BREEDING HABITAT OF THE BOBWHITE IN TEXAS[1]

ROB. R. REID, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station

CHRISTIAN E. GRUE, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station

NOVA J. SILVY, Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station

Abstract: Habitat types and structural features of the habitat were correlated with bobwhite (*Colinus virginianus*) whistle counts along 133 random transects in Texas. The probable biological significance of these parameters was ascertained by their interrelationships and from the literature. Bobwhite whistle counts were correlated with habitat types that provided adequate food, cover, nest sites, and song posts. If a habitat parameter provided one or more of these requisites and was limited or in excess, it was usually significantly correlated with bobwhite whistle counts. Mesquite (*Prosopis* spp.) habitats were important nesting sites for bobwhite within 7 of 9 ecological areas in which they occurred. Habitat parameters correlated with bobwhite densities differed between ecological areas and therefore, bobwhite breeding habitat should be managed by ecological area.

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Many field studies have been conducted on the bobwhite, however, they have reflected only general requirements of food, cover, and nesting habitat. Under early agricultural practices in the United States, quail flourished and extended their range. As agriculture became more mechanized, quail food supply was lessened and their numbers declined (Stoddard 1931, Schumacher 1969). In Texas, bobwhite are one of the most popular game birds (Jackson et al. 1966).

The methods for collecting data from whistle-count transects are well established (Bennitt 1951, Rosene 1957). Although the majority of bobwhite whistling is by unmated males (Stoddard 1931, Kabat and Thompson 1963, Stokes 1967), roadside counts of whistling bobwhite have been used as an index to relative abundance (Bennitt 1951, Elder 1956, Rosene 1957, Norton et al. 1961). If the number of males heard whistling within a radius of 0.8 km is an index to relative abundance (Baxter and Wolfe 1973), it should be possible to determine which habitat parameters are associated with high and low quail density. The habitat parameters associated with high quail density could then be used as a guide to habitat management for bobwhite. The objective of this study was to identify these habitat parameters as they relate to quail density estimated from road transect whistle counts in Texas.

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METHODS

The breeding habitat of the bobwhite was classified and inventoried on 133 transects within 10 ecological areas (Gould 1975) of Texas (Fig. 1). Each call-count transect was 24 km long and randomly established by the Texas Parks and Wildlife Department (Dunks 1975)

Through the cooperation of the Texas Parks and Wildlife Department, bobwhite whistle counts were obtained for the 133 transects. Each transect was surveyed three times between 20 May and 10 June 1976. Whistle-count data were collected at 1.6 km intervals (stops) along each 24 km transect, beginning 0.5 h before sunrise and ending 1.5 h after sunrise. An audio count was made of the total number of quail heard whistling during a 3 min period at each of 15 stops along each transect. Whistle counts were not conducted if it was raining or the wind speed was greater than 3 on the Beaufort Scale.

Habitat along the transects was also surveyed between 20 May and 10 June 1976, utilizing a method of classifying habitats from a vehicle (Grue et al. 1976, Reid 1977). Habitat type was defined as a description of the vegetation of an area consisting of a unique combination of canopy height, composition, and spatial distribution. The habitat was classified on both sides of each transect starting 0.8 km before and ending 0.8 km after each stop. Each of these 1.6 km units was defined as a transect interval. The linear distance of each observation of a habitat type intersecting the survey route was measured to the nearest 0.02 km, and the number of structural features present were recorded simultaneously within each transect interval on the 133 transects.

A two-way factorial analysis of variance with 15 observations per call was used to test for significant differences in whistle counts between the 3 surveys. Whistle-count data for each of the 3 surveys conducted on the 133 transects were included in all analyses because the variation in whistle counts between surveys was significant ($F = 1.65$; $df = 90{,}2002$; $P < 0.0003$). Transect whistle counts were calculated by determining the sum of the whistle counts for each of the 15 stops. Values for habitat types and structural features were defined as the sum of their linear distances and number within a transect, respectively.

Habitat interspersion and diversity indices were included as habitat parameters in addition to the 87 observed on the 133 whistle-count transects. An index to minimum habitat interspersion was developed based on the number of habitat types present within a transect as well as the presence or absence of each habitat type within adjacent transect intervals. If a particular habitat type was present within a transect interval but was absent within an adjacent interval, the value of the interspersion index increased by 1. Conversely, if a particular habitat type was present or absent within two adjacent transect intervals, interspersion was equal to 0 and the value of the index remained unchanged. This process was continued until all habitat types were examined within the 15 transect intervals of each of the 133 whistle-count transects. The interspersion-index on a particular transect was equal to this value plus the number of habitat types intersecting the transect. Habitat diversity was calculated for each transect using the Shannon-Wiener Index (Shannon 1948). This index incorporated the number of habitat types intersecting a survey route as well as their relative dominance. Individual crops were not included in either the interspersion or diversity indices because it was not possible to include cropland as a whole and diversions thereof within one index.

Habitat types and structural features significantly correlated with bobwhite whistle counts were identified from a matrix of product-moment correlation coefficients. The "Corr" procedure of the Statistical Analysis System (Barr and Goodnight 1972) was used. All the structural features and habitat types within the habitat classification scheme of Grue et al. (1976) were included. The probable biological significance of these habitat parameters were determined by their interrelationships and from literature on the bobwhite. Correlations were considered significant if $P \leq 0.05$.

RESULTS AND DISCUSSION

Mean transect whistle counts for bobwhite were determined for each ecological area, except the Trans-Pecos where bobwhite whistles were not heard (Table 1). Mean transect whistle counts were highest within the Cross Timbers and Prairies and lowest on the High Plains.

Pineywoods

Within the Pineywoods, road shoulder width, and structural features associated with edge and habitat interspersion (Table 2) were positively correlated with bobwhite whistle counts, and may have served as calling and/or nest sites. Edge ($r = 0.51$), intersecting fences ($r = 0.45$), and intersecting windbreaks ($r = 0.73$) were structural features significantly correlated with habitat interspersion. Parallel fences, buildings, intersecting railroad rights-of-way, and wide road shoulders were other structural features associated with high quail density, which may have been due to the openings they create in the extensive forests associated with this ecological area. Lay (1954) also found edges and fencerows important as nest sites for bobwhite in east Texas. Intersecting windbreaks may have also been important nesting cover. Wide road shoulders may have provided nesting and feeding habitat. In addition, parallel and intersecting fences, and intersecting windbreaks may have served as calling sites. Klimstra and Roseberry (1975) found 60 percent of bobwhite nests to be within 5 m of a break in the cover pattern in Illinois. Hanson

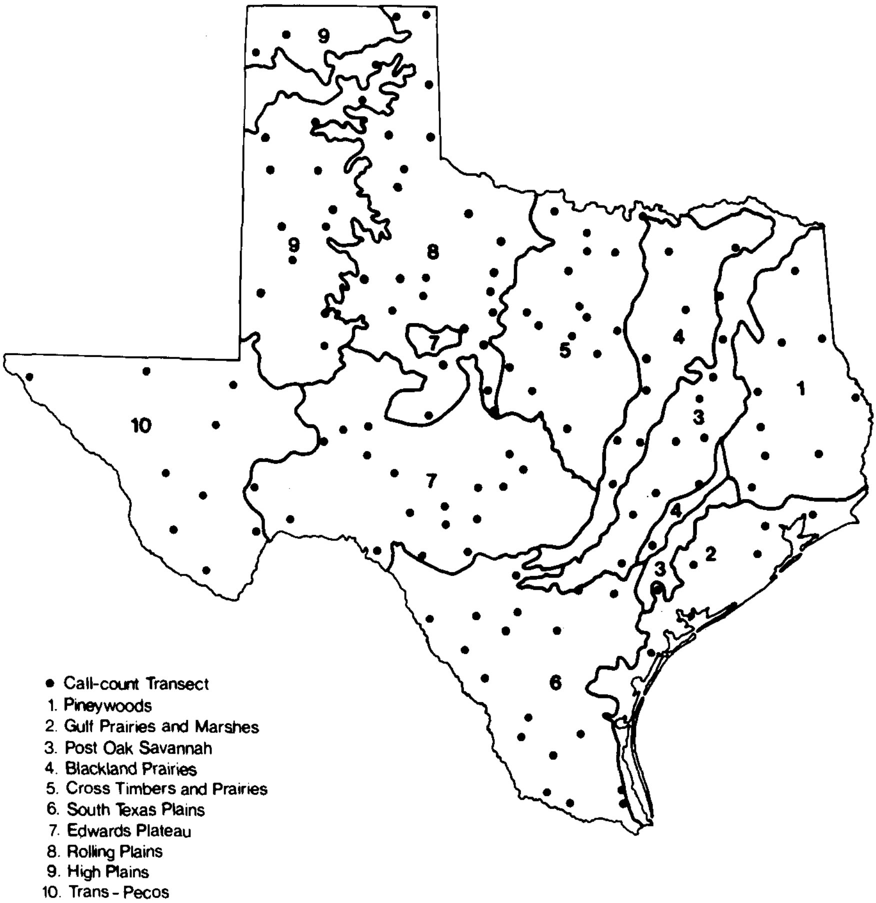

Fig. 1. Locations of the 133 call-count (whistle-count) transects within the 10 ecological areas (after Gould 1975) of Texas.

Table 1. Mean transect whistle counts for bobwhite by ecological area.

Ecological area		*Bobwhite whistle counts*				
No.	*Name*	*N*	*X*	*S.D.*	*Low*	*High*
1	Pineywoods	9	13	12.8	0	37
2	Gulf Prairies and Marshes	6	43	16.4	24	75
3	Post Oak Savannah	9	30	19.5	8	78
4	Blackland Prairies	10	29	13.2	5	52
5	Cross Timbers and Prairies	17	46	27.7	8	118
6	South Texas Plains	18	27	18.9	0	81
7	Edwards Plateau	18	12	15.6	0	71
8	Rolling Plains	23	38	26.4	0	95
9	High Plains	14	6	8.2	0	31
10	Trans-Pecos	9	0	0.0	0	0

and Miller (1961) suggested that the opening or thinning of forests should receive considerable attention from game managers.

Correlations between habitat types and whistle counts also suggested bobwhite were selecting breaks in the cover pattern within the Pineywoods. Pastures, orchards, mesquite and other deciduous habitats were associated with high quail density (Table 3). The edge of pastures and orchards may have been important nest locations. These areas may have provided the tall grass needed for nesting (Lay 1954, Rosene 1969, Klimstra and Roseberry 1975). Bobwhite appear to have been selecting breaks in the conifer forests as well as mesquite habitats and conifer woodland and forest without understory. The relatively open canopy and branching pattern of mesquite and other deciduous habitats may allow bobwhite adequate protection as well as exposure to sunlight for warming with minimum interference for flight (Stoddard 1931). Data also suggested that

Table 2. Product-moment correlation coefficients for structural features significantly ($P < 0.05$) correlated with bobwhite whistle counts by ecological area.

	Ecological area[a]								
Structural features	1	2	3	4	5	6	7	8	9
Edge	0.52	0.61	ns[b]	ns	ns	-0.41	ns	ns	ns
Buildings	0.41	0.58	ns	ns	ns	-0.40	ns	ns	0.31
Snags	ns	ns	0.87	ns	ns	0.54	0.39	0.25	
Brush piles	ns		ns		0.35	0.58			
Washes				ns	-0.32	ns	ns	ns	
Gravel pits			ns	ns	ns	ns		ns	
Livestock feeders	ns	ns	ns	ns	ns	ns		ns	
Irrigation pumps		ns					ns		ns
Road shoulders	0.73	ns	ns	ns	ns	ns	ns	ns	ns
Intersecting roads	ns	ns	-0.44	-0.43	ns	-0.38	ns	-0.28	ns
Road surface									
asphalt	ns	-0.60	ns	ns	ns	0.47	ns	ns	0.49
dirt	ns	0.82	ns	-0.39	0.30	-0.28	0.36	ns	-0.62
gravel	ns	ns	ns	ns	ns	-0.50	ns	ns	0.37
sand	ns	0.82	ns	ns	ns	ns		ns	
Railroads									
intersecting	0.43		ns	ns	-0.40	ns	ns	ns	ns
parallel	ns		ns	ns		ns			ns
Powerlines									
intersecting	ns	ns	ns	ns	ns	-0.29	ns	ns	ns
parallel	ns	0.64	ns	ns	ns	-0.37	0.36	ns	0.35
Fences									
intersecting	0.70	0.68	ns	ns	ns	ns	0.42	ns	ns
parallel	0.48	ns	ns	ns	0.58	0.49	ns	ns	-0.33
Shrubrows									
intersecting	ns	ns	ns	ns	ns	ns		ns	0.69
parallel	ns	ns	ns	ns	ns	ns	ns	0.26	0.69
Windbreaks									
intersecting	0.69	ns	ns	ns	ns	ns		0.27	ns
parallel	ns	0.70	ns	ns	ns	ns	0.30	ns	ns
Water									
number of sources	ns	ns	ns	ns	ns	ns	ns	ns	ns
presence of	ns	ns	ns	ns	ns	ns	0.27	ns	ns
Habitat interspersion	0.55	-0.60	ns	ns	ns	ns	0.51	0.33	0.80
Habitat diversity	ns	-0.63	ns	ns	ns	0.51	0.34	0.47	0.44

[a]Number for ecological areas correspond to names given in Table 1.
[b]Nonsignificant, $P < 0.05$.

Table 3. Product-moment correlation coefficients for habitat types significantly ($P \leq 0.05$) correlated with bobwhite whistle counts by ecological area.

	Ecological area[a]								
Habitat type	1	2	3	4	5	6	7	8	9
URBAN	ns[b]	ns	ns	ns	ns	-0.32	ns		ns
BARREN	ns		ns	ns	ns	ns		ns	
CROPLAND	ns	0.81	ns	ns	ns	-0.49	0.28	-0.28	ns
Grain crops	ns	0.83	0.57	ns	-0.36	-0.54		-0.38	-0.47
sorghum		0.72	0.79	ns	ns	-0.52		ns	0.57
corn	ns	0.86	0.54	ns	0.32	ns		-0.32	ns
wheat			ns	ns	ns	ns		-0.35	-0.46
oats	ns		ns	ns	-0.36	ns		ns	
rice		ns	ns						
Non-grain crops	ns	0.83	-0.56	ns		-0.42			
rootcrops		0.82	ns			ns			
fiber crops		0.82		ns		-0.44			
vegetable crops	ns	0.82	ns			ns			
Hay	ns	0.70	0.48	ns	ns	ns	ns	ns	ns
Plowed land	ns	ns	-0.50	-0.41	ns	ns	0.36	ns	0.51
PASTURE	0.73	ns	ns	ns	ns	ns	ns	ns	-0.48
SHRUBS									
Savannah	0.67	ns		0.39	ns	ns	-0.33	ns	ns
mesquite	0.71	ns	0.59	-0.51	ns	ns		0.25	0.37
mixed mesquite			ns		ns	0.53			
Parkland	ns	ns	ns	ns	ns	ns	ns	ns	ns
mesquite		ns	0.81	ns	ns	0.28		0.41	0.79
mixed mesquite		ns	ns		ns	0.48			
Shrubland	ns	ns	-0.56	ns	0.35	ns	ns	ns	0.82
mesquite	ns	0.58			ns	ns	ns	ns	0.69
mixed mesquite		ns	0.79		ns	ns	-0.31		
BRUSH									
Parkland	0.71					ns			
Brushland	0.71					ns	0.68		
with mesquite						ns			
TREES									
Savannah									
deciduous	0.80	ns	ns	ns	0.40	ns	0.56	0.40	
conifer	0.71		ns		ns			ns	
mixed	0.78		-0.45	0.40	ns				
mesquite			ns	ns	-0.43	0.60	0.46	ns	0.70
mixed mesquite		ns	0.86	ns	ns	ns	0.68	0.31	
Parkland									
deciduous	0.47	ns	ns	ns	ns	ns	ns	ns	0.40
conifer	ns	ns	ns	ns	ns		0.28	-0.32	
mixed	ns		ns	ns	ns	ns	ns		
mesquite		ns	ns	ns	ns	0.72	ns	0.41	0.40
mixed mesquite		ns	0.83	ns	-0. 2	0.28	0.26	ns	
Woodland									
deciduous	ns	ns	ns	ns	ns	0.27	ns	ns	
with understory	ns	ns	ns	ns	ns	ns	ns	ns	
without		0.82	-0.57	ns	ns	0.28	ns	ns	
conifer	-0.65	ns	ns		ns				
with understory	-0.80		ns						
without	ns	ns	ns		ns				
mixed	-0.70		ns	ns	ns	ns	ns		
with understory	-0.73		ns	ns	ns				
without	ns		ns				ns		
mesquite		ns	0.86	ns	ns	ns	ns	ns	0.75
mixed mesquite		0.71	0.87	ns	ns	0.30	0.31	ns	0.40

Table 3 (continued)

Habitat type	Ecological area[a] 1	2	3	4	5	6	7	8	9
Orchard	0.71	ns	ns	ns	ns	ns		ns	
Forest									
deciduous	0.54		-0.51	ns	ns		ns		
with understory	0.53		-0.52	ns	ns				
without	ns		ns	ns	ns		ns		
conifer	-0.61		ns						
with understory	-0.62								
without	ns		ns						
mixed	ns		ns					ns	
with understory	ns		ns					ns	
without	ns								

[a]Number for ecological areas corresponds to names given in Table 2.
[b]Nonsignificant, $P \leq 0.05$.

bobwhite were not selecting habitat types in proportion to their occurrence. Deciduous habitats comprised less than 5 percent of the land area intersecting the whistle-count transects.

Gulf Prairies and Marshes

Within the Gulf Prairies and Marshes, edge was positively correlated with bobwhite whistle counts, whereas habitat interspersion and diversity were correlated with low quail density (Table 2). Edge may have been positively correlated with whistle counts because borders between dissimilar crops were considered an edge, but were not in the interspersion and diversity indices. These breaks were often narrow dirt roads surrounded by tall grasses and forbs, and may have provided cover and accessibility to feeding areas. Dirt and sand roads were positively correlated with whistle counts (Table 2) and also associated with croplands, whereas asphalt roads were negatively correlated with quail density. Intersecting fences ($r = 0.64$), parallel powerlines ($r = 0.66$), and buildings ($r = 0.70$) were significantly correlated with edge as well as whistle counts. Parallel windbreaks were also positively correlated with bobwhite density (Table 2). These structural features may have been important as nesting and/or calling sites. Nesting cover associated with buildings may have been important because more than 70 percent of the land within the ecological area was cultivated or pasture.

Habitat types positively correlated with bobwhite whistle counts on the Gulf Prairies and Marshes included several types of cropland, and deciduous woodland without understory (Table 3). In addition to being positively correlated with whistle counts, sorghum ($r = 0.61$), corn ($r = 0.72$), rootcrops ($r = 0.69$), fiber crops ($r = 0.69$), vegetable crops ($r = 0.89$), and hay ($r = 0.84$) were significantly correlated with edge. Deciduous woodland without understory ($r = 0.69$) was also significantly correlated with edge and may have provided nesting cover. Hanson and Miller (1961) found the edge of cultivated fields was the habitat most utilized by bobwhite in Illinois. In Iowa, cropland was the second habitat type most utilized by bobwhite (Crim and Seitz 1972-1973). Cropland may have been utilized as feeding areas, and edges may have provided nesting cover.

Post Oak Savannah

Snags, sorghum, corn, hay, and eight habitat types containing mesquite were positively correlated with whistle counts in the Post Oak Savannah (Tables 2 and 3). Intersecting roads, non-grain crops, shrubland, mixed savannah, deciduous woodland without understory, and deciduous forest with understory were negatively correlated with quail density. Snags were positively correlated ($P<0.05$) with 8 of the 12 mesquite habitat types present and may have served as song posts. Bobwhite appeared not to be selecting habitat types in proportion to their occurrence within this ecological area because cropland and mesquite habitats comprised less than 12 percent of the land area intersecting the whistle-count transects. These data suggest that bobwhite may have been utilizing croplands as feeding aeras when the whistle-count surveys were conducted, and may have been selecting mesquite for cover and nest sites in favor of other deciduous habitats, primarily post oak (*Quercus stellata*). The more open canopy associated with mesquite may allow for abundant growth of grasses and forbs while providing adequate cover. Parmalee (1955) found the majority of bobwhite in the post oak region utilized the better grass cover along roadsides, in pastures, and in hay fields as nest sites, although brush and woodlands were also used to a limited extent.

Blackland Prairies

Intersecting roads and dirt road surface were negatively correlated with bobwhite whistle counts on the Blackland Prairies (Table 2). These structural features may have been associated with low quail density because of their abundance, particularly within cultivated areas.

Plowed land and mesquite shrub savannah were also negatively correlated with whistle counts (Table 3). Plowed land was probably negatively correlated with whistle counts because nearly 38 percent of the land area intersecting the whistle-count transects within this ecological area was under cultivation. Suitable nesting sites may have been limited within these areas. At the time whistle-count surveys were conducted, the majority of the cropland was freshly plowed. Cultivation was usually contiguous with roads, and fencerows were lacking. These cultivation practices leave little or no cover for quail (Schumacher 1969). Reasons for the negative correlation between mesquite shrub savannah and whistle counts were not apparent.

Shrub and mixed savannahs were positively correlated with whistle counts (Table 3), yet they comprised less than 1 percent of the total land area intersecting the whistle-count transects. Cropland and pasture comprised almost 77 percent of the ecological area. These data suggest that adequate nesting cover may have been lacking in many areas. Bobwhite seem to have selected areas with woody vegetation as nesting habitat. Klimstra and Roseberry (1975) found that in Illinois prime bobwhite nesting cover was typified by scattered shrubs and briars interspersed with a moderately dense stand of herbaceous and grassy vegetation.

Cross Timbers and Prairies

Within the Cross Timbers and Prairies, structural features correlated with high quail density included parallel fences, brush piles, and dirt road surface, whereas washes and intersecting railroad rights-of-way were negatively correlated with whistle counts (Table 2). Parmalee (1955) and Klimstra and Roseberry (1975) found fencerows provided good cover for bobwhite. Fences and their associated vegetation bordering the more open habitats in this ecological area may have provided nest sites. Brush piles provide cover for bobwhite (Lay 1954, Jackson et al. 1966) and may have also been used as song posts. The surface of dirt roads may have served as dusting areas for bobwhite, as shown by Rosene (1969). Reasons for the negative correlation coefficients for washes and railroad rights-of-way were not apparent.

With the exception of corn, grain crops were negatively correlated with whistle counts (Table 3). Rosene (1969) found that corn is the best crop for quail because it provides good cover and feeding areas. Insects are a food source before harvest and waste corn is plentiful after harvest. At the time the whistle-count surveys were conducted, corn plants were relatively immature. However, they may have provided cover and places for bobwhite to feed on insects. Bobwhite appeared to select shrubland and deciduous savannah as nesting habitat (Table 3). These two habitat types comprised only 1.1 and 10.8 percent of the land area intersecting the whistle-count transects, respectively. Mesquite habitats appear not to have been important as breeding habitat for bobwhite in this ecological area, as none of the 6 mesquite habitats present were positively correlated with whistle counts. Jackson et al. (1966) also found that this area of Texas offers examples of almost ideal bobwhite cover.

South Texas Plains

Snags, brush piles, asphalt road surface, and parallel fences were structural features positively correlated with bobwhite whistle counts on the South Texas Plains, while edge, buildings, powerlines, intersecting roads, and dirt and gravel road surface were negatively correlated with quail density (Table 2). Habitat diversity was also positively correlated with bobwhite whistle counts. The difference in sign of the correlation coefficients for edge and habitat diversity may have resulted because the diversity index did not include cropland divisions, whereas our definition of edge did. There was a significant correlation between cropland and edge ($r = 0.67$). In addition, our definition of edge included both sides of intersecting roads. The number of edges within this area was high due to the large number of intersecting roads and breaks in cropland. That powerlines, intersecting roads, and buildings were negatively correlated with whistle counts supports this conclusion. Parallel powerlings (r = 0.70), intersecting powerlines (r = 0.70), buildings (r = 0.79), and intersecting roads (r = 0.62) were also significantly correlated with age. Parallel fencerows may have provided nesting cover. Brush piles may have served as cover and/or song posts. Snags may have also served as whistling posts. Asphalt roads may have been positively correlated with whistle-counts because the greater runoff may have improved nesting cover on associated road shoulders, compared to gravel, sand, or dirt roads.

Bobwhite density was negatively correlated with urban development, sorghum and fiber crops (Table 3). Whistle-count surveys conducted within towns may have been affected by the noise associated with these areas. Bobwhite density was positively correlated with 7 mesquite habitats and deciduous woodland without understory (Table 3). These mesquite habitats were the taller and/or more open habitat types on the South Texas Plains. Lehman (1946) found that bobwhite on the South Texas Plains preferred open mesquite semi-prairie, and that other woody plants were important only as shade and whistling posts. Kiel (1976) observed no adverse effects to bobwhite populations in south Texas when 85 percent of an area was rootplowed.

Edwards Plateau

On the Edwards Plateau, intersecting fences, parallel powerlines and windbreaks, the presence of water and snags, and dirt road surface were positively correlated with whistle counts (Table 2). Intersecting fences were probably associated with breaks in the habitat. Both habitat interspersion and diversity were also positively correlated with quail density (Table 2). Parallel windbreaks may have provided nesting and calling sites. Data indicated that bobwhite nested in areas where water was present. Rosene (1969) reported that even though artificial ponds failed to produce increases in bobwhite density within their normal range, free water or dew was necessary for the bobwhite's survival. Snags were again significantly correlated with the presence of mesquite and may have served as calling sites. Dirt road surfaces may have been important as dusting areas.

Cropland, brushland, deciduous savannah, conifer (*Juniperus* spp.) parkland, and most habitats containing mesquite trees were associated with high whistle counts (Table 3). Bobwhite density was low within shrub savannah and mixed mesquite shrubland. Croplands comprised less than 1 percent of the land area intersecting the whistle-count transects and may have been utilized as feeding areas. Data suggested bobwhite were selecting the taller mesquite habitats as nest sites.

Rolling Plains

Bobwhite density was positively correlated with parallel shrubrows, intersecting windbreaks, and snags, and negatively correlated with intersecting roads (Table 2). Parallel shrubrows may have provided nesting cover. Snags probably served as whistling posts and were positively correlated ($P<0.05$) with 4 of the 7 mesquite habitat types present. Windbreaks, shrubrows, and snags were structural features associated with the more open habitat types. Intersecting roads were probably associated with cropland which was negatively correlated with quail density. Habitat interspersion and diversity were positively correlated with bobwhite whistle counts. Jackson (1969) also found habitat interspersion to be an important factor in bobwhite management on the Rolling Plains.

Mesquite shrub savannah and parkland, deciduous savannah, mixed mesquite savannah, and mesquite parkland were associated with high quail density, whereas corn, wheat, and conifer parkland were correlated with low whistle counts (Table 3). These data indicated bobwhite preferred the woody habitats for nesting, particularly mesquite. Mesquite was the most abundant and important woody cover for quail on the Rolling Plains, but acreages of mesquite were probably far greater than necessary for maximizing bobwhite numbers (Jackson et al. 1966). Mesquite is regarded as undesirable by range managers, but its entire removal from an area will displace bobwhite (Jackson 1969).

High Plains

Structural features positively correlated with bobwhite density on the High Plains included buildings, asphalt and gravel roads, parallel powerlines, and shrubrows, (Table 2). With the exception of road surface material, these structural features may have divided extensive croplands and provided nesting cover, as over 96 percent of the land intersecting the whistle-count transects was cultivated or overgrazed pastures. Habitat interspersion and diversity were also positively correlated with quail density. As on the Blackland Prairies, farming practices on the High Plains appeared not to be beneficial to bobwhite. Cultivation was contiguous with dirt roads, leaving little nesting cover. Dirt road surface and parallel fences were also associated with low whistle counts (Table 2). The latter was commonly associated with overgrazed pastures.

Sorghum, plowed land, shrubland, deciduous parkland, and all mesquite habitat types present were positively correlated with bobwhite density, whereas wheat and pastures were associated with low whistle counts (Table 3). All woody habitat types appeared to be important as nest sites. Woody vegetation comprised less than 4 percent of the total land area intersecting the whistle-count transects, and over 85 percent of this was mesquite. Wheat may not have been an important food source; Rosene (1969) found that wild bobwhite at feeders selected against wheat seeds. Pastures in this region were short and provided little nesting cover. Reasons for the positive correlation between plowed land and whistle counts were not apparent.

CONCLUSIONS

Product-moment correlation coefficients between habitat parameters and bobwhite whistle counts within the 10 ecological areas of Texas indicated:

(1) Bobwhite density was correlated with habitat parameters that provided adequate food, cover, nest sites, and song posts. If any habitat parameter providing 1 or more of these requisites was limited, it was usually positively correlated with whistle counts. Conversely, an excess of any habitat parameter which did not provide all of these requirements was usually negatively correlated with quail density.

(2) Mesquite appeared to be important cover for nesting bobwhite within 7 of the 9 ecological areas in which they occurred.

(3) Habitat parameters correlated with bobwhite density differed between ecological areas and therefore, the breeding habitat of the bobwhite should be managed by ecological area.

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