

Northern Bobwhite Habitat Requirements and Evaluation Guide

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Dr. Billy Teels originated this guide and the habitat evaluation concept in Oklahoma while working as the State Biologist for the USDA-Soil Conservation Service.



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Introduction

The northern bobwhite (*Colinus virginianus*, hereafter bobwhite) is a well-known and widespread upland game bird found in the eastern half of the United States. The bobwhite is particularly common in the southern Great Plains and its numbers are directly related to land use, management practices, and weather. Recently, bobwhite populations have been on a steady decline throughout much of its range, with an average annual decline of 2.0% in Oklahoma (30). Specifically, bobwhite habitat has been impacted by farming, conversion of native plant communities to introduced forages, fire suppression, forestry practices, and urban sprawl. In rangelands, heavy grazing and herbicide use have reduced the diversity of native plants that bobwhite require. In forests, the lack of both fire and tree thinning have reduced herbaceous and shrub cover that bobwhite require (27). Conversion of native plant communities to pastureland dominated by monocultures of introduced grasses has also eliminated habitat for bobwhite, as has the industrialization of rangelands for energy production.

Heavy grazing by cattle not only impacts plant composition, but it has further reduced herbaceous fuels to the point that fire cannot carry across the landscape. This has allowed eastern redcedar to invade, which negatively impacts bobwhite habitat, (3, 15, 17, 26). Finally, farming has eliminated bobwhite habitat by conversion of native plant communities to introduced forages (e.g., tall fescue, Bermudagrass, Old World bluestem) or crops.

Outside of habitat requirements, weather also plays an important role in abundance of bobwhite in the southern Great Plains. Specifically, temperature and precipitation influence the ecology of bobwhite (16, 23), especially in the breeding season. Less precipitation has been linked to shorter nesting seasons and fewer nesting hens, which in turn results in lower juvenile:adult ratios the following hunting season (18). Furthermore, bobwhite are very sensitive to extremes in temperatures (12), and abundance of bobwhite has been shown to be influenced by summer temperatures (23).

Fortunately, much of the southern Great Plains is still in native vegetation. Therefore, great potential exists to increase the number of bobwhite on the landscape given the limitations of weather. Lands in native vegetation have the potential to provide habitat for bobwhite. However, the quality of habitat will vary from poor to excellent depending on how the land is managed.

The purpose of this guide is to provide a means to systematically evaluate the suitability of habitat for bobwhite. The guide can also be used to evaluate non-native vegetation such as introduced pasture or cropland. It is designed to allow you to inventory existing habitat conditions and to determine what the limiting factor(s) are that keep bobwhite numbers below the potential of the land and climate. The limiting factor(s) are those elements that are limited in occurrence or missing. Those limited or missing elements must be improved or developed before the land becomes usable by bobwhite.

Habitat Requirements

Home Range and Carrying Capacity

The size and shape of an individual bobwhite's home range is thought to vary according to the suitability of vegetation within the home range. The home range will sometimes exceed 80 acres but generally averages between 20 and 40 acres (2, 22, 24, 28). Covey home ranges often overlap and there is considerable interchange of individuals between coveys. Individual movements are most pronounced in the spring and fall in what are termed "shuffles." These movements can exceed one mile while other areas rarely experience a "shuffle." An individual bobwhite covey can occupy as little as four acres; however, the average density on well-managed areas is one covey per 15 acres (29). Carrying capacity for bobwhite averaged over several years rarely exceeds one bird per acre. However, densities exceeding four birds per acre on very intensively managed areas in the southeastern states have been reported.

Bobwhite restrict their activities to a home range that varies in size depending on the kind, amount, condition, and arrangement of the required habitat components. All the requirements for the bobwhite's livelihood must be found within this area. The actual size and shape of the home range is determined by the inherent limits of how far the bobwhite can travel and the quality of various elements within the home range. Actual home ranges are not marked by permanent boundaries, nor are they the same from year to year or season to season.

The bobwhite is most abundant where native grasses, forbs (broadleaf plants, weeds), legumes, and shrubs occur together and are closely arranged (10). In summary, bobwhite abundance is determined by the composition and size of herbaceous and woody shrub patches (14, 15, 25).

Nesting Cover

Bobwhites build nests on the ground in warm-season grass clumps left from the previous growing season. Therefore, it should be immediately apparent the importance of low to moderate stocking rates of livestock. Little bluestem, broomsedge bluestem, and other grasses of similar growth habit (bunch grasses) make up the majority of nest sites (29, 35). In shrublands, woody structure is also important in nest site selection (33). Warm-season native short grasses such as buffalograss, blue and hairy grama, and introduced grasses such as Bermudagrass are not generally used for nesting. Because of their growth habit, Old World bluestems may be used for nesting if other habitat requirements are available, but other negative attributes (i.e. it tends to form monocultures) preclude it from being considered a desirable plant. Cool season grasses such as tall fescue, smooth brome, tall wheatgrass, annual bromes, and wild ryes are seldom used for nesting and are poor habitat for bobwhite.



Caption: Residual grass cover is critical for bobwhite nesting. This photo was taken in early spring and illustrates abundant bluestem cover that will be used in the next few months by nesting hens.

Nesting Cover Quantity: The optimum percentage of native grass is at least 30% within the bobwhite's home range (9).

Nesting Cover Height: Bobwhites begin nesting after covey break up (typically April). Tall and mid-height warm season grasses from the previous season (last year's dead growth) must be available for nesting at that time. Grasses must be of sufficient height (6 to 8 inches) to conceal quail, thus requiring light or no use by grazing animals.

Nesting Cover Diameter: Bobwhites prefer thick nesting cover greater than half a foot in diameter (1). Nesting cover

often includes more than one plant in close proximity (less than 6 inches apart).

Brood Cover

High insect availability for food is required for bobwhite hens and broods (4, 9). Open areas of herbaceous plants or cultivated grain and seed crops are used for feeding. These areas must contain bare ground or areas with limited litter at ground level. Areas that have been burned often produce green forage earlier than unburned areas and thus will attract high concentrations of insects. These areas are sometimes called "bugging grounds."



Caption: Disturbance can create forb rich areas that are important for bobwhite chicks. The foreground of this area was disked for a firebreak and the background was burned. Notice the abundant croton, ragweed, and sunflower all of which are important plants for bobwhite.

Brood Cover Quantity: At least 40% in food-producing plants such as native annual and perennial forbs or planted crops (10).

Screening Cover: Above a height of 6" (the height of a quail), there should be dense cover that screens quail from predators and sunlight.

Accessibility: Bobwhite chicks require forb and grass plants spaced far enough apart to provide travel corridors. Dense, tangled vegetation or heavy litter on the soil surface presents obstacles for the movement of young chicks and restricts food accessibility (32). Generally speaking, rank or closed corridor conditions would obstruct visibility at ground level at <4 inches (11). Moderately open corridor conditions would obstruct visibility between 10-20 inches, and open corridor conditions would have visibility >20 inches (11).

Protective Cover

Protective cover is used for loafing and is necessary for escaping from avian predators. Providing protective cover is likely the best option in deterring quail mortality from predators. Quail have a long evolved history with many predators (5). As such, predator control has not been shown to increase quail abundance (5, 13). Low-growing, dispersed woody plants, shrubs, resprouting trees, and large upright forbs are used for this type of cover because they provide a visual screen from aerial and ground predators. Protective cover must also persist during cold and hot weather when thermal protection is needed as woody cover is especially important during temperature extremes (16). Therefore, pure stands of grass with little to no short statured woody cover are not suitable bobwhite habitat.

Protective Cover Quantity: At least 30% of the bobwhite's home range should be brush or shrub cover (19). No point on the area should be >100 feet from brush or shrub cover (19).

Protective Cover Canopy Density: Protective cover should completely conceal quail from aerial predators (31). Protective cover should be thick, several feet above the ground, but relatively open at ground level to permit quail movement underneath (34).

Protective Cover Diameter: The protective cover area of loafing coverts should be larger than 10 feet in diameter (21). However, research has demonstrated that woody cover between 30 to 65 feet is ideal (19). Note that this applies to clonal shrubs such as sumac and plum. For shrubs that tend to grow more uniformly across an area, such as shinnery oak and sand sagebrush, shrub requirements are typically met unless the plants have been sprayed to thin them.



Caption: Maintaining shrub cover across the landscape is vital for bobwhite as they are a shrubland species. Many species of shrub can be utilized for protection from hot temperatures and predators. Some important shrubs

in the southern Great Plains include sumacs, plums, sand sagebrush, mesquite, and shinnery oak. Shrubs may either be either thicket forming as in the case of sand plum (left photo), or uniformly distributed such as sand sagebrush (right photo).

Food

The diet of adult bobwhite consists of insects, grass and forb seeds, along with some leaves (Table 1). Fruits of native shrubs and trees are also important. Seeds from cultivated crops are used if available. Seeds are eaten throughout the year. Insects are high in protein and are eaten year-round when available, especially by adult females (7). Because of their high dietary energy and protein requirement, insects are the primary food for quail broods during their first few weeks of life (9). Insects are high in energy and fat.



Caption: Ragweed and croton are both important food plants for bobwhite. If bobwhite management is a goal, resist the urge to spray these "weeds".

Enough food must be produced in the fall to last through the winter until spring (29). Naturally occurring foods are recommended over cultivated food plots or feeders because of their nutritional diversity. Forty to 60% of the bobwhite's home range should be in prairie with abundant forbs (i.e. weedy), shrubland, or open forest. Cropland may also provide foods (10), although this is less desirable because cropland typically does not provide habitat (food and cover) all year. Bobwhites secure most of their food on the ground or from the layer of leaves and stems on the soil surface (29). If seeds are to be found by bobwhite, they must be seen on bare ground or in litter that is sparse and can be moved easily (29). If seeds drop into a thick mat of stems and leaves they become inaccessible. Sandy soils provide better interspersion of plant canopies and bare ground than clay soils.

Water Requirements

Surface water is not essential for bobwhites, although it may be used if provided. Water needs are usually met by water found in plants, insects, dew, and snow (29). Also, metabolic water is produced during digestion and provides an

Table 1. Important Food Plants by Region.

Common Plant Name	Functional Group	Oak/Hickory	Pine/Hardwood	Cross Timbers /Tallgrass Prairie	Mixed/ Short-grass Prairie	Shinnery Oak	Sand Sage
Beefsteak plant	forb	X	X	X			
Crotons	forb	X	X	X	X	X	X
Dayflower	forb		X	X	X	X	X
Dock	forb	X	X	X	X		X
Goats beard	forb			X			
Golden waxweed	forb		X	X	X	X	
Lambsquarter	forb	X	X	X	X	X	X
Pigweed	forb	X	X	X	X	X	X
Pokeweed	forb	X	X	X			
Queens delight	forb			X	X	X	X
Ragweeds	forb	X	X	X	X	X	X
Smartweeds	forb	X	X	X	X	X	X
Snakeweed	forb			X		X	X
Spurges	forb	X	X	X	X	X	X
Sumpweed	forb	X	X	X			X
Sunflowers	forb	X	X	X	X	X	X
Three-seeded mercury	forb	X	X	X		X	X
Corn	grass	X	X	X	X	X	X
Crabgrass	grass	X	X	X	X	X	X
Dropseeds	grass			X	X	X	X
Foxtail	grass	X	X	X	X	X	X
Johnson grass	grass	X	X	X	X	X	X
Love grasses	grass	X	X	X	X		X
Panicums	grass	X	X	X	X	X	X
Paspalum	grass	X	X	X	X	X	X
Sorghums	grass	X	X	X	X	X	X
Sprangletops	grass			X	X		
Wheat/rye	grass			X	X	X	X
Cowpeas	legume				X		X
Desmodiums	legume	X	X	X			
Ground cherry	legume	X	X	X	X		
Hemp sesbania	legume		X	X			
Hog peanut	legume	X	X	X			
Milk pea	legume	X	X	X			
Native Lespedezas	legume	X	X	X			
Partridge pea	legume	X	X	X	X		X
Pencil flower	legume	X	X				
Soybean	legume	X	X	X			
Tephrosia	legume	X	X	X			
Vetch	legume	X	X	X	X	X	X
Wild beans	legume	X	X	X	X		X
Wild peas	legume	X	X	X			
Ash	woody	X	X	X			
Black locust	woody legume			X	X	X	X
Blackberry	woody	X	X	X			
Blackgum	woody	X	X				
Cherry	woody	X	X				
Chittamwood	woody	X	X	X	X	X	X
Dogwoods	woody	X	X	X	X		
Elderberry	woody	X	X	X			
Grapes	woody	X	X	X	X	X	X
Hackberries	woody	X	X	X			
Maple	woody	X	X				
Oak (acorns)	woody	X	X	X	X	X	X
Pine (seed)	woody		X				
Poison ivy	woody	X	X	X	X		
Sumac	woody	X	X	X	X	X	X
Sweetgum	woody	X					

Habitat Evaluation

additional source of water (12). Surface water such as ponds, creeks, and overflow from windmills produce micro-habitats, which can provide green, succulent vegetation and insects during dry or unfavorable weather conditions. There is no evidence that water developments increase the abundance or reproduction of quail. It may influence the distribution of quail (20).

Interspersion

Bobwhites prefer areas where grasses, forbs, and woody plants are interspersed (scattered). The closer one requirement is to another results in less distance quail must travel to meet their needs. Optimal bobwhite habitat is composed of closely interspersed patches of grasses, forbs, vines, shrubs, groups of low-growing shrubs and trees (8). On sandy sites interspersion is usually good if low to moderate grazing and has been used. In typical agricultural operations that include pastures or croplands along with woodlands, interspersion is important. In brushy prairie interspersion is already present because each patch contains necessary elements (14, 15). In the open forests where frequent fire is used, woody sprouts will provide adequate interspersion of herbaceous and low woody plant growth.



Caption: Having nesting, brood, and protective cover scattered across the landscape is ideal for bobwhite. Scattered sand plum thickets such as this are often the only major woody cover in grasslands in the southern Great Plains. Notice the area has been burned recently and that the outer perimeter of the sand plum thicket was top killed. However, the plant is quickly resprouting and the resultant edge areas of the thicket will be dense with the multiple resprouts of plum.

The purpose of this evaluation tool is to determine the limiting factors on a given area and what practices can be used to address the limiting factors. The limiting factor is determined by selecting the lowest value assigned to any of the requirements listed below. These values represent the general quality of habitat and identify the factor that is limiting the bobwhite population within the area of interest.

The following procedures describe the method for inventorying existing habitat conditions, rating the habitat, and determining the limiting factor. Since the system is based primarily on the kinds, amounts, condition, and arrangement of plants, inventories should be performed during the growing season. However, habitat can be evaluated year-round as long as the observer conceptualizes growing season conditions.

Ratings for the various habitat criteria range from 0 (poor) to 10 (excellent). The number of ratings per criteria depends on the number of variables that can be practically measured and levels of management that can be practically applied.

Step 1 - Determine if it is practical to even manage bobwhite on the land unit of interest. For example, if the unit is in wheat or introduced pasture such as Bermudagrass, it is not practical to manage for bobwhite without extensive vegetation change and expense.

Step 2 - Determine the intensity of management that you wish to use. Do you want high intensity management where bobwhite is the primary species of concern? Is the bobwhite a secondary species of concern behind beef cattle, goats, white-tailed deer, or a combination of species? Do you want moderately intensive management where farming and beef cattle or other combinations are the primary land use with bobwhite quail as a secondary land use? Or, do you wish to make few if any changes to your current operation and wish to provide the minimum habitat necessary to maintain bobwhite?

Step 3 - Examine the area to assure that all required elements are present. If any element is missing, a "0" value is recorded on that element's quantity criteria rating, which means that the habitat is unsuitable for bobwhite unless that habitat element is going to be provided. Some requirements may be filled by more than one element. For example, native herbaceous plants (forbs, grasses, or legumes) fulfill the bobwhite food requirement and brood habitat requirement. When this occurs, the criteria and rating will be adjusted to account for the situation.

Step 4 - Evaluate each required habitat element by matching habitat conditions with the ratings for the various criteria. Specific instructions are contained in the next section and the evaluation form.

Step 5 - Determine the limiting factor value, which is the lowest numeric value ranking within each requirement (e.g. nesting cover), for each requirement.

Step 6 - Determine the overall habitat value. This value is represented by the lowest value in the summary. This will be useful when comparing multiple areas.

Step 7 - Assess the elements or criteria that are limiting or missing and prepare a management plan that addresses the limiting factors.

Bobwhite Habitat Evaluation Form

Size of Evaluation Area (Acres): _____

Management Unit Name: _____

Type(s) of vegetative cover within home range or evaluation area (assign percent coverage).

Vegetation cover type	Percent
Prairie	_____
Shrubland	_____
Forest	_____
Introduced Pasture	_____
Cropland	_____
Other	_____

HABITAT REQUIREMENTS Essential habitat components needed for survival and propagation of bobwhite, these components include (A) nesting cover, (B) brood cover, (C) protective cover, (D) food, and (E) interspersions. Circle the lowest value and enter it in the box. Enter the score from each box on page 21.

A. NESTING COVER: Warm season bunchgrasses (either tallgrass or midgrass species).

1. Nesting Cover Quantity - Determine whether preferred bunch grasses that are either tall or mid grass species are present.

	<u>Value</u>
>50% or more of home range is a plant community with preferred grasses	10
30 to 50% of home range is a plant community with preferred grasses	7
10 to 30% of home range is a plant community with preferred grasses	3
0 to 10% of home range is a plant community with preferred grasses	0

2. Nesting Cover Height - Evaluate the average grass height that will remain during nesting season. Presence of last year's growth from April 1 to September 30.

	<u>Value</u>
Residual cover adequate (>8")	10
Residual cover moderate (6 to 8")	7
Residual cover low (4 to 6")	3
Residual cover minimal (<4")	0

3. Nesting Cover Diameter - Evaluate the average diameter of the nesting cover. Can include one or more preferred plants if they occur within 6 inches.

	<u>Value</u>
Half-foot or greater in diameter	10
Less than a half-foot in diameter	2

B. BROOD COVER: Native grass, forbs, and woody plants and some agricultural crops from June 1 to October 15.

1. Brood Cover Quantity - Evaluate the area for plants and insect abundance.

	<u>Value</u>
>50% of home range is a plant community with legumes, forbs, or crops	10
30 to 50% of home range is a plant community with legumes, forbs, or crops	7
10 to 30% of home range is a plant community with legumes, forbs, or crops	3
0 to 10% of the home range is a plant community with legumes, forbs, or crops	0

2. Screening Cover - Above height of a quail (6 inches).

	<u>Value</u>
>50% of canopy cover is >6 inches	10
30 to 50% of canopy cover is >6 inches	7
10 to 30% of canopy cover is >6 inches	3
0 to 10% of canopy cover is >6 inches	0

3. Accessibility - Below height of 6 inches (travel corridor).

	<u>Value</u>
Open condition below a height of 6 inches and >50% of the ground lacks leaf litter	10
Moderately open condition below a height of 6 inches and 25-50% of the ground lacks leaf litter	5
Closed or rank condition below a height of 6 inches and <25% of the ground lacks leaf litter	0

C. PROTECTIVE COVER (escape, loafing, and thermal): Shrubs, tall forbs, and low growing trees

1. Protective Cover Quantity - Evaluate the plant community area coverage.

	<u>Value</u>
>30% of the home range is comprised of woody plants	10
20 to 30% of the home range is comprised of woody plants	7

	<u>Value</u>
10 to 30% of the home range is comprised of woody plants	3
0 to 10% of the home range is comprised of woody plants	0

2. Protective Cover Canopy Density - Evaluate the woody canopy closure.

	<u>Value</u>
>30% canopy cover at 3 feet high	10
20 to 30% canopy cover at 3 feet high	7
10 to 20% canopy cover at 3 feet high	3
0 to 10% canopy cover at 3 feet high	0

3. Protective Cover Diameter – Determine the average diameter of each woody cover thicket.

	<u>Value</u>
>30 feet diameter	10
20 to 30 feet in diameter	8
10 to 20 feet in diameter	6
10 feet or less in diameter	2

D. SPATIAL ARRANGEMENT: The spatial arrangement of herbaceous and woody cover provides the habitat components including nesting cover, brood cover, and protective cover.

1. What proportion of the area has nesting, brood, and protective cover within 150 feet of each other?

	<u>Value</u>
>60%	10
40 to 60%	7
20 to 40%	3
0 to 20%	0

Summary of Limiting Factors for Bobwhite Quail

Criteria	Rating score from evaluation form	Management Recommendations
<u>A. Nesting Cover</u>		
A.1. Nesting Cover Quantity	_____	A,C,D,F
A.2. Nesting Cover Height	_____	B
A.3. Nesting Cover Diameter	_____	B
<u>B. Brood Cover</u>		
B.1. Brood Cover Quantity	_____	A,B,C,D,F,G,H
B.2. Screening Cover	_____	B,C,D,E,G,H
B.3. Accessibility	_____	A,B,F,G,
<u>C. Protective Cover</u>		
C.1. Protective Cover Quantity	_____	A,D,E,F
C.2. Protective Cover Canopy Density	_____	A,D,E,F
C.3. Protective Cover Diameter	_____	A,D,E,F,G
<u>D. Spatial Arrangement (interspersion)</u>		
E.1. What proportion of the area occurs within 150 feet of nesting cover, brood cover, protective cover, and food?	_____	All practices

The lowest habitat element score equals the limiting factor value for bobwhite habitat for the area being evaluated. Some elements cannot be changed because of soil type or site degradation from soil erosion. Adequate habitat should be maintained on as large of an area as possible. While there is variation in the amount of land needed to sustain a quail population, it appears that it takes thousands of acres of suitable habitat for a population to persist. Since most landowners do not own this amount of land, neighbors should be involved to make habitat management work for the bobwhite.

Land Management Practices to Correct Limiting Factor(s)

A. Prescribed Fire: Of all the management options available to land managers, none have more potential to restore and maintain bobwhite habitat. Prescribed fire is an inexpensive and natural process that can be used to manipulate the various habitat elements that are important to the bobwhite. Fire can stimulate food producing plants such as forbs, increase insect abundance, change the structure of woody vegetation, and increase the amount of bare ground. Fire will also control invasive plants such as eastern redcedar. Under certain prescriptions fire can also be used to thin forests and stimulate herbaceous understory growth.

B. Prescribed Grazing: Proper grazing management cannot be emphasized enough. Without proper grazing, bobwhite habitat cannot be managed and fuel for prescribed fire cannot be maintained. Moderate, light, or no stocking may be appropriate depending on the site and regional location. In some situations, primarily in areas exceeding 30 inches of annual precipitation, no grazing will result in herbaceous cover quickly becoming too dense. Grazing systems that encourage even grazing distribution should be avoided. Continuous stocking at a moderate to light stocking rate will provide adequate habitat structure and composition.

C. Establishing Native Warm Season Grasses and Forbs: Establishment of native herbaceous plants in cropland coming out of crop production provides nesting cover, brood cover, and food. However, trying to establish native plants into introduced forages such as Bermudagrass, Old World bluestem, or tall fescue should not be attempted until the introduced grasses are completely eliminated. Established stands of introduced plants will need to be treated with herbicides at least with 2-3 applications to eliminate. See USDA-NRCS for conversion guidelines.

D. Forest Thinning and/or Creating Opening in Native Forests: Many forests overstories are too dense to provide bobwhite habitat. The removal of trees by commercial thinning or timber stand improvement is necessary to restore and maintain forests and bobwhite habitat. Trees should be thinned to 40 to 60 square feet of basal area per acre to meet the bobwhite's habitat requirements. This treatment will result in sprouting woody plants for cover, increases in grass for nesting cover, and increases in forbs for brood and adult food and cover.

E. Restoring Native Woody Plants: In areas that historically supported native woody vegetation, shrubs can be established or encouraged. Some species may not be available for transplanting.

F. Herbicide Application: Herbicide can be an effective tool to reducing woody cover and to control undesirable plants. Herbicide is often used in combination with prescribed grazing and prescribed fire in a management system. Herbicide is relatively expensive and is seldom needed when an appropriate fire program is used. Herbicide use must follow all label instructions.

G. Disking: Disking is routinely used to disturb the soil, which creates early successional plants such as annual forbs (i.e. weeds), these provide excellent brood cover and food, along with accessibility (bare ground). The timing of the disking and precipitation following treatment will determine the plant response. Typical plants that germinate following disking include ragweed, croton, and sunflower. Disking around sand plum thickets can cause the plum thicket to increase in size and density. Size and shapes of disked areas may vary from long, stripped areas to more uniform square plots. Both techniques may be used and/or necessary based on the configuration of surrounding vegetation.

H. Planting Food Plots: Food plots are commonly used to attract and concentrate birds for harvest. Food plots can serve as an emergency food source during times of extended snow/ice coverage provided seeds remain in heads above the snow/ice. Attempting to increase habitat suitability with food plantings can be an expensive practice with outcomes marginal at best. Food plots intended for bobwhite should be located near (50 yards) of escape cover. Commonly planted warm season crops include corn, sunflowers, soybeans, millet, and milo. Because they typically provide overhead canopy, bare ground, and attract insects, warm season plantings can provide brood rearing habitat.



Caption: In forested areas it may be necessary to thin the tree cover substantially to create bobwhite habitat. This pine stand has been commercially thinned as is burned on a 2-3 year rotation to maintain the grass, forb, and shrub understory necessary for bobwhite.

Selected Literature

1. Arredondo, J. A., F. Hernández, F. C. Bryant, R. L. Bingham, and R. Howard. 2007. Habitat-suitability bounds for nesting cover of northern bobwhites on semiarid rangelands. *Journal of Wildlife Management* 78:2592-2599.
2. Baumgartner, F.M., M.J. Morris, J.A. Steele, and J.E. Williams. 1952. Oklahoma bobwhite food relations. *Trans. N. Am. Wildl. Conf.* 17:338-359.
3. Boyd, C.S. and T.G. Bidwell. 2002. Effects of prescribed fire on shinnery oak (*Quercus havardii*) plant communities in western Oklahoma. *Restoration Ecology* 10(2):324-333.
4. Brennan, L. A., and G. A. Hurst. 1995. Summer diet of northern bobwhite in eastern Mississippi: implications for habitat management. *Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies* 49:516-524.
5. Brennan, L. A. 1991. How can we reverse the northern bobwhite population decline? *Wildlife Society Bulletin* 19:544-555.
6. Cram, D.S., R.E. Masters, F.S. Guthery, D.M. Engle, and W.G. Montague. 2002. Northern bobwhite population and habitat response to pine-grassland restoration. *J. Wildl. Manage.* 66:1031-1039.
7. Davis, C.A. 1964. Components of the habitat of the bobwhite quail in Payne County, Oklahoma. Ph.D. Dissertation. Okla. State Univ., Stillwater. 105p.
8. De Arment, R.D. 1950. Evaluation of Payne County, Oklahoma, farmlands and vegetation patterns for bobwhite quail. M.S. Thesis. Okla. Agri. and Mech. College, Stillwater. 69p.
9. Doxon, E. D., and J. P. Carroll. 2010. Feeding ecology of ring-necked pheasant and northern bobwhite chicks in conservation reserve program fields. *Journal of Wildlife Management* 74:249-256.
10. Edminster, F.C. 1954. American game birds of field and forest. Charles Schribner's Sons, NY. 409p.
11. Gruchy, J. P. 2007. An evaluation of field management practices to improve bobwhite habitat. Thesis. The University of Tennessee, Knoxville, TN, USA.
12. Guthery, F. S. 2000. On Bobwhites. Texas A&M University Press, College Station, Texas, USA.
13. Guthery, F. S., and S. L. Beasom. 1977. Responses of game and nongame wildlife to predator control in south Texas. *Journal of Range Management* 30:404-409.
14. Guthery, F.S., M.C. Green, R.E. Masters, S.J. DeMaso, H.M. Wilson, and F. B. Steubing. 2001. Landcover and bobwhite abundance on Oklahoma's farms and ranches. *J. Wildl. Manage.* 65:838-849.
15. Guthery, F.S., R.E. Masters, and M.D. Porter. 2002. Bobwhites on Oklahoma farms and ranches: management options for landowners. Circular E-968. Coop. Ext. Serv., Okla. State Univ., Stillwater. 15p.
16. Guthery, F. S., A. R. Ryback, S. D. Fuhlendorf, T. L. Hiller, S. G. Smith, W. H. Puckett, Jr., and R. A. Baker. 2005. Aspect of thermal ecology of bobwhites in north Texas. *Wildlife Monographs* No. 159.
17. Harrel, W.C., S.D. Fuhlendorf, and T.G. Bidwell. 2001. Effects of prescribed fire on sand shinnery oak communities. *Journal of Range Management* 54:685-690.
18. Hernández, F., J. A. Arredondo, F. C. Bryant, L. A. Brennan, and R. L. Bingham. 2005. Influence of precipitation on demographics of northern bobwhites in southern Texas. *Wildlife Society Bulletin* 33:1071-1079.
19. Hiller, T. L., F. S. Guthery, A. R. Rybak, S. D. Fuhlendorf, S. G. Smith, W. H. Puckett, Jr., and R. A. Baker. 2007. Management implications of cover selection data: northern bobwhite example. *Journal of Wildlife Management* 71:195-201.
20. Hiller, T. L., A. B. Felix, and F. S. Guthery. 2009. Association of northern bobwhites with surface water in the semi-arid Texas panhandle. *Wilson Journal of Ornithology* 121:135-140.
21. Johnson, D. B., and F. S. Guthery. 1988. Loafing coverts used by northern bobwhites in subtropical environments. *Journal of Wildlife Management* 52:464-469.
22. Lehman, V.W. 1946. Mobility of bobwhite quail in southwestern Texas. *J. Wildl. Manage.* 10(2):124-136.
23. Lusk, J. J., F. S. Guthery, and S. J. DeMaso. 2002. Northern bobwhite (*Colinus virginianus*) abundance in relation to yearly weather and long-term climate patterns. *Ecological Modeling* 146:3-15.
24. Mangold, R.E. 1950. Fall and winter losses of eastern bobwhite on the Decatur County research area. M.S. Thesis, Iowa State College, Ames. 61p.
25. Masters, R., S. Ditchkoff and S. Farley. 2002. Edge and other wildlife concepts. *Forest Stewardship Wildlife Manage. Notes* No. 10. Publ. No. L-276. Coop. Ext. Serv., Okla. State Univ., Stillwater. 12p.
26. Masters, R., T.G. Bidwell, and J. Waymire. 2001. Effects of timber harvest and fire frequency on integrated land management options in the Ouachita Mountains. Department of Forestry, Oklahoma State University, Stillwater. 55p.

27. Masters, R., M. Stewart, T.G. Bidwell, and J. Sparks. 1996. Bobwhite quail. Forest Stewardship Wildlife Manage. Notes No. 2. Publ. No. L-268. Coop. Ext. Serv., Okla. State Univ., Stillwater. 12p.
28. Murphy, D.A. and T.S. Baskett. 1952. Bobwhite mortality in central Missouri. *J. Wildl. Manage.* 16:498-510.
29. Rosene, W. 1969. The bobwhite quail, its life and management. Rutgers Univ. Press. Rutgers, NJ. 418p.
30. Sauer, J. R., E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2011. The North American Breeding Bird Survey, Results and Analysis 1966-2010. Version 12.07.2011 USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA.
31. Stoddard, H.L. 1931. The bobwhite quail: its habits, preservation, and increase. Charles Scribner's Sons, NY. 559p.
32. Taylor, J. S., K. E. Church, and D. H. Rusch. 1999. Microhabitat selection by nesting and brood-rearing northern bobwhite in Kansas. *Journal of Wildlife Management* 63:686-694.
33. Townsend, D.E., R.E. Masters, R.L. Lochmiller, D.M. Leslie, Jr., S.J. Demaso, and A.D. Peoples. 2001. Characteristics of nest sites of northern bobwhites in western Oklahoma. *Journal of Range Management* 54:260-264.
34. Umber, R.W., C. Pregler, and J.H. Eve. 1979. The bobwhite quail in Oklahoma. Okla. Dept. Wildl. Cons., Okla. City. 32p.
35. Wiseman, D.S. 1977. Habitat use, food habits, and response to bird dog field trials of bobwhite on northeastern Oklahoma tallgrass prairie rangeland. M.S. Thesis. Okla. State Univ., Stillwater. 90p.

