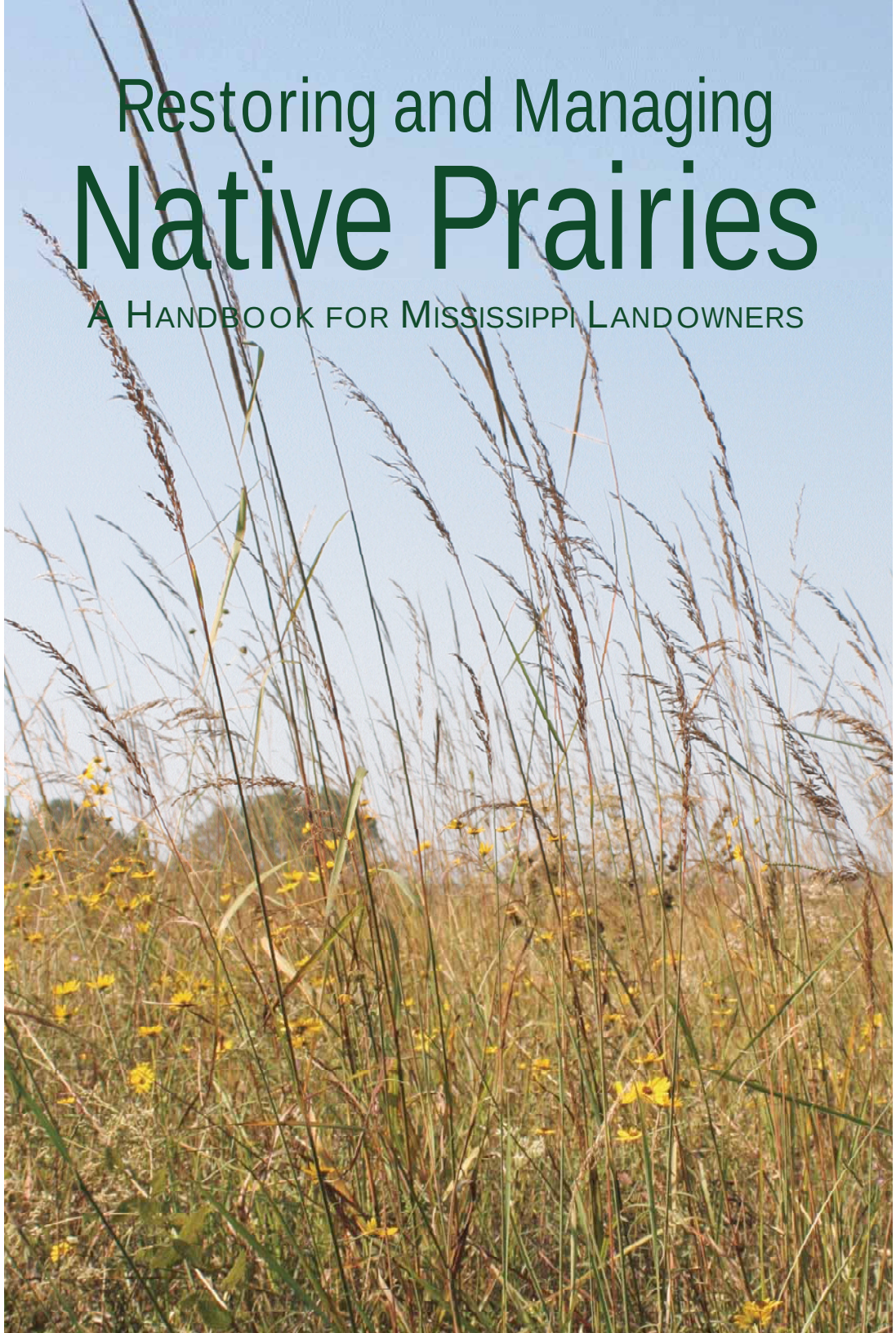
Restoring and Managing Native Prairies

A Handbook for Mississippi Landowners



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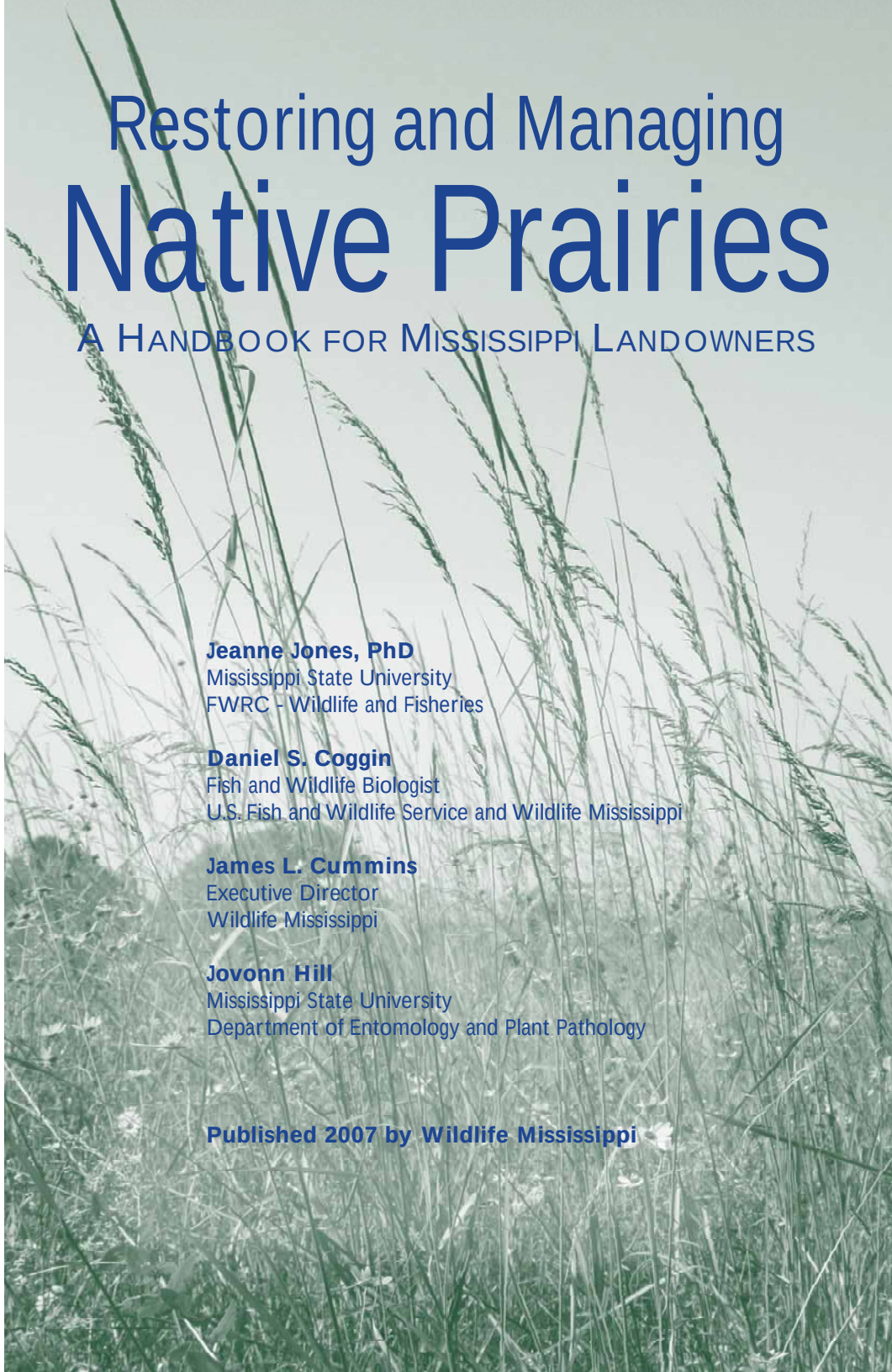

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A Handbook for Mississippi Landowners

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Description and History

Tall-grass prairies and woodland savannas once covered much of central North America and parts of the Southeast (Figure 1). When European settlers arrived on this continent, these vast grasslands stretched as far north as Manitoba, Canada, south to the coastal areas of Texas and Louisiana and east into Oklahoma, Mississippi and Alabama. These communities developed over thousands of years, shaped by soil type, climate and fires ignited by dry lightning and North American Indians. Differences in soil types, rainfall, moisture availability and fire incidence created varying degrees of habitat types from west to east across the country. For example, mixed- and short-grass prairies, and desert grasslands occurred in the drier mountains and deserts of western regions. To the east of the mixed-grass prairies, immense areas of treeless, tall-grass prairies extended from Southern Canada to Texas. From East Texas through Alabama, mosaics of prairies were interspersed with oak woodland savannas which were influenced by abundant annual rainfall, fertile soils and fire. To the south of the oak woodland-savannas region, lay vast pine savannas shaped by more frequent fires and sandy, drier soils. Thus, grasslands in the Southeastern United States are fire-dependent ecosystems that occur in a variety of soil and climate conditions.

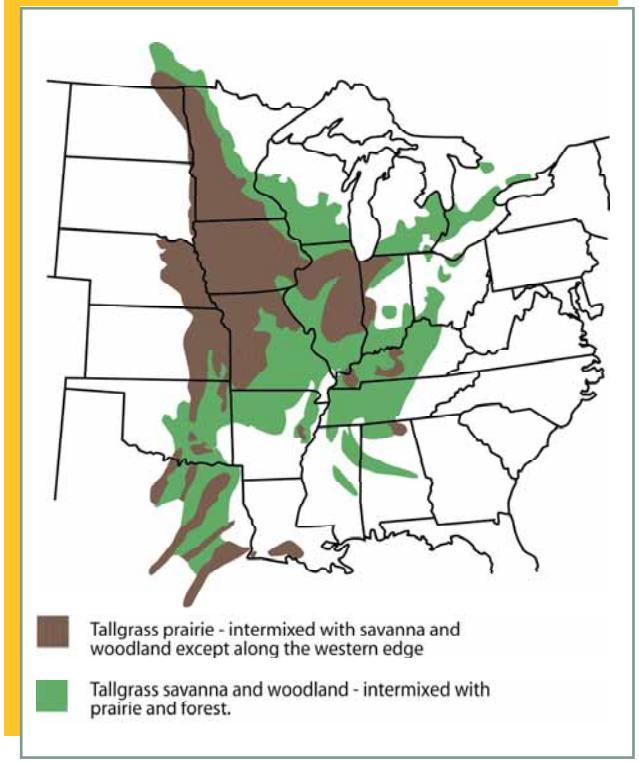

Figure 1. *The Tallgrass Prairie Region of the United States was once a major ecosystem type that stretched from the midwestern states into the southeastern states of the Lower Gulf Coastal Plain.*

Native grasslands of Mississippi are part of the Blackland Prairie Region, which occur in East Texas, Arkansas, Mississippi and Alabama. The largest of the Blackland Prairies and the most southeastern of the tall-grass prairie type is the Black Belt of Mississippi and Alabama (Figure 2). This crescent-shaped Black Belt is characterized by dark, fertile soils that extends for more than 300 miles from Southeastern Tennessee through East-central Mississippi to Southeastern Alabama. To the south of the Black Belt is the Jackson Prairie Belt, which stretches from Yazoo County, Mississippi, across the center of the state to the border of Alabama (Figure 3). Recent investigations of historical records from the 1800s reveal that about 355,680 acres of prairie were present in the Black Belt. Almost one-half of this prairie acreage occurred in the present-day Mississippi counties of Chickasaw, Clay, Kemper, Lee, Lowndes, Monroe, Noxubee, Oktibbeha and Pontotoc. Early records suggest that these prairies probably ranged from about 17 to 5,000 acres in size. About 48,300 acres of prairies also occurred in the Jackson Prairie Belt, neighboring areas and Western Mississippi. The greatest concentrations of prairies in the Jackson Prairie Belt occurred in Madison and Rankin Counties, but prairies were also found in Holmes and Yazoo Counties. Prairies were also found in

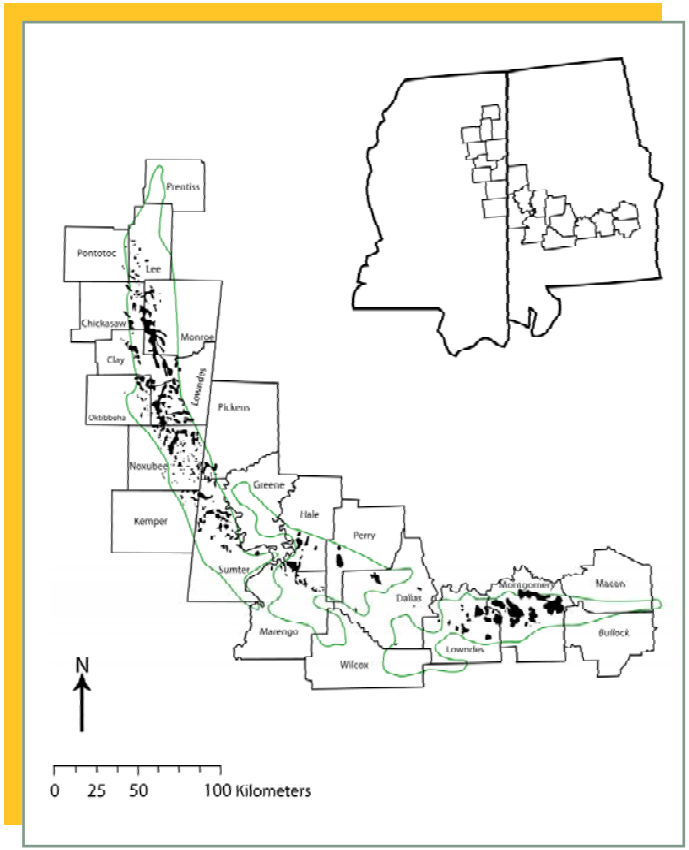

Figure 2*.The Blackland Prairie Region of the Southeastern United States historically exhibited prairies that were comprised of woodland savannas and tall grass prairie openings in Mississippi and Alabama (adapted from Barone 2005).*

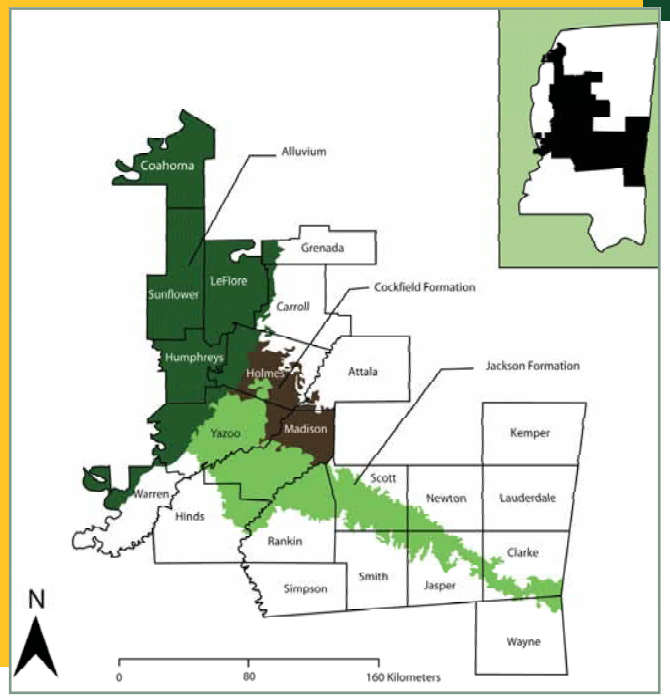

Figure 3. *The Jackson Prairie Belt of Mississippi included woodland savannas and prairies that occurred in South-central and Western Mississippi.*

Attala, Carroll, Clarke, Coahoma, Hinds, Jasper, Kemper, Leflore, Scott, Smith, Warren and Wayne Counties. In total, at least 27 of Mississippi's 82 counties supported expanses or patches of prairies and woodland savannas in the early 1800s.

Surveys conducted by the General Land Office in the 1830s reported that open grasslands with few or no trees occurred in patches across one-fourth of Alabama's Black Belt region, with more open forest savannas and dense forests occurring on the remainder of the landscape. Early explorers reported that in some areas, large expansive grasslands occurred with interspersed patches of woodlands arising with such beauty that they appeared to be planted. The presence of unique and lush vegetation was due, in part, to the soils of the region which were generally fertile, thick, alkaline and associated with specific formations. For example, the Jackson Prairie Belt is located on gently rolling uplands of Jackson Group and Cockfield soil formations that are underlain by Yazoo Clay parent material. About 17,290 acres of prairies in the western portion of the state were located on fertile, alluvial soils that had been deposited by streams or rivers. Blackland Prairies of the Black Belt Region are comprised of soils that originated from the Demopolis chalk of the Selma group. This chalk parent material is highly alkaline due to marine-deposited complexes such as calcium carbonate. During prehistoric times, this region was covered by ocean waters, and today, inspection of the chalk outcroppings often reveals fossils of marine life, such as shells of mollusks and sharks' teeth. The high mineral content and exposed chalk layers generally produce alkaline soil conditions on many prairie sites; although soil conditions may vary locally depending on topography and vegetation type. The alkaline nature and fertility of most prairie soils along with abundant rainfall and incidence of fire influenced the plant communities of Mississippi's grasslands.

Figure 4. *Habitat types that occur within Mississippi's prairie regions include open prairies dominated by grasses, legumes and forbs; chalk outcrops where parent material is exposed and plant cover is more sparse; and woodland savannas. In areas where fire is less frequent, upland and bottomland forests may occur.*

Much of the Black Belt had mosaics of three plant communities: open prairie or grasslands, chalk outcrops and forests (Figure 4). Today, prairies and chalk outcrops generally support many plants which are found only in Black Belt and Jackson Prairies of Mississippi and the prairie regions of Mid-western states. Some plant species that inhabit prairies are rare in Mississippi whereas some prairie grasses are found in longleaf pine savannas of South Mississippi as well as the Jackson and Blackland Prairies. All herbaceous plants of the open prairies require regular intervals of fire to persist and thrive. With less frequent fire and higher soil moisture, prairie vegetation is typically replaced by shrubs and trees over time. Plant communities are also influenced by major landscape features, such as rivers, streams and topography of the land. These major features affect vegetation through influences on soil type and depth; flooding, water drainage and soil moisture; and fire incidence and behavior. This influence can be seen in historical records of prairies in Noxubee County where the Noxubee River and its tributaries transected the Black Belt creating alluvial floodplain forests of bottomland hardwoods that crossed prairies, woodland savannas and upland forests. Six forest communities have been identified in Mississippi's Black Belt: dry, post oak ridges; moist, oak-hickory forests; bottomland hardwood forests; water tupelo swamps; mixed hardwood gallery forests; and prairie cedar woodlands, the latter thought to be a forest-type that developed after European settlement led to intensive land use, soil

erosion and reduced incidence of fire.

Today, very few tall-grass prairies remain over their historic range. Most of Mississippi's prairies were converted to agriculture by the late 1800s, leaving only small remnants of prairies, woodland savannas and chalk outcrops, with many of the latter being highly eroded. Cotton-based agriculture dominated the Black Belt from 1850 until the early 1900s, leaving behind a mixture of pastures, old fields and forest fragments along streams. Intensive land use related to agriculture, livestock production, urban and highway development and introduction of non-native plants continues to threaten today's prairie remnants. Consequently, Mississippi's prairie communities have been reduced dramatically, and only small remnants of prairie or woodland savannas remain. The Jackson Prairie region has undergone intense land use since the 1800s and today most of the land is forested or used for agricultural purposes. Today's Jackson Prairies total about 650 acres of openings that occur in patches that range from less than 1 acre to 130 acres. Most Jackson Prairie preserves that remain today are located on public forest land, such as the Bienville National Forest. Like the Jackson Prairies, today's Black Belt prairies can be found in isolated patches on public lands, such as Tombigbee National Forest, Noxubee National Wildlife Refuge and the Natchez Trace Parkway. On private lands, small patches of prairies may remain in fallow field edges, along abandoned roadsides or in very old cemeteries where vegetation is maintained by fire or occasional mowing. Because of their rarity and uniqueness, many private landowners are beginning to restore and maintain remnant prairie habitats on their lands. Many individuals are managing their native prairies to benefit Mississippi's wildlife. Because prairie ecosystems are now very rare, many species of wildlife that depend on these ecosystems are declining in numbers and becoming rare. Therefore, restoration of native grasslands and woodland savannas is an important conservation initiative at national, regional and state levels. On private and public lands, establishment of native grasslands is being used to accomplish erosion control along wetlands and streams, to enhance outdoor recreation opportunities, to conserve rare plants and animals and to improve wildlife habitat. Restoration of Mississippi's native grasslands has many benefits, including enhancement of our state's beauty and historical landscape, conservation of grassland species of wildlife and promotion of sustainable land use.

Wildlife, People and Plants of Native Grasslands

Archaeological evidence suggests that a diversity of habitats occurred within Mississippi's Black Belt. The interspersion of openings dominated by herbaceous grasses and other plants, savannas with scattered trees and shrubs and forests created excellent wildlife habitat for many native animals. Fertile soils and fire created conditions in which abundant forage and seed from herbaceous plants grew. Open prairies supported grassland birds, such as Northern bobwhite (bobwhite quail) and small mammals, such as cottontail rabbits, field mice, voles and cotton rats. Woodland savannas and adjacent forests supported trees, shrubs and vines that provided food and cover for edge and forest-dwelling species of wildlife, including owls, hawks, songbirds, wild turkey, swamp rabbits, white-tailed deer, bobcats, weasels and foxes. Evidence from archaeological sites indicates that the Black Belt region was once inhabited by large mammals, such as bison, wolves, panthers and black bears.

Abundant wildlife attracted people to prairie regions before this country was settled by Europeans. For many years, archaeologists have worked to learn about the early human inhabitants of Mississippi's historical grasslands. By exploring their village sites and encampments, archaeologists have found that the North American Indians of the region were hunters, gatherers and farmers. From their camps and home sites, scientists have found animal and plant remains and artifacts left by these early people. Prior to European settlement, native people of the Blackland Prairies hunted and utilized white-tailed deer, rabbits, beaver and bison. There is even evidence suggesting that early hunters settled in prairie areas due to the high abundance of deer. In addition to deer, they harvested large and small predators, such as black bears, foxes, otters and bobcats. Clues left in villages and encampments along streams also reveal that these early people consumed fish, turtles and many freshwater mussels. Over time, native people shaped their surroundings. For example, they consumed large amounts of freshwater mussels and may have even caused the demise of some species through intensive use. By manual labor, they cleared patches of land for growing crops, harvested trees for wood products and burned the grassland regularly. Use of fire and land clearing created different stages of plant communities within the Black and Jackson Prairie Belts. For example, regularly burned areas supported grass and broad-leaved plants interspersed with scattered tree and shrub cover. Less frequently burned areas typically supported more tree and shrub woodlands (Figure 5). Moist to wet areas that were not burned supported oak woodlands and bottomland hardwood forests. In low-lying areas that were cleared for crops and then left fallow, giant cane, also

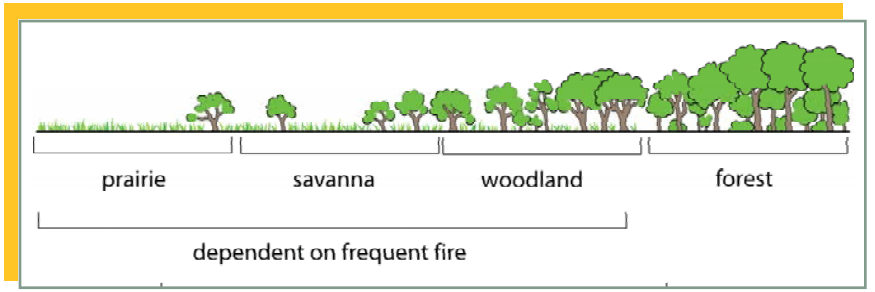

Figure 5. *A combination of prairies, woodland savannas and forests occurred in the prairie regions of Mississippi. Prairies and woodland savannas were more open and exhibited abundant ground cover of grasses, forbs and legumes due to regular fires and sunlight exposure.*

known as switch cane, created dense cane thickets called "canebrakes." These canebrakes created cover for many species of wildlife, including bears, deer, cane-cutters (swamp rabbits) and canebrake rattlesnakes (timber rattlesnakes). How do we know this? Archaeologists, botanists and other scientists have discovered plant and animal parts in the soils, mounds and in products found in village sites. These early people constructed their homes of bricks (also called daubs) made of wet prairie soils. In the process of collecting, transporting, shaping and drying these bricks, pieces of plants were pressed into the moist mud. Thus, in these bricks, scientists have discovered pieces of many plants – seeds, leaves, stems, nut hulls and pollen – that have helped us understand what plants grew in early prairies and savannas of our prairie region. There is no doubt that these people depended heavily on the natural resources for their prairie homes. Hundreds of years ago, they left behind clues about their surroundings – clues that are used in grassland restoration and conservation today.

Prairie Plant Communities

Prairies or grasslands are so named due to the dominance of warm-season perennial grasses. Prior to European settlement, native grasses were maintained by regular fires set by North American Indians and dry lightning strikes during drought periods. Although native grasses are tolerant to drought and low soil fertility, some species may reach over 6 feet in height on fertile soils in years of abundant rainfall. The most common grasses of Mississippi's prairies were big bluestem, little bluestem, switchgrass, Indiangrass and Eastern gamagrass. Other grasses of the prairie included sideoats grama, Florida paspalum, panic grasses, giant cane, purple top and grease grass.

Identification of Grassland Plants

Native warm-season grasses and other prairie plants can be identified with practice and user-friendly field guides. Most prairie grasses are perennial, in that they arise initially from seed, root or rhizome structures during the first growing season and form established root systems in following growing seasons. Because they are warm-season plants they exhibit vegetative growth, flowering and seed production during warm months of spring, summer and early fall. Perennial bunch-grasses generally develop large root systems over several growing seasons. These grasses may require several growing seasons for obvious establishment. After the first two growing seasons, perennial bunch-grasses usually exhibit root bases and clustered, above ground leaves that remain visible even following the frosts of winter months. Native wildflowers that inhabit prairies may be annual, biennial or perennial, depending on the species. Annual plants arise from seeds each year and do not establish root systems that over winter. Thus, they complete their entire life cycle and produce mature seed in one growing season. Biennial plants complete life cycles over 2 years of growth, with many producing flowers and viable seed during their second year of growth.

Knowledge of a plant's life habit and structural features can help landowners identify the plants growing in their restoration sites. Grasses, in general, exhibit characteristics that are unique to the grass family. Knowledge of these special features of grass structures can assist landowners in identification of both native and non-native species. Grasses have unique features that include the following: stems are round and internodes stem sections are generally hollow in cross section between solid nodes (areas appear as joints along the stem); linear leaves arising from the stem in two major directions (known as two-ranked leaves); presence of ligules at the base of the leaves, where the leaf arises from the stem; and lack of showy petals on the flowers with seed being highly visible on seed head or inflorescence. Each species of grass has characteristics that are unique to its species or genus. In general, grasses are most easily identified during flowering or seed production because of the unique appearance of seed heads or inflorescence structures. However, prior to maturation, the appearance of the ligules, leaves and root systems may be used to identify grass genera, and in many cases, species. Identification can be very important in monitoring the success of grassland restoration and early detection of problematic, non-native grasses on restoration sites.

Native Warm-season Grasses

Bluestems, also known as sage grasses and beard grasses, are perennial bunch-grasses that flower during late summer and fall. Hence, identification during much of the year must be from stem, leaf and root characteristics. Seeds are most obvious during late summer and fall months. In general, seeds and leaves of bluestems have a furry or hairy appearance, are light weight and spread by wind currents. Bluestems in Mississippi include common broomsedge, bushy bluestem, Elliott's bluestem, slender bluestem, splitbeard bluestem, little bluestem and big bluestem. Of these species, common broomsedge is the most widely distributed throughout Mississippi. This plant readily colonizes degraded, low fertility sites and occurs frequently in old fields, pastures, along roadsides and in open-canopy forest lands. Bluestems produce valuable nesting and escape cover for ground-nesting birds, rodents and rabbits. Specific features that produce good cover for wildlife include bunch-grass structure intermixed with bare ground, height of above-ground growth and the persistence of senescent (dead) leaves through the winter and early spring. This type of habitat structure is very important for the movement of young bobwhite quail chicks, wild turkey poults and rabbits. Species such as big and little bluestem produce high quality forage for livestock and American bison. Seed of some species are consumed by native sparrows, other seed-eating birds and small rodents. Stems and leaves of bluestems are consumed by white-footed mice, voles and cotton rats. Big and little bluestems were dominant grasses of the native prairies that once occurred in Mississippi. Today, they occur on isolated prairie remnants in the state and are considered to be indicator plants for prairie communities along

Figure 6. *Big Bluestem – Inflorescence and leaves, spikelet, roots and base of leaf blade with ligule.*

Big Bluestem.

with switchgrass, Indiangrass, Eastern gamagrass and sideoats grama. Because of this and their value to wildlife, these species are usually established on grassland restoration sites.

Big bluestem *(Andropogon gerardii)* is the largest of the native bluestems, often reaching over 6 feet in height. Although plants spread by rhizomes, bases are tightly clustered and tufted giving rise to broad, linear leaves that are covered by sparse to dense short hairs. Seed heads are borne at the tip of flowering stalks in 2- to 3-prong arrangements of racemes that resemble a turkey's foot. Each raceme is 2 to 4 inches in length and is purplish to reddish in color. Each seed has a twisted awn or hair-like structure at its tip that gives each seed head a bristled, hairy appearance (Figure 6). Prior to flowering and seeding, one can discern big bluestem from other grasses, such as Florida paspalum, by examination of the leaf base at the stem attachment point. With big bluestem, the leaf narrows slightly near the collar, widening gradually toward the leaf blade midsection. The collar and ligule of the inner leaf sheath is hairy and brownish to bronze in color. Big bluestem grows on a wide variety of soil types and is extremely drought-tolerant due to deep root systems that may reach soil depths of over 10 feet. It is one the best native forage-grasses in the Mid-western prairie states due to its high yield and palatability to livestock. In the Southeast, it is less abundant across grassland ranges, but may be overgrazed by cattle due to its scarcity and high palatability. Because cattle prefer this grass, they often graze the plant closely, preventing seed stalk development and seed production; thus, plantings of big

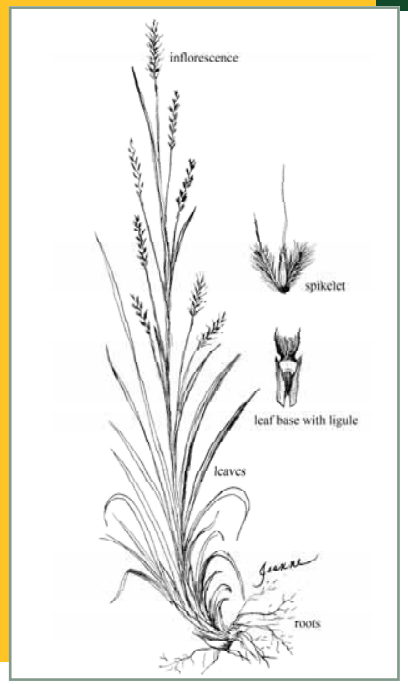

Figure 7. *Little Bluestem – Inflorescence, basal leaves and roots, spikelet and base of leaf blade with ligule.*

Little Bluestem.

bluestem should be protected from grazing by livestock during establishment phases. If grazing is allowed after establishment, effects of grazing should be monitored to ensure that seed production is not damaged; thus, sustainable grazing of big bluestem requires active monitoring and management.

Little Bluestem *(Schizachyrium scoparium)* is a small bluestem, generally growing from 2 to 4 feet in height. Stems are flattened at the base and arise in a clustered arrangement from the rootstock. Leaves and stems are reddish to purple during early growth, deepening to reddish-brown with maturation. Seeds are borne in spikes along the flowering stalk. Whitish hairs that cover and surround the seeds yield a fluffy appearance to the seed heads (Figure 7). Little bluestem can grow on a variety of soil types and produces quality nesting habitat for many species of wildlife. Seed are eaten by sparrows and rodents. The stems and leaves are consumed by rabbits, field mice and voles. Plantings of little bluestem are very compatible with prairie legume and forb establishment. This attractive native grass has great potential for landscaping and erosion control on low fertility, droughty soils and is a primary species targeted for establishment in native grassland restoration in Mississippi.

Switchgrass *(Panicum virgatum)* is a large, perennial panic grass that ranges from 3 to 6 feet in height. Taller, vigorous plants are common in moist, fertile soils. Plants will generally be sparser, shorter and less robust on dry soils.

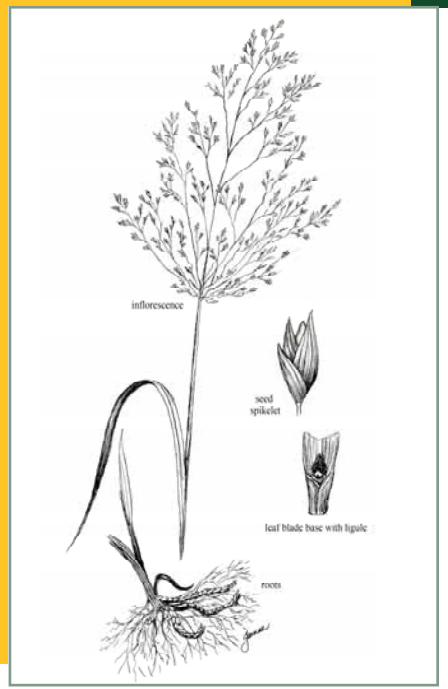

Figure 8. *Switchgrass – Inflorescence and leaf, roots, spikelet and base of leaf blade sheath with ligule.*

Switchgrass.

Because plants spread by numerous scaly rhizomes or underground roots, switchgrass often forms large dense colonies over time. Plants are generally hairless, except for on the ligule which exhibits dense clusters of short, whitish hairs. Switchgrass begins active growth during the warm spring months and produces abundant growth and flowers during early summer months. By late summer, elliptical husk-covered seeds are borne on open seed heads called panicles that range from 0.5 to 1.5 feet in length (Figure 8). Seed are often retained on the panicles through fall months. Panicles persist on the flower stalk through winter and the following growing season, providing a trait useful in identification through much of the year. Switchgrass is one of the most attractive native grasses, especially during fall months, when its leaves exhibit a curved growth form and take on a golden to amber coloration. Persistent seeds on panicles add to the showy nature of this grass during fall months. This grass, like other species of panic grass, produces palatable seed for wildlife. The bunch structure and height of switchgrass produces valuable nesting and escape cover for many ground-nesting birds, rabbits and rodents. Because of its growth habits and value to wildlife, switchgrass is used extensively for field border planting, erosion control filter strips and wildlife habitat enhancement, as well as in grassland restoration. Of the native prairie grasses, it is the most shade tolerant and grows readily under open forest cover.

Indiangrass *(Sorghastrum nutans)* grows from deep underground root systems and typically ranges from 4 to 7 feet in height. Leaf blades range from 10 to 24 inches and are flattened and narrow at their base. A diagnostic feature of this grass prior to flowering is the ligule, which resembles rabbit ears due to the notched center with horn-like projections on each side (Figure 9). Plants generally begin flowering in late summer, and golden to bronze seed heads become apparent on plants from September through November. Seeds are tan to golden in color with bristle-like awns. Awns on the seed make the seed head appear fluffy. Indiangrass grows in many soil types and textures and is moderately salt and drought tolerant. Although most common in prairies, Indiangrass may also be found in bottomlands and open woodlands.

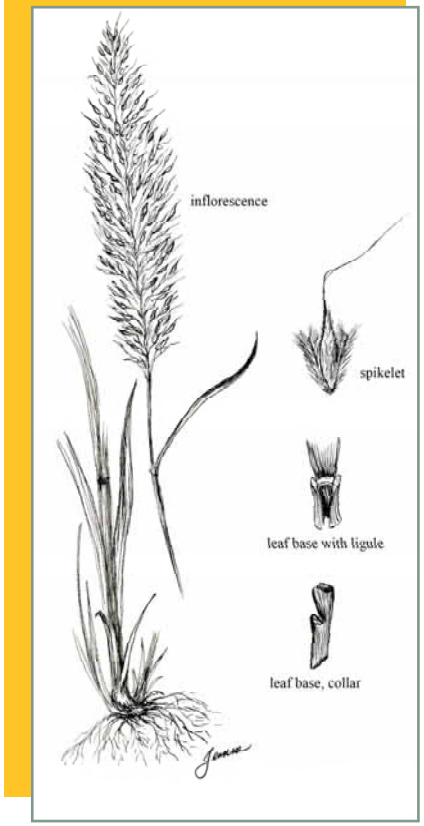

Figure 9. *Indiangrass – Inflorescence, basal leaves and roots, spikelet, base of leaf blade sheath with ligule and side view of leaf base sheath.*

Indian Grass.

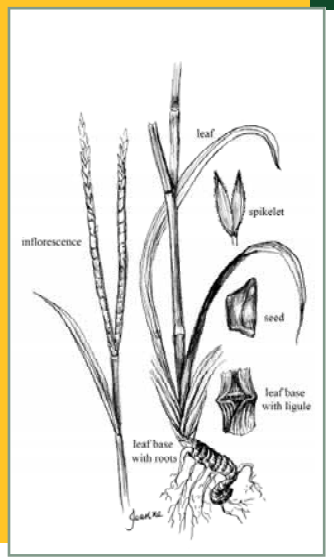

Figure 10. *Eastern gamagrass – Inflorescence, basal leaves and roots, seed and leaf blade sheath and ligule.*

Eastern gamagrass.

Eastern gamagrass *(Tripsacum dactyloides)* also called joint grass, is a stout bunch-grass that may reach from 6 to 8 feet in height. Flattened, smooth leaves arise from thickly jointed rhizomes that grow from a centralized base called a stool. Over time, the stool may exceed 4 feet in diameter and the center portion will lack stems and leaves. Gamagrass exhibits most growth in spring and early summer but remains green until late fall. Seeds are produced from mid-summer through early fall. The seed heads occur as 2 to 3 spikes at the end of stems or in leaf axils. Seed heads are 4 to 6 inches in length and exhibit a jointed appearance due to the overlap of seed structures along the spike. Individual seeds are green and resemble corn kernels in shape (Figure 10). Gamagrass grows best on moist, well-drained fertile soils, but it does not tolerate standing water for extended periods of time. Although gamagrass produces seed, much of the seed produced annually is not viable; therefore this plant reproduces and spreads primarily through rhizomes that give rise to new plants each year. Because of this method of reproduction, gamagrass is easily eliminated by continuous grazing. Gamagrass is excellent forage for livestock and American bison and is often planted for native pasture or hay crops.

Forbs and Legumes

Over one-third of the plants occurring in prairies are forbs and legumes. These plants typically have broader leaves than grasses. Most are classified as wildflowers due to their showy, attractive flowers. Many species produce important food for native animals, including pollen, nectar, seed and forage. Many broad-leaved plants of the prairie are in the sunflower family *(Asteraceae)*, pea family *(Fabaceae)*, mint family *(Lamiaceae)* and milkweed family *(Asclepiadaceae)*. Plants of the sunflower family may comprise a large portion of prairie wildflower communities and include compass plant, blazing star, cone flowers, native sunflowers, black-eyed Susan, goldenrod,

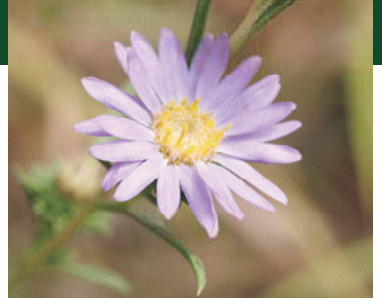

Figure 11. *Many wildflowers grow in prairie and savanna habitats including rosinweed, asters, blazing star and partridge pea.*

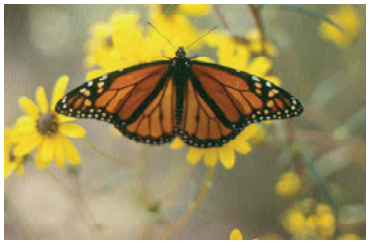

Figure 12 *Many prairie wildflowers are important food sources for wildlife, especially larvae and adults of butterflies and other pollinating insects.*

bonesets, daisy fleabane and asters (Figure 11). Many of these plants bear showy blooms and produce abundant nectar and pollen which attract a wide variety of insects to prairie habitats. Native sunflowers produce seeds that are consumed by birds and rodents. Milkweed and butterfly weed of the milkweed family serve as important food and host plants for beetles, moths and butterflies, such as the monarch butterfly (Figure 12).

Native legumes of the pea family are among the most important plants in grassland ecosystems. These plants are adapted to and favored by regular prescribed burning. Legumes enhance soil fertility through nitrogen fixation via bacterial associations in their root systems. Most legumes produce foliage and seed that are tasty and nutritious to many species of wildlife, including bobwhite quail, wild turkey, rabbits, deer and small rodents. Flowers and foliage of legumes attract many insects which, in turn, attract insectivorous animals, such as wild turkeys, bobwhite quail and non-game birds. Species of legumes that are of high value to wildlife include native lespedezas, beggar lice, partridge pea and native clovers (Figure 13).

Figure 13. *Native legumes are among the most important plants of prairies and woodland savannas. Many legumes, such as partridge pea and native lespedeza, are very important food plants for insects and upland gamebirds, such as bobwhite quail.*

Historically, woodland savannas of the Blackland Prairies exhibited open stands of blackjack, post and Durand oak. The incidence of fire dictated how much woody understory and midstory occurred in these forested savannas. In the past and today, trees that typically grow in prairie areas include osage orange, Carolina buckthorn, red-osier dogwood, sugarberry, ash, Eastern red cedar, persimmon, oak and hickory. Blackland Prairies were typically surrounded by hardwood forests dominated by hickory and oaks whereas upland

forests adjacent to Jackson Prairies were comprised of hardwoods and pine. Common shrubs and woody vines of prairies include wild plum, hawthorn, sumac, rattan vine, coral honeysuckle, wild grape, blackberry, dewberry and greenbrier (Figure 14). In areas where streams and rivers transect grasslands, bottomland hardwood forests of oak, pecan and hickory and forested wetlands of bald cypress and tupelo gum occur. Many of these plants produce nuts or fruit that are of high food value for many species of wildlife. Forest structure and forest edge habitats produce habitat diversity in prairie landscapes attracting a diversity of animals that depend on a mixture of forest, forest-edge and meadow habitats.

Figure 14. *The leaves of greenbrier are highly preferred by white-tailed deer.*

Animal Communities

Insects

The abundance of flowering plants attracts a variety of different insects. As with the plants, many insects are showy, colorful and obvious to the observer. Others may not be seen due to their habit of living underground or within the stems and leaves of native grasses and forbs. Of the groups studied thus far, Mississippi's prairies support approximately 24 species of grasshoppers, 27 species of ants and more than 878 species of moths! Many of these insects are rare in Mississippi and found only in the Blackland Prairies. Some species of grasshoppers, beetles, moths and bees are found in isolated populations of Alabama and Mississippi and the nearest locations of other known populations may be as far away as the prairies of Oklahoma, Texas and Kansas! There is even a beetle and a moth that are known only from Black Belt Prairie remnants in Mississippi and Alabama and nowhere else in the world. Regardless, one does not need special training to appreciate the abundance of the different insects of prairies. Just take a walk through prairie wildflowers during spring or summer months and listen to the buzz of the many insects. A closer look will reveal colorful milkweed beetles, many different species of bees, small ants, crickets and grasshoppers and the predators of this small world – assassin bugs, ladybird beetles, tiger beetles, praying mantids and lacewings. These insects play important roles of plant pollination and recycling of nutrients in prairie ecosystems. Additionally, they are very important food sources for insectivorous mammals and birds, especially young wild turkey and bobwhite quail, bluebirds, kingbirds, shrikes and flycatchers. Nectar and pollen are attractive food sources for many beetles, bees, wasps, butterflies and moths that feed commonly on flowers of native clovers, lespedezas, beggar tick, asters, wild mints and blazing stars. Selected plants, such as milkweeds and partridge pea, serve as host plants for larvae of butterflies. For example, caterpillars of the monarch butterfly feed on parts of milkweeds to gain the chemicals that provide their bad taste to birds.

Amphibians and Reptiles

Wetlands and low-lying areas of grasslands attract many other animal species seasonally. During high rainfall periods of late winter and spring, seasonal wetlands of the prairie resound with the calls of breeding frogs and toads, such as spring peepers, cricket frogs, chorus frogs, tree frogs, bronze frogs and northern crawfish frogs, the latter of which spends much of its life in crayfish burrows. Snakes that utilize prairies of the Black Belt include black racers, gray rat snakes, corn snakes, prairie king snakes, crown snakes, ringneck snakes, garter snakes and coach whips. Woodland savannahs provide habitats for other reptiles, including copperheads, box turtles and several lizard species, such as skinks, fence lizards and green anoles.

Birds

Grasslands and woodland savannas provide habitat for both game and non-game birds. Because native grasslands are now rare across the southeastern United States, many grassland bird species, such as bobwhite quail and native sparrows, have experienced state and regional declines in population. Grassland birds that require a dominance of open prairie for nesting, feeding and rearing their young include Henslow's sparrows, grasshopper sparrows, Le Conte's sparrows, dickcissels, indigo buntings, Eastern meadowlarks and bobwhite quail. Some species, such as bobwhite quail, are year-round residents that depend on grassland habitats for feeding, wintering, nesting and rearing their broods. Other species, such as grasshopper sparrows, meadowlarks and buntings, are migratory, returning to grasslands to nest and rear their broods during spring and summer. Some species, such as fox and song sparrows, may return to grasslands during the winter months where they over-winter before departing for breeding grounds to the north. Raptors, such as Northern harriers, American kestrels and barn owls, will also use open grasslands and woodland savannas for hunting grounds. Other birds catch insect prey on the wing as they fly over grasslands. These birds include several species of swallows and flycatchers, chimney swifts, purple martins, Chuck-wills-widows, whip-poor-wills

Figure 15. *Bobwhite quail are a common species found in the prairie.*

and common nighthawks, often called bull bats in Mississippi.

If grasslands are interspersed with open woodlands and shrub thickets, birds that feed and nest in shrub-vine and forest cover will be attracted. These grassland-shrub birds include field sparrows, orchard oriole, blue grosbeaks, common yellowthroats, yellow-breasted chats, prairie warblers, common towhees and grey catbirds. Grassland-woodland birds require open woodland savannas with herbaceous ground cover and interspersed thickets of vines and shrubs. Grassland-woodland birds include Eastern bluebirds, Bachman's sparrows, common towhees, loggerhead shrikes, red-headed woodpeckers, Northern cardinals, red-eyed vireos and grey catbirds. Raptors, including screech, barred, great horned and barn owls and red-tailed, red-shouldered, Cooper's and sharp-shinned hawks, may also use these habitats.

In addition to bobwhite quail, other game birds will use grassland habitats readily. An abundance of grass and forb seeds available on bare-soil surfaces interspersed with bunch-grass cover can attract mourning doves and wild turkeys. Wild turkey gobblers often use prairie openings for strutting and displaying during spring months. Wild turkey hens nest in grassland-woodland edges and take their poults to herbaceous openings of prairies to forage on spiders, insects and other invertebrates during spring and summer months. Wild turkey and bobwhite quail hens in need of high protein during breeding seasons will forage in grasslands to obtain new growth of tender spring vegetation and invertebrates. Areas of prairies that were burned in late fall or winter provide courtship display grounds for the American woodcock during the following February and March evenings. By day, these same areas may attract flocks of migrating American robins in search of earthworms and other invertebrates. In moist, low-lying sites, common snipe, killdeer and other shorebirds may feed on invertebrates and loaf beneath native grass cover. Wetlands and back waters of streams often provide foraging and resting sites for waterfowl, such as teal, mallards and wood ducks and wading birds, such as herons, egrets, ibises and wood storks (Figure 15).

Mammals

Tall-grass prairies and woodland savannas support a variety of mammals. Historic records indicate that white-tailed deer and bison were the largest herbivores in the Black Belt of Mississippi. Although bison no longer exist as free-ranging wildlife today, white-tailed deer populations are considered to be high in most parts of the Black Belt. Studies indicate that soil fertility and productivity creates an abundance of native and agricultural food plants that can produce heavy body weights in mature deer and enable does to produce more fawns annually. Because deer are a forest-edge species, today's restored grasslands will generally attract deer where openings are interspersed with forest and thicket edges. This type of interspersion can also attract cottontail and swamp rabbits. Studies have shown that over 17 species of small mammals shared prairie habitats with deer prior to European settlement. These species inhabit grasslands today and include cottontail and swamp rabbits, deer and field mice, voles, marsh rice and cotton rats, shrews and moles. Larger and mid-sized mammals that frequent the edges and thickets of grasslands include red foxes, gray foxes, bobcats, skunks, raccoons, opossums and weasels. Coyotes, foxes and bobcats may be attracted to grasslands and edges due to the abundance of small mammal prey. Woodland savannas may be inhabited by gray, fox and flying squirrels, especially if hard mast-producing trees are abundant. Wetlands and streams that transect prairies and woodland savannas may be inhabited by river otters, mink, muskrats and American beaver.

Grassland Restoration

Setting Goals and Planning

Many landowners become interested in grassland restoration because of their interest in conservation of native wildlife. Also, landowners may wish to increase their land's beauty and recreational uses, such as hunting and wildlife watching. Successful restoration and management of native grasslands can yield multiple benefits if planned and implemented properly. The first step in successful restoration is to identify the primary management goals for the land. When goals have been established, a management plan should be developed to address the approaches, methods and schedules of activities that will reach these goals. Landowners can obtain assistance with developing a grassland restoration and management plan from agencies, such as the U.S.D.A. Natural Resources Conservation Service, state wildlife agencies, cooperative extension services of land grant universities and organizations such as Wildlife Mississippi.

One of the first steps in planning grassland restoration is deciding the mixture of prairie plants to establish on the land. The plants selected should depend on restoration goals and the condition and contour of your land. Your goals will influence the plants included in seed mixtures and the seeding rates of those plants. For example, if you are restoring native grasses to provide hay or forage crops for livestock, or vegetation cover for erosion control, you will generally select native perennial grasses seeded at high rates to provide dense grass stands and good ground coverage (Table 1). On the other hand, if your goals are to provide good wildlife habitat or restore prairie plant diversity, a mixture of prairie grasses, forbs and legumes at reduced seeding rates will be more appropriate. To favor grassland wildlife, prairie seed mixtures should be planted at reduced rates to avoid high stem densities that may impede movement of young game birds and other small grassland animals (Table 2).

Because food plant abundance and habitat structure will influence what species of wildlife use restored grasslands and woodland savannas, landowners can favor specific wildlife by establishing food and cover plants attractive to species that they desire. For example, to provide more palatable seed and good brood cover for bobwhite quail, native legumes such as partridge pea should be part of the planting mixture. If quality nesting and brood habitat for wild turkey and bobwhite quail is desired, reduced seeding rates of bluestem mixtures and inclusion of little bluestem in the planting mixture are recommended. If landowners wish to attract butterflies as well as grassland birds, mixtures should include native wildflowers (i.e. coneflowers, compass plant, prairie clovers, blazing stars, sunflowers) and legumes, along with native prairie grasses (Tables 2 and 3).

Reduced seeding rates of prairie plant mixtures and regular habitat management, such as burning, are approaches used to produce desirable structure for grassland wildlife. Because most native prairie grasses grow in bunches, open space at ground level occurs when stands are not too dense. Open structure at ground level beneath overhead foliage cover of bunch-grasses and broad-leaved plants allows ease of movement and overhead cover for small wildlife, such as bobwhite quail, rabbits, young wild turkeys and native sparrows. This structure is especially important as brood cover for young bobwhite quail. Dense vegetation and leaf litter build-up, such as that produced by tall fescue and other agronomic grasses, inhibits animal movement and limits their ability to find food. Under these conditions, habitat quality declines and the number of animals an area can support is reduced.

Figure 16. *The basal leaves and senescent leaf blades of prairie grasses, such as gamagrass and the bluestems, create good cover during winter months. "Lodging" or the falling over of senescent leaves at the grass base creates excellent "lodges" that provide shelter and escape cover for ground-dwelling wildlife.*

Prairie plant communities with open structure are also valuable as nesting habitat. For doves, rabbits and bobwhite quail, one clump of prairie grasses is a desirable nesting site if the field has not been burned or disked within the past year. Grassland birds, rabbits and small rodents use senescent leaves of prairie grasses and forbs in nest construction. Also, leaves and stems of prairie bunch-grasses remain erect after dormancy. These senescent leaves lean against each other and create escape cover and shelter into the winter and following growing season. This tendency, called lodging, is especially characteristic in bluestems, Eastern gamagrass, switchgrass and Indiangrass (Figure 16).

Open structure at ground level is also important in providing growing space for forbs, legumes, vines and shrubs. Seed in the seed bank will germinate more readily in bare-soil areas. Plants such as common ragweed, blackberry, dewberry, pokeweed, native lespedezas, partridge pea, beggar lice and native sunflowers are among the valuable wildlife food plants that will become established in bare-soil space between prairie grasses. Abundant food plants can attract many insects and upland game birds, as well as deer and rabbits. Over

time, thickets of blackberry, greenbrier, rattan vine, wild plum, sumac and small trees, such as dogwood and Carolina buckthorn, will become established. Scattered thickets of woody vines, shrubs and small trees among native grasslands can provide attractive cover for rabbits, bobwhite quail and several species of songbirds. Bobwhite quail often use thickets as covey headquarters during fall and winter months. Shrub-grassland birds, such as indigo buntings, prairie warblers and Northern cardinals, use thickets for perching and nesting. Many woody plants that create thicket cover also produce valuable soft- and hard-mast foods. Thus, thicket cover patches within prairies and along prairie edges can benefit selected grassland and most shrub-grassland wildlife (Figure 17).

Figure 17. *Thickets of blackberry, dewberry, plums or other good soft-mast plants can provide cover and important food sources in and along edges of restored prairies.*

Although seed mixture selection and planting are the first steps in restoration, ongoing habitat management is needed to maintain optimal habitat conditions for prairie plants and grassland wildlife. Landowners should set goals for how they want their grassland to appear over time and grasslands should be managed to maintain high quality prairie habitats. To accomplish habitat management in a timely manner, site inspection and planning are necessary. Prescribed burning, disking, herbicide application and monitoring and control of non-native plants are all management actions that require good timing for the best outcome.

Table 1: Grassland Seed Mixtures Recommended for Unique Site Conditions and Goals.

Site Conditions	Recommended Grass Species	Seeding Rates (lbs. PLS/acre)[a]	Benefits
Moist or Wet Sites: Wetland Edges	Bushy bluestem	2 to 4 lbs.	Cover excellent for nesting birds, frogs and small mammals. Seed of sprangletop and switchgrass eaten by upland game birds, dabbling ducks, non-game birds. Seed and stems eaten by selected rodents. Nutrient uptake and sediment control by grasses can reduce organic wastes in septic tank drainages and detention basins.
	Big bluestem	4 to 6 lbs.	
	Sprangletop	3 to 5 lbs.	
	Switchgrass	4 to 6 lbs.	
	Eastern gamagrass	4 to 8 lbs.	
Erosion Control Filter Strips	Switchgrass	8 to 10 lbs.	Filter strips can reduce sediment deposition by 100 times that of unplanted, bare-soil areas. Thus, grass strips can protect streams, wetlands, newly planted areas and sensitive ecosystems from upslope soil erosion.
	Eastern gamagrass	10 to 12 lbs.	
	Indiangrass	10 to 12 lbs.	
Visibility Barriers	Big bluestem	10 to 12 lbs.	Heights of over 6 feet may be reached restricting views into wildlife plantings and fields
	Switchgrass	10 lbs.	
Upland Pastures	Big bluestem	10 to 12 lbs.	Forage and hay production of livestock and grazing wildlife. High grass density may lower value to grassland wildlife, such as bobwhite quail. High density and coverage may favor small mammals, rabbits along field edges and birds that build nests among tall-grass stems.
	Switchgrass	10 lbs.	
	Indiangrass	10 to 12 lbs.	
	Eastern gamagrass	10 to 12 lbs.	

[a] PLS - Pure Live Seed

Table 2: Grassland Seed Mixtures for Wildlife Habitat Production.

WILDLIFE HABITAT - TALL GRASS SEED MIXTURE

Prairie Species	Seedling rate (lbs. PLS/acre)[a]	Objectives and Considerations
Big bluestem	1.5 lbs.	Nesting and brood cover for bobwhite quail, wild turkey and grassland songbirds. Winter cover for bobwhite quail, rabbits and many small mammals. Escape cover for rabbits especially near woodland edges and thickets. Legumes and forbs provide forage, seed, nectar and pollen for insects and other animals.
Indiangrass	0.5 lbs.	
Little bluestem	1.5 lbs.	
Switchgrass	0.5 lbs.	
Native forbs	0.5 to 1.0 lbs.	
Native legumes	0.5 to 1.0 lbs.	

WILDLIFE HABITAT - SHORT GRASS SEED MIXTURE

Prairie Species	Seeding rate (lbs. PLS/acre)[a]	Objectives and Considerations
Little bluestem	3 lbs.	Nesting cover for bobwhite quail, wild turkey other ground nesting birds; spring display grounds for woodcock; brood cover for young wild turkey and bobwhite quail; and escape and foraging cover for rabbits and rodents. Seed, forage, pollen, nectar attracts insects, seed-eating birds, deer, rabbits and small rodents.
Sideoats grama	1 lbs.	
Indiangrass	0.5 lbs.	
Native forbs	0.5 to 1 lbs.	
Native legumes	0.5 to 1 lbs.	

FORAGE SEED MIXTURE

Prairie Species	Seeding rate (lbs. PLS/acre)[a]	Objectives and Considerations
Big bluestem	3.5 lbs.	Graze on rotation only. Avoid clipping during April, May or June due to ground nesting wildlife. Cut hay after nesting season for bobwhite quail and wild turkey (July, August or September).
Indiangrass	3.5 lbs.	
Little bluestem	3 lbs.	

continued

FORAGE OR FILTER STRIP SEED

Prairie Species	Seeding rate (lbs. PLS/acre)[a]	Objectives and Considerations
Switchgrass	8 to 10 lbs.	Buy cold stratified seed or wet chill seed before planting. Cover for rabbits, rodents and selected birds.

FORAGE SEED

Prairie Species	Seeding rate (lbs. PLS/acre)[a]	Objectives and Considerations
Eastern gamagrass	10 to 12 lbs.	Buy cold stratified seed and plant with corn planter.

[a]PLS - Pure Live Seed

Selected seeding rates adapted from Harper, C. A., G. E. Bates, M. J. Gudlin, and M. P. Hansbrough. 2004. *A Landowner's Guide to Native Warm-Season Grasses in the Mid-South.* University of Tennessee, Extension Service. PB 1746: 25 pp.

Table 3: Planting Specifications for Native Prairie Plants for Wildlife Habitat, Erosion Control and Hay Production.

Species	Planting Dates	Seeding Rate - Wildlife Habitat	Seeding Rate - Erosion control or Hay crop
GRASSES			
Big bluestem	April - May	4 to 6 lbs.	10 to 12 lbs.
Little bluestem	April - May	4 to 6 lbs.	
Indiangrass	April - May	4 to 6 lbs.	10 to 12 lbs.
Switchgrass	April - May	3 to 4 lbs.	10 lbs.
Eastern gamagrass	April - May	4 to 6 lbs.	10 to 12 lbs.
Sideoats grama	April - May	4 to 6 lbs.	
Legumes[a]			
Partride pea[b]	February - March	3 to 10 lbs.	
Native lespedeza	March - May	1 to 3 lbs.	
Prairie clover	March - May	0.5 to 3 lbs.	
Beggarweed	March - May	1 to 3 lbs.	

Table continued on page 28

Species	Planting Dates	Seeding Rate - Wildlife Habitat	Seeding Rate - Erosion control or Hay crop
Forbs[a]			
Purple coneflower	April - May	0.5 to 4 lbs.	
Prairie coneflower	April - May	0.5 to 2 lbs.	
Blazing star	April - May	0.5 to 3 lbs.	
Horse mint	April - May	0.5 to 2 lbs.	
Native sunflower	April - May	1 to 5 lbs.	
Compass plant	March - May	2 to 5 lbs.	
Black-eyed Susan	April - June	0.5 to 2 lbs.	

[a]Recommended seeding rates for forbs and legumes are ranges suggested for planting these species in mixtures with prairie grasses. If multiple species of forbs and legumes are used in mixtures, use lower seeding rates.
[b]Higher range of seeding rates should be used for bobwhite quail habitat enhancement.

Establishing Native Grasslands

Approaches used to establish native grassland plants will be dependent on the existing plant community and habitat conditions of the land. Several habitat types may exist, depending on type, intensity and duration of past land uses. In cases where roadsides, fields or pastures have been allowed to go fallow, landowners may find that many desirable native plants are present. In these cases, prescribed fire and selective control of undesired plants may be applied initially to encourage the existing prairie plants. Stands of desirable prairie plants should be protected from herbicide application. Soil tillage and mowing of desired annual plants, such as partridge pea, should not occur until seed are mature in fall or winter months. In areas where undesirable, non-native plants exist and prairie plants are absent, control of unwanted plants and seedbed preparation will be necessary to establish desired prairie plant communities. Control of unwanted plants, especially invasive, non-native plants should be conducted through the use of selective herbicide application, taking care to target the undesired plants and avoiding desired plants. Seedbed preparation may vary depending on existing vegetation cover. In many cases, prescribed burning can prepare a site for seeding of prairie plants directly onto bare soil created by the fire. For expensive propagules or seeds, landowners may prefer to shallow disk the soil following burning to create more bare-soil surface. Care should be taken to avoid deep coverage of seed if disking is employed. Following establishment, landowners should plan to manage native grasslands with prescribed burning and shallow disking and application of selective herbicides as needed to control undesired plants. Of all the possible scenarios, sites with existing remnants of native plants will generally be the easiest sites on which to restore, maintain and enhance prairie plant communities.

In the majority of cases, past land use has led to a dominance of non-native agronomic grasses, non-native forbs and resilient, native plants that are common to fallow fields, such as giant goldenrod, winged elm, sweetgum and ash. If these conditions exist, restoration will involve control of undesired vegetation, seedbed preparation and planting of desired grasses. If cool-season agronomic grasses are the dominant cover, herbicide applications should be conducted during fall months. If warm-season agronomic grasses are present, herbicide applications should be done during summer months. Following herbicide application to kill agronomic grasses, sites should be burned during February to early March to prepare the seed bed. Lands that have been in croplands will require control of undesired vegetation through application of pre-emergent herbicide for control of competing broad-leaf plants prior to seeding warm-season grasses in the spring.

Establishment of most perennial prairie plants generally requires 2 or more years for root growth, vigorous vegetative growth, flowering and seed production. Thus, establishment of these plants requires patience and a basic understanding of the growth phases of perennial plants. During the first year following planting, perennials develop extensive roots that will feed the above-ground plant in years to come. Thus, most of the plant's energy during the first growing season goes into root development. This condition combined with high seed dormancy rates in warm-season grasses may yield sparse stands during the first growing season. Therefore, landowners should not be discouraged during the first growing season. During year 2, plants will re-sprout from the roots that were established during the first growing season. At this time plants begin to exhibit more vigorous growth, and plants will begin to develop more above-ground leaves and stems. During year 2 or more, plants will typically produce flowers and seed heads. Growth phases are different in annual prairie plants in that annuals typically produce vigorous growth, flowers and seed in the first growing season following planting. Because annual plants die back each year, this growth phase allows for rapid establishment and production of seed in one growing season that will yield next year's plants.

Grassland restoration is often a slow process; however, some restoration efforts can be unsuccessful and slower than projected if specific steps are not taken before planting, during planting

and establishment periods. Reasons for lower restoration successes may vary and can be related to local site conditions, but the most common reasons for planting failures include planting seed too deep (greater than 0.25 inches), inadequate control of competing vegetation and planting too late in the growing season (Table 4). Recent equipment innovations and new information concerning use of selective herbicides and planting techniques have led to increased restoration success.

Table 4. Primary Reasons for Grassland Restoration Failures.

Reasons for Failure:	Recommendations:
Seed are planted too deep in soil. *Seed of bluestems, Indiangrass, switchgrass and sideoats grama grass, some wildflowers and legumes should not be planted deeper than 0.25 inches.*	Drill plant or cover seed no deeper than 0.25 inches. Seed of many prairie plants can be seeded onto soil surface and then packed with a cultipacker to depress them into soil's surface.
Inadequate control of competing vegetation. *Existing sod and agronomic grasses must be killed prior to planting. Non-native plants as well as high densities of some native plants, including trees and shrubs can hamper success. After planting, reoccurrence of non-native grasses can limit prairie plant establishment.*	Follow prescriptions to eliminate competing vegetation prior to planting. If invasive, non-native plants are present, this is critical. Monitoring of site for reoccurrence of agronomic grasses and other undesirable plants following planting and timely control of competing vegetation is essential.
Planting seed or propagules too late in the growing season. *Later planting dates limit the amount of time for young plants to become established before the dry and hot soil conditions of late summer arrive. Thus, young plants enter these stressful periods*	Plant according to planting date recommendations. For most warm-season species, planting from mid-April through early June is recommended. Seed of native lespedezas and partridge pea can be planted as early as March.

continued

Reasons for Failure:	Recommendations:
of low moisture availability with limited root development and less potential for survival.	
Incorrect seeding rate planted. *Pure live seed (PLS) not estimated properly; seeder or drill not calibrated properly prior to planting.*	Calculate PLS from information on product label; make sure that drill or seeder is calibrated properly before planting.
Lack of patience and time for establishment. *First year's growth of perennial grasses, forbs and legumes may appear sparse. These plants will be putting energy into developing strong root systems during the first year. Expect a sparse stand of the perennials with more coverage and flowering by annual plants, like partridge pea. Remember perennials need those rootstocks from which they will develop vigorous above ground growth, flowering and seed production by year 2 or 3 and in each successive year to come.*	Learn what your grassland should look like the first and second growing season following planting. Have patience and learn to read your grasslands by inspection and study. Monitor your fields by walking and looking, always look out for invasive, non-native plants, reoccurring non-native grasses and an overabundance of native plants that may outcompete your desired seeded plants. Control these competing plants selectively in a timely manner to give your prairie plants the competitive advantage.

Adapted from Harper, C. A., G. E. Bates, M. J. Gudlin, and M. P. Hansbrough. 2004. *A Landowner's Guide to Native Warm-Season Grasses in the Mid-South.* University of Tennessee, Extension Service. PB 1746: 25 pp.

Control of Vegetative Competition

Selection of prairie plant mixtures is extremely important in planning a successful restoration of native grasslands; however, before planting occurs, landowners should take actions to control non-native vegetation that will out-compete newly established prairie plants. Because of high soil fertility and good climate conditions in Mississippi's prairie belts, many areas where native grassland once occurred are now used for forestry or agricultural crop, forage and livestock production. On many of these acres, non-native agronomic grasses have been established for livestock forage or soil stabilization. Introduced because of their

hardiness and tendency to establish dense ground cover, these introduced grasses limit wildlife habitat quality and impede successful restoration of native prairie plants. Additionally, human-created disturbance, such as soil tillage, disturbance and compaction, may increase the spread of invasive, non-native plants that lower land productivity and value, reduce native plant diversity and degrade wildlife habitat. Elimination of existing agronomic grasses and invasive, non-native plants is imperative for successful restoration of native grasslands.

Agronomic Cool-season Grasses

Cool-season, perennial grasses occur commonly on many acres across Mississippi. Many species were originally established for erosion control, livestock forage and hay production or wildlife food plots. Most have become naturalized and have spread beyond the area of original introduction. These grasses include tall fescue, orchard grass, Kentucky bluegrass, ryegrass, timothy and brome grasses. In Mississippi, the most common and troublesome of the introduced cool-season grasses is tall fescue. Due to heaviest growth during the winter and spring months, tall fescue gained popularity as a food plot species for white-tailed deer in the Southeast. However, tall fescue and orchard grass are among the least preferred forage plants for white-tailed deer. Tall fescue has limited value for wildlife and causes toxicity problems for wildlife and livestock due to a fungal endophyte that grows within leaves and stems of the plant. This endophytic fungus produces chemicals that cause reproductive and physiological problems in wildlife and livestock that eat the grass. For example, cattle that consume tall fescue as hay or green forage often exhibit poor weight gains, hoof sloughing and loss, intolerance to heat and elevated body temperatures, failure to shed winter coats and reduced conception rates. Fescue toxicity in horses is often more severe, especially in mares within 60 to 90 days prior to foaling. Conditions may include abortion, placental thickening, retained placenta after foaling, prolonged gestation, reduced or no milk production, difficulty during foaling and death of mares during foaling. Although relatively little is known about fescue toxicity in wildlife, several studies have reported negative effects in selected upland game species. Specifically, studies have shown that endophyte-infected fescue causes intestinal lesions and reproductive failures in rabbits that ate the grass and death in bobwhite quail that consumed the seed. Additionally, cottontail rabbits had smaller litters and reduced body weights in habitats dominated by tall fescue. Bobwhite quail that were fed tall fescue seed exhibited cloacal swelling which caused sluggish behavior and eventual death. Because of toxicity problems in livestock and wildlife, fungus free varieties of fescue are now available commercially; however, most tall fescue found on land bases today is infected with the fungal endophyte.

In addition to low forage value, many non-native, cool-season grasses, such as tall fescue, develop dense ground coverage and thatch or litter at the ground's surface. Unlike the native bunch-grasses, these introduced grasses exhibit a different growth habit that causes complete ground coverage with

little to no bare ground at the soil's surface. Over several growing seasons, this dense coverage leads to undesirable habitat conditions for many species of wildlife, especially ground-nesting birds such as bobwhite quail and wild turkey. Dense ground cover and lack of bare-soil surface not only limits travel for young wild turkey and bobwhite quail, it also reduces the availability of fallen seed to foraging bobwhite quail and mourning doves. Dense thatch and leaf litter at the ground's surface also limits the establishment of desirable food and cover plants that require bare-soil surfaces for optimal seed germination.

Cool-season grasses will reduce planting successes of prairie plants through the development of thick thatch layers and above ground growth. These grasses compete with native prairie plants for growing space, moisture and nutrients. Some species, such as tall fescue, also limit establishment of native plants through allelopathy – the production of chemical that restricts growth of other plants. Therefore, effective control of cool-season grasses should be accomplished before planting of prairie plants. Control treatments should be applied when cool-season grasses are actively growing during fall or early spring. For application during fall months prior to spring planting, foliar application of a glyphosate herbicide should be applied at recommended rates (Table 5). For spring applications, tank mixtures of Roundup®, Plateau® and Journey® are recommended. Before sod is sprayed in spring, cool-season grasses should be burned, mowed, grazed or hayed and allowed to re-grow 6 to 10 inches in height. Application to new plant growth increases herbicide contact with actively growing plants and increases the rate of herbicide transport throughout the plant. After eradicating cool-season grasses, warm spring months will probably reveal an increased germination and emergence of warm-season species, such as Johnsongrass, Bermudagrass, bahaigrass, vaseygrass and dallisgrass.

Agronomic Warm-season Grasses

Grasses such as Johnsongrass, bahiagrass and Bermudagrass were originally introduced for hay production, livestock grazing and soil stabilization, and like cool-season grasses, many have spread and become naturalized throughout Mississippi. These grasses typically form dense ground cover over time. Due to their perennial growth habit and tendency to form dense rhizomes, stolons and above-ground growth, these plants will impede the establishment of prairie plants and reduce habitat quality for wildlife. These species typically exhibit maximum growth and greatest coverage during summer and fall months.

Some species, such as Johnsongrass, are allelopathic, preventing establishment of other plants through the release of phytotoxic chemicals from roots, leaves and stems. Johnsongrass favors disking and should be controlled before disking or tillage of the restoration site. Tillage or disking will cut stolons into smaller sections with nodes, each of which give rise to a new plant. Therefore, disking or soil tillage prior to herbicide application may result in greater stand densities of Johnsongrass. For control of Johnsongrass, bahiagrass

and broad-leaf plants, including giant goldenrod, cocklebur and giant ragweed, a combination of foliar and pre-emergence herbicide applications may be needed to reduce competition prior to planting and for several weeks after planting (Table 5). To reduce existing vegetative growth, spray actively growing plants with a glyphosate herbicide or grass-selective herbicide during the growing season prior to planting. In addition to the foliar application, pre-emergence herbicide application is recommended to control undesired plants several weeks following planting. A pre-emergence application of an imazapic herbicide, such as Plateau® or Journey®, is strongly recommended when planting bluestems, Indiangrass or sideoats grama. Prior to planting switchgrass or Eastern gamagrass, a pre-emergence application of Outrider® is recommended for control of Johnsongrass and undesired broad-leaf plants (Table 5).

During the last several years Caucasian bluestem, *Bothriochloa caucasica*, (Trin.) C.E. Hubb. has become an increasingly common grass along roadsides in the Black Belt of Mississippi and Alabama. Recently, this grass has become established in pastures and prairie remnants. In the Mid-west, range managers consider this grass one of the most aggressive and serious threats to native grasslands. Caucasian bluestem is considered a warm-season, perennial bunch-grass that has a tendency to turn into sod as the stands age. It was introduced from Russia in 1929 for use as a forage grass. Although this grass does have some forage value as it is palatable early in the year while the leaves are succulent, it quickly becomes unpalatable compared to native bluestems and switchgrass as the season progresses. Because of this, it quickly outcompetes native grasses and can take over a pasture. Caucasian bluestem has light fluffy seeds that germinate readily. This enables this species to spread rapidly, thus seed stalks should not be allowed to develop. To control this grass, use similar herbicide treatments that are recommended for the control of Bermudagrass and other warm-season grasses. If control proves difficult, apply herbicide treatments that are used for invasive, warm-season grasses, such as cogongrass.

Bermudagrass is one of the most difficult warm-season grasses to control. Although use of imazapyr-based herbicides can eventually eliminate Bermudagrass, complete control does not usually occur with a single spraying. Multiple sprayings over at least two growing seasons is usually required. Thus, control measures should be initiated at least 2 years prior to planting prairie grasses. In late winter, 2 years prior to planned restoration, burn Bermudagrass stands and allow them to regrow during spring and early summer. In Mississippi, Bermudagrass begins actively growing in May and June. As soon as flowering occurs in June and July, Bermudagrass should be sprayed with imazapyr (22 ounces of Arsenal® AC per acre with two pints of Methylated Seed Oil) (Table 5). Treated areas should be monitored for reoccurrence during the first and second growing seasons following herbicide application. Reoccurring patches of Bermudagrass should be spot sprayed as needed with the same herbicide mixture (Table 5). Two years following the initial treatment year, the field should be ready for planting.

If controlling Bermudagrasses or other agronomic grasses in sites where prairie forbs and legumes have been planted, use of grass selective herbicides, such as Fusilade®, can be used. Because these herbicides will also kill native prairie grasses, spot spraying is recommended. Their use may not be acceptable if desired prairie grasses are established in close proximity to prairie forbs and legumes where selective control of agronomic grasses is needed.

Invasive, Non-native Plants

Although many agronomic grasses already discussed are considered to be non-native invasives, landowners may encounter additional invasive plants on their lands. Of the 33 species now common to the Southeastern United States, most were originally introduced into Southern ecosystems for horticultural use, landscaping, erosion control or wildlife food plantings. Some were introduced unintentionally. These non-natives have spread from their original introduction areas by mowing equipment, animals and in some cases, intentional plantings. They are typically favored by repeated disturbance and intensive land use. After introduction, invasive plants tend to spread readily and cause degradation of wildlife habitat, land productivity and land value. They are a major threat to native plant communities, such as prairies. Landowners should learn how to recognize these plants so that they can implement control measures quickly following detection.

Cogongrass, An Invasive, Non-native Grass

Of the non-native plants in Mississippi, cogongrass is the most invasive and damaging to ecosystems and property values. Listed due to the Federal Noxious Weed Act as an invasive pest species, cogongrass is a perennial that grows to heights of 3 to 4 feet and forms dense stands that exclude native plants. The leaf blades are finely toothed with a prominent midrib, are furry on the upper side and embedded with silica (glass-like) crystals. Flowers appear in early spring producing abundant panicle-like spikes that yield whitish plumes of seed that are spread by wind. Cogongrass was first introduced accidentally as shipping material into the United States in 1911 at Mobile, Alabama. It was later intentionally introduced as a potential forage crop, ground cover for erosion control and an ornamental. Since its introduction, this invasive species has become established throughout the Southeastern United States in forests, rangelands, pastures, roadsides, reclaimed mining areas and natural areas. Currently, this grass is listed in the top seven worst invasive weeds globally. As of 2007, cogongrass has become established as far north as Tennessee and can now be found along highways, roadsides and tree plantations in Mississippi's Black Belt. This grass is favored by soil disturbance and prescribed fire and will readily move into grassland restoration sites through aerial seed transport onto bare-soil areas or through carriage of root sections and seed on mowing and soil-tillage equipment. Early detection and prompt control of cogongrass is essential for cost-effective treatment. Post treatment monitoring is

recommended, with follow-up herbicide treatment being needed in most infested sites. Because cogongrass is propagated primarily through root sections on equipment used for mowing and disking, all tractor implements and equipment should be inspected and cleaned prior to use on restoration sites. Because highest germination and establishment rates occur where seed comes into contact with bare-soil surface, prompt revegetation of bare-soil areas is recommended. Thus, establishment of native prairie grasses, legumes and forbs following herbicide treatment is integral to control of this invasive grass.

Control of cogongrass may involve mechanical and chemical treatment. On sites of low erodibility or low ecological sensitivity, spring mowing, disking or burning is recommended prior to herbicide application. When grass resprouts up to 6 to 10 inches, a 2 percent mixture of glyphosate should be applied if immediate revegetation is planned. Additional application of a 1 to 1.5 percent mixture of imazapyr is recommended in late summer to fall months. Treated sites should be monitored following treatment and reoccurring cogongrass should be spot treated with herbicide as necessary (Table 6). After treatment of cogongrass infested sites, clean all mowing, spraying and disking equipment thoroughly before using on other areas.

Non-native Legumes

Several non-native legumes that were originally introduced for forage, erosion control or wildlife food plants have become invasive plant problems and should be eliminated on restoration sites. These include Chinese or sericea lespedeza (also various trade names such as Serala and Interstate lespedeza), bicolor lespedeza and kudzu. Introduced in the Eastern United States from Japan, sericea and bicolor lespedezas are upright to ascending perennial legumes that develop dense stems that arise from woody rootcrowns. Both species spread from abundant seeds and rootstocks, generally producing dense ground-cover over time. These plants are favored by prescribed burning and may outcompete desired grassland plants if not controlled prior to grassland establishment. Unlike native and annual lespedezas, sericea lespedeza produces seed high in tannic acid that are of marginal value to upland game birds. Bicolor lespedeza was introduced for bobwhite quail food and cover plantings. Although bicolor lespedeza produces palatable seed for bobwhite quail, careful consideration should be given to monitoring and control of this plant due to its ability to spread and dominate a site, especially if prescribed fire will be used in management.

Of the non-native legumes, kudzu is the most invasive species. This leguminous vine was introduced from China into the United States from 1920 - 1950 for erosion control and livestock forage. Over 2 million acres were planted in kudzu during this time period and in the following decades. Kudzu spread beyond planted areas and now occurs throughout Mississippi and the Southeastern United States. The plants exhibit twining or trailing semi-woody, many noded stems that may reach over 100 feet in length. Spread of kudzu can root along stem nodes when vines contact ground or are covered by leaf litter and by viable seed. Root and stem propagules and seed can be spread by mowing and soil-moving equipment. High growth rates of over 1 foot per day produces dense mats of vegetation that exclude most native plants. Although kudzu is a pest species, the plant is readily eaten by white-tailed deer and dense kudzu thickets provide cover for young deer fawns. Thus, kudzu has been marketed in the Southeast by some commercial suppliers for deer food plantings in recent years, despite its invasive nature and impacts to land values. Early detection and eradication of kudzu is recommended on areas targeted for wildlife habitat enhancement, reforestation and grassland restoration (Table 6).

Non-native Woody Plants

Chinese and Japanese privet, autumn olive, mimosa and Japanese honeysuckle are non-native woody plants of openings, fence rows and forest edges. Most of these species have become naturalized by spreading from horticultural landscape plantings. Japanese honeysuckle has also been planted and encouraged due to its value as a deer food plant. Because they compete with native prairie plants and reduce diversity of wildlife food plants, eradication of these species is recommended in prairie restoration areas (Table 6).

Integrative Control of Non-native Plants

The most effective approach to controlling non-native invasive plants is through a combination of herbicide application, mechanical control or burning and revegetation with desirable plants following eradication. Mowing or burning agronomic grasses and broad-leaf plants and allowing regrowth or sprouting prior to foliar herbicide application is recommended to ensure that applied chemicals make contact with actively growing leaves and stems. If disking or mowing invasive species, such as cogongrass, mowing and tillage equipment should be cleaned before use in other sites. Mowing or clipping can be used to control undesired annual plants before they produce mature seed. This measure will reduce coverage but will also limit the amount of seeds in the seedbank during future growing seasons. Mowing can be used to clip the above ground growth of perennial plants and their seedheads to limit their coverage temporarily. However, perennial plants are less impacted by mowing due to their tendency to arise from established rootstocks. Also, some shrubs and grasses may actually increase stem densities in response to mowing. Thus, mowing combined with chemical control is generally the most effective approach for reduction of competing vegetation. When mowing, the clipper or mower should be set several feet above ground level so root bases of warm-season grasses are not damaged. If coverage of broad-leaf native plants is patchy and dispersed over the site, native grasses, such as Eastern gamagrass and switchgrass, will generally outcompete these plants by the second to third growing season.

Table 5. Herbicide use guide for native grassland restoration and management.

Herbicide	Use	Application Rate	Objectives/ Considerations
Glyphosate (Roundup®, Accord®, Gly-4)	Eradication of tall fescue, other agronomic grasses and unwanted plants prior to restoration or when prairie plants are dormant during winter.	Fall: 1.5 to 2 qts/ac Spring: 2 qts/ac	Broad spectrum herbicide – will kill desired plants if growing or green. Post-emergence only with no soil activity or residual control.
	Control of woody saplings, Japanese honeysuckle and privet; sericea lespedeza, thistles, giant ragweed, goldenrod, Bermudagrass, bahaigrass, Johnsongrass, dallisgrass.	2.5 to 4 qts/ac	
Imazapic (Plateau®)	Pre-emergence weed control prior to bluestems, sideoats grama and Indiangrass.	6 to 8 oz/ac	Residual weed control for approximately 60 days. Check label for tolerance of native grasses and wildflowers. Wait at least 60 days post-treatment before establishing sensitive prairie plants.
	Eradication of tall fescue and other agronomic grasses to allow seedbank response.	12 oz/ac	
	Post-emergence control of Johnsongrass, crabgrass, cocklebur and other broad-leaved plants in established prairies.	6 to 8 oz/ac	
Imazapic + Glyphosate (Journey®)	Pre-emergence weed control prior to bluestems, sideoats grama and Indiangrass. Eradication of tall fescue and other existing cover prior to establishment of	11 to 32 oz/ac	

continued

Herbicide	Use	Application Rate	Objectives/ Considerations
	grassland species, or while native grasses and forbs are dormant during winter.		
	Post-emergence control of Johnsongrass, crabgrass, cocklebur and other broad-leaved plants in established prairies.	11 oz/ac	
Imazapyr (Arsenal®)	Control of undesired woody plants; often best control by mixing with other herbicides.	See label for application rates/ mixtures for control of specific plants.	Use as spot treatment or selective treatment where undesired woody plants are invading.
2,4-D	Control of giant goldenrod, giant ragweed, thistles and cocklbur.	1 to 4 pts/ac post-emergence application	Will also kill desirable legumes, forbs and damage warm-season grass seedlings.
Dicambia (Banvel®, Clarity®)	Control of undesired broad-leaf and woody plants.	2 to 4 pts/ac pre- or post-emergence application	Will also kill desirable legumes, wildflowers and broad leaf plants.
Sulfosulfuron (Outrider®)	Pre- and post-emergence control of Johnsongrass and other undesired plants in warm-season grasses (including switchgrass).	0.75 to 2 oz/ac	Caution is advised due to possible groundwater and surface water contamination.
Triclopyr (Garlon® 3A)	Control of sericea lespedeza and other broad-leaf plants in established warm-season grasses.	1 qt/ac	Apply in early summer during early growth stages of sericea. Will not kill warm-season grasses, but will kill desired legumes and wildflowers.
	Control of woody saplings.	1 to 5 gal/ac see label for different rates of applications	Refer to label for rate to control other unwanted plants at different volume treatments.

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Herbicide	Use	Application Rate	Objectives/ Considerations
Metsulfuron methyl (Escort®, Cimarron®)	Control of sericea and bicolor lespedeza and other broad-leaf plants.	0.1 to 2 pts/ac post-emergence application	Apply to sericea during blooming (July-August). Fall application may provide spring control. Does not kill warm-season grasses.
Sethoxydim (Poast® Plus)	Control of undesirable cool-season grasses prior to warm-season grass emergence. Reduction of warm-season grasses in stands that are too dense.	2 pts/ac post-emergence application	To reduce stand density of native grasses, apply selectively in strips or adjust sprayer so that every 3rd nozzle is open, with 2 nozzles between closed.
Clethodium (Select®)	Control of undesirable cool-season grasses prior to warm-season grass emergence. Reduction of very dense stands of warm-season grasses.	10 oz/ac post-emergence application	To reduce density of native grasses, apply selectively in strips or adjust sprayer so that every 3rd nozzle is open, with 2 nozzles between closed.

Table 6. Control measures for selected invasive, non-native plants that may occur on grassland restoration sites of Mississippi's Blackland and Jackson Prairies.

Invasive Plant Species	Growth Habit and Season	Recommended Control Measures
Cogongrass	Perennial Warm-Season Grass	If possible, burn in winter prior to herbicide application and allow resprouting of new growth. Apply glyphosate herbicide as a 2% solution (8 oz per 3 gallon mix) in summer and in fall, apply Arsenal® AC as a 1% solution (4 oz per 3 gallon mix). Repeat glyphosate application to new growth in spring and repeat applications of both herbicides until eradication.
Kudzu, Chinese Wisteria	Perennial Warm-Season Leguminous Vines	Repeated treatment over years during summer or early fall months with one of the following: Tordon® 101+ as 3% solution (12 oz per 3 gallon mix); Tordon® K as 2% solution (8 oz per 3 gallon mix); Escort® at 3 to 4 oz per acre in water (0.8-1.2 dry oz per 3 gallon mix); or when safety of non-target plants is desired Transline® as a 0.5% solution in water (2 oz per 3 gallon mix). Spray vines as high as possible and cut vines that are not controlled after herbicide treatment. Tordon® and Escort® will kill prairie plants so careful application or use of Transline® is recommended in established prairies.
Lespedezas (Sericea and Bicolor)	Perennial Shrub-like Legumes	Mowing several times before herbicide application can enhance control. Thoroughly wet leaves with one of the following chemicals mixed in water: Garlon® 4, 2% solution (8 oz. per 3 gallon mix); glyphosate herbicide, 2% solution (8 oz per 3 gallon mix); or Transline®, 0.2% solution (1 oz. per 3 gallon mix) if safety of non-target plants is a concern.

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Invasive Plant Species	Growth Habit and Season	Recommended Control Measures
Chinese Privet	Evergreen Shrub	Apply foliar herbicide from August through December with one of following: Glyphosate herbicide 3% solution (12 oz per 3 gallon mix) or Arsenal® AC 1% solution (4 oz per 3 gallon mix). Foliar applications are recommended in winter when desired warm-season species are dormant. For large shrubs and when safety of nearby vegetation is desired, cut stems or stumps and apply Garlon® 3A or glyphosate herbicide, 20% solution (2.5 quarts per 3 gallon mix).
Silk Tree, Mimosa	Deciduous Tree	Cut stems or trunks and spray cut surfaces with Arsenal® AC or Garlon® 3A in dilutions recommended on product labels. Spray foliage of resprouts or seedlings with Garlon® 3A, Garlon® 4, or glyphosate herbicide, 2% solution (8oz per 3 gallon mix in July - October or Transline®, 0.2% - 0.4% solution (1- 2 oz per 3 gallon mix) for less risk in damaging non-target plants.
Autumn Olive	Deciduous Shrub	Thoroughly wet all leaves with Arsenal® AC or Vanquish® as a 1% solution in water (4 oz per 3 gallons water) with a surfactant. Apply at least once during growing season from April - October. If shrubs are too large for foliar application, cut stems or trunks and apply on the cut stem surfaces, one of the following: 1 quart of Arsenal® per 3 gallons of water with surfactant (10% solution) or 2.5 quarts of glyphosate herbicide mixed with 3 gallons of water (20% solution).
Japanese Honeysuckle	Evergreen Vine	Spray foliage during warm days of early winter with glyphosate herbicide, 2% solution (8 oz per 3 gallon mix) or Garlon® 3A or Garlon® 4 as a 3 to 5% solution (12 to 20 oz per 3 gallon mix). Treatment of resprouting after burning can enhance control.

Soil Amendments

Although many prairie plants are adapted to a wide variety of nutrient and soil pH levels, soil testing is recommended to determine soil quality conditions on the restoration site. Collection of soil samples across the restoration site is recommended during winter to early spring months. Soil sample analyses can provide specific application rates for desired plants; thus, soil testing can be a very cost-effective component of determining soil amendment needs and rates that are appropriate specifically for the restoration site. Analyses for determination of macro-nutrient [Nitrogen (N), Phosphorous (P), Potassium (K) and Sulfur (S)] and soil pH levels are recommended. To determine the most cost-effective liming based on locally specific needs of the site, soil testing is always the best approach. Soil samples can be analyzed by a privately-owned business or by the Soil Testing Laboratory of Mississippi Cooperative Extension Service, Mississippi State University, Mississippi State, MS, 39762 (www.msucares.com). They should be contacted for information concerning soil collection boxes and cost of analyses.

Addition of nutrients for encouraging rapid establishment of perennial grasses may be necessary on areas where dense stands of grasses are desired for hay and forage production, visibility barriers or erosion control strips. For optimal growth on hay fields, pH levels should range from 6.0 to 7.0 and P and K should be at medium to high levels in the soil (31 to 120 lbs/acre for P and 161 to 320 lbs/acre for K). Up to 60 lbs/acre of N can be applied in spring months for maximum hay and forage production; although application of N is not generally needed or recommended at planting due to positive effects on competing vegetation. When planting bluestems or Indiangrass with the use of an imazapic pre-emergent application, 15 to 30 lbs/acre of N can be added when these bunch-grasses reach 4 to 6 inches in height if ample soil moisture is present. When planting Eastern gamagrass or switchgrass, N should not be applied until weeds are controlled and grass stands are established.

Addition of fertilizers is not generally necessary when grasslands are being established for wildlife habitat. However, landowners can favor selected plants with application of fertilizers that include different nutrients. For example, legumes can be favored with the application of fertilizers that are low in nitrogen and higher in phosphorous and potassium (i.e., 0-14-14 or 0-20-20). Additionally, small amounts of micronutrients, such as boron, may be added to enhance coverage of annual clovers and other legumes. Fertilizers that are high in N are not generally applied for legume growth. On the other hand, N applications will generally stimulate growth of grasses and selected forbs. To enhance N fixation in legumes, apply the recommended inoculum – powdered additive that has bacterial association needed for N fixation – as indicated on product label specifications.

Addition of lime is generally not needed unless the soil pH level is 5.0 or less. At lower pH levels, nutrient availability and absorption is lower in plants, and growth of plants is reduced. In general, most plants grow best at pH levels ranging from 6.0 to 7.5. Most Blackland Prairie soils in Mississippi exhibit

neutral to alkaline soil pH levels. Generally, soil pH levels range from 6.5 to over 8.0 in the Black Belt, and most prairie plants are best adapted to this pH range. More acidic soils may be encountered in disturbed sites, in forested areas or in wetlands. If pH levels are less than 6.0, application of lime at recommended rates can enhance plant establishment. In areas where chalk outcrops or clay horizons are exposed, pH levels may be higher than 8.0. In these areas, no lime application would be needed. If needed, best results are realized from lime application when liming is accomplished at least one month prior to planting. This allows ample time for lime to increase soil pH levels prior to the growing season. However, fertilizer should be applied just prior to seedbed preparation and planting.

Seedbed Preparation

After control of undesired vegetation is accomplished, the seedbed should be prepared before planting. The type of seedbed preparation will be dependent on planting mixtures and method of planting. If seed is to be drilled, a firm and "clean" seedbed, free of above ground thatch and other plant parts is desired. To best accomplish this, the area should be burned prior to planting. If existing vegetation is sparse and only a few inches tall, no preparation may be needed. If seed are to be sown over the soil surface or "top-seeded," the seedbed should be prepared by conventional tillage methods. If addition of fertilizers is necessary, best results are obtained by applying these amendments prior to seedbed preparation so that tillage will incorporate nutrients into soil layers.

Planting Dates and Methods

Planting prairie plants during the proper planting periods is essential for successful establishment. This is especially important for warm-season grasses, which should be seeded from April through early June. Plantings during mid- to late June can result in successful establishment; however, germination and growth of plants may be lower. As spring gives way to summer, higher soil temperatures combined with less soil moisture create stressful conditions that may limit the survival and growth of young plants. Additionally, seedlings of plants germinating in mid- to late summer may not have ample time for root development before the onset of dry periods. Thus, seedlings may not survive if seed are planted late.

Most forbs and legumes can be planted in the seed mixture with warm-season grasses. Seed of partridge pea can also be planted earlier in February and March. Seed can be top sown (seeded directly onto the soil surface) and site preparation burning can be applied following this seeding. Heat and high-humidity during burning can enhance germination rates of partridge pea through seed coat scarification.

Seed of most prairie plants should be top-sown or drilled. Drilling is usually the preferred method for planting warm-season grasses, especially for large area plantings. Seed of Eastern gamagrass can be planted with a corn planter. Seed of forbs and legumes can be top sown over the soil surface for best results. Regardless of planting method, seed should not be covered or planted deeper than 0.25 inches. When drilled, at least one-third of the seed should be visible at the soil's surface or on top of the planting furrow. The exception to this rule is with the seed of Eastern gamagrass, which should be planted 1 inch deep.

Drilling

Planting of warm-season grasses with a drill creates a solid continuous stand and is preferred if grasses are being established for hay or forage production. Switchgrass can be planted with conventional drills. Specialized drills are required for seeding the fluffy, light-weight seed of bluestems and Indiangrass. These drills are equipped with a specialized seed box that contains picker wheels that extract the seed, preventing them from lodging in the seed chute. Drills are often available for use through organizations, such as Wildlife Mississippi. Some county cooperatives may also rent drills to landowners. All drills must be calibrated prior to use to ensure that seed are applied at the appropriate rates. Seed of Eastern gamagrass is usually planted with a corn planter in rows spaced 18 to 24 inches apart. Planting in rows of 12 inches apart creates a more erect growth form and is used when Eastern gamagrass is planted for hay production.

Broadcast Seeding

Grasslands established for wildlife can be planted by broadcast application of seed. Broadcast seeding can be accomplished with a hand-held ("cyclone") or tractor-mounted seeder. Switchgrass, partridge pea, native lespedezas and sunflowers can all be broadcast seeded with conventional seeders. However, when planting seeds of bluestems, Indiangrass or selected forbs (i.e. blazing star), a broadcast seeder with picker wheels is preferred to spread the fluffy seed efficiently. If this type of seeder is not available, some type of carrier agent, such as pelletized lime, fertilizer, cracked corn or cottonseed hulls, can be added to enhance dispersal of seed. Prior to broadcast seeding, the seedbed should be burned or disked to ensure that seed will make soil contact. After seeding, cultipacking will increase seed to soil contact and will improve germination rates. Disking over planted areas is not recommended due to the potential of covering the seed too deeply.

Prairie Plant Seeds and Propagules

If prairie plants are rare or absent in your area, you will need to introduce them through planting of seed or vegetative propagules, such as rootstocks, bulbs or rooted stolons. Seeding is the most economical approach, especially on restoration sites that exceed 0.25 acres. In some cases, landowners may wish to plant propagules – rootstocks or rootings – rather than seeds. Propagules are generally more expensive than seed; thus, propagules are generally used when rapid establishment is desired on small restoration areas. Some landowners

establish wildflowers in this manner, establishing a source population initially and managing them over time so that they spread over the restoration area.

Plan your grassland restoration in plenty of time to order and acquire seed so that planting can be done during the recommended planting periods. Whether using seed or propagules, check with commercial sources to determine availability for the growing season in which planting is planned. If plants that you desire for your grassland seed mixture are rare or in high demand, early ordering is wise. At times, propagules and seed of wildflowers, such as prairie clover, compass plant and purple coneflower, are difficult to obtain because of their popularity in native plant landscaping and grassland restoration. In cases where seed availability is low and demand is high, early ordering with instructions to delay shipment just prior to planting periods may be prudent.

Seed from plant varieties that grow well in Mississippi's soils and climate are recommended. Therefore, when feasible, obtain seed that are collected from varieties that grow naturally or perform well in the Gulf Coastal Plain of the Southeast. Plant stock grown from seed stock collected in the Gulf Coastal States of Mississippi, Louisiana, Arkansas, Alabama, Tennessee, Georgia and North Florida are recommended. Depending on the plant species, seed sources from or developed for East Texas, Southern Oklahoma, Kentucky and Missouri may also grow well in Mississippi's Blacklands.

In rare cases, collection of seed or propagules from local donor sites may be possible. Plantings with locally collected propagules or seeds can be used on smaller areas, such as strips along roadsides and driveways or small patches in landscaped areas or fallow fields. Because this can be a labor-intensive venture, collection of plants for planting large areas may not be feasible. Additionally, collection of native plants is illegal on public lands, roadside right-of-ways, and private lands without consent of the landowner or managing agency. Cases where collection of plant seeds and propagules may be appropriate are under conditions where plants at the original donor site are threatened by intensive land use, such as intensive grazing, herbiciding or mechanical control of vegetation, permanent flooding or land development, such as urban or highway construction. Under these circumstances, existing plant communities will be changed or destroyed, and relocating prairie plants to a restoration site can actually conserve genetic and species diversity of plants. Remember, however, that collection of plants from natural areas is not recommended if plant communities are not threatened by disturbance. Collection of plants from the wild can actually cause extinction of native plants; thus, collection should only be considered when plant stock can be saved by relocation to a restoration area. Again, one should always gain permission from land managers or landowners before collecting plants anywhere, regardless of future land use.

If collecting seed from native plants at donor sites, only mature seed should be collected. Seed maturation may vary depending on the active growth period of each plant species. Plants that flower during early spring may yield mature seed as early as June or July. Because many prairie plants flower during the summer, seed are generally mature during late summer and fall. For example, seed of Eastern gamagrass, switchgrass, Indiangrass, bluestems, compass plant, coneflowers and blazing stars begin maturing during August to September and are fully mature during September to October. Seed should be collected after they are dry and brown in color. Collection of seed while they are still green and moist will generally result in low seed viability. Vegetative propagules, such as root bases, bulbs and stolons, yield highest plant survival if collection occurs when the plant is dormant. Thus, collection during winter months is optimal for successful transplanting of bulbs or rootstocks. To relocate dormant plants in winter, one may need to mark the plant's location when it is actively growing and identifiable during the growing season.

Obtaining Seed from Commercial Sources

Commercial sources for obtaining prairie plant seeds and propagules can be obtained from assisting governmental agencies and organizations. Additionally, addresses of many sources can be obtained from the internet (See Commercial Vendors List). Because obtaining quality seed is very important to successful plant establishment, seed should be obtained from reputable sources. Therefore, landowners should do research into the companies from which they intend to buy seeds or propagules. Selected specifications should be guaranteed by seed companies and labeling should include specific information about the product purchased, including guarantees of the absence of noxious weeds or non-native invasive plants, identification of species included in seed mixtures, seed purity and seed germination rates (Table 7). Knowledge of seed purity and germination rates is necessary for determination of appropriate seeding rates, because these factors are related to the actual amount of seed that will give rise to your newly planted stand of prairie plants. This information is usually included on package labeling or in seed purchase literature. Seed purity of native warm-season grasses is generally 50 to 70 percent unless stated otherwise. Seed purity of native legumes and forbs may be higher than that of grasses. The remaining percentages (30 to 50 percent) include materials that will not germinate or inert materials, such as stems, leaves and other plant debris. Additionally, not all seed in the mix will germinate, and this influences the total seed that will give rise to new prairie plants. The actual amount of seed that will germinate, called pure live seed (PLS), can be calculated from information provided on the seed packaging or seed tags. Germination rates of seeds may be as low as 50 to 60 percent of the total weight purchased; thus, applied seeding rates that have not been adjusted according to PLS will result in lower than needed seed rates in restoration sites.

To calculate the amount of seed that should be planted per acre, look for the percentage of pure seed and total germination on the seed tag or package label (Table 7: information required for determining PLS in bold font). With these percentages, you will estimate PLS as follows: [67.62% (pure seed) x

86.00% (total germination) ÷ 100% = 58.15% PLS]. To estimate the seeding rate to plant 6 lbs per acre, do as follows: 6 lbs (desired seeding rate) ÷ 58.15 (PLS) x 100 = 10 lbs. Therefore, approximately 10 pounds of bulk material from the seed bag should be seeded per acre to apply 6 pounds of seed that will germinate.

Table 7. Information generally included on seed tags and seed package labeling.

PURE LIVE SEED (PLS)

Seed: Indiangrass

Pure Seed: 67.62%	Germination: 64.00%
Other crops: 0.05%	Firm/Dormant: 22.00%
Weed Seed: 0.42%	**Total Germination: 86.00%**
Inert: 26.23%	Noxious Weeds: 0.00%
Origin: Texas	Test Date: 23 December 2003

Adapted from Harper, C. A., G. E. Bates, M. J. Gudlin, and M. P. Hansbrough. 2004. *A Landowner's Guide to Native Warm-Season Grasses in the Mid-South.* University of Tennessee, Extension Service. PB 1746: 25 pp.

Treatment and Storage of Seeds and Propagules

Prior to planting, seed should be stored in a cool, dry place. Always store seed where it will not become moistened by condensation or rainfall. In Mississippi, condensation may occur on concrete floors during times of high humidity and temperature change. If seed is stored on concrete or bare-ground surfaces, seed bags should be placed on slats that allow ventilation between the bag and the floor. A vapor barrier of plastic is also recommended between the floor and bags. This type of storage may also be necessary on substrates that may become moist from horizontal or upward movement of soil moisture. If storage is necessary for several weeks to months, seed should be stored in rodent-proof containers. For long-term storage, protection of seed from insect larvae and weevils should be considered. Proper storage prior to planting will ensure that seed remain viable for germination.

Despite proper storage of viable seed, many prairie plant species exhibit high seed dormancy rates or delayed germination. This characteristic enables prairie plants to germinate over time and increases the probability that some young plants will germinate and grow under optimal environmental conditions over several growing seasons. Two prairie grasses, switchgrass and Eastern gamagrass, generally have high seed dormancy rates. Many native legumes, such as partridge pea, produce hard-coated seed that may remain in the soil's seed bank for many years before germinating. For most species, environmental conditions, such as fire or weathering over seasons, are needed to break down impermeable seed coats and enhance germination. Thus, to maximize germination during the first growing season, seed treatment to simulate environmental conditions that stimulate germination is recommended. For most species, seed can be purchased that has already been treated to break seed dormancy, and this is the best option for effective and easy planting successes. Purchase of scarified seed is recommended for establishment of legumes, such as partridge pea. Seed of selected grasses can be purchased that have been treated through cold stratification. Specifically, purchase of cold stratified seed of Eastern gamagrass seed from a dealer is recommended if planting can be conducted immediately upon receiving shipment. If purchase of treated seed is not possible, several methods can be used. Switchgrass seed can be wet-chilled by soaking it in a mesh bag overnight and then allowing it to drip dry overnight. After wetting and drip drying, the seed should be stored in a cool area (40 to 45 ºF) for at least 2 weeks.

Vegetative propagules should always be stored and planted according to product labeling. In general, propagules should be stored in a cool, dry place away from direct sunlight, unless otherwise specified by product labeling. In general, living plant propagules are more sensitive to extreme light, moisture and temperature conditions. For example, warm to hot temperature combined with moisture may cause propagules to sprout or rot in the packaging. Generally, propagules stored under poor conditions will not produce viable plants. Thus, appropriate storage and planting in a timely manner is essential to the successful use of propagules to establish prairie plants. For best results, plant during recommended planting periods or according to specific planting recommendations provided on seed or propagule packaging.

Managing Native Grasslands for Wildife

Prairies or native grasslands are ecosystems that depend on disturbance to set back succession – to maintain a dominance of native grasses, legumes and wild flowers. Without some type of management that mimics the natural disturbances that maintained native grasslands, vegetation coverage will undergo changes that produce less desirable habitat for grassland wildlife. For example, without management, native warm-season grasses can become too dense for many species of wildlife. Additionally, in the absence of disturbance over several years, woody plants will colonize and out-compete herbaceous prairie plants. Disturbance that creates open structure at ground level can enhance habitat conditions for grassland birds, rabbits and rodents. Additionally, bare-soil surfaces are needed to provide substrate for germination and establishment of native legumes and forbs. Management that creates the desired vegetative composition and structure and some bare-soil surface includes prescribed burning or disking.

Figure 18. *Spraying sites helps control noxious grass species and provides fuel for prescribed fires.*

Habitat Management Methods

Prescribed Fire

Prescribed fire is the best habitat management method for restoration and maintenance of grasslands. Prescribed fire reduces dead plant material at ground level, increases availability of selected soil nutrients, increases seed germination through seed coat scarification, stimulates sprouting and herbaceous growth and reduces coverage of dense woody plant cover.

Prescribed fire can be used at different times of the year to accomplish different goals. Historically, North American Indians burned grasslands during the late summer and fall (mid-August through mid-November). Use of fire at this time generally reduces the ground layer densities of most prairie grasses and stimulates next year's coverage of many annual legumes and wild flowers. Fall burning allows time for annual legumes, such as partridge pea and beggar weed, to produce mature seed for the next growing season. Mature seed of annual plants fall to bare-soil surfaces, produced by fall burns and germination, can be enhanced by this soil-seed contact. Burning at this time can also reduce woody plant cover if burning is conducted before leaf senescence and plant dormancy occurs. If woody plants are dense enough to limit growth of desired prairie plants, fields can be burned during early spring, just after bud break and new growth appears. Dormant season fires (fires that are set in winter months) are often used to manage grasslands. Most fields are burned in late winter (December to February), just before "green up." These fires reduce cover for a short duration and do not disrupt reproducing wildlife. Prescribed fires that are set in spring and summer months are called growing season burns. Growing season burns can enhance coverage of most prairie grasses. Effects of growing season fires on various native grasses may be influenced by climate conditions. For example, summer burning during years of drought has been reported to reduce coverage of little bluestem and increase coverage of switchgrass and big bluestem. Ground-nesting wildlife, such as rabbits and birds, and insects that inhabit stems and leaves may be negatively affected by growing season fires if these fires encompass the entire restoration site. Thus, when growing season fires are employed, burning should be conducted in mosaic or alternate strip patterns to maintain areas that have not been burned annually. This burning pattern creates diversity of habitat structure across the restoration site while maintaining source populations of pollinating and stem dwelling insects and ground-nesting wildlife, such as rabbits and wild turkey (Figures 18, 19 and 20).

Figure 19. *Prescribed fire prior to restoration helps with good seed-soil contact.*

Even when conducting dormant season or fall burning, removal of escape cover over the

Figure 20. *Site planted after prescribed fire.*

entire site can limit escape and cover. Therefore, alternate strip or mosaic burns are most desirable to retain different stages of plant succession and plant cover types across the restoration site. This measure may be especially important if rabbits or bobwhite quail are desired species. This is not a new idea, for as early as the 1950s, wildlife biologists recommended protecting plum and blackberry thickets from burning to retain for bobwhite quail in burned areas.

In some situations, woody plants such as sumac, sweetgum, ash and Eastern baccharis may become too dense and exclude desired plants. If well established and dense, prescribed burns may only "top-kill" these woody species due to extensive underground root systems. Resprouting from established root systems following burning may actually stimulate greater stem densities in the following growing seasons in sweetgum, baccharis and winged sumac. Under these conditions, selective herbicide treatment combined with fire may be necessary to reduce woody plant coverage.

To maintain prairie plant and animal communities over the long term, landowners should continue burning programs over time. Frequency of burning should depend on the condition of the vegetation at the site. Thus, inspection of the grassland is important to determine how often an area should be burned. In newly planted fields of warm-season grass seed, burning may not be necessary during the first 2 years following planting. However, this may depend on specific conditions at the site. Burning should be conducted when several situations occur – grasses and past year's plant growth cover over 70 percent of surface at ground level, wildflowers and native legumes begin to decline in occurrence and coverage or woody plants becomes too dense, excluding desired grasses, legumes and forbs (Figures 21 and 22). In general, prescribed burning should be conducted at 3- to 5-year intervals. In some cases, burning may be conducted at

Figure 21. *Prescribed fire should be considered when native grasses, forbs and legumes begin to decline in occurance.*

Figure 22. *Prescribed burning can reduce dense growth of woody plants to favor native herbaceous prairie plants.*

2-year intervals if undesired woody plant competition is a problem.

Because burning will be conducted over time, landowners should usually establish permanent fire breaks or fire lanes to restrict the movement of fire. Fire lanes that surround the restoration site are of primary importance, because these lanes are designed to contain fire within areas targeted for burning. Adequate fire lanes are essential for the reduction of liability associated with burning. Fire lanes that are located within the interior of the restoration sites may be used to protect valuable thicket cover and soft- and hard-mast producing plants. Also, interior fire lanes are used to divide the site into strips or patches that will be burned during different years (Figure 23). Perimeter fire lanes that surround the area to be burned should be created by disking strips of 10 to 30 feet in width. Mowing or clipping of vegetation within fire lanes may be necessary prior to disking to reduce above-ground vegetation for more efficient disking. The soil surface in the fire lane should have little to no above-ground vegetation following disking. To increase food availability across the restoration site, portions of fire lanes should be seeded to wildlife food plants (Table 8). Non-native grasses (tall fescue, Johnsongrass, orchardgrass or brome grass) or introduced legumes (sericea lespedeza, bicolor lespedeza or kudzu) should never be planted in fire lanes due to the invasive tendencies of these species. Additionally, sites targeted for fire lane creation should be inspected prior to disking to detect invasive plants that may be spread by soil disturbance. Cogongrass and Johnsongrass are two plants that can be enhanced and spread by disking. Thus, control of these grasses should occur prior to soil disturbance. Small patches of these invasive grasses may be removed by digging and removal; whereas larger patches will require application of recommended herbicides. Areas that may erode should be re-vegetated with recommended fire lane plantings to limit soil erosion. Fire lanes that occur on a slope should be constructed so that the fire lane runs horizontally with the slope contour or perpendicular to the slope direction. Landowners should contact professionals with their state or federal wildlife agencies and non-profit conservation organizations for assistance of fire lane creation on highly erodible lands and erodible lands adjacent to streams, rivers, ponds and wetlands.

Figure 23. *Fire lanes planted to an agricultural crop for a food plot.*

Prescribed burning is the most ecologically desirable, efficient, cost-effective management tool for enhancement of grasslands. However, burning requires planning and careful implementation. All prescribed burning should be

Table 8. Plant Mixtures and Seeding Rates per Acre for Firelanes

COOL-SEASON ANNUAL MIXTURES	WARM-SEASON ANNUAL MIXTURES
25 lbs. wheat or oats 15 lbs. crimson clover 3 lbs. arrowleaf clover	3 lbs. partridge pea 5 lbs. browntop millet 10 lbs. Kobe lespedeza
COOL-SEASON PERENNIAL/ANNUAL MIXTURE	**WARM-SEASON ANNUAL MIXTURE[a]**
15 lbs. wheat 10 lbs. oats 8 lbs. ladino white or white dutch clover	20 lbs. soybeans 15 lbs. iron clay peas 10 lbs. browntop millet 5 lbs. grain sorghum

[a] In areas of high deer and rabbit abundance, planted beans and peas may be consumed and eliminated prior to seed production.

conducted according to state guidelines developed by the Mississippi Forestry Commission (MFC). Planning, experience and compliance with state regulations are necessary to accomplish controlled burns that result in the least liability for managers and landowners. Prior to conducting a burn, individuals should contact the MFC to obtain a burn plan and permit application. Completion and submission of a burning plan and conducting burns under the conditions delineated in the plan reduces liabilities associated with burning, such as smoke concentrations, fire escape and accidental property damage. Professionals with the MFC, the Mississippi Department of Wildlife, Fisheries and Parks, the Natural Resources Conservation Service and non-governmental organizations, such as Wildlife Mississippi, can help landowners who need assistance with developing plans for and implementing prescribed burns.

Disking

Although burning is the best way to manage restored grasslands, fire and smoke management issues may preclude burning in some areas. For example, prescribed burning near roads, highways or towns can be hampered by smoke management issues related to low visibility, accidents and air quality. Many landowners are reluctant to burn due to inexperience and limited assistance. Burning under the optimal environmental conditions may also preclude timely implementation of burns. In these situations, grasslands may be managed by disking. Disking can set back succession, create open space at ground level, incorporate and facilitate incorporation and decomposition of dead plant material, create bare soil for germination of prairie plant seeds and enhance coverage of annual wildlife food plants. Portions of disked areas can be seeded with legumes and forbs to increase wildlife food plants in fields dominated by warm-season grasses (Tables 3 and 8). Newly disked strips can provide increased food plants, bugging areas for game birds and access lanes for wildlife watching, hunting or walking.

Disking during different seasons affects vegetation composition differently depending on soil conditions, climate conditions and seed bank and plant community composition. For example, disking during late fall through early spring months will generally stimulate germination of annual bobwhite quail food plants, such as partridge pea and common ragweed, if seed are present in the seed bank. On areas that have good coverage of annual wildlife food plants, disking should not be conducted until seed have matured. Because perennial plants arise from established root systems each year, seed maturation may not be as critical to next year's cover for perennials as opposed to annual plants. However, late summer disking may limit coverage of perennial plants if root balls are exposed during periods of drought. Because the effects are locally specific, landowners may want to experiment with disking in different seasons to determine vegetation response. Additionally care should be taken to avoid deep disking and coverage of desirable seed or root systems. Non-native plants should be eliminated from the area prior to disking. Selected non-native grasses, such as Johnsongrass and cogongrass, actually benefit from disking. Thus, disking areas where these plants still exist will lead to denser coverage and spreading of these undesirable non-native grasses.

Disking should be conducted on portions of the restoration site. As with alternate strip burning, disking should be conducted in blocks or strips over several years across a site to increase vegetation diversity. Depending on the size of the restoration site, disked blocks can be an acre or more in size. With three blocks in each field, a block is disked each year yielding three different successional stages of vegetation by the end of the third growing season. Landowners may prefer to divide the field into strips for alternate year disking. Disked strips should be at least 50 feet in width and should run with the contour of the field to limit soil erosion. Undisked strips should be about twice as wide as disked strips. If a site is divided into three strips, this approach allows one third of the site to be disked each year. To encourage annual plants for bobwhite quail and wild turkey, disking should be conducted during October through March along forest openings or near cover. When disking for bobwhite quail, leave a 30-foot or wider buffer along the border of openings to provide cover during spring and summer while disked areas are re-growing sufficient cover.

Caution should be used when disking under the following conditions. Deep

disking should not be employed on soils that may have high soil acidities or phytotoxic chemical concentrations in the subsoil or lower soil horizons. Exposure of some chemicals that occur in deep substrates may render the site less productive for plant growth. Disking of chalk outcrops should be avoided. Continued disking under moist or wet soil conditions can create hard pans and soil compaction that limits root penetration, plant growth and establishment of desired prairie plants. Disked strips should be oriented with the contour of the field so that soil erosion is limited. Disking should not be conducted in close proximity to water bodies, streams, wetlands or immediately upslope from tree or shrub plantings. Maintenance of undisturbed strips of vegetation of at least 50 feet in width is recommended between disked areas and these sensitive habitats.

Mowing

Mowing of vegetation in restored grassland is generally used to reduce vegetation cover prior to disking to allow for more efficient soil disturbance. Mowing may also be used prior to burning to limit flame height and fire intensity along fire lanes and in the area targeted for burning. Although mowing is used in these conditions, regular mowing or clipping, alone, is not recommended for management of native grasslands. Clipping or mowing of vegetation without follow up burning increases the vegetation litter layer, inhibits germination of desirable seed and makes travel through the field difficult for small wildlife, such as wild turkey poults, young rabbits and bobwhite quail chicks. Additionally, mowing during spring through summer months destroys nest of ground nesting animals and limits seed production in many native annual food plants.

Herbicide Applications

Use of herbicides to control undesirable vegetation is a habitat management practice that is used during establishment and management phases of grassland restoration. Pre-emergent and foliar-contact herbicides may used to reduce non-native plants prior to planting. After establishment, herbicide application can also be important in reducing density of perennial grasses, elimination of non-native plants and reduction of dense coverage of dominant woody and herbaceous plants that are inhibiting desired prairie plants. Use of herbicides that are selective for the control of the plant targeted for reduction is recommended. For example, strip spraying of a grass-selective herbicide in late April can reduce grass density, create open space at ground level and stimulate the seed bank while not adversely affecting broad-leaved wildlife food plants and wildflowers. To create more habitat diversity, strip spraying should be conducted in patterns similar to those recommended for disking. Spot spraying, stem application or broadcast application can be also used, depending on the species of plant to be controlled and the size of the treatment patch (Table 5). Several treatments may be needed to control problem grasses, such as

cogongrass, crabgrass, Bermudagrass or tall fescue. Some herbicides may have residual toxic effects for months following applications, especially if excessive application rates are used. Landowners should always read product labels to determine what plants the herbicides control, the potential toxic effects on desired plants and soil residual effects and persistence following applications. Careful applications of selective herbicides at recommended rates are highly recommended to avoid damage to existing desired prairie and wildlife food plants.

Grazing

Historically, grasslands were influenced by grazing from native herbivores, such as bison, and fire. Rotational grazing can be used to mimic the effects of native herbivores; however, newly restored grasslands should be protected from all grazing by domestic livestock. Extensive research has been conducted in the Mid-western United States to determine grazing regimes that can benefit grasslands; however, limited information exists for management of grazing on native grasslands of the Gulf Coast states. Thus, prescriptions for grazing are limited in this publication.

Northern Bobwhite

Featured Wildlife Management

COLINUS VIRGINIANUS

Northern Bobwhite.

Historically, the Northern bobwhite (bobwhite quail) was one of the most important species of game in the Southeastern United States. However, in recent decades, bobwhite quail have exhibited population declines across most of Mississippi. These declines are attributed primarily to habitat loss and degradation of remaining habitat. Historically, in Mississippi bobwhite quail thrived due to early farming practices that created patchy mosaics of habitat types across the landscape. Also, regular burning of habitat created good habitat conditions for bobwhite quail. Changes in land use practices that have led to degradation and loss of bobwhite quail habitat in Mississippi include urbanization, intensive plantation forestry, conversion of native grasses to dense stands of agronomic grasses, clean farming and large-scale row crop production and reduced use of fire. Because bobwhite quail depend on native grassland habitats, restoration and management of prairies and woodland savannahs can increase the quality and amount of bobwhite quail habitat in Mississippi.

Habitat structure and composition is important for maintaining bobwhite quail populations over time. Primary types of habitats required include nesting, brood, feeding, loafing and escape cover. Good nesting cover is typified by a dominance of bunch-grasses (at least 70 percent coverage) interspersed with broad-leafed forbs (at least 20 percent) with abundant leaf litter at ground level and about 6 percent bare soil. Bobwhite quail tend to nest near areas that have access to bare ground, near thickets or briar brambles and in vegetation that is sufficiently open at the bird's level for ease of movement. Good nesting cover is characterized by scattered shrubs and brambles interspersed with moderately dense stands of herbaceous and grassy vegetation. To give bobwhite quail ample nesting habitat, at least 25 percent of the restored grassland should be managed for nesting cover. Brood-rearing habitat is characterized by native bunch-grasses (about 30 percent cover) and broad-leaved forbs and legumes (about 40 percent cover), about 40 percent coverage of scattered shrubs or brush for thermal cover, abundant insects, and 20 to 50 percent bare ground on the soil surface. It is here that young bobwhite quail chicks will spend the first weeks of their lives following their parents in search of insects and other invertebrates. Due to their small size, open structure at ground level is very important for their movement, yet overhead cover is important to hide them as they forage with their parents. Many of the native forbs and legumes that provide overhead cover also attract an abundance of insects, the main food source for chicks during the first weeks of their lives.

Escape and loafing cover are needed by bobwhite quail to rest and to avoid avian predators, such as sharp-shinned hawks. Brushy areas along watersheds, wetlands or fencerows make excellent escape and loafing sites. Additional loafing and escape cover can be created by establishing fire lanes around thickets of woody shrubs and vines, such a wild plum and blackberry.

As adults, bobwhite quail eat a variety of seed, green vegetation and invertebrates (insects, snails and spiders). Primary food plants that are present in well-managed, native grasslands include panic grasses, bull grasses, common ragweed, croton, blackberry, dewberry, partridge pea, beggar lice, native lespedezas and other native legumes. Bobwhite quail will also consume seed or fruit of trees and shrubs, such as sweetgum, pine, oak, ash, sumac and wild plum. Frequent prescribed burning on 2- to 4-year intervals will favor native legumes and grasses. Strip disking and fire will enhance coverage of annual forbs, such as common ragweed. Fruit-producing vines, shrubs, and trees, on the other hand, require less frequent fires or protection from fire for maximum fruit production. Burning at more than 5-year intervals can increase density of plum and blackberry thickets but can also allow above-ground stems ample time for maturation and optimal fruit production. Thus, protection of these thickets can produce escape, loafing and feeding cover for bobwhite quail and other species of wildlife, such as rabbits and deer.

Eastern Wild Turkey

MELEAGRIS GALLOPAVO

Eastern Wild Turkey.

Historically, Eastern wild turkey were common in woodland savannas and floodplain forests of the Blackland Prairie region of Mississippi and Alabama. Wild turkeys were very important to early North American Indians. Following European settlement, wild turkey populations declined drastically due to habitat loss and unregulated harvest by subsistence and market hunters. Recovery of wild turkey populations in the Southeast is a conservation success story. Populations of wild turkey have increased significantly through extensive reforestation, protection and restoration efforts of numerous state agencies, private landowners and conservation organizations.

Wild turkeys are opportunistic feeders, eating a variety of plant foods, insects, spiders, lizards and small snakes. Adult birds feed primarily on vegetation – stems, leaves, nuts, seeds and fruits of plants. Poults consume insects and other animal matter during the first weeks of their lives. Hard seeds of oaks, beech, pine, pecans and sweetgum are favored. Preferred soft mast includes fruit of blackberry, dew berry, dogwood, black cherry, blueberry, huckleberry, hawthorns, wild grape, sugarberry and black gum. Seeds and green foliage of forbs, legumes and grasses, such as panic and bull grasses, are also consumed. Primary cover types needed by wild turkeys include feeding, nesting, brood and roosting cover.

Use of grasslands by wild turkey will be dependent on the types of cover that are available across the restoration site. In turn, cover types will be influenced by the frequency and pattern of burning on the site. Because wild turkeys inhabit forests during much of the year, proximity of grassland to mature hardwood and pine forests will influence grassland use. Wild turkeys will also roost in mature bald cypress and hardwoods near and within forested wetlands. Protection of streamside management zones (SMZ) where hardwoods are allowed to reach at least 50 years of age or more will attract wild turkeys. Grassland restoration sites that are adjacent to or transected by forested SMZs will generally be used by wild turkeys. Although burning is recommended for native grasslands and savannas, burning should be excluded from hardwood forests of beech and cherrybark, water, willow and white oaks. Forested SMZs

also provide good travel corridors, foraging and roosting sites.

In woodland savannas where dormant season fires are conducted at 3- to 5-year intervals, woodland-savanna trees, such as post and blackjack oak, will persist along with herbaceous food plants. These areas can provide good foraging, nesting and brood habitats for wild turkey. Grassland openings that are burned more frequently (every 2 to 3 years) typically provide more open conditions that create good strutting grounds, foraging and brood habitats. Hens with poults will frequent these areas due to an abundance of foods that include insects, spiders, green vegetation and seeds of panic grasses, bull grasses and native legumes. Wild turkeys prefer to nest in areas of herbaceous and woody understory. Hens will generally select nesting habitats typified by an interspersion of shrub and vine thickets and bunch-grasses. Strip and mosaic burning at alternate year intervals and protection of thickets from frequent fire will generally create these nesting conditions. Additionally, fire lanes seeded with clover, vetches and annual grains, such as winter wheat and oats, provide good food sources for adult birds as well as bugging areas for hens with poults.

Mourning Dove

ZENAIDA MACROURA

Mourning Dove.

Because mourning doves prefer early successional habitats, they were attracted by clearing of forests, grazing, introduction of grain crops and farming practices during European settlement. Lightening strikes and human-set fires benefited doves as well by stimulating growth of seed producing plants and creating bare-soil areas where they could easily glean seed. In the past decade, dove populations across the Southeast have declined primarily due to reforestation of open fields and croplands. Conversion of open, early successional habitat to dense forest cover has created undesirable conditions through reduction in both agricultural and native food plants and degradation of foraging conditions for mourning doves.

About 99 percent of a mourning dove's diet consists of seed of native plants and cultivated crops. Native food plants include ragweed, dove weed, croton, pokeweed, pigweed, sunflowers, smartweeds, panic, bull and other grasses, wild mustards and pine. Agricultural crops, particularly cereal grains, are sought by doves wherever available and include sorghum, corn, millet, rye, sunflower, wheat, soybean and peanut. Doves feed on the ground by picking seed directly from bare soil surfaces. They have weak scratching abilities and require seed exposure on bare-soil surfaces for maximum availability. Therefore, areas with thick ground litter or dense stands of herbaceous vegetation without bare-soil surfaces are of marginal use to doves for foraging. Thus, native grasslands that support a mixture of native grasses, forbs and legumes and are managed with disking or burning to keep strips or blocks with bare-soil surfaces beneath herbaceous cover produce good foraging conditions for mourning doves. Good foraging conditions generally exist during the first to second year following prescribed fire or disking. Nesting and feeding doves are attracted to recently burned areas. Areas burned during fall through winter months will often attract feeding doves immediately due to seed availability on bare-soil surfaces. Dove use of restored grasslands can be enhanced if cereal grain crops are located nearby, fire lanes plantings include winter wheat, sunflower and oat and open water sources are available. Studies have shown that ideal habitat conditions for doves are on landscapes that are comprised of about 70 percent agricultural grain crops, old fields, native grasslands and pastureland, 25 percent to 28 percent in forests of hardwoods or pine that are at least 20 years of age and about 2 percent to 5 percent in ponds or wetlands with sloping shorelines. Retention of dead trees or snags is recommended for loafing and roosting sites. Additional roosting, loafing and nesting cover types are created by interspersed forested strips or blocks in or adjacent to openings. Thus, restoration of woodland savannas and retention of trees and shrubs along roadsides, wetlands and watersheds along with native grassland management that includes prescribed burning can create attractive habitat conditions for mourning doves.

Non-game Grassland Birds

Like bobwhite quail, non-game grassland birds require perennial bunch-grasses intermixed with native forbs and legumes with bare-soil surfaces at ground level. This habitat structure provides good escape, nesting and foraging cover for many grassland species, including Eastern meadowlarks, dickcissels, bobolinks, indigo buntings, loggerhead shrikes and native sparrows, such as Henslow's and grasshopper sparrows. Grassland sites that are burned at 2- to 3-year intervals following establishment generally provide good habitat for these bird species due to the abundance of herbaceous plants and the habitat structure conditions. Open structure of bunch-grasses is desired due to the tendency of native sparrows and meadowlarks to run on the ground surface or move among bunch-grass patches. Many species actually build their nest on the ground or in bunch-grasses. A mixture of flowering legumes and forbs within native bunch-grasses is desirable because many of these plants attract insects and spiders and produce palatable seeds consumed by grassland birds. Foods eaten vary among species; however, most sparrows feed on seed of native

grasses, sunflowers and other forbs. Fruit of blackberry and other species of shrub and vine may also be eaten seasonally. During breeding and brood rearing periods, most grassland birds eat insects and other invertebrates to attain needed protein in their diets. Large blocks of native grasslands and woodland savannas (100 acres or more) may be required for many bird species to nest successfully (Table 9). However, smaller acreages of well-managed, native grasslands may provide an abundance of foods and ample resting and refueling habitats during migration.

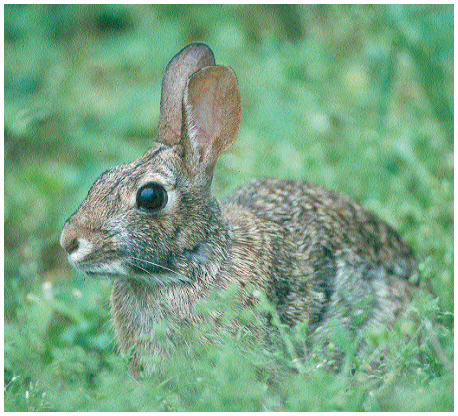
Non-game Shrub-woodland Birds

Grassland-shrub birds require a combination of openings and shrub-vine thickets for nesting and feeding and include field sparrows, orchard oriole, blue grosbeaks, common yellowthroats, yellow-breasted chats, Eastern towhees and grey catbirds. These birds generally nest in and forage in young trees, in vine and shrub thickets that occupy the midstory of forests and in forest edges. Therefore they can be attracted by retention of native shrub, vine and tree thickets within grasslands and along wetland edges, drainages, streams and woodlands. Grassland-woodland birds require similar habitats as grassland-shrub birds. Many woodland birds nest in trees or tree cavities. Open woodlands with herbaceous groundcover and interspersed thickets of vines and shrubs will attract Eastern bluebirds, Bachman's sparrows, common towhees, Northern shrikes, red-headed woodpeckers, cardinals and red-eyed vireos; screech, barred, and barn owls; and American kestrel, red-tailed, red-shouldered, Cooper's and sharp-shinned hawks.

Rabbits

SYLVILAGUS SPP.

Eastern cottontails *(S. floridanus)* and swamp rabbits *(S. aquaticus)* inhabit Mississippi's Black Belt and Jackson prairies. Classified as small-game mammals, both species prefer lands with an interspersion of openings, shrublands and forest edges. Generally, cottontail rabbits are common to brushy grasslands of uplands, whereas swamp rabbits are more common to bottomland forests, wetland edges and cane thicket. Both species require a mixture of openings for nesting and feeding and thickets for escape cover. Thus, native grasslands that are managed to create a mosaic of openings with at least



Eastern cottontail rabbit.

10 percent brushy cover can support up to one rabbit per acre. Rabbits may range over 10 acres during their annual life cycle; however, if abundant food plants and cover are available, rabbits may spend much of their lives on 1 to 3 acres.

Rabbits eat a variety of grasses, legumes, forbs and woody plants. They will even consume grain, such as corn, if available. Woody plants frequently consumed include blackberry, greenbrier and bark of sumac and tree saplings. Herbaceous food plants include lespedezas, partridge pea, clovers, vetches, panic and bull grasses, sedges and rushes. Planting of fire lanes with cool-season clovers and vetches provide excellent winter and spring food sources for rabbits. Feeding areas should be located in close proximity to escape cover (100 feet or less). Tall bunch-grasses, forbs (giant goldenrod) and perennial lespedezas that have not been mowed or burned in 2 years or more can provide good escape cover; whereas, grassy openings that are burned or mowed at 2-year intervals produce ideal nesting cover for rabbits. For ideal escape cover, brushy wetland edges, watersheds and streamside areas or clusters of thickets should be retained in native shrubs or trees. Plowing firebreaks around thickets and brushy areas prior to burning can retain escape cover for rabbits as well as bobwhite quail and shrub nesting birds. Woody plants that create good cover include greenbrier, blackberry, rattan vine, beauty berry, Chickasaw plum and winged and smooth sumac. For best conditions, cover strips and thickets should be at least 20 feet in width and interspersed among grassland habitat. Blackberry thickets that are allowed to reach 5 to 6 feet in height and at least 20 feet in diameter provide excellent escape cover. Studies have shown that construction of brush piles are an excellent way of enhancing rabbit habitat. Brush piles can be constructed by piling logs, tree tops and brush in piles of at least 12 to 15 feet in width and 5 to 6 feet in height. Bobwhite quail and other birds will often use brush piles and use of these piles by fruit-eating birds will result in deposition of seed of various fruiting plants by birds. Thus, landowners can expect to find blackberry, greenbrier, wild plum, cherry, poke salad, elderberry and sumac growing within brush piles, yielding thickets over time.

White-tailed Deer

ODOCOILEUS VIRGINIANUS

Although white-tailed deer populations were very low during the early 1900s due to overexploitation, today deer are common and abundant in most of the Black Belt region. Studies from

White-tailed deer.

Alabama indicate that high soil fertility and productivity of Alabama's Black Belt produces an abundance of native and agricultural food plants that promote heavy body weights in mature deer and higher numbers of fawns produced per doe. Because deer are forest-edge species, today's restored grasslands will generally attract deer where openings are interspersed with forest and thicket edges. This type of interspersion can also attract cottontail and swamp rabbits and selected species of birds.

White-tailed deer eat a variety of plant foods, including fruits, stems, buds, and leaves of shrubs, trees and vines and hard mast, such as acorns, hickory, pecan and beech. Deer also eat many of the legumes and forbs that are common to native grasslands. Prescribed fire stimulates germination of herbaceous food plants and resprouting of woody browse plants. In particular, dormant-season burns that top kill woody plants usually promote resprouting of succulent, nutritious forage during the following growing season. For example, newly burned patches of blackberry and dewberry create highly palatable browse for deer during the first year of growth following burning. Shrubs that produce preferred soft mast for deer include beauty berry, blueberry, huckleberry, hawthorn and serviceberry. Native vines that produce fruit and browse include blackberry, dewberry, rattan vine, greenbrier and wild grape.

Because deer prefer a diversity of habitat types across the landscape, interspersion of woodland savannas, floodplain hardwoods, thickets and bushy ecotones can enhance use of grasslands by deer. Blackberry thickets within grassland openings, thicket cover along drainages and wetlands and SMZs with mature mast-producing hardwoods, such as oaks, hickory and beech, will also benefit deer. Planting mixtures recommended for fire lanes that include annual clovers, wheat and oats will provide good winter and early spring food sources. Deer will also be attracted to grain, peanut and bean crops that are in close proximity to restored grasslands.

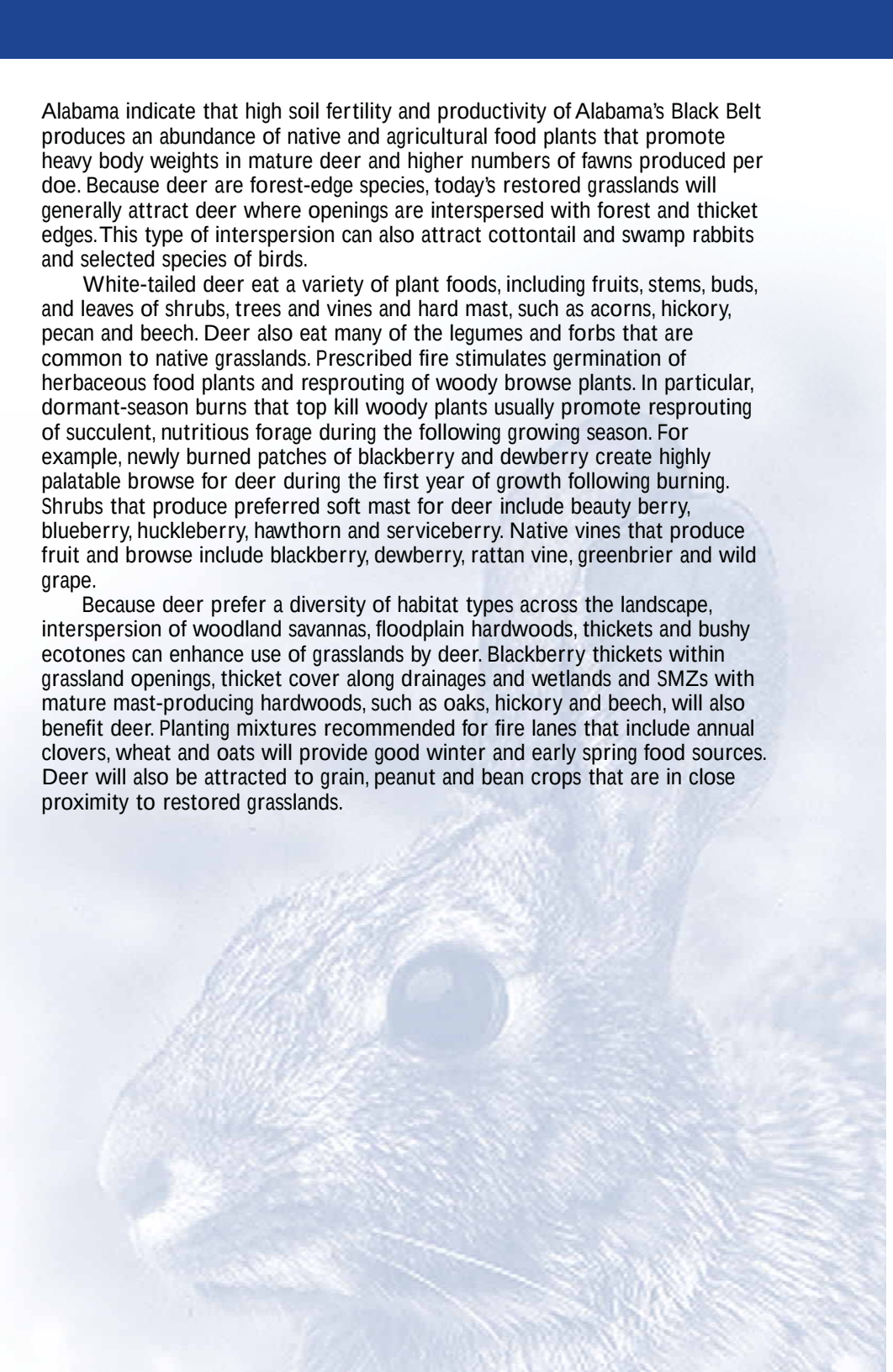


Table 9. Habitat Management for Featured Wildlife in Mississippi's Grasslands.

FEATURED ANIMAL SPECIES	% OF LAND IN GRASSLANDS	SIZE AND ARRANGEMENT OF GRASSLAND	% OF LAND IN COOL-SEASON LEGUMES/ ANNUAL GRAINS	% OF LAND IN MAST-PRODUCING HARDWOODS	% OF LAND IN THICKET COVER (VINES, SHRUBS, YOUNG TREES)
Northern Bobwhite	20% to 80%	Blocks of 2 acres or greater or strips greater than 50 feet in width	2% in firebreaks	5% to 25%	20% to 50%
Mourning Dove	30% to 80%	Blocks of 1 to 5 acres or strips of 50 feet or more in width	> 5% in firebreaks, especially annual wheat and oats	< 20%	20% to 50%
Eastern Wild Turkey	10% to 30%	Blocks of 2 acres or greater	2 to 5% in firebreaks or fields	40% to 75%	10% to 30%
Cottontail Rabbit	10% to 80%	Blocks of 1 to 5 acres or in strips of 50 feet or more in width	2% in firebreaks, especially annual clovers and vetch	10% to 40%	20% to 50%
White-tailed Deer	5% to 30%	Blocks of 2 acres or more	2 to 5% in firebreaks or fields, annual clovers	40% to 70%	20% to 40%
Grassland-shrub Birds	30% to 70%	Blocks of 5 acres or more or strips of 50 or more feet in width	In firebreaks only	0	30% to 70%
Grassland Birds	70% to 100%	Blocks or fields of 100 acres or more	In firebreaks only	0	20%
Grassland-woodland Birds	30% to 70%	Blocks of 2 acres interspersed blocks of woodland savanna	In firebreaks only	30 to 60%	20% to 30%
Butterflies	20% to 80%	Blocks of 1 acre or more or strips of 30 to100 feet in width preferred	2% in firebreaks, annual clovers and vetch	0	< 20%

Adapted from Harper, C. A., G. E. Bates, M. J. Gudlin, and M. P. Hansbrough. 2004. *A Landowner's Guide to Native Warm-Season Grasses in the Mid-South.* University of Tennessee, Extension Service. PB 1746: 25 pp.

Table 10. Primary Food and Cover Plants of Native Birds in Native Grassland and Woodland Savanna Habitats of Mississippi's Blackland Prairies.

FEATURED BIRDS	PRIMARY FOOD PLANTS OR FOOD ITEMS	COVER
Northern Bobwhite	Seed of beggarweed, partridge pea, trailing wild bean and milk pea, native and annual lespedezas, vetch, panic grasses, bull grasses, sunflowers, smartweeds and common ragweed. Hard mast of ash, oak, pine and sweetgum. Insects consumed during breeding and brood-rearing periods.	**Nesting cover:** native warm-season bunch-grasses and forbs with some woody cover. **Brood cover**: bunch-grasses, native legumes and forbs with at least 50% bare soil at ground level. **Escape cover:** thickets of blackberry, wild plum, rattan vine, Carolina buckthorn, osage orange, young pine or hardwood trees (<1 to 5 years of age).
Mourning Dove	Seeds of woolly croton, common ragweed, panic and bull grasses, poke salad, wild sunflowers, millets and native lespedezas.	**Nesting cover:** osage orange, ash, post and blackjack oak, standing dead snags. 2% of land in open water will attract doves.
Eastern Wild Turkey	Seed of native legumes, panic grasses, bull grasses; foliage of clovers, vetch, young grasses and other forbs. Hard mast of hickory, oaks, and pine. Soft mast of blackberry, rattan vine, black cherry, plum, service berry,	**Nesting cover:** native warm-season bunch-grasses 2 to 3 years following burning with downed logs or stumps near woodland or thicket edges. **Brood cover:** abundant herbaceous plants and

continued

FEATURED BIRDS	PRIMARY FOOD PLANTS OR FOOD ITEMS	COVER
	sugarberry and greenbrier. Insects, snails and spiders eaten by hens and poults during breeding and brood-rearing periods.	insects in openings or in open forest conditions, or mature hardwoods with abundant leaf litter and invertebrates. **Roosting cover:** large pines or hardwoods; bald cypress in wetlands.
Grassland Sparrows, Dickcissels	Seed of panic and bull grasses, bluestems, sunflowers and other native forbs. Insects and other invertebrates utilized heavily during nesting season.	Warm-season bunch-grasses, native forbs and legumes.
Shrubland Birds (ie., Field Sparrow, Orchard Oriole, Blue Grosbeak, Indigo Bunting, Common Yellowthroat, Yellow-Breasted Chat, Catbird, Prairie Warbler)	Many depend heavily on insects and invertebrates especially during breeding and brood rearing. Fruit of sumac, poison ivy, buckthorn, rattan vine, service berry, blueberry, blackberry, dewberry, greenbrier, wild cherry, hawthorn, elderberry, poke salad, elderberry, dogwood and devil's walking stick.	Warm-season bunch-grasses with interspersed woody thickets young trees, shrubs and woody vines.

Table continued on page 68

FEATURED BIRDS	PRIMARY FOOD PLANTS OR FOOD ITEMS	COVER
Woodland Savanna Birds (ie., Eastern Bluebird, Bachman's Sparrow, Common Towhee, Carolina Wren, Cardinal, Tufted Titmouse, Red-headed Woodpecker, Sapsucker)	Woodpeckers and some songbirds feed on invertebrates throughout much of the year. Fruit of sumac, poison ivy, persimmon, beauty berry, dogwood, buckthorn, rattan vine, service berry, blueberry, blackberry, dewberry, greenbrier, wild cherry, hawthorn, elderberry, poke salad, sugarberry and devil's walking stick. Seed of ash, oaks, sweetgum, hophornbeam and pine.	Open woodlands with interspersed thickets of fruit-producing vines and shrubs. Cavity trees and standing snags for nesting and foraging woodpeckers and cavity-nesting species, such as chickadees, wrens and titmice.

FEATURED MAMMALS	PRIMARY FOOD PLANTS	COVER
White-tailed Deer	Stems, leaves and fruit of blackberry, dewberry, rattan vine, greenbrier, blueberry, hawthorn, strawberry bush, serviceberry, buckthorn, persimmon, beauty berry; acorns, hickory nuts, beech mast. Annual clovers, vetch, native legumes and selected native forbs. Crops, including soybeans, peas, corn, wheat, oats, sorghum, chufa, peanuts and milo.	**Winter day beds:** tall bunch-grasses. **Escape cover:** thickets of woody vines, such as blackberry and rattan vine, switchcane, shrubs and stands of young trees.

continued

FEATURED MAMMALS	PRIMARY FOOD PLANTS	COVER
Cottontail and Swamp Rabbit	Stems and leaves of greenbrier, panic grasses, sedges, bull grasses, native legumes and forbs. Annual clovers, oats, wheat and vetches. Bark of sumac and small trees may be eaten during winter months. Grain and foliage of crops (i.e., soybeans, wheat, oats, milo, sorghum and corn).	**Nesting cover:** bunch-grasses and forbs along woodland and shrubby edges. **Escape cover:** switchcane, plum and blackberry thickets, young age class tree stands with interspersed shrub and thicket cover.
Fox and Gray Squirrel	Fruit of black cherry, plum, dogwood, hawthorn, persimmon, sugarberry, greenbrier, service berry, rattan vine, magnolia and black and tupelo gums. Hard mast of pine, ash, hophornbeam, hornbeam, oaks, hickory, beech and bald cypress.	**Cavity trees:** beech, bald cypress, oaks, black and sweet gum, sycamore and hickory.

Financial Assistance for Enhancement, Restoration and Protection of Native Prairies

Conservation Easements

A conservation easement is a legal agreement that ensures a property will be managed in perpetuity according to the landowner's desires. It may also qualify the landowner for tax benefits.

Conservation easements are one of the most landowner-friendly conservation tools available for those wishing to preserve a particular conservation ethic on a specific piece of land. Easements enable a landowner to protect natural habitats on their property while at the same time taking advantage of potentially substantial federal tax benefits.

Mississippi is one of several states that has adopted a Uniform Conservation Easement Act. Under the act, a landowner can place restrictions on the present and future uses of their property with the intent of preserving conservation practices.

Furthermore, the federal government, specifically the Internal Revenue Service, recognizes the conveyance of a real property interest to a qualified conservation organization to accomplish a specific purpose has public benefits and as such could qualify the owner for a substantial tax deduction.

The simplest way to understand the concept involved in conservation easements is to look at the basic rights that come with land ownership. When a conservation easement is placed on a property, the owner may give up certain rights (e.g., the right to subdivide the property, develop the property, etc.). Restrictions on the property are specified in the easement document. The conveyance of the property must be made in perpetuity in order to receive federal tax benefits. The easement document itself is a legal instrument signed and recorded in the county of record. Since the conservation easement continues on the land forever, the restrictions remain on the property even after the landowner dies or sells the property.

Three important aspects of a conservation easement must conform to the Uniform Conservation Easement Act. First, the easement must meet a definite conservation purpose. Secondly, in order to qualify as a conservation easement under the Uniform Act, the easement must be granted to or held by a "qualified conservation organization," such as the Mississippi Land Trust (www.misslandtrust.org) or the Mississippi River Trust (www.mississippirivertrust.org).

It is important to note that the conservation organization which holds the easement does not actually acquire the rights donated by the conservation easement. Instead the easement gives the conservation organization the right and responsibility to monitor and enforce the restrictions placed on the property and to ensure adherence to the easement document in perpetuity. Therefore, it is essential that the landowner clearly define and communicate, through the easement document, the rights he or she is giving up. It should be understood that the easement does not give the conservation organization or easement holder the ability to exercise any rights that the landowner has specifically chosen to restrict. Conservation easements do not allow public access to the property unless it is specifically provided for in the easement document.

A third essential aspect of the conservation easement process called for in the Uniform Act is the development of a baseline ecological assessment. This assessment is usually conducted by resource professionals experienced in ecological progression and associated plant, animal and physiographic details. It is an "ecological snapshot" of the property at the time of the conveyance. The baseline ecological assessment establishes and records the condition of the property as well as the land uses that exist when the conservation easement is established. The baseline document is then used in monitoring by the conservation organization which serves as the easement holder of the property.

Except for the restrictions described by the easement, the property owner retains all other rights that were conveyed when the property was purchased. Hunting, fishing, wildlife viewing and timber management can still be conducted. Conservation easements do not allow public access to the property.

As in any conservation program, it is best to seek the advice of fish and wildlife and tax professionals with experience in the development of conservation easements.

For more information on conservation easements, contact the Mississippi Land Trust at (662) 256-4486 or visit their web site at www.misslandtrust.org.

Conservation Reserve Program

The Conservation Reserve Program (CRP) has been hailed as one of the most successful conservation programs in the United States. It has been largely responsible for the increase in grasslands across the nation.

The CRP protects highly erodible and environmentally sensitive lands with grass, trees and other cover. It allows up to 39.2 million acres to be enrolled at any one time. New enrollments can replace expired or terminated contracts. Lands with high environmental values, including filer strips, prairies, waterways, windbreaks, riparian areas, wetlands and lands planted to hardwoods and longleaf pine are given priority.

For more information on the CRP contact your local USDA Service Center or Wildlife Mississippi at (662) 256-4486 or www.wildifemiss.org.

Continuous Conservation Reserve Program, Habitat Buffers for Upland Birds

One of the more recent conservation incentive practices within the CRP is the Continuous Conservation Reserve Program Practice CP-33 (Habitat Buffers for Upland Birds). Administered by the Farm Service Agency (FSA), the primary purpose of this program is to provide essential wildlife habitat components including food, nesting cover and escape cover for bobwhite quail and other upland birds in cropland areas. In Mississippi, bobwhite quail have experienced a dramatic population decline during the last 50 years. The loss of suitable habitat is one of the reasons for this decline.

The CP-33 practice is designed to create suitable habitat by creating buffers around cropland areas. These buffers will not only provide critical habitat for bobwhite quail but will also serve as transition zones and travel corridors between cropland and other types of habitat. This linking of fragmented habitats with buffers will greatly increase the use of an area by bobwhite quail and other wildlife. In addition to providing wildlife habitat, buffers will also reduce erosion, protect water quality by trapping sediment, chemicals and other pollutants and serve as buffers from sensitive areas when applying pesticides or fertilizers.

To qualify, the cropland area must have been planted or considered planted to an agricultural crop during 4 of the last 6 crop years. Also, the area must be physically and legally capable of being planted in a normal manner to an agricultural crop. With this program, only field borders will be considered. Whole fields are not eligible. However, the landowner is not required to crop the interior portion of the field not included in the buffer.

Landowners that are approved for the program will receive an annual rental payment that is determined by the weighted average soil rental rate per acre of the three predominant soils on the eligible acres. Landowners will also receive a maintenance rate of $5 per acre per year as an incentive to perform maintenance practices as well as a signing incentive payment that is a one-time incentive payment of $10 for each acre enrolled. Lastly, approved landowners will receive a practice incentive payment that is a one-time payment of up to 40 percent of the eligible establishment cost to participants. This is made after cover is established and cost-share payment is made. Up to 50 percent of the establishment costs are eligible for cost-share assistance under this program.

Therefore, a total of 90 percent cost-share is provided.

Habitat buffers will be established to a mixture of native grasses, legumes and/or forbs and have a minimum average width of 30 feet with a maximum average width of 120 feet. Generally, the wider the habitat buffer, the greater the number of species that will utilize it. Wider widths have also been shown to decrease the destruction of nests by predators and by locating the buffers around the entire field; the environmental benefits are also greatly increased. Noxious weeds and other undesirable plants, insects and pests will need to be controlled. Grazing of buffers by domestic livestock (including haying) is prohibited. The buffers can not be used as turn rows, roads or for storage of crops or equipment.

Management of buffers is required on a 3-year rotation by light disking, prescribed burning and/or spot spraying to set back vegetative succession starting in the fall/winter following the second growing season. However, management activities will not be allowed during the primary nesting period of April 1 through August 15.

For more information on CP-33 or other CRP practices contact your local USDA Service Center or Wildlife Mississippi at (662) 256-4486 or www.wildifemiss.org.

Estate Tax Exemptions For Conservation

It is no secret that the conservation of lands in the Magnolia State plays an important role for Mississippi as well as our nation. And more importantly, for our children and grandchildren.

Conservation easements are the newest of tools available for private property owners to preserve property for a specific conservation purpose. Easements enable a property owner to protect habitats on their property while, at the same time, take advantage of substantial tax benefits.

To fully understand conservation easements, one needs to consider the rights that come with owning property. When one places a conservation easement on a piece of property, the owner may give up some rights (e.g., the right to develop the property, etc.) In other words, the property owner gives up only those rights which allow him or her to achieve the intended conservation purposes of the easement; all other rights of ownership remain unchanged. Restrictions on the use of the property are detailed in the easement, which is perpetual in length. The easement is a legal instrument that is recorded in a particular county.

On August 5, 1997, President Clinton signed into law a modified version of The American Farm and Ranch Protection Act, which provided an exclusion from the federal estate tax for property subject to a permanent conservation easement.

Section 508 of the Taxpayer Relief Act offers tax incentives to people who retire property and place a conservation easement on it rather than try to develop it. The provision was inserted in the reconciliation bill by the late U.S.

Senator John Chafee of Rhode Island, and allows a 40 percent estate tax exemption for land committed to conservation. It sets a $500,000 cap on tax benefits.

The measure applies only to land within 25 miles of a federally designated metropolitan statistical area as defined by the Office of Management and Budget (i.e., Biloxi, Gulfport, Hattiesburg, Jackson, Memphis, Tennessee, including parts of DeSoto County and Pascagoula), national parks (i.e., Gulf Islands National Seashore, Natchez Trace Parkway, Tupelo National Battlefield or Vicksburg National Cemetery), wilderness areas or within 10 miles of an urban forest as defined by the USDA Forest Service (e.g., Gulfport, Jackson, Meridian, etc.).

The property must be owned by the descendent or a member of the descendant's family at all times during the 3-year period ending on the descendant's death. The property can be owned by a partnership, corporation or trust if at least 30 percent of the entity is owned (directly or indirectly) by the descendent. If there is a lienholder on the property, the lienholder must agree to the easement. Taxes are still paid on the property by the property owner.

Except for the restrictions described by the easement, the property owner retains all other rights which were conveyed when the property was purchased. Hunting, fishing, wildlife viewing and timber management can still be conducted.

However, this Act prohibits use of the property where more than a minimum use of the property for a commercial recreational activity is allowed. When the owner of such property is not the owner of the surface estate and mineral interests, the tax benefits associated with the conservation easement shall occur if the probability of such surface mining occurring on such property is so remote as to be negligible.

When one places a conservation easement on a piece of property, the owner can be assured that the property will remain in a natural state forever. The property owner is rewarded by the fact that the easement will promote his or her conservation ethic while receiving immediate tax benefits.

Conservation easements are increasingly recognized as a desirable tool for property owners interested in protecting their property. Through the efforts of private property owners we can be assured that Mississippi's cherished natural resources will be passed on to our children and grandchildren.

As in any conservation program, it is best to seek the advice of fish and wildlife and tax professionals with experience in the development of conservation easements.

The Act is the federal government's first tax incentive for voluntary land conservation in 20 years.

Grassland Reserve Program

When the Grassland Reserve Act was introduced in the U.S. House of Representatives, of the sixteen original co-sponsors, four of them were Congressmen from Mississippi. The Grassland Reserve Program (GRP) provides technical expertise and financial assistance to landowners and groups interested in restoring the native prairies of the state. Grasslands are important both for the forage they provide for farming operations and for the wildlife habitat they provide.

The program authorizes the U.S. Department of Agriculture to purchase either permanent or 30-year easements from landowners in exchange for a cash payment. The program also authorizes the restoration of native grasslands which is particularly important in the Black Prairie of Northeast Mississippi (1,349,120 acres) and the Jackson Prairie in East-Central Mississippi (611,200 acres). These grasslands once supported vast populations of bobwhite quail, wild turkey and many species of songbirds.

The program permits unrestricted grazing on the easement property. Haying is permitted after the nesting season for birds in the local area. Prohibitions are intended to prevent cultivation of the soil for row crops or otherwise breaking the soil for production of agricultural commodities.

The Grassland Reserve Act authorizes qualified conservation and land trust organizations (i.e., Mississippi River Trust, Mississippi Land Trust, etc.) and state agencies to hold and enforce easements. The Department of Agriculture's obligations under the program are limited to executing easement documents, restoring grasslands when desired and to hold easements if so desired by participating landowners. Additionally, the U.S. Department of Agriculture is required to conduct periodic inspections of the easement properties. Landowners who violate easement terms may be required to repay the funds they receive under the program, plus interest.

For more information on the GRP, contact your local USDA Service Center or you can contact Wildlife Mississippi at (662) 256-4486 or www.wildlifemiss.org.

Partners For Fish and Wildlife

Congress passed the Fish and Wildlife Act of 1956, which gave the U.S. Fish and Wildlife Service (USFWS) broad statutory authority to enter into voluntary agreements with non-federal government entities, including private landowners, to restore and enhance habitat for federal trust fish and wildlife resources. In 1987, the USFWS began a voluntary partnership program with landowners interested in restoring wetlands and other important fish and wildlife habitats on their lands. The Partners for Fish and Wildlife Program (Partners Program) provides financial and technical assistance to private landowners through voluntary cooperative agreements.

The restoration of degraded wetlands, native grasslands, streams, riparian areas and other habitat, to conditions as close to natural, is emphasized. The program's philosophy is to work proactively with private landowners for the mutual benefit of declining federal trust species and the interests of the landowners involved.

Usually, a dollar-for-dollar cost-share is achieved by working with

landowners and a host of nationally based and local entities (e.g., federal, state and local agencies, soil and water conservation districts and private conservation organizations). Landowners sign an agreement to restore the habitat for the life of the agreement (at least 10 years) and otherwise retain full control of the land.

The Partners Program has had many accomplishments since it was started in 1987. From 1987 to 2006, the program worked with private landowners to restore 800,000 acres of wetlands; 2,000,000 acres of prairie, native grassland and other uplands; and 6,500 miles of riparian and in-stream habitat. This involved over 41,000 landowner agreements. Mississippi has been a leader in this program, with over 30 percent of the Southeast acreage being in the state.

Activities of the Partners for Fish and Wildlife program typically include, but are not limited to:

(1) Upland Wildlife Habitat: planting field borders and filter strips to grass/legume mixtures; establishing openings; planting, fertilizing and seed bed preparation for food, cover and nesting; establishing native prairie and grassland; brush management and rangeland seeding; fencing for habitat protection; prescribed burning, strip disking and mowing; flushing bars; restoration of wildlife habitat and corridors; and forest stand improvement to include site preparation, tree planting, direct seeding, firebreaks, release and site preparation for natural regeneration.

(2) Wetland Wildlife Habitat: installation of water control structures in agricultural fields, moist-soil areas and forested wetlands to provide beneficial habitat for wetland wildlife; installation of nesting structures; restoration of hydrology; restoration of wildlife habitat and corridors; fencing for habitat protection; forest-stand improvement to include site preparation, tree planting, direct seeding, firebreaks, release and site preparation for natural regeneration; strip disking and mowing; establishing openings; fertilizing, seed bed preparation and planting for food, cover and nesting.

(3) Threatened and Endangered Species Habitat: removal of barriers for aquatic species; establishment, management, maintenance, enhancement and restoration of grassed waterways and riparian areas; fencing for habitat protection; stream bank stabilization; installation of instream deflectors; restoration of threatened and endangered species habitat and corridors; placement of fish screens; control or eradication of invasive exotic or competing species of animals and plants; and forest-stand improvement to include site preparation, tree planting, direct seeding, firebreaks, prescribed burning, release and site preparation for natural regeneration.

(4) Fisheries Habitat: restoration of rivers and streams; development and placement of fish structure and gravel spawning beds; removal of fish barriers; placement of fish screens; establishment, management, maintenance, enhancement and restoration of grassed waterways and riparian areas; stream bank stabilization; installation of low water weirs and in stream deflectors; fencing for habitat protection; and augmentation of flows.

(5) Other activities approved by the USFWS.

To learn more about Partners For Fish and Wildlife Program, contact your local office of the USFWS or Wildlife Mississippi at (662) 256-4486 or www.wildifemiss.org.

Soil and Water Tax Credit

For many of Mississippi's farmers, good stewardship of the land is very important. By applying sound conservation practices, farmers help control and prevent erosion and increase soil fertility which corresponds to better wildlife habitat, cleaner rivers and streams and more productive farmland. To assist with the cost of practices aimed at improving soil and water quality on agricultural lands, The Internal Revenue Service (IRS) allows for the deduction of certain expenses for soil and water conservation or for the prevention of erosion on lands used for farming. However, the IRS does not allow for the deduction of ordinary and necessary expenses such as interest and taxes, cost of periodically clearing brush from productive land, annual removal of sediment from drainage ditches and any other expenses paid or incurred to produce an agricultural crop.

According to the IRS, a person is considered to be farming if that person cultivates, operates or manages a farm for profit, either as owner or tenant. A person is not considered to be farming if he or she farms for recreation or pleasure and not for profit. Also, forestry and/or the growing of trees are not considered farming by the IRS.

A farm is defined by the IRS as including stock, dairy, poultry, fish, fruit and truck farms. Plantations, ranches, ranges and orchards are also included. Also, according to the IRS, a plant nursery is considered to be a farm for the purposes of deducting soil and water conservation expenses.

The IRS allows for the deduction of soil and water conservation practices only if they are consistent with a plan approved by the Natural Resources Conservation Service (NRCS). If the farmer does not have a conservation plan from the NRCS, then a plan from a comparable state agency can be used. A conservation plan is defined as a plan that includes those farming conservation practices that have been approved for the farmer's area. The NRCS can develop both individual site plans and county plans. Individual site plans include conservation practices that are recommended for a particular individuals farmland. County plans are developed for a specific county and the farmland found within its boundaries and includes those conservation practices recommend for that area. Both can be obtained by contacting your local NRCS Office (www.nrcs.usda.gov).

Expenses that are incurred by a farmer for soil and water conservation are deductible only for lands owned by the farmer or the tenant that is using the land for farming. The expenses that qualify for deduction include:

Treatment or movement of earth:

- Leveling,

- Conditioning,
- Grading,
- Terracing,
- Contour furrowing, and
- Restoration of soil fertility.

Construction, control and protection of:

- Diversion channels,
- Drainage ditches,
- Irrigation ditches,
- Earthen dams, and
- Watercourses, outlets and ponds.

A person **cannot** deduct expenses for soil and water conservation for draining or filling in a wetland, or to prepare land for center pivot irrigation systems.

In some cases, landowners are levied an assessment for soil and water conservation practices conducted by the area soil and water or drainage district. These expenses are also deducible as a conservation expense if they cover expenses you could deduct if you had paid them directly or covers expenses for depreciable property used in the district's business. Types of depreciable property include pumps, locks, concrete structures (including dams and weir gates), draglines and similar equipment.

For more detailed information on soil and water conservation tax tips, go to the IRS website at www.irs.gov and review publication number 225 (Farmer's Tax Guide).

Wildlife Habitat Incentives Program

The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for private landowners who are interested in creating high-quality wildlife habitat on their property. Through WHIP, private landowners are provided technical and financial assistance by the Natural Resources Conservation Service (NRCS) to develop upland, wetland, riparian and aquatic habitat on their property.

This program is different than most incentive programs because it indicates an underlying shift from only providing incentives for land retirement to placing an emphasis on land management practices. It provides cost-share payments, not rental or easement payments, to landowners.

The WHIP had its inception in the 1996 Farm Bill as the brainchild of Senator Thad Cochran. The initial participation in the WHIP greatly exceeded the funds available for the program. Mississippi ranks second in the nation in WHIP enrollment.

To participate in WHIP, private landowners may go by their local USDA Service Center or conservation district office and fill out a WHIP application at any time. Under the WHIP, applications are ranked and point values are assigned to the land that is submitted for financial assistance. Priority is given to those lands that: (1) provide habitat for fish and species of wildlife experiencing declining or significantly reduced populations; (2) practices that are beneficial to fish and wildlife that may not otherwise be funded; and/or (3) fish and wildlife habitats identified by the local working group as priority areas. Applications with the most points will be funded. Once accepted into the program, the landowner and the NRCS will enter into an agreement to implement the fish and/or wildlife management practices desired by the landowner and NRCS.

Landowners participating in this program must own or control land and agree to implement a management plan which contains certain conservation practices to be installed on the property. The plan describes the landowner's goals for conservation, including the conservation practices necessary to achieve such goals. The NRCS agrees to provide the necessary technical assistance in conducting the recommended conservation practices and pay up to 75 percent of the cost of installing the practices. Some of the conservation practices under the WHIP available to private landowners include prescribed burning, firebreaks, quality vegetative management in pine stands, tree and shrub plantings and quality vegetative management in old fields. These practices will help provide cover for wildlife, including the planting of trees, as well as nesting and brood rearing habitat for species like wild turkey and bobwhite quail. Aquatic habitats and water quality can be improved by establishing habitat adjacent to streams. Wildlife habitat can also be improved through these programs by creating small openings in forest stands.

For more information on the WHIP, contact your local USDA Service Center or Wildlife Mississippi at (662) 256-4486 or www.wildlifemiss.org.

About Wildlife Mississippi

Who Are We?

In 1997 Mississippians had the vision and dedication to create Wildlife Mississippi. Wildlife Mississippi is a low-overhead, no frills organization which was founded to conserve, restore and enhance our fisheries and wildlife resources for the enjoyment and enrichment of all residents of Mississippi, their progeny and visitors to our state.

Wildlife Mississippi has an effective conservation philosophy. It is based on three basic principles: 1) a strong economy provides incentives, 2) encourage conservation stewardship while recognizing private property rights and 3) polluters should be liable for harm they cause others. Now is the time to establish conservation philosophy that contains effective and cost-efficient programs to improve Mississippi's fish and wildlife resources for years to come.

Wildlife Mississippi's success will not be measured by number of members, nor size of staff, nor budget, nor an impressive office building which will never be built. Mississippi's wealth of leadership and overwhelming support and participation of sportsmen, industry, business, farmers, landowners and wildlife enthusiasts will ensure that Wildlife Mississippi will succeed. All funds raised by Wildlife Mississippi will stay at home, in Mississippi. Wildlife Mississippi has already become a model for America. The future of Wildlife Mississippi is unlimited.

Conservation Initiatives

To support its focused conservation goals, Wildlife Mississippi is concentrating its staff and fiscal resources on four major initiatives.

• Conservation Education: Wildlife Mississippi educated citizens about conserving natural resources. Each year throughout the state, Wildlife Mississippi conducts countless presentations, classes and programs as well as annual seminars and workshops. We publish landowner guides, widely-read newspaper columns, educational brochures and technical handbooks.

• Fish and Wildlife Habitat: Wildlife Mississippi has restored thousands of acres of hardwood and longleaf pine forests and native prairie, all beneficial for wild turkey, white-tail deer, bobwhite quail and many other species of wildlife. We've protected, restored and enhanced fisheries habitat in lakes, ponds, rivers and streams, plus the nesting, migration and wintering habitats of waterfowl. Wildlife Mississippi believes in protecting Mississippi's rare and declining species of fish, wildlife and plants before they are declared threatened or endangered and work to recover species already declared.

• Outdoor Recreation and Parks: Wildlife Mississippi believes safe, family-oriented outdoor recreational opportunities enrich our lives and promote tourism. From kid's camps to our conservation education center, we work to cultivate an appreciation for outdoor activities and areas. We encourage new boat ramps, wildlife management areas, refuges and improved parks and national forests. We are involved in creating outdoor recreation areas and parks accessible for all Mississippians. In addition, we have worked to make shooting houses available for the physically challenged.

• Conservation Policy: Wildlife Mississippi works with conservation agencies, the Mississippi Legislature and the United States Congress to identify strategies to help protect, restore and enhance our natural resources. We help shape public policy with on-the-ground action to conserve Mississippi's natural resources. The Wildlife Habitat Incentives Programs and the Healthy Forests Reserve Program were concepts of Wildlife Mississippi. We conceptualized the Theodore Roosevelt and the Holt Collier National Wildlife Refuges, as well as the Sky Lake Wildlife Management Area, the largest stand of ancient cypress in the world.

References and Information Sources

Information Sources: Thanks go to the authors of the following publications. These references make excellent additional readings for learning more about the native prairies, prairie plants and their wildlife uses, prairie restoration in the Southeastern United States, invasive plant species and wildlife habitat management.

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To attain this publication free of charge: Southern Research Station, P.O. Box 2680, Asheville, North Carolina 28802

Miller, J. H. and K.V. Miller. 1999. *Forest Plants of the Southeast and their Wildlife Uses.* Southern Weed Society. University of Georgia Press, Athens, Georgia. 454 pp.

Packard, S and C. F. Mutel. 1997. *The Tallgrass Restoration Handbook for Prairies, Savannas, and Woodlands.* Island Press, Washington, D.C. 463 pp.

Stewart, S. 2005. *Ecology and Management of the Bobwhite in Alabama.* Alabama Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries. 46 pp.
To attain this publication: Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries. 64 North Union St. Montgomery, Alabama; (1) 800-262-3151 or www.outdooralabama.com

Yarrow, G. K. and D.T. Yarrow. 1999. *Managing Wildlife.* Sweetwater Press, Clemson University and Alabama Wildlife Federation. 588 pp.

Sample Outline of Prairie Restoration Plan for Wildlife

I. Identify your goals – Outdoor Recreation, Beauty, Wildlife Conservation?

A. If wildlife conservation is a priority, what species of wildlife do you wish to favor or attract?
B. What plant communities do you prefer to see on your land? Remember that the plant composition will influence wildlife use of your restoration sites.
C. How much land will restore to native prairie or savanna habitats? Remember some grassland wildlife require large tracts of habitat whereas some, such as rabbits and butterflies may require less acreage.

II. Assess conditions on your land.

A. How much acreage will be restored?
B. Determine arrangement of the restoration sites on the land base. This information is important for evaluating access for recreational use and future management, such as disking burning, wildlife visibility or road-wildlife conflicts.
C. Estimate amounts of seed and propagules needed based on your goals and amount of acres to be restored.
D. Estimate herbicide, disking and burning needs based on conditions on your land.

III. Design the Restoration Sites.

A. Estimate the amount of acreage to be restored.
B. Determine the arrangement of the restoration sites.
C. Develop maps of existing conditions and land use and proposed restoration sites, with acreages and planting mixtures identified on maps or attached supplemental material.
D. Develop a schedule for accomplishing the following:
   1. Ordering of seed, collection of propagules.
   2. Receipt and storage of seed.
   3. Site preparation and planting, including proposed dates for herbicide application, burning, disking and seeding.
   4. Habitat management, including years and season of prescribed burning.
   5. Fire lane construction and seeding.
   6. Enjoyment of your restored prairie and woodland savanna!!!
E. Develop a budget with projected costs of grassland establishment and management.
F. Order seed and propagules as soon as you have determined how much and what seed you intend to plant!

IV. After visiting and inspecting your future restoration areas, you will base you actions on the condition and vegetation cover existing on your land. Several scenarios exist and may need to be considered.

A. Croplands:
   1. If identified restoration sites are croplands, warm-season grasses can be seeded in spring with a pre-emergent herbicide application.
   2. After establishment of warm-season grasses, prairie wildflowers and legumes can be seeded onto bare-soil areas or in following years after prescribed burning.
B. Non-native, warm-season pasture grasses, such as dallisgrass or Bermudagrass (eradication of Bermudagrass generally requires 2 years of treatment):
   1. Apply appropriate herbicide during summer when grasses are actively growing.
   2. Burn the following February or March.
   3. Disk in spring if sites are not erodible.
   4. If good response by desired native plants, manage by periodic disking or burning, and selective herbicide, if needed for woody or invasive plant control.
   5. If poor response by desired native plants or if undesired plants are present, apply appropriate herbicide selectively to undesired vegetation, burn the following February or March, and plant native warm-season grasses with pre-emergent herbicide to control undesired broad-leaf plants. If planting grasses with mixtures of prairie forbs and legumes, do not use pre-emergent herbicides; or select herbicides that will not damage seeded legumes and forbs.
C. Cool-season agronomic grasses, such as tall fescue or brome grass:
   1. Apply appropriate herbicide during fall when grasses are actively growing.
   2. Burn the following February or March.

3. Disk in spring if sites are not erodible.
4. If good response by desired native plants, manage by periodic disking or burning, and selective herbicide, if needed for woody or invasive plant control.
5. If poor response by desired native plants or if undesired plants are present, apply appropriate herbicide selectively to undesired vegetation, burn the following February or March, and plant native warm-season grasses with pre-emergent herbicide to control undesired broad-leaf plants. If planting grasses with mixtures of prairie forbs and legumes, do not use pre-emergent herbicides; or select herbicides that will not damage seeded legumes and forbs.

D. Fallow old field vegetation with some desired native plants:
1. Seed native lespedezas and partridge pea during February.
2. Burn in February through early March.
3. Seed desired prairie forbs and grasses, such as Indiangrass and switchgrass, during April and May.
4. Use selective herbicide to eliminate patches of undesired non-native plants such as agronomic grasses, sericea lespedeza, privet hedge or dense woody plant cover, such as ash.

E. If invasive, non-native plants are present in any of the cases described in A through D from above, these plants should be controlled immediately and monitored for future reoccurrence.

V. After establishment of prairie vegetation, adjust your management to favor the wildlife that you desire on your land. You may enhance habitat for many species by implementing some of the following management tools:

A. Manage with prescribed burning by burning strips or blocks in alternate years at 2- to 5-year intervals.
B. Disk warm-season grasses if they become too dense at ground level.
C. Enhance legume or wildflower composition by direct seeding of desired species over existing bare-soil areas or introducing plant propagules in selected areas.
D. To produce thicket cover and soft-mast foods in the grassland, allow plum and blackberry thickets to grow in clumps and along ecotones. Protect these thickets from mowing, disking and frequent fire allowing at least 5 to 6 years between burning.
E. Plant annual clovers and vetches in fire lanes.
F. Protect SMZs that have abundant hard and soft-mast producing trees, shrubs and vines.

Glossary of Terms

Alkaline – Soil or water pH levels that are in excess of 7.0 (neutral pH).

Allelopathic – The ability of a plant to produce chemical inhibitors that suppress germination and growth of competing vegetation.

Annual plant – A plant that completes its life cycle in one year or less, with seed germination, vegetative growth, flowering and seed production occurring in one growing season.

Biennial plant – A plant that completes its life cycle in 2 years, generally germinating and growing vegetatively in year 1 with flowers and seed produced in year 2.

Brood – The young of birds, such as wild turkey, bobwhite quail, grouse or non-game birds, during the period of time that they are dependent on their parents for survival. The young of fish, reptiles, amphibians, spiders and insects may also be referred to as "brood."

Browse – Leaves, shoots, buds and stems of woody plants, trees, shrubs and vines, which are eaten by wildlife, such as deer, rabbits and rodents.

Calcium – The major cation element of the parent material in our prairies. Calcium is also an important nutrient for growth and health of plants and animals.

Calcium carbonate – Mineral complex comprised of calcium and carbon that originated from deposits created by ocean creatures during time when prairie areas were covered by ocean waters. Presence of calcium carbonate in parent materials or bedrock tends to produce alkaline conditions in soil pH levels.

Chalk – In reference to prairie ecosystems, the outcropping or exposure of calcium carbonate and other high mineral content substrates at the soil's surface. This exposure may be caused by erosion that has removed topsoil layers over time.

Conservation – The discipline of sustainable use of natural resources in which a resource is used by humans but the use is informed, regulated and accomplished in a manner that ensures the continued existence and availability of the resource over time for present and future generations.

Cool-season plants – Plants that germinate and grow primarily during late fall, winter and early spring months.

Donor site – Area where propagules or seeds can be collected for transplanting to a restoration site.

Dormancy – Period of metabolic inactivity. Seed dormancy which is common in many prairie grasses, may limit seed germination during the first growing season after planting. In the Southeastern United States, dormancy of warm-season plants is generally associated with loss of foliage, high amounts of food storage in roots and limited or no vegetative growth in winter months; whereas, cool-season plants, such as clovers, may go dormant during the hottest of summer and fall months.

Dormant season fire – Fire that occurs or is set during late fall through late winter when most warm-season plants are dormant.

Ecosystem – An interacting system comprised of living organisms and their physical environment. In an ecosystem, complex relationships develop between organisms and their environment producing a self-sustaining system driven by photosynthesis, production, decomposition and recycling of nutrients.

Endophyte (Endophytic) – Growing within an organism. For example, the fungus that grows within the tissues of tall fescue is an "endophytic" fungus.

Erosion – The loss of soil from a bare-soil or disturbed area through the action of wind or water. In our area, several types of erosion can occur on bare-soil areas from water flow. Sheet erosion occurs evenly across the soil surface moving upper layers of sediment downslope. Rill erosion is characterized by concentrated flow in small channels with small gullies becoming evident as soil loss progresses. If left untreated, most sheet and rill erosion can become gully erosion where concentrated water flow washing soil producing ditches or gullies.

Field guide – A book that is designed to be used in the field to teach the user about a particular aspect of field biology, botany, geology or ecology. Field guides are available for identification and study of insects, spiders, fish, amphibians, reptiles, mammals, birds and plants, including trees, shrubs, vines and herbaceous plants, like wildflowers and grasses. Field guides can be purchased from bookstores, research institutions or commercial vendors on the internet. For beginners, we recommend field guides that have good photographs or

illustrations, range maps and descriptions of subject matter in question – whether plants, animals, artifacts or rocks! Some field guides even have water proof covers and pages for use in the field!

Fire lane – A natural or artificial barrier used to contain or stop the spread of fire. Fire lanes are often called "fire breaks."

Forb – A herbaceous plant that generally has broader leaves and showier flowers than grasses, rushes and sedges. Flowers are generally showy due to the presence of colorful petals, and leaves generally exhibit veins that branch from a central midvein. Most forbs are classified as dicots and include familiar wildflowers, such as daisies, goldenrod, black-eyed susans, meadow beauties, salvia, mints and sunflowers.

Game – Category of species of wildlife for which a seasonal harvest is allowed.

Glade – Within the Black and Jackson Prairie Belts, an area that is characterized by thin upper soil horizons, calcareous or chalk outcroppings and sparse plant cover. Within the Black Belt, chalk outcroppings or parent calcium carbonate parent material is exposed and interspersed with Eastern red cedar, rattan vine, prairie grasses, legumes and forbs. Due to bare soil, abundant dead wood and sparse vegetation, some glades were called "barrens" by early explorers and naturalists. Despite thin topsoil, glades may support very rare plant species that grow in glades only.

Grass – Monocot plants that are grouped in the family *Poaceae.* Grasses typically have reduced flowers that lack showy petals, linear leaves with parallel venation, leaves that depart from the stem in two directions (two-ranked) and roots that are bunched in basal clusters or stoloniferous, running underground or over the soil surface.

Grassland – Term used to denote a prairie ecosystem (see Prairie).

Grassland birds – Species of birds, such as Northern bobwhite quail, Eastern meadowlark and Henslow's sparrow, that depend on grasslands or prairies for survival. Most grassland birds use prairies or grasslands for reproduction, foraging and nesting. Due to the rarity of native grasslands, many grassland birds are exhibiting regional and local population declines.

Growing season fire – Fires that occur or are set during spring through early fall when warm-season plants are actively growing.

Habitat – The environment or place where an animal or plant lives or grows.

Hard mast – Seed and nuts of plants that are covered with a tough, dry shell or husk, that are an important source of food for many species of wildlife.

Hard pan – A layer of compacted substrate created in soil by heavy traffic of vehicles or heavy equipment, including farming equipment. Hard plans, also called "plow pans," are especially common in clay soils where vehicular traffic or equipment has occurred when the soil is wet or moist. These compacted layers can restrict root growth of plants, water holding capabilities of soil and general productivity of a site. Therefore, use of a breaking plow or some other implement may be needed to ameliorate this condition for maximum plant growth.

Herbaceous – Forbs, grasses and legumes that do not contain woody material, such as lignin or cellulose, in their tissues. These plants often referred to as "herbs" maintain their structure primarily by turgor or water pressure within their tissues.

Inert material – Material included in seed shipments or packets that will not germinate, such as seed husks or dry vegetation parts.

Inflorescence – The flowering, fruiting or seed producing structure of a plant.

Inoculum – A mixture of bacteria and carrier material that can be purchased commercially to increase germination of many legumes. Inoculum powders generally include Rhizobium or other bacteria that help legumes form root nodules and begin to "fix nitrogen." Follow seed packet recommendation on specific inoculums to use with specific plants.

Internode – The part of the stem between two nodes or joints.

Invertebrates – Animals that lack vertebrae or a "back bone," including spiders, snails, slugs, insects and crustaceans. Thousands of invertebrates live on our planet and are very important in the functioning of ecosystems. Invertebrates of prairie ecosystems are important for nutrient recycling (earthworms, snails and slugs), foods for wildlife (insects, spiders, snails, earthworms) and pollination of grasses, wildflowers and crops (insects, including butterflies, moths, bees, wasps and native ants).

Legume – Plants of the family *Fabaceae* that include beans, peas, patridge pea, beggar weed and lespedezas. Seed, flowers and foliage of many legumes are important wildlife foods. Additionally, legumes can enhance soil quality through nitrogen fixation, a process by which bacteria associated with their root nodules, converts gaseous nitrogen from the air into forms of nitrogen that can be used by plants.

Ligule – In grasses, a thin, membranous, hairy or ridgelike structure that occurs where the leaf blade's sheath clasps around the stem. The shape and condition of the ligule can often be used to identify a grass species or genera prior the flower or seedhead formation.

Linear – Long and narrow in shape.

Node – A joint in the stem of a plant, especially grasses, that gives rise to one or more leaves.

Non-game – Category of wildlife that is protected from harvest.

Perennial – Plants that germinate from seed during their growing season and arise from established roots systems in following growing seasons. Perennials may reproduce annually by producing viable seed or through vegetative reproduction, spreading by sprouting new plants from roots, stolons or stems.

pH – Measure of acidity. A pH level of 7.0 indicates a neutral soil or water, whereas a pH less than 7.0 indicates acid condition and more than 7.0 indicates alkaline conditions. Most plants grow best at near neutral pH levels; however, most prairie plants are highly adapted to alkaline soil conditions.

Phytotoxic – Toxic to plants.

Prairie – An ecosystem type that is characterized by herbaceous plant cover, such as grasses, forbs and legumes. Woody plant cover may occur intermittently across prairies. Prairies are also called grasslands because of the dominance of perennial, warm-season grasses. Prairies occur throughout the world and are generally dependent on fire to maintain early successional stages of herbaceous plant cover.

Prescribed fire – Use or application of fire to the land base in a manner that burning is planned and managed to attain identified goals of vegetation, wildlife and land management.

Propagule – Any portion of a plant that can give rise to a new plant. Seed, roots (or sprigs), rhizomes, stolons, tubers, bulbs, stems and even-leaf portions may be propagules depending on the species of plant. Propagules of most prairie plants that are used in planting include seed, sprigs of root clusters, underground bulbs or rhizomes.

Pure live seed – The actual amount of viable seed that will germinate in a batch of seed and inert material. Calculation of pure live seed (PLS) is an essential for assessing the appropriate seeding rates for perennial, warm-season grasses.

Raceme – An arrangement of flowers or seed on an inflorescence (flowering parts) or seed head in which a central stem gives rise to many branches that bear flowers and eventually seed. Racemes can appear plume like in many wildflowers and grasses.

Restoration – The processes and actions taken to re-establish an animal community, plant community or an ecosystem that has been lost or destroyed.

Rhizome – Underground stem that is distinguishable from a root by its nodes (joints in the stem), buds and scale-like leaves.

Rootstock – A rhizome or underground stem.

Scarified – In this publication, used to refer to the process by which seed coats are broken down or weakened to increase seed germination. Burning, freezing, heating or actually scratching or sanding the seed coats are methods of seed scarification.

Senescent (Senescence) – Dormant or in a state of dormancy. Generally used to refer to a plant after the growing season is over, when leaves and stems have died.

Shrubland birds – Birds that depend on shrub, small tree and vine cover for nesting, feeding and loafing.

Soft mast – Soft-tissue fruit of plants, including pomes, berries, aggregates and drupes, that is eaten by many animals. Wild grape, Chickasaw plum, blackberry, dewberry, rattan vine, black cherry, elderberry, pokeweed, greenbrier and mulberry produce soft mast used as food by wildlife.

Spike – The arrangement of the flowers or seed of many grasses when seed are attached closely to the stem.

Spikelet – The smallest or basic part of a plant's seeding or flowering structure (inflorescence) – usually a single flower or seed with surrounding structures.

Stolon – A horizontal above ground branch or runner that can root at each node. Stoloniferous grasses and vines can reproduce vegetatively from their stolons.

Stool – The root base of grasses, such as Eastern gamagrass.

Streamside management zone (SMZ) – A corridor along a stream or river that is protected from disturbance to protect water quality, provide wildlife habitat, increase beauty of land and increase recreation of forest-based pursuits, such as wild turkey and squirrel hunting.

Succession – The process by which one community of plants and animals replaces another community over time. For example, early successional habitat that exists after a fire supports grassland wildlife and many herbaceous plants. In the absence of fire over 5 to 10 years, the grassland community gives way to colonizing trees, shrubs and woody vines. With this colonization and establishment of woody species, woodland species of wildlife replace grassland species of wildlife.

Surfactant – Chemical used in conjunction with herbicides to increase adherence of applied herbicide to the targeted plant foliage after application.

Top sown – Seeded directly onto the soil surface.

Warm-season plants – Plants that germinate and grow during the warm months of spring, summer and early fall.

Woodland savanna (savannah) – An ecosystem type that is characterized by a lush understory of herbaceous plant cover and widely spaced trees. Also spelled "savannah." Woodland savannas of the Black Belt are characterized by herbaceous prairie vegetation and oak tree cover. Jackson Prairies have similar plant communities with mixed pine and hardwood tree cover.

Woodland savanna birds – Bird species that depend on woodland savanna habitats for nesting, feeding and loafing.

Commercial Suppliers of Prairie Plants

Carlin Horticultural Supplies
www.carlinsales.com
Westfield, Indiana
800-657-0745
E-mail: info@carlinsales.com
Fax: 414-355-3107

Ion Exchange
www.ionexchange.com
Harpers Ferry, Iowa
800-291-2143
E-mail: sales@ionexchange.com
Fax: 563-535-7362

Native American Seed
www.seedsource.com
Junction, Texas
800-728-4043
E-mail: info@seedsource.com

Oak Prairie Farm
www.oakprairiefarm.com
Pardeeville, Wisconsin
800-894-3884
E-mail: customercare@oakprairiefarm.com

Prairie Frontier
www.prairiefrontier.com
Waukesha, Wisconsin
262-544-6708
E-mail: wildflower@prairiefrontier.com

Prairie Nursery
www.prairienursery.com
Westfield, Wisconsin
800-476-9453
E-mail: webcs@prairienursery.com
Fax: 608-296-2741

Prairie Restorations Inc.
www.prairieresto.com
Princeton, Minnesota
763-389-4342
E-mail: info@prairieresto.com
Fax: 763-389-4346

Prairiemoon Nursery
www.prairiemoon.com
Winona, Minnesota
866-417-8156
E-mail: info@prairiemoon.com
Fax: 507-454-5238

Roundstone Seed Company, LLC
www.roundstoneseed.com
Upton, Kentucky
270-531-3034

Sharp Brothers Seed Company
www.sharpbro.com
Clinton, Missouri
800-451-3779 or
660-885-7551

Shooting Star Nursery
www.shootingstarnursery.com
Westfield, Kentucky
502-867-7979
E-mail: shootingstarnursery@msn.com
Fax: 502-867-7677

Star Seed Company
www.gostarseed.com
Osborne, Kansas
800-782-7311
E-mail: info@gostarseed.com

Sunrise Seeds
www.sunriseseeds.com
Union City, Indiana
765-964-3956
E-mail: sunrise@woh.rr.com

Wax Seed Company
Amory, Mississippi
800-647-1226

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Harper, C. A., G. E. Bates, M. J. Gudlin, and M. P. Hansbrough. 2004. A Landowner's Guide to Native Warm-Season Grasses in the Mid-South. University of Tennessee, Extension Service. PB 1746: 25 pp.

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