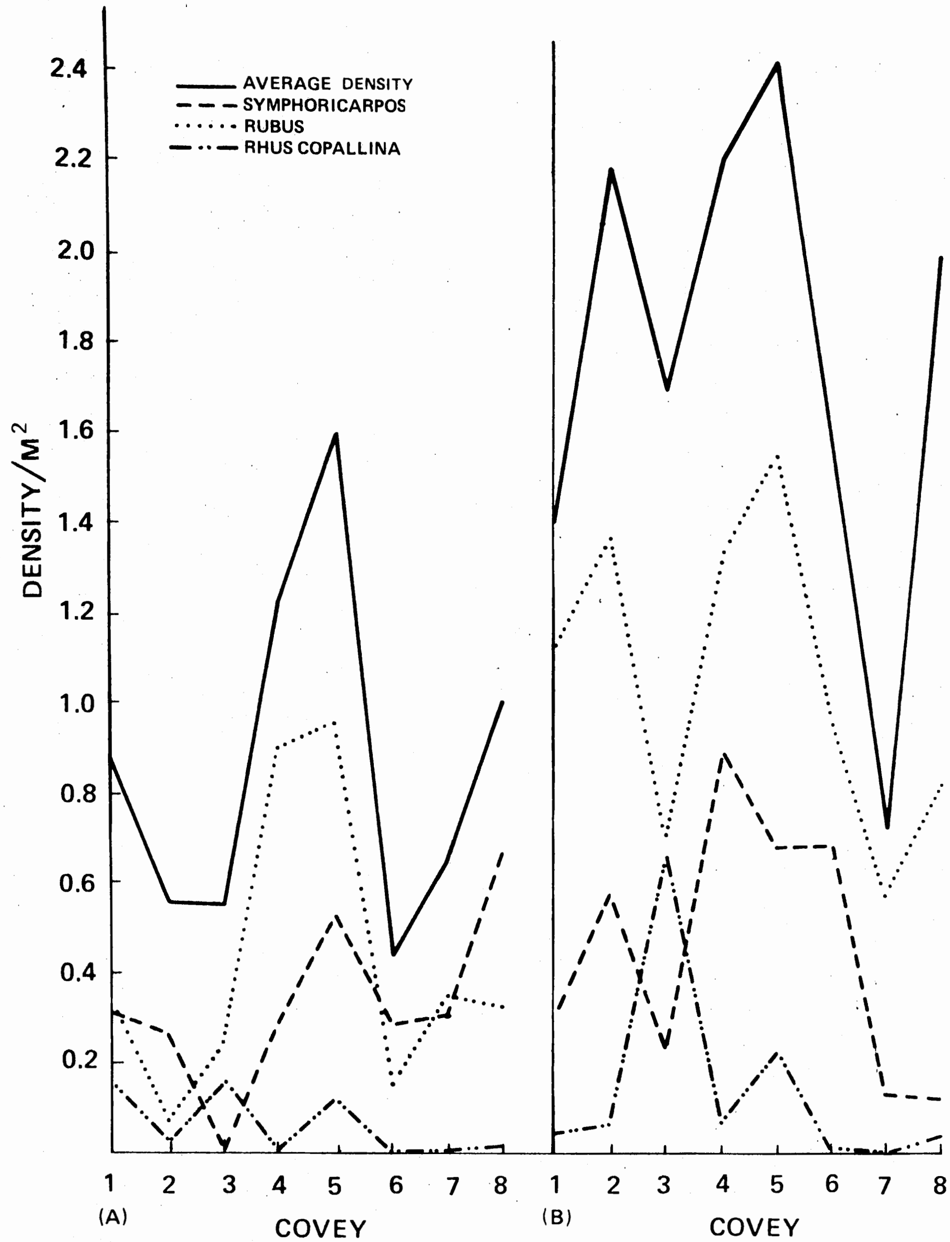


Fig. 9. Total average density (stems/m^2) and density of the three dominant shrubs per covey home range, Rogers County, Oklahoma. (A). Draws (B). Slopes.

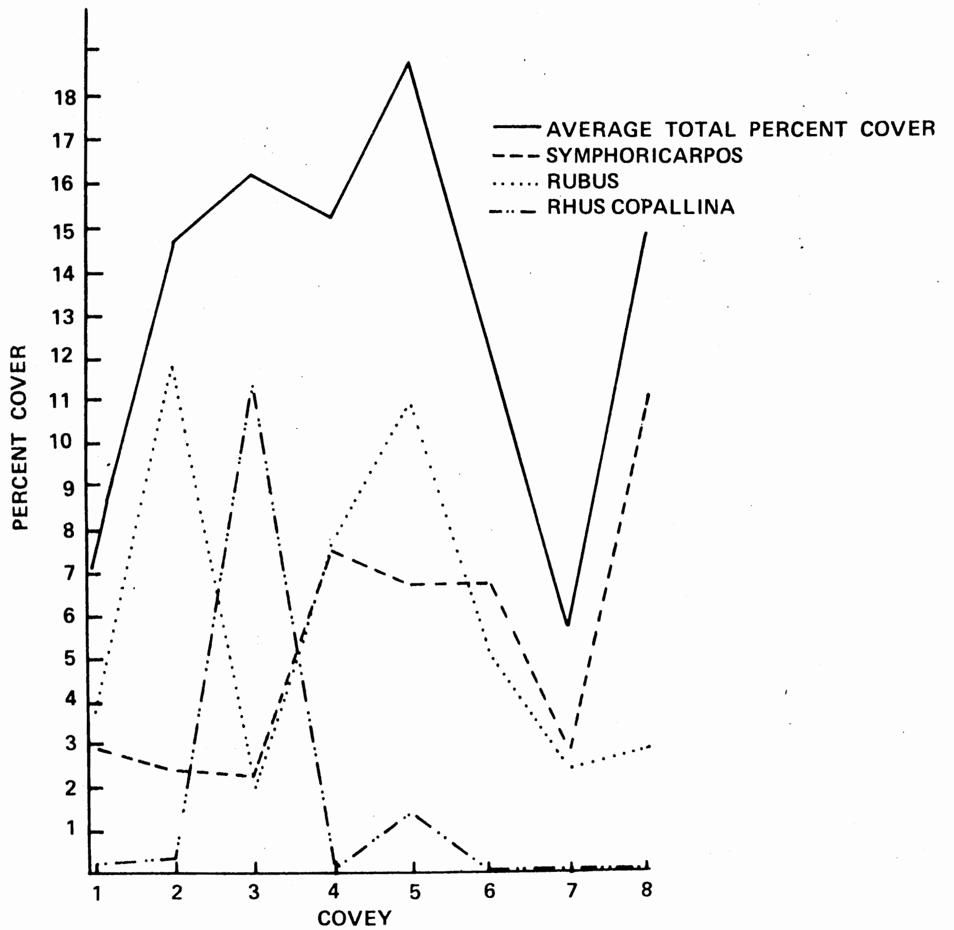


Fig. 10. **Total average** percent cover **and** percent **~~cover of~~** **the three dominant shrubs** per covey home range (draws), Rogers County, Oklahoma.

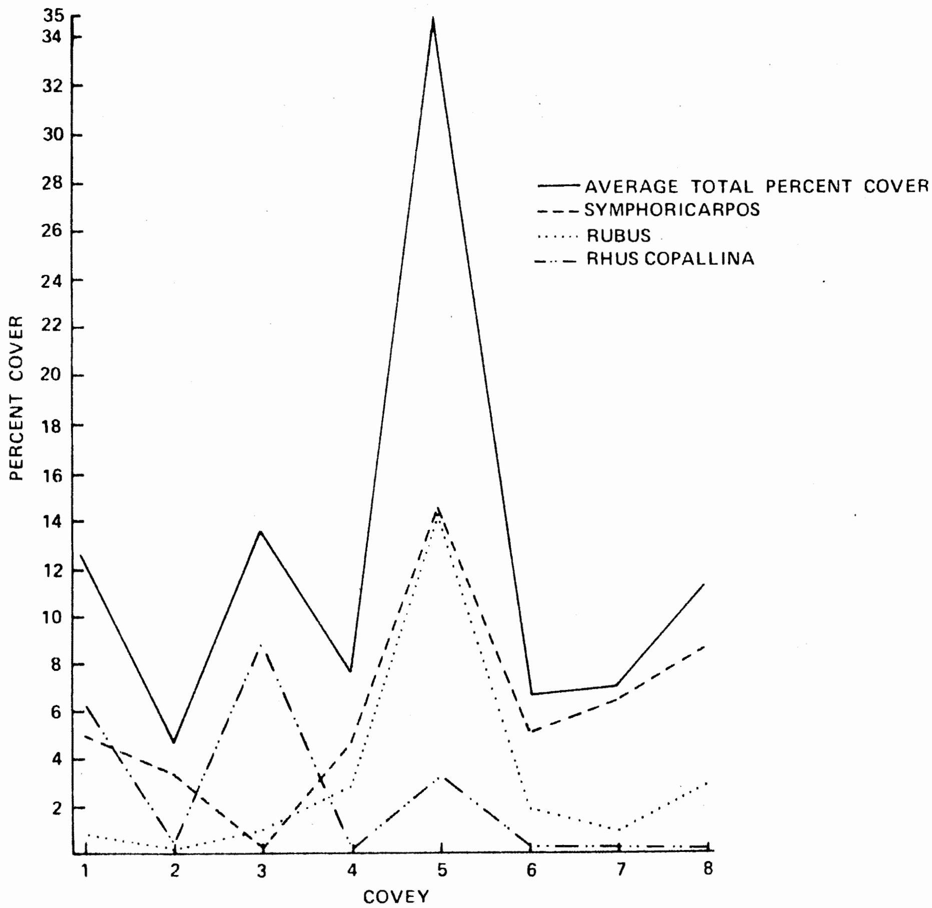


Fig. 11. Total average percent cover and percent cover of the three dominant shrubs per covey home range (slopes), Rogers County, Oklahoma.

available within each covey's home range (Wiseman 1977a). The very low density values shown in Figure 9 are misleading until one considers the method by which density is calculated (Cox 1972). In this case, density was averaged over the entire draw and slope areas sampled within each covey's home range. Relative to each other, however, the values do indicate which home ranges were characterized by denser shrub growth.

The variation in total shrub cover, cover in draws, and cover on slopes is reflected in the analyses of variance of these values (Appendices A, B). High observed significance levels ($P<0.62$, $P<0.66$, $P<0.69$) indicate that pasture differences were due to chance and were not biologically important to the quail. While draw cover differed significantly both among all home ranges ($P<0.025$) and among home ranges within a pasture ($P<0.025$), the observed significance levels of differences among home ranges and among home ranges within a pasture for both total shrub cover and slope shrub cover varied from $P<0.15$ to $P<0.75$. This trend characterizes the analyses of variance of cover and density of the three dominant shrub species as well, and indicates that bobwhites are adapted to variable amounts of shrub cover and density.

Vines

Two vines, Smilax bona-nox and Rosa setigera, were also sampled along sampling units. Commonly an understory component of wooded areas, Smilax occurred almost exclusively in draws where it provided little useable cover for bobwhites. Both density and cover of Smilax in draws differed significantly among pastures ($P<0.05$, $P<0.01$). The total absence of Smilax in draws of the Butler Pasture contributed to the lack

? of biologically significant differences among all home ranges and among home ranges within a pasture. Rosa was sampled less frequently than

Smilax. It provided less cover and was also less dense.

Food Plants

In order to determine the food habits of bobwhite quail, Wiseman (1977a) conducted extensive crop analyses of birds collected on the McFarlin-Ingersoll Ranch. His observations and conclusions concerning the variability of seasonal consumption of foods, some of which are summarized below, are supported by the taxa densities and frequencies reported here.

Of the three principal plant foods (*Lespedeza*, *Rhus*, *Sorghum*) eaten by bobwhites, fruits of *Lespedeza* were consumed most frequently. Seven species, *L. intermedia*, *L. repens*, *L. stipulacea*, *L. striata*, *L. stuevei*, *L. violacea*, *L. virginica*, were sampled in the eight home ranges. Both *Rhus copallina* and *R. glabra* were sampled, with the former occurring more frequently than the latter. Cultivated in food plots or supplied via feeders, *Sorghum* was not sampled.

Generally, the most important taxa consumed by bobwhites occurred more frequently on slopes than in draws (Table 6). Frequency data (Fig. 12) also indicate that most of these taxa were common, if not abundant, in all covey home ranges. The frequencies and distribution of these species help to explain the variation in seasonal consumption reported by Wiseman (1977a). The increased utilization of *Lespedeza* from late summer to late fall corresponded to the period when fruits began to mature. Fruits remain attached to the plant throughout fall and winter and were therefore available during the winter months of December and January. Consumption during these months however, declined, while that of *Rhus* and *Sorghum* increased. While *Lespedeza* was more abundant than *Rhus*, quail often remained in woody cover during periods

Table 6. Percent frequency of occurrence in draws and on slopes of six important plant taxa consumed by quail, Rogers County, Oklahoma.

Species	% frequency of occurrence draw	% frequency of occurrence slope
Lespedeza spp.	42	60
Rhus spp.	18	36
Ambrosia spp.	42	88
Diospyros virginiana	22	16
Prunus spp.	6	8
Panicum spp.	84	100

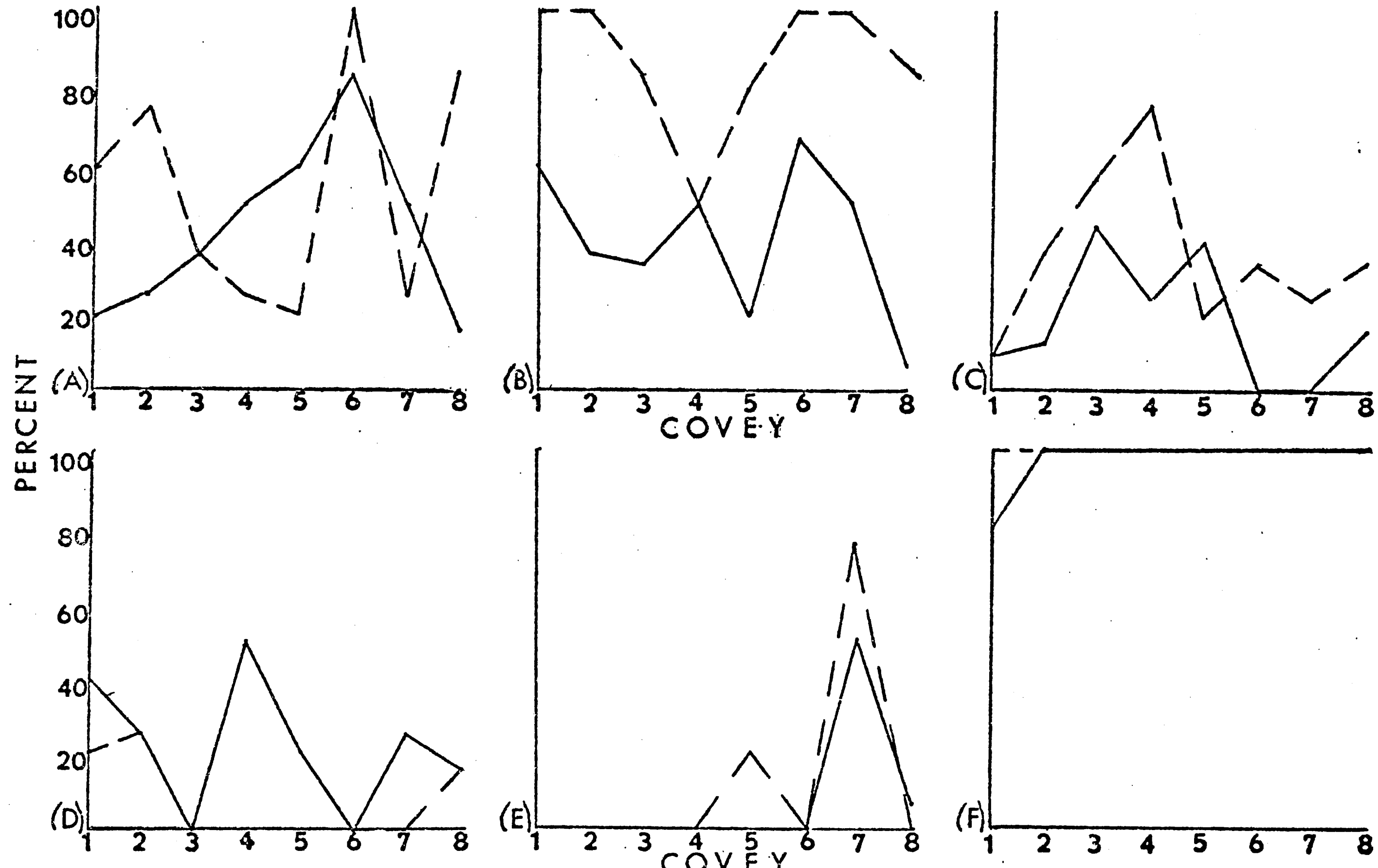


Fig. 12. Percent frequency of occurrence in draws (solid line) and on slopes (hashed line) of six taxa consumed by bobwhites, Rogers County, Oklahoma. (A). Lespedeza (B). Ambrosia (C). Rhus (D). Diospyros (E). Prunus (F). Panicum.

of inclement weather. Periods of high consumption of Lespedeza corresponded to periods of mild weather when quail were more likely to venture out into grassland areas where the fruits were most abundant. Rhus played an important dual role in providing both winter food and cover for quail.

The other most important food plants, Ambrosia, Diospyros, and Prunus, each comprised less than five percent of the average volume of food consumed by quail. Seasonal consumption of all three genera was variable(Wiseman 1977a). Ambrosia was the most frequently sampled of the three. Of the four species encountered (A. artemissiifolia, A. bidentata, A. psilostachya, A. trifida), A. psilostachya was most common. Like Lespedeza, Ambrosia occurred most frequently on slopes and was used to the greatest extent during the fall when fruits were most abundant. During October and November, only Lespedeza was consumed more frequently and in greater volume, indicating, as Wiseman (1977a) concluded, a preference for these two genera during this time period.

Substantial amounts of Diospyros were consumed only during November when the ripened, fallen fruits were readily available to quail. The relatively low frequencies of Diospyros and the fact that it, like Rhus, tends to form discrete stands which provide cover as well as food support Wiseman's (1977a) conclusion that Diospyros is a preferred food. Prunus was less abundant than Diospyros. Three species, P. hortulana, P. munsoniana, P. serotina, were sampled in only three covey home ranges. The great increase in consumption during January and February may be related to the cover provided by Prunus thickets.

The most frequently eaten grasses were maize and Panicum species.

Maize was obtained from maintained feeders. Thirteen species of Panicum (Appendix C), representing several different habitats were sampled. It is not surprising, therefore, that this genus was sampled in every sampling unit. In all cases, Panicum comprised very little of the total percent volume consumed by quail. The availability of Panicum in all home ranges and the fact that it was consumed in smaller amounts than some of the less common food plants indicated that Panicum is not a preferred food.

Taxa Encountered

Two hundred seventy five species representing sixty families were pressed, identified, and deposited in the Oklahoma State University Herbarium. The three families represented by the largest number of species were Graminae (56), Compositae (42), Leguminosae (20), and together comprised 43 percent of the taxa collected. In addition, the Cyperaceae and Rosaceae each were represented by 11 species, while 10 species of the Euphorbiaceae were collected.

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APPENDIX A

ANALYSES OF VARIANCE OF TREE COVER AND SHRUB COVER AND DENSITY VALUES

Table 1. Analyses of variance of tree cover of the two intensive study areas, Rogers County, Oklahoma. (A). Total cover (B). Draw cover (C). Slope cover.

Source	Degrees of freedom	Sum of squares	Mean square	F value	Observed significance level (α)
(A). Pastures	1	275.54	275.54	0.218	**0.659**
Coveys within pastures	6	7601.32	1266.89	2.325	0.049
Transects within coveys	42	22887.92	544.95		
Coveys	7	7876.86	1125.27	2.065	0.069
(B). Pastures	1	208.08	208.08	0.048	0.828
Coveys within pastures	6	26203.62	4367.27	2.832	0.021
Transects within coveys	42	64756.62	1541.82		
Coveys	7	26411.69	3773.09	2.447	0.033
(C). Pastures	1	1240.02	1240.02	2.577	0.158
Coveys within pastures	6	2887.35	481.23	1.215	0.317
Transects within coveys	42	16629.61	395.94		
Coveys	7	4127.37	589.63	1.489	0.197

Table 2. Analyses of variance of shrub cover of the two intensive study areas, Rogers County, Oklahoma. (A). Total cover (B). Draw cover (C). Slope cover.

Source	Degrees of freedom	Sum of squares	Mean square	F value	Observed significance level ($\hat{\alpha}$)
(A).					
Pastures	1	54.00	54.00	0.288	0.614
Coveys within pastures	6	1122.08	187.01	1.658	0.155
Transects within coveys	42	4737.14	112.79		
Coveys	7	1176.08	168.01	1.489	0.197
(B).					
Pastures	1	126.09	129.09	0.226	0.654
Coveys within pastures	6	3349.29	558.21	3.051	0.014
Transects within coveys	42	7683.02	182.93		
Coveys	7	3475.37	496.48	2.714	0.020
(C).					
Pastures	1	25.21	25.21	0.175	0.690
Coveys within pastures	6	862.73	143.79	0.697	0.655
Transects within coveys	42	8666.02	206.33		
Coveys	7	887.93	126.85	0.615	0.742

Table 3. Analyses of variance of Rubus cover in the two intensive study areas, Rogers County, Oklahoma. (A). Total cover (B). Draw cover (C). Slope cover.

Source	Degrees of freedom	Sum of squares	Mean square	F value	Observed significance level (α)
(A). Pastures	1	21.34	21.34	0.269	0.626
Coveys within pastures	6	476.58	79.43	1.805	0.121
Transects within coveys	42	1848.32	44.01		
Coveys	7	497.91	71.13	1.616	0.157
(B). Pastures	1	178.98	178.98	1.812	0.226
Coveys within pastures	6	592.49	98.75	6.443	0.000
Transects within coveys	42	643.69	15.33		
Coveys	7	771.48	110.21	7.191	0.000
(C). Pastures	1	0.41	0.41	0.004	0.952
Coveys within pastures	6	660.99	110.17	1.304	0.417
Transects within coveys	42	4473.22	106.51		
Coveys	7	661.40	94.49	0.887	0.525

Table 4. Analyses of variance of Symphoricarpos cover in the two intensive study areas, Rogers County, Oklahoma. (A). Total cover (B). Draw cover (C). Slope cover.

Source	Degrees of freedom	Sum of squares	Mean square	F value	Observed significance level ($\hat{\alpha}$)
(A).					
Pastures	1	274.59	274.59	10.892	0.016
Coveys within pastures	6	151.26	25.21	1.391	0.239
Transects within coveys	42	760.73	18.11		
Coveys	7	425.86	60.84	3.358	0.006
(B).					
Pastures	1	268.19	268.19	3.728	0.100
Coveys within pastures	6	431.59	71.93	1.532	0.191
Transects within coveys	42	1971.83	46.95		
Coveys	7	699.78	99.97	2.129	0.061
(C).					
Pastures	1	278.48	278.48	9.399	0.021
Coveys within pastures	6	177.77	29.63	0.893	0.509
Transects within coveys	42	1392.43	33.15		
Coveys	7	456.25	65.18	1.965	0.083

Table 5. Analyses of variance of _Rhus_ _copallina_ cover in the two intensive study areas, Rogers County, Oklahoma. (A). Total cover (B). Draw cover (C). Slope cover.

Source	Degrees of freedom	Sum of squares	Mean square	F value	Observed significance level ($\hat{\alpha}$)
(A).					
Pastures	1	165.45	162.45	2.252	0.183
Coveys within pastures	6	432.80	72.13	2.379	0.045
Transects within coveys	42	1273.48	30.32		
Coveys	7	595.25	85.04	2.805	0.017
(B).					
Pastures	1	250.88	250.88	4.527	0.076
Coveys within pastures	6	332.51	55.42	0.391	0.882
Transects within coveys	42	5939.33	141.41		
Coveys	7	583.39	83.34	0.589	0.762
(C).					
Pastures		118.58	118.58	1.121	0.332
Coveys within pastures		634.15	105.69	3.392	0.008
Transects within coveys		1308.79	31.16		
Coveys		752.73	107.53	3.451	0.006

Table 6. Analyses of variance of Rubus density in the two intensive study areas, Rogers County, Oklahoma. (A). Total density (B). Draw density (C). Slope density[a].

Source	Degrees of freedom	Sum of squares	Mean square	F value	Observed significance level (α)
(A).					
Pastures	1	3528.00	3528.00	0.519	0.503
Coveys within pastures	6	40789.41	6798.23	2.858	0.019
Transects within coveys	42	99896.59	2378.49		
Coveys	7	44317.41	6331.06	2.662	0.022
(B).					
Pastures	1	3732.48	3732.48	2.095	0.197
Coveys within pastures	6	10689.86	1781.64	3.944	0.004
Transects within coveys	42	18974.15	451.77		
Coveys	7	14422.33	2060.33	4.561	0.001
(C).					
Pastures	1	2.88	2.88	0.001	0.974
Coveys within pastures	6	16311.36	2718.56	1.421	0.229
Transects within coveys	42	80312.64	1912.21		
Coveys	7	16314.24	2330.61	1.219	0.314

[a] stems/m^2

Table 7. Analyses of varience of <u>Symphoricarpos</u> density in the two intensive study areas, Rogers County, Oklahoma. (A). Total density (B). Draw density (C). Slope density[a].

Source	Degrees of freedom	Sum of squares	Mean square	F value	Observed significance level (α)
(A).					
Pastures	1	14999.12	14999.12	4.116	0.087
Coveys within pastures	6	21863.45	3643.91	2.509	0.036
Transects within coveys	42	61009.75	1452.61		
Coveys	7	36862.57	5266.08	3.625	0.004
(B).					
Pastures	1	2035.22	2035.22	3.319	0.117
Coveys within pastures	6	3678.21	613.03	1.768	0.129
Transects within coveys	42	14565.56	346.79		
Coveys	7	5713.42	816.20	2.354	0.039
(C).					
Pastures	1	5984.18	5984.18	3.254	0.119
Coveys within pasture	6	11031.38	1838.56	1.419	0.229
Transects within coveys	42	54418.62	1295.68		
Coveys	7	17015.56	2430.79	1.876	0.098

[a] Stems/m^2

Table 8. Analyses of variance of Rhus copallina density in the two intensive study areas, Rogers County, Oklahoma. (A). Total density (B). Draw density (C). Slope density[a].

Source	Degrees of freedom	Sum of squares	Mean square	F value	Observed significance level ($\hat{\alpha}$)
(A).					
Pastures	1	2394.32	2394.32	1.516	0.264
Coveys within pastures	6	9478.43	1579.74	2.286	0.053
Transects within coveys	42	29028.37	691.15		
Coveys	7	11872.75	1696.11	2.455	0.033
(B).					
Pastures	1	292.82	292.82	3.547	0.107
Coveys within pastures	6	495.29	82.55	0.368	0.895
Transects within coveys	42	9425.90	224.43		
Coveys	7	788.12	112.59	0.502	0.829
(C).					
Pastures	1	1012.50	1012.50	0.824	0.598
Coveys within pastures	6	7372.19	1228.69	2.588	0.031
Transects within coveys	42	19943.08	474.84		
Coveys	7	8384.69	1197.81	2.523	0.029

[a] stems/m^2

APPENDIX B

SAMPLE SIZES, MEANS, AND STANDARD DEVIATIONS OF TREE COVER AND SHRUB COVER AND DENSITY VALUES

Table 1. Sample size, mean, and standard deviation of <u>Rubus</u> cover (%) per covey home range of the two intensive study areas, Rogers County, Oklahoma.

Cover	Covey	Sample size	Mean	Standard deviation
Draw	1[a]	10	0.80	0.86
Slope		10	3.75	9.25
Draw	2[a]	8	0.13	0.23
Slope		8	11.75	20.70
Draw	3[a]	7	0.86	0.63
Slope		7	2.07	2.15
Draw	4[b]	4	2.75	2.50
Slope		4	7.63	12.27
Draw	5[b]	5	14.00	11.20
Slope		5	10.80	2.28
Draw	6[b]	6	1.62	2.73
Slope		6	5.00	4.83
Draw	7[b]	4	0.75	0.96
Slope		4	2.38	2.49
Draw	8[b]	6	2.65	3.84
Slope		6	2.92	3.69

[a]Walnut Pasture

[b]Butler Pasture

Table 2. Sample size, mean, and standard deviation of Symphoricarpos cover (%) per covey home range of the two intensive study areas, Rogers County, Oklahoma.

Cover	Covey	Sample size	Mean	Standard deviation
Draw	1[a]	10	5.05	10.06
Slope		10	2.85	2.81
Draw	2[a]	8	3.38	4.57
Slope		8	2.44	2.56
Draw	3[a]	7	0.07	0.19
Slope		7	2.29	4.39
Draw	4[b]	4	4.50	3.69
Slope		4	7.50	12.48
Draw	5[b]	5	14.40	10.16
Slope		5	6.70	8.04
Draw	6[b]	6	4.83	4.02
Slope		6	6.75	4.49
Draw	7[b]	4	6.05	9.35
Slope		4	2.75	3.59
Draw	8[b]	6	8.43	4.83
Slope		6	11.16	7.68

[a]Walnut Pasture

[b]Butler Pasture

Table 3. Sample size, mean, and standard deviation of _Rhus copallina_ cover (%) per covey home range of the two intensive study areas, Rogers County, Oklahoma.

Cover	Covey	Sample size	Mean	Standard deviation
Draw	1[a]	10	6.40	20.24
Slope		10	0.20	0.63
Draw	2[a]	8	0.25	0.71
Slope		8	0.38	0.74
Draw	3[a]	7	8.71	18.57
Slope		7	11.43	14.50
Draw	4[b]	4	0.00	0.00
Slope		4	0.13	0.25
Draw	5[b]	5	3.00	6.71
Slope		5	1.40	3.13
Draw	6[b]	6	0.00	0.00
Slope		6	0.00	0.00
Draw	7[b]	4	0.00	0.00
Slope		4	0.00	0.00
Draw	8[b]	6	0.00	0.00
Slope		6	0.08	0.20

[a]Walnut Pasture

[b]Butler Pasture

Table 4. Sample size, mean, and standard deviation of Rubus density (stems/m^2) per covey home range of the two intensive study areas, Rogers County, Oklahoma.

Cover	Covey	Sample size	Mean	Standard deviation
Draw	1[a]	10	16.70	24.39
Slope		10	61.00	38.79
Draw	2[a]	8	4.25	3.92
Slope		8	81.88	53.54
Draw	3[a]	7	14.29	9.19
Slope		7	42.71	32.46
Draw	4[b]	4	53.75	40.78
Slope		4	79.75	70.58
Draw	5[b]	5	57.40	32.91
Slope		5	93.00	45.80
Draw	6[b]	6	8.83	8.28
Slope		6	56.83	35.49
Draw	7[b]	4	20.50	23.69
Slope		4	33.25	21.23
Draw	8[b]	6	19.33	18.22
Slope		6	49.00	43.34

[a] Walnut Pasture

[b] Butler Pasture

Table 5. Sample size, mean, and standard deviation of <u>Symphoricarpos</u> density (stems/m^2) per covey home range of the two intensive study areas, Rogers County, Oklahoma.

Cover	Covey	Sample size	Mean	Standard deviation
Draw	1[a]	10	18.60	23.69
Slope		10	17.30	22.49
Draw	2[a]	8	15.50	19.00
Slope		8	33.88	32.71
Draw	3[a]	7	0.86	2.27
Slope		7	13.29	21.42
Draw	4[b]	4	17.00	16.71
Slope		4	52.25	71.67
Draw	5[b]	5	31.20	17.21
Slope		5	40.20	37.41
Draw	6[b]	6	17.00	16.33
Slope		6	40.33	23.18
Draw	7[b]	4	18.00	21.79
Slope		4	7.00	9.69
Draw	8[b]	6	39.50	20.86
Slope		6	67.33	55.94

[a]Walnut Pasture

[b]Butler Pasture

Table 6. Sample size, mean, and standard deviation of Rhus copallina density (stems/m^2) per covey home range of the two intensive study areas, Rogers County, Oklahoma.

Cover	Covey	Sample size	Mean	Standard deviation
Draw	1[a]	10	9.20	29.09
Slope		10	2.10	6.64
Draw	2[a]	8	1.38	3.89
Slope		8	3.75	7.98
Draw	3[a]	7	8.71	13.43
Slope		7	39.57	50.67
Draw	4[b]	4	0.50	1.00
Slope		4	4.00	6.06
Draw	5[b]	5	7.00	12.12
Slope		5	13.20	29.52
Draw	6[b]	6	0.00	0.00
Slope		6	0.83	1.60
Draw	7[b]	4	0.00	0.00
Slope		4	0.00	0.00
Draw	8[b]	6	1.00	2.45
Slope		6	2.67	4.18

[a] Walmut Pasture

[b] Butler Pasture

APPENDIX C

LIST OF TAXA COLLECTED IN THE TWO INTENSIVE STUDY AREAS BETWEEN APRIL AND OCTOBER, 1976

A list of the taxa occurring in the two intensive study sites on the McFarlin-Ingersoll Ranch, Rogers County, Oklahoma, is given below. Families are arranged according to the Engler-Prantl classification scheme. Genera within a family are listed alphabetically. Nomenclature follows that of Waterfall (1972).

GRAMINAE

Andropogon gerardii Vitman
A. saccharoides Sw.
A. scoparius Michx.
A. ternarius Michx.
A. virginicus L.

Aristida dichotoma Michx., var. *dichotoma*
A. longespica Poir.
A. purpurascens Poir.
A. ramosissima Engelm.

Bouteloua hirsuta Lag.

Bromus secalinus L.
B. tectorum L.

Chloris verticillata Nutt.

Cinna arundinacea L., var. *inexpansa* Fern. & Grisc.

Digitaria filiformis (L.) Koel
D. Ischaemum (Schreb.) Muhl.

Echinochloa crusgalli (L.) Beauv.

Elymus canadensis L.
E. virginicus L.

Eragrostis hirsuta (Michx.) Nees
E. intermedia Hitchc.
E. spectabilis (Pursh.) Steud.
E. trichodes (Nutt.) Nash

Festuca octoflora Walt.

Hordeum pusillum Nutt.

Leersia oryzoides (L.) Sw.
L. virginica Willd.

Leptoloma cognatum (Schultes) Chase

Muhlenbergia Schreberi J.F. Gmel.
M. sobolifera (Muhl.) Trin.
M. sylvatica Torr.

Panicum agrostoides Spreng.
P. anceps Michx.
P. capillare L.
P. dichotomiflorum Michx.
P. dichotomum L.
P. lanuginosum Ell.
P. malacophyllum Nash
P. oligosanthes Schultes
P. philadelphicum Bernh.
P. polyanthes Schultes
P. scoparium Lam.
P. sphaerocarpon Ell.
P. virgatum L.

Paspalum laeve Michx., var. laeve
P. setaceum Michx., var stramineum (Nash) D. Banks

Phalaris caroliniana Walter

Poa annua L.

Setaria geniculata (Lam.) Beauv.

Sorghastrum nutans (L.) Nash

Spartina pectinata Link, var. Suttiei (Farw.) Fern.

Sporobolus asper (Michx.) Kunth
S. vaginiflorus (Torr.) Wood

Tridens flavus (L.) Hitchc.
T. strictus (Nutt.) Nash

Uniola latifolia Michx.

CYPERACEAE

Carex cephalophora Muhl.
C. Frankii Kunth
C. Muhlenbergii Schkuhr, var. enervis Boott
C. stipata Muhl.
C. stricta Lam., var. elongata (Boeck) Gleason

Cyperus strigosus L.
C. uniflorus Torr. & Hook.

Eleocharis compressa Sulliv.
E. obtusa (Willd.) Schultes
E. radicans (Poir.) Kunth

Scirpus loilolepis (Steud.) Gleason

COMMELINACEAE

Tradescantia ohiensis Raf.

JUNCACEAE

Juncus brachycarpus Engelm.
J. Dudleyi (Weig.) Hermann
J. interior Wieg.
J. marginatus Rostk.
J. secundus Beauv.

LILLIACEAE

Allium canadense L.

Nothoscordum bivalve (L.) Britton

Smilax Bona-nox L.
S. tamnoides L.

AMARYLLIDACEAE

Hypoxis hirsuta (L.) Coville

IRIDACEAE

Sisyrinchium angustifolium Miller

ORCHIDACEAE

Spiranthes cernua (L.) Richard

SALICACEAE

Populus deltoides Marsh.

Salix nigra Marsh.

JUGLANDACEAE

Carya tomentosa (Poir.) Nutt.

Juglans nigra L.

FAGACEAE

Quercus marilandica Muenchh.
Q. palustris Muenchh.
Q. stellata Wang.

ULMACEAE

<u>Celtis laevigata</u> Willd.
<u>C. occidentalis</u> Pursh

<u>Ulmus americana</u> L.

MORACEAE

<u>Morus alba</u> L.
<u>M. rubra</u> L.

POLYGONACEAE

<u>Eriogonum longifolium</u> Nutt.

<u>Polygonum aviculare</u> L.
<u>P. coccineum</u> Muhl.
<u>P. hydropiperoides</u> Michx.
<u>P. pennsylvanicum</u> L.
<u>P. Persicaria</u> L.
<u>P. punctatum</u> Ell.

<u>Rumex hastatulus</u> Baldw.
<u>R. hymenosepalus</u> Torr.

NYCTAGINACEAE

<u>Mirabilis albida</u> (Walt.) MacM.

PHYTOLACCACEAE

<u>Phytolacca americana</u> L.

AIZOACEAE

<u>Mollugo verticillata</u> L.

PORTULACACEAE

<u>Claytonia virginica</u> L.

CARYOPHYLLACEAE

<u>Arenaria Drummondii</u> Shinners

<u>Cerastium brachypodum</u> (Engelm.) Robinson

<u>Stellaria media</u> (L.) Cyrillo

NYMPHACEAE

<u>Nuphar advena</u> (Ait.) Ait.

RANUNCULACEAE

Anemone caroliniana Walt., forma violacea Clute

Delphinium tricorne Michx., forma albiflora Millsp.

Myosurus minimus L., var. interior Boivin

MENISPERMACEAE

Cocculus carolinus (L.) DC.

FUMARIACEAE

Corydalis crystallina Engelm.

CRUCIFERAE

Capsella bursa-pastoralis (L.) Medic.

Cardamine pennsylvanica Muhl.

Lepidium virginicum L.

ROSACEAE

Agrimonia parviflora Ait.

Crataegus coccinioides Ashe
C. Mackenzii Sarg.
C. viridis L.

Geum canadense Jacq.

Potentilla simplex Michx.

Prunus hortulana Bailey
P. Munsoniana Wright & Hedrick
P. serotina Ehrh.

Rosa setigera Michx., var. setigera

Rubus allagheniensis Porter

LEGUMINOSAE

Amorpha canescens Pursh., forma canescens

Astragalus crassicarpus Nutt., var. crassicarpus

Baptisia australis (L.) R. Br., var. minor (Lehm.) Fern.
B. bicolor Greenm. & Larisey
B. leucophaea Nutt., var leucophaea

Desmodium ciliare Nuhl.
D. laevigatum (Nutt.) DC.
D. sessilifolium (Torr.) Y. & G.

Lespedeza intermedia (L.) Britt.
L. repens (L.) Bart.
L. stipulacea Maxim.
L. Stuevei Nutt.
L. striata (Thunb.) H. & A.
L. violacea (L.) Pers.
L. virginica (L.) Britt.

Medicago minima (L.) Bartilini

Petalostemum purpureum (Vent.) Rydberg

Psoralea tenuiflora Pursh

Schrankia uncinata Willd.

Stylosanthes biflora (L.) BSP., var. hispidissima (Michx.) Pollard & Ball

LINACEAE

Linum rigidum Pursh.

OXALIDACEAE

Oxalis stricta L.
O. violacea L., var. violacea

POLYGALACEAE

Polygala sanguinea L.
P. verticillata L.

EUPHORBIACEAE

Acalypha gracilens Gray
A. virginica L.

Croton capitatus Michx.
C. glandulosus L., var. septentrionalis Nuehll. Arg.
C. Lindheimerianus Scheele
C. monanthogynous Michx.

Euphorbia corollata L.
E. supina Raf.

Stillingia sylvatica L.

Tragia betonicifolia Nuttall

ANACARDIACEAE

Rhus copallina L.
R. glabra L.
R. radicans L.

AQUIFOLIACEAE

Ilex decidua Walt.

VITACEAE

Parthenocissus quinquefolia (L.) Planch

Vitis cinera Engelm.
V. vulpina L.

MALVACEAE

Abutilon Theophrasti Medic.

VIOLACEAE

Viola Langloisii Greene
V. pedata L., var. *liniariloba* DC.
V. primulifolia L.
V. Rafinesquii Greene

CACTACEAE

Opuntia sp.

LYTHRACEAE

Cuphea petiolata (L.) Koehne

ONAGRACEAE

Gaura filiformis Small

Jussiaea peploides (HBK) Raven, var. ***glabrescens* (Ktze.) Shinners**

Ludwigia alternifolia L.

Oenothera linifolia Nuttall

UMBELLIFERAE

Chaerophyllum procumbens (L.) Crantz
C. texanum Coulter & Rose

Cicuta maculata L.

Polytaenia Nuttallii DC.

Ptilmnium *Nuttallii* (DC) Britt.

CORNACEAE

Cornus *Drummondii* Meyer
C. *obliqua* Raf.

SAPOTACEAE

Bumelia *lanuginosa* (Michx.) Pers.

EBENACEAE

Diospyros *virginiana* L., var. *virginiana*

OLEACEAE

Fraxinus *pennsylvanica* Marsh., var. *pennsylvanica*

GENTIANACEAE

Sabatia *campestris* Nuttall, forma *campestris*

APOCYNACEAE

Apocynum *cannabinum* L., var. *glaberrimum* A. DC.

ASCLEPIADACEAE

Asclepias *hirtella* (Pennell) Woodson
A. *tuberosa* L.
A. *viridis* Walt.

POLEMONIACEAE

Phlox *cuspidata* Scheele

HYDROPHYLLACEAE

Phacelia *strictiflora* (Engelm. & Gray) Gray

VERBENACEAE

Verbena *bracteata* Lag. & Rodr.
V. *canadensis* (L.) Britton
V. *hastata* L.

LABIATAE

Monarda *fistulosa* L., var. *fistulosa*

Physostegia *angustifolia* Fern.

Prunella *vulgaris* L., var. *lanceolata* (Bart.) Fern.

Pycnanthemum tenuifolium Schrad.

Salvia sp.

Scutellaria parvula Michx.

Teucrium canadense L.

SOLANACEAE

Datura Stramonium L.

Solanum carolinense L., forma *albiflorum* (O. Ktze.) Benke
S. rostratum Dunal

SCROPHULARIACEAE

Collinsia violacea Nuttall

Gerardia fasciculata Ell.
G. heterophylla Nuttall

Gratiola virginiana L.

Linaria canadensis (L.) Dumont, var. *texana* (Scheele) Pennell

Penstemon tubaeflorus Nuttall

Veronica peregrina L.
V. polita Fries

ACANTHACEAE

Justicia americana (L.) Vahl.

Ruellia humilis Nutt.

PLANTAGINACEAE

Plantago aristata Michx.
P. virginica L.

RUBIACEAE

Cephalanthus occidentalis L.

Diodia teres Walt., var. *setifera* Fern. & Grisc.

Galium Aparine L.

Hedyotis crassifolia Raf.
H. nigricans (Lam.) Fosb.

CAPRIFOLIACEAE

Symphoricarpos orbiculatus Moench

VALERIANACEAE

Valerianella radiata Dufr.

CAMPANULACEAE

Specularia leptocarpa (Nuttall) Gray
S. perfoliata (L.) A. DC.

LOBELIACEAE

Lobelia appendiculata A. DC.
L. spicata Lam.

COMPOSITAE

Achillea lanulosa Nutt., forma lanulosa

Ambrosia artemisiifolia L., var. elatior (L.) Descourtils
A. bidentata Michx.
A. psilostachya DC., var. coronopifolia (T. & G.) Farw.
A. trifida L., var. texana Scheele

Antennaria sp.

Artemisia ludoviciana Nuttall

Aster ericoides L.
A. praealtus Poir.

Bidens polylepis Blake

Boltonia asteroides (L.) L'Her.

Chrysopsis pilosa Nuttall

Cirsium altissimum (L.) Spreng

Coreopsis grandiflora Hogg

Conyza canadensis (L.) Cronq., var. glabrata (Gray) Cronq.

Echinacea pallida Nuttall

Elephantopus carolinianus Willd.

Erigeron philadelphicus L.
E. strigosus Muhl. ex Willd.

Eupatorium altissimum L.
E. perfoliatum L.
E. rugosum Horett.
E. serotinum Michx.

Gaillardia lanceolata Michx., var. fastigiata (Greene) Waterfall

Gnaphalium obtusifolium L.

Gutierrizia dracunculoides (DC.) Blake

Helenium amarum Raf.
H. autumnale L.

Krigia oppositifolia Raf.

Liatris aspera Michx., var. aspera
L. punctata Hooker

Pyrrhopappus scaposus DC.

Rudbeckia hirta L.

Solidago canadensis L., var. gilvocanescens Rydb.
S. canadensis L., var. scabra (Muhl.) T. & G.
S. gymnospermoides (Greene) Fern.
S. missouriensis Nutt.
S. nitida T. & G.
S. radula Nutt.

Vernonia altissima Raf.
V. Baldwinii Torr.

Xanthium strumarium L., var. canadense (Mill.) T. & G.

VITA 2

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Master of Science

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Major Field: Botany

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