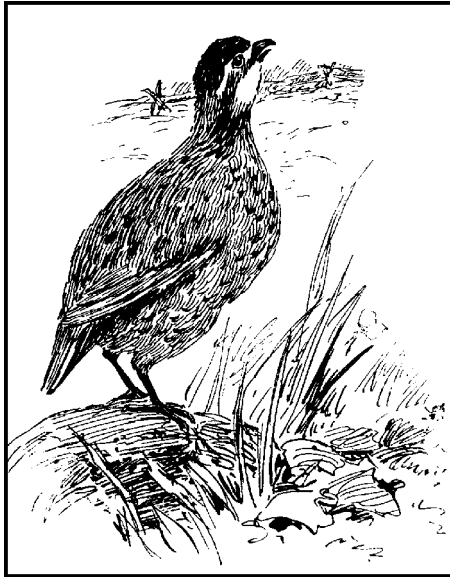


Ecology of Northern Bobwhite Quail in Missouri

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The Europeans who settled in North America brought with them a rich tradition of hunting wild fowl, and they adapted their practices to game birds found in the New World. Northern bobwhite quail (*Colinus virginianus*) quickly became a premier upland game bird, possibly because interest centered on the challenging opportunities that sport hunting provided, their excellent table fare, and the bird's princely appearance and distinctive call. In Missouri and across the southeastern United States, bobwhite hunting quickly became known as the gentleman's sport, and the great tradition of quail hunting developed.

In more recent times, bobwhite numbers reached peak levels from 1900 to the mid-1950s and then began a slow decline. The high quail populations during this era were, for the most part, a by-product of existing land-management practices that developed as early settlers carved out farms in large expanses of forestland or converted prairies to small fields of agricultural crops. Small fields of row crops and frequent disturbance such as burning, grazing and logging provided the right patchwork or "mosaic" of early plant successional habitats (i.e., annual weeds, grasses, shrubs) that the birds require — and populations flourished.



Population trends

As human activity once accidentally created these favorable quail habitats, changes in land use and the introduction of improved technology contributed to declining habitat quality. In Missouri, populations of bobwhites and many other upland wildlife species associated with early successional stages of vegetation have declined over the last several decades to historically low levels. Bobwhites have declined in more than three-fourths of the United States across its geographic range. In Missouri, bobwhite populations have declined by more than 70 percent over the past 30 years. The rate of decline has increased from an average of 1.5 percent per

year during the 1960s and 1970s to nearly 5 percent per year during the 1980s, 1990s and early this decade.

These population declines are attributed to many causes, including predators, pathogens and pesticides. However, the primary cause for this decline is deteriorating bobwhite habitat quality due to advanced natural succession of the plant community, intensive use of monocultures, larger field sizes within the agricultural landscape, reduced use of prescribed fire, the extensive use of exotic grasses (e.g., tall fescue and smooth brome), and increased urban sprawl.

Land-use patterns and quail habitat

The relatively high bobwhite populations of past decades were accidental by-products of diverse land-use practices that created a patchwork of row crops, grasses, fallow acres and forested lands to which bobwhite were ideally suited. In 1931 Herbert Stoddard, the "dean" of bobwhite research, published *The Bobwhite Quail: Its Habits, Preservation, and Increase*. Beginning in 1935 and continuing for the next several decades, there was an explosion of bobwhite quail research. Wildlife

This publication is designed to provide an overview of the ecology of northern bobwhite quail in Missouri. A companion publication, G9432, Habitat Management Practices for Bobwhite Quail, provides more detailed information on selected habitat management practices that landowners can use to improve bobwhite habitat on their property. Readers are also encouraged to obtain a copy of On the Edge: A Guide to Managing Land for Bobwhite Quail, published by the Missouri Department of Conservation, for information on the life history of Missouri bobwhite and on managing property for quail.

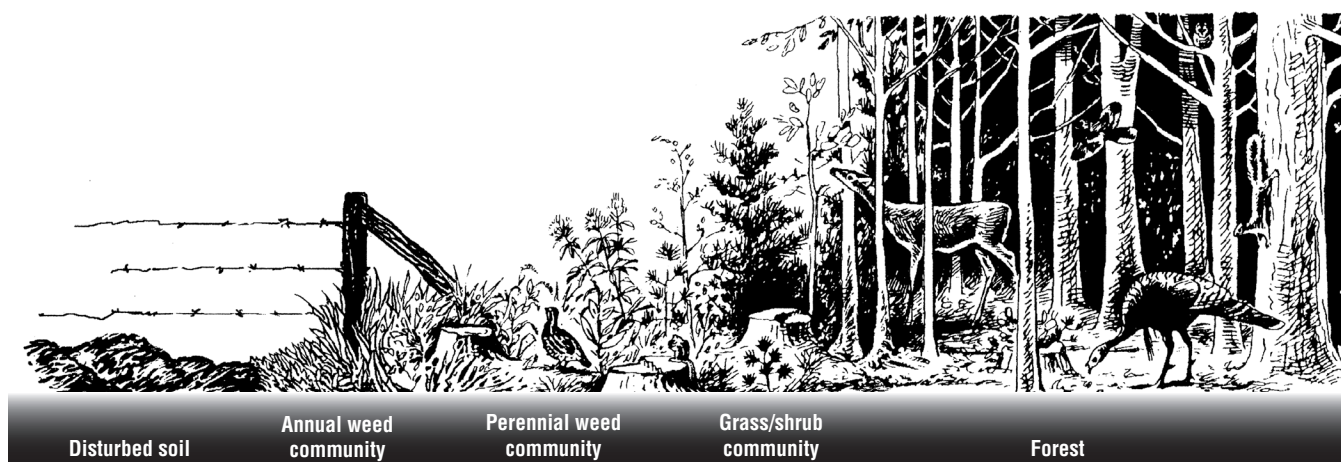


Figure 1. Bobwhites require the proper mix of early plant successional habitats, made up of weeds, grasses and shrubs.

biologists and other professionals learned that bobwhites require patchy habitats that provide a mix of bare ground, seeds and insects as well as vegetation for nesting, brood-rearing cover and protection from predators.

Bobwhites require the proper mix and arrangement of early successional plant communities to provide important habitat components (Figure 1). However, too much of one component results in a deficiency of another and reduces the overall habitat quality. Modern land-use practices have tended to simplify the landscape by producing an abundance of one habitat type and excluding others, which has eliminated the patchy landscape and edge habitats that bobwhites require. These changes within the landscape have contributed to declining bobwhite populations.

Agricultural farming methods have progressively become more mechanized, and chemical control of insect and plant pests has increased dramatically. Farm sizes have increased in Missouri while farm numbers have decreased. These large-scale changes eliminated thousands of miles of weedy ditch banks, brushy draws and fencerows that once provided nesting, brood-rearing and protective cover for the bobwhite. Marginal, erodible areas that were once farmed for crops have been abandoned or have been planted to exotic grasses such as tall fescue and smooth brome or to thick stands of native warm-season grasses to prevent erosion.

Abandoned agricultural areas may be suitable bobwhite habitat for two to three years, but within a few years, plant succession causes these types of areas to become less desirable. Stoddard noted, "The grass-bound field is the greatest enemy of the bobwhite quail."

Like abandoned fields, areas converted to woodlands and various types of forest plantations may be acceptable bobwhite habitat for a short time, but because of reduced soil disturbance and diminished sunlight to the forest floor, closed-canopy forests quickly eliminate the understory conditions that are

favorable for bobwhites.

In some locations, unmanaged, high-crown-density forests offer less habitat than stands that are frequently thinned. In other locations, early-successional shrubby thickets and woody fencerow edge habitats have been cleared and converted to other land uses or have been allowed to grow up into more mature stands of woody vegetation.

In addition, native Americans and early settlers typically burned vast areas of prairie and forestland for purposes that included game management, increasing hunting success and improving access. Fire, as well as other types of disturbance, tends to encourage the growth of annual, seed-producing forbs and weeds and generally improves the habitat for bobwhites.

Fires occur at varying frequencies in most forest ecosystems. At one time, the Ozark forests were burned on a fairly frequent basis. Historically, these fires created areas that could be characterized as an "open" forest or savanna. The resulting landscape consisted of scattered oaks and pines with an understory of annual forbs, warm-season grasses and shrubs. These periodic fires maintained a ground cover of grasses, legumes and forbs beneficial to bobwhites.

Fire has now been eliminated from most landscapes or is used less frequently as a management tool. Most forest landowners do not include the use of fire in their land management plan. In the absence of fire, the grassy and weedy understory is typically replaced by dense hardwood brush that shades and outcompetes the herbaceous ground cover essential for bobwhite nesting, brooding and foraging. The diminished use of prescribed burning has contributed, in part, to the bobwhite's decline.

A prescribed fire is one of the most useful tools for maintaining or restoring early successional plant communities. However, prescribed fires should be planned so that burning occurs under exact weather and fuel conditions and under the guidance of professional assistance so that specific vegetation management objectives can be accomplished.

Grazing practices have also changed significantly over the years. Livestock once grazed on native grasses and lespedeza pastures. Farmers rotated livestock among native grass fields and woodlots. Today, many pastures are planted to fields of exotic grasses, such as tall fescue, which provide high-quality grazing but poor quail habitat. Although the benefits of rotational grazing for livestock have been documented in recent years, many of these short-duration grazing systems do not allow for the development of an irregular mosaic of grazed and ungrazed patches of grass stands, which are beneficial for quail. These mosaic stands of grass have been replaced with uniform, intensive grazing by animals confined to smaller areas. Higher stocking rates result in better use of forage resources but do not provide the conditions necessary for quail to thrive.

More recent land-use changes include those that occur with increased development at the interface between urban and rural areas. Besides the loss of habitat, development brings a dramatic increase in the number of people purchasing small tracts of property and conducting management practices that are not generally “quail friendly” or not doing any management at all. Among practices that spell disaster for bobwhites are the increased use of sod-forming grasses and intensive “fencerow-to-fencerow,” manicured landscaping.

In general, changing land-use patterns have resulted in the declining quantity and quality of habitat for the bobwhite, although other factors certainly cloud the bobwhite picture. Without active management of habitat, the once-abundant populations of bobwhite quail will become part of the past.

Can quail be managed successfully?

Although declining quail population trends are discouraging, bobwhites respond well to certain habitat management practices. If efforts are put into on-the-ground management, quail numbers can be dramatically increased, usually in just a few years. These habitat enhancement practices can often be integrated with other ongoing farm management and production activities. Bobwhites are a prolific species and can respond rapidly to habitat management; however, it is important to recognize that the magnitude of the population response is not only directly related to the intensity of management on a particular tract of land but also to the creation and maintenance of suitable cover on surrounding lands.

Successful results from habitat management are common across Missouri. For instance, one group of landowners in northwest Missouri began to notice from their records that the number of coveys on their property were at an all-time low. After determining the factors that were limiting quail numbers, these landowners began to implement the necessary manage-

ment practices to enhance quail habitat. These practices included developing field edges and managing areas for protective escape cover (otherwise known as covey headquarters); strip disking and prescribed burning of old fields and rank stands of grasslands; controlling tall fescue; and encouraging stands of quail food and cover plants that volunteered following these practices. Within a few years, these landowners noticed that the number of coveys on their property increased by up to 100 percent. Implementing habitat management practices for quail can be successful and produce acceptable results. However, to be a successful manager of habitat for the bobwhite, it is important to understand the annual cycle and major events that occur in the life history of the species (Figure 2).

Life history

Courtship and nesting

The familiar two- or three-note “bobwhite” whistle made by males in early spring to attract a female is the earliest sign that the reproductive season is under way. Courting pairs are initially formed in April and May; however, pair bonds will form and break, then re-form throughout the breeding season, which runs from May to September. During a given breeding season, individual bobwhites may mate and initiate nesting attempts with as many as three different mates. Studies indicate that bobwhites have a complex breeding system, combining elements of monogamy and promiscuity.

A look at the typical breeding season scenario will help explain how these birds succeed despite poor odds. In April, pairs start forming and hens begin laying eggs in their first nests. If this nest hatches, the female has several options. She can attempt to raise the brood by herself or with her mate and, if successful, possibly quit for the year. Or, she can try to double her production by attempting a second nest. Biologists call this practice “double-clutching.” Studies conducted by the Missouri Department of Conservation indicate that about 25 percent of the hens attempt a second nest after successfully hatching a first nest. Females attempt to double-clutch in several different ways. During the first two weeks after hatching the first nest, some females will turn the brood over to a male (presumably her mate) to raise the chicks and then begin to lay in a second nest that she incubates and raises independently. Other females may raise chicks from the first nest until they are about three to six weeks old and then abandon them to fend for themselves while the female lays and incubates a second clutch. In any case, either the male or the female incubates the nest, rarely alternating incubation duties. This complex social structure allows multiple nesting attempts during the breeding season and contributes to the bird’s high reproductive potential.

Females whose first nests failed have a different set

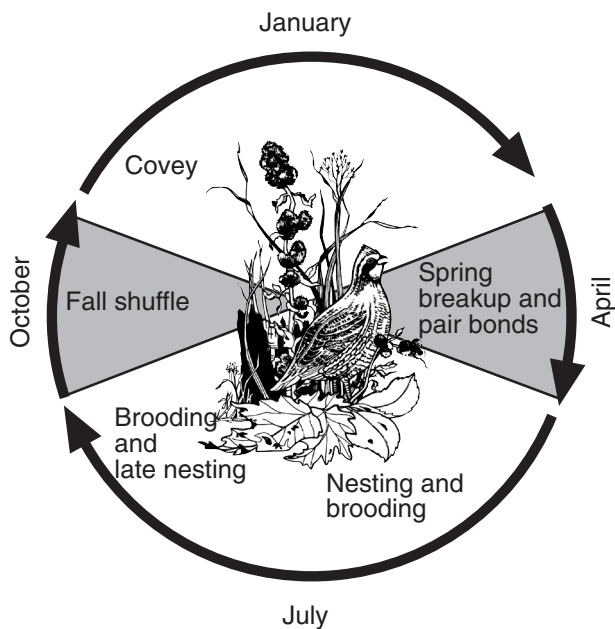


Figure 2. Annual cycle and major events in the life history of bobwhite quail.

of options to contend with. Again, studies have shown that about 40 percent of these hens just give up for the season and do not attempt to renest. But almost 60 percent of the hens that fail in their initial nest attempt will renest one or more times.

With this complex breeding strategy, an important question is, which one contributes to the fall population? Research has shown that a female's first nest has more eggs per nest as well as a greater chance of hatching. In Missouri studies, about 52 percent of the successful nests were female-incubated first nests, 29 percent male-incubated nests, 15 percent female-incubated renests, and 4 percent female-incubated double clutches. Thus, good nesting cover (obtained through management during the previous growing season) and mild weather during April, May and June are critical for a successful first nest attempt, and for high fall quail populations; poor nesting cover and cool, wet springs often yield smaller quail populations.

This understanding of bobwhite breeding ecology helps to explain how quail populations can sustain themselves despite high annual mortality and quickly recover from the decimating effects of harsh winter weather such as snow and ice. Detailed knowledge of the timing and contribution of first nests, renests, male-incubated nests and second broods to overall production helps us to focus on habitat management techniques that need to be implemented to take advantage of the bobwhite's naturally high reproductive potential.

Quail usually select a nest site where grasses are the predominant vegetative type. Quail prefer knee-high cover for nesting, near an edge that adjoins an opening or bare ground. Some scattered woody vegetation can enhance the site. The male constructs the

nest under the critical eye of the female. The nest is built on a slight depression in the soil, using available dead grasses and stems left over from the previous year. These often include broomsedge, little bluestem and other native warm-season grasses as well as various cool-season grasses such as timothy, orchardgrass or redtop. Construction takes about a day. The hen lays about one egg daily until the clutch of 12 to 15 eggs is produced. This usually requires 15 to 20 days following completion of nest construction, often with a slight delay between construction and the onset of egg laying. The average clutch is 14 eggs. Within two to five days of the last egg being laid, the hen or cock will start incubation.

Females incubate three-fourths of the nests, and thus, are most susceptible to nest predators, which take their toll. Snakes and a host of mammalian species (including raccoons, skunks, weasels and fox) are common nest predators. Incubation is a risky job. Predators, mowing activities or weather events destroy 55 to 70 percent of the nests, and the attending adult is killed in about 25 percent of nest failures. After 23 days of incubation, with only a couple of brief feeding periods for the adult each day, the eggs hatch. Once hatching begins, most chicks emerge within an hour or two. As soon as the chicks are dry, the hen uses her survival instincts to lead them away from the nest. Eggs that do not hatch or hatch late are left behind.

Distribution of nesting time

Activity	Days
Nest building and until the first egg is laid	5
Egg laying	18–20
Interval between egg laying and start of incubation	1–7
Incubation period	23
Total	47–55

Brood rearing

Reproductive attempts may require up to 55 days, and the peak hatch often occurs during mid to late June. Some broods may hatch in early September, but most are complete by mid to late summer. As indicated, not all pairs successfully produce a brood. Newly hatched chicks are covered with natal down, weigh about one-quarter of an ounce, and are not much larger than bumblebees. They are very alert, move around on the ground quite readily, and are flightless for the first two weeks. Parents watch the chicks closely, and the brood may cover 2 to 100 acres during the flightless period. Hens take the chicks to open, insect-rich "bugging" habitat that provides the right amount of protection from predators, intense heat, or wet conditions, yet has enough overhead cover and bare ground to allow the chicks to move freely through the vegetation. The first

two weeks are the most critical, because loss to predation and wet, rainy weather may take 50 percent or more of the hatch.

“Brooding” or covering the chicks at night and during much of the day is accomplished by one or both adults. During the first two weeks after hatch, the flightless chicks are especially vulnerable to predators. Bobwhites are tenacious parents and although predation is high during the incubation period, attending flightless chicks is risky as well.

Between two and six weeks after hatching, chicks develop juvenile plumage and flight abilities, and by six weeks of age, the chick’s diet shifts partially from insects to seeds and berries. Much of the feeding habits and behavior of the young chicks is learned from the parents. At 12 to 16 weeks, juveniles are nearly the size of adult birds. By the age of 21 weeks, quail have the plumage that will be worn into the next breeding season. At two months, hens are readily distinguished from cocks by the brown feathering in the throat patch, whereas cocks have a white throat patch and a black eye stripe and collar. Juveniles can be distinguished from adults by their more pointed ninth and tenth primary wing feathers and buff-colored tips of the greater primary coverts on the wings. Figure 3 shows wing and feather characteristics that can be used for identifying the age of bobwhites.

Summer life for birds of all ages consists of daytime activities that include traveling, feeding, dusting to clean feathers, and loafing. They may feed during early morning, rest during midmorning, loaf, sleep, and dust during the middle of the day, and feed again during the two to three hours before dark.

Covey structure

By late summer, bobwhites begin to exhibit the characteristic night roosting habits of forming a circle on the ground, with tails together and heads pointing out. This behavior may have important social, escape and heat-conservation implications. The bobwhite’s preferred mode of travel is by walking directly on mineral soil. Thick stands of grass are more difficult for quail to move through. Flying requires an expense of energy and exposes birds to avian predators such as hawks and owls.

During the late summer and early fall, birds begin to intermix from brood to brood and form coveys, or social groups of birds. Coveys may contain as many as 20 to 30 bobwhites, but average covey size is 10 to 12. This period of transition and increased movement is often called the “fall shuffle,” and populations typically have peaked for the year. As fall and winter arrive, food is most abundant, bird movements are reduced, and juvenile birds compose 75 to 80 percent of the covey. A covey will not normally mix with another covey, although covey ranges may overlap. Depending on habitat quality, coveys may require 15 to 160 acres

or more to meet their food and cover needs.

By the following spring, as much as 80 percent of the previous fall population may be lost to natural mortality. As winter progresses, cover and food conditions deteriorate. Food supply is at an all-time low in late winter, just before spring green-up. Environmental and other factors take their toll on the population. As spring approaches, longer days and better weather conditions trigger the gradual breakup of the coveys. Bobwhites begin calling again in earnest, and pairing begins again as the breeding season arrives.

General habitat needs

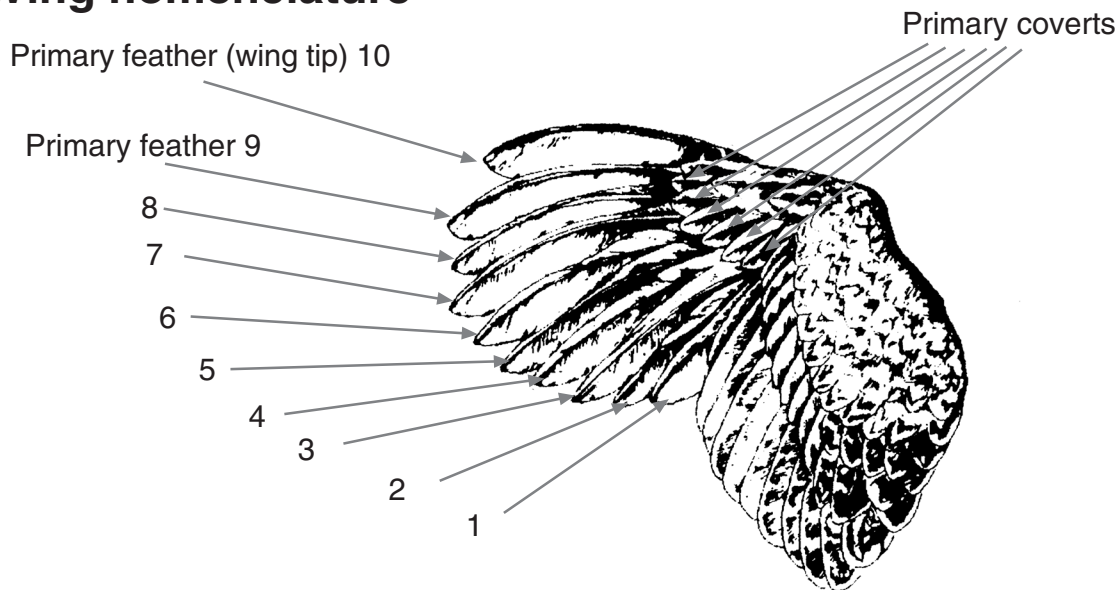
A typical day in the life of a bobwhite depends on the season and the habitat conditions that exist within its home range. Quail require a variety of cover types interspersed in a way that provides areas for nesting, brood-rearing, feeding, roosting and loafing as well as for escaping predators. Bobwhites have adapted to survive and flourish under habitat conditions that favor early-successional stages of plant vegetation, whether under the open canopy of a pine or hardwood forest, around cultivated areas, or on lands that are actively grazed. Although the species has adapted and can live within a wide range of land types, they are primarily birds of open country characterized by small field sizes interspersed with plenty of shrubby cover. MU publication G9432, *Habitat Management Practices for Bobwhite Quail*, and the Missouri Department of Conservation publication *On the Edge: A Guide to Managing Land for Bobwhite Quail* describe specific habitat enhancement techniques that can be used to improve habitats for quail.

If left undisturbed, natural plant communities gradually change over time. Following soil disturbance, an annual weed and forb community initially develops. Depending on the site, within two to three years this community is replaced by a perennial weed community, which gradually transitions into a perennial grass community. Without a disturbance, succession continues to the next stage, a grass/shrub/old field plant community. This process may take from five to 10 years, depending on soil fertility, moisture conditions, length of the growing season and other factors. This grass and shrub community will eventually be replaced by a woodland community if left undisturbed.

Bobwhites depend on different early successional stages of this continuum to meet specific seasonal habitat needs. Management must set back natural succession and create early successional annual weed and grass plant communities: frequent soil and vegetation disturbance is critical to maintaining good quail habitat.

Like other animals, quail have basic habitat requirements for survival. Water, food, cover and space all must be present throughout the year. The requirements that

Wing nomenclature



Age characteristics

Birds less than one year old

Primary covert buff tipped or sharp pointed



Primary feathers #9 and 10 frayed and pointed, often chocolate brown



Bird more than one year old

Primary covert **not** buff tipped and is rounded



Primary feathers #9 and 10 smooth, rounded and black



Figure 3. Wing and feather characteristics can be used to distinguish between juvenile and adult bobwhites.

are in the shortest supply, or the limiting factors, will restrict quail populations. Fortunately, water is rarely a limiting factor in Missouri, as quail generally meet their water needs through dew, moisture in food items such as berries and insects, and metabolic water that is produced during digestion. Free-standing water may be used when available but is usually not required.

Specific food and cover needs of quail change throughout the year. Food and cover are provided by distinct early successional plant communities that are present in differing habitat combinations. Food and cover cannot be separated, because many of the important cover-plant species also provide equally important foods, and vice versa.

Both cover and food must be provided in the greatest quantity and quality possible, as close together as possible, and be present year-round. Because bobwhites conduct their daily activities on the ground, dense vegetation or thick litter restricts movement and inhibits their ability to use such areas. This is an example of a limiting factor that can be addressed as management activities are implemented. Cover needs to be open at

ground level so that birds can move and feed easily. As much as 50 percent of the ground surface should be free of vegetation. Quail also need a fairly thick canopy overhead to provide protection from predators and adverse weather conditions. Lack of shrubby cover that provides this type of habitat is another example of a limiting factor that can inhibit quail populations but can be addressed as management practices are implemented.

Nesting and brood-rearing habitat

In the late spring and summer, nesting cover consists of warm- and cool-season grasses left from the previous growing season. Clump grasses with second-year growth provide excellent early-season nesting cover. As the time since a disturbance increases beyond three years, litter often accumulates, grasses become too dense, and nesting quality declines. Research indicates that a high percentage of nest sites are located within 50 feet of an opening to bare ground such as a field edge, road, or path; and nearly 90 percent of nests are constructed of leaves and stems of dead grasses

and forbs produced the previous season. Nest sites are typically located where a clump of grass or other suitable vegetation forms a canopy to hide the incubating bird and the eggs.

Although weed and grain seeds are the food of adult bobwhites, newly hatched chicks require a different diet. In the first six weeks of life, bobwhite chicks and laying hens eat a high-protein diet composed almost exclusively of insects, which are abundant in stands of annual grasses, broadleaf weeds and legumes (forbs). These areas are easily accessible with abundant bare ground.

Brood rearing requires a different type of cover than is required by nesting and is characterized by the annual weed community found in areas that have been left fallow one to two years after a soil disturbance. A fallow row-crop field planted the year before is a good example and often provides an abundance of high-protein insects needed for rapid chick development. Good brood habitat also provides overhead cover to conceal birds from predators, while remaining relatively open at ground level to allow chicks to move about. More than 50 percent bare ground, with little accumulated plant litter, allows this ease of access.

Dusting sites are needed year-round and can consist of small, drier, open areas of bare ground located close to overhead cover. Edges of crop fields adjacent to hedgerows and shrubby areas provide good dusting areas.

Escape and loafing cover

Escape cover is necessary for avoiding predators. Escape cover is often identified as a critical limiting factor on farms in Missouri and is needed year-round in close proximity to other cover and food needs sources. Often referred to as “a covey headquarters,” these areas are characterized by dense stands of overgrown shrubby cover such as plum thickets, blackberry, sassafras, dogwoods, buckbrush or shrub lespedezas. Protective cover must persist throughout the year, especially during cold weather when thermal protection is needed. These areas also serve as transition zones that may “feather” habitat changes from woods to an open agricultural field or grassland and provide an interspersed area of escape cover and feeding areas.

During moderate weather, preferred roosting

cover is sparse vegetation about 2 feet tall and open overhead. Quail select sites with good drainage and southwestern exposures that have been warmed by the afternoon sun. These sites are often on bare ground and need to be in or adjacent to suitable early-morning or late-afternoon feeding areas. Sites with dense shrubby cover may be used during severe weather.

Loafing cover is normally close to feeding and escape cover so movements are minimized. If a covey is disturbed, only a short flight to suitable escape cover is necessary. The covey headquarters area often provides loafing cover as well.

Food requirements

Bobwhite quail are primarily seedeaters, although seasonal diets vary considerably, depending on food availability and nutritional requirements. In early spring, green plant material is a frequently used food item and thought to be an important vitamin source. Insects and other invertebrates are major food items from spring through fall, especially during the nesting and brood-rearing seasons, when insects make up as much as 80 percent of the diet of chicks.

During the summer, soft fruits and seeds such as blackberries, wild grapes, and grass seeds of various types provide carbohydrate-rich, high-energy foods. The fall period furnishes a variety of native foods, and quail prefer ragweed seeds and large grass seeds early on. Legume seeds are important throughout the year, but particularly important later in the fall. Legume seeds may include beggarweed, milk peas, wild lespedezas and partridge peas. Legumes also provide an insect-rich cover for chicks. Hard-mast items such as acorns and pine seed are important when available from the fall through late winter. Corn, soybean, grain sorghum, millet, sunflower and other agricultural crops can supplement or replace certain native foods when they are not available.

Portions of this publication have been adapted from Publication 2179, *Ecology and Management of the Northern Bobwhite*, 2001, Mississippi State University Extension Service.

The authors acknowledge the Missouri Quail Technical Committee for their review of this publication.

Selected resources for bobwhite quail management

Educational publications

On the Edge: A Guide to Managing Land for Bobwhite Quail – published by the Missouri Department of Conservation.

Wildlife Management for Missouri Landowners, 3rd edition – published by the Missouri Department of Conservation.

Missouri Bobwhite Quail Habitat Appraisal Guide – Assessing Your Farm's Potential for Bobwhites – University of Missouri Extension Publication MP 902.

Habitat Management Practices for Bobwhite Quail – University of Missouri Extension publication G9432.

"The Covey Headquarters Newsletter" – quarterly newsletter that provides timely advice to landowners interested in managing for bobwhite quail. Access the newsletter and additional information at the Covey Headquarters Web site: <http://coveyheadquarters.com>.

Educational videos

(Contact the MDC, USDA NRCS or your MU Extension Center for additional information):

"Bobwhite quail management workshop" – a cooperatively developed video that demonstrates management techniques that can be used to enhance quail habitat on your property. Contact the MDC, USDA NRCS or your MU Extension Center for a copy.

"A landowner tour: Bringing back bobwhite quail" – features landowners who have successfully implemented management practices to improve habitats for bobwhites on their property.

"Managing Conservation Reserve Program lands for wildlife – improving habitat for small game wildlife and songbirds" – shows how landowners can implement approved management practices to improve CRP lands for small game wildlife and grassland songbirds.

Useful Web sites

Missouri Department of Conservation – <http://mdc.mo.gov>

USDA Natural Resources Conservation Service – <http://www.mo.nrcs.usda.gov>

Quail Unlimited – <http://qu.org>

Covey Headquarters – <http://coveyheadquarters.com>

Quail Forever – <http://quailforever.org>

MU Extension – <http://www.muextension.missouri.edu>