Establishing and Managing Early Successional Habitats for Wildlife on Agricultural Lands

A case study featuring habitat practices designed to benefit bobwhite quail conducted at the University of Missouri Bradford Research Center

University of Missouri Extension

MP907

Foreword

A diversity of early successional plant communities within the agricultural landscape provides food and cover for a variety of wildlife species, including bobwhite quail, grassland birds and cottontail rabbits. However, this type of habitat is in short supply on many farms in Missouri. This publication describes the process used to create and manage early successional vegetation at the University of Missouri Bradford Research Center (MU BREC), located near Columbia. The framework for making habitat management decisions is described, and the process used for planning and implementing management practices is highlighted. This report serves as a case study showcasing wildlife habitat practices landowners can implement that benefit bobwhite quail and a variety of other wildlife and that can be designed to complement ongoing farm management, agronomic and economic goals and objectives.

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Land-use changes and the impacts on wildlife

Wildlife populations in Missouri are dependent on the management decisions of private landowners, as about 93 percent of the land base is privately owned. A diversity of wildlife species that require early successional vegetation (for example, warm-season grasses, shrubs, annual weeds and legumes, also known as "forbs") was once an accidental by-product of land management and benefitted from farming practices that provided a diversity of plant communities on agricultural lands. During the past several decades, changes in land use have resulted in a loss of habitat for many wildlife species that are dependent on these plant communities for food and cover. These changes have negatively impacted populations of bobwhite quail, cottontail rabbits and numerous grassland bird species — including dickcissels, Eastern meadowlarks, and grasshopper and Henslow's sparrows — that need a diversity of native grasses, annual weeds and legumes, and shrubby cover for nesting, brood rearing, food and protection (Figure 1).

In Missouri, populations of many of these species have been declining for the past 30 to 40 years. For example,

Figure 1. Changes in land use in Missouri have diminished the habitat of these and other wildlife species: (left to right, top) dickcissels, meadowlarks, (bottom) bobwhite quail and cottontail rabbits.

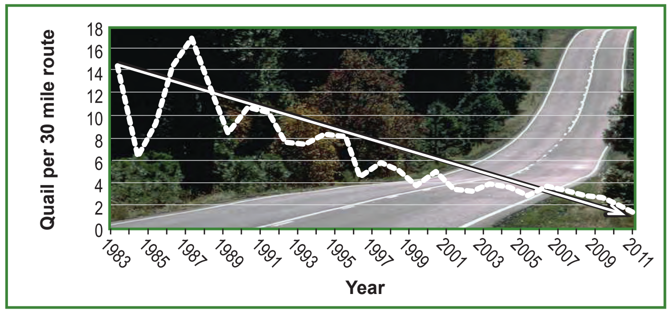

Figure 2. Missouri statewide population trends for bobwhite quail from 1983 to 2011 show a long-term decline. Data summarized from Missouri Department of Conservation annual August roadside survey.

Figure 2 depicts long-term bobwhite quail population trend data that has been collected during the Missouri Department of Conservation's annual roadside survey since 1983. This information provides a snapshot view of bobwhite numbers throughout the state and is largely reflective of conditions on private lands. Suitable bobwhite habitat continues to decrease statewide as competing land uses, such as urban growth and loss of small farms, change the landscape to the detriment of the species. The following factors have contributed to this habitat loss within the agricultural ecosystem (Figure 3):

- Intensive farming practices and advances in harvesting technology
- Reliance on grazing and row crop production systems that promote monocultures (that is, raising only one crop or product) and thus contribute to a reduction of plant diversity
- Consolidation of farms, which has resulted in a landscape made up of larger fields
- Advanced plant succession (large, mature trees) in areas where fence-row habitats consisting of shrubby thickets once existed around crop fields
- Reliance in pastures on nonnative turfgrasses, such as tall fescue, that are aggressive and outcompete native forbs and legumes
- Continued use and spread of nonnative invasive plants
- Urban and suburban sprawl and development

Many Missouri landowners are interested in implementing soil conservation and habitat management practices that benefit wildlife, particularly when these can complement their agricultural production objectives. However, implementation of these practices can be limited by conflicts between economic and conservation objectives and by the voluntary nature of participating in state and

Figure 3. A variety of land-use practices have contributed to the decline in the overall quality of wildlife habitat within the agroecosystem. These practices include (left to right) overgrazing and monocultures of tall fescue; large field sizes with a lack of plant diversity around field edges; and advanced plant succession in areas that once consisted of low-growing shrubs and thickets.

federal agricultural programs that provide cost-share incentives for conducting conservation practices. Proper planning is key to successful integration of wildlife, soil conservation and agronomic goals on your property.

Managing wildlife habitat on your property

Wildlife species require four basic habitat components for survival: food, cover, water and space. The geographic distribution and abundance of a particular species depends on many factors, including the species' physical limitations and the environmental conditions. Habitats are influenced by the composition and structure of the vegetation, which provides food, cover and places for wildlife to breed and raise young, within the area.

The habitat needs of a species often change throughout its life history, which includes key events and strategies that have been adapted for survival, such as mate selection, nesting, brood rearing, food selection and migration. In addition, the biological processes that govern a species' life history vary through the year, as depicted in the example for bobwhite quail in Figure 4. The availability and abundance of food and cover that wildlife require vary during each season. Examples of habitat types that provide areas for nesting, brood-rearing and escape cover for bobwhite quail are shown in Figure 5.

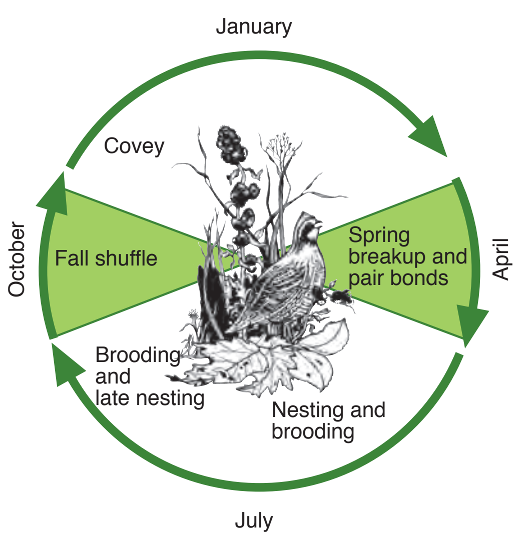

Figure 4. Annual cycle and major events in the life history of bobwhite quail.

Wildlife populations generally respond to management practices conducted to enhance their habitat. The quality and arrangement of the four basic habitat components also influence the survival and productivity of wildlife, as higher-quality habitats generally have the potential to support a higher density of animals. Wildlife management practices are more likely to succeed when landowners develop

- an understanding of the life history, biology and habitat needs of the wildlife species or community (group of species) of interest;
- the knowledge and skills to improve habitats through the manipulation of natural processes and the use of appropriate management practices; and
- an understanding of the impacts of management and how their lands fit into the surrounding landscape.

Once you decide what wildlife species you want to attract, learn about their biology and their habitat needs.

Next, assess the existing conditions of your property and determine which of the basic habitat components — food, cover, water and space — are in short supply or in need of improvement. This is an extremely important step whether you are interested in managing for species such as white-tailed deer, wild turkey, waterfowl, bluebirds or bobwhite quail, or for a diversity of wildlife. These "limiting factors" will need to be addressed through the implementation of management practices.

Finally, develop a wildlife management plan that identifies your overall wildlife goals and specific objectives for implementing the management practices that need to be conducted. Professional experience can be helpful when developing a plan and is available from wildlife biologists certified by The Wildlife Society and from private lands conservationists with the Missouri Department of Conservation.

Figure 5. Examples of cover needed by bobwhite quail: (left to right, top) nesting and brood cover; brood cover (two ground-level and one wide view); and (bottom) protective escape cover located near habitats that provide sources of food.

Manipulating ecological succession

All wildlife species have adapted features that allow them to exploit unique parts of an environment and plant community. Each species acquires energetic and nutritional resources by foraging on specific foods that are available in a particular successional stage of one or more plant communities.

Plant communities do not remain static but rather change over time. The orderly process that describes the change from one plant community to another is called "ecological succession." As a plant community's composition and structure change, so do the food and cover resources it provides. Therefore, the wildlife community that a tract of land supports changes as ecological succession proceeds to a mature stage (Figure 6). Wildlife management success is achieved by manipulating the natural processes that determine the type of plant community that exists in an area. Soon after a disturbance, annual weeds and forbs will be replaced by perennial grasses and shrubs in just a few years, particularly with the abundant rainfall patterns in most of Missouri. Without disturbance, litter will begin to accumulate and the amount of bare ground will decrease as succession advances. Perennial cool-season and warm-season grasses will dominate the site,

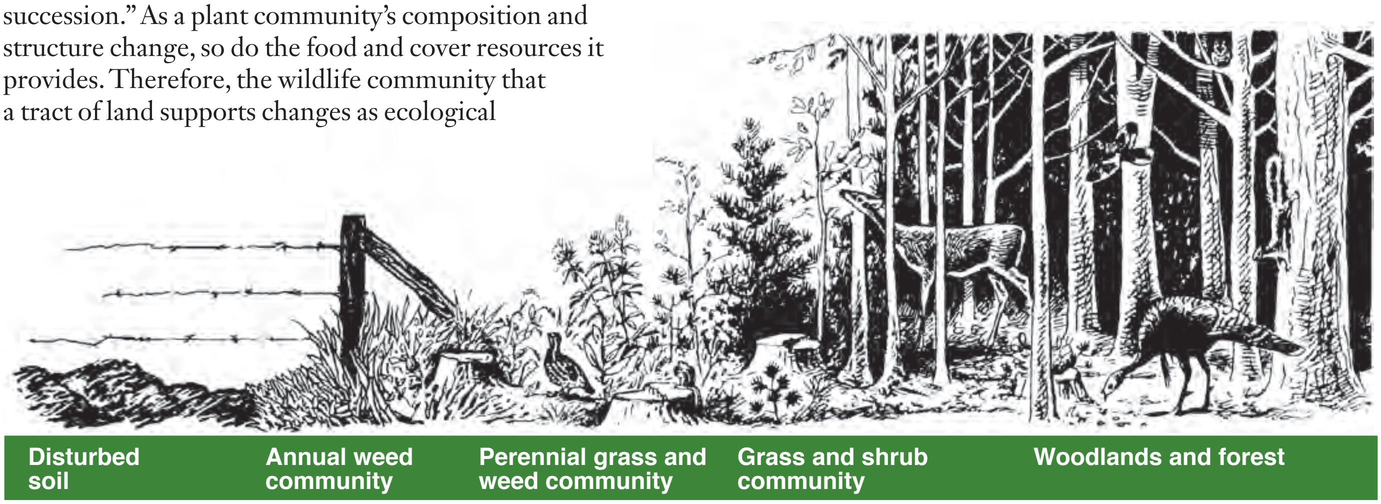

Figure 6. As ecological succession proceeds, the changing plant community generally supports different wildlife species as well as species that use multiple successional stages for food and cover needs.

and the density of the vegetation will increase. At this point, the rank vegetation growth will not allow forbs and legumes to persist in the stand, decreasing the amount of important foods, such as seeds and insects, available. As plant succession advances, the ability of the plant community to provide specific wildlife habitat requirements also changes.

One important objective for managing habitats is to create the specific type of plant community that provides the energetic, nutritional and cover requirements of wildlife throughout the year. Landowners can affect the plant community or successional stage by manipulating the frequency, timing and intensity of disturbances.

Practices such as planting shrubs, fertilizing a food plot or flooding a crop field will increase the rate of plant succession. Practices such as prescribed fires, disking, mowing, herbicide applications, timber stand improvements and tree harvests will set back plant succession. Effective wildlife management depends on recognizing the successional stages to which a species has adapted and conducting appropriate habitat management practices to create and maintain those specific plant communities throughout the year.

Developing a plan for achieving wildlife management goals

Specific activities need to be conducted as part of the planning process:

- Identify your wildlife management objectives.
- Develop an understanding of the biology and life history of the wildlife species or community of interest.
- Consider the seasonal habitat requirements for the species of interest.
- Evaluate the property and surrounding landscape to identify habitat deficiencies and the limiting factors.
- Determine the plant communities that need to be managed to provide for essential life needs.
- Develop a wildlife management plan that can be implemented over time to meet the habitat requirements and address the limiting factors for the species of interest.
- Identify management practices that will be implemented to create and maintain the desired plant communities.
- Identify conservation programs and cost-share incentives that can provide assistance.
- Implement, evaluate and continually modify the plan to accomplish the wildlife management goals.

The following case study describes the process used to create and manage early successional plant communities at the MU Bradford Research Center (MU BREC) for wildlife, agronomic and economic benefits. It showcases a three-phase process landowners can use to make informed habitat-management decisions on their properties to achieve their wildlife goals.

Tasks performed to accomplish case study objectives

- Established edge-feathering and field border management practices around crop fields for improved wildlife habitat and increased corn and soybean yields at edges of the field.
- Compared combinations of native stiff-stemmed grasses within a grass waterway diversion channel for potential conservation benefits.
- Demonstrated management practices that control invasive species such as reed carnarygrass and sericea lespedeza.
- Established native warm-season grasses and forbs that can be used as an alternative to nonnative cool-season grasses such as tall fescue.
- Conducted management practices, including prescribed burning and disking, in stands of native warm-season grasses for improved wildlife habitat.
- Established native shrubs for developing covey headquarters and escape cover habitat.
- Conducted educational programs, including field days and workshops, to demonstrate management practices for the above objectives.

Integrating wildlife and agronomic goals on the farm

The MU BREC, ***http://aes.missouri.edu/Bradford***, is one of 12 MU Agricultural Experiment Stations of the University Missouri and is located 15 miles east of Columbia. The center encompasses almost 800 acres and traditionally has supported agronomic research and extension programs. In recent years, the center has also become a venue for conducting natural resource and wildlife extension programs. Management practices have been implemented to demonstrate techniques that can be used for improving soil conservation and enhancing habitats for a variety of wildlife, including bobwhite quail, that require early successional vegetation. These practices were established to complement the crop production and conservation objectives in a sustainable and economic manner. Wildlife management practices were established to accomplish three broad educational goals:

- Demonstrate the use of a systematic planning process for assessing existing wildlife habitat conditions at the MU BREC and implementing management practices that address the limiting factors and habitat needs of bobwhite quail and other wildlife species of interest (Figure 7).
- Demonstrate practices that can be integrated for wildlife benefits on the farm that complement soil conservation, agronomic and economic objectives.
- Develop an educational model that Missouri landowners could use to successfully integrate wildlife management and soil conservation practices with ongoing agricultural objectives on their farms.

Wildlife management planning process

Pre-planning

- Accumulate necessary educational materials and resources needed for the planning process.

Phase 1. Evaluate the existing habitat conditions on the farm.

- Identify problems that need to be addressed and potential benefits and opportunities that will result.
- Determine wildlife management goals.
- Inventory and evaluate resources.

Phase 2. Implement management practices that address the identified problems.

- Formulate management alternatives.
- Evaluate the costs and benefits and the various trade-offs that result from implementing management practices.
- Make appropriate decisions and implement the planned management practices.

Phase 3. Evaluate the success and response of the implemented management practices.

- Evaluate habitat and monitor wildlife to gauge the success of the management activities.
- Continue to evaluate the plan.
- Modify the plan and revisit Phase 2 to implement other alternatives to achieve success.

Figure 7. A three-phase process was used for making wildlife management decisions.

Implementing wildlife habitat enhancement practices for bobwhite quail

Phase 1. Evaluate existing habitat conditions

Wildlife management success begins with planning. Important first steps are to identify and document management objectives and to gather sufficient data and information to analyze and understand the current natural resource conditions on the property. Although there were opportunities to enhance the habitat for a variety of species at the MU BREC, management practices were initially developed to address the habitat needs of bobwhite quail.

Bobwhite quail need a diversity of habitat types throughout the year for feeding, nesting, brood rearing and escaping predators; loafing; and protection from harsh weather. Habitats that provide for these needs will have mixtures of early successional plant communities dominated by herbaceous vegetation such as annual weeds and forbs, legumes, grasses, grain crops and shrubby cover all interspersed closely together. MU Extension publication MP903, *Quail-Friendly Plants of the Midwest*, provides an overview of the important plants that provide food and cover for bobwhite quail in Missouri.

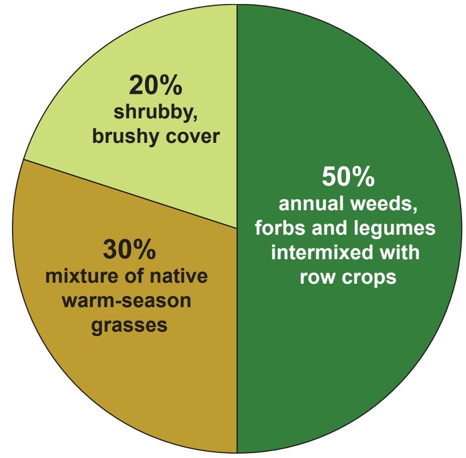

Figure 8. The ideal bobwhite quail habitat has a mixture of these plant communities, interspersed closely together.

The presence of early successional plant communities in an area is highly influenced by land-use patterns and the type and frequency of disturbances being used. Common disturbances include prescribed fire, disking, use of herbicides, timber harvests and grazing practices. These disturbances promote the establishment of early successional plant communities. In general, the optimal habitat for bobwhite quail consists of mixtures of early successional plant communities: about 50 percent annual weeds and legumes intermixed with row crops, 30 percent native grasses and 20 percent shrubby, brushy cover, all closely interspersed (Figure 8).

The MU BREC property was evaluated to determine the existing habitat conditions and to identify habitat components in short supply — the limiting factors — that needed to be addressed to potentially increase the number of coveys. MU Extension publication MP902/DVD16, *Missouri Bobwhite Quail Habitat Appraisal Guide*, describes the process for collecting this information and provides help determining habitat and population goals for a farm.

Determine population goals and establish conceptual home ranges for bobwhites on your property

The first step in habitat appraisal is to determine your population goals for bobwhite quail. For instance, your 100-acre farm may currently provide habitat for one or two coveys, but your goal is for it to support four coveys. An aerial photo of your property can help you identify conceptual home ranges — areas in which to initially focus your management efforts.

This process was used to identify locations to focus management activities at the MU BREC. Using aerial photos of the farm, we identified six conceptual home ranges for bobwhite quail, and our initial management efforts were focused in these areas (Figure 9).

Identify the limiting factors

The limiting factors, or habitat components in short supply, were identified within each of the conceptual home

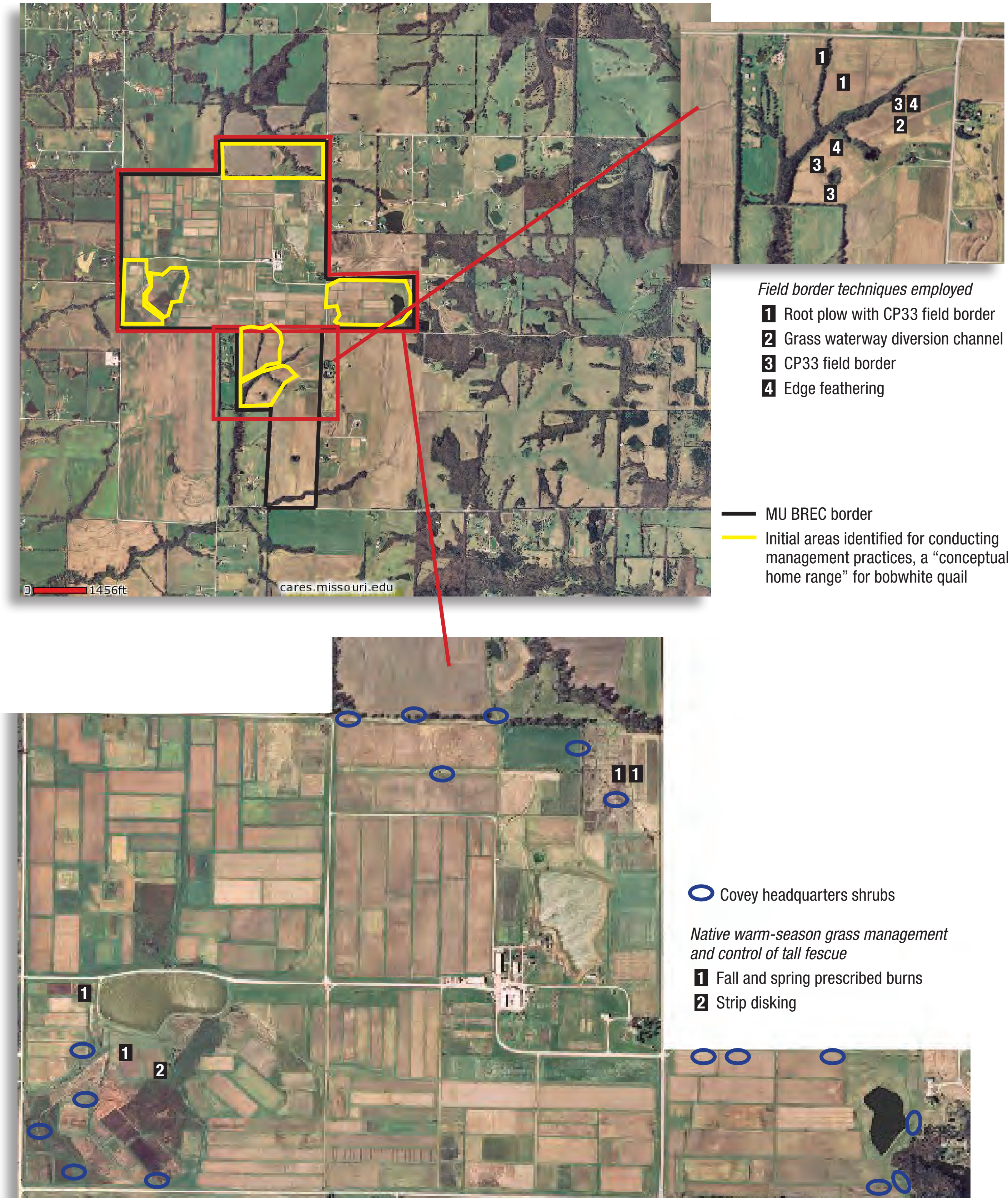

Figure 9. Aerial photos of your property, such as the one we used of the MU BREC and surrounding landscape, can be used to help identify areas in which to focus initial bobwhite quail habitat management efforts. Locations for conducting select habitat management practices that addressed limiting factors are identified on the photos.




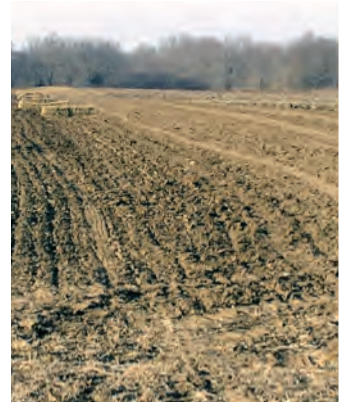

Figure 10. Examples of habitat limitations that needed to be addressed when managing for bobwhite quail: (left to right) unmanaged stands of warm-season grasses; nonnative cool-season grasses; no transition zone or field border between crop field and woodland; and lack of shrubby cover.

ranges to provide a basis for making management decisions. Brood-rearing and escape cover were most limiting and were therefore the two habitat components that needed to be initially addressed within each of the conceptual home ranges as well as across the entire farm. In addition, existing nesting cover needed to be improved for optimal use. The habitat conditions on the farm had the following general characteristics:

- Little plant diversity around crop fields (lack of shrubby edge and fence-row habitat that provides protective escape cover)
- Field edges with no native vegetation or with advanced stages of plant succession, such as over-mature trees
- Lack of brood-rearing habitat (early successional forbs, annual plants and bare ground) near available nesting and escape cover
- Lack of quality nesting cover (mix of native warm-season grasses and forbs)
- Pastures and grasslands dominated by tall fescue, which does not provide quality nesting or brood-rearing habitats
- Unmanaged, rank stands of native warm-season grasses, which do not provide quality nesting or brood-rearing cover

Figure 10 depicts several of the existing habitat conditions that needed to be addressed for bobwhite quail. Table 1 describes the habitat limitations found on the MU BREC and the management actions that were taken to overcome them.

Phase 2. Implement habitat management practices

The next step is to implement management practices that address the limiting factors. At the MU BREC, plant succession was manipulated to create brood-rearing and escape cover and to improve nesting cover. The following management practices were implemented to address these limiting factors.

Establish and manage field borders

Bobwhite quail, cottontail rabbits and many songbird species thrive in areas composed of native grasses, forbs, weeds and small shrubs. These early successional plant communities provide critical areas for nesting, brood rearing and escaping from predators. They also provide wildlife with food in the form of insects and seed-producing plants. Many wildlife species dependent on early successional vegetation will respond to habitat management practices that create food and cover around crop fields. According to research, more than 150 wildlife species in Missouri prefer this type of edge habitat.

The areas around the perimeter of select crop fields, the field borders, were managed to provide brood-rearing and escape cover beneficial for bobwhites. Field borders are generally defined as the area of vegetation — including

Table 1. Management actions for addressing habitat-limiting factors.

Limitation	Management action
Little plant diversity for nesting, brood-rearing or escape cover adjacent to crop fields	Establish and manage field borders by edge feathering and planting mixes of native warm-season grasses and forbs.
Lack of annual plant communities for brood cover	Conduct prescribed fire and disking practices to set back plant succession.
No woody escape cover	Establish shrubs for covey headquarters or conduct edge-feathering practices.
No transition zones, such as field border or filter strip, between crop field and adjacent woodland	Establish 30- to 60-foot field borders in strategic locations adjacent to crop fields.
Extensive plantings of exotic grasses such as tall fescue with a deep litter layer from years of annual mowing	Renovate tall fescue by herbicide applications and prescribed fire, and overseed with annual forbs and legumes. Refrain from recreational mowing around crop fields.
Rank and unmanaged switchgrass fields	Conduct prescribed burns and strip-disking practices to set back plant succession.

Figure 11. Rows of corn adjacent to mature trees do not typically produce a high yield, making fertilizer applications and other agronomic practices uneconomical.

Figure 12. Outer rows of corn next to mature trees are the least productive areas of the field, as depicted by the average size of the ears. Note how the yield increases (left to right) in rows that are farther from the mature trees.

Figure 13. Locations for establishing a herbaceous field border are identified next to woodland. Note the lack of a transition zone or edge habitat between the woodland and crop field.

Figure 14. Edge-feathering practices were implemented to provide increased escape cover and plant diversity adjacent to crop fields and field borders.

grasses, forbs and legumes — that is established along edges of crop fields to provide natural food and cover for wildlife. Field borders also support beneficial insects that may reduce pest insects in crops. Through the use of conservation practices, these low-yield portions of the field can also be made to benefit wildlife and to help reduce soil erosion and protect water quality.

Research has shown that managing field borders can provide agronomic and economic benefits. Field borders next to mature woodlands may suffer yield reductions of over 30 percent, making these areas unprofitable to plant, fertilize, treat with pesticides and harvest. Precision farming techniques indicate that the outer rows of crop fields that are next to mature trees are the least productive areas of the field due to shading and competition from the adjacent woodland (Figure 11). Not only is yield lower in the outer rows, but crop growth is also stunted (Figure 12).

In addition, many wildlife species use dense shrubby cover daily. However, this important cover is lacking when field borders are absent or consist of abrupt changes from crop to grass or mature woodlands (Figure 13).

Field borders also provide the structure for vegetative habitat that provides protective cover for wildlife during severe winter weather.

MU Extension publication G9421, *Field Borders for Agronomic, Economic and Wildlife Benefits*, outlines techniques for establishing and managing field borders and describes how they can provide important habitats for many wildlife species and increase agronomic and economic benefits for a farm. In this case study, the following techniques were used to enhance habitats adjacent to crop fields and improve early successional vegetation and plant diversity.

Technique 1: Edge feathering

Edge feathering was done in strategic locations where mature trees and woodlands were next to crop fields or herbaceous field borders. This practice was implemented to create a transition zone of plant diversity between crop fields and the woodland habitat and provided protective escape cover (Figure 14).

A 1,500-foot woodland border was identified for edge feathering. About 80 percent of the trees were cut, leaving only those that were next to the stream to prevent soil erosion and maintain stream bank stability (Figure 15).

Three techniques were used to implement the edge-feathering practices and treatments (Figure 16):

- Harvesting undesirable trees and treating stumps with a herbicide to prevent resprouting

- Hinge-cutting undesirable trees
- Harvesting mature trees and not treating stumps with a herbicide to allow for resprouting

Figure 15. This is part of the area in which edge-feathering practices were implemented. The flags (circled) identified areas in which an adjacent field border would be established.

Figure 16. Certain unmerchantable trees were selected to be cut during the edge-feathering practice. (Left to right) A tree shear was used to open the stand, and some trees were hinge-cut and left to provide improved escape cover, resulting in the edge-feathered border shown at bottom.

Technique 2: Conservation Reserve Program CP33 practice

The Conservation Reserve Program CP33: Habitat Buffers for Upland Birds provides financial assistance to agriculture producers for establishing and managing field borders around qualifying crop fields. Research has shown that creating herbaceous field borders around crop fields can provide economic, agronomic and wildlife benefits.

Field borders around crops. Herbaceous field borders should be 30 to 60 feet wide to be most beneficial for wildlife. Field borders can be created around row crops that are next to woodlands, pastures or other crop fields. At the MU BREC, CP33 field borders were established at 30-, 60- and 120-foot widths next to a mature stand of trees using a standard CP33 mix containing a 3-to-1 ratio of forbs to native warm-season grass species. (See the USDA NRCS publication *Habitat Buffers for Upland Birds* listed under *Additional information*.)

Figure 17 shows the planting techniques used and the vegetative response to implementation of field border habitats around crop fields. Table 2 lists the mix of the two species of native warm-season grasses and 10 species of forbs used in the herbaceous field borders.

Field borders beside a woody edge. Establishment of the CP33 mix adjacent to a woody edge that had been edge feathered provided excellent brood-rearing and escape cover with an immediate emergence of forbs and annual weeds during the first year (Figure 18). In following years, the amount of little bluestem and side oats gramma increased. Within two years of planting, the mix provided excellent nesting and brood-rearing habitat for birds and provided food and cover for small mammals. Numerous species of insect pollinators also thrive in these plant communities. Species of bees, beetles, butterflies and flies are important for carrying pollen from one plant to another as they collect nectar and, in doing so, help pollinate over 75 percent of flowering plants and nearly 75 percent of crops (Figure 18).

By the third year, tall fescue began to spread into the area. Controlling it required a postemergent grass herbicide application during the fall when the warm-season grasses were dormant.

The Food and Agricultural Policy Research Institute (FAPRI) at MU has conducted studies to estimate the net economic benefits of enrolling crop acres in the CP33 conservation reserve program. FAPRI obtained information from groups of Missouri producers for real-world estimates of key variables such as enrolled field border configurations, yields with and without field borders, program payments and costs of production. Specific types of farm businesses were then simulated for 10 years into the future under outlook scenarios. The FAPRI study did not attempt to estimate any benefits from improved wildlife habitat, such as recreational value. Although the net benefits were not positive for all scenarios, the simulations generally showed that, of the farm types studied (corn-soybean-wheat rotations), program payments would likely offset all of the foregone returns from crops, even with projections of historically high crop prices.

Enrolling acres is more likely to pay where inefficient crop production exists due to any combination of low yields or high costs relative to prices. Farms with high-valued output relative to costs on field edges are less likely to benefit. Farmers indicate that corn and soybean yields

Figure 17. (Left to right, top row) Herbaceous field borders using mixtures of native warm-season grasses with forbs and legumes were established using a native plant no-till drill during the spring. (Second and third rows) Note the forb response and increased plant diversity that occurred during the second and third year after establishment. Ragweeds and partridge pea were also common in the field borders. (Bottom row) These areas provided important nesting and brood-rearing cover for bobwhite quail and important food and cover for wildlife during heavy winter snows and ice storms.

Table 2. Grasses and forbs planted to create herbaceous field borders.

Native warm-season grasses	Forbs
Little bluestem	White beardtongue
Side oats gramma	Blackeyed susan
	Upright prairie coneflower
	Purple prairie clover
	Rigid goldenrod
	Plains coreopsis
	Lanceleaf coreopsis
	Partridge pea
	Gray-headed coneflower
	Illinois bundle flower

Figure 18. Pollinators such as (right to left) the juniper hairstreak and bumblebee benefit from herbaceous field borders, and row crops benefit from their pollinating activity. (Donna Brunet photos, http://donnabrunet.com)

Figure 19. (Top) A large percentage of grass waterways are planted to tall fescue for soil conservation benefits. (Bottom) The use of a variety of native plant mixes (Table 3), as an alternative to tall fescue, can provide soil conservation as well as wildlife benefits in grass waterway diversion channels.

suffer more than wheat yields, perhaps due to the dates of maturity. Thus, farmers have less financial incentive to place borders on the edges of wheat fields.

For the complete FAPRI report and more updated information on market conditions, visit the FAPRI website, ***http://fapri.missouri.edu***. For more information on conservation programs, contact your USDA Farm Services Agency or Natural Resources Conservation Service (NRCS) office, or visit the NRCS website, ***http://www.mo.nrcs.usda.gov***.

Technique 3: Management of grass waterway diversion channels

Many agricultural fields in Missouri contain natural swales and depressions that concentrate water flow after rainfall. Grass waterways, sometimes called "filter strips," are areas of herbaceous vegetation that are established between crop fields, generally on the down slope margin of a field, to reduce water runoff and nonpoint source pollution (that is, pollution such as fertilizer runoff collected by the water from multiple sources along its path).

These areas can be planted to reduce the flow rate of surface water and provide many conservation benefits, including preventing soil erosion, reducing herbicide runoff from fields and serving as buffers next to streams to protect water quality and aquatic habitat and enhance habitats for wildlife and beneficial insects (Figure 19).

At the MU BREC, a grass waterway diversion channel, or filter strip, was planted to a variety of grass-forb combinations as an alternative to tall fescue for determining which mixtures provided soil and wildlife conservation benefits (Table 3). Soil tests were conducted, and the area was fertilized based on soil test recommendations. The establishment and growth characteristics of the various mixtures were observed throughout the year. Mixtures and seedings that contained Virginia wildrye (Cuivre) established quickly, and their growth was equal or superior to tall fescue, offering an excellent alternative to tall fescue as a predominant planting in a grass waterway diversion channel.

Grass waterway diversion channels can be managed to enhance soil conservation and improve habitat for wildlife if the following four recommendations are considered.

Avoid the overuse of tall fescue. Tall fescue is a nonnative cool-season grass. Tall fescue should be used only in steep and highly erodible areas or high-use areas. Although it is an important forage crop, tall fescue provides little benefit for wildlife because of its thick, turfgrass growth characteristics. It is often considered an invasive plant in pastures and grass waterways because of its

Table 3. Grass planting mixtures and seeding rates within the waterway diversion channel.

Grasses	Seeding rates (pounds per acre)
Tall fescue	17.0
Switchgrass (Cave in rock)	10.1
+ Virginia wildrye (Cuivre)	11.6
Switchgrass	10.1
+ Virginia wildrye	11.6
Big bluestem	18.0
+ Virginia wildrye	11.6
Tall dropseed	1.5
+ Sideoats gramma	6.1
+ Fox sedge	0.9
Big bluestem	6.0
+ Sideoats gramma	4.6
+ Little bluestem	3.3
+ Fox sedge	0.7
Tall dropseed	1.7
+ Virginia wildrye	11.6
+ Fox sedge	1.0
Virginia wildrye	46.5

Notes:
The treatments within the waterway diversion channel were subdivided into equal portions and planted to these mixtures.
All treatments were made with the listed proportions of pure live seed.

Figure 20. Root plowing the edge of the soybean field adjacent to the tree line showed no significant benefit. However, establishing field borders adjacent to the tree line and at the minimum recommended width allows edge yield loss to be minimized to a few of rows before reaching the field yield average.

aggressive growth habit and ability to outcompete native vegetation.

Plant stiff-stemmed, native warm-season grasses such as switchgrass, Indiangrass and big bluestems. Research at the University of Missouri has shown that stiff-stemmed warm-season grasses are superior to tall fescue in capturing and storing nutrient and pesticide runoff. A drawback to using native warm-season grasses is that they are often difficult and slow to establish. However, mixing in a native cool-season grass can help establish a quick ground cover within the waterway until the warm-season grasses become established.

Plant a combination of cool-season and warm-season grasses — such as orchardgrass, perennial ryegrass, redtop, Virginia wildrye (Cuivre), switchgrass or timothy with a mixture of clovers, partridge peas or annual lespedezas — to enhance plant diversity.

Minimize or eliminate disturbance during the nesting season. Once the grass waterway is established, mow it on a two- to three-year rotation so that only half to a third of it is mowed during a given year. This practice will maintain the integrity of the waterway while providing some winter cover and areas for early-spring nesting habitat. Mow cool-season and native warm-season grasses no shorter than 6 inches.

Technique 4: Root plowing

Another option for maintaining a field border beside an existing woody edge is to use a root plow to sever tree roots that compete with crops for moisture along the field edge (Figure 20). Root plowing allows crops to be grown in the low-yielding, "sapped" zone next to windbreaks. This technique is especially applicable to Osage-orange hedgerows but works on other tree species as well, especially those with large lateral root systems.

Root plows halt the sapping effect of tree borders on adjacent crops without destroying the windbreak, the border's value as wildlife cover or its other benefits to crop yields. Windbreaks have been shown to cause increased crop yields in adjacent fields, which occurs because of the moderating effect windbreaks have on temperature and humidity.

At the MU BREC, 30- and 60-foot-wide field borders were created adjacent to mature trees where root plowing was conducted. Conventional planting and cultural practices were used for both corn and soybean planting date, pest management and fertility. Single rows were harvested beginning at the edge of the field border for the control and root plow treatments at the edge of the 30- and 60-foot CP33 field borders. The single-row harvest allowed us to determine how far competition for light, water and nutrients extended out from the field border. These yield differences were compared at the 30- and 60-foot widths from the field border (Figures 21 and 22). Results show that the 30-foot-wide field borders were the most cost-effective to implement and provided optimal yields compared with the other treatments.

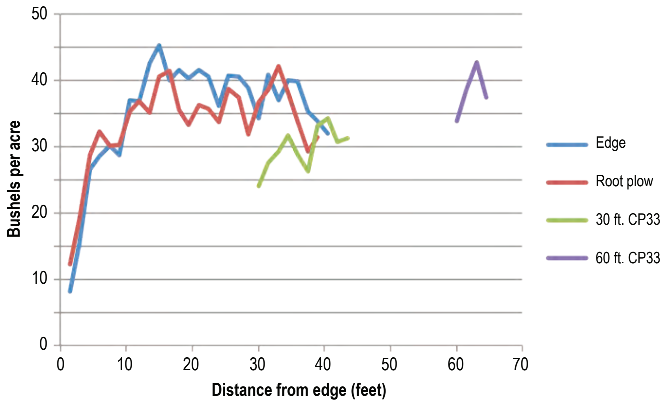

Figure 21. Soybean field-border study 2007–2009, average yield. The use of a root plow next to soybean fields did not provide a significant yield benefit. However, when combined with the establishment of a 30-foot field border, yield losses at the field edge were minimal.

Figure 23. A lack of escape cover was one of the habitat limiting factors identified at the MU BREC. Covey headquarters and shrubby thickets were established to address this important habitat component.

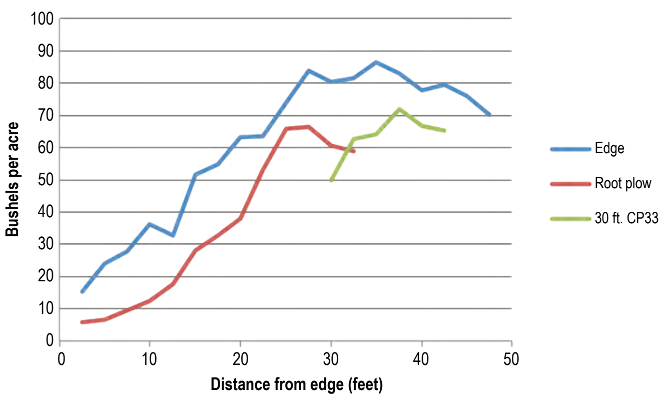

Figure 22. Corn field-border study 2007–2009, average yield. The use of a root plow around corn fields did not provide a significant yield benefit. However, establishing 30-foot field borders did minimize yield losses in rows adjacent to the field edge.

Figure 24. Quail cover bundles of native shrubs were established in strategic locations on the farm adjacent to nesting and brood-rearing habitat to provide escape cover. Shrubs that made up these covey headquarters included wild plum, rough-leafed dogwood, silky dogwood, fragrant sumac, false wild indigo and blackberry.

Establish quail covey headquarters for escape cover

As discussed above, the lack of escape cover was identified as one of the primary limiting factors and a habitat component that needed to be addressed (Figure 23). Edge feathering the woodland edges provided access to escape cover in certain locations. However, a large portion of the farm did not have existing escape cover, so shrubs and thickets were planted to advance plant succession.

The term "covey headquarters" is used to describe areas of dense shrubby cover that bobwhites use to escape from predators and harsh weather. They also loaf in this type of cover daily. Covey headquarters are shrubby thickets with a 3- to 12-foot-high canopy and with little or no vegetation to impede the birds' movements at ground level. Shrubs that provide this type of structure include gray or roughleaf dogwood, American or Chickasaw plum, blackberry, false indigo and shrub lespedeza (Figure 24). Other good species include hazelnut, elderberry, chokecherry, witch hazel and aromatic sumac.

Covey headquarters were established within select conceptual home ranges for escape cover in areas next to early successional herbaceous vegetation that provided nesting and brood-rearing habitat (Figure 25). In addition, the edge-feathering practices provided escape cover habitat in areas where shrubs were not planted.

Set back plant succession

Early successional herbaceous vegetation provides important nesting and brood-rearing habitats for bobwhites and many grassland bird species. However, these types of plant communities require some form of active management — such as prescribed fire, disking or the selective use of herbicides — to keep from becoming a dense, rank stand of grasses or from advancing to a woodland or forest. Dense sod or vegetation provides little habitat and is detrimental to wildlife feeding and movement (Figure 26). These rank stands of grasses can be improved by disturbances that reduce residue and create bare ground conditions that encourage the germination of desirable seed-producing forbs and legumes.

Both prescribed burning and disking were used at the MU BREC to improve plant diversity in existing stands of native warm-season grasses and as a management tool to promote early successional habitat. The timing of these

Figure 25. Protecting shrubs and thickets and allowing plant succession to advance also created areas of escape cover that are valuable habitats for bobwhite quail.

Figure 26. Rank and dense stands of native warm-season grasses needed to be managed to provide more optimal habitat and use by a variety of wildlife species, including bobwhite quail.

management practices depends on the specific objectives. Figure 27 depicts the time of year to conduct prescribed fire and disking practices to achieve a specific outcome or objective.

Technique 1: Prescribed burning

Prescribed burning is the practice of applying a controlled fire within a predetermined area as a habitat management tool. Prescribed fire removes plant litter, improves the level of the vegetation at ground level and stimulates the desirable annual, seed-producing forbs and legumes that are in the seed bank (that is, the reservoir of viable seeds in the soil). Fire improves wildlife habitat by setting back the plant successional stage on an area, controls undesirable vegetation and reduces wildfire hazards (Figure 28).

At the MU BREC, rank stands of native warm-season grasses were burned either in the spring or fall, and one-third of each burned area was also disked. Fall and winter burns were conducted to stimulate the germination of annual weeds and forbs in stands of warm-season grasses (Figure 29). These practices also helped to improve plant structure and diversity and to increase insect populations, an important food source for bobwhites during the summer.

	Timing of implementation																							
Habitat management practice	**Jan.**		**Feb.**		**March**		**April**		**May**		**June**		**July**		**Aug.**		**Sept.**		**Oct.**		**Nov.**		**Dec.**	
Burn cool-season grasses						■	■	■																
Burn warm-season grasses	■	■	■	■	■												■	■	■	■	■	■	■	■
Disk	■	■	■	■													■	■	■	■	■	■	■	■
Spray cool-season grasses						■	■	■											■	■	■	■		
Spray warm-season grasses													■	■	■	■								
Interseed legumes and wildflowers*	■	■	■	■																				

** Interseed in conjunction with the management options above. Do not interseed birdsfoot trefoil, serecia lespedeza, sweet clover or crown vetch.*

Note: Shaded cells indicate when practices were implemented. Left cell under each month indicates first half of month; right cell, second half.

Figure 27. Calendar of select habitat management practices implemented at the MU BREC.

Figure 28. Prescribed fire was used to set back plant succession and promote plant diversity in stands of native warm-season grasses.

Figure 29. A prescribed fire was conducted during the fall to set back plant succession in native warm-season grass stands to promote the growth of annual weeds and forbs.

Burning during the spring (March or April) or on a short duration (two- to three-year interval) tends to promote herbaceous vegetation and potentially a greater density of warm-season grasses, which provide nesting cover for bobwhites and are ideal for grassland birds. Burning during the late summer or fall (August through October) tends to stimulate the germination of forbs and legumes.

Figure 30. Strip disking was also used to create a disturbance, set back plant succession and improve plant diversity in stands of native warm-season grasses and cool-season grasses such as tall fescue. Disking during the fall promoted the growth of forbs and legumes within the stand of grasses.

Technique 2: Disking

Disking can also be used to set back plant succession (Figure 30). Dense, rank stands of cool-season or warm-season grasses can be disked to open the canopy and allow beneficial forbs to establish, which provides food for wildlife. Disking improves the habitat structure and composition by incorporating litter, reducing the density of the vegetation at ground level and stimulating the germination of desirable forbs.

At the MU BREC, disking was conducted in rank stands of cool-season and warm-season grasses and in areas located next to shrubby cover — such as covey headquarters, downed tree structures, edge feathering and native shrub thickets — to create early successional vegetation that benefits a variety of wildlife species.

Figure 31. Stands of sericea lespedeza were controlled through a combination of a prescribed fire and herbicide applications.

Timing of disking can also influence the composition of the herbaceous vegetation. Disking during the fall and winter reduces the dominance of the native warm-season grass in the stand and tends to promote the germination of forbs and legumes. Disking in the summer is not recommended as it would destroy beneficial cover that may be important during the nesting and brood-rearing season.

Technique 3: Selective use of herbicides

The selective use of recommended herbicides is another technique that can be used to set back plant succession and control undesirable vegetation. Certain species of nonnative plants, such as tall fescue and sericea lespedeza, can have invasive growth habits and outcompete more desirable native vegetation that provide food and cover for wildlife (Figure 31).

At the MU BREC, glyphosate (Round-up) was applied in certain areas in the fall to prevent tall fescue from encroaching on the field borders and underneath covey headquarters habitats that had been created. In addition, herbicides were used in combination with prescribed fire and strip disking to control nonnative plants in strategic locations on the farm. Stands of sericea lespedeza in native warm-season grasses were controlled through a combination of a prescribed fire conducted during the spring with follow-up applications of the herbicides metsulfuron (Ally) and triclopyr (Remedy). However, each of these nonselective herbicides will also suppress the germination and growth of desirable native forbs and legumes after establishment, so success depends on applying them at the proper time, targeting the plant species to be controlled and following all label directions.

Phase 3. Evaluate accomplishments and impacts

Conducting a bobwhite quail habitat appraisal of the MU BREC served to identify several significant limiting factors that needed to be addressed. The essential habitat components of nesting, brood-rearing and escape cover were scarce, particularly in the more intensively cropped portions of the property. Consequently, establishing field borders and managing field edges for brood-rearing and escape cover, or establishing covey headquarters, was emphasized. The fields that were dominated by tall fescue and rank stands of warm-season grasses lacked brood-rearing cover and food sources, making these areas unsuitable for bobwhites. These dense grasses had prevented the establishment of native forbs and legumes, and they inhibited the movement of quail chicks and foraging adult birds.

As described earlier, bobwhites require a habitat that is composed of a mix of early successional stages of vegetation that include a diverse annual plant community (native forbs and legumes), native warm-season grasses and shrubby, woody cover. Thus, the management objective was to document the habitat components that were missing or in short supply within each of the conceptual home ranges identified on the property and implement the appropriate management practice that would create and maintain these essential plant communities.

Bobwhite quail populations naturally fluctuate from year to year. Important factors that impact a population include the severity of the winter and spring weather; the availability of good nesting, brood-rearing and escape cover; and the available food resources. If appropriate habitats are prevalent across the landscape and the weather is not extreme, bobwhite numbers can increase dramatically.

Based on past bird surveys conducted during the winter months, an estimated two coveys of bobwhite quail were on the property before habitat management practices were implemented in 2005.

Although the number of bobwhite quail coveys has fluctuated on the property for the past several years, the population has generally increased as a result of favorable conditions and the implementation of habitat management practices. After habitat management practices were implemented, covey call counts were conducted during the fall using techniques described in MU Extension publication G9433, *Methods for Counting Quail on Your Property*. Figure 32 depicts on an aerial photo the locations of the listening points for the fall covey call counts. These covey call counts have revealed a significant increase in the number of coveys on the farm. Table 4 summarizes the covey call counts conducted on the property from 2008 to 2011. Note that covey numbers were highest in 2008 and 2009 and significantly lower in 2010. This fluctuation may have been due to the extremely poor weather conditions during the winter and spring of that year, which negatively impacted nest success and brood survival.

Table 4. Estimated coveys at the MU BREC, 2008–2011.*

Year	Estimated number of coveys
2008	38
2009	42
2010	13
2011	26

** Data summarized from covey call counts taken at six listening points.*

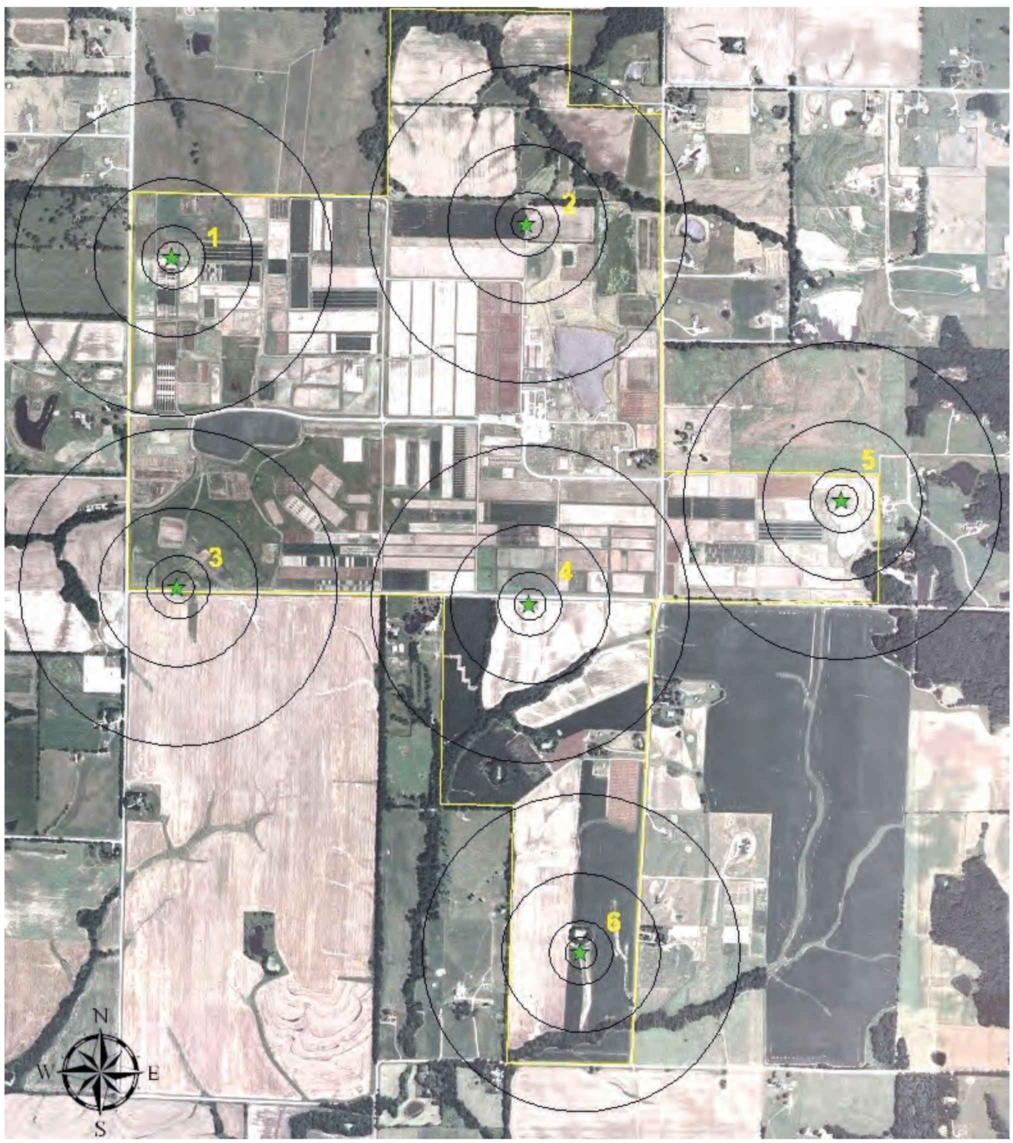

Figure 32. This aerial photo depicts the MU BREC covey call count locations, with 50-, 100-, 250- and 500-meter distances marked.

Figure 33. Wildlife habitat management practices are demonstrated at MU BREC educational events.

The bobwhite quail is not the only wildlife species that has benefitted from these management practices. Research has shown that more than 100 species benefit from the creation and management of early successional plant communities in Missouri. Surveys conducted by the Missouri Audubon Society have documented more than 150 avian species (migratory as well as resident birds) using habitats provided at the MU BREC.

Conclusion

This case study was developed to demonstrate the planning process used at the MU BREC to determine and implement a variety of wildlife management practices for achieving the identified wildlife conservation goals and objectives. The process consisted of the following tasks:

- Identify and develop an understanding of the resource problem or potential management opportunity.
- Determine wildlife goals for the property.
- Consider the seasonal habitats of the species of interest.
- Conduct a habitat appraisal to identify habitat components that are limiting, or in short supply.
- Determine the plant communities that will provide these important habitat components.
- Identify and implement management practices that create and maintain these plant communities.
- Evaluate and modify the plan to address future needs.

This case study outlines an objective-driven planning process for creating and managing high-quality early successional vegetation for bobwhite quail and a variety of wildlife — a process that agriculture producers and landowners can adopt for improving their properties for wildlife. Wildlife habitats were once thought of as an accidental by-product of agricultural practices on farms in Missouri, but that is no longer the case. Today, planning and management are required to ensure that farms contain habitats to support populations of a variety of wildlife species, particularly species that require early successional plant communities.

Landowners, natural resource professionals and wildlife enthusiasts participate in a variety of educational events conducted each year at the MU BREC. These events include field days, tours and workshops that provide information on integrating wildlife habitat into the agricultural landscape and on farms in Missouri (Figure 33). The habitat management demonstrations and this case study can serve as models to be followed by landowners interested in managing wildlife on their properties and implementing objective-driven management practices that can be integrated with the agricultural goals of their farms.

Additional information

MU Extension

http://extension.missouri.edu/publications

- DVD16, *Missouri bobwhite quail habitat appraisal guide* (includes a copy of MP902)
- G9421, *Field borders for agronomic, economic and wildlife benefits*
- G9431, *Ecology and management of bobwhite quail in Missouri*
- G9432, *Habitat management practices for bobwhite quail*
- G9433, *Methods for counting quail on your property*
- MP902, *Missouri bobwhite quail habitat appraisal guide*
- MP903, *Quail-friendly plants of the Midwest*

Missouri Department of Conservation

- *Missouri Covey Headquarters Newsletter*, ***http://mdc.mo.gov/node/9261***
- *Missouri Quail blog*, ***http://mdc.mo.gov/node/8728***
- *On the edge: A guide to managing land for bobwhite quail*, ***http://mdc4.mdc.mo.gov/Documents/259.pdf***
- *Wildlife management for Missouri landowners*, 3rd ed., ***http://mdc4.mdc.mo.gov/Documents/258.pdf***

U.S. Department of Agriculture, Natural Resources Conservation Service

http://www.mo.nrcs.usda.gov/technical/forms/wildlife.html

- JS-15, *Prescribed burning for wildlife*
- JS-18, *Edge feathering — Forest edge*
- JS-19, *Quail covey headquarters*
- JS-21, *Downed tree structure*
- JS-24, *Disking for early successional habitat*

Other NRCS publications

- CP-33 Specification Sheet, *Habitat buffers for upland birds*, ***http://www.mo.nrcs.usda.gov/programs/CRP/crp_practice_wksh.html***
- *Creating early successional wildlife habitat through federal farm programs: An objective-driven approach with case studies*, ***http://www.fwrc.msstate.edu/pubs/early_successional.pdf***

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