Effect of Prescribed Fire on Bobwhite Quail Habitat in the Rolling Plains of Texas

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Highlight: Bobwhite quail preferred lotebush as loafing cover over all other woody plants, although honey mesquite was also used during summer months. Most (88.3%) lotebushes on the study area were resprouts of burned plants. During the first 5 to 6 years after burning, quail used large lotebushes that had escaped fire or were partially defoliated. Following fire, only 3.9 lotebushes/ha were available as cover for quail. Little covey movement was observed between seasons, indicating yearlong cover requirements were being met within a fairly small area. Before burning large pastures, at least 10 large honey mesquite and 4 large lotebushes per hectare in each primary rest area should be ringed with 7-m firebreaks to insure adequate cover for quail.

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This research was supported in part by the Forest Service, U.S. Department of Agriculture, through the Eisenhower Consortium for Western Environmental Forestry Research, and is published as Eisenhower Consortium Journal Series No. 16, and as Texas Tech University, College of Agricultural Sciences Publication No. T-9-167.

Manuscript received May 20, 1977.

Prescribed burning is a useful tool to manage tobosagrass (*Hilaria mutica*)-honey mesquite (*Prosopis glandulosa* var. *glandulosa*) communities for livestock production in the Rolling Plains of West Texas (Wright 1972), but its effects on bobwhite quail (*Colinus virginianus*) habitat have not been evaluated. Suitable habitat must contain some type of brush or woody cover where quail can rest most of the day (Robinson 1957; Casey 1965). Present burning prescriptions (Wright 1974) remove most cover because they are designed to eliminate dead mesquite stems and to top-kill resprouts of associated shrubs. Lotebush (*Ziziphus obtusifolia*) is a co-dominate with mesquite throughout the Rolling Plains and is the primary source of fall, winter, and spring cover for bobwhite quail in the Rolling Plains.

Fire has never been used extensively for quail management in Texas and has never been used in the Rolling Plains of West Texas, which is near the western edge of the bobwhite quail range (Jackson 1969). Jackson (1969) attributed this to the danger of fire plus the widely held belief that fire is a destructive

force in grassland management. He believed that the only alternatives left to retard succession were discing or grazing even though he recognized the benefits of fire in increasing grass and forb production. Jackson (1969) reported one instance where a wildlife management area was burned by a wildfire covering 2,000 acres. Regrowth of plants in the burned area produced 15% more quail food than the unburned area with most of the unburned land decreasing in food production the following year. However, the loss of shrub cover in grasslands after fire may have offset any food benefits.

This study was conducted from November 1, 1973, to September 1, 1975, to determine the effects of a 7-year burning program on bobwhite quail habitat, particularly woody cover. Field work was directed at habitat measurements and quail population studies following prescribed burns.

Study Areas and Methods

The study area, which was sprayed with 2,4,5-T (2,4,5-trichlorophenoxy acetic acid) in 1966, is on the Renderbrook-Spade Ranch, 32.2 km south of Colorado City, Tex., in Mitchell County. The area lies on the southwest edge of the Rolling Plains described by Thomas (Gould 1969). Average precipitation is 48.2 cm per year. Slopes range from 0 to 3% on a Stamford Clay (Typic Chromustert) soil. Vegetation is dominated by tobosagrass, buffalograss (*Buchloe dactyloides*), and annual broomweed (*Xanthocephalum dracunculoides*), with an overstory of honey mesquite and scattered lotebush.

Seven treatments and one control were used to evaluate the effect of fire on quail habitat. These included areas burned in 1969 (109.7 ha), 1970 (57.1 ha), 1971 (60.2 ha), 1972 (123.1 ha), 1973 (71.2 ha), 1974 (73.2 ha), 1975 (91.1 ha), and an unburned control (140.8 ha).

Bobwhite quail coveys were located using the territory-mapping technique (Overton 1971). Coveys were flushed at midday to identify plants used as loafing cover. Preliminary observations indicated that lotebush was a preferred loafing site and this study was undertaken to characterize the plants used by quail.

Thirty plants were selected in each of the seven treatment areas (1, 2, 3, 4, 5, 6, and 7 year-old burns) plus the control. Fifteen of the lotebushes selected were used by quail and 15 were randomly chosen. A volume figure for each plant was calculated by multiplying the mean height × width × length. Understory characteristics were recorded as light grass (< 50% herbaceous cover), heavy grass (> 50% herbaceous cover), light litter (< 50% ground cover), heavy litter (> 50% ground cover), and percent bare ground. The height and cover of vegetation adjacent to lotebushes used by quail which might have affected visibility or escape routes were recorded along a 1 m tansect in each of the four cardinal directions beginning at the edge of the lotebush canopy.

The minimum size of lotebush used by quail was identified by averaging the volume measurements of the two smallest plants used in each treatment area. Ages of closed-canopy resprouts used by quail were estimated by counting rings from the two largest stems of each plant. This aided in determining the age at which lotebushes would be of value to quail following fire. Volume measurements of mesquite trees were also taken to identify the size of tree used by quail.

Woody plant densities were recorded in each treatment and control using two 50 × 50-m plots. In addition, the density of woody plants within each primary rest area in covey home ranges was measured using one 50 × 50-m plot. Woody plant cover within home ranges was sampled with two 250-m line intercepts.

Home ranges and primary rest areas were mapped using the territory-mapping technique (Overton 1971) and results from retrapping leg-banded quail.

Baited walk-in traps were used to capture quail. Each bird was tagged with a serially numbered aluminum leg band. Trapping data provided information on mortality, breeding success, and covey movements. All traps were baited with 150 gm of grain sorghum. When quail were captured, the amount of bait consumed was estimated and the estimate divided equally among the number of birds caught and subtracted from their weights.

Both parametric and nonparametric tests were used to evaluate the data. Spearmans Rho Test (Canover 1971:248) was used to determine the correlation of home range size with covey size and with woody plant density during different seasons to determine habitat suitability.

Results and Discussion

Habitat Measurements

Bobwhite quail used lotebush as loafing cover more than all other woody plants (Table 1). Differences in seasonal use of various plants appeared to be dependent on growth form. Winter use of lotebush may have been due to the closed, spinescent canopy (Fig. 1) that provided overhead concealment and protection from predators. It is generally agreed that there is no single cause for quail population fluctuations from year to year (Mosby and Overton 1950); however, the number of coveys that can be supported on any given unit of rangeland may be dependent on the amount of winter cover (Burger and Linduska 1967). In addition, winter cover may be selected which best protects coveys from climatic extremes. In grasslands there is no biotic protection in the community against environmental changes (Wiens 1974). The lotebush canopy retains large amounts of wind-blown litter which may create an insulated microhabitat favorable to quail during winter months.

Table 1. Number of each plant species (for total study area) used for loafing cover by bobwhite quail by season in Mitchell County, Tex., 1973–1975.

	Plants				
Season	Lotebush	Honey mesquite	Fourwing[1] saltbush	Annual broomweed	Catclaw acacia
Winter 1973	39	15	0	0	0
Spring 1974	30	21	0	0	0
Summer 1974	18	44	0	0	0
Fall 1974	28	11	5	0	0
Winter 1974	32	8	3	0	0
Spring 1975	14	0	0	0	0
Summer 1975	4	0	0	30	0

[1] Scientific name is *Atriplex canescens*.

Other characteristics of lotebush may have resulted in its selection as yearlong cover by quail. Understory measurements showed that 97.8% of the bushes used by quail had bare ground or light grass under the canopy, thus furnishing good visibility as well as secure dusting sites. Measurements of adjacent vegetation showed that grass height was significantly shorter near those lotebush plants that were used by quail than near those that were not used by quail.

Quail use of large mesquite on the study area during the dry summer of 1974 may have been due to the weather extremes during that season. Wiens (1974) observed that dry years in grasslands are typified by higher than average winds and temperatures, thus quail may have required a more open situation which supplied shade, cover, and access to cooler breezes found in large mesquite stands. Heavy use of broomweed during the summer of 1975 followed a spraying program during the spring. Coveys depended on broomweed once mesquite and lotebush were defoliated.

Lotebush is a highly volatile species and burns easily. Consequently, most (88.3%) of the lotebushes that were chosen randomly and considered typical of the burns had been burned and were recovering from the effects of the fire. The resprouts grew slowly for the first 3 years after burning, and then grew rapidly during the fourth and fifth years (Neuenschwander and

Fig. 1. *By the sixth growing season after burning, about 70% of the volume of burned lotebushes has recovered and the largest plants are used by quail. The plants are rigid and have a closed, spinescent canopy that provides overhead concealment from predators.*

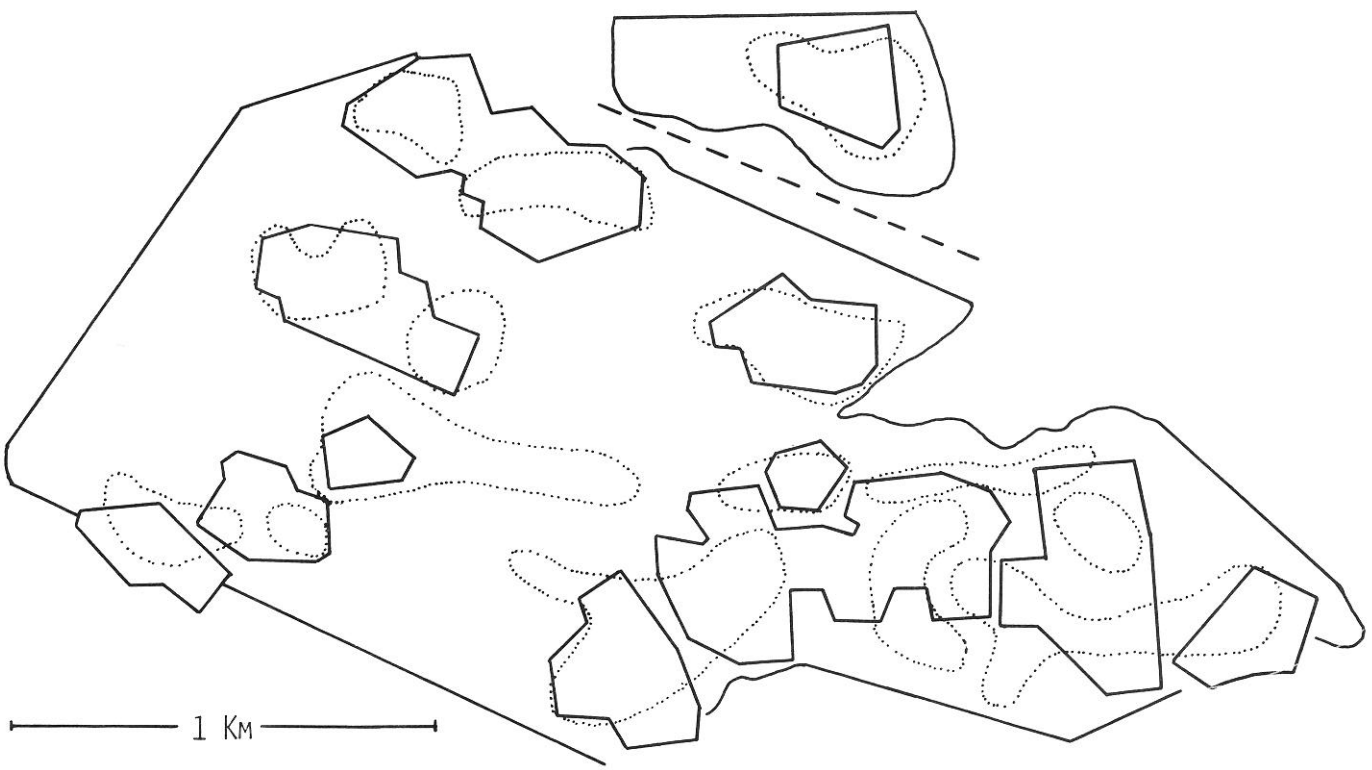

Fig. 2. *Map of the study area containing all ages of burns and showing the outside boundaries of composite home ranges (dotted lines) of bobwhite quail from June 1, 1974, to August 26, 1975, in Mitchell County, Tex. Area within dotted lines are concentrations of woody cover.*

Fig. 3. *A typical primary rest area of the Rolling Plains that would be preferred by bobwhite quail because it contains large mesquite trees and lotebushes.*

Wright 1973). By the sixth growing season after burning about 70% of the volume of burned lotebushes had recovered and the largest plants were being used by quail (Fig. 1). As expected, volume measurements of lotebushes in the control were greater than those in the burns with one exception. The 1971 burn had more bushes on higher ground where the fire did not carry well, thus randomly chosen plants in this burn tended to be larger than those in other treatments.

Hot fires (burning with a relative humidity of 20 to 40%, a wind of 13 to 24 km/hour, and air temperature of 21 to 26°C, and no green forbs in the understory vegetation) similar to the 1974 burn are most effective in reducing above-ground growth of lotebushes, though the plants are rarely killed (Scifres and Kothmann 1976). In this treatment all lotebushes burned in an April fire, but resprouting was evident by October. No coveys were observed loafing in this treatment area after the burn, though feeding birds were occasionally flushed. Burns during wet years (when green forbs were abundant) such as 1975 have the least effect on lotebushes, even though fire may reach the canopies of some plants. A burn in 1975 had a low intensity because annual forbs greened up early, winds were 10 to 13 km/hour, and relative humidity was 40%. This resulted in some bushes being defoliated and a few burned to ground level, but due to the patchiness of this "cool" burn, enough lotebushes survived to support resident coveys with no displacement.

Lotebushes used by quail averaged 3.8 m^3 and were significantly ($P < .05$) larger than plants randomly chosen. Only 11.8% of these plants had been burned and returned to a closed-canopy form. The rest of the plants had either escaped the fires or were partially defoliated. The two smallest plants used by quail had an average volume of 0.97 m^3, which we consider to be the minimum size for lotebush to be useful to quail.

Mesquite trees used by quail tended to be large, averaging 48.6 m^3. Low-growing, multiple-stemmed resprouts that resulted from burning were rarely selected by loafing quail when larger trees or lotebushes were available. Since fine fuel was too light around the base of most large trees for top-kill with fire, many older mesquite trees escaped fire and furnished loafing cover for quail during the warmer months. Trees that were 48.6 m^3 in size averaged 11.6 trees/ha on the burned treatments and 17.7 trees/ha on the unburned control.

The large number of lotebushes used by quail yearlong is of particular interest when related to woody plant densities following fire. Lotebush densities for burned treatments averaged 33.6 plants/ha. However, only 3.9 plants/ha were large enough to be used for loafing cover. Densities of lotebush in the control (18.4

Table 2. Home range and primary rest areas of bobwhite quail and average covey population by season from 1974–1975 in Mitchell County, Tex.

Season	Number of coveys	Home range (ha)			Primary rest area (ha)			Number of birds/ covey
		Smallest	Largest	Mean	Smallest	Largest	Mean	
Summer 1974	12	2.2	13.9	7.2	0.4	3.7	2.1	9.1
Fall/winter 1974	13	1.1	3.4	1.9	0.4	1.1	0.5	6.1
Spring 1975	10	0.8	2.1	1.4	0.4	1.4	0.8	5.6
Summer 1975	15	0.7	2.8	1.7	0.3	1.5	0.9	14.8

Table 3. Percent woody cover in home ranges of bobwhite quail in Mitchell County, Tex., 1974–1975.

Season	Number of coveys	Home range		
		Smallest	Largest	Mean
Summer 1974	12	7.11	30.30	14.77
Fall/winter 1974	13	3.84	30.30	12.01
Spring 1975	9	2.08	13.80	8.73
Summer 1975	16	1.36	10.54	4.35

plants/ha) were significantly lower than in the burns, but most (63.4%) were larger bushes and used as loafing cover by quail.

A composite map of bobwhite quail home range (Fig. 2) on various ages of tobosagrass burns shows that large areas remained unoccupied by coveys. These areas did not have concentrations of woody cover and did not appear to have space for travel lanes and dusting sites in the thick tobosagrass.

Large coveys of quail were always associated with mixtures of large lotebush shrubs and mesquite trees (Fig. 3) during the summer of 1974. At this time a positive correlation ($P < .05$) was noted between covey size and the density of mesquite in covey headquarters. Larger coveys appeared more active in daily movements. Coveys using dense stands of mesquite were occasionally seen moving about midday when coveys residing in areas of scattered trees were loafing. The dense blocks of mesquite may have acted as screening cover, allowing coveys to move about more confidently in any direction in search of food.

The 1974 fall and winter home ranges (Table 2) were much smaller than summer ranges. By comparison, winter home ranges averaged less than half (4.8 ha) of the 24 acres (9.7 ha) reported by Johnsgard (1973:422) as the average winter range for Texas and Missouri bobwhites, but equal to Kansas studies. More coveys were found in open grassland habitats which had only a few mesquite trees in the primary rest areas. The number of lotebushes suitable for cover in home ranges remained the same as for coveys in the summer of 1974, indicating a possible minimum number of lotebushes required for fall and winter cover. This number included two to three clones of lotebushes in the primary rest area plus three to five individual lotebush plants to serve as screening cover when coveys traveled through home ranges.

Observations recorded before covey break-up in the spring of 1975 showed that quail had moved back into areas of higher mesquite density. Home ranges averaged only 1.4 ha and covey size dropped to 5.6 quail/covey. Early spring rains increased the food supplies of forbs and insects and home ranges were apparently adequate for the smaller coveys.

Woody cover measurements in quail home ranges showed a wide variation within and between seasons (Table 3). The smallest percentages of cover were generally associated with covey home ranges on upland sites and the largest percentages were measured in home ranges on bottomland sites. Mesquite trees in bottomland sites are very fire tolerant, whereas mesquite on upland sites are moderately susceptible to fire (Wright et al. 1976). Lotebush, catclaw acacia (*Acacia greggii*), and algerita (*Berberis trifoliata*) made up more than half (63.4%) of the woody cover in home ranges on upland sites.

Management Implications for Quail

Management for bobwhite quail in honey mesquite-tobosagrass communities centers around the amount and type of woody plants necessary to maintain yearlong cover. Prescribed burning as outlined by Wright (1974) would generally benefit quail habitat if added precautions are taken. Fire has the greatest effect on mesquite resprouts which are the prime concern of ranchers and which are of little value to quail. Larger trees need no protection from fire unless they have been previously top-killed, then 7-m firelines should be dozed in circles with 30-m diameters around at least 10 large mesquite trees/ha for optimum summer cover. Once lotebush plants are burned it may take 6 to 7 years before they become useful to quail. By that time pastures should be burned again to increase production and utilization of tobosagrass (Wright 1972). In primary rest areas, 7-m firelines should be dozed in circles with 15-m diameters around at least four clones of lotebush or large individual plants/ha to insure optimum winter cover for quail.

Since lotebush is a clonal plant and some shrubs may be 9 m^3 in volume while others are very small, only 10 or 20% of the land on a ranch may be key cover areas for quail. Feeding areas, however, may cover 50 to 80% of the ranch. Thus preparing firelines for the protection of lotebush and mesquite plants from prescribed fire is biologically feasible and would leave only a small amount of unburned brush.

The cost to cut a fireline around each group of four clones of lotebush that contained mesquite plants would be $2.00 to $4.00. Prorated over the entire acreage for many such firelines within a section of land, this would be $.20 to $.80/acre, depending on amount of lotebush in the area. Since the life of the detrimental effects of fire on lotebush is 6 years or more, the cost for firelines can be further prorated to $.04 to $.14/acre/year plus interest. Hunting leases for quail cost from $.25 to $1.00/year in the Rolling Plains.

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