Integrating Practices That Benefit Wildlife With Crops Grown for Biomass in Missouri

Landowners are considering growing crops for biomass to reduce our reliance on nonrenewable energy. There is also interest in developing cellulosic materials that could be used for ethanol and biodiesel production, and which can also be pelletized. However, growing crops for biomass can be detrimental to local wildlife unless their needs are considered when fields are being established. This guide describes management practices that can be conducted in fields used for biomass production to benefit wildlife. It also provides information to help landowners make informed decisions on enhancing habitats on surrounding areas of their property while producing crops for biomass.

Potential biomass crops

Current research in the Midwest has focused on developing cultural methods for using biomass from native warm-season grasses and introduced species, such as tall fescue or *Miscanthus* spp., for biofuel production. Research and demonstrations of potential biomass crops, which include native warm-season grasses and mixtures of native grasses and forbs, have been established at the MU Bradford Research Center (near Columbia, Mo.) and Hundley-Whaley Research Center (near Albany, Mo.) to determine ideal cultural methods, expected yield and possible effects on wildlife.

A variety of native warm-season grasses have been considered as crops for biofuel production. These grasses include indiangrass, switchgrass and big bluestem. Switchgrass, a native perennial, has been given the most consideration for biofuel production because of its wide adaptation, low inputs, ability to grow on soils with low fertility, and relatively high biomass yield. Once switchgrass has been established, little management is required over the life of the stand, which can be as long as 10 to 15 years

Figure 1. A variety of native warm-season grasses, such as indiangrass, big bluestem and switchgrass, are potential crops for biofuel production.

Summary of beneficial management practices

- Incorporate forbs and use mixed stands rather than stands of a single crop.
- Establishing bioenergy crops will have the fewest negative effects on local wildlife when cropland, nonnative pasture or nonnative tree plantations are converted instead of native habitats.
- Bioenergy plantings can be strategically located to provide suitable habitats for targeted wildlife species and create corridors between existing fragmented habitats.
- Keep field sizes relatively small (10 to 15 acres) and broken up with wide hedgerows and field borders of early successional vegetation around each field.
- Avoid harvesting during the nesting or brood-rearing seasons.
- The most efficient, economical and wildlife-friendly harvest timing is after a killing frost during the dormant season.
- If feasible, modify harvest equipment to leave a crop stubble height of at least 8 inches to provide nesting habitat the following spring.
- Harvest larger fields in thirds, leaving blocks — not narrow strips — to provide winter escape cover and nesting the following spring.
- Conduct a prescribed fire no more than once every three years.
- If possible, avoid the use of exotic species or genetically altered varieties that could become invasive.

Written by
Robert A. Pierce II, Fisheries and Wildlife State Specialist, School of Natural Resources
Bill White, Private Lands Division Chief, Missouri Department of Conservation
Tim Reinbott, Superintendent, MU Bradford Research Center
Ray Wright, Research Specialist, MU Bradford Research Center

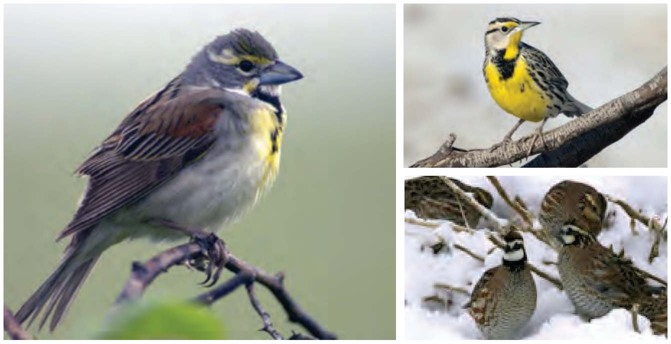

Figure 2. Populations of many species dependent on early successional plant communities — such as (clockwise from left) dicksissels, eastern meadowlarks and bobwhite quail — have been declining but can be supported through habitat management.

Figure 3. Missouri landowners are becoming increasingly interested in producing miscanthus as a crop for biomass.

with proper fertilization and harvest (Figure 1). Native warm-season grasses also provide important habitats for many species of wildlife that are dependent on early successional plant communities, such as bobwhite quail, cottontail rabbits and species of grassland songbirds (Figure 2). The grasses and forbs that make up these plant communities provide structure and cover as well as food sources and pollinator habitat. Switchgrass monocultures and combinations of switchgrass, big bluestem and native forbs have been the focus of biomass projects conducted at the MU Bradford Research Center. Preliminary results of biomass and forage yields indicate that mixtures of forbs planted with switchgrass and big bluestem produced relatively equal tonnages during the year (without any nitrogen fertilizer or herbicides applied) as monocultures of these grasses produced.

Miscanthus giganteous, a robust, rhizomatous ornamental sterile hybrid grass, is also being considered (Figure 3). This grass has been established on several fields enrolled in the U.S. Department of Agriculture (USDA) Biomass Cropland Assistance Program (BCAP) and has the potential to produce up to 12 tons of biomass per acre each year; however, little is known about the potential values of this species to Missouri wildlife.

Management decisions that affect wildlife

In general, the management decisions that likely have the greatest effects on wildlife and habitat are those regarding the crop to produce, the cultural and management strategies to implement, and the harvest methods and timing. Although the effects will fluctuate greatly from field to field, some questions concerning effects on wildlife are common to all situations:

- What crop is being produced for biomass?
- Is the crop replacing natural vegetation?
- Does producing this crop result in a land-use change? If so, on what scale?
- How often and when will the crop need to be planted and harvested?
- Does the crop complement, improve or eliminate current or future wildlife habitat?
- Are you willing to balance production goals with wildlife habitats?
- How do the surrounding habitat types affect wildlife use and survival?

Table 1 lists a few of the management decisions that influence the wildlife value of a field producing crops for biomass production and provides general ratings of the habitat values that result from their implementation.

Table 1. Wildlife habitat value.

Lower	FEATURE	Higher
Cropland	**Habitat type**	Diverse native habitats
Exotic monocultures	**Plant diversity**	Diverse native grasslands or forests
Breeding or nesting season	**Harvest and disturbance timing**	Late fall or early spring
Multiple harvests per year	**Harvest frequency**	Single harvests more than a year apart
Little or no remaining stubble	**Postharvest stubble height**	Tall stubble or regrowth
Complete harvest in field with no borders	**Habitat refuges or undisturbed areas**	Unharvested areas within field with wide borders
Isolated patch or field with little diversity	**Landscape context**	Diversity of fields or habitat patches

Figure 4. The plant composition of early successional plant communities, such as mixtures of native grasses and forbs, provides the vertical structure and food sources that are essential for a variety of wildlife species.

Figure 5. Scattered patches of shrubs and thickets, which commonly occur in early successional habitats, provide important areas of escape cover and food sources for wildlife.

Effects of converting native habitats to biomass production

Converting native grasslands, woodlands or wetlands to energy crops results in a loss of biodiversity. These native habitats, already greatly diminished in quality or quantity in some areas of the state, provide multiple benefits to society and are important to conserve rather than convert to other land uses such as biomass production.

Conversion of native habitats to *monocultures* of biomass crops results in the loss of existing wildlife habitat. (A monoculture is a field covered with a single crop.) The conversion of native habitats to monocultures and the harvesting techniques used can also result in the reduction of residual nesting and escape cover required by cottontail rabbits, bobwhite quail and other species of ground-nesting birds, such as meadowlarks, dickcissels and grasshopper sparrows.

If retained, these native habitats can be managed to provide sources of biomass that can supplement bioenergy production, depending on the management practice conducted. Beneficial practices include removal of invasive species, haying, forest thinnings, fuel management, removal of diseased and fire scarred trees, and use of waste wood products. Improvements in the technologies that can use these diverse sources of biomass will expand opportunities for limited, sustainable use of native habitats for bioenergy.

Figure 6. Stands of sod-forming grasses, such as tall fescue and orchard grass, can inhibit access for bobwhite quail and other wildlife, limit the availability of seed and invertebrates, and prevent competition of other plant species.

Figure 7. Miscanthus stands provide an abundance of biomass, but the mature crop's thick, dense growth provides little access for wildlife at ground level.

The importance of plant composition within the field

The plant composition of a particular field along with the management practices that are conducted through the year greatly influences the field's ability to provide quality wildlife habitat (Figure 4). Fields composed of a diversity of plants can attract a wide variety of wildlife. Forbs could include ragweed, partridge pea, beggar's lice, native lespedezas and various asters. Scattered patches of shrubs — such as blackberry, wild plum thickets and sumac — could

Figure 8. Native warm-season grasses grow compatibly with many species of native forbs, providing a rich diversity of cover, browse, seed, and insect foods (inset) for wildlife.

Figure 9. To retain important cover for nesting wildlife, delay harvest of switchgrass until after a killing frost, typically in late October in Missouri.

be established in strategic locations to provide structure for nesting, soft mast, browse and winter escape cover (Figure 5).

Many old fields, pastures and early successional habitats have been replaced with nonnative grasses, such as tall fescue and orchardgrass, that are used for grazing and haying. The conversion of native grasses and forbs to monocultures of these sod-forming grasses has negatively affected many species of wildlife (Figure 6). The potential exists for many fields to be converted to monoculture stands of miscanthus, but the dense growth of vegetation at ground level, closed canopy and structure in fields of miscanthus is not attractive to many wildlife species (Figure 7). As described earlier, when sod-forming grasses are removed and native grasses and forbs are planted, an open structure at ground level is created that enables quail chicks, young turkeys and species of grassland birds to travel, nest and feed throughout the field while protected by overhead cover (Figure 8). Mixtures of native grasses and forbs can also be established for livestock forage as well as a potential crop for biomass.

Managing fields of switchgrass for biofuel production and wildlife benefits

Although stands of native warm-season grasses can provide desirable structure and cover, they do not provide sources of food for many species in Missouri. White-tailed deer, cottontail rabbits, groundhogs and other herbivores do not use these perennial grasses as a forage any more than they would use nonnative perennial grasses.

The primary value of these native grasses is the vegetative structure they provide and their bunch-like growth at ground level that allows for the germination and establishment of native forbs. These forbs produce a quality seed and attract various insects that are important food sources for many wildlife species (Figure 8). However, rank stands of these grasses will not provide this type of structural or vegetative diversity unless some sort of disturbance practice is implemented, such as a prescribed fire, disking or harvesting for hay or biomass.

Figure 10. To retain important wildlife habitat and cover through the winter, delay harvest of switchgrass until the next spring.

Stands of switchgrass produced for biofuel can be managed to provide an important habitat component for a variety of wildlife species. Strategies to enhance wildlife habitat include delaying winter harvest so that winter cover is retained or rotating harvest so that some fields or portions of fields are harvested at two- to three-year intervals. Leaving buffer or fallow strips within and around fields also enhances habitat conditions.

Timing of harvest

Switchgrass is typically harvested once a year during the fall, after a killing frost has occurred, when mineral and moisture contents are at their lowest. Waiting until fall to harvest leaves nesting cover intact during the summer when it is most needed.

When switchgrass fields are harvested in late May or June, nests of many songbirds, bobwhite quail and wild turkey may be destroyed, and white-tailed deer lose access to fields with substantial amounts of cover during their peak fawning period. Waiting until after the first frost to harvest switchgrass will ensure that this cover is available when it is important for wildlife reproduction and recruitment (Figure 9).

Delaying harvest until later in the winter can provide critical winter cover that is used by a variety of wildlife

(Figure 10). Studies have shown the quality and yield of biomass are not reduced by delaying harvest until late in the winter or until March.

Leave areas of the field unharvested

Although harvesting during the fall maintains habitat used for nesting and escape cover, harvesting entire fields at this time will not provide winter cover important for many species. Leaving one-third of a switchgrass field unharvested can provide great benefits for wildlife by providing cover during the winter and nesting habitat the next spring. However, if switchgrass is harvested in the fall, as opposed to delaying harvest until March, leaving some of the area unharvested to provide winter cover is particularly important. Retaining as little as 5 percent of a field, preferably around the field edge or near other cover types, is highly recommended, particularly if field borders have not been established.

Another method of retaining cover for wildlife is to defer harvesting the entire field from one year to the next. Harvesting fields in strips that are at least 50 feet wide or in blocks of at least a half acre is also recommended. Narrow strips and small blocks of unharvested switchgrass will be used by wildlife; however, these habitats will also be used by predators. Wider strips and larger blocks of cover are recommended as they present more difficulties for predators searching for prey.

Consider stubble height at time of harvest

Another important practice is to modify harvest equipment to leave grass stubble that is at least 8 inches tall to provide nesting habitat for ground-nesting songbirds, bobwhite quail and wild turkey to use the following spring. Research suggests that the optimal vegetation height for grassland birds at the time of nest initiation, when the first egg is laid, is 14 inches for greater prairie chicken and 17 inches for wild turkey by April 15, and 6 to 8 inches for bobwhite quail by mid-May (Figure 11). Ensuring that the grass stubble is at least 8 inches tall in the late fall will allow for enough regrowth to provide potential nesting cover the next spring.

Figure 11. When harvesting biomass crops, leave stubble 6 to 8 inches tall to provide residual cover for nesting grassland birds, bobwhite quail and wild turkeys to use the next spring.

Consider planting mixed stands of native warm-season grasses and forbs

Monocultures of switchgrass and other native grasses tend to be very dense and are largely free of other valuable plants such as forbs and weedy vegetation that provide important foods for wildlife. Characterized as being *high-input*, *low-diversity* (HILD), these forb-free stands of warm-season grasses, like rank stands of tall fescue, provide only marginal wildlife habitat. Wildlife habitat can be greatly enhanced by planting a mixed stand of native warm-season grasses and native forbs, as opposed to using monocultures of grasses for biomass production. Not only do forbs provide forage, seed and soft-mast, they attract a diversity of insects and pollinator species that provide several benefits, including being important sources of food (Figure 12).

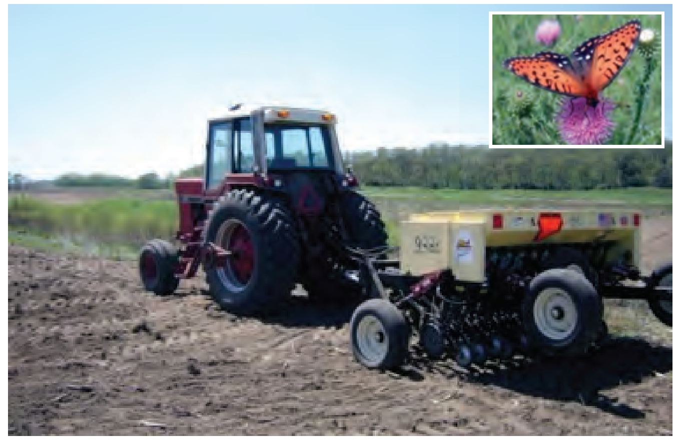

Figure 12. Planting diverse mixes of forbs together with native warm-season grasses can produce crops for biomass and enhance habitats for wildlife, including species of pollinators (inset).

In addition, research suggests that the biomass generated from mixed *low-input*, *high-diversity* (LIHD) stands can be greater than that generated from stands of switchgrass monocultures, which require higher inputs, such as fertilizer requirements, and are lower in plant diversity. Stands of grasses and forbs characterized as LIHD provide vertical structure, seeds and insects for such birds as bobwhite quail, meadowlarks and grasshopper sparrows, as well as many species of small mammals and cottontail rabbits. Diverse stands can also provide quality habitat for

Table 2. Seeding rates for native warm-season grasses, legumes and native forbs that can be used in low-input, high diversity stands for livestock grazing, biomass production and wildlife habitat.

	Pounds of pure live seed (PLS)	
Mixture of grass and legume species	**Livestock grazing or biomass**	**Wildlife habitat**
Big bluestem	3.5	0.5–1
Little bluestem	1.5	3–5
Indiangrass	2	0–0.5
Eastern gamagrass	2	0–0.5
Sideoats grama	1	0.5
Switchgrass	0.25	0.25
Canada and Virginia wildrye	1	1
Alfalfa	0–1	0–1
Total	**8–10**	**4–7**
plus forbs*	**1–3**	**3**

**Forbs that are often added to native warm-season grass mixtures include partridge pea, tick trefoils, Illinois bundleflower, roundhead lespedeza, perennial sunflowers, purple prairieclover, purple coneflower, blazing star and lance-leaved coreopsis.*

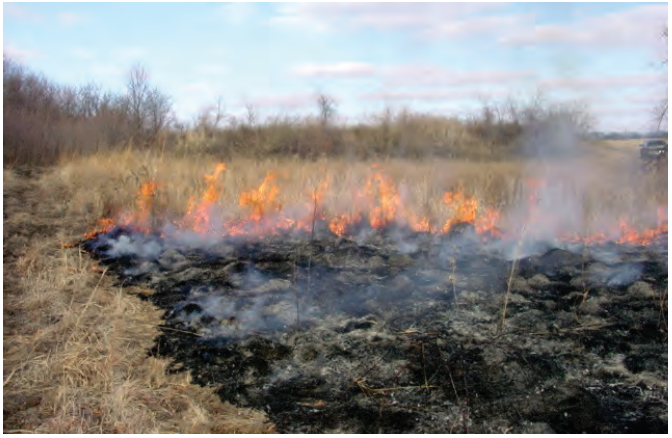

Figure 13. Prescribed fire, an effective tool for managing native warm-season grass stands, can be used to control woody invasion, stimulate desirable, or suppress undesirable plant species.

wildlife and persist better in drought conditions. A variety of species such as partridge pea, clover, alfalfa, tick trefoils and other native forbs can provide desirable mixtures that enhance an area for wildlife (Table 2).

Conducting a prescribed fire to maintain productive stands

Prescribed fire is a management practice that helps maintain productive stands of native warm-season grasses and benefits wildlife (Figure 13). You can dictate the vegetation response by the time of year you burn. The season and frequency, or burn interval, can be manipulated to either encourage a greater response of grasses or improve the germination and response of native forbs. Typically, conducting a prescribed fire in stands of warm-season grass during the early spring will encourage a flush of regrowth of these grasses. A summer or fall burn will encourage the germination and regrowth of native forbs and promote a diversity of plants in the stand.

Although implementing a prescribed fire at a recommended interval can improve habitat conditions for wildlife, there may be a trade-off to consider as the production of biomass may be less during the year the burn was conducted. For biomass production, a three-year burn interval may be recommended to maintain productive stands of native warm-season grasses.

Before conducting a burn, seek professional advice from natural resource professionals with the Missouri Department of Conservation (MDC) or the USDA Natural Resource Conservation Service (NRCS). They can help you develop a burn plan so that the fire is conducted safely and under exact weather and fuel conditions to accomplish your objectives and the desired changes in vegetation.

Establishing and managing habitat around the field

Switchgrass and other grasses used for biofuels can be enhanced for wildlife by incorporating shrubby cover in the form of shrub plantings, feathered field edges or

Figure 14. Planting 30- to 50-foot-wide field borders to early successional forbs and mixes of native warm-season grasses can increase food availability around the field and provide a crucial source of cover during the winter, especially if biomass crops are harvested in the fall.

Figure 15. Edge feathering and hinge-cutting along field borders adjacent to crop fields or fields of biomass crops can enhance these areas for wildlife.

downed tree structures (Figure 14). Shrubs such as wild plum, blackberry, elderberry and sumac are extremely beneficial for wildlife and can be used to break up fields into 5- to 10-acre sections and help to create an interspersion of habitats within stands of grasses. Establishing field borders of herbaceous native forbs and legumes is also recommended. Refer to MU Extension publication G9421, *Field Borders for Agronomic, Economic and Wildlife Benefits*, for additional recommendations on establishing and managing field borders.

Another practice that can enhance areas surrounding fields is to feather the field edges and thin trees along the edges within the adjacent woodlands. Hinge-cutting trees along a field edge or conducting other edge feathering practices creates a diversity of plants that provide food and cover that may be missing on the property (Figure 15).

Thinning undesirable trees about 100 feet into the woodland from the edge will allow the crowns of adjacent mast-producing trees to grow larger and produce more acorns and hard mast. The increased sunlight stimulates the growth of plants at ground level, providing increased usable space for many species that require early successional vegetation. Refer to MU Extension publication MP 907, *Establishing and Managing Early Successional Habitats for Wildlife on Agricultural Lands*, for additional information on implementing these practices for improved wildlife habitat on your property.

Conclusion

Although fields of switchgrass and other monocultures grown for biomass do not provide the same quality of habitat as diverse fields made up of native grasses and forbs, plans can be made and practices implemented that integrate wildlife considerations into biomass plantings. Decisions related to field layout, harvest timing, retention of wildlife cover, incorporating forbs and developing quality food and cover resources around and within fields will each have important effects on wildlife habitats and populations.

Contact an MDC private land conservationist or an MU Extension natural resource specialist for additional information and assistance on enhancing wildlife habitat on your property.

Additional information and resources

In addition to the related MU Extension publications listed in the box at the bottom of the page, you may want to refer to these publications from other sources for more information:

Adler, P.R., M.A. Sanderson, A.A. Boateng, P.J. Weimer, and H.G. Jung. 2006. Biomass yield and biofuel quality of switchgrass harvested in fall or spring. *Agronomy Journal* 98:1518–25.

Fargione, J.E., T.R. Cooper, D.J. Flaspohler, J. Hill, C. Lehman, T. McCoy, S. Mcleod, E.J. Nelson, K.S. Oberhauser, and D. Tilman. 2009. Bioenergy and wildlife: Threats and opportunities for grassland conservation. *Bioscience* 59(9): 767–77.

Harper, C.A., and P.D. Keyser. 2008. *Potential impacts on wildlife of switchgrass grown for biofuels*. University of Tennessee Extension. ***https://utextension.tennessee.edu/publications/documents/SP704-A.pdf***.

Missouri Department of Conservation. 2007. Rich grasslands for Missouri landowners. Jefferson City: Missouri Department of Conservation. ***http://www.moprairie.org/wp-content/uploads/2013/04/MDCRichGrasslandsForMOOwners.pdf***.

Pitts, D.E., and W.D. McGuire. 2000. *Wildlife management for Missouri landowners*, 3rd ed. Jefferson City: Missouri Department of Conservation. ***http://mdc.mo.gov/sites/default/files/resources/2010/05/5354_3245.pdf***.

Rupp, S.P., L. Bies, A. Glaser, C. Kowaleski, T. McCoy, T. Rentz, S. Riffell, J.Sibbing, J. Verschuyl, and T. Wigley. 2012. *Effects of bioenergy production on wildlife and wildlife habitat*. Wildlife Society Technical Review 12-03. Bethesda, MD: Wildlife Society. ***http://wildlife.org/documents/technical-reviews/docs/Effects%20of%20Bioenergy%20on%20Wildlife.pdf***.

Tillman, D., J. Hill, and C. Lehman. 2006. Carbon-negative biofuels from low-input high-diversity grassland biomass. *Science* 314:1598–1600.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2011. *Planting and managing giant miscanthus as a biomass energy crop*. Plant Materials Program, Technical Note No. 4. Washington, D.C.: USDA NRCS. ***http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044768.pdf***.

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ALSO FROM MU EXTENSION PUBLICATIONS

G9421	*Field Borders for Agronomic, Economic and Wildlife Benefits*
G9432	*Habitat Management Practices for Bobwhite Quail*
MP902	*Missouri Bobwhite Quail Habitat Appraisal Guide*
MP903	*Establishing and Managing Early Successional Habitats for Wildlife on Agricultural Lands*
MP907	*Quail-Friendly Plants of the Midwest*

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