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United States Department of Agriculture

Arkansas NRCS Pollinator Conservation Planning Handbook

Arkansas

Natural Resources Conservation Service

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Acknowledgments

This document is the result of collaboration with state and federal agencies, non-governmental organizations, as well as individuals in the private sector. The editors would like to express their sincere gratitude for technical assistance, photographs shared, and time spent advising, reviewing and editing.

The handbook is based on pollinator handbooks developed for West Virginia and Kentucky by Kentucky State Biologist Casey Shrader in collaboration with other NRCS staff, the Xerces Society for Invertebrate Conservation, and many other partners. The editors of the Arkansas handbook are deeply grateful for generosity in sharing this work.

Editors of the Arkansas handbook include Nancy Lee Adamson, Sarah Hamilton-Buxton, Ray Moranz, and Sara Morris of the Xerces Society for Invertebrate Conservation (Xerces). Aimee Code and Stephanie Frischie of Xerces reviewed pesticide content and plant materials, respectively. Ryan Diener and Leslie Fowler Cooper of Quail Forever and partner biologists with the Arkansas NRCS helped refine the handbook outline, created native plant species lists and seed mixes, provided photographs, and reviewed the full contents. Steve Duzan and Eric Hunt contributed photographs of Arkansas pollinators, plants, and natural communities. Coleman Little of the University of Central Arkansas Biology Department contributed photos of native bees of Arkansas. Other photographers are acknowledged below.

This work was spearheaded by Helen Denniston, Arkansas NRCS State Resource Conservationist. We hope it inspires thoughtful stewardship of pollinators and other wildlife in Arkansas while also supporting crop production and healthy watersheds throughout the state and surrounding region.

For reviewing content, we are grateful to James Baker, AR NRCS State Biologist; Troyce Barnett, AR NRCS State Agronomist; Keith Scoggins, AR NRCS Cropland Agronomist; Doug Akin, AR NRCS State Forester; Theo Witsell, AR Natural Heritage Program Botanist; Allison Fowler, Arkansas Game and Fish Commission Diversity Program Coordinator; Melissa Lombardi, US Fish and Wildlife Service Arkansas Ecological Services Field Office Biologist (Insects); and Coleman Little of the University of Central Arkansas.

For assistance with current agronomic technical guidance for Arkansas, we are grateful to the University of Arkansas Cooperative Extension and research staff, including Matt Fryer, Soil Science Instructor, Division of Agriculture, University of Arkansas; Dr. Elena Garcia, Horticulture Professor, Division of Agriculture, University of Arkansas; Lizzy Herrera, Program Technician-Horticulture, University of Arkansas Cooperative Extension; Paige Hickman, formerly Graduate Student, Horticulture Department, University of Arkansas and subsequently a doctoral student at the University of Idaho; Dr. Jackie Lee, Resident Director, Fruit Research Station; Dr. Trenton Roberts, Associate Professor of Soil Fertility/Soil Testing, Crop, Soil, and Environmental Science Department, University of Arkansas.

Cover photos—front *(clockwise from top left)*: Monarch butterfly (*Danaus plexippus*) on ox-eye false sunflower (*Heliopsis helianthoides*), bumble bee queen (Bombus impatiens) on peach (*Prunus persica*), whitefly predator beetle (Delphastus pusillus) consuming white fly larvae (family Aleyrodidae), and a pollinator planting established with technical and financial assistance from USDA Natural Resources Conservation Service and Farm Service Agency planted next to crop fields in Arkansas. [Photos: Jim Hudgins, USFWS Midwest / flickr; Nancy Lee Adamson; Jack Dykinga / USDA–ARS; Ryan Diener, Quail Forever.] Back *(clockwise from top)*: Native prairie restoration planting for pollinators in Arkansas; green metallic sweat bee (Halictidae family) buzz pollinating a tomato (*Solanum lycopersicum*) flower; green metallic sweat bee (Halictidae family) nectaring on butterfly milkweed (*Asclepias tuberosa*) in Arkansas. [Photos: Jacob Swafford, Quail Forever; Nancy Lee Adamson; Steven Duzan.]

Other photos were contributed by Nancy Lee Adamson, Larry Allain / USGS, David Biddinger / PennState University, Marcus Bradley, Kelly Bufkin, Whitney Cranshaw / Colorado State University*, Rob Cruickshank†, Barbara Driscoll, Howard Ensign Evans / Colorado State University*, Sarah Foltz Jordan, Steve Gibson, Bill Glass, Jolie Goldenetz Dollar, Peggy Greb / USDA–ARS, Thelma Heidel-Baker, Jennifer Hopwood, Austin Klais, Isis Longo, Jacy Lucier†, Jonathan Lundgren, Ray Moranz, Sara Morris†, Eric Riddick, Matthew Shepherd, Creston Shrum, Jacob Swafford, Elijah Talamas / USDA–ARS, Glynn Tillman, Brittany Viers-Scott, William Warby, and Eva Wiedeman. *Via Bugwood.org. †Via flickr.com

The design and layout of the publication was created by Sara Morris, Xerces Society Communications and Outreach Program.

Kindly send comments and questions regarding the handbook to Ray.Moranz@xerces.org.

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The Variety of Native Bees

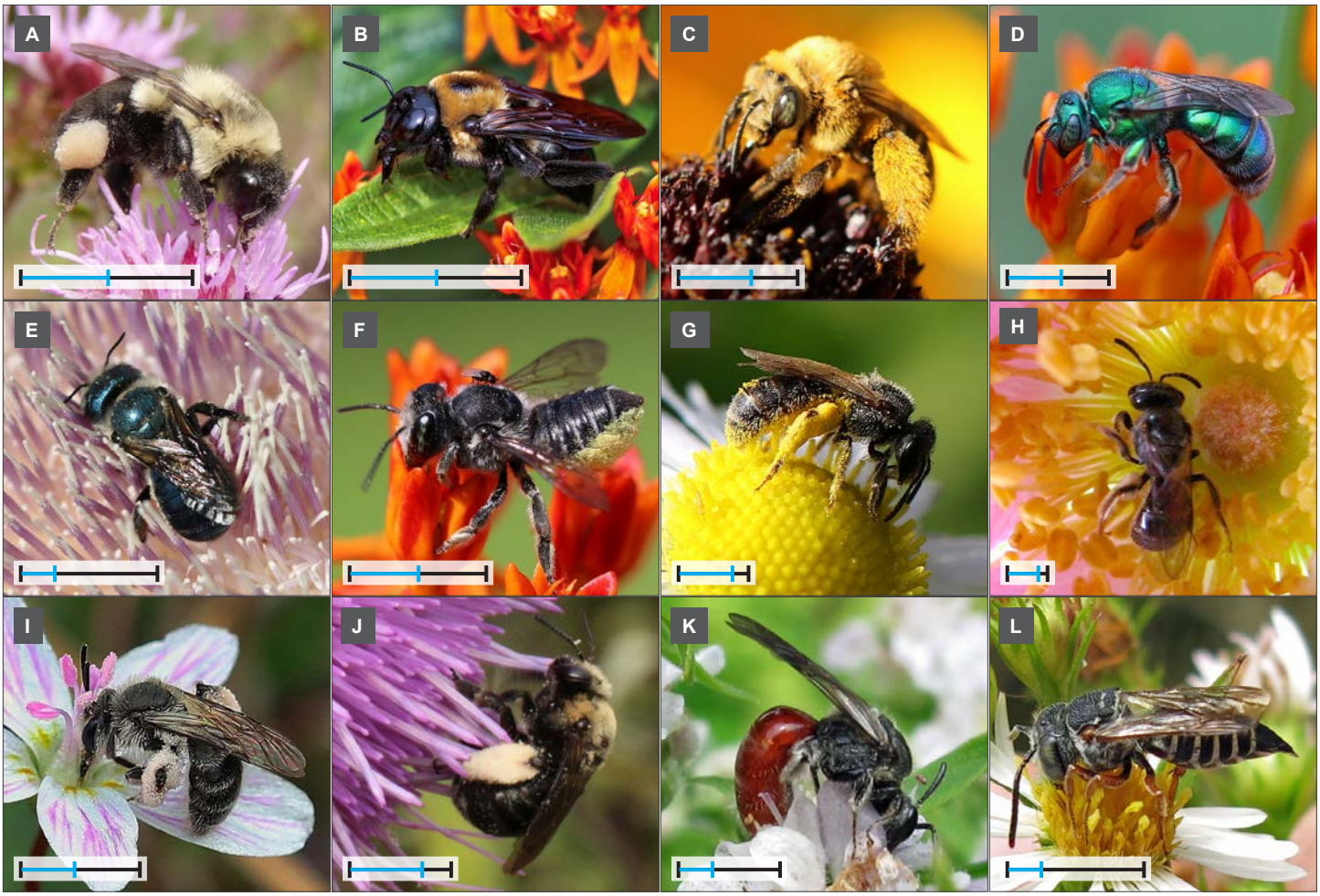


Figure 1—Pictured here are examples of the wide diversity of native bees you might observe on flowers. Look for some of the features described below. (Photos: Nancy Lee Adamson [A, H]; Steve Duzan [B, D, F, G, I]; Jennifer Hopwood [C, J]; Larry Allain, USGS [E]; Jacy Lucier, flickr [K, L].)

Size: Native bees can range in size from tiny, dark-colored sweat (Halictidae) and mining (Andrenidae) bees that are ⅛ to ¼" long (e.g., D, G, H), to bumble bees (*Bombus* spp. [A]) and large carpenter bees (*Xylocopa* spp. [B]) that are more than 1" long.

Shape: Native bees can be relatively slender, as in some of the small carpenter bees (*Ceratina* spp.). They can be moderately wide, similar to European honey bees (*Apis mellifera*). Or they can be quite stocky and robust, as in the bumble bees or large carpenter bees.

Color: Bees vary greatly in color on their body surface (exoskeleton) and in the color of their hairs. Their exoskeleton can range from black, yellow, or red to metallic green and blue. Hair colors found on bees include black, grey, brown, yellow, orange, and white, and frequently create striped patterns.

Distribution of Hair: The patterns and locations of hair can make some bees look very "fuzzy" while other species are hairy only in certain areas (e.g., legs) and, overall, may look quite shiny or bald.

Pollen Transport: Honey bees and bumble bees (A) carry a mixture of pollen and nectar located on a flattened area on the hind leg called the pollen basket. Other bees carry pollen in a dense mass of stiff, branched hairs called the scopae. The scopae are often located on the hind legs, but in some species they are located on the underside of the abdomen (E, F). ***Note:*** only female bees have pollen-carrying structures.

Pollen: Bees can carry moistened pollen loads (mixture of pollen and nectar) or dry pollen. The wet pollen balls in the pollen baskets of European honey bees helps set them apart from all of the native bees in North America except bumble bees.

Approximate size: smallest (**blue**) / largest (**black**)

Note: For more information on native bee species, see *Appendix F: Common & Specialist Bees of Arkansas*.

Introduction

Adding plant diversity to create and enhance pollinator habitat on farms and in other landscapes benefits broad communities of wildlife by enhancing insect diversity. Besides benefitting farm production, insect diversity is vital for other wildlife—for birds, mammals, fish, amphibians, and reptiles. Pollinator habitat provides multiple benefits for farms and communities in Arkansas by:

1. Helping ensure successful pollination of crops;
2. Supporting natural enemies of crop pests;
3. Enhancing income via improved pollination of, and reduced pest-management costs for, crops;
4. Creating new sources of income with fruits, cut flowers, herbs, and other floral cuttings;
5. Improving soil, watershed, and human health;
6. Helping reduce pesticide and particulate drift onto and off of farms;
7. Providing habitat for other wildlife such as birds that also help keep crop pests in balance; and
8. Adding beauty for agritourism.

When trees are used to enhance pollinator habitat, they can also add shade that benefits people and livestock; help reduce energy costs; and improve water infiltration, water quality, and air quality. Bees and other pollinators pollinate 75% of food crops worldwide. Animal-pollinated crops include the most nutrient and vitamin rich parts of our diets—fruits and vegetables—along with modern staples like chocolate and coffee. Animal-pollinated plants make up about 35% of our diets—the rest is largely wind-pollinated (e.g., corn, rice, and wheat). We also depend on pollinators for forage crops, biofuel oils, fibers, medicines, and construction materials. Native plants are even more dependent on pollinators. Ninety percent of wild (non-cultivated) plants depend on animal pollinators (mainly bees). This is a weighted average that takes into account the higher number of species in tropical regions; 78% of native plants in temperate regions and 94% of native plants in tropical regions depend on animal pollinators.

Animal pollinators include bees, butterflies, moths, wasps, flies, beetles, ants, bats, and hummingbirds. There are about 20,000 species of bees worldwide, with about 3,600 species native to the United States. While we often rely on the non-native European honey bee (*Apis mellifera*) as a managed pollinator for many crops in the United States, much research highlights the importance of diverse wild pollinators, especially native bees, in crop production.

Accelerated decline of honey bee colonies has raised awareness of the need for providing habitat and adjusting management practices to better support all pollinators and other insects, such as natural enemies of crop pests, to ensure successful crop production. There are no fees for native bee pollination services, but bees require habitat close to agricultural crops that includes nesting sites, sources of pollen and nectar throughout the growing season, and shelter from disturbance (i.e., crop harvest, tillage, or pesticides).

Planner Note

Planners should pay particular attention to boxes like this. Throughout this document there are Planner Notes intended to provide tips and guidance for NRCS conservation planning.

This document is provided primarily as a guidance tool for NRCS planners. Landowners with an interest in enhancing diversity on their farms for improving pollination and pest management will also find it valuable. It focuses on native bees, the most important crop pollinators in temperate North America, but also addresses the habitat needs of butterflies, hummingbirds, and other insects beneficial to agriculture (e.g., predatory and parasitoid insects that reduce crop pest populations). Enhancing habitat for native pollinators also supports European honey bee health. References and information within this handbook will be updated and additional materials will be provided periodically as they become available through revisions or supplements by NRCS.

Figure 2—*left to right*: Mining bees (*Andrena* spp.), bumble bees (*Bombus* spp.), and other native bees are among the most important pollinators for early spring blooms, like Arkansas' state flower, apple, when there is adequate natural habitat close to orchards. European honey bees (*Apis mellifera*) are especially important pollinators in very large orchards in the areas farthest from natural habitat (native bees provide adequate apple pollination along orchard perimeters near diverse field borders, hedgerows, or natural habitat). (Photos: Nancy Lee Adamson.)

Many native bees are pollen specialists (see *Appendix F: Common & Specialist Bees of Arkansas*), such as squash bees (*Peponapis* and *Xenoglossa* spp.), blueberry bees (such as *Habropoda laboriosa*), and okra (or hibiscus) bees (*Ptilothrix bombiformis*). Most are only active during a few weeks each year, with many especially important for early spring-flowering crops, such as apple and other fruit trees, blueberries, and strawberries*. Native species are frequently active earlier and later in the day than honey bees. For squash and other cucurbits, squash bees and bumble bees (*Bombus* spp.) often provide early morning (sometimes pre-dawn) pollination before most other bees become active.

Figure 3—*left to right*: Bumble bees, flies, and beetles help pollinate many cultivated crops such as peach, buckwheat, and onion, and butterflies are important pollinators of many wild and nursery or garden plants, such as Turk's cap lily (*Lilium superbum*). (Photos: Nancy Lee Adamson.)

Some plants—those in the nightshade and heath families, for example tomatoes and blueberries—require sonication, or "buzz pollination," to release pollen from their anthers. Buzz pollination is an important service nearly all our native bees can provide by vibrating their wing muscles at a specific frequency that causes enough pressure within the anther to release pollen. Though honey bees can "buzz" for warmth, the frequency does not match what our native plants and some crops need for sonication. Since most of our native bees are solitary species, they collect nectar and pollen on every trip (to provision nest cells and for their own sustenance), making them especially effective pollinators on a bee-per-bee basis compared to honey bees, whose foragers may only collect one or the other (pollen or nectar). Honey bees can make up for their lower efficiency with concentrated numbers and mobility; plus they can be brought in at peak flowering time, which is important in areas without sufficient natural habitat to support wild bee populations near crops. Research published in 2006 estimated the value of annual crop production attributed to native bees for the United States economy at three billion dollars, but subsequent research suggests their contribution is much greater. Measures taken to improve habitat and management help maintain diverse pollinators and promote a healthy balance of pests and predators, reducing costs over time and improving production.

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) can assist landowners by suggesting regionally appropriate plants and farm management practices that provide forage resources (nectar and pollen sources) and nesting habitat for organisms that provide pollination services. These plantings and farm management approaches also support a diversity of other native predators and parasitoids that help reduce crop pest populations.

Figure 4—*left to right*: Hummingbirds are the primary pollinators of most of our native flowers with red, tubular flowers, such as cardinal flower (*Lobelia cardinalis*) and trumpet creeper (*Campsis radicans*), but they collect nectar and insects from many other native plants like thistle (*Cirsium* spp.). Columbine (*Aquilegia canadensis*), coral bean (*Erythrina herbacea*), coral honeysuckle (*Lonicera sempervirens*), and some native azaleas have tubular flowers primarily pollinated by hummingbirds. (Photos Steve Duzan.)

* See *Appendix B: Species Lists* for various lists of plants (including common and scientific names) related to restoration and farming.

Pollination Services in Arkansas

Why care about pollinators? Over 100 crop species in North America require a visit from an insect pollinator to be productive and approximately one out of every three mouthfuls of food or beverage consumed requires insect pollination. Directly and indirectly, insect-pollinated crops in North America are estimated to be worth about $30 billion annually—including food, medicines, dyes, and textile fibers.

Figure 5—*left to right*: Blueberries, raspberries (*Rubus* spp., shown: 'Fall Gold'), and watermelons (*Citrullus lanatus*) are among the many fruits and vegetables that depend on bees for pollination. (Photos: Nancy Lee Adamson.)

Insects and flowering plants diversified and evolved together, resulting in the most widespread mutual interdependence in the natural world. In temperate zones, most 'showy' flowers are pollinated by insects, especially bees. Almost all herbaceous wildflowers are insect-pollinated, as are many trees and shrubs, including dogwoods (*Cornus* spp.), redbuds (*Cercis* spp.), wild plums (*Prunus* spp.), sassafras (*Sassafras albidum*), spicebush (*Lindera* spp.), magnolias (*Magnolia* spp.) and willows (*Salix* spp.). Most native insect-pollinated plants are adapted to a particular group of pollinators that are active at a specific time of the year. Insects that co-evolved with particular plants developed physical traits for picking up and depositing their host species' pollen effectively, and the ability to digest certain phytochemicals produced by those plants. As plants are the basis of food webs, their reproduction is essential for all life, and depends on native pollinators. Therefore, if native pollinators disappear, plant diversity would decline, causing a cascade of negative effects on other species and their ecosystems. The shape, position, chemical and visual attributes of the flower determine which type of pollinator is most likely to be attracted to it. Bee-pollinated flowers are usually open and accessible, but some, such as flowers of legumes are irregular in shape, often requiring bees to disturb petals and other structures to gain access to nectar. This, in turn, leads bees to pick up or drop off pollen on each visit, thus ensuring pollination in the process. Ultraviolet patches and lines (nectar guides) on petals of some flowers guide bees to nectar and pollen, increasing efficacy. Flower species with broad or large flowers that are elevated above surrounding vegetation, such as milkweeds (*Asclepias* spp.), attract butterflies. Flies are significant in pollinating many trees, such as sassafras, and are attracted to small, open shallow or clustered flowers. Other fly or beetle species are attracted to rancid smelling blooms, like Jack-in-the-pulpit (*Arisaema triphyllum*), mistaking them for carrion on which to lay eggs. Hummingbirds are especially attracted to red, tubular flowers such as cardinal flower (*Lobelia cardinalis*) and coral bean (*Erythrina herbacea*). Pollen is deposited around their head, and transferred to other flowers. Other beneficial insects, including some beetles and wasps, transfer pollen as they clamber around blooms in search of food or mates.

Figure 6—Different types of pollinators are attracted to different shapes, sizes, and colors of flowers *(left to right)*: tall thistle (*Cirsium altissimum*) with a bumble bee, Carolina rose (*Rosa carolina*) with a beetle, and plains coreopsis (*Coreopsis lanceolata*) with a syrphid fly. (Photos: Ryan Diener, Quail Forever.)

However, where cropping intensity is high, farms often do not have adequate nearby habitat to support native pollinators. To ensure adequate pollination services, producers have come to rely on European honey bees that can be moved into crop fields as needed. Agricultural producers may pay large rental fees to pollinate their crop, but research shows that native bees can provide all the pollination needed for many agricultural crops as long as enough habitat is available to support them. Their diversity helps mitigate loss of pollinators in any given year due to disease or climatic conditions. Natural habitat also supports wild (feral) colonies of honey bees in Arkansas, though fewer feral colonies are found now compared to past decades.

Pollinators have been declining worldwide. European honey bee hive failures are a worrisome and well-documented occurrence in the United States. Many native bees and other pollinators are facing steeper declines (Forister et al. 2019, Potts et al. 2016, Zattara and Aizen 2019). Degradation and fragmentation of habitat, complete loss of habitat, and pesticide use are all contributing to these declines. Some plants have declined and become endangered principally because of the loss of specific pollinators. Biologists are now required to hand-pollinate some endangered Hawaiian plants, and fruit growers in some parts of China must hand-pollinate their crops because pesticide use has killed off bees around orchards. In western states such as California, Washington, and Oregon, rates for hiring honey bees or buying bumble bees have risen dramatically. Rate increases stem from higher costs of rearing European honey bees and maintaining viable colonies with increased parasitic mite and associated disease loads. With some care and planning, Arkansans can help native pollinators flourish and consequently help improve European honey bee health by using straightforward and simple practices to provide foraging plants and protect nesting sites.

Crops Needing or Benefitting from Pollination in Arkansas

Among crops grown in Arkansas, many require insects for successful pollination and others benefit from cross-pollination (produce more or better-quality fruit when receiving pollen from other flowers) (NASS 2017). Arkansas vegetable, fruit, and nut crops requiring pollinators include* almond, apple, apricot, aronia berries, blackberry (including marionberry), black raspberry, blueberry, cherry, some cucumbers, eggplant, elderberry, melon (cantaloupe, honeydew, and muskmelon), okra, peach, pear, persimmon, plum, pumpkin, seed (sunflower for oil and seed, other flowers, and vegetables), squash, strawberry, tomato, and watermelon. Some Arkansas crops produce more or better-quality fruit with cross-pollination, including beans (lima, snap, soy, and others), canola, cotton, some cucumber, pea (blackeyed, cowpea, crowder, green, and others), pepper (Bell, chili, pimiento, and others), pomegranate, strawberry, and tomato. Cucumbers and strawberries are listed in both groups since some, but not all, are self-fertile. Many non-grass crops like alfalfa and carrots, cover crops, herbs, and cut flowers grown from seed require or benefit from insect pollination for seed production, though not all are grown for seed in Arkansas. Other crops, like Jerusalem artichoke (*Helianthus tuberosus*), a native sunflower, are often propagated from tubers, but their flowers provide excellent forage and seeds produced (that are viable for production) require pollinators. In Appendix B, find cover crops, annual cut flowers, herbs, and, when left to flower, other production crops grown in Arkansas visited by pollinators.

Diversity of Pollinators and Other Agriculturally Beneficial Insects

Arkansas is blessed with diverse landscapes varying in topography, elevation, climate, and aspect. The state's diverse geology and topography make it rich in ecological communities, ranging from bottomland wetlands, rich floodplains, and riparian corridors to upland forests, open woodlands, prairie remnants, barrens, and glades. The plant and animal life in Arkansas, from the bottomland swamps in the east to the rich Ozark and Ouachita forests and woodlands in the west, is extraordinary, as well as beautiful. These ecosystems woven

* For more information on these crops, including their scientific names, see *Index of Crop Names* in Appendix B.

Figure 7—Many plants growing naturally in wetland areas support diverse pollinators, and also grow well in average soils. These include (*left to right*): buttonbush (*Cephalanthus occidentalis*) with a bumble bee, blue vervain (*Verbena hastata*) with a green sweat bee, and yellow wingstem (*Verbesina alternifolia*) with native mining bees and a European honey bee. (Photos: Steve Duzan [left]; Nancy Lee Adamson [center, right].)

together form a biologically diverse web of life that is unique to Arkansas. The state's ecosystems are teeming with a plethora of native species from cerulean warblers (*Setophaga cerulea*) to liverworts. Some of these species are endemic—found nowhere else in the world. The aquatic systems of the state are home to strawberry darters (*Etheostoma fragi*), Boston Mountains crayfish (*Cambarus causeyi*), Arkansas fatmucket mussels (*Lampsilis powellii*), and an impressive array of other species that constitute some of the greatest levels of freshwater diversity on the planet. Among this diversity is an abundance of insect life that provides pollination services to support natural and cultivated ecosystems, and produces food and shelter for people and other wildlife.

Given the demise of many managed honey bee colonies, it is important to support the diverse wild pollinators that sustain farm production. Hundreds of species of native bees pollinate crops. These unmanaged bees provide a free and valuable service, but require habitat in order to thrive. Some native bee and fly species, like mason bees, bumble bees and syrphid flies, are active when conditions are too cold and wet for honey bees. In Arkansas, bumble bees are especially important for pollination since they are active when the climate is too cool and wet for many other bees. Native bees are more efficient pollinators than honey bees for some crops, particularly those needing sonication, a.k.a. buzz pollination. Sonication causes pollen to be released from poricidal anthers of nightshade and heath flowers, such as tomato and blueberry. Native bees vibrate their wing muscles at the frequency needed to release pollen. Although European honey bees can vibrate their wing muscles, it is not the right frequency for buzz-pollination. When sonicated, such plants may produce larger and more-abundant fruit.

Most native bees are solitary (not living in colonies) and unlikely to sting, even near their nests, since they do not have offspring, a queen, honey, or pollen stores to defend. Only social insects like honey bees or some social wasps like yellow jackets (*Vespula* spp.) or hornets (*Dolichovespula* spp.) tend to defend their colonies when predators (or something they perceive as a predator, like people) approach their nests. When bees are visiting flowers, they are not defensive and will not sting unless stepped on or caught. Most wasps are also solitary, and although they do pollinate flowers, are considered beneficial primarily as excellent predators of crop and garden pests.

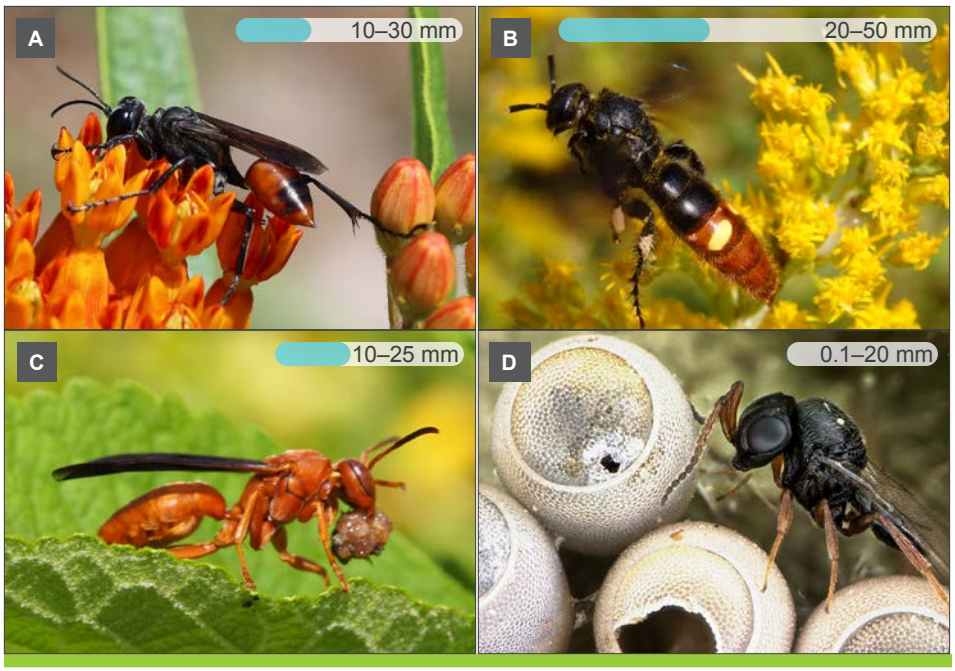


Figure 8—A sphecid or thread-waisted wasp (A, Prionychini Tribe) nectaring on butterfly milkweed (*Asclepias tuberosa*) is solitary, as are scoliid wasps (B, *Scolia dubia*). Female scoliid wasps dig into turf to find grubs to lay their eggs on. The scoliid wasp larvae consume the grubs from the inside out, while adults feed on nectar and pollen. Red wasps (C, *Polistes carolina*—here rolling up a caterpillar to take back to the larvae in her colony) and other social wasps are only defensive near their nests. When scouting for prey on plants, they will fly away if approached. Tiny parasitic wasps (also solitary) lay their eggs in other insects or insect eggs, where the larvae develop, pupate, and transform to adults, like this one (D, *Trissolcus euschisti*) recently emerged, from the egg casing of a brown marmorated stink bug. The adults need nectar and pollen. (Photos: Steve Duzan [A]; Nancy Lee Adamson [B, C]; Elijah Talamas, USDA [D].)

Important Insect Pollinators

Across the world pollinators come in many sizes and forms, including mammals and birds. While the number of pollinator species is not really known, the estimates vary from 130,000 to 300,000, the vast majority of which are insects. There are four main orders of pollinating insects briefly described below. They include Hymenoptera (bees, wasps, ants, and sawflies), Diptera (flies), Coleoptera (beetles) and Lepidoptera (butterflies and moths).

1. Hymenoptera—Bees and Wasps

While Hymenoptera include bees, wasps, ants, and sawflies; bees and wasps are the important pollinators in this order.

Bees

Bees are by far the most important pollinating insects and Arkansas is home to between 450 and 600 native bee species. With the exception of a few wasp species, bees are the only insects that consume pollen and nectar as adults and deliberately gather pollen and nectar as provisions for their young. In colonial species like bumble bees, they feed young larvae pollen and nectar directly. In solitary species (the vast majority of bees), like squash bees, a single female digs in the earth or finds a cavity for brood cells, provisions each

cell with pollen and nectar, then lays an egg. She never sees her young hatch out, consume the food she collected, and then pupate and transform into an adult with wings that can reproduce. Since not all flowers may have good quantities of pollen or nectar at any given time, once bees find good sources, they exhibit a behavior known as flower constancy—returning to the same flower species during foraging trips. Returning to a flower that is known to have adequate nectar and pollen saves energy, prevents wasted visits to flowers without pollen or nectar, and makes bees especially efficient pollinators. Individual bees may visit hundreds of flowers on a single foraging trip, transferring pollen along the way.

Figure 9—*left to right:* Squash bees (*Peponapis pruinosa*) on a female squash blossom, a male long-horned bee (*Melissodes* sp.) on tickseed, and a bumble bee with full pollen baskets (corbicula) on wild bergamot. Male bees have one extra antennal segment, and in some species, like *Melissodes*, male antennae are also elongated. Bees use their antennae like noses, so the extra length aids in finding females. (Photos: Nancy Lee Adamson [left, center]; Steve Duzan [right].)

Bees evolved from wasps as flowers diversified. They developed branched (feathered) hairs for carrying pollen and longer tongues (compared to wasps) for reaching nectar. They also have specialized aggregations of hairs, called scopae (singular scopa), on each hind leg or on the underside of their abdomen. On honey bees and bumble bees, very stiff hairs on each hind leg form a pollen basket, called a corbicula. When full, the corbiculae make recognizing honey bees and bumble bees in the field relatively easy.

Bees and wasps are distinguished from flies by a narrow waist and two pairs of wings that are "married"—connected by a series of tiny hooks (the family name Hymenoptera comes from Hymen, the Greek god of marriage). Bees and wasps also have longer antennae compared to flies and their tongues are cylindrical. See *Appendix F: Common & Specialist Bees of Arkansas* for additional details about common native bees in Arkansas (families, genera, and a few species).

Wasps

Wasps as adults also feed on nectar and pollen, but they collect other insects or lay their eggs in or on prey insects to feed their young. They have much shorter tongues than bees and are generally much less hairy (with unbranched hairs), though many are relatively hairy. They are most effective in pollinating composite flowers, where many individual flowers are clustered together, such as goldenrod (*Solidago* spp.), mountain mint (*Pycnanthemum* spp.), dill (*Anethum graveolens*), blackberry, or raspberry—flowers in the aster, mint, parsley, and rose families, among others. Some research also shows they are effective in pollinating alfalfa (*Medicago sativa*) and cotton, and may be important for pollination in many wild plants, such as rattlesnake master (*Eryngium yuccifolium*).

In agriculture, they are much more important as predators and parasitoids of crop pests, and can be seen methodically scanning plants for prey to feed young larvae in colonial species or, for solitary species, for provisioning brood nests or as a host to lay an egg on or in. Many plants, such as beans (*Phaseolus* spp.), cowpeas (*Vigna unguiculata*), and sesame, attract wasps (and ants) with extrafloral nectaries.

The vast majority of wasps are solitary species, such as mud dauber or digger wasps, that collect insects to provision brood nests or parasitic wasps that lay their eggs in other insects or other insect eggs. The predatory species paralyze prey, place it in a brood cell with enough other prey for one offspring, lay an egg, seal the cell, and repeat the process. They do not have colonies to defend, so it is not dangerous to be close to their nests. They never see their young hatch and mature. In some species, young develop, pupate, and emerge within a few weeks (they are multivoltine, e.g., multiple and successional generations emerge each growing season), while others overwinter in the nest cell as a larva or pupa, and only emerge the following year (they are univoltine; e.g., they produce one generation per year). Parasitic species are generally very host-specific, with multiple generations. Since their young mature within host bodies or eggs, they are especially sensitive to pesticides aimed at their hosts.

Colonial species such as yellow jackets are also considered very important predators. They have annual colonies, started by a single queen in spring. Her daughters, like honey bees, work to provision and protect the colony through the growing season. Unlike honey bees (with colonies that live through the winter), wasps produce new queens in late summer, who mate and overwinter, while the rest of

the colony dies. Around homes and on farms, placing a wasp deterrent lantern under an eave will fool a new queen into thinking there is already a colony nesting in that area. Seeing an existing nest, she will look for an area without other wasps to ensure there will be enough food for her family through summer. Blue ceilings on porches or other outdoor structures are also effective at deterring colonial wasps from nesting—they perceive the blue as sky.

Figure 10—*left to right*: Wasps like this spider wasp (a.k.a. mud dauber, a solitary species [*Entypus* sp.]) can be effective pollinators when moving pollen from one tiny flower to another in tight clusters of flowers like rattlesnake master (*Eryngium yuccifolium*). Notice how hairy the scoliid wasp (*Dielis plumipes*) in spotted beebalm (*Monarda punctata*) is—as an adult, she feeds on nectar and pollen, and is likely to be an effective pollinator due to her hairiness. Many plants, like this cowpea, have extrafloral nectaries that attract wasps (shown: *Polistes dominulus*), ants, and other predators when the cowpeas are ripe—once there, wasps are likely to prey on herbivores in the vicinity and help ensure the cowpea seeds ripen unharmed. (Photos: Steve Duzan [left]; Nancy Lee Adamson [center, right].)

2. Diptera—Flies

Flies (including midges and gnats) are among the most diverse groups of insects on earth—extremely variable in size and appearance. Because their diets are also variable, they sometimes receive less credit than deserved for their role in pollination. Like wasps, many adults depend on pollen and nectar, and seek smaller flowers where their short tongues can reach nectar, such as composite and umbelliferous flowers in the aster, parsley, and rose families. They tend to be active in cooler weather than many bees and are pollinators of some early spring crops such as apple, brassicas, parsnip and other umbelliferous crops (for seed production), peach, plum, and strawberry. Onion breeders have used them for onion seed production. Some flies are attracted to maroon flowers that emit odors mimicking rotting meat, such as pawpaw (*Asimina triloba*) and Jack-in-the-pulpit (*Arisaema triphyllum*). In Europe, in areas with cooler and wetter climate, syrphid flies are usually included in pollinator monitoring for crops such as apple. In tropical areas, midges are responsible for the pollination of one of our favorite foods: chocolate.

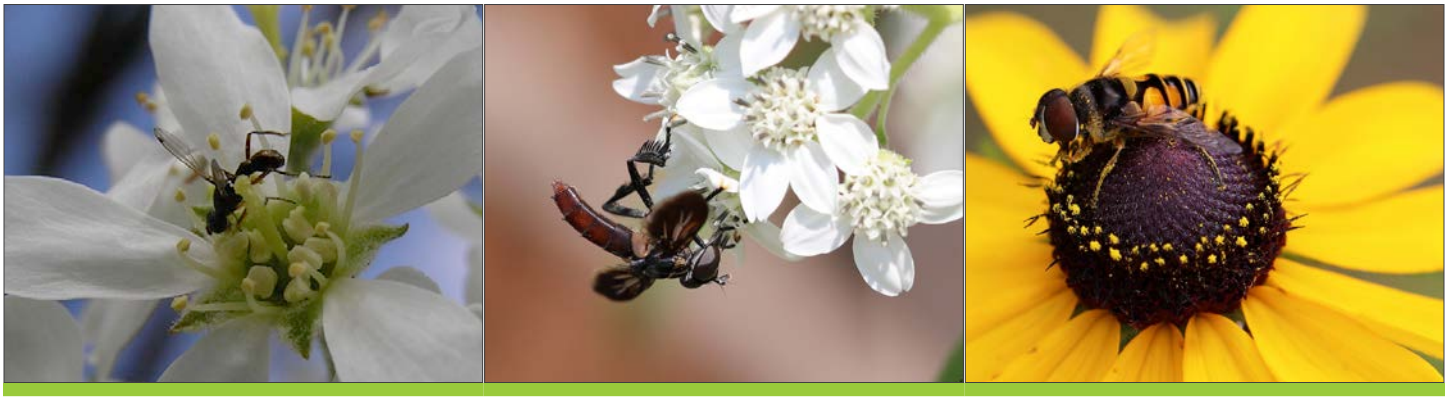


Figure 11—*left to right*: Flies are especially important pollinators for early spring flowers such as serviceberry (*Amelanchier* sp.) that produces a delicious berry in June, giving it another common name, Juneberry. Tachinid flies eat nectar and pollen as adults (on white crownbeard, [*Verbesina virginica*]), and lay their eggs (or deposit live larvae) on or near crop pests such as stink bugs and cabbage moth caterpillars—only a few tachinids lay eggs in their hosts. Providing native plant forage for adults, such as this black-eyed Susan (*Rudbeckia* sp., with a syrphid fly) can help reduce pest outbreaks on farms and in gardens. Mimicking bees may make flower-visiting flies less likely to be eaten by birds or other insect predators. (Photos: Nancy Lee Adamson [left]; Steve Duzan (center and right).)

Flies can be distinguished from bees and wasps by larger eyes that often nearly touch one another, variable antennae that may be stubby (vs. long and slender in bees and wasps), and by their single set of wings. Instead of a pair of hind wings, flies have halteres—short rods

with a round tip that are modified wings (aiding in balance). Flies have sucking mouthparts that are sponge-like rather than cylindrical (like those of bees and wasps). Most flower-visiting flies are far less hairy than bees. Like wasps, many visit composite or umbelliferous flowers that have clusters of tiny flowers packed close together—simply moving across the cluster can help move pollen from flower to flower.In agriculture, except in cool and wet climates, flies are often appreciated more for their role in pest management than pollination. Many adult and larval flies are voracious predators or effective parasitoids of other insects or insect eggs on plants, including aphids, white flies, and stink bugs. Flies that mimic other insects, especially bees, may intimidate potential predators. Another very important role of flies is decomposition. Fly larvae are particularly important in helping to break down organic matter and spread fungal spores that also help with decomposition, helping to recycle vital nutrients in food webs.

3. Coleoptera—Beetles

Beetles are the oldest and most diverse group of pollinators, but in temperate regions are considered more important for pollinating wild plants than agricultural crops. There are about 30,000 species of beetles in North America and over 340,000 species worldwide. Common flower-visiting beetles include ladybugs (a.k.a. lady beetles, Coccinellidae), soldier beetles (Cantharidae), long-horned beetles (Cerambycidae), jewel beetles (Buprestidae), blister beetles (Meloidae), scarab beetles (Scarabaeidae), soft-winged beetles (Melyridae), checkered beetles (Cleridae), tumbling flower beetles (Mordellidae), and sap beetles (Nitidulidae). Ground beetles (Carabidae) and rove beetles (Staphylinidae) are also very important in agriculture as predators of crop pests and/or consumers of weed seeds. Some flower-visiting beetles, like delta flower beetles (Trigonopeltastes delta), consume pollen and nectar only, while others, such as lady beetles also prey on other insects visiting flowers. Beetle-pollinated flowers are often heavily scented, large, light-colored, with a bowl shape and easily accessible pollen—like magnolia flowers. Beetles also pollinate plants with clusters of small flowers like buckwheat, onion, mountain mint, and goldenrod. Scents attractive to beetles may be sweet or spicy or mimic decaying organic material. Some plants pollinated by beetles are thermogenic—they create heat that helps disperse volatile plant chemicals that attract pollinators.

Figure 12—*left to right*: The spotted lady beetle a.k.a. “C-mac” (*Coleomegilla maculata*) is a native species that may be collecting pollen from flowers, like strawberries (*Fragaria* sp.), and also searching for tiny insects to eat. Lady beetle larvae also consume pollen and nectar (primarily from extra-floral nectaries), but are best known as voracious predators of aphids and other tiny crop pests, here on a bean leaf consuming aphids. Many insects have specialized relationships with plants, such as this milkweed beetle (*Tetraopes tetrophthalmus*) on swamp milkweed (*Asclepias incarnata*). The bold black and red or orange colors warn predators that they are toxic. (Photos: Eric Riddick, USDA ARS [left]; Nancy Lee Adamson [center, right].)

4. Lepidoptera—Butterflies and Moths

Lepidoptera include some of the most widespread and widely recognizable insects in the world, encompassing moths and the two superfamilies of butterflies and skippers (Papilionoidea) and moth-butterflies (Hedyloidea). In Arkansas, they are especially important pollinators of some native lilies (*Lilium* spp.) and azaleas (*Rhododendron* spp.). Butterflies are probably the most recognized and conspicuous insects and, therefore, most noticeable insect pollinators on the planet. They start their lives as larvae (caterpillars) with only chewing mouthparts and transform into adults with wings, but without the ability to chew—adults only drink liquids. Lepidoptera use differing strategies to survive the winter including migration to warmer climates or overwintering as eggs, larvae, pupae, or adults. Moths typically tend to be active during the night and butterflies are active in daylight, but there are exceptions. While most moths are colored to blend in with bark or leaves during the day, some are nearly as brightly colored as butterflies.Moths and butterflies need leaves and other plant tissues for larvae and nectar for adults. Butterfly gardens and waystations for migratory monarchs have multiple benefits for providing habitat and educating communities. Relatively small landscape footprints and low establishment costs continue to make them popular.

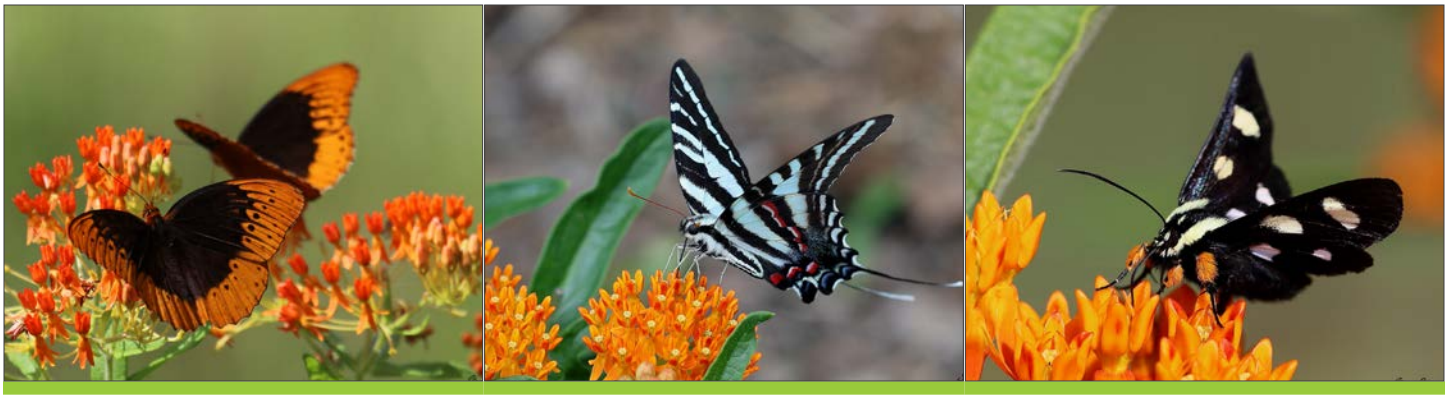


Figure 13—*left to right*: The Diana fritillary butterfly (*Speyeria diana*) is Arkansas' state butterfly, here nectaring on butterfly milkweed (*Asclepias tuberosa*). The zebra swallowtail butterfly (*Protographium marcellus*) and eight-spotted forester moth (*Alypia octomaculata*), a day-flying moth, are also nectaring on butterfly milkweed. Their larval host plants are violets (*Viola* spp.), pawpaw (*Asimina triloba*), and Virginia creeper (*Parthenocissus quinquefolia*), respectively. (Photos: Steve Duzan.)

The Monarch Butterfly

The monarch butterfly (*Danaus plexippus*) is probably the most well-known butterfly in North America. There are three populations in the United States. The eastern population is the largest and winters in a single region—the forested mountains of central Mexico. The western population is much smaller and overwinters in forests in coastal California. There is also a small non-migratory population that remains in southern Florida year-round.

Figure 14—*left to right*: Blazing stars (*Liatris* spp.), and native perennial sunflowers (*Helianthus* spp.), are vital nectar sources for fall-migrating monarchs. With wings open, the two dots on the hind wing and relatively narrow veins let observers know this monarch is male. Monarch caterpillars make it hard for predators to know which end is the front (longer antennae) as they eat milkweed leaves. (Photos: Steve Duzan.)

In early March each year, monarch butterflies overwintering in Mexico become more active at their overwintering sites and begin to mate. As the days grow longer in mid-March, they leave their roosts to fly north, looking for milkweed plants on which to lay their eggs. These monarchs have already survived a long southern migration dodging hungry predators and many other obstacles. They are the only monarchs left that can produce a new generation; but if they return too early—before the milkweed is growing in the spring—they will not be able to lay their eggs and continue the cycle. Most of them make it no further than Texas and the Gulf Coast States, but significant numbers reach Oklahoma and Arkansas. If female monarchs find milkweeds in these states in March and April, they lay eggs on them, typically no more than two eggs on any single milkweed plant. After three to five days, those eggs hatch into caterpillars, which feed exclusively on milkweed plants, grow, change into pupae, and then emerge as the familiar orange-and-black adults about one month after eggs are laid. These adults are known as first generation monarchs; most monarchs seen in Arkansas during spring are part of this generation. In late April and May, first generation monarchs migrate north. As they fly north as far as southern Canada, they lay eggs on milkweeds they find on the way. Those eggs develop into second generation adults, which give rise to third generation adults, and so on. Since each female lays up to 400 eggs before dying, the total population of monarch butterflies increases throughout the summer—as long as weather and other conditions are favorable for survival and reproduction.

Figure 15—*left to right*: Monarch adult female ovipositing and egg on the underside of a common milkweed (*Asclepias syriaca*); this egg will hatch, and the larva will have ample food from the healthy milkweed plant. Monarch caterpillars often seek non-milkweed sites when ready to pupate, such as grasses. Fall-migrating monarchs roost in trees during their flight south when they encounter a strong wind on a warm fall day. (Photos: Ryan Diener, Quail Forever [left, right]; William Warby/flickr [center].)

Depending on weather conditions, the eastern monarchs may have as many as five generations during spring and summer. This multi-generational migration results in the eastern population spreading to all states east of the Rocky Mountains and into southern Canada. In the fall, individuals from the final summer generation migrate south to wintering grounds in central Mexico, and the annual cycle is repeated the following spring. Fall-migrating monarchs are most commonly seen heading south in Arkansas in September and October.

Most milkweeds contain cardiac glycosides which are stored in the bodies of both the caterpillar and adult. These poisons are distasteful to birds and other predators. After tasting a monarch, a predator might associate the bright warning colors of the adult or caterpillar with an unpleasant meal and avoid monarchs in the future.

Intensifying agriculture, development of rural lands, and the use of mowing and herbicides to control vegetation have all reduced the abundance of naturally occurring milkweeds. This has resulted in a substantial loss of critical resources available for monarchs throughout much of the United States.

Imperiled Species of Arkansas

Although Arkansas is home to thousands of species of plants and animals that are believed to be abundant and secure populations, the state is also home to rare and imperiled species. At the request of the U.S. Fish and Wildlife Service, the Arkansas Game and Fish Commission (AGFC) published the Arkansas Wildlife Action Plan in 2005 (and revised the plan in 2006 and 2015). This plan, available to the public online, describes the strategies that AGFC has developed for the conservation of non-game species in Arkansas, particularly for rare and imperiled species. These species, referred to as Species of Greatest Conservation Need (SGCN), include 35 species of pollinators. This set includes three species of moths, the rarest of which is the rattlesnake master borer moth (*Papaipema eryngii*). The AGFC identified 31 species of butterflies as SGCN, including well-known species such as the monarch and more obscure species such as the lace-winged roadside skipper (*Amblyscirtes aesculapius*). Five butterfly species are critically imperiled in the state: the Appalachian azure (*Celastrina neglecta major*), dusky azure (*C. nigra*), arogos skipper (*Atrytone arogos*), swamp metalmark (*Calephelis muticum*), and Texas frosted elfin (*Callophrys irus hadros*). Only one bee species is listed as an SGCN: the anthophorid bee, *Tetraloniella albata*, which is known from one site in the state. Given that Arkansas is home to hundreds of native bee species, it is possible that other bee species are imperiled as well, but we suspect that lack of data on bee abundance and distribution within Arkansas (as in many states) makes it difficult to know the status of most bee species.

Figure 16—*left to right*: Many species of concern require specific food plants to complete their life cycles. Monarchs need milkweeds, but other examples include the rattlesnake master borer moth (*Papaipema eryngii*) that depends on rattlesnake master (*Eryngium yuccifolium*); and the Diana fritillary butterfly whose larvae require native violet species such as Bird's foot violet (*Viola pedata*). (Photos: Bill Glass [left]; Ryan Diener, Quail Forever [center, right].)

Pollinator Biology and Habitat

Natural areas on and near farms can serve as refugia for native pollinators. Protecting, enhancing, and providing habitat is the best way to conserve native pollinators and provide pollen and nectar resources that support them. On farms with sufficient natural habitat, native pollinators can provide all of the pollination for some crops. These areas also support native predators and parasitoids that reduce crop pest populations.

Figure 17—Unmown areas with abundant native forbs or winter weeds that flower when the main crop is not in bloom, such as these flowering forbs in the understory and some shrubs and trees adjacent to this peach orchard, can support resident pollinator populations through the growing season and over winter. (Photo: Creston Shrum, AR NRCS.)

Pollinators have three basic habitat requirements. These include **1)** foraging plants (sources of pollen and nectar), **2)** nesting sites; and **3)** protection or shelter (from disturbance or pesticides). Pollinators must have access to a diversity of plants with overlapping bloom times so that flowers are available to provide pollen and nectar from early in the spring until late in the fall. Because pollinator needs vary, it is important to provide flowers of different sizes, shapes, and colors. To support as many bees and other pollinators as possible, we must have a great diversity of native forbs, grasses, shrubs, and trees.

Second, they need places to nest. The majority of native bees are solitary and do not build the wax or paper structures we associate with honey bees or wasps. Most bees nest in small interconnected tunnels and cells they construct underground. Others nest in narrow tunnels often left behind by beetle larvae in dead trees, and a few use the soft pith of some plants. Whether underground or in snags, most solitary bees spend the greater part of the year maturing in their nest (brood) cells. In these cells, they are vulnerable to mechanical nest disturbances such as deep soil tillage or tree removal.

Bumble bees are the most familiar social bee group native to the United States. They require small cavities, either in trees, underground, or under clumps of lodged grass. Often, they move into old rodent burrows. Because their nests are started anew each spring by overwintering queens, bumble bees need cavities to raise their young, as well as undisturbed duff for queens to burrow and hibernate through the winter.

Finally, bees need protection from most pesticides. Many insecticides are broad-spectrum and are therefore deadly to bees. Furthermore, indiscriminate herbicide use can remove many of the flowers that bees need for food or, if sprayed when bees are visiting, may destroy the waxy cuticle that protects them. Sections of this handbook are dedicated to explaining how these three needs (foraging plants, nesting sites, and protection or shelter) may be created, enhanced, or maintained.

Table 1: General Pollinator Habitat Requirements*

POLLINATOR		FOOD / SHELTER
Solitary Bees		Pollen and nectar. Most nest in bare or partially vegetated, well-drained soil, while a few use wetter clay soils. Many others nest in narrow tunnels in dead standing trees, or excavate nests within the pith of stems and twigs. Some construct domed nests of mud, plant resins, saps, or gums on the surface of—or cavities within—rocks, trees, or other structures.
Bumble Bees		Pollen and nectar. Most nest in small (softball size) cavities, are often underground in abandoned rodent nests, or under clumps of grass. May also occur in hollow trees, bird nests, bird houses, or walls.
Butterflies & Moths	**Egg**	Non-feeding stage. Usually on or near larval host plant.
	Caterpillar	Leaves and other parts of larval host plants. Larval host plants.
	Pupa	Non-feeding stage. A protected site—often not the host plant—such as a shrub, brush piles, tall grass, a pile of leaves or sticks or, in the case of some moths, underground.
	Adult	Nectar; some males obtain nutrients, minerals, and salt from rotting fruit, tree sap, animal dung and urine, carrion, clay deposits, and mud puddles. Protected site such as a tree, shrub, brush piles, tall grass, or a pile of leaves, sticks, or rocks.
Ruby-throated hummingbirds†		Nectar, insects, tree sap, spiders, caterpillars, aphids, insect eggs, and willow catkins; respond well to red, deep-throated flowers, such as cardinal flower, trumpet creeper, or penstemons. Trees, shrubs, and vines. Nests made of mosses, lichens; thistle and cattail, and other soft lining materials like feathers, cotton or wool; spider silk for binding; and bits of bark and leaves may help to conceal.
KEY: FOOD SHELTER		

* Adapted from: *Native Pollinators (February 2006)*.

† Not significant crop pollinators.

Pollinator Conservation and Farm Planning

Pollinator habitat (any habitat that provides a diversity and abundance of native flowering plants—i.e., prairie, woodlands and forests managed with thinning and prescribed fire, young forest, or native forb and grass plantings) provides multiple benefits. Diverse native plantings benefit other wildlife species in addition to monarchs and other pollinators, such as bobwhite quail, turkey, and deer. They can serve as corridors to facilitate wildlife movement, help stabilize and build soil, and improve water quality. Native habitat plantings also support other beneficial insects that prey on crop pests and help eliminate or reduce pesticide use on farms. Planners should become familiar with locally common agricultural pests and their biology to avoid inadvertent increases in pests when promoting pollinators, though maintaining predator populations generally far outweighs any risk of pest population increase.

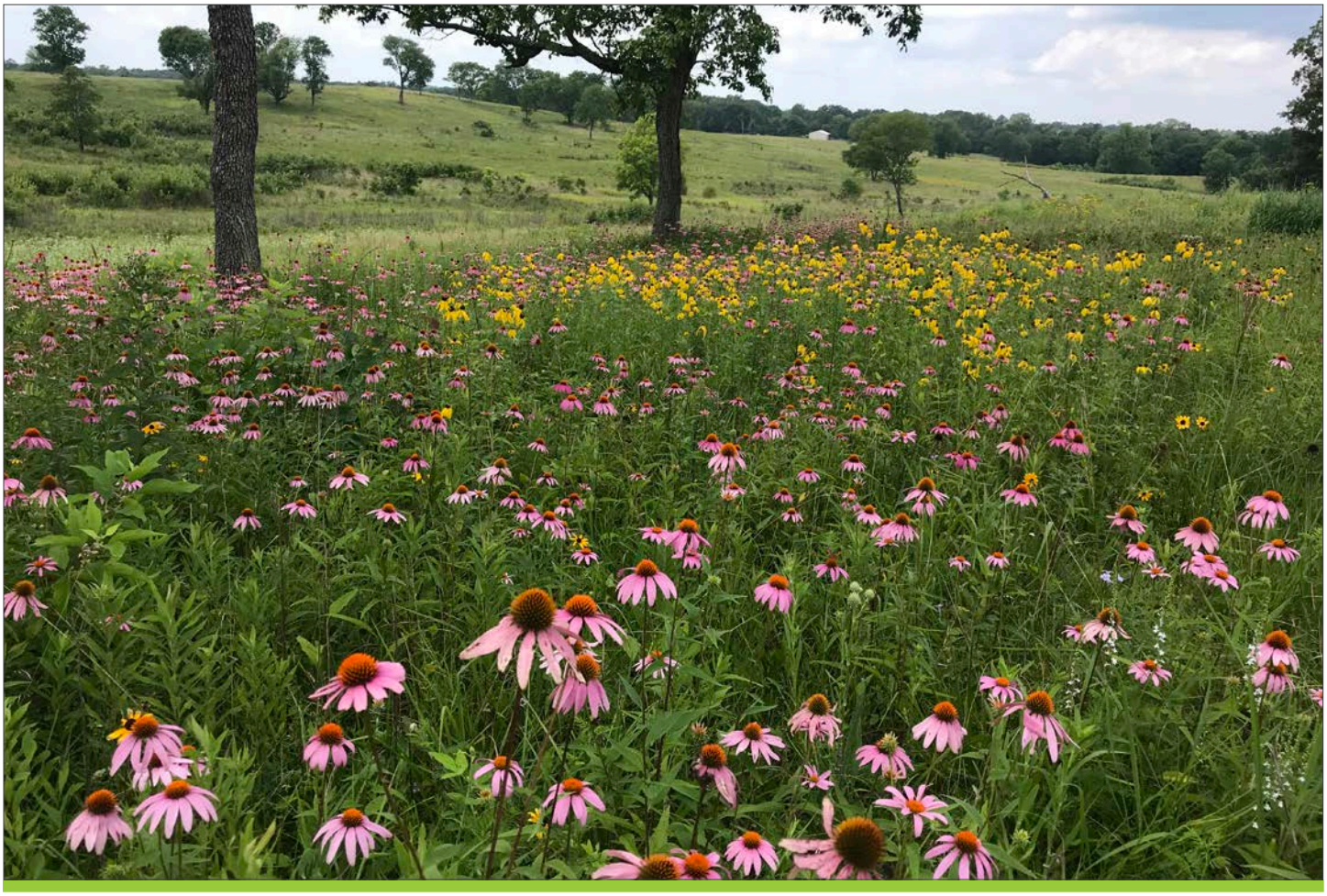


Figure 18—When planning pollinator habitat, consider using open, sunny areas and the existing plants and trees that occur naturally. Select complimentary plants that augment those that already exist in the landscape like this Grant County, Arkansas, site. (Photo: Kelly Bufkin, Quail Forever.)

Many of the NRCS conservation practices that we plan and implement on a regular basis can be significant pollinator enhancement practices with simple adjustments to increase floral diversity. These practices can also improve the overall aesthetics of a landscape by adding color and structure from early spring to late fall and often over the winter.

This document provides a four-step approach to pollinator conservation which includes: **1)** advice on **recognizing existing pollinator habitat**; **2)** steps to **protect pollinators** and existing habitat; **3)** methods to **create, enhance, or restore habitat** for pollinators; and **4)** methods for **managing habitat** for the benefit of a diverse pollinator community.

I. Recognizing Existing Pollinator Habitat

Many landowners may already have an abundance of habitat for native pollinators on or near their land. Having natural or semi-natural habitat available significantly increases pollinator populations. Linear habitats along field margins such as field edges, hedgerows, and drainage ditches offer both nesting and foraging locations for a variety of pollinators. Woodlots, conservation areas, utility easements, farm roads, and other untilled areas may also contain good habitat. Often, marginal areas, less fit for crops, may be best used and managed as pollinator habitat. Forests and woodlands managed for diverse plant communities include floral resources, resins, and nesting sites that support a tremendous diversity of pollinators, as well. Pollinator habitat near crops not only helps ensure successful crop pollination, but also helps support pest management by helping natural enemies of crop pests thrive. These habitats support diverse predatory and parasitoid insects that help reduce crop pest populations. While the focus of this document is on pollinators, predators and parasitoids (such as wasps, flies, spiders, ladybugs, ambush bugs, lacewings, mantids, and assassin bugs) depend on the same habitat. Many also feed on nectar and pollen at one or more stages of their lives. The diversity of flowering plants—and the insects they support—in turn provide food for birds, mammals, and other wildlife such as monarch butterflies (*Danaus plexippus*). In this chapter, we provide advice on recognizing specific habitat resources so that they can be factored into farm planning.

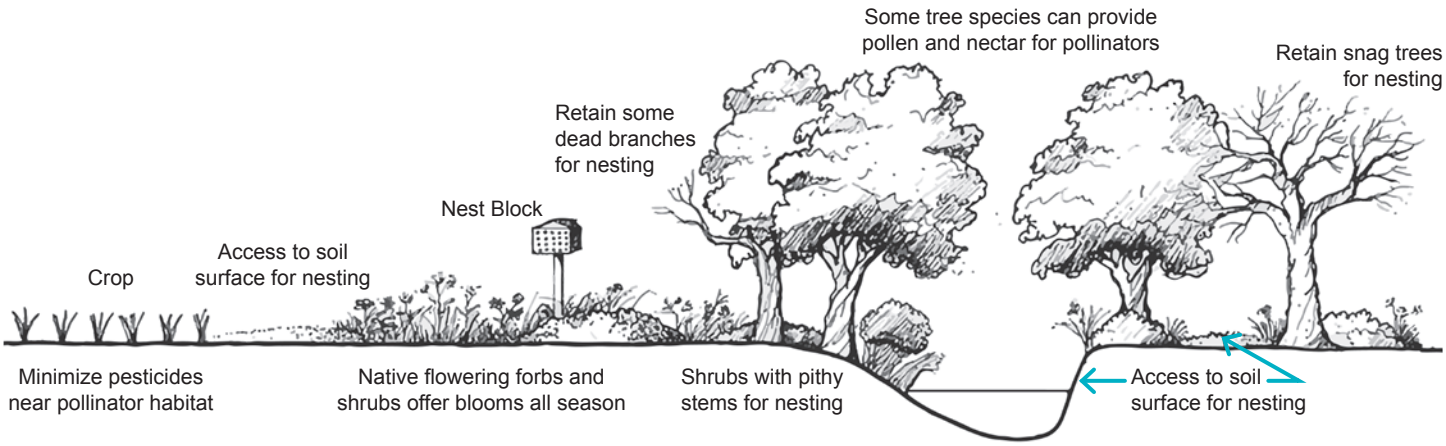


Figure 19—Many existing landscapes already possess food, nesting sites, and other critical resources for pollinators. Graphic adapted from *Enhancing Nest Sites for Native Bee Crop Pollinators (February 2007)*.

A. Plant Communities Providing Nectar, Pollen, and Habitat

Arkansas is home to diverse native plant communities that evolved with local insects and other wildlife. The landscape of Arkansas was historically a complex mosaic of treeless grasslands, savannas, open woodlands, closed forests, and wetlands, each existing on sites with the right environmental conditions to support them. Periodic natural disturbance processes like fire, drought, flooding, and grazing and browsing by herbivores, keep habitats open and filled with sun-loving wildflowers and grasses, while naturally closed habitats like mesic forests may be dominated by shade-tolerant plants that can bloom under a more closed canopy.

When assessing pollen and nectar resources in cultivated landscapes, it is important to look at all of the potential plant resources on and around a landowner's or producer's property and which species of plants are heavily visited by bees and other pollinators. These plants may include insect-pollinated crops, as well as the flowers and forbs in buffer areas, forest edges, hedgerows, roadsides, natural areas, fallow fields, etc. Insect-pollinated crops may supply abundant forage for short periods of time, and such flowering crops should be factored into an overall farm plan if a landowner is interested in supporting native pollinators. However, for pollinators to be most productive, nectar and pollen resources are needed outside the period of crop bloom. This ensures a consistent food source for pollinators throughout the growing season (i.e., spring, summer, and fall).

As long as a plant is not a noxious or state-listed invasive weed species that should be removed or controlled, landowners might consider allowing some of the native or non-native forbs that are currently present on the property to bloom prior to and during their crop bloom to attract and support pollinators and predators. However, it is strongly recommended that only regionally-appropriate, native plant species be used and selected in the planning process.

Some non-native flowering plants can be good resources for pollinating insects. For example, dandelion (*Taraxacum* spp.), clovers (*Trifolium* spp.), and other non-native plants provide valuable pollinator forage. Producers who let those plants flower or allow some

crops to bolt are providing valuable pollinator resources. Many non-native plants attract common species of pollinators that are generalists that feed on a wide range of plants, but they are of little value to specialists that require specific native plants within one family or genus. The flowers of arugula (*Eruca vesicaria* ssp. *sativa*), chervil (*Anthriscus cerefolium*), chicory (*Cichorium intybus*), mustards (*Brassica* spp.) and other greens also support pest management by attracting predators and parasitoids of crop pests.

Keep in mind that small bees may only fly a couple hundred yards, while large bees, such as bumble bees (*Bombus* spp.), easily forage a mile or more from their nest. Therefore, taken together, a wide array of flowering crops, wild plants on field margins, and plants up to a half mile away on adjacent land, can provide sequential blooms necessary to support a resident population of diverse pollinators and natural enemies of pests.

Figure 20—Open grassland habitat containing a variety of blooms, color, and height is key to providing resources for pollinators. Remember to consider the surrounding landscape including trees, forbs, and shrubs for the resources they provide. (Photo: Ryan Diener, Quail Forever.)

B. Nesting and Overwintering Sites

To support populations of native bees, protecting or providing nest sites is as important as providing floral resources. Similarly, if butterfly habitat is a management objective, caterpillar host plants are necessary for robust butterfly populations. It is ideal to have nesting and forage resources in the same habitat patch, but bees are able to adapt to landscapes in which nesting and forage resources are separated. However, it is important that these two key habitat components are not located too far apart.

Native bees often nest in inconspicuous locations in the ground or in cavities. Nearly all are solitary—after mating, females make and provision nests individually. Solitary bees do not have young or stores to protect, so they are never defensive, even close to their nests (they fly away or hide in their nests, if approached). It is important to retain or encourage as many naturally occurring sites as possible and to create new ones where appropriate.

Though the majority of ground-nesting bees are solitary, some will share the nest entrance or cooperate to excavate and supply the nest. Still other species will nest independently, but in large aggregations with as many as hundreds or thousands of bees excavating nests in the same area.

Figure 21—*left to right*: Most solitary bees and wasps nest underground, digging nest cavities, like this rose mallow bee (*Ptilothrix bombiformis*), mining bee (*Andrena* sp.), and sand wasp (*Bembix* sp.) taking a stink bug into a brood cell. (Photos: Nancy Lee Adamson [left, right]; Matthew Shepherd, Xerces Society [center].)

Most of North America's native bee species (about 70% or roughly 2,800 species) nest in the ground. These bees usually need direct access to the soil surface to excavate and access their nests. Ground-nesting bees seldom nest in rich soils, so poorer-quality sandy or loamy-sand soils may provide fine sites.

Approximately 30% (or roughly 1,200 species) of bees in North America are cavity-nesters. Many cavity-nesting bees nest in abandoned beetle tunnels in logs, stumps, and snags. Some can chew out the centers of woody plant stems and twigs, such as blackberry (*Rubus* spp.), elderberry (*Sambucus* spp.), sumac (*Rhus* spp.), and in the case of the large carpenter bees (*Xylocopa* spp.), even soft pines (*Pinus* spp.) and tuliptree (*Liriodendron tulipifera*). Dead limbs, logs, or snags should be preserved wherever possible. Some wood-nesters also use materials such as mud, plant materials (e.g., leaf pieces, flower petals, or fibers), or tree resins to construct brood cells in their nests.

Bumble bees are our most well-known native social bees. There are 46 species in North America. They nest in small cavities, such as abandoned rodent nests under grass tussocks or in the ground. Leaving patches of rough undisturbed grass in which rodents can nest will create future nest sites for bumble bees. Bunchgrasses or clump-forming grasses, including many native warm- and cool-season grasses, provide better nesting habitat than sod-forming grasses like Bermuda grass (*Cynodon dactylon*). These native bunchgrasses protect bees from predators and rain, yet allow movement, just as they do for other grassland wildlife. Structures such as brush piles, fences, hedgerows, and stone fences also provide nesting habitat for bumble bees.

Figure 22—*left to right*: Foraging habitat located near woody debris that can be used as nesting habitat is very important. Native clump-forming grasses like little bluestem (*Schizachyrium scoparium*), that exist in a matrix with some bare soil and forbs makes excellent nesting habitat for ground-dwelling bees. (Photos: Ryan Diener, Quail Forever.)

A secondary benefit of flower-rich foraging habitats is the provision of egg-laying sites for butterflies and moths. These insects lay their eggs on or near the plant on which their larvae will feed once they hatch. Some butterflies may rely on plants of a single species or a closely related group of plants (family, subfamily, or genus) for host plants. The monarch butterfly (*Danaus plexippus*) is an example of a species that relies on a single family of plants, Apocynaceae, primarily milkweeds (*Asclepias* spp.) in the subfamily Asclepiadoideae, along with two other genera in the same family: *Cynanchum* (swallowworts) and *Matelea* (milkvines).

Figure 23—A monarch egg on the foliage of tall green milkweed (*Asclepias hirtella*) in a remnant prairie in central Arkansas. (Photo: Ray Moranz, Xerces Society.)

Planner Note

When working with landowners who don't have large acreage, strive to establish clusters of herbaceous plants or woody shrubs at least three feet by three feet of single species. This can be a useful strategy in small settings or urban areas.

Other butterflies and moths may exploit a wide range of plants, such as the tiger swallowtail butterfly (*Papilio glaucus*) whose larvae can eat a range of trees including willow (*Salix* spp.), sweetbay magnolia (*Magnolia virginiana*), and cherry (Prunus spp.). In order to provide egg-laying habitat for the highest number of butterflies and moths, landowners should first provide plants that can be used by a number of species. Later, those plants can be supplemented with host plants targeted for more specialized species.

C. Existing Areas of Open and Woodland Landscapes

Arkansas today is characterized by a mosaic of remnant prairies, croplands, pastures, haylands, woodlands, and forests. Historically, fire and other natural disturbance helped maintain diverse plant and animal communities in a prairie landscape with scattered trees (savannas) in much of the state and open woodlands where water was more abundant or in upland habitats like those in the Ozark or Ouachita Mountains. Present day forested and grassland landscapes that are managed with thinning and prescribed fire can provide pollinator habitat that supports a variety of insects, birds, and other wildlife from spring through fall, and over winter. Early-blooming trees and shrubs can provide vital pollen and nectar for pollinators, predators, and parasitoids in early spring, and host sites for Lepidoptera (butterflies and moths) that depend on specific native trees for their offspring (caterpillars). However, without active management to increase sunlight through tree canopies that promotes the growth of herbaceous understory (and some prairie) vegetation on the forest floor or along a forest edge, forests may be less valuable.

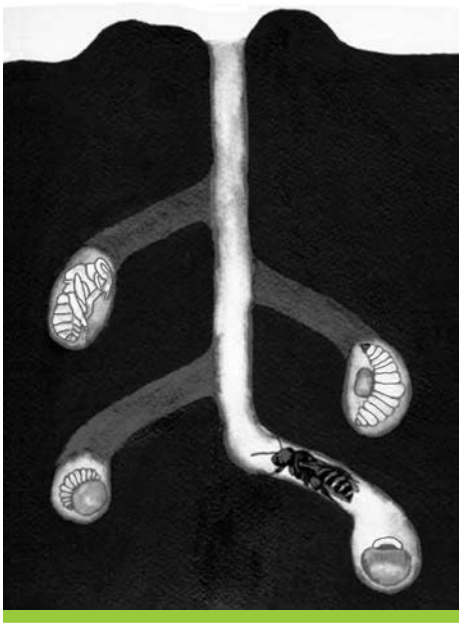


Figure 24—Solitary ground-nesting native bees spend most of the year growing through the egg, larval, and pupal stages while hidden in their nest cells underground. Adapted from the illustration by Sarina Jepsen / The Xerces Society in *Agroforestry Notes* #32 (August 2006).

High-quality managed forests, open woodlands, savannas, and grasslands are becoming increasingly fragmented, with small pockets of natural or semi-natural landscapes surrounded by farms, towns, roads, and vast swaths of dense unmanaged forests that provide little or low-quality habitat. Fragmentation makes it harder for animals to provide ecosystem services such as pollination and pest management. Pollination corridors that connect fragments of natural, planted, or managed habitat can support the movement of pollinators and other wildlife in increasingly fragmented landscapes. Such corridors help ensure more diverse communities of pollinators over time. Without active management to maintain and enhance diverse habitat corridors, plant species that do not rely on animal pollinators could eventually come to dominate. This can be seen in Arkansas with the dramatic increase in abundance and dominance of eastern red cedar (*Juniperus virginiana*) in our wooded landscapes, where fire historically maintained a much more open woodland ecosystem, and richer native plant communities.

D. Habitat Assessment Tools

To assess the quality of pollinator habitat in existing landscapes, consider using *Arkansas Wildlife Habitat Evaluation Guide for Pollinators* or *Pollinator Habitat Assessment Guides* developed by the Xerces Society in collaboration with NRCS. If existing habitat is predominantly native, planners and landowners may want to choose other sites for new plantings and consider utilizing prescribed fire or weed management, if appropriate, to enhance the natural diversity of the site rather than planting. If the site is predominantly invasive species, it may be prudent to choose a location where site prep will not be as arduous if the planting must be done soon. Sites with invasive species issues (like sericea lespedeza [*Lespedeza cuneata*] or Johnson grass [*Sorghum halepense*]) should be allowed at least two to three years of herbicide, mechanical, or cultural treatments to remove or reduce those species so a native seeding will be successful. Sites with invasive species present are great areas to work with landowners and producers to remove those species and replace them in the long term with diverse native plantings to improve the pollinator habitat quality of those sites.

E. Natural Divisions of Arkansas

Those who have traveled across Arkansas are likely to have noticed that the state is not homogenous, but instead has regions with characteristic topography, plant communities, and land uses. Based on the Environmental Protection Agency (EPA) Ecoregions (www.epa.gov/eco-research/ecoregions), Arkansas has seven natural divisions. Also see the *Arkansas Natural Heritage Commission Ecoregion Descriptions*. Below is a summary of each of Arkansas' ecoregions. Note that the Ozark Plateau is divided in the newest classification into two ecoregions, the Boston Mountains and the Ozark Highlands.

Boston Mountains

The Boston Mountains Ecoregion is the southern-most, highest, and most rugged part of the larger Ozark Plateau and is located between the Ozark Highlands and the Arkansas Valley. This region supports a mosaic of dry oak-hickory and oak-pine woodland on drier sites and mesic hardwood forest on more moist sites like north- and east-facing slopes, along streams, in deep hollows, below bluffs, and at high elevation. Small, open glades on sandstone or shale are common but widely scattered. Soils there tend to be rocky, making them less suitable for cash-crop agriculture. Therefore, the Boston Mountains had a long history of subsistence agriculture, with much of the less rugged terrain today converted to non-native pasture.

Ozark Highlands

The Ozark Highlands Ecoregion is the northern portion of the larger Ozark Plateau. It is lower in elevation and in general less rugged than the Boston Mountains. Historically the flat to gently rolling portions of the Ozark Highlands supported scattered treeless prairies and extensive oak savannas and woodlands, while the more dissected portions supported a variety of open woodlands and mesic forests. Extensive glades on limestone, dolomite, and sandstone occur in some regions. As with many regions of Arkansas, the less rugged areas of the Ozark Highlands are largely converted to non-native pasture.

Ouachita Mountains

This natural division is in west-central Arkansas, and features numerous long, rocky ridges that are often covered with mixed stands of hardwoods and short-leaf pine (*Pinus echinata*). The valleys between the ridges are often large enough to support large crop fields and pastures. The south-facing slopes and ridgetops of the Ouachitas historically supported open woodland and savanna, with glades occurring in the most rocky and shallowest soils. The moister north facing slopes of the ridges naturally support more dense woodland and forest.

Arkansas Valley

The Arkansas Valley Natural Division separates the Ozark Plateau in the north from the Ouachita Mountains in the south. Due to this valley's large amount of flat land, good soil and water, much of it is large-scale cropland or pasture. Historically, the Arkansas Valley contained large swaths of tallgrass prairie that transitioned to savanna and open woodland as it went up the hills. In contrast to the broad plains, the Arkansas Valley also includes high ridges and mesas, including the state's highest peak, Mount Magazine.

Gulf Coastal Plain

The Gulf Coastal Plain Natural Division is in southwestern and southcentral Arkansas, and is dominated by pine forest, much of which is now managed for timber production. The Coastal Plain of Arkansas, part of the West Gulf Coastal Plain ecoregion, was historically a flowing mosaic of blackland prairies, wet prairies, open woodlands, pine savannas, and bottomland hardwoods. Certain regions supported very open woodland or savanna with a diverse herbaceous understory.

Delta

The Delta Natural Division (also known as the Mississippi Alluvial Plain) includes most of the eastern third of the state, including all the land along the Mississippi River and the lower portions of the White and Arkansas rivers. It once was dominated by vast bottomland hardwood forests, but most of those forests were cleared, drained, and replaced with large crop fields characterized by deep, rich soil. Bottomland hardwood forest was far from the only habitat type in the Delta, however. The region was also home to extensive grasslands, such as the Grand Prairie, that occupied over half a million acres in the Delta. Unique elevated woodlands also existed on the higher terraces outside of the floodplains in the Delta. The sites include oak, and rarely pine, flatwoods on clay soils and upland oak woodlands or savannas on sandy or loamy soils.

Crowley's Ridge

This natural division is in northeastern Arkansas, where it rises 200 to 300' over the Delta Natural Division that surrounds it. Crowley's Ridge was formed by the long-term deposition of wind-borne soil (loess) and has a large amount of forest and woodland. The area historically consisted of both upland forests and open woodlands. The rich herbaceous growth of the ground layer was similar to both the Ozarks and the Appalachians to the east.

F. Naturally Maintained Diversity

Figure 25—The diversity of wildflowers at Baker Prairie in Boone County, Arkansas, is maintained with periodic fire. When burned regularly, grasses can carry the fire quickly through the prairie (ideally, leaving some unburned patches). Mineralized nutrients and open soil give wildflower seeds the right conditions to germinate and take root. Germination of some seeds is triggered by chemical cues in smoke. Flowers in bloom include goat's rue (*Tephrosia virginiana*), pale purple coneflower *(Echinacea pallida*), Carolina larkspur (*Delphinium carolinianum*), winecups (*Callirhoe digitata*), and compass plant *(Silphium laciniatum*). (Photo: Ryan Diener, Quail Forever.)

Fire, grazing by buffalo and elk, wind, rain, and flooding caused by precipitation and beavers have shaped the composition and diversity within these landscapes. While working to restore diversity in our cultivated landscapes, we have learned that fire helps to revitalize communities by helping to keep forest canopies open and maintain prairies. Fire helps more sunlight reach the forest floor and converts plant materials into available soil nutrients, stimulating germination of some seeds, the release of seeds from some plants (pines), and providing dead or downed wood for diverse wildlife. Annual flooding also replenishes soil nutrients, and prevents some wet-intolerant plants from persisting, maintaining open wet meadows or opening forest canopies, which helps enhance floral diversity. Flooding caused by beavers similarly supports greater floral diversity, which leads to greater pollinator and other insect diversity, enriching the diets of many other animals, enhancing water supplies and supporting flowering during times of drought, and providing habitat for waterfowl (resident and migratory species). New research has found that where beaver dams persist, floods caused by 100-year-storms cause less damage because water infiltrates better in the beaver pond soils. Wind falls and blowouts from lightning strikes also open canopies. The dead wood feeds myriad insects and provides nesting sites for cavity-nesting bees. Decaying wood also provides moist conditions where seeds germinate and are more likely to grow to maturity. Understanding how natural cycles help maintain diversity can guide planning and help improve pollination and pest management in our agricultural landscapes.

II. Protecting Pollinators and Their Habitat

Farm management can greatly enhance the value of pollinator habitat for agricultural production. Understanding how pollinators, predators, and parasitoids use farm habitats can help producers better support insects and insect allies that improve the size, quantity, and quality of many of the crops they grow. Farmers can improve habitat connectivity and manage disturbance such as mowing, tillage, prescribed burning, or pesticide use to enhance benefits to and reduce negative impacts on insects, spiders, and other beneficial wildlife that support agricultural production.

Relatively small management changes in mowing and tillage practices can enhance existing marginal habitat or reduce negative impacts on the diversity of insect populations, improving pollination and reducing pest outbreaks. Likewise, adopting non-chemical pest prevention and management techniques to reduce pesticide use, adjusting the types and timing of pesticides applied, and preventing off-site movement such as drift can reduce negative impacts on non-target pollinators, predators, and parasitoids. Predators and parasitoids reduce the likelihood of pest outbreaks and pest management costs. If chemicals are being applied, planners may need to work with landowners to ensure a fully integrated pest management system is in place.

For more detailed planning guidance beyond the summaries included here, see:

- *Agronomy Technical Note No. 9—Preventing or Mitigating Potential Negative Impacts of Pesticides on Pollinators Using Integrated Pest Management and Other Conservation Practices (February 2014)*
- *Pest Management Conservation System Practice Standard (595)* [https://efotg.sc.egov.usda.gov/references/public/AR/Integrated_Pest_Management.pdf]
- Windows Pesticide Screening Tool (WIN-PST). Planners working with landowners who apply chemicals on land that is part of a conservation agreement may need to use WIN-PST to develop site-specific implementation requirements (see last section of this chapter).
- *Using Agroforestry Practices to Reduce Pesticide Risks to Pollinators & Other Agriculturally Beneficial Insects (June 2017)*
- Pesticide Risk Tool
- Bee Precaution Pesticide Ratings

A. Enhancing Connectivity in Time and Space

Close proximity to habitat improves crop pollination and pest management. The shorter the distance pollinators and predators travel to a crop, the more likely they are to visit the crop, the lower their energy costs, and the more successful their nesting. Pollinators and other beneficial insects depend on the resources in adjacent habitat, particularly before and after crops flower or produce. Scientists recommend habitat within 500' of crops. Although diverse insects have diverse needs, farmers can keep in mind some basic principles to enhance habitat. See the Best Management Practices section for detailed recommendations.

- ***Maintain habitat connectivity.*** Identify habitat corridors and try to maintain connectivity between crops and habitat. Although bees and many other insects are mobile, they are more likely to travel within habitat corridors. Some predators like ground beetles and spiders will move more readily through vegetation where they are safer from larger predators and less exposed to the sun (insects are very susceptible to desiccation).
- ***Reduce mowing.*** Simply reducing mowing can provide tremendously valuable habitat. Leaving land adjacent to crops, including weedy species, unmown as long as possible can provide nesting areas, nectar and pollen year-round. Winter weeds, both native and non-native, can be especially important with unpredictable climate impacts that lead to earlier and later bloom times or unexpected frost kill of flowers that pollinators depend on, such as spring-blooming trees and shrubs.
- ***Habitat is 3D*** (three dimensional)—ground layer, mid-layer, and taller plant materials. Including shrubs and small trees, or maintaining brush piles in areas adjacent to croplands helps ensure habitat persists when mowing field edges, and also provides a "hedge" against trucks or farm equipment that compact soil and can reduce its suitability for nesting.
- ***The shorter the distance to habitat, the better for pollination and pest management.*** Field borders and adjacent habitat are vital, but strip farming, strip cover crops, or beetle banks can greatly improve connectivity. Strip farming is planting different kinds of crops (with different harvest times) in long patches that are wide enough for management yet enhance diversity in a crop field. Strips of annual cover crops or perennial beetle banks (perennial native grasses and forbs) within crop fields likewise reduce the distance beneficial insects travel to pollinate or consume pests or weed seeds. While choosing crops and covers, keep in mind potential impacts of pesticides or herbicides applied to adjacent cash or cover crops.
- ***Maintain some areas free of disturbance.*** In addition to keeping habitat close to crops, avoid disturbing all of the cropland or

surrounding habitat at the same time, so that refugia (areas not disturbed that year) are always present. For practical reasons, land managers cannot always avoid disturbing a whole area at once, so having diverse habitats helps mitigate losses in one area. Leave plant debris as long as possible between plantings and over winter. Refugia are important for pollinators, predators, and for prey for predators. Predatory insects need alternative prey (in addition to pests on crops) so they remain near crop fields before crops grow and after harvest.

- ***Rotate mowing or burning regimes.*** Aim to rotate timing of disturbance through the year over several years to promote diversity. For example, if an area must be mown annually to prevent tree encroachment, create a patch system that allows for mowing one patch in early spring one year, late summer the next, and fall the next.
- ***Avoid deep tillage.*** If tilling is needed, try to avoid deep tillage, since many bees and beetles nest or live in the ground. Many adult ground beetles prey on crop pests or consume weed seeds, as do the larvae of a variety of insects that live in or very close to the surface of the soil. No-till farming has been shown to increase the abundance and diversity of beneficial insects.
- ***Plant drift barriers.*** If pesticide use is unavoidable, agroforestry practices such as windbreaks and hedgerows (narrow plantings of shrubs and trees) can reduce wind, trap particulates, provide refuge, and provide alternate food sources. If adjacent crops are not likely to be sprayed when the barrier plants are in flower, including flowering species can be beneficial; otherwise, evergreen species or native grasses may be best. Buffers of native grass to separate crop field edges from pollinator habitat also provide protection from drift. Planting a strip of native grasses at least 30' wide (up to 60') can reduce drift into the pollinator forage habitat drastically. See Weather Considerations section below for more details.

Planner Note

Consider using vegetative screens in areas where pesticides are utilized or bees are foraging. Conservation practices such as hedgerows, windbreaks, tree/shrub establishment, and vegetative barriers. Each can provide differing levels of protection and chemical interception. Conifers may work best for interception, but if the hedgerow flowers well before a crop field is sprayed, flowering hedgerows that also provide food (pollen and nectar) enhance habitat.

B. Minimizing Pesticide Use

Pesticides, including insecticides, herbicides, fungicides and miticides are common farm management tools. Unfortunately, their use can negatively affect pollinators and other agriculturally beneficial insects. Producers ideally use pesticides on a limited basis, within integrated pest management (IPM) plans that utilize a variety of practices, including enhancing diversity, to reduce pest outbreaks.

Integrated pest and pollinator management (IPPM) goes one step further than IPM by recognizing the multiple benefits of habitat for farm production (Biddinger et al. 2015). This section highlights ways to eliminate or reduce pesticide use and make choices regarding pesticide target range, formulation, and timing to reduce negative impacts of pesticides on non-target organisms and to help ensure overall farm and community health. Alternatives to pesticides and the Windows Pesticide Screening Tool (WIN-PST) are also discussed.

C. Pesticide Exposure Pathways

Pollinators and other beneficial insects can be exposed to pesticides, conventional and organic, at the site of application, as well as in areas that have not been treated but have become contaminated by chemicals drifting, leaching, or otherwise moving off the intended site. Contact exposure can occur when pesticides are applied while pollinators or other beneficials are actively foraging, collecting nest materials, hunting prey, or when parasitoids are developing within their hosts/crop pests, on or near the target crops. Not all contact exposure occurs during a pesticide application. Residual contact occurs hours to days after application when insects are visiting flowers, walking on treated leaves, or gathering contaminated nectar, pollen, or nesting materials. Systemic pesticides (from seed coatings, soil drenches, trunk injections, and foliar sprays) may also be taken up by non-target plants. Soils and brushy areas where many native insects nest can become contaminated, exposing both adults and young. Predators and parasitoids, such as wasps, can also be exposed by ingesting poisoned prey or hosts.

Lethal (immediate killing of the pollinator, predator, or parasitoid) and sublethal impacts can negatively impact pollination and pest management. Sublethal effects include impeding foraging success, reducing fecundity and nesting success, or reducing growth—particularly of parasitoid insects that develop within their hosts, or larvae ingesting contaminated pollen, nectar, or prey their mothers collect for them (when provisioning brood cells).

D. Reducing Non-Target Impacts

Basic rules of thumb for avoiding non-target impacts of pesticides include:

Maintain healthy soil and plants. Healthy plants are less susceptible to pests. Practices that support healthy soil microorganisms; the use of disease- and pest-resistant plant varieties; the use of cover crops to improve soil health, retain moisture, and reduce soil temperatures; and enhancing crop and farm diversity overall, reduce the likelihood of pest and disease outbreaks.

Monitor pest and beneficial insect populations; learn economic thresholds. Monitor to keep track of pest and predator presence in crops and adjacent farmland. Many pests and predators look very similar, so learning how to identify both is key to reducing pesticide use and negative non-target impacts. Some crop damage does not necessarily reduce production, and can actually stimulate plants to grow more vigorously, so learning economic thresholds for each crop will help eliminate or reduce pesticide use.

- Arkansas Pest Management—Insects, Weeds, and Plant Diseases: pest and disease identification tools care of University of Arkansas Extension [www.uaex.edu/farm-ranch/pest-management/].
- *Habitat Planning for Beneficial Insects*.
- *Beneficial Insect Scouting Guides* for natural pest control provide simple protocols for monitoring natural enemies of pests. People are often surprised at how many of the insects they find are pest predators rather than pests when they start scouting regularly.

Expand the use of cultural, mechanical, physical, and other management methods. The University of Arkansas Rosen Alternative Pest Control Center [http://rosencenter.uark.edu/] helps inform Arkansas Cooperative Extension's farm and ranch recommendations [www.uaex.edu/farm-ranch/default.aspx]. Available pesticide alternatives depend on crop and farm size. Maximizing crop diversity and rotation helps reduce pest outbreaks. In crops like apples, pheromones for mating disruption and kaolin clay do not kill pests but interfere with pest behavior to reduce pest populations and crop damage. Physical barriers include trap crops, row covers, and netting. The same plant diversity on farms that supports pollinators also supports natural enemies of pests.

Apply pest control (non-chemical or chemical) only when an economic threshold is reached. Contact your local extension agent to learn the most current threshold recommendations or submit questions to Arkansas Cooperative Extension's "Ask the Pest Crew" (www.uaex.edu/farm-ranch/pest-management/ask-pest-crew.aspx).

Follow pesticide label but be aware of its limitations. In addition to being required by law to be followed, labels include guidelines aimed at reducing potential drift. Pesticide labels will occasionally provide specific guidelines on acceptable wind velocities for spraying a particular product. Always check and follow those recommendations when present.

Choose the pesticide least toxic to bees. Using the Windows Pesticide Screening Tool (WIN-PST), NRCS planners can help farmers determine which pesticides are least toxic to bees and mitigate unintended risk tradeoffs.

Avoid applying pesticides on crops in bloom or when field borders are in flower; or mow blooming plants prior to spraying. This reduces direct contact with pollinators and flying insects such as predatory wasps and flies, but will not protect slower-moving or ground-dwelling insects such as syrphid fly larvae (that consume aphids and other small pests on crops), ground beetles (that consume pest nematodes, etc. and weed seeds), or ground-nesting native bees such as squash and mining bees.

Avoid applying pesticides during the day when pollinators are foraging or most active. Mid-day spraying is also less desirable because as the ground warms, rising air can lift the spray particles in vertical convection currents. These droplets may remain aloft for some time, and can travel many miles. Spraying in the evening or very early morning reduces the likelihood of direct contact but will not protect male bees and other insects that sleep on plants or are active at night, such as moths. Applications during low temperatures may also reduce contact since many bees are less active in cooler conditions. However, cool temperatures and dewy nights may cause an insecticide to remain wet on the foliage and be more toxic to bees and other insects the following morning. **Note that some crops and wild plants that do not require insect pollination, like corn and oaks, are nevertheless visited by bees collecting pollen.**

A Note about Pesticide Labels

Bear in mind that pesticide labels do not address some of the unique risks faced by native pollinators and other non-target insects. While some pesticide labels include requirements to minimize bee exposures, these practices were mostly developed with consideration for honey bee (*Apis mellifera*) hives. For example, label directions may require that beekeepers move hives away from spray areas or cover their hives during spraying operations whereas wild bees can continue to forage and nest in treated areas. Furthermore, applications that cause soil contamination (e.g., planting treated seed and using soil drenches) don't include protections for the 70% of native bees that are ground-nesting. Pesticide labels also often fail to address some of the more subtle concerns that pesticides pose to both honey bees and native bees. For example, pesticide labels don't address the potential effects caused by fungicide exposure.

Reducing Negative Impacts of Pesticides in Row Crops Brings Higher Yields

Arkansas cotton (*Gossypium* spp.) farmers produce 7% of cotton in the United States, making Arkansas third in the nation's production. Although cotton does not require pollinators, cross-pollination can improve yield and quality. Besides the rose mallow bee (*Ptilothrix bombiformis*)*, a bee that specializes on pollen from plants in the same family as cotton (the Malvaceae family), cotton flowers are visited by many other wild bees and European honey bees (*Apis mellifera*)—cotton honey is a delicacy. While we usually estimate a 10–15% yield increase when visited by bees, research in Burkina Faso, Africa, found that for smallholder producers, insect pollinators (managed and wild honey bees, 26 species of other wild bees, and four wasp species) increased yield between 37–42% (Stein et al. 2017).

Figure 26—left to right: Okra (or rose mallow) bee (*Ptilothrix bombiformis*) in okra and deep down inside a cotton flower, along with a green sweat bee (*Agapostemon* sp.); two-spotted bumble bee (*Bombus bimaculatus*) in cotton. (Photos: Nancy Lee Adamson [left, center]; Creston Shrum [right].)

* For more information on the rose mallow bee (including other common names), see *Appendix F: Common & Specialist Bees of Arkansas*.

Choose targeted or selective over broad-spectrum pesticides, whenever possible. Targeted pesticides generally improve effectiveness, lower costs, and can reduce negative impacts on non-target species. A targeted insecticide like *Bacillus thuringiensis kurstaki* (Btk) that targets caterpillars and is less toxic to bees, may be applied directly on brassicas with lower risk of harming non-target organisms.

E. Weather Considerations

Weather-related drift increases with temperature, wind velocity, convection air currents, and during temperature inversions. Even a light wind can cause considerable drift. Wind-related drift can be minimized by spraying during early morning or in the evening when the wind velocity is often lower. During temperature inversions—when warm air masses rise and cool air masses settle—spray droplets become trapped in a cool lower air mass and move laterally along the ground, potential drifting over greater distances. Inversions often occur when cool night temperatures follow high day temperatures, often worst during early morning before the ground warms. Low humidity and high temperature conditions also promote drift through the evaporation of spray droplets and the corresponding reduction of particle size.

Reducing wind. Planting shrub and tree borders or hedgerows can help reduce wind speeds, reduce drift, and support improved pollination and pest management since wind can also interfere in insect movement. The best types of windbreaks and hedgerows for capturing pesticide drift contain coniferous evergreens that allow some of the wind to pass through them, while at the same time capturing most of the drift on their needles. Planting tree and shrub lines with multiple layers is beneficial. Try to include several rows of shrubs with any hedgerow plantings. Spray drift can occur as either spray droplets or vapors. Factors affecting drift include weather, method of application, equipment settings, and spray formulation. Woody plant borders can also help slow movement or support microorganisms that help break down pesticides carried through the soil in water, such as some systemic pesticides. See *Using Agroforestry Practices to Reduce Pesticide Risks to Pollinators & Other Agriculturally Beneficial Insects (June 2017)*.

Planner Note

Planners may recommend and landowners may choose to use a broad-spectrum herbicide for new habitat plantings or to "release" old fields. For new plantings, this short-term herbicide use is generally aimed at reducing weed competition, can greatly reduce site preparation time and cost, and help ensure successful establishment and longevity of habitat plantings. In old fields where invasive plants are not a concern but cool-season pasture grasses dominate, a single application of a grass-specific herbicide or a low-rate application of a broad-spectrum herbicide sprayed targeting cool-season grasses can "release" a more diverse native seed bank suppressed by pasture grasses—a cost-effective way to enhance diversity.

F. Application Method and Pesticide Formulations

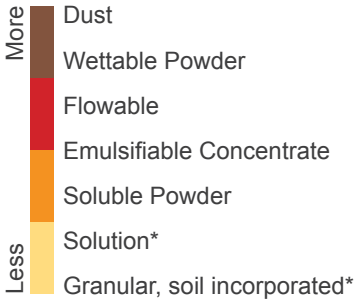
Spray application methods and equipment settings also strongly influence the potential for drift. Since small droplets are most likely to drift the longest distances, where feasible avoid aerial applications and mist blowers. Standard boom sprayers should be operated at the lowest effective pressure and with the nozzles set as low as possible. Drop nozzles should be used to deliver insecticide within the crop canopy where less likely to be carried by wind currents. Regardless of the chemical or type of application equipment used, sprayers should be properly calibrated to ensure that excess amounts of pesticide are not applied.

Nozzle type also has a great influence on the amount of drift a sprayer produces. Turbo jet, raindrop, and air-induction nozzles produce less drift than conventional nozzles. Standard flat fan or hollow cone nozzles are generally poor choices for reduction of drift. Select only nozzles capable of operating at low pressures (15 to 30 psi) to produce larger, heavier droplets. Finally, oil-based chemical carriers produce smaller, lighter droplets than water carriers and should also be avoided when possible. Consider using thickening agents if they are compatible with the pesticide.

Pesticide formulations that bees can mistake for pollen grains, such as dusts, pose the greatest risk of poisoning bees that unwittingly consume or carry the grain-like materials back to nests. Some natural enemies that eat pollen may also mistakenly consume some formulations. Wettable powder, flowable, emulsifiable concentrate, soluble powder, solution, and soil incorporated granular formulations pose the next highest danger, in that order. While formulations incorporated into soil are less likely to be consumed, they may poison ground-nesting adults and larvae of bees, beetles, and other soil-dwelling microorganisms that help maintain soil and plant health. Water-soluble pesticides are more likely to move through soil and contaminate groundwater and, if systemic, be taken up by non-target plants.

Landowners who use pesticides should be provided risk assessments using the NRCS pesticide screening tool (i.e., WIN-PST). This risk assessment is based on the soils and pesticides used in farm operations. As new planning tools such as the Conservation Application Ranking Tool (CART) are implemented, WIN-PST will continue to be used for risk assessment. See the *Planner Note: NRCS Pesticide Planning & Risk Assessment* for more information.

Pollinator Hazard Levels of Pesticide Formulations



*Granular formations incorporated into soil and solutions are considered less toxic because they are less likely to be consumed or carried back to nests. However, they do negatively impact ground-nesting insects such as bees and beetles, as well as the microflora that helps maintain plant health.

Graphic adapted from *Using Agroforestry Practices to Reduce Pesticide Risks to Pollinators and Other Agriculturally Beneficial Insects* (www.fs.usda.gov/nac/documents/agroforestrynotes/an35g09.pdf).

G. Supporting Diversity in Row Crop Systems

Given the extent of row crop* production in Arkansas, this section highlights research illustrating how protecting pollinators, predators, and parasitoids, and supporting overall farm diversity—including maintaining soil health—with diverse plantings, can support row crop production. Adding field borders, using cover crops or intercropping, leaving areas fallow or uncultivated, and incorporating plant diversity throughout farms helps support pollinators, natural enemies of pests, and also helps maintain soil microbiota that improve plant health for soybeans, rice, corn, cotton , and peanuts can benefit from. In addition, using pest- and disease-resistant varieties can also prevent crop loss (Morandin et al. 2006, Nicholls et al. 2013).

Pollinators visit cotton, peanuts, rice, and soybeans for pollen or nectar, improving production with cross-pollination (McGregor 1976, Stephenson 2017). Adding nectar sources near corn, cotton, and peanuts such as pollinator or monarch habitat plantings helps support natural enemies (parasitoid wasps and flies) of green and brown stink bugs; and other forb and grass covers support natural enemies such as lady beetles and ants that reduce pest populations in cotton (Conway 2006, Tillman 2010, Tillman et al. 2004 and 2014). Common predators of white grubs, scoliid wasps, lay their eggs on grubs in the ground, but depend on nectar and pollen as adults and are also effective pollinators (Cock et al. 2017).

Planner Note

When growing row crops, adding pesticide-free buffer zones of native grasses between the crop and pollinator habitat has multiple benefits. Besides protecting pollinators, the native grasses help reduce runoff and also support many natural enemies of pests such as spiders and ground beetles that can recolonize crop fields when harvested and replanted. Ground beetles eat weed seeds, slugs, and other pests. Help landowners to consider utilizing Conservation Cover (327), Wildlife Habitat Planting (420), Field Border (386), Contour Buffer Strips (332), Riparian Forest Buffer (391), or other practices as appropriate.

* For more information on crop species in Arkansas, see *Table B11. Arkansas Crop-Pollinator Relationships*.

Planner Note: NRCS Pesticide Planning & Risk Assessment

NRCS planners should refer to the USDA–NRCS *Agronomy Technical Note No. 9—Preventing or Mitigating Potential Negative Impacts of Pesticides on Pollinators Using Integrated Pest Management and Other Conservation Practices (February 2014)* (developed in cooperation with The Xerces Society) and utilize the Windows Pesticide Screening Tool (WIN-PST) to assess the risks of pesticides. WIN-PST provides an assessment of risks associated with specific pesticide use and soil conditions for honey bees.

The information that the WIN-PST tool provides is focused mainly on honey bees because toxicity to honey bees is part of the EPA required chemical safety screening process. Managed honey bees (used for pollination or honey production) can be moved; however, native bees cannot. Less is known about the toxicity of pesticides for native bees. Most native bees are solitary, and many are smaller; they may be more sensitive to smaller doses of chemicals and their solitary nesting behavior may lead to greater negative impacts from pesticide exposure. In addition, the effects of pesticides on larvae and pupae may be very different from effects on adult honey bees.

The WIN-PST tool should always be utilized when determining the risk to using pesticides for either establishment or maintenance of habitat. Many of the herbicides utilized are listed as relatively non-toxic to honey bees, but stickers, the substances that help pesticides adhere to plant tissues, also penetrate insect cuticles. Always follow label directions to reduce potential negative impacts. If there are multiple herbicides available that will provide the same desired effect, select the product that is the least toxic to bees according to WIN-PST. Landowners can consult with Arkansas Cooperative Extension to gain a deeper understanding of pesticide risks. Note that the benefits of one or two season's use of herbicides to establish native plant stands generally outweighs harm if utilized according to the label and performed in accordance with a management plan.

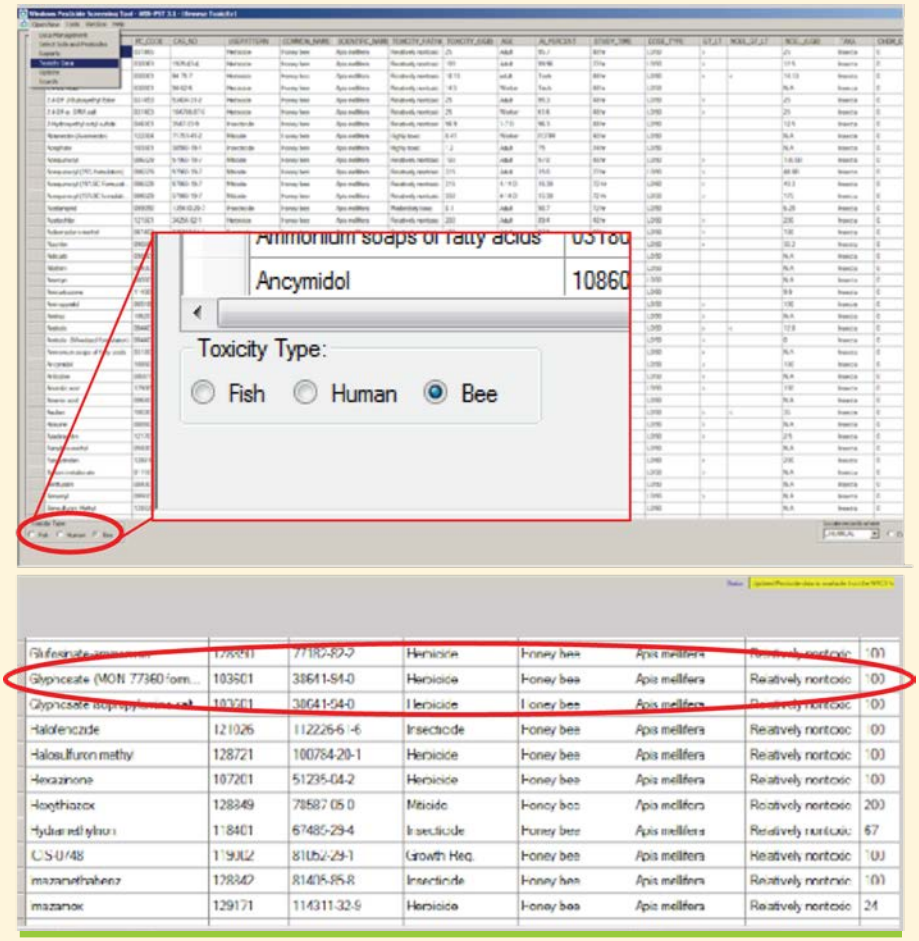


Figure 27—Computer screenshots of NRCS WIN-PST 3.1 toxicity data. Data is updated periodically, and landowners should always follow label instructions.

Pesticides of greatest concern to arthropods and other wildlife in row crop production are neonicotinoids (Gibbons et al. 2015, Main et al. 2018) and, to a lesser degree, some herbicides (Bohnenblust 2016, Bredesen and Lundgren 2019). Dusts released from neonicotinoid-coated seeds have led to honey bee kills. Neonicotinoid pesticides have long residual activity and can travel with water through soil, contaminating non-target plants and harming non-target insects and other wildlife (Hladik et al. 2018, Main et al. 2020, Morrissey 2015). New research investigating less toxic and more targeted bioinsecticides is highlighted on the University of Arkansas Cooperative Extension Arkansas Field Crop Pest Management page and other row crop publications (www.arkansas-crops.com/publications/).

The practices that support beneficial insect diversity by maintaining plant diversity (crop rotations, use of cover crops, intercropping, reduction of or elimination of chemical inputs) also help soil microorganisms thrive. Healthy soils and soil microorganisms, reduced soil temperatures when crops or residues are maintained, and maintenance of soil structure for good aeration and water balance, all support healthier plants, improved production, and reduce the need for chemical inputs, including pesticides. NRCS maintains an excellent collection of resources, including technical guidance, videos, webinars, podcasts, and other media on soil health at www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/.

Figure 28—Pollinator habitat can be incorporated into cropland systems through targeted conservation practices. Practices like field borders or buffers (as in CP33 and CP21 seen above) can increase acres of habitat on the edge of fields where crop production may suffer due to compaction, shade, or standing water. Highly erodible areas, like the hillside in the picture above, are good areas to use CP42 Pollinator Habitat to plant permanent cover that is highly beneficial for pollinators. (Photo: Ryan Diener, Quail Forever.)

Soybean

Figure 29—left to right: Minute pirate bug (*Orius insidiosus*) feeding on soybean aphid (*Aphis glycines*), brown lacewing larva (Hemerobiidae family) eating soybean aphid, a syrphid fly (*Toxomerus marginatus*) on soybean and adult green lacewing (Chrysopidae family) on purple coneflower (*Echinacea* sp.). While the lacewing and syrphid fly larvae are voracious aphid predators, the adults need nectar and pollen. Natural enemies of crop pests in habitat adjacent to crops are more likely to recolonize a new crop when one is harvested. (Photos: Thelma Heidel-Baker, Xerces Society [left three]; Sara Morris, Xerces Society [right].)

Soybeans are self-pollinating, but research in Arkansas shows that yields can improve by 15% with bee pollination (Ahrent and Caviness 1994, Erickson et al. 1978). In addition to the European honey bee, at least 29 species of wild bees in the midwestern and eastern United States visit soybean flowers (Dennis 2018, Rust et al. 1980). Among common pest species, many rarely reach damaging levels in Arkansas due to existing populations of natural enemies (Lorenz et al. 2000). Important natural enemies in soybean include spiders (order Arachnida), big-eyed bugs (*Geocoris* spp.), assassin bugs (Reduviidae family), and damsel bugs (Nabidae family) (Drees 1985), The Arkansas Soybean Production Handbook's chapter on insect pest management (www.uaex.edu/publications/MP-197.aspx) describes in detail the most common soybean pests in Arkansas, their relative importance and the conditions affecting their impact. Pest groups controlled by natural enemies include caterpillars such as the green cloverworm (*Hypena scabra*), soybean looper (*Chrysodeixis includens*), velvetbean caterpillar (*Anticarsia gemmatalis*), and garden webworms (*Hyphantria cunea*).

Corn

While corn is wind-pollinated, many bees and other pollinators collect its pollen. If pesticides must be applied, avoid applying while tassels are in flower or during times of the day when bees are most active. Some corn pests, such as corn leaf aphid (*Rhopalosiphum maidis*), are parasitized by parasitoid wasps that lay their eggs in the aphids but depend on nectar and pollen from floral resources as adults. "Mummified" aphids—light brown, swollen bodies of the aphids that have been turned into the pupal case of the wasp larvae—are signs that the parasitoid wasp is present. Other aphid predators in corn supported by diverse plantings include lady beetles (Coccinellidae family), syrphid fly larvae (Syrphidae family), insidious flower bugs (*Orius insidiosus*), and green lacewing larvae (*Chrysoperla* spp.) (Studebaker et al. 2014). The introduction of Bt corn has reduced corn borer (*Ostrinia nubilalis*) populations, but where they persist, destruction of corn stalks can reduce populations by 80% (McLeod and Studebaker 2002). Disk stalks into small pieces to increase mortality from exposure to cold, rain, and natural enemies (insects, birds, and rodents).

Figure 30—*left to right*: This ground beetle (*Cyclotrachelus alternans*) and daddy longlegs (*Phalangium opilio*) are important predators of corn rootwom larvae (*Diabrotica* spp.) Crab spiders (Thomisidae family), shown eating a green stink bug (*Nezara viridula*) in corn, are generalist predators. While corn is wind pollinated, many bees collect the pollen, such as this bumble bee. Natural habitat adjacent to crops is vital refuge for natural enemies of crop pests and pollinators, particularl when crops are harvested and replanted. (Photos: Jonathan Lundgren, USDA ARS [left]; Peggy Greb, USDA ARS [center left]; Glynn Tillman, USDA ARS [center right]; Nancy Lee Adamson [right].)

Rice

Although rice is primarily self-pollinating (only about 1% of Arkansas rice is estimated to be cross-pollinated),studies in the Gulf Coast, China and the Philippines indicate diverse bees and other insects visit the flowers (Hardke 2013, Hass 2018, Parys et al. 2020, Pu et al. 2014). In Arkansas, natural enemies of rice water weevil (*Lissorhoptrus oryzophilus*) include a nematode (Mermithidae family) that parasitizes them, katydids (a.k.a. long-horned grasshoppers in the Tettigoniidae family), and various aquatic predators that feed on the weevil. Several parasitoid flies and wasps feed on eggs, nymphs, and adults of the rice stink bug (*Oebalus pugnax*); and the larvae of an egg parasite (the parasitoid wasp *Trichogramma minutum*) help reduce rice stalk borer (*Scirpophaga incertulas*) populations. Natural enemies like tachinid flies and wasps like *Telenomus podisi* are shown to parasitize stink bugs at much higher rates when nectar sources are available for the adult flies and wasps (their larvae consume the stink bugs and eggs). Parasitoids—whose presence within their hosts is not always apparent—are more sensitive to pesticides since they are living within their hosts (pests such as rice water weevils, stink bugs, or stalk borers).

Cotton

Cotton has a specialist pollinator sometimes called the cotton bee* (*Ptilothrix bombiformis*), that can be confused with bumble bees (*Bombus* spp.), which are also important pollinators. Cusser et al. (2016) found 52 pollinator species on cotton flowers in southeastern Texas: 36 bees, one wasp, five flies, seven butterflies or moths, and three beetles. Of those, one solitary bee, the European honey bee, a syrphid fly, and sweat bees from one genus, *Lasioglossum*, made up 21%, 19%, 16%, and 15% of specimens collected, respectively. Cusser et al. (2016) found that outcrossing provided by diverse and abundant pollinators close to natural habitat produced significantly larger cotton bolls in southeastern Texas. Cotton honey is still produced in Arkansas and nearby states, but has declined due to pesticides, particularly dicamba (Steed 2019). When alternative forage was growing near cotton, visitation to cotton flowers by native bees was significantly higher; forage available included native sunflowers (*Helianthus* spp.), alfalfa (*Medicago sativa*), and field bindweed (*Convolvulus arvensis*) (Berger 1982). Assassin bugs, big-eyed bugs, collops beetles (Melyridae family), damsel bugs, ground beetles (Carabidae family), lacewing larvae (Chrysopsidae family), lady beetles, minute pirate bugs, spiders, syrphid fly larvae, and diverse parasitoid wasps are important natural enemies of cotton pests and depend on natural habitat near croplands to thrive (Vyavhare et al. 2018, Whitcomb 1963).

Peanut

Research in Georgia in the 1960s found 24 species of bees pollinating peanut flowers, though they are self-fertile (do not require pollinators) and do not produce nectar to attract visitors (Leuck and Hammons 1965). Yields increased with bee pollination by 6–11%, with small sweat bees providing the most effective pollination early in the day. More recent research in Australia found that new varieties did not attract bees and hypothesized that hybridization had reduced the value/attraction of pollen in the flowers. However, Coffelt's (1989) study in Virginia found natural crossing indicating bees continue to visit varieties grown in the United States (Blanche et al. 2006).

To reduce migratory pest problems, Tillman (2013) found planting sorghum between peanuts and cotton created an effective barrier that was more attractive to pests than crop species. The sorghum flowers provided food for predators such as the minute pirate bug (*Orius insidiosus*), an egg predator of stink bugs. Recommendations to maintain healthy soils, enhance habitat to support natural enemies of peanut pests, and use resistant varieties, are relevant for both organic and conventional peanut growers (Guerena and Adam 2008). Planting prairie strips or pollinator strips in crop fields through CRP would be beneficial both economically and for increased pest control by predatory insects and physical barriers. Longer crop rotations (three or more other crops) help maintain healthy soil plants. Crop rotations could include cotton, wheat, corn, other grasses, sweet potatoes (*Ipomoea batatas*), cotton, sesame, vegetables, and small grains. Since many peanut pests are caterpillars, targeted bioinsecticides like *Bacillus thuringiensis* serotype *kurstaki* (Btk) are available that are less likely to harm other beneficial organisms.

H. Supporting Diversity in Grasslands, Shrublands and Grazeable Forest Lands

Arkansas has millions of acres of grasslands, shrublands, and grazeable forest lands (NRCS 2012). These land cover types typically have perennial vegetation (which is in general superior to annual plants for providing nesting habitat for stem-nesting bees), but also less intense disturbance cycles and less insecticide use than croplands, thus typically have great potential to serve as habitat for pollinators. The two most important factors in determining the value of these cover types as habitat are plant community composition and management regime. The state has approximately 4.5 million acres of grasslands in the form of pasture (University of Arkansas Cooperative Extension Service 2019) with pasture defined by NRCS as "grazing lands comprised of introduced or domesticated native forage species that are used primarily for the production of livestock" (Butler et al 2003). Pasture plant communities are typically dominated by highly competitive forage species that limit the diversity and abundance of native forbs and legumes that are the most important components of excellent pollinator habitat. However, many pastures do have some native forbs and legumes, and management can help maintain abundance of native floral resources. Additionally, some non-native forbs and legumes can serve as secondary floral resources as well. Arkansas has approximately 1.5 million acres of haylands, and these, too, can serve as pollinator habitat depending on their plant community composition and management regime. The state has hundreds of thousands of acres of grazeable forest land; forest management practices can help increase abundance and diversity of floral resources on these acres. Finally, Arkansas has a few small parcels of what can be considered native rangeland and prairie, which, due to its native-dominated plant community, can often serve as excellent pollinator habitat as long as it is managed properly. Below, we discuss some of the management regimes that can be used in Arkansas's grasslands, shrublands, and grazeable forest lands.

Best Management Practices for Grazing, Haying, Mowing, and Prescribed Burning

Many of the pollinators in this region utilize early successional, and other open grassland habitats, for nesting or laying eggs and foraging. Open grassland habitat is dependent upon management or natural disturbance. Management activities that help maintain flowering forbs and grasses in grasslands, shrublands, and grazeable forests include grazing, haying, mowing, and prescribed burning. When developing management strategies with pollinators in mind, it is important to consider the timing, amount, and intensity of the practices. Haying, mowing, and prescribed burning tend to remove almost all above-ground plant material from a management unit within a few hours, which can be a devastating event for localized populations of one or more pollinator species. Therefore, a general rule is that only 33% to 50% of pollinator habitat should be disturbed by haying, mowing, or prescribed burning at any one time in order to protect immature and adult pollinators, as well as other wildlife, such as ground-nesting birds. The management activities should not totally eliminate a resource critical to pollinator habitat such as the only area providing pollen and nectar resources during a given period. This will allow for re-colonization of the area from nearby undisturbed refugia, an important factor in the recovery of pollinator populations after management. In order to maximize foraging and egg-laying opportunities, management activities should be avoided while plants are in flower and during the nesting season for ground-nesting birds. However, in order to achieve certain management objectives, it can at times be necessary to perform management activities during the growing season. Prescribed burning in August and September can be a good tool to reduce tree encroachment in open areas to maintain pollinator habitat in the long term, while having some short-term impacts. The long-term positive effects far outweigh those short-term detriments.

Figure 31—*left to right*: Some farmers fear milkweed (*Asclepias* spp.) may harm cattle, but if a pasture is not overgrazed, cattle avoid milkweed. Prescribed burning is most often implemented in winter, and can rejuvenate grasslands, as at this site burned three to six months earlier. (Photos: Ryan Diener, Quail Forever.)

Grazing

Native pasture and grazeable forest land, when managed with appropriate grazing systems, can support species rich plant communities with abundant wildflower populations, heterogeneous vegetation structure, and sufficient nesting resources, such as bare ground, for wild pollinators (Hobbs and Huenneke 1992; Vulliamy et al. 2006; Black et al. 2011; Briske et al. 2011). The primary goal of managing grazing lands for pollinators is to promote a diverse, resilient plant community that allows wildflowers to bloom throughout the growing season. To achieve this goal, proper stocking rates are essential. Grazing regimes with excessive stocking rates can harm some pollinators by trampling and consumption of wildflowers by livestock (Black et al. 2011). There is some fear among livestock operators concerning milkweed (*Asclepias* spp.) in pastures. While milkweeds do contain a toxin, only a couple of species are potent enough to have a large effect on cattle, and those species occur in the desert southwest, not in Arkansas. Cattle often avoid grazing milkweed because of the sour taste. They will not usually eat milkweed unless the area is overgrazed, and it is the only available forage. Local NRCS Field Office staff should be able to calculate the stocking rates that will allow producers to support pollinator habitat while also profiting from livestock production.

Choosing a grazing system that will allow for adequate recovery of plants between grazing events is also very important (Tainton et al. 1977; Manske and Sedivec 1999). Adequate recovery of highly palatable forage cannot be obtained with year after year of continuous grazing on a single grazing unit unless the stocking rate is low. Prescribed grazing can mitigate some of the negative effects of grazing by creating a landscape with varying levels of disturbance and recovery. One basic system that allows recovery is having multiple pastures, with some pastures being grazed in a given year, while others are being rested. Cattle will be rotated from one pasture to another each year. In doing so, a patchy vegetation structure can be created and maintained as each pasture is in varying stages of use and recovery throughout the growing season. Another option is to use fencing to create multiple paddocks, and to rotate cattle through the paddocks (rotations could range from one day to weekly or monthly), moving cattle through all paddocks over the course of the year. By rotating livestock from one pasture to another, the land manager can maintain proper utilization levels and recovery periods of palatable plants (Tainton et al. 1977; Manske and Sedivec 1999). To benefit pollinators, each paddock should receive at least 60 days of rest, preferably more. A third approach is patch-burn grazing, in which the landowner conducts a prescribed burn on a portion of a grazing unit. Livestock tend to prefer the fresh, highly nutritious growth that emerges after the fire, and will often spend most of the season grazing heavily in the recently burned area, thus providing rest for vegetation in other portions in the grazing unit. All three of these approaches can generate heterogeneity (variation) in vegetation structure, which has been shown to be valuable to numerous wildlife species. Of these three approaches, patch-burn grazing typically provides the greatest degree of structural variation. Local NRCS Field Office staff or grazing land specialists should discuss recovery time needed by desirable plant species on the property and develop a prescribed grazing plan.

Introduced pasturelands, though typically much lower in native plant diversity than native prairies, native pastures, or grazeable forest lands, can be made more valuable to pollinators via planting of nectar- and pollen-rich forbs and legumes, and also by using the grazing management principles described above. For instance, reducing stocking rate slightly on an improved pasture might be enough to allow exotic legumes like red clover to produce more flowers, which would enhance the value of the pasture to pollinators.

Haying and Mowing

Haying involves cutting and removing herbaceous plant material from a field for future use as forage, whereas mowing involves cutting and leaving plant material in the mowed area. Both can improve pollinator habitat by keeping it at an early successional stage that is favorable to a diverse community of wildflowers, but both can injure or kill insect pollinators (particularly immobile or nearly

immobile immature stages) and can cause short-term loss of blooming flowers. Both of these options are an attempt to mimic the effects of prescribed burning, without getting all of the same positive benefits that we get from fire. Haying and mowing are secondary management options if burning cannot be implemented. Haying and mowing should be completed on pollinator areas when there is a management need or objective for it, for example grass that is getting too thick and needs to be set back for increased forb development. Mowing has the added problem of increasing the amount of thatch that can shade out young wildflowers.

For the sake of conserving pollinators in hayed or mowed grasslands, no more than 33% to 50% should be disturbed at any given time, if possible. Ideally, disturbance should not occur every year, and creating a three- to five-year rotational plan can help sustain diversity. For example, divide the area into three or more parcels, mow one parcel in late winter/early spring, another after bird nesting season (September), and others in early or late fall. For maximum diversity, mix up when each patch is mowed each year (e.g., do not mow the same patch at the same time every year). In some situations, haying or mowing only in late fall or early winter is the best practice with regards to pollinators. However, in grasslands with large numbers of green antelopehorn milkweeds (*A. viridis*), haying or mowing in July is actually advantageous for monarch butterflies as it causes many specimens of this plant to break dormancy and send up new shoots, thus providing food for monarch butterfly larvae in August and September. Hay or mow during daylight hours at speeds less than 8 mph, so that adult pollinators can escape the mower.

Prescribed Burning

Prescribed burning is also discussed in *IV. Establishment, Management, and Maintenance of Pollinator Habitat*, since prescribed fire has multiple benefits as a management tool. Prescribed burning is the most effective and economical management tool for promoting native plant communities. Fire has played an important role in natural ecosystems and prescribed burns are an increasingly common management tool. Effects of fire management on insect communities are highly variable but recent research on longleaf pine ecosystems found clear benefits for native bee populations (Moylett et al. 2020). If used appropriately, fire benefits many insect communities through the restoration and maintenance of suitable habitat, but some species, particularly some butterflies, may be harmed by fire. Prairie communities are adapted to wildfires, and generally thrive with regular burns, as long as there are some unburned areas nearby that can provide colonizers into the burned habitat. Some research suggests that burning small habitat fragments that support rare species risks extirpation of some insect species because of limited recolonization from adjacent habitats.

- Always have a prescribed burning plan by certified planners and trained personnel. Contact:
  Arkansas NRCS (www.nrcs.usda.gov/wps/portal/nrcs/ar/home/),
  Quail Forever (https://quailforever.org/Habitat/findBiologist.aspx),
  the Arkansas Game and Fish Commission (https://agfc.com/en/wildlife-management/private-lands-program/)
  the Arkansas Prescribed Fire Council (www.facebook.com/ArPrescribedFireCouncil/),
  the Arkansas Forestry Commission (www.agriculture.arkansas.gov/arkansas-forestry-commission),
  The Nature Conservancy (www.nature.org/en-us/about-us/where-we-work/united-states/arkansas/),
  or private contractors. Follow all state and local laws regarding prescribed burning.
- A program of rotational burning where small sections are burnt every few years will ensure adequate colonization potential for pollinators. It is best to burn no more than one third of a property per year.
- Sometimes the window for burning is very limited based on labor and weather. Burning a larger area than ideal can still be tremendously valuable for wildlife overall. However, where rare species are of concern, extra precautions are needed.
- There is some evidence that growing season burns are superior to dormant season burns for increasing abundance and diversity of forbs.
- Including grasses in mixes can help ensure that fire is carried quickly through the site, leaving some habitat patches intact amidst the burn. Grasses should make up no more than 25% by pure live seed (PLS) of a pollinator seed mix.
- A mosaic of burned and unburned areas is ideal. Leave unburned patches within a burn unit. Even small patches (one to three yards in diameter) are helpful as micro-refuges. Total black in the burn area is not the measure of success of a prescribed burn.

Sometimes, especially for prescribed burns, it is just not practical to burn only part of a planting. The long-term benefit of the burn will generally outweigh any short-term loss, particularly if there are undisturbed areas nearby.

I. Protecting Ground-Nesting Bees and Ground Beetles

Native ground-nesting bees generally utilize bare or partially bare ground for nesting. Ground beetles live and lay their eggs in more vegetated areas. Tilling, the use of fumigants like Chloropicrin for the control of soil-borne crop pathogens (such as *Verticillium* wilt), or covering large areas with plastic mulch, can destroy or harm beneficial ground-nesting insects like bees and ground beetles. Farmers can scout bare areas to locate ground-nesting areas, but each bee species may only be active for a few weeks, so finding nest sites is not easy. To protect ground-nesting bees, avoid tilling or disturbing bare or partially bare ground. If tilling is necessary, surface (shallow) tilling is much less detrimental to native bees. Weed control alternatives to tillage include the use of selective crop herbicides and hooded sprayers for between-row herbicide applications. Since ground beetles live closer to the surface and are more sensitive to tilling and herbicide, try to leave some areas undisturbed near tilled, sprayed, harvested, or grazed sites to provide refuge (and potential populations for recolonization). Tillage should not be considered an option for native range/prairie, natural forest areas, or other areas that have never had soil disturbance. Grazing can negatively impact ground-nesting bees and beetles, particularly bumble bees that often nest at the base of lodged grasses (where they are protected from rain and predators). One sign that an area is overgrazed is dry dung. Where vegetation is adequate to support ground-nesting beetles, dung beetles thrive and quickly break down new piles of dung, improving soil health and reducing nutrient runoff.

J. Protecting Tunnel-Nesting Bees

Tunnel-nesting bees make their homes in cavities they can find such as the abandoned tunnels of wood-boring beetles and pithy plant stems such as elderberry (*Sambucus* spp.), raspberry and blackberry (*Rubus* spp.), boxelder (*Acer negundo*), sumac (*Rhus* spp.), wingstem (*Verbesina* spp.), and other stout, hollow- or pithy-stemmed plants. Allow snags and dead trees to stand (or cut them to a safe height), create loose brush piles or wattle fences, and plant or protect pithy (hollow) stemmed plants. Wattle fences are woven fences that public gardens or field stations can use if neatness takes precedence over the value of a brush pile. Snags, loose brush piles, and the plants with pithy stems are also excellent habitat for birds that can be important predators of crop pests, particularly caterpillars.

K. Supporting Managed Honey Bees

While not native to North America, the European honey bee (*Apis mellifera*) remains a crucial agricultural pollinator, producing an estimated $3 million worth of honey for Arkansas beekeepers in 2016 (English et al. 2017).

Figure 32—When bees pollinate soybeans, yields can increase 10–15% (left, honey bee on soybean flower). In Arkansas, some beekeepers sell pumpkin flower honey (center, honey bee visiting cucurbit). Like native bees, honey bees depend on wild plants for pollen and nectar (right, native bees and honey bee visiting yellow wingstem [*Verbesina alternifolia*], an excellent honey plant). (Photos: Steve Gibson, NC Beekeeping Association [left]; Nancy Lee Adamson [center, right].)

Upon its introduction to North America in 1622, the honey bee initially thrived with feral colonies rapidly spreading across the continent by swarming from managed hives. The accidental introduction of parasitic mites and bee diseases, loss of habitat, and pesticide issues have led to declines in both feral and managed honey bees in the United States. The number of managed honey bee hives in the United States has declined by 50% since 1945, while the amount of crop acreage requiring bee pollination continues to rise.

While many native bees are more effective pollinators than honey bees on a bee-per-bee basis, honey bees are vital in certain agricultural crops because of the large numbers per colony and ease of transport at critical times for pollination. They are also highly valued

Planner Note

The same conservation practices used to provide native bee habitat (food and protection) will also benefit managed honey bee colonies. Planners should primarily concentrate on providing quality long-term native floral resources for managed bees.

for their honey and wax production, and the income for beekeepers who provide pollination services. Solutions to the parasite and disease problems facing honey bees requires ongoing research. Habitat degradation, however, can be addressed now. Honey bee and native bee populations benefit from habitat enhancement that ensures abundant pollen and nectar sources in spring, summer, and fall, and protection from pesticides.

One habitat requirement for honey bees is access to water. Honey bees require clean water to cool their hives through evaporation (which they carry back to the hive in their stomach). Preferred water sources are shallow and calm with low approaches where bees can stand while they drink. It is imperative that water sources be clean and free of pesticides or other chemicals. Many native bees and wasps need clean water for nest building.

L. Protecting Predatory and Parasitoid Insects

Protecting predatory and parasitoid insects helps avoid pest outbreaks. Understanding a little about the life cycles of predatory and parasitoid insects that consume crop pests can help planners and farmers improve farm production. Many adult predators, including adult wasps, flies, and beetles, and some larvae, depend on the same food resources as bees—pollen and nectar. Ensure flowers (crop and non-crop) are available through the growing season, maintain some undisturbed areas, and reduce pesticide use within crops and in adjacent lands. Ground beetles—important predators and weed seed eaters—are especially sensitive to tillage, so maintaining unmown grass or mixed grass, wildflower, and shrub/tree strips close to crops helps protect them. Various types of larvae that cannot fly, such as syrphid fly larvae that consume small insect pests, are especially vulnerable to pesticides. Likewise, parasitoid larvae dwell within the bodies of their hosts and will perish if their hosts are exposed to pesticides. Some, like parasitoid wasp larvae in stink bugs or hornworms are not visible. The presence of others may be detected by the mummified bodies of their hosts, like the wasps that parasitize aphids or bean beetles. Systemic pesticide use can lead to secondary pest outbreaks when non-target predatory or parasitoid insects are inadvertently killed (Hopwood 2013). For example, slug outbreaks have occurred in soybean production when systemic pesticides targeting soybean aphids killed ground beetles—predators that had kept slug populations in check (Douglas 2015).

For predatory and parasitoid species to be present in crop fields, there must be populations of prey, so maintaining predatory and parasitoid populations means not eliminating all crop pests. Patryk Battle of Living Web Farms (www.livingwebfarms.org) who teaches about farmscaping promotes expanding IPPM (integrated pest and pollinator management) to include the word prey (IPPPM) to remind farmers that pests (prey), especially when living on non-crop plants, are integral to a well-balanced system that will help reduce pest outbreaks. Pest species in border plantings and other areas adjacent to crops help ensure predators and parasitoids feeding on them will be able to recolonize new crops when fields are harvested and replanted. Many predators and parasitoids are also pollinators, particularly many wasps, flies, and beetles.

III. Enhancing and Developing New Pollinator Habitat

Landowners who want to take a more active role in conserving resident pollinators and natural enemies of crop pests can increase available foraging habitat to include a range of plants that bloom and provide abundant sources of pollen and nectar throughout the growing season and shelter throughout the year

Pollinator meadows or bee pastures, insectary strips, nectar corridors, riparian plantings, field borders, orchard understory plantings, hedgerows and windbreaks with flowering trees and shrubs, flowering cover crops, green manures, and any plantings or management that enhances diversity will improve pollination and pest management on the farm.

This chapter highlights the value of native plants; site selection, design, and plant selection for permanent herbaceous or woody primarily native plantings; native and non-native cover crops and intercropping; and nesting. See Chapter 3 for ways to enhance habitat via reducing mowing, prescribed fire, and creating habitat connectivity.

Figure 33—*left to right*: Green sweat bee "buzz" pollinating a tomato (*Solanum lycopersicum*) flower. She holds onto the flower gently with her mandibles and one pair of legs, releases her wing muscles to create a vibration that causes pollen within the anther (flower part holding the pollen) to pour out. Green sweat bee and monarch butterfly (*Danaus plexippus*) on butterfly milkweed (*Asclepias tuberosa*). (Photos: Nancy Lee Adamson [left, center]; Austin Klais [right].)

As discussed in Pollination Services in Arkansas, native plants evolved with local fauna and, therefore, support a much greater diversity of insects and other wildlife than non-native plants. Native species are also adapted to local soils and climate cycles. While native plants provide the most long-term benefits for farm production, many non-invasive, non-native plants can provide quick cover on disturbed sites or for site preparation, can complement natives as nurse crops during establishment, and provide multiple benefits as cover crops where perennial plantings may not be appropriate. Native and non-native herbs and flowers (that can be harvested for culinary or ornamental use) can also provide excellent forage for pollinators, predators, and parasitoids, and additional income (see *Appendix B: Species Lists* for more information on pollinator plants).

A. Site Assessment and Selection

Before planting new habitat, assess existing plant communities (see *II. Protecting Pollinators and Their Habitat*) using *Arkansas Wildlife Habitat Evaluation Guide for Pollinators* or *Pollinator Habitat Assessment Guides* developed by the Xerces Society in collaboration with NRCS. If existing habitat is predominantly native, planners and landowners may want to choose other sites for new plantings and consider utilizing prescribed fire or weed management, if appropriate, to enhance the natural diversity of the site rather than planting. If the site is predominantly invasive species, it may be prudent to choose a location where site prep will not be as arduous if the planting must be done soon. Sites with invasive species issues (like sericea lespedeza [*Lespedeza cuneata*] or Johnson grass [*Sorghum halepense*]) should be allowed at least two to three years of herbicide, mechanical, or cultural treatments to remove or reduce those species so a native seeding will be successful. Simply removing invasive species can greatly improve the value of habitat for pollinators and other wildlife. Sites with invasive species present can be excellent areas for restoration but require additional care and management.

Planner Note

Work with landowners and producers to remove invasive species using the conservation practices Brush Management (314), Herbaceous Weed Management (315), Prescribed Fire (383), or Prescribed Grazing (528). Then, help them improve the pollinator habitat quality, as needed, with diverse native plantings.

When choosing a site, consider if marginal crop, pasture, or haylands might also be suitable, based on adjacent land use, exposure (aspect and sun/shade), and soil conditions.

Marginal Land

Lands that are not optimal for crop or forage production, such as drainage ways, waterways, and buffer areas, may be suitable for pollinator plantings and provide additional benefits in helping absorb excess nutrients from runoff. Ditches, field buffer strips and borders, driveway/roadside edges, and even grassed waterways can be planted with pollinator-friendly mixes of forbs and grasses.

Adjacent Land Use

Assess plant communities and farm management of adjacent lands with particular attention to invasive species and pesticide use.

- If invasive species or aggressive weeds are present, can they be removed or prevented from encroaching on the new planting? Plan ahead to allow an additional year or two of site prep to remove invasives to ensure the seeding is successful. Also plan for future spot-treatment of invasive species.
- Will adjacent crops be treated with pesticides? If so, to what extent could drift harm pollinators and other insects inhabiting the new planting? Adjacent crops may change seasonally or annually, so it is important to consider the timing of floral resources in the new planting relative to potential pesticide applications nearby. In some crop systems, although pesticides are applied, the application timing may pose less risk to flower visitors depending on the season of flowering. For example, where pesticides are applied in early summer, there is reduced risk to pollinators and other flower-visiting insects if the planting blooms primarily in early spring or fall.

Aspect

Aspect, the direction land slopes relative to the sun, affects the intensity and duration of sunlight and potentially wind, and may influence plant choices for successful establishment. Areas of level ground, with full sun throughout the day and good air circulation may offer fewer challenges for establishment. Slopes may require erosion control. East-facing slopes, and to some extent, south-facing ones, have adequate light and may retain moisture more than west-facing slopes. Unless the site is located near a large body of water, hot afternoon sunlight and drying winds often associated with west-facing slopes will be much drier. Such slopes, if they retain bare ground or are covered in native bunchgrasses, may provide good nest sites for ground-nesting bees and bumble bees (*Bombus* spp.). It is important to consider the aspect and type of habitat present. By selecting the proper native plant species, you can greatly improve the success of the planting. For dry west and south facing slopes, selecting plant species that naturally occur in those same habitats and regionally adapted seeds is very important. See the provided seed mixes in the Appendix for examples and visit with a biologist for recommendations.

Sun Exposure

Consider both current and future sun exposure. A site that is open and sunny now may become shady as shrubs and trees mature. Many plants flower more and provide greater amounts of nectar and pollen when they receive more sunlight, but plants requiring shade may need to be planted only after shrubs or trees are tall and full enough to provide adequate cover. This is important when selecting a seed mix for areas under tree plantings. Plantings being done in open fields or in openly spaced trees will perform fine with standard pollinator- and prairie-type seed mixes.

Soil Characteristics

Some plants grow, reproduce and flower better in specific soil textures (i.e., sands, silts, clays, or loams). Drainage, pH, organic content, bulk density, and compaction are some of the other factors that influence plant establishment and productivity. Most of these factors can be determined from local soil surveys and the NRCS Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/). Choose plants adapted to site soils and moisture. These plant characteristics can be found in the species list in *Appendix B*.

During the planning process, also consider fertility, soil pathogens, the presence of rhizobium bacteria, and previous herbicide use (see *Appendix E: Herbicide Residual Times*). Soil fertility will be most critical during early plant establishment, especially on previously cropped lands. Many native species compete better against introduced weeds in less fertile soils. Native plants perform well on a wide range of pH; applying lime and adding fertilizer is more beneficial to weeds than it is the native seedlings. For native plantings, few, if any, inputs should be required.

Figure 34—*left to right:* Lady beetle adult on seedbox (*Ludwigia* sp.); lady beetle pupae on goldenrod (*Solidago* sp.); lady beetle larva on eggplant. (Photos: Nancy Lee Adamson.)

Previously cropped areas may harbor soil-borne pathogens that could inhibit plant development. When planning to grow a brassica like broccoli or kale, avoid using a cover crop mix that includes other brassicas, such as tillage radish. Where such conditions are known to exist, crop rotations or pathogen-resistant plant species should be considered. Conversely, some soil microorganisms, such as rhizobium bacteria, are essential for the successful establishment of legumes. If rhizobium bacteria are absent in the soil, inoculated seed is often available to improve establishment. Pesticide residues, particularly herbicides like atrazine and trifluralin, can inhibit seed germination. Soils in crop fields often consist of bacterial microorganism assemblages. Reduced chemical inputs and no-till farming can increase the mycorrhizal fungi component in soil that is important for native plant establishment. Minimizing or removing tillage from site preparation is important to maintain mycorrhizal fungi communities in the soil. Certain cover crops, like forage sorghum, can help build mycorrhizal fungi in the soil prior to planting natives.

Soil fertility testing is recommended prior to establishment. Soil fertility can be tested for by the University of Arkansas Cooperative Extension Service (www.uaex.edu/environment-nature/soil/soil-test.aspx) and the Arkansas Soil Testing & Research Laboratory. Chemical residue, soil pathogen, and beneficial microorganisms tests are provided by the Fayetteville Agricultural Diagnostic Analytical Laboratory (https://aaes.uark.edu/research-locations/Fayetteville_Agricultural_Diagnostic_Analytical_Laboratory/default.aspx)

Figure 35—*left to right*: Native plants like spiderwort (*Tradescantia* spp.) support pollinators, including European honey bees (*Apis mellifera*), native bees (center, a sweat bee), and diverse native predators (right, syrphid fly whose larvae are important predators) and parasitoids that help prevent crop pest outbreaks. (Photos: Nancy Lee Adamson [left, right]; Steve Duzan [center].)

Size and Shape

Generally, the larger the planting area, the greater the potential benefit to pollinators, predators, and parasitoids. Ideally, habitat is interspersed within crop fields so that the distance to crops is no more than 500'. Studies in a variety of crops have found that native insects can provide full pollination and pest management benefits when 30% of a farm is natural habitat. Heterogeneity is key and both large and small patches are beneficial to increase production and reduce pest outbreaks. Although large, square planting blocks will minimize edge and reduce susceptibility to invasion by weeds, linear corridor plantings (e.g., along a stream or a hedgerow, or a crop border) will often be more practical. Conservation Practice Standards (CPS) require different widths for specific purposes; planners should refer to the criteria outlined within NRCS practice standards to determine the proper widths of linear plantings and acreage requirements of all plantings.

B. Habitat Design

After choosing an appropriate site, choose plants that ensure multiple species blooming in each season. Whether predominantly wildflowers, shrubs, or trees, most plantings will also include grasses, not only for their habitat value, but also soil stabilization and weed management. Grasses should make up no more than 25% of the seed mix by PLS seeds/ft^2.

Many conservation plantings are aimed at supporting spring- and fall-migrating species. For monarch butterflies (*Danaus plexippus*) migrating through Arkansas in spring and fall, try to include or protect milkweeds (*Asclepias* spp.) and for fall nectar sources, goldenrods (*Solidago* spp.) and asters (*Eurybia*, *Ionactis*, and *Symphyotrichum* spp.). Milkweeds have varying success showing up quickly from seed, if you are focused on providing milkweed, it may make sense to add several clusters of plugs or containerized seedlings to seeded habitats. For more on milkweeds see *Native Milkweeds of Arkansas* (see NRCS Field Office Technical Guides [https://efotg.sc.egov.usda.gov]) and *Pollinator Plants of the Central United States: Native Milkweeds* (*Asclepias* spp.) (www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mopmcpu11905.pdf). Other host plants are highlighted in *Appendix B: Species Lists*.

Planner Note

Diversity in bloom time and structure helps support a diversity of pollinators and other agriculturally beneficial insects. NRCS and FSA practices requiring a minimum of three blooming species per season help attract and sustain pollinator and natural enemy populations.

Figure 36—*left to right*: Habitats designed for pollinators often utilize open sunny areas (shown: green antelopehorn milkweed [*Asclepias viridis*], and Carolina larkspur [*Delphinium carolinianum*], near Hope, AR), but shrub and tree plantings, as well as forest management, can be tremendously valuable for pollinators and other insects beneficial to agriculture, such as honey bees and syrphid flies on willow (*Salix* sp.). (Photos: Eric Hunt [left]; Nancy Lee Adamson [center, right].)

Landscape Consideration

How will the planting function within adjacent landscapes? Flight distances of small native bees might be less than 500', while larger bumble bees may forage more than a mile from their nests, so aiming for habitat within 500' of all crops is prudent. Fallow or natural areas, existing abandoned fields, or unmanaged landscapes located near new plantings can be rich sources of diverse pollinator, predatory, and parasitoid species. These areas may already have abundant nest sites, such as fallen trees or bare ground, but only lack floral resources through all or part of the year. If existing corridors are rich in early spring flowering trees or fall wildflowers, habitat enhancement can be focused more on improving summer forage. Existing habitats might also be enhanced with additional pollinator plants, nesting sites, protection or exclusion from livestock, weed management, or prescribed fire.

Diverse Plantings

Diversity is a critical factor in the design of pollinator enhancement areas. Flowers should be available through the growing season. Mixtures of flower colors, sizes, and shapes help support the greatest diversity of pollinators and other insects. Most bee species are generalists, which means that they feed on a range of plants throughout their life cycle. Many others, including some important crop pollinators, only forage on a single family or even a single genus of plants. Including those specific plant families or genera in a seed mix is important if they attract the same insect species that pollinate the adjacent crops.

Choose native plants with a variety of flower shapes. Some flowers need a pollinator strong enough to push open closed petals (like some pea flowers, such as redbud [*Cercis canadensis*] or goat's rue [*Tephrosia virginiana*]), or a long tongue—like that of a butterfly or hummingbird—to reach nectaries at the end of long tubular flowers like coral honeysuckle (*Lonicera sempervirens*) and phlox (*Phlox* spp.). Flowers in the heath family (blueberries, huckleberries, and cranberries) and nightshade family (tomatoes, peppers, and potatoes) depend on bees that can sonicate, also called "buzz" pollination. These flowers hold pollen within a tube (called a poricidal anther) that releases pollen when vibrated at just the right frequency.

Figure 37—*left to right*: Some spring to early summer blooming native forbs include white wild indigo (*Baptisia alba*) with a bumble bee, golden Alexanders (*Zizia aurea*) with a yellow-faced bee (*Hylaeus* sp.), and white crownbeard (*Verbesina virginica*) with a caterpillar predator, a potter wasp. (Photos: Larry Allain, USGS [left]; Nancy Lee Adamson [center]; Steve Duzan [right].)

Including an array of flower colors can also help attract more diverse pollinators. Many insects see colors in the ultraviolet spectrum, plus flowers provide scent and electrical cues to invite or deflect bees when needing or no longer needing pollination. Bees visit a wide range of colors, especially blue, purple, yellow, orange, pink, and white; wasps seem most attracted to white, yellow, and purple; flies to white, yellow, purple, maroon, and green; butterflies to white, yellow, and pink; moths to white (most visible at night); beetles to white, yellow, pink, and green; and ants to yellow, green, white, and purple (Reverté et al. 2016). Depending on what is available, typical preferences may change.

By having several plant species flowering at once, and a sequence of plants flowering through the spring, summer, and fall, habitat enhancements are able to support a wide range of pollinating insects that fly at different times of the season.

Plant Density and Bloom Time

Plantings with nine or more species of plants with different bloom times grouped together at a single site tend to attract a greater abundance and diversity of bees and other pollinators because there is continuous bloom. The higher the forb diversity of a seeding, the higher the diversity and abundance of pollinator species it will attract.

For this reason, many NRCS conservation practices require at least three different pollinator plants within each of three bloom periods (i.e., very early and early, mid, or late season). Refer to the *Appendix B: Species Lists* of this document for a list of species and corresponding bloom periods.

BLOOM PERIODS		
MONTH	**TREES & SHRUBS**	**FORBS**
February through March	Very Early Season	Early Season*
April through May	Early Season	
May through July	Mid-Season	Mid-Season
July through Sept (or later)	Late Season	Late Season

* For habitat planning purposes, Very Early and Early count as **a single blooming period** for herbaceous plantings.

Planner Note

Using natural ecosystems to design plantings can provide the most long-lasting benefits and such plantings may be better able to resist pest, disease, and weed epidemics. Species found in association with each other in local natural areas are likely to have the same light, moisture, and nutrient needs, and form stable communities.

Under this criterion, a minimum of nine blooming plants should be established in pollinator enhancement sites. When establishing woody species as part of a pollinator habitat, know that most shrub and tree species are very early, early, and mid-season bloomers, there are relatively few late-season blooming woody species. Be aware that including an herbaceous and shrub component when establishing trees enhances habitat value greatly. Herbaceous species are critical for ensuring that nectar and pollen are available throughout the season.

It is especially important to include plants that flower early in the season. Many native bees, such as bumble bees and some sweat bees, produce multiple generations of offspring each year. More forage available early in the season will lead to greater reproduction and more bees in the middle and end of the year. Likewise, predators and parasitoids need early spring forage, especially plants with small flowers such as willow and hawthorn (see Table 2 below and *Appendix B: Species Lists*). Early forage may also encourage bumble bee queens that are emerging from hibernation to start their nests nearby, or simply increase the success rate of nearby nests. Conversely, it is also important to include plants that flower late in the season to ensure that queen bumble bees are strong and numerous going into winter hibernation.

Table 2: Blooming Periods for Common Native Trees and Shrubs in Arkansas

TREES			
APPROXIMATE BLOOM TIME[1]		SCIENTIFIC NAME[2]	COMMON NAME
Very Early	March–April	*Acer rubrum*	Red maple
	March–April	*Sassafras albidum*	Sassafras
Very Early–Early	March–May	*Amelanchier arborea*	Serviceberry
	April–May	*Celtis* spp.	Hackberry & sugarberry
	March–May	*Prunus* spp.	Cherry & plum[3]
Very Early–Mid	March–May	*Salix* spp.	Willow
Early	April–May	*Morus rubra*	Red mulberry
Early–Mid	April–May	*Nyssa sylvatica*	Blackgum
	May–June	*Robinia pseudoacacia*	Black locust
Mid	May	*Liriodendron tulipifera*	Tuliptree
	May–July	*Tilia americana*	American basswood

SHRUBS/SMALL TREES			
APPROXIMATE BLOOM TIME[1]		SCIENTIFIC NAME[2]	COMMON NAME
Very Early	March–April	*Asimina triloba*	Pawpaw
	March–April	*Cercis canadensis*	Eastern redbud
Very Early–Early	March–May	*Prunus* spp.	Cherry & plum[3]
Very Early–Mid	May–June	*Vaccinium* spp.	Blueberry & huckleberry
Early–Mid	April–May/May–June	*Cornus* spp.	Dogwood
	June–August	*Rhus* spp.	Sumac
	May–July	*Rosa* spp.	Wild rose
	April–July	*Rubus* spp.	Blackberry & black raspberry
Mid	April–July	*Sambucus nigra* ssp. *canadensis*	Common elderberry
Mid–Late	May	*Cephalanthus* spp.	Buttonush
	June–September	*Hypericum prolificum*	Shrubby St. John's wort

1. The actual flowering period depends upon the species, year-to-year variations and other factors. It may actually last only a short portion of the period listed. Consult with plant experts to develop a list of overlapping bloom times.
2. Check sources for species and varieties that are adapted to local climate and conditions.
3. Note that *Prunus* includes wild plums that are shrubs—*P. americana*, *P. angustifolia*, and *P. mexicana*—as well as the tree, black cherry (*P. serotina*).

When twigs are clipped on these plants, the soft pith provides nesting opportunities for small tunnel-nesting bees.

Note that primocane cultivars of raspberries (*Rubus idaeus*, introduced) and blackberries may continue flowering until frost.

Clusters of single species or repetition of a species within a larger planting can help attract pollinators better than widely scattered species or randomly dispersed small clumps. The goal is for the established blocks to form a large block of color when in flower. Larger clusters of perennials or shrubs more than 25 square feet in size may be ideal for attracting pollinators and providing efficient foraging.

Inclusion of Grasses

Grasses are key components of most plant communities. Common species include big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indiangrass (*Sorghastrum nutans*), switchgrass and other panic grasses (*Panicum* spp. and *Dichanthelium* spp.), eastern gama grass (*Tripsacum dactyloides*), purple top tridens (*Tridens flavus*) and wildryes (*Elymus* spp.). Many of these are warm-season, clump-forming species that are also good forage, provide nesting sites for ground-nesting birds (and bumble bees), habitat for ground beetles, and overwintering cover for many fauna. Native cool-season grasses can make good companion plants during establishment, but may decrease in abundance in sunnier, drier sites over time. Grasses and sedges provide forage resources for diverse beneficial insects and some are host plants for native butterflies. They also are potential nesting sites for colonies of bumble bees and overwintering sites for beneficial insects, such as predaceous ground beetles. Grasses combined with forbs can form a tight living mass

that over time will resist weed colonization. In some parts of Arkansas, non-native forage grasses dominate where planted for livestock or erosion control, or where they spread from pastures into natural areas. It is important to control these non-native grasses completely prior to seeding natives.

When including grasses in your pollinator stands, strive for a plant community that mimics native communities to maximize habitat for pollinators and other native beneficial insects. Include at least one warm-season bunchgrass (or sedge, if appropriate). This is in addition to the three or more forbs or shrubs from each of three bloom-periods, resulting in a minimum of 10 plant species per planting. Acceptable bunchgrasses are included within the Species Lists and in the recommended seed mixes in the appendix. The table below also shows appropriate species to include in plantings and for habitat evaluation.

Figure 38—Bumble bees nest in warm-season grasses and are among the earliest foragers, important for pollinating early spring crops in Arkansas like peach (a). Native warm-season grasses like little bluestem (b), splitbeard bluestem (c) and little bluestem (d) provide excellent habitat for wildlife, including monarch butterflies that move to non-milkweed plants when they pupate. (Photos: Nancy Lee Adamson [A,C]; Marcus Bradley [B]; Brittany Viers-Scott [D].)

Care should be taken to prevent grasses from dominating pollinator sites (this is somewhat true for ground-nesting birds, as well—grass density should not be too great). Anecdotal evidence suggests that tall grasses are more likely than short grasses to crowd out forbs, and that non-native cool-season grasses are more competitive against many native forbs than warm-season grasses. As a general rule, grasses and sedges should comprise no more than 25% of the total seeding mixture. Fall and winter planting can favor forb development over grasses.

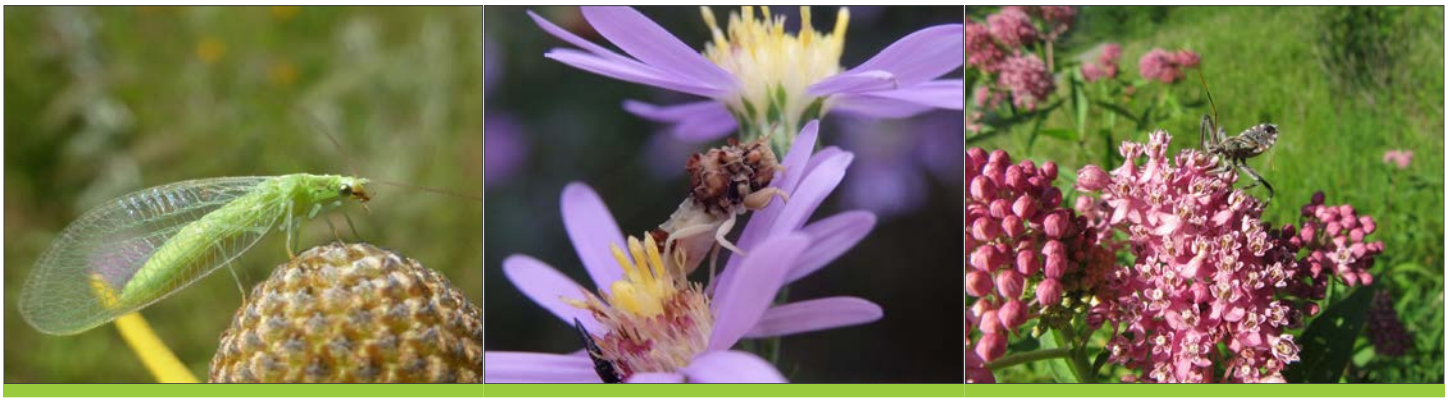


Figure 39—*left to right*: Habitats that support pollinators also provide habitat for many other agriculturally beneficial insects and other wildlife, such as green lacewings (*Chrysoperla* sp.) on cutleaf coneflower (*Rudbeckia laciniata*), ambush bug (*Phymata* sp.) and rove beetle (Staphylinidae family) on smooth blue aster (*Symphyotrichum laeve*), and wheel bug (*Arilus cristatus*) nectaring on swamp milkweed (*Asclepias incarnata*). (Photos: Sarah Foltz Jordan, Xerces Society [left]; Nancy Lee Adamson [center, right].)

Establishing native grasses and forbs may take as long as three years to see all species express themselves in the stand and may require special attention to seedbed preparation and weed control. Native plantings will have some development in the first year, with more species coming in during the second year and on through time. The extra effort required is offset by the wildlife benefits provided.

Table 3: Common Native Grass/Grasslike Species Suitable for Pollinator Habitat

COMMON NAME	SCIENTIFIC NAME	COMMENTS	
Big bluestem	*Andropogon gerardii*	**Taller species.** Use lower seeding rates with wildflower plantings	Some of these seeds are lighter and more difficult to disperse. For best establishment, plant using a drill seeder or add appropriate bulk material to aid dispersal with a broadcast seeder. Switchgrass is very common and cheap but quickly becomes dominant in forb plantings and should be planted at extremely low rates per acre or avoided completely.
Switchgrass	*Panicum virgatum*		
Indiangrass	*Sorghastrum nutans*		
Splitbeard bluestem	*Andropogon ternarius*	**Shorter or less aggressive species** that tend to be more compatible with wildflower plantings	Some of these seeds are lighter and more difficult to disperse. For best establishment, plant using a drill seeder or add appropriate bulk material to aid dispersal with a broadcast seeder. Note that *Elymus virginicus* is a cool-season grass. Sedges (*Carex* spp.) and rushes (*Juncus* spp.) are not true grasses. Other than path rush (*Juncus tenuis*), most *Juncus* spp. are suitable for wetter conditions. Depending on the species, *Carex* may be suited to dry or moist conditions.
Broomsedge	*Andropogon virginicus*		
Side oats grama	*Bouteloua curtipendula*		
Sedges	*Carex* spp.		
Deertongue	*Dichanthelium* spp.		
Virginia wildrye	*Elymus virginicus*		
Rushes	*Juncus* spp.		
Little bluestem	*Schizachyrium scoparium*		
Prairie dropseed	*Sporobolus heterolepis*		
Purple top tridens	*Tridens flavus*		

C. Principal Specialty Crops in Arkansas and Corresponding Bloom Periods

If the goal is to provide habitat in critical periods when crops are not in bloom, it is important to understand the bloom periods of the most important crops being grown in your area. Below is a table of a few common crops. This might assist planners in determining what to establish for periods when pollen and nectar are absent or when space or landscape factors limit available forage. There are many different cultivars and varieties of crops. Therefore the bloom time will vary significantly depending on the species and variety planted. Planners should discuss the specific plant and rotation to understand the critical time periods for pollination. Note that pollinators can improve quality and yield of many crops that do not require pollinators (i.e., wind- or self-pollinated), such as cotton, soy and other beans, tomatoes, and peppers. For more information about growing tree fruits, berries, and nuts, including cultivars recommended for Arkansas, visit www.uaex.edu/farm-ranch/crops-commercial-horticulture/horticulture/commercial-fruit-production/ (for commercial production) or www.uaex.edu/yard-garden/fruits-nuts/fruit-trees.aspx (for home gardeners).

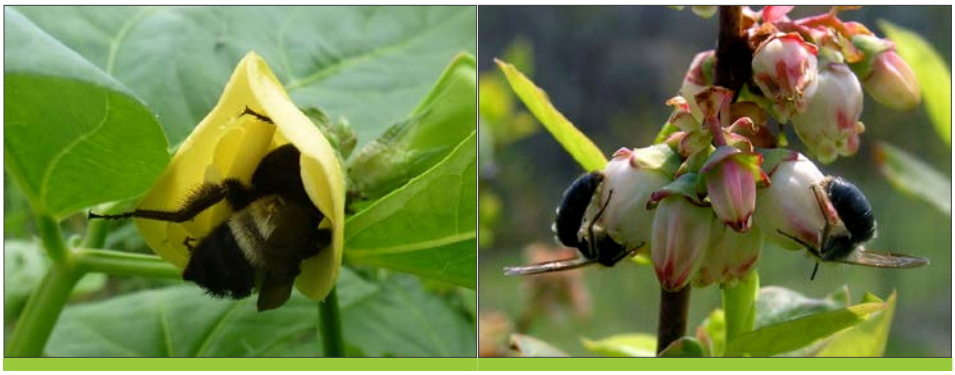


Figure 40—Numerous native bee species pollinate specialty crops like legumes and blueberries. On the left, a bumble bee pollinates pinkeyed purple-hulled cowpea and on the right, some early-emerging mining bees are blueberry specialists. (Photos: Nancy Lee Adamson.)

Planner Note

When establishing native pollinator sites, use a minimum of three early-season, three mid-season, and three late-season blooming plants. It is highly recommended that more diverse seed mixes be used, increasing forb diversity to 40 or more species. This ensures sufficient food for pollinators throughout the growing season. Also include a native grass or grasses, mimicking natural community structure that will be more likely to thrive over time and provide nesting and overwintering sites for many species of insects and other wildlife.

Planting both woody and herbaceous species is often appropriate, especially for riparian areas and other existing corridors, but may require careful planning due to shade tolerance requirements, crown spacing, competition and other factors. It may be best to establish woody and herbaceous plantings in separate phases.

Table 4: Blooming Periods for Common Specialty Crops

CROP	BLOOM PERIOD[1]
Apple	March and April
Blackberry & raspberry	Floricane varieties bloom April through mid-May and primocane varieties will continue blooming through the growing season
Blueberry	April through mid-May
Okra	May through July or August
Peach & nectarine	March and April
Pear	March and April
Peas, cowpea & purple hull (a.k.a. black-eyed)	June through August if planted consecutively
Pumpkin	June through late July
Squash	May through late July (successional plantings may bloom in August)
Strawberry	late February through late May
Tomato	May to frost

1. Note that bloom periods may differ by two to four weeks from north to south in Arkansas.

Planner Note

Sometimes farmers worry that plantings may compete with crops for pollinators. NRCS planners can help farmers understand that plantings that include blooms at the same time as crops not only attract and keep pollinators in the crop, but also help attract and sustain natural enemies of crop pests, reducing the likelihood of pest outbreaks. If honey bees are kept year-round in crop fields, they can communicate with their sisters to draw foragers to more distant habitats, but most bees, wasps, and other insects important in crop production are solitary, so will not travel longer distances unless no food is available. Even honey bees, if brought in to the crop only at peak flowering time, are unlikely to stray.

D. Plant Selection and Seed Sources

Assess the existing diversity of the site to ensure that planting can enhance diversity (see *II. Protecting Pollinators and Their Habitat*). If the natural diversity is already high, management such as thinning, burning, weed or non-native grass control, or stopping or reducing mowing (to restore diversity) may provide the best habitat enhancement.

If planting is the best way to enhance diversity, choose species with soil and sunlight requirements compatible with the planting site. The Species Lists located in *Appendix B* provide a starting point for selecting regionally appropriate pollinator plants. If these species are not available, other closely related species may serve as suitable replacements, however it is important to verify if they are native to Arkansas. Contact a Quail Forever biologist, Arkansas Game and Fish Commission, or University of Arkansas Cooperative Extension to determine other suitable species.

If you are doing a flowering tree and shrub planting, refer to the Arkansas NRCS Tree and Shrub Establishment Specifications (Code 612) in the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov) which includes information related to corridor spacing, soil drainage class, and shade tolerance for several common native woody species. If applying spacing from these tables, utilize the wider ranges of spacing to allow fuller crown development and increased bloom.

Figure 41—A mixture of trees, shrubs, and herbaceous plants can provide the greatest habitat diversity, supporting the greatest diversity of pollinators and other wildlife. Early spring trees like (*left to right*): redbud (*Cercis canadensis*) with a bumble bee, later spring flowering butterfly milkweed (*Asclepias tuberosa*) with a leafcutter bee, and summer flowering buttonbush (*Cephalanthus occidentalis*) with an eastern tiger swallowtail butterfly. (Photos: Nancy Lee Adamson [left]; Steve Duzan [center, right].)

Woody plants may support pollinator habitat in a variety of settings. Hedgerows and riparian corridors provide excellent pollinator habitat components when they include species that bloom throughout the growing season (Ogle et al. 2021). Many trees and shrubs that bloom prior to herbaceous plants in early spring are vital for bees and predators like lady beetles in early spring, but should be paired with other herbaceous blooming species to ensure successional and overlapping blooms.

Many species of woody plants are actually wind pollinated, but still support a diversity of pollinators and other wildlife, such as hickory (*Carya* spp.), ash (*Fraxinus* spp.), and oak (*Quercus* spp.). Farm production may benefit most from woody plants that are more attractive to bees such as willow (*Salix* spp.), eastern redbud (*Cercis canadensis*), maple (*Acer* spp.), holly (*Ilex* spp.), blackgum and tupelo (*Nyssa* spp.), blueberry (*Vaccinium* spp.), hawthorn (*Crataegus* spp.), Virginia sweetspire (*Itea virginica*), American beautyberry (*Callicarpa americana*), blackberries/black raspberries/dewberries (*Rubus* spp.), wild roses (*Rosa* spp.), and buttonbush (*Cephalanthus occidentalis*). Landowners interested primarily in supporting wildlife, especially particular butterflies or birds may be interested in host plants for butterfly caterpillars or plants that produce berries. Supplemental or enrichment woody plantings may be utilized to enhance an area by interspersion of woody species in already existing woodlands, riparian areas, or hedgerows. They may also be established as stand-alone woody plantings to provide corridors or nectaring areas. Be aware that some woody species may be alternate hosts for plant diseases (e.g., cedar apple rust).

Before considering pollinator projects that include planting trees, consider managing existing communities first. Natural succession following disturbance may provide excellent pollinator resources. Where possible, take these naturally occurring species into consideration when planning and evaluating the success of pollinator plantings. Most wooded areas are already too thick; thinning trees and managing the area with prescribed burning may be the most beneficial. Plantings of flowering trees and shrubs should be considered as supplemental to herbaceous pollinator seedings.

Native Plants

Native plants are adapted to local climate, soil conditions, and natural disturbances such as fire. Native pollinators evolved with native plants and many have specialist relationships in which the plant and pollinator depend on one another to survive and reproduce. Some non-native plants that are invasive may spread and degrade existing native plant communities, reducing the diversity and stability of food webs and related populations of wildlife.

Studies have shown drastically reduced wildlife use of non-native species, even those in the same genera as natives, with devastating impacts on the reproductive success of associated wildlife (Tallamy 2009). In some cases, native fauna try to utilize a non-native plant that produces similar semiochemicals, but the plant lacks the nutrients needed for larvae to develop. Or, as with the Arkansas state butterfly, the Diana fritillary (*Speyeria diana*), habitat loss and land management, particularly fire suppression, have led to the butterfly being identified as a species of greatest conservation need (SGCN) by the Arkansas Game and Fish Commission (AGFC), tracked by the Arkansas Natural Heritage Program (ANHP) as a "species of state conservation concern." Creating, enhancing, or restoring native plant communities and ongoing management that mimics natural systems can greatly benefit not only farm production, but also help restore the natural diversity of the region.

Native perennial plants are advantageous because they generally:

1. Require no to few fertilizers and do not usually require pesticides for maintenance;
2. Can be more tolerant of climate cycles than non-native plantings;
3. Provide permanent shelter and food for diverse wildlife;
4. Will not become invasive like some non-native plants; and
5. Promote biological diversity.

Using native plants helps provide connectivity for existing native plant populations. Providing connectivity on a landscape level increases the ability of species to move in response to environmental shifts, which can also help sustain potential genetic variability.

The cost of native plants may seem higher than non-native alternatives, but when the costs of maintenance (e.g., weeding, watering, fertilizing) are calculated over the long term, native plantings are ultimately more cost efficient for pollinator enhancement. It is a common misconception that pollinator seed mixes cost much more than they actually do. Native pollinator seed mixes typically cost between $250 and $350 per acre. Native plantings can greatly enhance biological diversity and are the logical choice for supporting native pollinators, predators, and parasitoids for farm production, and wildlife overall.

Planner Note

Not all commercial pollinator mixes are created equal. Always check mixes from commercial sources to ensure that the species included are native to Arkansas and that the mix provides sustained blooming throughout the growing season (i.e., multiple species that bloom per season in the growing period). Also check to make sure that annuals and biennials do not make up more than 15% of the mix. Some have been seen to be over 50% annual species, which will greatly reduce the diversity and abundance of perennial plants over time.

Seed Sources

The term "local ecotype" refers to seed and plant stocks harvested from local sources, often within a few hundred miles. Where available and economical, local ecotype native plants and seed should be procured. Plants selected from local sources will generally establish and grow well because they are adapted to local conditions.

For seeds purchased for plantings supported with Farm Bill programs, NRCS requires pure live seed (PLS). Each pound of pure live seed has a pound of viable seeds, so the bulk weight (including inert or nonviable seeds) may be more than one pound. Buying pure live seed helps ensure the seeding rate is adequate. Between 20–40 PLS/square foot is generally recommended, with 25–30 PLS/square foot being the ideal target range for seed mixes. Commercially procured seed should also be certified according to Arkansas state laws and recommendations. Seed certification guarantees a number of quality standards, including proper species, germination rate, and a minimum amount of weed seed or inert material.

Transplants

Enhancement sites may be planted with plugs, container-grown, containerized, bare-root, live stakes, or balled and burlapped stock. NRCS planners should rely on the Arkansas conservation practice (420) Wildlife Habitat Planting, (327) Conservation Cover, (643) Rare and Declining Habitat Management, (612) Tree/Shrub Establishment, (422) Hedgerow, or other appropriate standards for more information.

Herbaceous plants purchased as plugs have the advantage of rapid establishment and flowering earlier, although the cost and feasibility of using plugs can be prohibitive for large plantings. Transplants may need mulching and supplemental water to ensure survival.

Planner Note

Careful planning and adequate site preparation are critical to the success of pollinator plantings. Producers invest a significant amount of time and expense in these projects and we want them to be successful.

When planting woody species, there are trade-offs between size, ease of establishment, supplemental water needed, and time to reach mature size. Generally, smaller material, such as bare-root and tubelings, are most cost effective, but will take a couple to a few years to catch up in size to larger container or balled and burlapped shrubs and trees. Bare-root plants can only be planted during the dormant season (winter) and tubelings are best planted in fall or very early spring. Although the cost of containerized plants is typically low for bare-root and tubelings, the cost of containerized plants may be prohibitive on larger sites. Live stakes or wattles are cuttings of woody plants made during the dormant season for planting during the dormant season. These are frequently used on moist soils at minimal cost; particularly if there is a source of the species nearby. Typically they include willow species in riparian or frequently flooded areas. Hardwood species with rooting ability can be found in NRCS' *Plant Species with Rooting Ability from Live Hardwood Materials for Use in Soil Bioengineering Techniques (Technical Note-No. 1, Plant Materials Program)*. Note that species in the list shown as "adaptable" to Arkansas are not all native to Arkansas, and those non-native species are not recommended.

Figure 42—*left to right*: Native sweat bee, fly, and European honey bee visiting serviceberry (*Amelanchier* sp.) blossoms. Serviceberry is an early-blooming native small tree that produces delicious berries. (Photos: Nancy Lee Adamson.)

Avoid Nuisance Plants

When selecting plants, avoid ones that act as alternate or intermediate hosts for crop pests and diseases. Similarly, economically important agricultural plants (or closely related species) may be unsuitable for enhancement areas if they serve as a host reservoir for insect pests and crop diseases. For example, commercial apple growers may prefer not to see native crabapple trees used in adjacent conservation plantings for wildlife because the trees may harbor pests or diseases. It is prudent to be familiar with the crops and their commonly associated diseases in the region.

Non-Native Plant Materials

While in most cases native plants are preferred, non-native cover crops, cut flowers, and herbs can provide some pollinator habitat—including nectar and pollen resources for pollinators, predators, and parasitoids—and additional income. A non-native, non-invasive plant may be chosen to fill in gaps in bloom times, provide pollinator resources during cropping sequences, or to attract a particular pollinator, such as parsley or fennel for black swallowtail butterfly (*Papilio polyxenes*) caterpillars around the homestead. On farms where agritourism is important, farmers may want to plant showy annual species along the edges of perennial plantings until the perennials are established. For more information on acceptable non-native plants for pollinators refer to *Appendix B: Species Lists* of this handbook.

Figure 43—*left to right*: Cover crops like buckwheat (*Fagopyrum esculentum*), annuals like Mexican sunflower (*Tithonia rotundifolia*), and perennial or annual herbs like Thai basil (*Ocimum basilicum* var. *thyrsiflora*), an annual, can improve soil health or provide additional income while also supporting diverse insects. (Photos: Nancy Lee Adamson.)

Pollinator Seed Mixes

Commercial pollinator mixes available for sale online and through mail order catalogues often do not meet pollinator habitat specifications. Some mixes use primarily non-native annual species that may not persist over time (i.e., compete well against weedier species) or may not provide pollinator resources throughout the growing season. Commercial mixes are often tailored for quick establishment and aesthetics as opposed to production of pollen and nectar and longevity. Some mixes contain non-native species that are aggressive in native ecosystems; these should be avoided. Mixes that utilize native species and provide food and nectar throughout the growing season provide the greatest habitat benefits, with greatest potential for supporting pollinators, predators, parasitoids, and other wildlife. **Producers and landowners should buy seed mixes as designed by planners or biologists from reputable native seed dealers, some are listed in the appendices in the back of this book.**

E. Enhancing Nest Sites

Remember that natural habitat is the best nesting place for bees and other insects, but providing nests can supplement pollination and pest management or provide educational opportunities to learn about solitary cavity-nesting bees and wasps, and help family, friends, farm workers, and other community members learn that solitary bees and wasps are safe to be around and fun to watch.

There are many successful ways to provide nesting sites for different kinds of native bees, including bundles of reeds, drilled wooden blocks, bare ground, adobe bricks, and solitary bee observation houses. The Xerces Society's publications *Farming with Native Beneficial Insects: Ecological Pest Control Solutions*and *Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms. 3rd Ed* and *Nesting & Overwintering Habitat for Pollinators & Other Beneficial Insects* provide detailed information on how to build artificial nest sites. While providing habitat for nesting is ideal, adding nest sites provides excellent opportunities for observing the solitary species of bees and wasps that utilize them.

Most native bees (solitary bees and bumble bees) nest in the ground. The requirements of one species, the alkali bee (*Nomia melanderi*) are so well understood that artificial nesting sites are created commercially to provide reliable crop pollination for alfalfa in eastern Washington and Idaho. Unlike the alkali bee, however, the precise conditions needed by most other ground-nesting bees are not well known. Some species nest in the ground at the base of plants, and others utilize packed bare ground where vegetation is sparse. Landowners can create conditions suitable to a variety of species by maintaining areas of rarely disturbed (periodic mowing or prescribed burning is acceptable) and untilled ground. Landowners may want to scout sites where little vegetation grows to learn which areas are utilized by bees through the growing season. Ground-nesting bee activity can be difficult to observe because there is often little above-ground evidence of the nests. Tunnel entrances usually resemble small ant mounds and can range in size from less than ⅛" in diameter to almost ½" in diameter, depending on the species. Diverse species of bees utilize diverse soils and are active at different times during the growing season, but research shows that many ground-nesting bees prefer sandy, loamy-sand, or sandy-loam soils. Note that many wasps also

nest in the ground and that the vast majority of wasps are also solitary, so not defensive around their nests like yellow jackets (*Vespula* spp.). Cicada killer wasps (*Sphecius* spp.), like many solitary bees, aggregate nests where conditions are best. Solitary bees and wasps are never defensive since they only provision nests, lay an egg, and never see their young.

Potential nesting areas could be constructed with soil excavated from drainage ditches or silt traps and stabilized with native bunchgrasses and forbs. Some bees utilize soil or dry stone walls below barn roofs (protected somewhat from rain). Constructed ground-nest sites should receive direct sunlight, and dense vegetation should be removed regularly (through prescribed burning, periodic mowing, or herbicide use), making sure that some patches of bare ground are accessible. Once constructed, these nest locations should be protected from digging and compaction. Colonization of these nest sites will depend upon which bees are already present in the area and the suitability of other nearby sites.

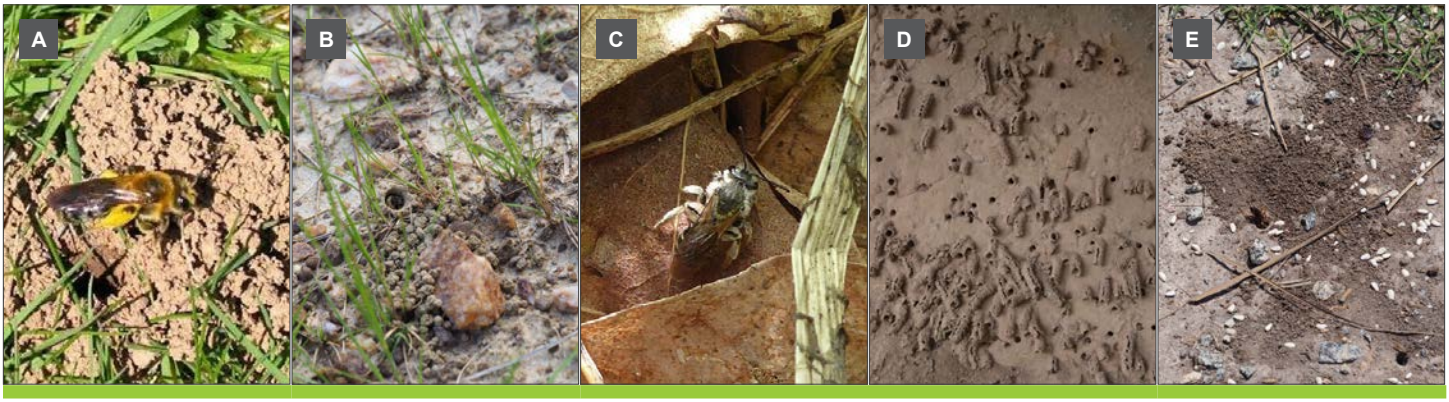


Figure 44—Ground-nesting bee nests are often in bare or sparsely vegetated areas (A, B), but may also be below leaves in woodland settings (C). Some ground-nesting bees, particularly anthophorid bees, will utilize adobe-like walls such as this clay oven (D). Some solitary wasps, like this great golden digger wasp, nest in well-drained, somewhat sandy soils, as well (E). Solitary ground-nesting bees and wasps often aggregate nests, but as single parents who never see their young (they provide provision in the nest cell and lay an egg), they are never defensive near their nests—if people approach, they will hide, fly away, or continue their work. (Photos: Nancy Lee Adamson [A–C, E]; Isis Longo [D].)

In contrast to ground-nesting bees, other species such as mason (*Osmia* spp.) and leafcutter (*Megachile* spp.) bees naturally nest in existing cavities, such as pithy stems of plants, tunnels made by beetles or other insects in dead trees, or other cavities they can find. Most mason bees and solitary wasps use mud to create individual cells in these cavities, but some mason bees and all leafcutter bees use leaves for cell construction. Solitary bees and wasps may also utilize other materials such as pebbles, plant resins, grasses, sand grains, small pieces of leaves, petals and grass filaments, fibers, small twigs, threads of spider webs, and salivary secretions (Morato and Martins 2006; MacIvor 2017).

Landowners can supplement nesting sites for cavity-nesting bees with NRCS (649) Structures for Wildlife practices. These include downed tree structures and edge feathering to create loose brush piles. Creating brush piles from woody debris (twigs, logs), stiff herbaceous stems (like blackberry or wingstem), and tree girdling are all excellent ways to support cavity-nesting bees and many other beneficial insects such as spider and potter wasps (solitary predatory wasps in the Pompilidae family and the Eumeninae subfamily [Vespidae family]).

Figure 45—Snags and brush piles provide multiple benefits for diverse wildlife. Cavity-nesting bees, wasps, and other predatory insects, as well as bumble bees, may nest or overwinter in them. Other wildlife shelters in and feeds on insects that live in or consume the wood. Shown—*left to right*: Eastern chipmunk (*Tamias striatus*), fledgling Carolina wrens (*Thryothorus ludovicianus*), and an eastern box turtle (*Terrapene carolina carolina*) found nesting and sheltering in brush piles. (Photos—*left to right*: Paul Cooper*, Toni Genberg*, and Ben Wurst*. *Via flickr.*com.*)

Figure 46—Research has found that two non-native mason bees, *Osmia cornifrons* and *O. taurus* (a), tend to be the most common occupants of artificial nests sized to attract native blue orchard bees (*O. lignaria*), but a range of sizes can encourage native mason bees, leafcutter (*Megachile* spp.) bees, and predatory wasps to nest. Pupae of native mason bee (*Osmia* sp., b). Nesting native mason bee (*Osmia* sp.), that masticates leaves to line its nest (c) rather than using mud. Both mason and leafcutter bees are in the leafcutter family (Megachilidae), with pollen-carrying hairs on their abdomens (easier to unload in a cavity). Leafcutter bee with a pollen-filled scopa (the pollen-carrying hairs on her abdomen), on blanket flower (*Gaillardia* sp.) (d). Wild senna (*Senna marilandica*) leaf cut by a leafcutter bee; plants in the pea and rose family, plus species like cottonwood (*Populus deltoides*), are known to be used by leafcutter bees, likely due to antifungal or antibacterial properties (e). Solitary wasps, such as this crabonid wasp (*Trypoxylon* sp.), may nest in artificial nests though they usually nest in soil (f, left). A chalcid (parasitic) wasp is searching for prey she can lay her eggs in (f, right). (Photos: Barbara Driscoll [D]; Nancy Lee Adamson [A–C, E, F].)

Landowners can also buy or construct bee observation houses with a range of holes routed into the surface of a wood plank (with the back end left intact), covered in a clear plexiglass plate (with a door to keep light out), if they would like to watch solitary mason or leafcutter bees, and some solitary wasps (like spider or potter wasps) nest. Nests can be created by cutting and bundling fresh bamboo, leaving one end closed. Diameter openings should be no bigger than a pencil (at most ⅜") to as small as 3⁄32" and the lengths for the largest openings should be about 6" ranging to 3" for those with smaller openings. A range of hole diameters will encourage a diversity of species through the season. Alternatively, nests can be made by drilling a series of holes into wooden blocks. For bamboo or wood block nests, rolled up parchment paper or paper straws inserted into nesting holes can help reduce parasite and disease problems. These can be removed, and pupae and larvae sorted and stored.

Commercially produced bee blocks, consisting of a wood block drilled with a series of dead-end tunnels are now widely available. These types of bee nests were initially developed in the 1960's by alfalfa seed producers in the western United States to attract and manage large numbers of the non-native alfalfa leafcutter bee (*M. rotundata*). More recently artificial nests have been modified to manage the blue orchard bee (*O. lignaria*) for orchard fruit and almond pollination. These artificial nests contain tunnels that are uniform size and depth. However, because they are designed to suit specific species, they may either be too large or too small for many other species. Also, the blue orchard bee is active only in the spring and will not pollinate later-flowering fruits and vegetables.

Nest blocks with a greater diversity of hole sizes and depths are active throughout the growing season. As with bamboo, holes sizes between 3⁄32–⅜" in diameter will attract diverse cavity-nesters. Space holes approximately ¾" apart in blocks of preservative-free lumber. The holes should be smooth inside, and closed at one end. The height of the nest is not critical, but should at least be 8" above the ground. The depth of the hole, however, affects the ratio of male to female offspring, so it is important. Holes less than ¼" diameter should be 3–4" deep. For holes ¼" or larger, a 5–6" depth is best. Nest blocks should be hung in a protected location where they receive strong indirect sunlight and are protected from rain.

Artificial nests can attract large numbers of tunnel-nesting bees and boost local populations, but only if managed carefully over time. Because the nests concentrate the bees in unnaturally large numbers within a relatively small space, they are susceptible to infestations of parasites and diseases after a few seasons. Without regular sanitation or the phasing out of nest materials, these parasites and diseases can threaten long-term pollinator health. For more precautions, see https://entomologistlounge.wordpress.com/2017/09/18/insect-hotels-a-refuge-or-a-fad/.

Recommended Nesting Block Hole Dimensions

⊙	→	⭱
<¼"	3–4"	≥8" from ground level
>¼"	5–6"	

Hole: ⊙ Diameter → Length ⭱ Height

Planner Note

NRCS planners should refer to the Invertebrate Conservation Fact Sheet Nests for Native Bees and the Fish and Wildlife Habitat Management Leaflet Number 20 entitled *Artificial Nesting Structures*. The Arkansas conservation practice standard (649) Structures for Wildlife should be followed when recommending these strategies.

Planner Note

NRCS planners should always conduct a habitat assessment and thoroughly evaluate the need and maintenance requirements for any artificial nesting structures before recommending them. When possible, utilize conservation practice standard (649) Structures for Wildlife to create habitat.

Figure 47—Nesting cavities for tunnel-nesting solitary bees and wasps can help support their populations if managed properly. Bee observation boxes (A, B) with a range of hole sizes (3⁄32″ to 3⁄8″) provide the additional benefit of allowing observation of the various bees and wasps that utilize them. Occupation usually begins in spring with mason bees (*Osmia* spp. [C, D]) and is followed in late spring through summer by small carpenter bees (*Ceratina* spp. [E]), yellow-faced bees (*Hylaeus* spp. [F–top]), leafcutter bees (*Megachile* and other genera [G, H]) and various wasps that may include mud daubers (Sphecidae or Crabonidae) that collect and paralyze caterpillars [F–bottom] or spiders for their young and grass-carrying wasps [I] that prey on tree crickets for their young. Once a tunnel nest is finished, the open end of the nest is "capped" using the same materials as the cells inside. Because these are all solitary species, it is safe to observe them up close. This box is co-located with a bird house (nesting birds collect large numbers of caterpillars for their young) and the pole is painted with "insect-a-slip," a highly slippery coating that, once dry, prevents ants from crossing it and entering either house. (Photos: (A, B); David Biddinger, PennState University (C); D; Howard Ensign Evans, Colorado State University, Bugwood.org (E); Rob Cruickshank, flickr (F–I); Whitney Cranshaw, Colorado State University, Bugwood.org (J).

Contaminated nest blocks left unattended in the landscape continue to attract wild bees from the surrounding area and have the potential to cause mortality to bees. In order to be sustainable over the long term, artificial nests will require regular maintenance.

Managing wood blocks with annual cleaning takes some extra effort. To ensure that a block is empty prior to cleaning, cover the nest and provide a single exit hole while placing a new block adjacent to the one that needs to be cleaned. Bees and wasps will exit but have a hard time reentering so are more likely to use the new block. Empty nest blocks can then be cleaned using a mild solution of bleach water to reduce the risk of mold, parasites and disease. To further resist the build-up of parasites and risk of disease, nest blocks need to be replaced every three to four years.

If using bamboo, placing small bundles in a few locations each year, and removing some each year can help reduce potential disease and parasite concentrations. In fall, the bamboo can also be gently split open from the back end so that larvae and pupae can be sorted

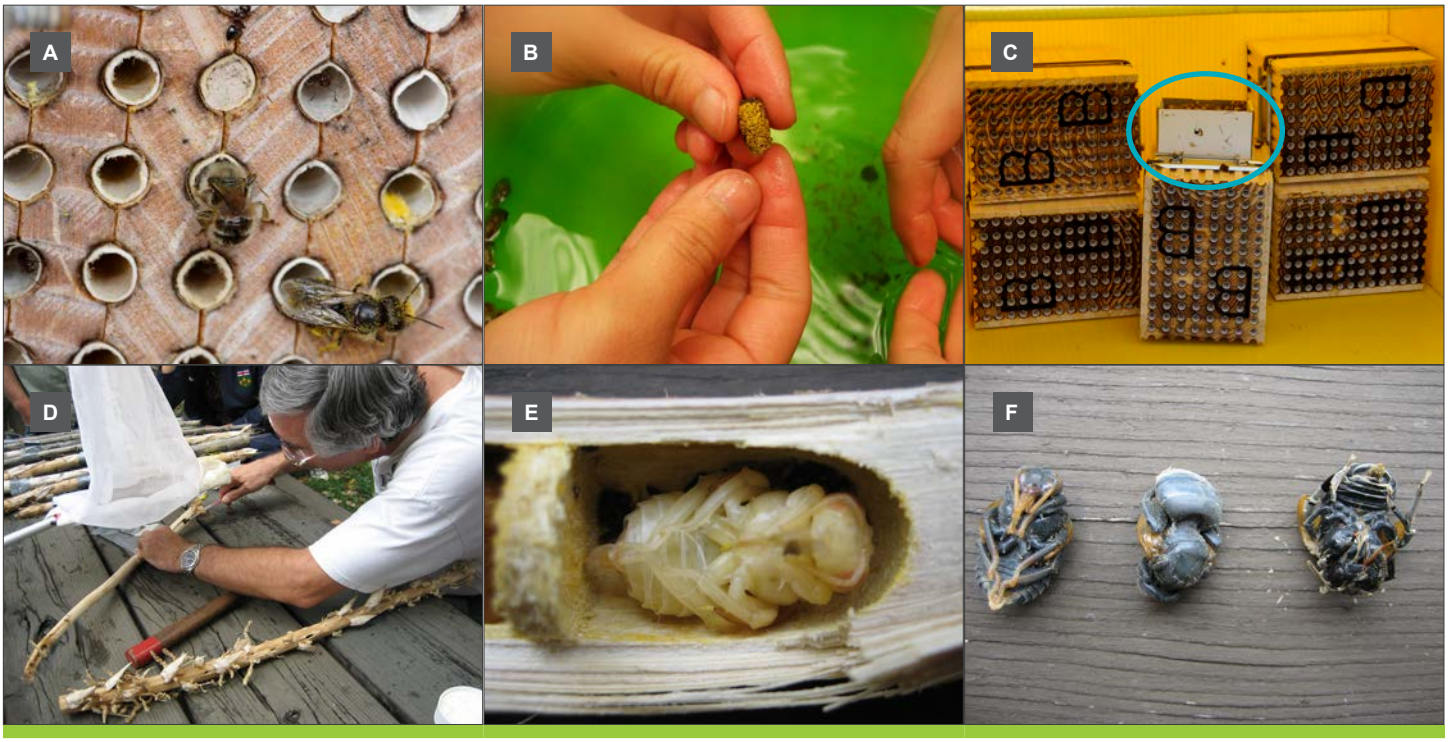


Figure 48—Whenever artificial nesting sites are provided, annual maintenance and sanitation is vital for preventing disease or parasite infestations. Commercial bee blocks (that house solitary bees and wasps) can either be opened and cleaned at the end of the season or lined with paper tubesthat split open easily (A), so the cocoons can be removed and examined for disease or parasites. Parasitized cocoons may be lighter in color or have a tiny entry hole. Before placing the hibernating bees in storage for the winter, the cocoons can be gently washed in a dilute bleach solution (not soap or detergent), then thoroughly rinsed in clean water, to reduce potential disease or parasite loads. Note that feces do not pose a problem (B), but examining with a hand lens may help you identify pollen mites or other signs of parasites. Just before the bees are ready to emerge in the spring, their cocoons are placed in a release box (C, circled) near new or sanitized nest blocks. For bundles of pithy stems, the stems should be split open at the end of the season (D)—so they can't be reused the next year—then the healthy pupae (E) or cocoons are removed from the nests, cleaned, and collected (F) for safekeeping and release just like bees and wasps from commercial blocks. (Photos: David Biddinger, PennState University [A, C]; Steph L., flickr [B]; Katharina Ullmann, Xerces Society [D, E, F].)

and managed. Healthy pupae can be placed in a non-sealed container in the crisper drawer of the refrigerator, while wasp and fly larvae (grubs) can be placed outside in tins with a clean exit hole. Live grubs (without protective pupal cases) desiccate in a refrigerator. If placed in cardboard rather than metal or wood boxes, they may be eaten by mice. If pupae are stored in the refrigerator, they must be placed outside in a box with a clean exit hole in early spring if mason bees, or early summer if leafcutter bees.

Many tunnel-nesting bees do not forage far from their nest site, so multiple blocks may be useful adjacent to cropland that requires pollination. For areas where natural nest cavities may be limited, supply at least two to three blocks per acre, each with at least 20 drilled holes per block. In addition to wooden blocks or bamboo, artificial nests could be constructed with bundles of paper straws, cardboard tubes, or other hollow plant stems.

Sources for Nesting Information

Foltz Jordan, S., J. Hopwood, and S. Morris. 2020. *Nesting & Overwintering Habitat for Pollinators & Other Beneficial Insects*. Portland, OR: The Xerces Society for Invertebrate Conservation. https://www.xerces.org/publications/fact-sheets/nesting-overwintering-habitat

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IV. Establishment, Management, and Maintenance of Pollinator Habitat

Figure 49—Look for inspiration from natural communities like this native prairie at Mount Magazine State Park in Logan County, Arkansas, when designing new pollinator plantings. (Photo: Eric Hunt.)

Pollinator habitat may be protected or enhanced with management of existing plant communities, or created with new plantings. Always assess existing conditions (see *I. Recognizing Existing Pollinator Habitat*) to help determine if management (such as mowing, light disking, thinning of woody species, prescribed burning, etc.) or a new planting is best for achieving landowner goals and for providing pollinator habitat. This chapter highlights early successional and other open grassland habitat, native forb and grass establishment, woody establishment, and long-term maintenance.

NRCS planting guidance is included in conservation practice standards and technical notes in the NRCS Field Office Technical Guide and from the Booneville Plant Materials Center:

- NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov)
- Booneville Plant Materials Center (PMC) www.nrcs.usda.gov/wps/portal/nrcs/publications/plantmaterials/pmc/southeast/arpmc/pub.

Arkansas NRCS is also partnering with a collaboration of diverse public and private organizations through the Arkansas Monarch Conservation Partnership to provide guidance on habitat for monarch butterflies (*Danaus plexippus*) and other pollinators and implement the statewide Monarch and Pollinator Conservation Plan (http://arkansasmonarchs.org/).

Highlighted here are basic approaches commonly recommended. Additional guidance on installation of herbaceous and woody plantings for pollinators, as well as organic site preparation, is available from the Xerces Society at https://xerces.org/pollinator-conservation/habitat-installation-guides. See *Appendix B: Species Lists* and *Appendix C: Seed Mixes* for recommended plants.

A. Open Grassland and Early Successional Habitats

Open grassland habitat is a conservation priority because many species of wildlife dependent on this habitat type are experiencing

population declines. See the Terrestrial Habitats section of the *Arkansas Wildlife Action Plan* for more details about specific wildlife habitat needs. Open grassland habitats require some disturbance to persist. Historically, and to a limited extent now, natural fires, bison and other large grazers, beavers, strong winds, and periodic flooding helped create or maintain such habitats. We often use the term "early successional" to refer to open grassland habitats, but remnant prairies are actually very late successional, more precisely termed "climax communities" dominated by conservative late successional forbs (such as prairie blazing star [*Liatris pycnostachya*] and rattlesnake master [*Eryngium yuccifolium*]) and grasses. True early successional habitats are dominated by weedy forbs and grasses, but over time are replaced by late successional (conservative) species that take longer to establish. Early successional habitats are also important habitats for all sorts of pollinators and other wildlife. Common modern day early successional habitats include weedy areas, newly planted grasslands, old fields, shrub thickets, and young forest. Mowing, prescribed burning, brush-hogging, disking, cutting, prescribed grazing, herbicide application, timber harvest, and a combination of methods, can help maintain or restore open grassland and early successional habitats. While much effort to create and manage these habitats has focused on birds and mammals, they also provide excellent habitat for pollinators. Open grassland habitats, including early successional habitats, may include a diversity of native grasses, forbs, shrubs, and trees that provide both food (pollen and nectar) and cover.

Figure 50—Natural glade restored by removing cedar (*Juniperus virginiana*) and other hardwood brush followed by prescribed fire. Without some sort of disturbance such as fire, trees and shrubs would eventually shade out many of these wildflowers. (Photo: Ryan Diener, Quail Forever.)

Old fields (fallow or abandoned pastures and crop fields) often provide a mix of flowering forbs that may include native and non-native plants. Common perennial natives include grasses like purpletop, broomsedge, and little bluestem; wildflowers such as lyre-leaved sage, mountain mints, wild bergamot, goldenrods, rosinweeds, and asters; and some shrubs like sumacs, blackberries, black raspberries, and roses. Common introduced species include legumes like clovers and vetches; and forbs like Queen Anne's lace and mustards; and grasses like fescue and Bermuda. Wetter areas may have abundant native grasses like beaked panic grass or bushy bluestem and native forbs like blue or white vervain, joe-pye weed, ironweed, sunflowers, boneset, and marsh marigold. These areas can often be managed and improved through prescribed fire and careful removal of non-native species to increase the native grass and forb component.

Early successional shrubs and trees found in woodland communities will colonize old fields as well. Species such as cherry, willow, wild roses, hawthorn, crabapple, black raspberry and blackberry, sumac, dogwood, and viburnum provide an important source of nectar and/or pollen. Many of these woody species bloom during spring when flowering forbs are scarce, making them very important for successful pollinator reproduction. Woody plants also provide important nesting habitat for cavity-nesting bees. However, sweetgum (*Liquidambar styraciflua*) often invades grassland habitats and can quickly dominate the area and shade out beneficial plants. Care should be taken to make sure woody encroachment is kept under control and the species are beneficial and not detrimental in the long term.

When creating a new open grassland area, try to focus attention on larger blocks of habitat. Five-acre blocks or larger will provide the most benefit to the greatest number of species—both vertebrate and invertebrate. Larger openings allow more sunlight to reach plants, leading to more flowering (and food for pollinators and other wildlife). Adding or restoring habitat adjacent to existing open habitats may have broader impact than scattered patches, but both are valuable.

B. Planning Process

Establishing and maintaining new pollinator habitat requires careful planning and long-term maintenance. Weed competition and strategies to suppress weeds must be considered during all phases of pollinator plantings. Consider site preparation, planting, and maintenance in the planning process.

Establishing habitat usually takes about three years to see a majority of the species in the seed mix show up as blooming plants. This is normal—native seedings have some species that establish quickly in the first year and, as the stand matures over the next couple of years, more of the perennial species begin to show up. The extra effort required to establish perennial plantings is offset by the long-term benefits they provide. Smaller patches of habitat such as backyards or small garden-type plantings may require significantly less effort and maintenance, especially if plugs or containers are used instead of seed.

C. Site Preparation

The primary goal of site preparation is reducing weed competition. For seeding, an additional goal is providing a firm, clean seedbed. Reducing weed competition for a full season prior to planting is critical for perennial plantings and will help ensure long term success. Depending on weed competition, two seasons of weed control or selecting a different (less challenging) site may be recommended. Because tilling brings weed seeds to the surface where sunlight stimulates their germination, avoid tilling if possible. Haying/grazing or burning a site prior to or after herbicide application is a great method for removing litter and preparing the seedbed.

Some landowners interested in pollinator habitat and bees are reluctant to use herbicides, while others feel that the long-term habitat benefits outweigh potential negative impacts on very limited (short-term) use. See *II. Protecting Pollinators and Their Habitat* for more details on herbicide risks and the NRCS WIN-PST tool for assessing risks.

Planner Note

Smaller sized plantings and potential nesting sites should be scattered throughout the farm, ideally separated by no more than 500' (150 m). This can encourage bees and other agriculturally beneficial insects to travel farther into croplands and also provide refuge when croplands are harvested or otherwise disturbed. These sites are best when at least a half acre in size.

Tillage combined with smother cropping or solarization are the two primary organic site preparation methods. While both approaches are appropriate for seed or container plantings, the additional costs that may be associated with solarization are warranted when planting seeds. Although there are organic herbicides, the need for multiple applications and their limited effectiveness make them less recommended.

Herbicide Site Preparation

Herbicides can be applied prior to planting (pre-emergent) or after the stand has begun to grow to control competition (post-emergent). Utilize pesticides according to the label. For annual plantings, many farmers and landscape contractors will use an herbicide treatment in fall, followed by a spring herbicide treatment, and spring planting. For perennial plantings, it is generally best to prepare the site for one whole growing season, if possible, using a broad spectrum herbicide to kill existing vegetation starting in spring and repeating applications, as needed, through the growing season. Some non-native grasses like Bermuda may take multiple applications throughout the year, or a different herbicide like imazapyr. Prior to herbicide application, remove excess vegetation by burning, mowing, or grazing, and allow a few inches of regrowth prior to spraying. Some herbicides have long residual activity that can inhibit or kill native perennial and annual seeds (see *Appendix E: Herbicide Residual Times)*. These herbicides list species that are tolerant on the label, but even listed species may not tolerate areas where rates may inadvertently be increased (such as corners of fields). For seeding, a clean seedbed helps ensure good seed-to-soil contact. Burn or rake off any remaining vegetation prior to planting.

Non-native cool-season grasses are best controlled with a spraying in late fall or early winter. These grasses will stay active after a frost when native plants have gone dormant. Spray on a warm sunny day (50's or 60's) after the area has had a killing frost. The cool-season grasses will uptake the chemical and will show signs of control by the following spring. Follow this application with a late winter or early spring fire to release the native seed bank from the dead grass thatch.

Smother Crops Site Preparation

Smother-cropping is a good way to prepare a seedbed that can reduce herbicide needs in some instances and help keep cover on the area through the growing season leading up to seeding. Smother crops can be established through two common methods; herbicides and no-till planting, or tillage and planting. To establish smother crops via no-till, use a broad-spectrum herbicide in the spring to remove unwanted non-native vegetation, then no-till drill your smother crop species into the field. Forage sorghum is a good option for a smother crop, it gets thick enough to suppress the growth of weeds and unwanted vegetation throughout the year and can provide additional forage. Forage sorghum can also help increase mycorrhizal fungi in the soil, which can improve the growth of native plants the first year of the seeding. At the end of the growing season, the sorghum can be hayed or grazed off to make use of the vegetation and remove the excess material to get bare soil for seeding, or it can be burned off in early winter prior to planting natives. The field should be scouted to make sure no unwanted vegetation is in the field. If needed, a final spraying could be done after removing the smother crop. If herbicides cannot be used in the area, tillage and then planting a smother crop is an option. Till the area in spring as soon as the ground can be worked. When a new flush of growth is established in two to three weeks, till again. Let plants flush and till once more. Plant buckwheat or other cover crop densely. When a large portion of the buckwheat is finished flowering, till and plant a dense summer cover, like cowpeas or forage sorghum. Ideally, this will die prior to seeding time. If not, mow or crimp just prior to planting. Do not till within two months of planting (tilling brings up new weed seeds and can also create a planting bed that is too soft). If vegetation is dense, you can burn, graze, or hay and remove any excess plant materials prior to planting. For seeding, a clean seedbed helps ensure good seed-to-soil contact.

Tarp or Solarization Site Preparation

UV-stabilized plastic and/or opaque tarp can be used, if available, in areas where stubble would not damage the plastic or tarp, and where deer or other wildlife will not puncture the plastic. Prior to installing tarp or plastic, mow as close to the ground as possible, and water if the soils are dry. Tarp or UV-stabilized plastic should be dug in at its perimeter—bury about 6" of the edge and try not to stretch too tightly (leave some give so less likely to tear if stepped on). UV-stabilized plastic has the advantage of allowing weed seeds to germinate (most weed seeds require sunlight to germinate). Under the clear plastic, the weed sprouts usually die due to excessive heat or moisture. Leave in place until close to planting unless plants that thrive under the plastic are present, such as some sedges that may germinate in late summer. This option is expensive and may not be feasible for larger plantings. It can be a viable option for small areas or garden-type plantings.

Nutrient Management

Never apply nitrogen during the planting year. Nitrogen tends to support non-native weeds that are less adapted to Arkansas soils. Consider applying lime, phosphorous, and potassium, only if soil tests indicate they are needed. Native plants are adapted to the local soil conditions, and many like slightly acidic soils here in Arkansas. It is better to make a seed mix of species that will do well on your site than to try to amend the soils to a certain pH. Soils that test high in nitrogen (N) or phosphorus (P) will pose issues for native seedings. High levels of N and P will encourage excessive weed growth. Some native plants are sensitive to (i.e., harmed by) high phosphorus levels.

D. Herbaceous Plantings

Forbs and grasses are usually planted as seed using conventional or no-till methods. No-till has the advantage of minimum soil disturbance, thus reducing weed competition and soil erosion. When planting into tilled soil, care must be taken to ensure the planting bed is firm to avoid planting too deeply (using a cultipacker or other equipment to pack the bed after tillage will be necessary). For smaller areas, hand-broadcasting, a cyclone seeder, or similar equipment adapted to all-terrain vehicles or tractors may be the best option. Broadcasting generally requires adding an inert material to help with spread and distribution of the seed.

Seed Notes

Seed mixes developed for restoration plantings are designed to ensure overlapping blooms throughout the growing season. Some species will actively grow and senesce early in the season while others may not actively start growing until the mid-point of the season, initiating bloom much later in the summer. Many native plant seeds require a cold, moist period prior to germination, called a stratification period. Some seed may be purchased already stratified. Most seed will be un-stratified seed and should be planted in the winter (December 1–March 1). This will allow for the seed to naturally go through cold-moist stratification through the winter months and have better

germination in the spring. Native seed that is planted in April or May will have a large proportion of the seed that does not germinate that first year but should come in after the winter and into the second growing season. Spring plantings can set seedings back and allow for more weeds to grow. If you have stratified seed, it can be planted between April 1 and May 15. This should only be done if all of the seed in your mix is stratified by the supplier; if only some species are stratified the planting should be done in the winter. Check with the supplier to determine if any seed will require stratification or specific storage methods prior to planting.

Figure 51—Herbaceous plantings can be modeled on diverse native prairies in Arkansas, like this one at Cherokee Prairie Natural Area. Blazing stars provide tremendous resources for butterflies and many other kinds of pollinators, like this prairie blazing star with a black swallowtail butterfly nectaring. (Photos: Steve Duzan [left]; Eric Hunt [right].)

NRCS requires purchasing seeds as Pure Live Seed (PLS). PLS has been tested for germination, dormancy, and percent bulk. One pound PLS contains one pound of viable seed but may weigh more than one pound based on the amount of inert materials or non-viable seed.

Commercial seed mixes are typically sold based on an estimated number of seeds per square foot. For 20 to 40 seeds per square foot (a range that ensures adequate coverage without wasting seed with an ideal range of 25 to 30 seeds per square foot), 2.5 to 8 pounds of seed may be needed. The total pounds of seed is less important than the seeds per square foot parameter, which truly tells us the coverage of the seed mix since the seed of each species can be drastically different in size and weight. For guidance on using seed calculators, consult with a local NRCS District Conservationist, Arkansas Game and Fish Commission, or Quail Forever Biologist for help with seed calculators; or utilize the seed mixes in Appendix C.

The Importance of Good Seed-to-Soil Contact

Prepare the seedbed by removing as much of the thatch as possible and creating a smooth seedbed. Do not cultivate or till the area because this will allow weed seeds in the soil to germinate and compete with the planting. Seeds of native plants are often very small in size (millions of seeds per pound). Some species of native plants important to pollinators have smooth seeds, while others may have fluffy “beards” or other material that makes them difficult to be seeded through conventional no-till seeders. It is often difficult to determine the uniformity of dispersal when planting and may require some trial and error in methods of establishment. If possible, utilize fluffy seed boxes and other specialized equipment geared specifically for native plant establishment. Specialized drills have seed boxes with dividers, agitators, and oversized drop tubes and may be adjusted for shallow planting depths. Broadcast fluffy seed with a drop- or cyclone-type spreader. For broadcast seeding, air-flow seeders may help ensure a more even distribution. Wind speed should be minimal when broadcast seeding.

Use a bulking agent to ensure even coverage. Add one part seed to at least an equivalent volume of bulking agent (four to twenty times is best). It may take several times the volume depending on the seeding equipment used and how well it can be metered down to light seed rates. Commonly used bulking agents include pelletized lime, potash, sand, polenta (or other cornmeal products), ground soybean hulls, rice hulls, sawdust, vermiculite, kitty litter, or other suitable material. Do not use cracked corn or milo seed as it may attract birds or other wildlife that could eat a high proportion of your seed along with the cracked grain. Companion seeds such as oats may be used when needed on disturbed soil sites for erosion control but should not make up more than 10 to 15% when added to the native seed mix. Divide seed into at least two separate batches (three or four is not a bad idea), and plan on at least two seeding passes from opposite corners of the planting area for full coverage.

When planting, good seed-to-soil contact is vital. Unless the ground is wet, seed can be pressed into the soil surface using a polyethylene roller filled with water, a cultipacker, or other equipment that will press seed firmly into the soil without burying it too deeply or disturbing the soil. Do not cultipack if the ground is wet since seeds will cake with mud on the equipment. If dry, an ATV or truck can also be used.

Key Steps to Using a Drop- or Broadcast Spreader:

1. Set the flow control to the lowest setting possible to start and work your way up from there. This will ensure that seed does not flow out too fast in the first pass. Use a bulking agent to help control the seed flow as well. Use only broadcast equipment that has an agitator in the bottom to keep the seed well mixed and flowing.
2. Start with seed for a half acre or one acre in the broadcast seeder and cover an area measured out to that size. Check the seeder to see if the seed has run out or if any is still left and adjust as needed before planting the whole field. It is best to still have some seed left and go over the ground a couple extra passes.
3. **Do not cover seed with soil.** Instead use a cultipacker or turf roller to compact the seed into the soil surface. Precipitation or lightly watering can ensure good seed-to-soil contact, especially if the area has been sprayed and then burned off. Rain or snow on the seed and ashes will get excellent seed-to-soil contact.

It is imperative that the seedbed be dry and firm to ensure proper planting depth. Saturated soils should never be cultipacked or planted (to avoid getting the seed too deep or caking on equipment). There has been some success with dropping seed from an airplane into saturated soils.

Figure 52—*left to right*: Mix seeds with bulking agents, making three or four batches, to help ensure even coverage and that you do not run out of seed with a single batch before the full area is covered. The bulking agent, in this case sand, also helps to show where the mix has landed. (Photos: Nancy Lee Adamson.)

Figure 53—Small areas can be hand-broadcast seeded after mixing seed with a bulking agent. One type of spreader, a pendulum spreader, that can be mounted on a tracker, is useful in small and large areas. Spread on to firm surface and roll after planting to ensure good seed-to-soil contact. (Photos: Nancy Lee Adamson [left, right]; Ryan Diener, Quail Forever [center].)

Planting immediately following an annual row crop such as corn can be an effective approach for reduced weed competition. If it is likely that pesticides were used for crop or weed management, you must ensure ample time for residual chemicals to metabolize or be removed from the soil prior to planting. Some of these chemical residues may inhibit germination or be taken up by new plants and harm pollinators and other insects. Planners need to be mindful of this and talk to the producer about the history of the field and what has been sprayed in the past three years. See *II. Protecting Pollinators and Their Habitat* for more details on mitigating pesticide risks.

No-Till Using a Native Seed Drill

With a native seed drill, you should only plant when the soil is dry enough to not stick to the coulters or when the soil is frozen. Under wet conditions, small seeds are likely to stick to mud-caked parts of the drill and not germinate as intended.

Figure 54—*left to right*: Most pollinator plantings are established using specialized drills and equipment. These plantings often follow herbicide applications or other season-long site preparation. Typical native seed drill models (A) can plant in light stubble (B), have separate seed boxes for various seed sizes (C), and have depth controls for optimal seed placement. (Photos: Sarah Foltz Jordan, Xerces Society.)

Four Key Steps to Using a No-Till Drill

1. Calibrate the drill based on the owner's manual from the drill manufacturer for seeding native grasses and forbs.
2. Loosely fill the seed boxes with the intended mix and do not compact the seed into the boxes. If there is not enough seed to cover the agitators, do not drill the seed or use a filler. Small volumes of seed should be broadcast.
3. For most mixes, the depth should be set to plant no deeper than ⅛–¼" (6mm) deep. It is common to set drills as shallow as they will possibly go for planting native seeds, you may have to have hydraulic blocks to keep the drill elevated to ensure shallow planting depth. Native seed planted deeper than ¼" will not germinate. Stop periodically to ensure that the depth is correct throughout the planting process. Some seed should actually be seen on the surface of the ground or just barely covered.
4. The drill should be operated slowly. Never exceed 5 mph. Stop frequently to ensure the operation is functioning and seed tubes are not clogged. Fluffy seed can clog frequently and gets more inclined to clog if the drill is operated in reverse.

Long-Term Maintenance for Herbaceous Plantings

Reducing weed competition during the initial years of establishment is the most important part of pollinator habitat planting success. Proper site prep and planting native seeds in the winter and getting the best possible germination in the first year is the most important part of reducing weed competition. Mechanical and chemical control are common methods for the first couple of years if needed. Prescribed fire when the stand is well-established, or when the seeding is completely dormant in the first couple of winters, is also a great tool. A prescribed fire in December or January can help remove annual grass residue that can smother new seedlings. A "wickbar" or similar device may be used to selectively apply herbicides if weeds have overgrown the planting, but this would be an extreme option or for certain weed species like Johnson grass if the need arises. Generally mowing will provide sufficient weed management for pollinator planting establishment. If the weeds present are annual broadleaf species (common ragweed, marestail, etc.) they often do not require any control methods. These annual broadleaf plants have open canopies and do not typically shade out the native seedlings unless they have grown extraordinarily thick. If left to grow with the annual broadleaves, the native seedlings come up very well the second season without the annuals coming back in at all.

Mow During the First Growing Season

During the first year of growth, there will likely be a lot of annual weeds along with very small seedlings of new perennial wildflowers and grasses. If the weeds are growing in thickly and significantly reducing available sunlight getting to the seedlings, mowing may be a good option. To allow sunlight to reach the new seedlings and prevent smothering of the new seedlings, aim to mow the new planting throughout the first season. Early in the first season, when the planting is 12" tall, mow to 6". Later in the season, when the planting reaches 15" to 18", mow to 12" or 10". This will not harm the perennials, even if a few, like black-eyed Susan (*Rudbeckia* spp.) and coreopsis (*Coreopsis* spp.) may be flowering. The mowing will allow more sunlight to reach the seedlings, stimulate root growth for those that are already taller, and prevent weeds from going to seed. If you wait until the weeds are much taller than 18", you run the risk of smothering the seedlings from the cut. If you must cut after the weeds are taller, due to other priorities or difficulty accessing the site due to prolonged rain, just be sure to rake the plant material off so the new seedlings are not smothered. If you cannot rake or remove that material, it is best to not mow and just let it grow the rest of the season. The dead growth of the weeds can be removed with a prescribed burn in the winter to prepare the area for rapid seedling growth the second year.

If there are invasive perennials like privet, they should be carefully dug, hand-pulled, or cut off at ground-level (and treated with herbicide, if appropriate for the landowner). Care should be taken to monitor the planting for any other non-native and/or undesirable perennial species that may encroach on the area. Sericea lespedeza should be spot-treated with hand equipment if found in the planted area.

Seeding Management in Subsequent Years

Monitor plantings beginning in early spring of the second year. If non-native weeds are shading out perennial seedlings, mow once as in first year. Mowing should not be done after May in the second year.

In subsequent years, continue to monitor weeds and control non-native invasive plants. Maintain open sunny areas and remove or girdle large undesirable trees. Keep in mind that habitat provided by native shrubs also supports diverse pollinators and other wildlife. Scattered native shrubs amidst forbs and grasses provide excellent wildlife habitat.

In the fifth year and beyond, some farmers may choose to harvest hay or graze their meadows. Hay can be spread in other habitat planting sites to provide native seeds. Harvesting in fall will generally provide the greatest percentage of viable seeds, but harvesting a third pre-bird-nesting season, and so on, will capture a greater diversity of seeds.

Planner Note

Scheduling field site visits during the first season allows planners to remind farmers how critical scouting the planting is during the first year. Planners may need to let farmers know if mowing is needed during the first season for preventing weeds from going to seed and allowing sunlight to reach seedlings. Since the new perennial seedlings can be hard to see, a field site visit also helps remind farmers that patience is best during the first season and that perennials need more than one season to become fully established. The site should also be scouted for possible invasive species issues and treated accordingly.

Limit Disturbance to ⅓ to ½ or Less of the Habitat for the Long Term

In the years following establishment, most meadow plantings need to be disked or burned periodically. For habitat management, no more than ⅓ to ½ should be disturbed at any given time, if possible. Ideally, disturbance should not occur every year, and creating a two to four-year rotational plan can help sustain diversity. For example, divide the area into two or more parcels, burn one parcel in late winter/early spring, another after bird-nesting season (September), and others in early or late fall. For maximum diversity, mix up when each patch is disked or burned each year (e.g., do not burn the same patch at the same time every year). Disturbances should be completed for each site as needed and at the time of the year to have the desired impact (i.e. late summer or fall burning to reduce tree sprouts or grass dominance, or winter to simply remove built up thatch). Sometimes, especially for prescribed burns, it is just not practical to burn only part of a planting. The long-term benefit of the burn will generally outweigh any short-term loss, particularly if there are undisturbed areas nearby.

Monitoring: Are the Plantings Fulfilling Their Intended Purpose?

Monitor plantings to ensure they are fulfilling intended purposes. Use caution when determining what species of vegetation are considered weeds. Some native species of forbs already present may provide pollinator resources and serve as supplemental resources. Where possible, avoid herbicides or reserve herbicide applications to non-native invasive species that can choke out more beneficial native species.

Prescribed Fire

Fire has played an important role in natural ecosystems and prescribed burns are an increasingly common management tool. Effects of fire management on insect communities are highly variable. If used appropriately, fire benefits many insect communities through the restoration and maintenance of suitable habitat, but some species, particularly some butterflies, may be harmed by fire. Prairie communities are adapted to wildfires, and generally thrive with regular burns, as long as there are some unburned areas nearby that can provide colonizers into the burned habitat. Some research suggests that burning small habitat fragments that support rare species risks extirpation of some insect species because of limited recolonization from adjacent habitats.

- Always have a prescribed burning plan by certified planners and trained personnel. Contact:
  Arkansas NRCS (www.nrcs.usda.gov/wps/portal/nrcs/ar/home/),
  Quail Forever (https://quailforever.org/Habitat/findBiologist.aspx),
  the Arkansas Game and Fish Commission (https://agfc.com/en/wildlife-management/private-lands-program/),
  the Arkansas Prescribed Fire Council (www.facebook.com/ArPrescribedFireCouncil/),
  the Arkansas Forestry Commission (www.agriculture.arkansas.gov/arkansas-forestry-commission),
  The Nature Conservancy (www.nature.org/en-us/about-us/where-we-work/united-states/arkansas/), *or* other private contractors.
  Follow all state and local laws regarding prescribed burning.
- A program of rotational burning where small sections are burnt every few years will ensure adequate colonization potential for pollinators. It is best to burn no more than one third to one half of a property per year.

- Sometimes the window for burning is very limited based on labor and weather and burning a larger area than ideal can still be tremendously valuable for wildlife overall. However, where rare species are of concern, extra precautions are needed.
- There is some evidence that growing season burns (late summer and fall) are superior to dormant season burns for increasing abundance and diversity of forbs. Spring burns often decrease forb abundance and increase grass abundance. Dormant season fire will help maintain current diversity and not be detrimental to most forbs.
- Including grasses in mixes can help ensure that fire is carried quickly through the site, leaving some habitat patches intact amidst the burn.
- A mosaic of burned and unburned areas is ideal. Leave unburned patches within a burn unit. Even small patches (one to three yards in diameter) are helpful as micro-refuges.

Additional Notes on Mowing, Haying, and Light Disking

When utilizing mowing to maintain pollinator plantings, care must be taken to avoid leaving too much residue that will smother and inhibit new growth. Haying helps maintain open habitat and remove excess plant material from the site. It can also be used for seeding new habitat. Schedule management for late fall after resident bees have become inactive.

Overly wet soils may force landowners to postpone mowing until drier times when wildlife are more likely to be disturbed. Limiting disturbance to ⅓ or ½ of the area, at most, will help reduce potential negative impacts. Light disking in conjunction with herbicide application can be an alternative for reducing residue and rejuvenating stands.

When mowing in fall, allow sufficient recovery periods before winter dormancy. Stands containing warm-season grasses should be allowed to regrow at least 30 days before the first killing frost. Remember that frequent mowing can be detrimental to pollinators.

Light disking (2–4" deep) may temporarily reduce the density of the stand, provide openings in the planting, promote germination of annual and perennial wildflowers and enhance habitat for other wildlife such as northern bobwhite and other ground-nesting birds. If you disk, do so on a rotational basis, disking no more than one third of the stand each year.

On sites where soils are too wet in the spring (or other times) to mow, disturbance may be performed during periods when the soil is at its driest point. Often times the driest periods for these areas are during critical bloom periods for plants that provide pollinator resources. Management schedules should account for these periods and take precautions not to remove more than 50% of the pollinator resources in one disturbance period.

Prescribed Flash-Grazing

Livestock can be utilized to manipulate stand density and remove residue on pasturelands. Flash-grazing involves grazing at a high intensity for a very brief period (a few hours or days) in order to suppress certain plants (such as Johnson grass) or plant functional groups (such as cool-season grasses) if they are overly dominant. For some sites, this method provides the most benefits with the least negative impacts on wildlife. Use only in accordance with a grazing plan with pollinator habitat as the primary objective. Livestock can quickly eliminate the floral resources from an area, so it is important that grazing be monitored closely. Additionally, some native forbs can be toxic to livestock. Always check to ensure the stand will not harm livestock prior to implementing this method.

Planner Note

Note that some native forbs can be toxic to livestock. Always check with grazing lands experts, native plant experts, or the Arkansas Cooperative Extension to ensure that livestock poisoning does not occur if grazing as a maintenance strategy is considered.

Native grasses can be grazed below the normal minimum height of 6" but livestock should not graze more than one-half of the above-ground height of other plants in the stand. Grazing the grass lower will help reduce the overabundance of grass and increase forb dominance in the stand. Most plants need to have some regrowth in the fall in order to build root reserves for wintering and initiating spring growth. This requires a minimum of 40 days, corresponding closely with the optimum rest period for warm-season grasses of 42–49 days. As a general rule, native warm-season grasses should not be grazed 30 or less days prior to the first killing frost. Residual native grass growth is excellent overwinter cover and may provide nesting areas for bumble bees the following spring.

Speak with your local grazing land specialist to develop a prescribed grazing plan specific to operation and management goals.

Combination Management (Mowing/Disking/Burning/Herbicide/Grazing)

Most landowners will use a combination of methods to maintain the diversity of their pollinator habitat plantings. With diverse plants blooming throughout the growing season, varying in height, density and structure, a combination of mowing, prescribed burning (and perhaps disking), and sometimes grazing can help retain an open grassland, early successional meadow, or an open woodland that benefits pollinators and diverse wildlife. Discuss the best management options for a particular stand with Quail Forever Farm Bill Biologists or Arkansas Game and Fish Commission Private Lands Biologists.

E. Monarch Habitat Management

Monarch habitat management focuses on protection, enhancement, and creation of open grasslands containing milkweeds for larvae and nectar plants for adults aimed at linking habitat fragments (providing corridors). At a landscape scale, nectar corridors are pathways of food sources for migratory species, such as monarch butterflies and various hummingbirds, that connect scattered habitats along great migration distances. On a smaller (farm planning) scale, these areas may be ditches, hedgerows, riparian areas, etc. to facilitate movement throughout a habitat area or provide pollinator resources, such as nectar, pollen, milkweed, and insects (for hummingbirds). Cumulatively, small-scale corridors can greatly enhance the habitat value of fragmented landscapes. Sites of any size or location can help, from urban parks, schools, and home gardens to commercial developments, municipalities, and rural roadsides. Obviously, land management techniques that favor or establish milkweeds are a priority since milkweeds provide food for both larval and adult monarchs. There are 21 native species of milkweed in Arkansas and over 130 species in North America. The Arkansas native species include 14 in the genus *Asclepias*, along with honeyvine or sandvine milkweed (*Cynanchum laeve*), climbing milkweed or twinevine (*Funastrum cynanchoides*), anglepod (*Gonolobus suberosus*), and milkvines or spiny pods (*Matelea baldwyniana*, *Matelea cynanchoides*, *Matelea decipiens*, and *Matelea hirtelliflora*). There are also some invasive non-native milkweeds that should be avoided, including tropical milkweed (*Asclepias curassavica*) and black swallowwort (*Vincetoxicum nigrum*, formerly called *Cynanchum louiseae*).

Due to the egg-laying times for monarchs (and other butterflies and pollinators), the timing, intensity, and techniques of habitat management may need to be adjusted. Any habitat management should be prior to initial spring arrival of monarchs in Arkansas, which usually occurs in early- to mid-April, or after the last monarchs have left the area in late October. Research has shown that a disturbance in July can stimulate some native milkweeds to re-sprout and be available for the fall migration as well. Burning, light disking, haying, or mowing can all work to accomplish this. Take care to consider potential loss of habitat for other pollinators and wildlife for a short time. This timing may not be allowed by NRCS programs that require avoidance of mowing or other disturbance during the bird-nesting season.

For establishment, specialized equipment may be necessary such as no-till drills with specialized seed boxes to plant milkweed seeds with other native perennial wildflowers and grasses. Sometimes the equipment used must be modified to allow proper seed dispersal and coverage. A combination of mowing, burning, and disking areas may be required to set back succession. The size and location of the area will dictate the type of management and planting required. Refer to *Appendix B: Species Lists* and *Appendix C: Seed Mixes* of this document for recommended plants for monarchs.

Use caution when burning or mowing, which removes habitat and insects any time of the year. Burning or mowing in patches ensures that all pollinators always have access to undisturbed patches of habitat until plants and insects can recolonize the disturbed area. **Milkweeds do not respond well to frequent mowing and will likely disappear if mowing is too frequent.**

Herbicide application is usually necessary before planting an area to monarch and pollinator habitat. It is almost always required for removal of existing vegetation, control of invasives, or to set back succession. Always use minimal, well-timed herbicide applications that are the least toxic alternative, and apply them early and late in the day when fewer butterflies are present. Please note that herbicides might kill monarch larvae. They should be applied with targeted spot-treatments instead of a broadcast method. Always read and follow herbicide label recommendations. Whenever possible, mechanical removal of invasive shrubs and trees should be used in combination with herbicides to maintain pollinator habitat.

If landowners are interested in registering their habitat project as a monarch waystation visit www.monarchwatch.org.

F. Woody Plant Establishment

Woody plantings for pollinators, combined with some native perennial or annual forbs and grasses, are valuable for enhancing habitat niche diversity, and have multiple additional benefits (reducing run-off, enhancing infiltration, preventing drift, and, where appropriate, providing shade). For pollinators, woody plantings along waterways can be particularly beneficial during periods of drought.

Containerized plants, seedlings, bare root, live stakes, or even seeds may be appropriate depending upon the site. Planting a diverse hedgerow with clusters of species rather than individual rows creates a more diverse canopy (structurally and florally) that helps reduce weed competition and is also more effective in reducing soil erosion. It can also be aesthetically more beautiful (avoiding the gap effect over time if one or more shrub dies). Smaller stock is more economical, can be planted more densely, and also help reduce weed competition. Mulch or mow between plants (if not mulched there) until established. Alternatively, interplant with a light meadow mix of forbs and shade-tolerant cool-season grasses like Virginia wildrye that will provide habitat until the shrubs and trees are established, with the understanding that most of the herbaceous species would eventually be shaded out, or could be transplanted to other parts of the farm when becoming overshadowed by shrub growth.

Existing soil, light, and moisture conditions should guide plant choices. Provide room for crown development (trees) and spreading (shrubs). While spacing for breadth and height at full maturity is often recommended, planting more densely than needed can reduce weed competition. Planting or seeding annual or perennial "companion" forbs and short-stature native grasses can also reduce weed competition until the woody plants mature. Note that it may take several growing seasons for some woody species to reach flowering stage, but companion plantings of annual or perennial grasses and forbs can help provide forage and shelter right away.

Fall planting is generally best for woody plantings other than bare root or live stakes, which are best planted in the dormant season (in winter, when the plants are not growing leaves). Cooler temperatures help retain soil moisture and, on warmer days, plants have a chance to develop roots before hot summer. However, even fall plantings may require irrigation at establishment and during the first season of growth, depending on weather conditions. If fall planting is not possible, dormant season (winter) or early spring plantings are recommended, in that order, if conditions are good for planting (not too wet for equipment and not covered in snow).

Figure 55—*left to right*: Many trees like silverbell (*Halesia carolina*), here with a pipevine swallowtail butterfly (*Battus philenor*), provide vital early-spring resources before many perennial wildflowers are abundant. Because of its numerous tiny flowers that support a huge diversity of bees, wasps, flies, and other agriculturally important insects, its drought tolerance, and small stature, New Jersey tea (*Ceanothus americanus*), is an excellent small shrub to include in pollinator plantings (shown here with a mining bee [*Andrena* sp.]). Shrubs in riparian corridors are especially important in summer droughts, such as buttonbush (*Cephalanthus occidentalis*), shown here with a buckeye butterfly (*Junonia coenia*). (Photos: Steve Duzan [left, right]; Ryan Diener, Quail Forever [center].)

Woody Stand Maintenance

In the first years after planting, trees and shrubs may need additional watering, weed control to reduce competition (or prevent weeds from going to seed), and protection from browsing animals, mowers, and herbicides. Landowners may want to maintain the stand by pruning out any dead or diseased limbs to encourage healthy growth. While diseased material may need to be removed, dead wood can be left in place to support wildlife. If herbaceous species are used as companion plantings, they can be moved as the shrubs and trees create shade.

Planner Note

Site preparation, establishment and maintenance of trees and shrubs should follow the Arkansas Conservation Practice Standards: Tree/ Shrub Establishment (612), Tree/ Shrub Site Preparation (490), or Hedgerow Planting (422), as appropriate.

V. Pollinator Habitat and NRCS Practices

The Natural Resources Conservation Service supports the use of native species in many Conservation Practices. In fact, most vegetative practices may be made pollinator friendly by including species that provide pollinator resources. In many instances, simply incorporating native flowering forbs into conservation practices intended for other specific purposes is consequently beneficial to pollinators; even if the primary conservation activity is implemented for another purpose. A good example is during selection of species to plant for a constructed fill site like an irrigation reservoir embankment. Select species that have multiple consecutive flowering times, yet still provide the water quality, soil erosion and other benefits for which the seeding is primarily intended. Selecting pollinator-friendly native species for these practices can provide many additional conservation benefits.

Planner Note

NRCS planners should look closely at the Criteria and the Considerations portions of the NRCS practice standards to identify recommendations that could benefit pollinators.

The tables on the following pages (primary and supporting practices) are a quick reference to NRCS practice standards and implementation requirements (IRs, formerly job sheets) to aid in planning the appropriate practices for pollinators. As practice standards are periodically revised this list will likely change.

Table 5: NRCS Primary Conservation Practices for Pollinator Habitat Establishment in Arkansas

CONSERVATION PRACTICE NAME (UNITS)	CODE	RELEVANCE TO POLLINATOR HABITAT
Conservation Cover (Ac.)	327	This practice will allow planners and clients to create customized types of vegetative covers to provide blocks of habitat areas (bee pastures) or other type of pollinator enhancements. Include diverse mixtures of plants to increase diversity and ensure flowers are in bloom for as long as possible and provide nectar and pollen throughout the season. Interseeding of non-native, non-invasive or native plants can benefit pollinators, but are seldom enough to provide resources throughout the season. In some situations, openings in otherwise less suitable cover may be established to provide open and sunny habitat for pollinators.
Contour Buffer Strips (Ac.)	332	This practices' primary purpose is to control erosion on steep cropland; however, it could be beneficial to include diverse legumes or other forbs that provide pollen and nectar for native pollinators. Establish a minimum of three species of forbs that bloom during consecutive bloom periods (one in each blooming period). More forbs are recommended, up to a maximum of ten total species. Establishment should not compromise the intended principal purpose. Also, the introduction of one or more non-native or introduced species such as clover into existing mixes/ stands will provide pollen and nectar resources when allowed to bloom.
Cover Crop (Ac.)	340	This practice is critical in cropland settings to provide supplemental forage for pollinators that either provide pollen and nectar outside the bloom period of the principal crop; or supplemental resources during the bloom period of the crop. It may consist of one or more species and rotations. Select plants that achieve one or more of the following: (1) species mix with different maturity dates, (2) attract beneficial insects, (3) attract pollinators, (4) increase soil biological diversity, (5) serve as a trap crop for insect pests, or (6) provide food and cover for wildlife-habitat management.
Early Successional Habitat Development/ Management (Ac.)	647	This pollinator practice may be utilized as a primary maintenance practice for retaining pollinator habitat. Strip-disking, herbicides and mowing in conjunction with prescribed fire should be used to revitalize rank stands and improve vegetative structure and density.
Field Border (Ac.)	386	This practice may provide nesting, foraging, and various other forms of habitat along the edges of fields. It provides early successional habitat with nectar- or pollen-producing plants in a border strip at least 20-feet-wide to provide floral resources throughout the year.

Table 5: NRCS Primary Conservation Practices (CPs) for Pollinator Habitat Establishment in Arkansas CONTINUED

CONSERVATION PRACTICE NAME (UNITS)	CODE	RELEVANCE TO POLLINATOR HABITAT
Forest Stand Improvement (Ac.)	666	This practice includes criteria that can help maintain open understory and forest gaps which support diverse pollen- and nectar-producing forbs and shrubs for wildlife and pollinators. In addition, the retention of very-early- and early-blooming species that flower during harvest activities, especially near edges of fields and openings, is highly encouraged.
Hedgerow Planting (Ft.)	422	The minimum width for hedgerows where the principle purpose is to provide pollinator habitat is 25'. Include trees and shrubs that provide pollen and nectar during the entire growing season (a minimum of three woody species in the bloom periods of very early/early and mid-season). Consider integrating shrubs that provide nesting cover for tunnel-nesting bees or provide artificial nesting blocks, and management practices that provides semi-bare ground and unmown herbaceous strips for bumble bees (*Bombus* spp.). This practice also can help reduce pesticide drift onto areas of pollinator habitat.
Herbaceous Weed Control (Ac.)	315	Utilize this practice to reduce or eliminate noxious herbaceous plants to maintain or restore a native or other established plant community that supports native pollinators (O&M). Where possible or feasible, establish replacement species prior to noxious plant removal to provide continuous resources when noxious species are suspected of providing the principal pollinator resources. In addition, apply herbicides using wildlife-friendly methods to prevent harm to native pollinators and their food sources.
Prescribed Burning	338	Consider fire intensities for native pollinators by utilizing one or more of the following strategies: burn only a portion of the areas in a single season; leave unburned patches; avoid burning an aea too frequently; or burn low intensity (temperature) fires.
Prescribed Grazing (Ac.)	528	Manage grazing to maintain or enhance the abundance of nectar and pollen sources for pollinators. Flash-grazing or long rotation periods can create disturbance regimes and assist in maintaining early successional habitat and associated flowering plants. This practice be utilized as an O&M practice to maintain well-established stands of pollinator habitat. For pollinator habitat disturbance regimes, flash-grazing should have long rotation periods and should be performed no more frequently than every two to three years.
Restoration and Management of Rare and Declining Habitats (Ac.)	643	This practice can be used to provide native pollinator forage (forbs, shrubs, and trees) and nesting resources for pollinators. Many specialist pollinators are closely tied to rare plants or habitats that may significantly benefit from restoration or management efforts. However, pollinator plants should only be planted if they were part of the rare ecosystem you are trying to restore (e.g., installing rattlesnake master [*Eryngium yuccifolium*] in the range of the rattlesnake master borer moth [*Papaipema eryngii*]).
Riparian Forest Buffer (Ac.)	391	Riparian corridors are appropriate places to establish pollinator habitats. Desirable species should be selected that encourage use by pollinators and bloom throughout as much of the early growing season as possible. Utilize a minimum of three species of trees or shrubs consisting of very-early-, early-, or mid-season bloom periods. Include trees, shrubs, and forbs especially chosen to provide pollen and nectar during the early season for pollinators. This practice also can help reduce drift of pesticides to areas of pollinator habitat.
Riparian Herbaceous Cover (Ac.)	390	Include diverse forbs and native grasses or sedges that provide pollen and nectar during the entire growing season for native bees. Utilize a minimum of nine species of native forbs and one grass, with at least three forb species in each bloom period.
Structures for Wildlife	649	This practice may describe the design construction and placement of artificial nesting structures such as nesting blocks or bundles for bees and wasps. In addition, structures such as brush pile and downed trees, and the practice of edge feathering may provide shelter for pollinators, and predatory insects such as lacewings and predatory wasps.
Tree/Shrub Establishment (Ac.)	612	Include trees and shrubs especially chosen to provide pollen and nectar for pollinators, host plants for butterflies, or plants with pithy stems for tunnel-nesting bees. Early-blooming trees are vitally important for native bees in the early growing season.

Table 5: NRCS Primary Conservation Practices (CPs) for Pollinator Habitat Establishment in Arkansas CONTINUED

CONSERVATION PRACTICE NAME (UNITS)	CODE	RELEVANCE TO POLLINATOR HABITAT
Upland Wildlife Habitat Management (Ac.)	645	Enhance diversity of upland habitat—a primary practice for providing and establishing pollinator habitat in Arkansas.
Wildlife Habitat Planting (Ac.)	420	Use this practice to plant pollinator habitat composed primarily of herbaceous plants and shrubs. Annuals beneficial to pollinators can be planted, but only if they persist over the life of the practice or act as a nurse crop to aid the establishment of desired perennial vegetation.

Table 6: NRCS Supporting Conservation Practices for Pollinator Habitat Establishment in Arkansas

CONSERVATION PRACTICE NAME (UNITS)	CODE	RELEVANCE TO POLLINATOR HABITAT
Brush Management (Ac.)	314	This practice may be utilized to reduce or eliminate noxious woody plants and help maintain pollinator-friendly early successional habitat. Where feasible and possible, remove noxious plants outside the bloom period if noxious species are suspected of providing the principal source of pollinator habitat in a given area.
Conservation Crop Rotation (Ac.)	328	Include rotation plantings of forbs that provide abundant forage for pollinators (e.g., various legumes, buckwheat, phacelia, etc.). Moving insect-pollinated crops no more than 800' during a rotation will help maintain the local populations of native bees. Planners should consider crop rotations that include a juxtaposition of diverse crops with bloom timing that overlaps through the growing season to support pollinator populations. Growers might also consider using Integrated Pest Management (595) to minimize broad-spectrum insecticide applications or use bee-friendly insecticides in cover crop rotations.
Critical Area Planting (Ac.)	342	Include plant species that provide abundant pollen and nectar for native pollinators where feasible. To benefit pollinators, flowering shrubs and wildflowers with tough root systems and good soil-holding capacity also should be considered for incorporation as a small percentage of a larger grass-dominated planting.
Forage and Biomass Planting (Ac.)	512	A consideration is included to establish diverse legumes (e.g., alfalfa, clovers) or other forbs in conjunction with a prescribed grazing plan that allows adequate time for these species to bloom and provide pollen and nectar for native pollinators. *NOTE: Criteria for establishment of native grass species for purposes other than forage and biomass is located under conservation practice standard (327) Conservation Cover.*
Forage Harvest Management (Ac.)	511	Delayed harvest of areas utilized for hayland (especially areas that contain forbs and native species) to provide forage areas for pollinators. Delayed or idling of fields, or portions of fields, in rotations of two to three years may provide areas for bumble bee (*Bombus* spp.) nesting.
Grassed Waterway (Ac.)	412	Medium or tall bunchgrasses and perennial forbs may also be planted along waterway margins to improve pollinator habitat. Waterways with these wildlife features are more beneficial when connecting other habitat types (e.g., riparian areas, wooded tracts and wetlands). *When possible, select species of vegetation that can serve multiple purposes, such as benefiting wildlife, while still meeting the basic criteria needed for providing a stable conveyance for runoff. Consider including diverse legumes or other forbs such as milkweeds (Asclepias spp.) that provide pollen and nectar for native pollinators. The criteria is to include a minimum of three species (one in each concurrent bloom period) to supply additional pollen and nectar resources. Flow length should be increased a minimum of 10'.*

Table 6: NRCS Supporting Conservation Practices (CPs) for Pollinator Habitat Establishment in Arkansas CONTINUED

CONSERVATION PRACTICE NAME (UNITS)	CODE	RELEVANCE TO POLLINATOR HABITAT
Integrated Pest Management (Ac.)	595	Criteria for direct-contact pesticide risks to pollinators and other beneficial species in the application area were added that require at least two IPM mitigation techniques from the *Pesticide Direct Contact section of* **Agronomy Technical Note No. 5—Pest Management in the Conservation Planning Process (February 2011)**. A consideration was added for biological pest management to include plantings that attract beneficial insects that predate or parasitize crop pests. Plants commonly used for pest management that are also beneficial to bees include: yarrow (*Achillea* spp.), phacelia (*Phacelia* spp.), and sunflowers (*Helianthus* spp.)
Residue and Tillage Management, No-Till (Ac.)	329	This practice has the ability to provide protection of nest sites by converting tillage operations to no-till or minimal tillage. Leaving standing crop residue can protect bees that are nesting in the ground at the base of the plants they pollinate (i.e., squash). Tillage digs up these nests (located 0.5–3' underground) or blocks the emergence of new adult bees the preceding year. This practice should be utilized primarily to protect established nest sites in vegetable crop settings.
Residue and Tillage Management, Reduced Till (Ac.)	345	This practice has the ability to provide protection of nest sites by converting tillage operations to no-till or minimal tillage. Leaving standing crop residue can protect bees that are nesting in the ground at the base of the plants they pollinate (i.e., squash). Tillage digs up these nests (located 0.5–3' underground) or blocks the emergence of new adult bees the following year. This practice should be utilized primarily to protect established nest sites in vegetable crop settings.
Stream Habitat Improvement and Management (Ac.)	395	A consideration in this standard is to select plants for adjoining riparian areas. These can include trees, shrubs, and forbs that provide pollen and nectar for pollinators. Maximizing plant diversity in riparian areas will result in more pollinators and other terrestrial insects to feed fish and other aquatic animals in the streams.
Streambank and Shoreline Protection (Ft.)	580	When restoring and protecting streams, choose plants such as shrubs, trees and forbs that provide pollen and nectar for pollinators (e.g., willow [*Salix* spp.], dogwood [*Cornus* spp.], and goldenrod [*Solidago* spp.]). The addition of native forbs and legumes to grass mixes will increase the value of plantings for both pollinators and other wildlife.
Stripcropping (Ac.)	585	If insect-pollinated crops are grown, plants used in adjacent strips of vegetative cover may be carefully chosen to provide complementary bloom periods prior to and after the crop.
Vegetated Treatment Area (Ac.)	635	Consider utilizing plants that provide pollen and nectar for pollinators without compromising the function of the practice. Plants that have characteristics that could be utilized for vegetated treatment areas may also serve as supplemental pollinator forage. Contact the State Biologist for recommendations of specific plants.
Wetland Creation (Ac.)	658	Wetland and adjacent uplands could be enhanced such that trees, shrubs, and forbs are selected to provide pollen and nectar for pollinators. Snags (standing dead trees) should be identified and protected, or nest blocks for bees erected, to provide supplemental nesting areas. Some forbs used may enable pollinator reproduction. These areas may serve as production areas for invertebrates. See also Structures for Wildlife (649).
Wetland Restoration (Ac.)	657	When restoring wetlands and adjacent upland, consider including trees, shrubs, and forbs that provide pollen and nectar for pollinators. Snags should be identified and protected, or nest blocks for bees erected, to provide supplemental nesting areas. Some forbs used for restoration will enable pollinator reproduction. See also Structures for Wildlife (649).
Wetland Wildlife Habitat Management (Ac.)	644	Wetlands and adjacent uplands can include trees, shrubs, and forbs especially chosen to provide pollen and nectar for pollinators. Snags can be protected or nest blocks for bees erected. See also Structures for Wildlife (649).
Windbreak / Shelterbelt Establishment (Ft.)	380	Include trees, shrubs, and forbs especially chosen to provide pollen and nectar for pollinators. These areas may also be used to develop natural nesting habitats or place nesting structures for native bees. Windbreaks and shelterbelts will also help reduce drift of insecticides to areas of pollinator habitat.

Table 7: NRCS Reference Guide to Various Pollinator Requirements and Corresponding Conservation Practices

The following table lists the primary practices anticipated to be used to provide pollinator resources. Primary practices have specific criteria geared toward providing resources to pollinators. Secondary practices are practices that could have pollinator benefits if installed with pollinators in mind. Secondary practices have other principal purposes but have considerations for pollinators in the standard. Other practices may have criteria or considerations outlined within the standard that could be useful in addressing the needs of pollinators. All primary practices should ideally be planned under (645) Upland Wildlife Habitat Management as component practices.

Guide to Pollinator Requirements and Corresponding Conservation Practices*

POLLINATOR RESOURCE		PRIMARY CONSERVATION PRACTICE CODE & NAME		SECONDARY CONSERVATION PRACTICE CODE & NAME	
FOOD	Forage (diverse sources of pollen and nectar that support pollinators from early in the spring to late in the fall)	327	Conservation Cover	393	Filter Strip
		328	Conservation Crop Rotation	395	Stream Habitat Imp. & Mgmt.
		340	Cover Crop	412	Grassed Waterway
		386	Field Border	585	Stripcropping
		390	Riparian Herbaceous Cover	512	Forage & Biomass Planting
		391	Riparian Forest Buffer	635	Vegetated Treatment Area
		420	Wildlife Habitat Planting	644	Wetland Wildlife Habitat Mgmt.
		422	Hedgerow Planting	657	Wetland Restoration
		612	Tree/Shrub Establishment	658	Wetland Creation
		332	Contour Buffer Strips	659	Wetland Enhancement
		342	Critical Area Planting	666	Forest Stand Improvement
NESTING	Nest sites (stable ground, holes in wood, pithy-stemmed plants, cavities for bumble bees, or overwintering sites for bumble bee queens)	327	Conservation Cover	384	Mulching
		329	Residue & Tillage Mgmt.	395	Stream Habitat Imp.& Mgmt.
		345	No-till /Reduced Till	643	Restoration & Mgmt. of Rare & Decl. Habitats
		386	Field Border	580	Streambank & Shoreline Protection
		390	Riparian Herbaceous Cover	580	Streambank & Shoreline Protection
		391	Riparian Forest Buffer	643	Restoration & Mgmt. of Rare & Decl. Habitats
		420	Wildlife Habitat Planting	644	Wetland Wildlife Habitat Mgmt.
		422	Hedgerow Planting	657	Wetland Restoration
		511	Forage Harvest Mgmt.	658	Wetland Creation
		647	Early Successional Habitat Dev/Mgmt.	659	Wetland Enhancement
		649	Structures for Wildlife	666	Forest Stand Improvement
		380	Windbreak/Shelterbelt Establishment		
REFUGE	Pesticide protection (refuge from spray, buffers to drift, etc.)	380	Windbreak/Shelterbelt Establishment	612	Tree/Shrub Establishment
		386	Field Border	412	Grassed Waterway
		391	Riparian Forest Buffer	393	Filter Strip
		422	Hedgerow Planting	395	Stream Habitat Restoration & Improvement
		595	Integrated Pest Mgmt.		
O&M	Site management for pollinators	314	Brush Mgmt.	647	Early Successional Habitat Dev/Mgmt.
		315	Herbaceous Weed Control	643	Restoration & Mgmt. of Rare & Decl. Habitats
		511	Forage Harvest Mgmt.	644	Wetland Wildlife Habitat Mgmt.
		528	Prescribed Grazing	666	Forest Stand Improvement
		383	Prescribed Burning		

* Adapted and modified from *USDA NRCS Tech Note 78, 2nd Ed. Using 2014 Farm Bill Programs for Pollinator Conservation*

A set of supporting practices that also greatly benefit pollinators, other agriculturally important insects, and wildlife, are designed to protect riparian corridors by providing alternative watering facilities for livestock. These include Forest Trails and Landing (655), Fence (382), Livestock Pipeline (516), and Watering Facility (614).

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Appendix A: Financial Resources

The following two tables highlight USDA and Arkansas Game and Fish Commission financial resources that support wildlife habitat conservation

Table A1: USDA Financial Resources*

The following are federal Farm Bill conservation programs that could be used to promote pollinators on working lands either directly or indirectly, and may provide financial assistance for implementation of pollinator friendly conservation practices. All programs are voluntary. Please see the NRCS (www.nrcs.usda.gov/programs/) or FSA (www.fsa.usda.gov) web sites for more information. ***NOTE:** Table adapted from *Using Farm Bill Programs for Pollinator Conservation* (Stine et al. 2015). Programs and Program rule changes occur frequently. Always consult the local NRCS or FSA office for the most current program guidelines.

PROGRAM	
CRP	**Conservation Reserve Program (CRP)**
	ⓘ Land conservation program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. An offshoot of CRP, Conservation Reserve Enhancement Program (CREP) emphasizes partnerships among State, Tribal, or local governments, private groups, and the USDA.
	✓ Highly erodible land, wetland, streamside areas in pasture land, certain other lands. Eligible wetlands must have been cropped 3 of 10 previous years; highly erodible cropland 4 of 6 previous years.
	$ Annual payment plus cost-share of up to 50% of the eligible costs to install the practice. Contracts require a 10- to 15-year commitment to keep lands out of agricultural production. CRP is administered by FSA. NRCS provides technical assistance.
	? Contact your NRCS or FSA State or local office: www.fsa.usda.gov/programs-and-services/conservation-programs/index
CSP	**Conservation Stewardship Program (CSP)**
	ⓘ The Conservation Stewardship Program helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns. Participants earn CSP payments for conservation performance - the higher the performance, the higher the payment.
	✓ Eligible lands include private agricultural lands, cropland, grassland, pastureland, rangeland and nonindustrial private forest land. CSP is available to all producers, regardless of operation size or type of crops produced, in all 50 states, the District of Columbia and the Caribbean and Pacific Island areas. Applicants may include individuals, legal entities, joint operations or Indian tribes.
	$ CSP provides technical and financial assistance for many enhancements to your land. For more information on enhancements and their payment schedules, visit www.nrcs.usda.gov/wps/portal/nrcs/ar/programs/financial/csp/
	? *Note that there is a new CSP Grasslands Conservation Initiative, which encourages farmers and ranchers to conserve soil, wildlife and other resources on grazing lands.*
EQIP	**Environmental Quality Incentives Program (EQIP)**
	ⓘ Promotes agricultural production and environmental quality as compatible national goals by helping eligible participants install or implement structural and management practices.
	✓ Land on which agricultural commodities, livestock, or forest-related products are produced.
	$ EQIP provides financial and technical assistance to eligible producers to help offset the cost of implementation of NRCS-approved conservation practices. Payment rates developed each fiscal year are based on the estimated incurred cost and potential income foregone resulting from practice implementation. The 2014 Act included a requirement that at least 5% of available financial assistance funds be targeted to development of wildlife habitat, which includes pollinators.
	? Contact your NRCS State or local office: www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/.
ACEP	**Agricultural Conservation Easement Program (ACEP)**
	ⓘ ACEP is an easement program introduced in the 2014 Farm Bill. It replaced the Wetlands Reserve Program, Grassland Reserve Program, and Farm and Ranch Land Protection Program. ACEP helps protect, restore, and enhance wetlands, grasslands, and working farms and ranches. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect and enhance enrolled wetlands.
	✓ Land in production for crops, grazing, or private forests is eligible for the agricultural land easements. Wetlands that have been converted to agricultural purposes, but could be effectively restored, are eligible for the wetland reserve easements.
	$ For agricultural land easements, NRCS contributes up to 50% financial assistance; up to 75% on grasslands of special environmental significance. For wetland easements, NRCS may pay 100% of the value for a permanent easement and 75% for 30-year easements. NRCS can also help with costs associated with recording the easement. Additionally, NRCS may pay between 75–100% of the restoration costs on a permanent easement.
	? Contact your NRCS State or local office: www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/

KEY: ⓘ Purpose ✓ Land Eligibility $ Type Of Assistance ? Contact/Additional Information

Table A2: Arkansas Game and Fish Commission Wildlife Management Private Lands Program

Arkansas Game and Fish Commission employs private lands biologists across the state who offer private landowners technical assistance and advice to manage wildlife on their land www.agfc.com/en/wildlife-management/private-lands-program/. For assistance managing for wildlife on your land, contact the private lands biologist who covers the county where your land is located on this map www.agfc.com/en/wildlife-management/private-lands-program/private-lands-biologist/.

These state programs can help enhance diversity that benefits pollinator and other wildlife populations. Programming and funding may vary from year to year, so check the state website and consult with private lands biologists for current program information.

	PROGRAM
	Acres for Wildlife
	ⓘ Acres for Wildlife is a free environmental action program of the Arkansas Game and Fish Commission which targets all wildlife species and gives special emphasis to species of greatest conservation concern. It improves habitat and encourages landowners to consider wildlife needs in conjunction with good farming, livestock production and forestry practices.
	✓ A landowner is required to have a minimum of five contiguous acres that can be planted to participate; must own or have at least a 5-year lease on the property.
	$ Free technical assistance from a Private Lands Biologist. Signs to place around gates and entry roads to indicate that the area is being managed for wildlife. Seed packets will be distributed only to landowners enrolled in the Native Grass/Forb Component of the program. Each landowner is eligible to receive up to $5000 + in-kind practices per contract. www.agfc.com/en/wildlife-management/private-lands-program/acres-for-wildlife
RICE	**Arkansas Waterfowl RICE Program (2019 Pilot Program)**
RICE	ⓘ Conserve waterfowl food in harvested rice fields to increase their value to waterfowl and hunting opportunity. Help farmers enhance waterfowl habitat on rice fields without financial burden.
RICE	✓ Eligible properties are those within 10 miles of certain Wildlife Management Areas. Landowners who agree to provide shallow water in fall on harvested rice fields, complete one or more post-harvest practices instead of fall tillage (leave stubble standing, roll stubble, or conduct patchy burns), and allow permitted waterfowl hunting on fields enrolled in the program.
RICE	$ Free technical assistance from a Private Lands Biologist. Enrolled farmers receive incentive payments. https://drive.google.com/file/d/1n9Bimc7FaQ_7Y26FCcP_IupemrHe6iQA/view
	Bring Back the Bobwhite
	ⓘ Although this program targets the recovery of quail populations, quality quail habitat is also very beneficial for other species, including pollinators and other agriculturally beneficial insects, deer, and turkey.
	✓ Landowners can receive technical assistance and should check annually to learn if there are state-level incentives.
	$ Free technical assistance from a Private Lands Biologist. www.agfc.com/en/hunting/small-game/quail

KEY*: ⓘ Purpose ✓ Land Eligibility $ Type Of Assistance ? Contact/Additional Information

Appendix B: Species Lists

This appendix includes five sections:

1. **Native Species Lists:**
   i. Table B1: Native Forbs for Pollinators,
   ii. Table B2: Native Grasses, Sedges, and Rushes for Pollinators,
   iii. Table B3: Native Shrubs and Small Trees for Pollinators,
   iv. Table B4: Native Trees for Pollinators, and
   v. Table B5: Native Vines for Pollinators
2. **Plants with Specialist Pollinators**—Table B6: Plants with Bee, Butterfly, and Moth Specialist Relationships,
3. **Cover Crop, Other Annuals, and Herb Species Lists:**
   i. Table B7: Cover Crops Recommended for Arkansas That Support Pollinators and Natural Enemies of Pests[1],
   ii. Table B8: Additional Cover Crops for Pollinators and Natural Enemies of Crop Pests That May Grow Well in Arkansas1, and
   iii. Table B9: Herbs (Annual and Perennial) That Provide Forage and Habitat for Pollinators, Predators, and Parasitoids
4. **Flowering Crops**—Table B10: Pollinator-Friendly Crops to Enhance Crop Rotation Diversity, and
5. **Plant Species Index**—Table B11: Index of Crop Names. Table B11 is included as a reference for scientific names not included in the main text.

Native Species Lists

The following tables include native plants that are important components of natural communities in Arkansas. The full native species lists include some species that may not be widely commercially available, or not available every year. The species list found here is not a full list of species found in Arkansas, and other species may be used. Please consult with specialists to determine if species are native to and appropriate for conservation plantings in Arkansas. See *Appendix C: Seed Mixes* for regional seed mixes that include only commercially available species.

When planning field borders, filter strips, insectaries, nectar corridors, bee pastures, riparian buffers, hedgerows, windbreaks, alley crops, waterways, or any plantings to enhance habitat for pollinators and natural enemies (predators and parasitoids) of crop pests, include as many flowering species as possible. Pollinator plantings include species with overlapping bloom periods appropriate for site conditions (soil type, light regimes, moisture requirements, pH) and landowner goals. Native plantings rarely require fertilization (fertilizers tend to benefit non-native species more). Transplants (containerized or bareroot) may require supplemental irrigation for establishment.

Establishment of a full (adequately dense) perennial planting generally takes three years but will persist indefinitely if managed well. For the most part, only perennial plants are included in the species lists (Tables B1 to B6). Annual and biennial plants do provide food and other resources for pollinators but are often already present in the seedbank or surrounding landscape. Annuals and biennials are included in seed mixes to aid in establishment and provide benefit during initial years. The establishment of permanent habitat consisting of perennials is more cost effective and provides greater benefit over a longer period of time.

Plant Table Notes and Definitions

Plant Family

Plants within the same family have common characteristics and often support similar groups of insects and other wildlife.

Bloom Period(s)

BLOOM PERIODS*		
MONTH	**TREES & SHRUBS**	**FORBS**
February through March	Very Early Season	Early Season†
April through May	Early Season	
May through July	Mid-Season	Mid-Season
July through Sept (or later)	Late Season	Late Season

* Note that there is overlap in bloom period ranges since blooms may vary from north to south and each year.

† For habitat planning purposes, Very Early and Early count as a single blooming period for herbaceous plantings.

Planner Note

If plants identified in pollinator mixes are not available, select plants from this handbook that have the same bloom periods and growing requirements as the unavailable species.

Flower Color

Describes the primary color(s) of standard blossoms: white [**Wh**]; cream [**Cr**]; yellow [**Ye**]; pink [**Pk**]; red [**Rd**]; maroon [**Ma**]; orange [**Or**]; purple [**Pr**]; violet [**Vi**]; lavender [**La**]; green [**Gr**]; blue [**Bl**]; brown [**Br**]

Height at Maturity

This indicates the potential height the plant will reach upon maturing and may vary depending upon local site conditions such as soil fertility, sunlight, climate, etc.

Shade Tolerance

Describes the relative tolerance for this plant to grow in shade conditions.

- **Intolerant:** will not tolerate shaded conditions
- **Intermediate:** will tolerate partially shaded conditions
- **Tolerant:** will tolerate full shade and usually does not prefer full sun

pH Range

This range indicates the minimum and maximum soil pH, of the top 12" of soil, within the plant's known geographical range. Soil pH is a measure of the acidity or alkalinity of the soil. Common ranges are: acid 5.6–6.0, slightly acid 6.1–6.5, neutral 6.6–7.3, and slightly alkaline 7.4–7.8. For more details, see the Soil Quality Information Sheet on Soil Quality Indicators: pH www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052208.pdf

Pollinator Preference

The identified plant species produce resources that attract, support or are pollinated by native bees, butterflies, moths, hummingbirds, and various other beneficial insects, including wasps, flies, beetles, and bugs. ***Note that most plants visited by native bees and/or honey bees are also visited by other beneficial insects, as well as spiders (that are excellent predators).*** Some of the forage, bee nesting, overwintering, and host plant data included here comes from the *Recommended Species Lists: Plants for Pollinators* lists found on the Lady Bird Johnson Wildflower Center website that were created with input from Xerces Society and the Butterflies and Moths of North America. Other sources were used for pollen and nectar plants, primarily for honey bees (Wikipedia 2020a, Wikipedia 2020b).

- **Native bee species**
- **European honey bee**
- **Native butterfly & moth species**
- **Native beneficial insects** besides native bees (pollinators and crop pest predators/parasitoids, including wasps, flies, beetles, and bugs)
- **Ruby-throated hummingbirds**
- **Nesting and overwintering** (Note: native butterflies and insects besides native bees may lay their eggs or overwinter in diverse places, but this designation highlights pithy-stemmed species whose cavities may be utilized by native bees, wasps, flies, ants, and spiders.)

Drainage

Refers to the range of soil drainage that the plant species will tolerate. Class is defined as follows:

- **Well-Drained:** Water is removed from the soil readily but not rapidly and available to plants most of the growing season. Wetness does not inhibit growth of roots for significant periods.
- **Moderately Well-Drained:** Water is removed from the soil somewhat slowly during some periods. These soils are wet for only a short time during the growing season. They may contain an impervious layer or receive periodic heavy rainfall or both.
- **Somewhat Poorly-Drained:** Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of some plants. They commonly have an impervious layer or receive periodic heavy rainfall or both.
- **Poorly-Drained:** Water is removed so slowly that the soil remains saturated for significant periods during the growing season or remains wet for long periods. Standing water is common. Poor drainage may result from high water tables, impervious layers within the profile, seepage or any combination of these factors.

Wetland Status

Atlantic and Gulf Coastal Plain and Midwest regions—These codes are included to provide insight to the areas for establishment (e.g., wetland restoration, flood prone areas, etc.). Use this to help determine potential candidates for establishment for wetter areas or drier conditions.

- **OBL:** Obligate wetland taxon. Occur almost always (estimated probability >99%) under natural conditions in wetlands.
- **FACW:** Facultative wetland taxon. Usually occur in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
- **FAC:** Facultative taxon. Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
- **FACU:** Facultative upland taxon. Usually occur in non-wetlands (estimated probability 67%-99%), but occasionally found in wetlands (estimated probability 1%-33%).
- **UPL:** Almost always occurs in non-wetlands under natural conditions (estimated probability > 99%).

Table B1: Native Forbs for Pollinators

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]	BLOOM PERIOD(S)	FLOWER COLOR	HEIGHT AT MATURITY	SHADE TOLERANCE	PH RANGE	POLLINATOR	DRAINAGE	WETLAND STATUS
Achillea millefolium	Yarrow	Asteraceae [sunflower]	Early	Wh	3	◐	6.0–8.0			FACU
Actaea pachypoda	Doll's eyes	Ranunculaceae [buttercup]	Early	Wh	3	●	< 6.8			FACU & UPL
Agalinis fasciculata	Beach false foxglove	Scrophulariaceae [figwort]	Late	Pk, Pr	3	○	< 6.0			FAC
Agastache nepetoides	Yellow giant hyssop	Lamiaceae [mint]	Late	Ye, Gr	6	◐	—			FACW & FAC
Allium canadense* var. *mobilense	Meadow wild onion	Liliaceae [lily]	Early	Wh, Pk	1	◐	—			UPL
Amsonia ciliata	Bluestar	Apocynaceae [dogbane]	Early	Bl	2	◐	—			UPL
Amsonia illustris	Shining bluestar	Apocynaceae [dogbane]	Early	Bl	6	◐	< 6.8			UPL
Amsonia tabernaemontana	Eastern bluestar	Apocynaceae [dogbane]	Early	Bl, Pr	3	◐	6.0–8.0			FACW & FAC
Anemone americana	Roundlobe hepatica	Ranunculaceae [buttercup]	Very Early	Wh, Pk, Bl, Pr	0.4	●	< 6.8			UPL
Anemone virginiana	Thimbleweed	Ranunculaceae [buttercup]	Mid	Wh, Gr, Br	2	○ – ◐	< 7.2			FACU
Angelica venenosa	Hairy angelica	Apiaceae [parsley]	Mid	Wh	6	◐	6.1–7.8			UPL
Apocynum cannabinum	Indian hemp	Apocynaceae [dogbane]	Mid	Wh	3	◐	4.5–7.0			FAC
Aquilegia canadensis	Columbine	Ranunculaceae [buttercup]	Early	Rd, Pk, Ye	2	◐ – ●	> 6.8			FAC & FACU
***Arisaema dracontium*[1]**	Green dragon	Araceae [arum]	Early	Wh, Ye, Gr, Br	3	○ – ●	5.6–7.5			FACW
***Arisaema triphyllum*[1]**	Jack-in-the-pulpit	Araceae [arum]	Early	Gr, Pr, Br	3	○ – ●	> 6.8			FACW
Arnoglossum plantagineum	Groovestem Indian plantain	Asteraceae [sunflower]	Late	Wh	5	○ – ●	6.8–7.2			FACW & FACU
Asarum canadense	Wild ginger	Aristolochiaceae [birthwort]	Early	Rd, Gr, Pr, Br	<1	◐ – ●	< 7.2			FACU & UPL
Asclepias amplexicaulis	Clasping milkweed	Apocynaceae [dogbane]	Mid	Pk	3	◐	5.0–8.5			UPL
Asclepias hirtella	Tall green milkweed	Apocynaceae [dogbane]	Mid	Wh, Gr, Br	3	◐	5.1–7.5			UPL
Asclepias perennis	Aquatic milkweed	Apocynaceae [dogbane]	Mid	Wh, Pk	6	○ – ◐	—			OBL
Asclepias purpurascens	Purple milkweed	Apocynaceae [dogbane]	Mid	Pr	4	◐	5.0–8.5			FACU
Asclepias syriaca	Common milkweed	Apocynaceae [dogbane]	Mid	Pk	5	◐	5.0–7.5			FACU
Asclepias tuberosa	Butterfly milkweed	Apocynaceae [dogbane]	Mid	Or	3	◐	5.0–7.0			UPL
Asclepias variegata	Redring milkweed	Apocynaceae [dogbane]	Mid	Wh	4	◐	5.0–7.0			FACU
Asclepias verticillata	Whorled milkweed	Apocynaceae [dogbane]	Mid	Wh, Gr	3	○ – ◐	—			FACU
Asclepias viridiflora	Green milkweed	Apocynaceae [dogbane]	Mid	Gr	3	○	—			UPL
Asclepias viridis	Green antelopehorn milkweed	Apocynaceae [dogbane]	Early	Wh, Ye, Gr, Pr	2	○	—			UPL
Astragalus canadensis	Canada milkvetch	Fabaceae [bean]	Mid	Cr	4	◐	6.0–8.0			FAC
Baptisia alba	White wild indigo	Fabaceae [bean]	Early	Wh	4	○	5.9–7.8			UPL
Baptisia australis	Blue wild indigo	Fabaceae [bean]	Early	Pr	3	○	5.9–7.8			UPL
Baptisia bracteata	Cream wild indigo	Fabaceae [bean]	Early	Ye	2	○	5.9–7.8			UPL
Baptisia nuttalliana	Nuttall's wild indigo	Fabaceae [bean]	Early	Light Ye	3	○ – ◐	—			UPL
Baptisia sphaerocarpa	Yellow wild indigo	Fabaceae [bean]	Early	Ye	4	○	—			UPL
Bidens aristosa	Tickseed sunflower	Asteraceae [sunflower]	Mid	Ye	3.5	◐	5.0–7.0			FACW
Bidens cernua	Nodding bur marigold	Asteraceae [sunflower]	Late	Ye	3.2	◐	5.1–7.0			OBL
Bidens frondosa	Beggartick	Asteraceae [sunflower]	Mid	Ye	4	◐	5.2–7.2			FACW
Bidens laevis	Smooth tickseed	Asteraceae [sunflower]	Late	Ye	3	◐	5.0–7.0			OBL
Blephilia ciliata	Ohio horsemint	Lamiaceae [mint]	Late	Pr	3	◐	5.1–7.9			UPL
Boltonia asteroides	False aster	Asteraceae [sunflower]	Late	Wh	8	◐	5.3–7.0			FACW
Brickellia eupatorioides	False boneset	Asteraceae [sunflower]	Mid	Wh	2	○	5.6–7.8			UPL
Callirhoe digitata	Fringed poppy mallow	Malvaceae [mallow]	Mid	Wh, Rd, Pr	1.5	○	—			UPL
Callirhoe involucrata	Purple poppy mallow	Malvaceae [mallow]	Early	Wh, Pk, Pr	1	○ – ◐	5.5–7.5			UPL

KEY*: BLOOM PERIOD(S) | FLOWER COLOR | HEIGHT AT MATURITY | SHADE TOLERANCE | POLLINATOR PREFERENCE | DRAINAGE | WETLAND STATUS

*See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

Table B1: Native Forbs for Pollinators CONTINUED

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]								
Camassia scilloides	Wild hyacinth	Liliaceae [lily]	Early	Wh, Bl, Pr	2	◐–●	4.2–6.5		UPL
Campanula americana	Tall bellflower	Campanulaceae [bellflower]	Mid	Bl, Pr	6	●	5.5–7.5		FACW & FAC
Castilleja coccinea[2]	Indian paintbrush	Scrophulariaceae [figwort]	Mid	Rd, Pk	2	●	4.9–6.8		FAC
Chamaecrista fasciculata	Showy partridge pea	Fabaceae [bean]	Mid	Ye	3	○	4.3–6.5		FACU
Chamaecrista nictitans	Sensitive partridge pea	Fabaceae [bean]	Mid	Ye	1	○	6.6–7.5		FACU
Conoclinium coelestinum	Blue mistflower	Asteraceae [sunflower]	Late	Bl	2	◐	5.5–7.5		UPL
Coreopsis grandiflora	Bigflower coreopsis	Asteraceae [sunflower]	Early	Ye	2	◐	6.1–7.8		UPL
Coreopsis lanceolata	Lanceleaf coreopsis	Asteraceae [sunflower]	Mid	Ye	2	○	6.0–7.0		FACU
Coreopsis palmata	Prairie coreopsis	Asteraceae [sunflower]	Mid	Ye	2.5	◐	6.1–7.8		UPL
Coreopsis pubescens	Star tickseed	Asteraceae [sunflower]	Early	Ye	1	○	6.1–7.8		FACW & FAC
Coreopsis tinctoria	Plains coreopsis	Asteraceae [sunflower]	Early	Ye, Br	3	◐	5.2–7.8		FAC
Coreopsis tripteris	Tall coreopsis	Asteraceae [sunflower]	Late	Ye	9	◐	6.1–7.8		FAC
Crotalaria sagittalis	Rattlebox	Fabaceae [bean]	Mid	Ye	1	○	4.0–6.0		UPL
Dalea candida	White prairie clover	Fabaceae [bean]	Mid	Wh	3	○	—		UPL
Dalea purpurea	Purple prairie clover	Fabaceae [bean]	Late	Pr	3	○	5.0–7.9		UPL
Delphinium carolinianum	Carolina larkspur	Ranunculaceae [buttercup]	Early	Wh, Bl, Vi	2	◐	—		UPL
Delphinium tricorne	Dwarf larkspur	Ranunculaceae [buttercup]	Early	Pr	1	●	5.8–7.8		UPL
Desmanthus illinoensis	Illinois bundleflower	Fabaceae [bean]	Mid	Wh	3	○	5.0–8.0		UPL
Desmodium canescens	Hoary tick-trefoil	Fabaceae [bean]	Mid	Pk	3	○–●	—		UPL
Dodecatheon meadia	Shooting star	Primulaceae [primrose]	Early	Wh	2	●	4.5–7.5		FACU
Echinacea pallida	Pale purple coneflower	Asteraceae [sunflower]	Mid	Pk, Pr	1.2	○	6.5–7.2		UPL
Echinacea purpurea	Purple coneflower	Asteraceae [sunflower]	Mid	Pr	1	○	6.5–7.2		UPL
Echinacea simulata	Glade coneflower	Asteraceae [sunflower]	Mid	Pk, Pr	3	○–◐	6.1–7.8		UPL
Erigeron pulchellus	Robin's-plantain	Poaceae [grass]	Early	Wh, Ye, Bl, Pr	1.5	◐	—		FACU
Eryngium yuccifolium	Rattlesnake master	Apiaceae [parsley]	Mid	Wh	6	○	6.6–7.5		FAC
Eupatorium perfoliatum	Common boneset	Asteraceae [sunflower]	Late	Wh	6	◐	5.0–7.5		FACW
Eupatorium rotundifolium* var. *ovatum	Roundleaf thoroughwort	Asteraceae [sunflower]	Late	Wh	2	●	5.0–7.0		UPL
Eupatorium rugosum	White snakeroot	Asteraceae [sunflower]	Late	Wh	6	◐	5.0–7.5		FAC
Eupatorium serotinum	Late boneset	Asteraceae [sunflower]	Late	Wh	3	◐	5.0–7.5		FAC
Euphorbia corollata	Flowering spurge	Euphorbiaceae [spurge]	Mid	Wh	3	○	6.1–7.8		UPL
Eurybia hemispherica	Southern swamp aster	Asteraceae [sunflower]	Late	Ye, Pr	3	○	< 7.3		FACU
Eutrochium fistulosum	Common Joe Pye weed	Asteraceae [sunflower]	Late	Pr	11	◐	5.0–7.5		FAC
Eutrochium purpureum	Purple Joe Pye weed	Asteraceae [sunflower]	Late	Pr	4	◐	5.0–7.5		UPL
Fleischmannia incarnata	Pink thoroughwort	Asteraceae [sunflower]	Late	Wh	4	◐	5.0–7.5		FACW
Fragaria virginiana	Wild strawberry	Rosaceae [rose]	Early	Wh	1	○–◐	5.1–7.8		FACU
Gaillardia aestivalis	Lanceleaf blanketflower	Asteraceae [sunflower]	Mid	Wh, Pk, Ye, Pr	2	○	6.1–7.8		UPL
Gaillardia pulchella	Indian blanket	Asteraceae [sunflower]	Mid	Rd, Ye, Br	3	○–◐	7.0–8.5		UPL
Geranium maculatum	Wild geranium	Geraniaceae [geranium]	Early	Pr	2	◐	5.5–8.5		FACU
Glandularia canadensis	Rose verbena	Verbenaceae [verbena]	Very Early	Pk	<1	◐	< 6.8		UPL
Grindelia lanceolata	Spiny-toothed gumweed	Asteraceae [sunflower]	Late	Ye	3	○	6.1–8.5		UPL
Helenium autumnale	Sneezeweed	Asteraceae [sunflower]	Late	Ye	4	○	4.0–7.0		FACW
Helenium flexuosum	Purple-headed sneezeweed	Asteraceae [sunflower]	Mid	Ye	3.2	○	4.5–7.5		FACW & FAC

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS

*See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

Table B1: Native Forbs for Pollinators CONTINUED

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]						PH RANGE	POLLINATOR ⓘ		
Helianthus angustifolius	Narrowleaf sunflower	Asteraceae [sunflower]	Late	Ye	3	○		4.0–8.0		–💧💧	FACW
Helianthus divaricatus	Woodland sunflower	Asteraceae [sunflower]	Mid	Ye	6	○–●		—		💧	UPL
Helianthus grosseserratus	Sawtooth sunflower	Asteraceae [sunflower]	Late	Ye	5	○		5.8–7.3		–💧💧	FACW & FAC
Helianthus hirsutus	Hairy woodland sunflower	Asteraceae [sunflower]	Late	Ye, Br	1.5	○–◐		—		–💧💧	UPL
Helianthus mollis	Ashy sunflower	Asteraceae [sunflower]	Mid	Ye, Br	6	○		—		💧	UPL
Helianthus silphioides	Rosinweed sunflower	Asteraceae [sunflower]	Late	Rd, Ye	10	○–◐		—		–💧💧	UPL
Helianthus strumosus	Paleleaf woodland sunflower	Asteraceae [sunflower]	Late	Ye	7	○–●		< 6.8		💧	FACU & UPL
Helianthus tuberosus	Jerusalem artichoke	Asteraceae [sunflower]	Late	Ye	10	◐		4.0–7.0		–💧💧	FAC
Heliopsis helianthoides	Ox-eye false sunflower	Asteraceae [sunflower]	Mid	Ye	5	○–◐		—		–💧💧	FACU & UPL
Heuchera americana	American alumroot	Saxifragaceae [saxifrage]	Very Early	Rd, Gr, Pr, Br	3	◐–●		< 6.8		–💧💧	FACU
Hibiscus laevis	Halberd-leaf rose mallow	Malvaceae [mallow]	Mid	Wh, Pk	8	○–◐		5.5–7.2		–💧💧	OBL
Hibiscus lasiocarpos	Rose mallow	Malvaceae [mallow]	Mid	Wh, Rd, Pk	5	○		—		–💧💧	UPL
Hydrophyllum virginianum	Shawnee salad	Boraginaceae > Hydrophyloideae [waterleaf]	Early	Bl	2	●		5.7–7.5		–💧💧	FAC
Hypoxis hirsuta	Yellow star grass	Liliaceae [lily]	Early	Ye	0.8	◐		5.2–7.2		–💧💧	FAC
Impatiens capensis	Spotted jewelweed	Balsaminaceae [balsam]	Mid	Ye	5	●		6.4–7.4		–💧💧	FACW
Iris cristata	Dwarf crested iris	Iridaceae [iris]	Early	Bl	3	●		< 6.8		–💧💧	UPL
Iris fulva	Copper flag	Iridaceae [iris]	Early	Rd/Or	3	●		5.0–8.5		–💧💧	OBL
Iris virginica shrevei	Blue flag	Iridaceae [iris]	Early	Bl	3	●		4.8–7.3		–💧💧	FACW
Lespedeza capitata	Roundhead lespedeza	Fabaceae [bean]	Late	Pk	4	○		5.5–6.9		–💧💧	FACU
Lespedeza hirta	Hairy bush clover	Fabaceae [bean]	Late	Wh	3	○		5.0–9.0		–💧💧	UPL
Lespedeza procumbens	Trailing lespedeza	Fabaceae [bean]	Mid	Pk	1	○		—		–💧💧	UPL
Lespedeza violacea	Violet lespedeza	Fabaceae [bean]	Mid	Pk/Pr	2	◐		—		–💧💧	UPL
Lespedeza virginica	Slender lespedeza	Fabaceae [bean]	Late	Pr	3	◐		5.7–9.0		–💧💧	FACU
Liatris aspera	Rough blazing star	Asteraceae [sunflower]	Late	Pr	3	○		5.6–7.5		–💧💧	FACU
Liatris pycnostachya	Prairie blazing star	Asteraceae [sunflower]	Mid	Pk	6	○		6.0–8.5		–💧💧	FACU
Liatris squarrulosa	Appalachian blazing star	Asteraceae [sunflower]	Late	Pr	4	○		5.6–7.5		–💧💧	UPL
Lilium superbum	Turk's cap lilly	Liliaceae [lily]	Mid	Or	4	○		5.8–7.8		–💧💧	FACW
Linum medium* var. *texanum	Stiff yellow flax	Linaceae [flax]	Mid	Ye	2	○		—		–💧💧	FACU
Lobelia cardinalis	Cardinal flower	Campanulaceae [bellflower]	Late	Rd	3	◐		5.8–7.8		–💧💧	FACW
Lobelia puberula	Downy lobelia	Campanulaceae [bellflower]	Late	Bl	4	◐		5.1–6.5		–💧💧	UPL
Lobelia siphilitica	Great blue lobelia	Campanulaceae [bellflower]	Late	Bl	3	◐		5.6–7.8		–💧💧	FACW
Ludwigia alternifolia	Seedbox	Onagraceae [evening primrose]	Mid	Ye	4	◐		< 6.0		–💧💧	OBL
Lysimachia lanceolata	Yellow-loosestrife	Primulaceae [primrose]	Mid	Pr	3	●		5.0–7.0		–💧💧	FAC
Maianthemum racemosum	False Solomon's seal	Liliaceae [lily]	Early	Wh	3	●		< 6.8		–💧💧	FACU
Manfreda virginica	False aloe	Asparagaceae > Agavoideae [agave]	Mid	Gr-Wh	5	◐		—		–💧💧	UPL
Mertensia virginica	Virginia bluebells	Boraginaceae [borage]	Very Early	Bl	2	●		4.5–8.0		–💧💧	FACW
Mimosa quadrivalvis* var. *nuttalli	Sensitive briar	Fabaceae [bean]	Mid	Pk	1	◐		6.1–7.8		–💧💧	UPL
Mimulus alatus	Monkey flower	Scrophulariaceae [figwort]	Early	Bl/Wh	2	●		6.2–7.8		–💧💧	OBL
Monarda bradburiana	Savanna bergamot	Lamiaceae [mint]	Mid	Pk	2	◐		5.1–7.3		–💧💧	UPL
Monarda citriodora	Lemon mint	Lamiaceae [mint]	Mid	Pk/Wh	2	◐		6.1–7.8		–💧💧	UPL
Monarda fistulosa	Wild bergamot	Lamiaceae [mint]	Mid	La	3	◐		5.6–7.5		–💧💧	FACU
Monarda punctata	Spotted beebalm	Lamiaceae [mint]	Mid	Ye/Pr	3	◐		6.8–7.2		–💧💧	FACU

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS

*See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

Table B1: Native Forbs for Pollinators CONTINUED

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]					PH RANGE	POLLINATOR ⓘ		
Monarda russeliana	Russell's beebalm	Lamiaceae [mint]	Mid	Pr/Wh	2	◐	6.1–7.8		–◌	UPL
Oenothera biennis	Common evening primrose	Onagraceae [evening primrose]	Late	Ye	6	◐	4.5–6.0		–◌	UPL
Oenothera filiformis[3]	Longflower beeblossom	Onagraceae [evening primrose]	Mid	Wh	6.5	◐	—		–◌	UPL
Oenothera fruticosa	Narrowleaved evening primrose	Onagraceae [evening primrose]	Mid	Ye	3	◯	4.9–6.8		–●	FAC
Oenothera macrocarpa	Missouri evening primrose	Onagraceae [evening primrose]	Early–Late	Ye	1.5	◐	6.1–7.8		–◌	UPL
***Opuntia* spp.**[4]	Prickly pear	Cactaceae [cactus]	Mid	Ye	1	◯	6.1–7.5		◌	UPL
Orbexilum pedunculatum	Sampson's snakeroot	Fabaceae [bean]	Mid	Pr	2.5	◐	5.6–6.0		–◌	FACU
Oxalis violacea	Violet wood-sorrel	Oxalidaceae [wood sorrel]	Early	Vi	1	◐	6.1–7.8		–◌	UPL
Packera obovata	Roundleaf ragwort	Asteraceae [sunflower]	Vey Early	Ye	1.5	●	—		–◌	FACU
Palafoxia callosa	Spanish needles	Asteraceae [sunflower]	Late	Wh, Pk, Pr	3	◯	—		◌	UPL
Parthenium integrifolium	Wild quinine	Asteraceae [sunflower]	Mid	Wh	3	◐	5.0–7.5		–◌	UPL
Pedicularis canadensis	Wood betony	Scrophulariaceae [figwort]	Very Early	Rd, Ye	1.3	●	4.0–7.0		–◌	FACU
Penstemon arkansanus	Arkansas beardtongue	Scrophulariaceae [figwort]	Mid	Wh, Pk	2	◯	—		◌	UPL
Penstemon digitalis	Foxglove beardtongue	Scrophulariaceae [figwort]	Early	Pr	4	◐	5.5–7.0		–●	FAC
Penstemon pallidus	Pale beardtongue	Scrophulariaceae [figwort]	Mid	Pk	3	◐	5.6–7.6		–◌	FACU
Penstemon tubaeflorus	Prairie beardtongue	Scrophulariaceae [figwort]	Mid	Wh	3	◯	6.1–8.5		–◌	UPL
Phlox divaricata* var. *laphamii	Woodland phlox	Polemoniaceae [phlox]	Early	Pr	3	◐	5.5–7.2		–◌	FACU
Phlox drummondii	Drummond phlox	Polemoniaceae [phlox]	Very Early	Wh, Rd, Pk, Pr	1.5	◯–◐	< 7.2		◌	UPL
Phlox glaberrima	Smooth phlox	Polemoniaceae [phlox]	Early	Pk	2	◐	5.0–7.0		–●	FAC
Phlox paniculata	Garden phlox	Polemoniaceae [phlox]	Mid	Pk, Pr	4	◯	6.1–7.8		◌	FACU
Phlox pilosa	Prairie phlox	Polemoniaceae [phlox]	Very Early	Wh, Pk, Pr	2	◯–◐	< 6.8		◌	FACU
Physostegia angustifolia	Narrowleaf obedient plant	Lamiaceae [mint]	Late	Pr	3	◯	4.9–7.8		–●	UPL
Physostegia virginiana	Obedient plant	Lamiaceae [mint]	Late	Pr	4	◐	5.8–8.6		–●	FACW
Plectocephalus americana	American basket-flower	Asteraceae [sunflower]	Mid	Wh, Pk	5	◐	< 6.8		–◌	UPL
Podophyllum peltatum	Mayapple	Berberidaceae [barberry]	Very Early	Wh, Pk	1.5	◐–●	< 6.8		◌	FACU
Polemonium reptans	Jacob's-ladder	Polemoniaceae [phlox]	Very Early	Pk, Bl	1	●	6.8–7.2		◌	FACW & FAC
Polygonatum biflorum	Solomon's seal	Liliaceae [lily]	Very Early	Wh, Ye, Gr, Br	5	◐–●	< 6.8		–◌	FACU
Polytaenia nuttallii	Prairie parsley	Apiaceae [parsley]	Mid	Ye	2	◯–◐	—		–◌	UPL
Pontederia cordata	Pickerelweed	Pontederiaceae [water-hyacinth]	Mid	Wh, Bl, Pr	3	◯–◐	4.9–8.7		–●	OBL
Pycnanthemum albescens	Whiteleaf mountain mint	Lamiaceae [mint]	Late	Wh	4	◯–◐	6.8≲7.2		◌	FAC & UPL
Pycnanthemum muticum	Short-toothed mountain mint	Lamiaceae [mint]	Mid	Wh, Rd, Pk, Bl, Pr	3	◯–◐	6.1–7.8		◌	FACW & FAC
Pycnanthemum tenuifolium	Slender mountain mint	Lamiaceae [mint]	Mid–Late	Wh	3	◯	4.6–7.0		–◌	UPL
Pycnanthemum verticillatum* var. *pilosum	Hairy mountain mint	Lamiaceae [mint]	Late	Wh, Pr	4	◯–◐	—		–◌	FAC & UPL
Ratibida columnifera	Upright prairie coneflower	Asteraceae [sunflower]	Mid	Ye & Rd	3	◯	5.9–7.0		–◌	UPL
Ratibida pinnata	Gray-headed coneflower	Asteraceae [sunflower]	Mid	Ye	4	◯	5.6–6.8		–◌	UPL
Rhexia mariana	Maryland meadow beauty	Melastomataceae [melastome]	Mid	Pk	2.5	◐	5.1–6.5		–●	OBL & FACW
Rhexia virginica	Virginia meadow beauty	Melastomataceae [melastome]	Early–Late	Pk	2	◐	< 6.8		–●	OBL & FACW
Rosa carolina[5]	Carolina rose	Rosaceae [rose]	Early–Mid	Pk	3	◐	< 6.8		◌	FACU
Rudbeckia amplexicaulis	Clasping coneflower	Asteraceae [sunflower]	Mid–Late	Ye	2	◯	6.0–7.5		–◌	FAC & FACU
Rudbeckia grandiflora* var. *alismifolia	Rough coneflower	Asteraceae [sunflower]	Mid–Late	Ye	6	◐	5.6–7.5		–◌	UPL
Rudbeckia grandiflora* var. *grandiflora	Large coneflower	Asteraceae [sunflower]	Mid–Late	Ye	6	◐	5.6–7.5		–◌	UPL
Rudbeckia hirta	Black-eyed Susan	Asteraceae [sunflower]	Late	Or	1	◯	6.0–7.0		–◌	FACU

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE ⓘ POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS

*See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

Table B1: Native Forbs for Pollinators CONTINUED

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]					PH RANGE	POLLINATOR ⓘ		
Rudbeckia laciniata	Cutleaf coneflower	Asteraceae [sunflower]	Late	Ye	8	●	4.5–7.0		FACW
Rudbeckia missouriensis	Missouri black-eyed Susan	Asteraceae [sunflower]	Mid	Ye	2.5	◐	6.1–7.8		FACU & UPL
Rudbeckia subtomentosa	Sweet black-eyed Susan	Asteraceae [sunflower]	Mid–Late	Ye	6	◐	5.6–7.5		FAC & FACU
Rudbeckia triloba	Brown-eyed Susan	Asteraceae [sunflower]	Late	Ye	6	○	5.2–7.2		FACU
Ruellia humilis	Hairy wild petunia	Acanthaceae [acanthus]	Early–Late	La	2.6	●	4.5–7.5		FACU
Ruellia pedunculata	Stalked wild petunia	Acanthaceae [acanthus]	Early–Late	La	1.5	◐	—		UPL
Salvia azurea	Pitcher sage	Lamiaceae [mint]	Late	Bl	5	○	6.1–7.8		UPL
Salvia lyrata	Lyreleaf sage	Lamiaceae [mint]	Early	La	1	◐	5.5–7.5		UPL
Sanguinaria canadensis	Bloodroot	Papaveraceae [poppy]	Very Early	Wh	0.5	●	5.0–7.0		FACU & UPL
Scrophularia lanceolata	Early figwort	Scrophulariaceae [figwort]	Early	Pr	3	○	4.5–7.6		FACU
Scutellaria incana	Downy skullcap	Lamiaceae [mint]	Mid–Late	Bl/Pr	3.5	◐	< 6.8		UPL
Sedum ternatum	Wild stonecrop	Crassulaceae [stonecrop]	Early	Wh	<0.5	●	3.9–7.1		UPL
Senna marilandica	Maryland senna	Fabaceae [bean]	Mid	Ye	4	◐	5.0–7.8		FAC
Silene stellata	Starry campion	Caryophyllaceae [pinks]	Mid	Wh	3	◐	5.5–8.5		UPL
Silene virginica	Firepink	Caryophyllaceae [pinks]	Mid	Rd	1	◐	5.0–7.0		UPL
Silphium asteriscus	Starry rosinweed	Asteraceae [sunflower]	Late	Ye	6	○	5.5–7.2		UPL
Silphium integrifolium	Rosinweed	Asteraceae [sunflower]	Late	Ye	6	○	4.5–7.6		UPL
Silphium laciniatum	Compass plant	Asteraceae [sunflower]	Late	Ye	6	○	4.5–7.6		UPL
Silphium perfoliatum	Cup plant	Asteraceae [sunflower]	Late	Ye	6	○	6.1–7.6		FAC
Silphium terebinthinaceum	Prairie dock	Asteraceae [sunflower]	Late	Ye	6	○	5.1–7.8		FACU
Sisyrinchium angustifolium	Blue-eyed grass	Iridaceae [iris]	Early	Bl	1.5	◐	5.0–7.0		FACW & FAC
Sisyrinchium campestre	Prairie blue-eyed grass	Iridaceae [iris]	Early	Bl	1	○	—		UPL
Smallanthus uvedalia	Bear's-foot	Asteraceae [sunflower]	Mid	Ye	10	○	5.6–7.8		UPL
Solidago altissima	Tall goldenrod	Asteraceae [sunflower]	Late	Ye	4	◐	5.2–7.3		UPL
Solidago caesia	Blue-stemmed goldenrod	Asteraceae [sunflower]	Mid	Ye	3	◐	5.5–7.0		FACU
Solidago gigantea	Giant goldenrod	Asteraceae [sunflower]	Late	Ye	8	◐	4.0–8.0		FACW
Solidago hispida	Hairy goldenrod	Asteraceae [sunflower]	Mid	Ye	3	○	> 7.2		UPL
Solidago nemoralis	Gray goldenrod	Asteraceae [sunflower]	Mid	Ye	2	○	6.5–7.5		UPL
Solidago odora	Anise–scented goldenrod	Asteraceae [sunflower]	Late	Ye	5	○	5.0–6.8		UPL
Solidago petiolaris	Savanna goldenrod	Asteraceae [sunflower]	Late	Ye	4	◐	—		UPL
Solidago radula	Rough goldenrod	Asteraceae [sunflower]	Late	Ye	3	○	—		UPL
Solidago rigida* ssp. *rigida	Stiff goldenrod	Asteraceae [sunflower]	Late	Ye	4	◐	5.0–7.5		UPL
Solidago rugosa	Rough-leaf goldenrod	Asteraceae [sunflower]	Mid–Late	Ye	3	○	5.6–7.8		FAC
Solidago ulmifolia	Elm-leaf goldenrod	Asteraceae [sunflower]	Mid–Late	Ye	3	◐	—		UPL
Spigelia marilandica	Indian-pink	Loganiaceae [logania]	Early	Rd & Ye	3	◐	< 6.8		UPL
Strophostyles helvola[6]	Pink fuzzy bean	Fabaceae [bean]	Mid–Late	Pk	10	◐	—		FAC
Strophostyles leiosperma[6]	Slickseed wild bean	Fabaceae [bean]	Mid–Late	Pk	3	◐	—		UPL
Symphyotrichum anomalum	Manyray aster	Asteraceae [sunflower]	Mid–Late	La	2.5	○	—		UPL
Symphyotrichum drummondii	Drummond's aster	Asteraceae [sunflower]	Late	Pr	3	●	5.4–7.4		UPL
Symphyotrichum laeve	Smooth blue aster	Asteraceae [sunflower]	Late	Wh	3	○	5.9–7.0		UPL
Symphyotrichum lateriflorum	Calico aster	Asteraceae [sunflower]	Late	Wh	3	○	5.4–7.4		FAC
Symphyotrichum novae–angliae	New England aster	Asteraceae [sunflower]	Late	Pr	4	◐	5.2–7.5		FACW

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS

*See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

Table B1: Native Forbs for Pollinators CONTINUED

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]					PH RANGE	POLLINATOR ⓘ		
Symphyotrichum oblongifolium	Aromatic aster	Asteraceae [sunflower]	Late	La	3	◐	5.1–6.5			UPL
Symphyotrichum oolentangiense	Sky blue aster	Asteraceae [sunflower]	Late	La	4	○	5.1–6.5			UPL
Symphyotrichum patens	Late purple American aster	Asteraceae [sunflower]	Late	Pr	3	○	4.9–7.9			UPL
Symphyotrichum pilosum	Frost aster	Asteraceae [sunflower]	Late	Wh	3	○	5.4–7.0			UPL
Symphyotrichum praealtum	Willowleaf American aster	Asteraceae [sunflower]	Late	Wh	3	○	5.5–7.5			FACW
Tephrosia onobrychoides	Hoary pea	Fabaceae [bean]	Early	Wh & Pk	2.8	◐	—			UPL
Tephrosia virginiana	Goat's rue	Fabaceae [bean]	Mid	Pk	3	◐	4.5–7.0			UPL
Teucrium canadense	American germander	Lamiaceae [mint]	Late	Pk	2	◐	6.3–8.0			FACW
Thalictrum dasycarpum	Purple meadow rue	Ranunculaceae [buttercup]	Early	Wh	5	◐	—			FACW & FAC
Thalictrum revolutum	Wax-leaf meadow-rue	Ranunculaceae [buttercup]	Mid	Wh	7	◐	—			FAC
Thalictrum thalictroides	Rue-anemone	Ranunculaceae [buttercup]	Early	Wh	0.7	◐	< 6.8			FACU
Thaspium chapmanii	Hairy–jointed meadow parsnip	Apiaceae [parsley]	Early	Ye	3	◐	5.5–7.5			FACU
Tradescantia ernestiana	Ernest's spiderwort	Commelinaceae [dayflower]	Very Early–Early	Pk	2	◐	—			UPL
Tradescantia occidentalis	Prairie spiderwort	Commelinaceae [dayflower]	Mid	Bl/Pr/Wh	2	◐	6.1–7.8			UPL
Tradescantia ohiensis	Ohio spiderwort	Commelinaceae [dayflower]	Early	Bl	1	◐	4.0–8.0			FAC
Trillium recurvatum	Purple trillium	Liliaceae [lily]	Early	Ma or Ye	1.5	●	< 6.0–8.0			FACU
Uvularia grandiflora	Large bellwort	Liliaceae [lily]	Early	Ye	2	●	6.0–7.5			UPL
Uvularia sessilifolia	Sessile bellwort	Liliaceae [lily]	Early	Ye/Cr	1	●	< 6.0–8.0			FACW & FAC
Verbena hastata	Blue vervain	Verbenaceae [verbena]	Late	Bl	5	○	5.1–7.1			FACW
Verbena stricta	Hoary vervain	Verbenaceae [verbena]	Late	Bl	4	○	4.0–8.0			UPL
Verbesina alternifolia	Yellow wingstem	Asteraceae [sunflower]	Late	Ye	4	◐	5.0–7.0			FAC
Verbesina helianthoides	Yellow crownbeard	Asteraceae [sunflower]	Mid	Ye	2	○	5.0–7.5			UPL
Verbesina virginica	White crownbeard	Asteraceae [sunflower]	Late	Wh	5	◐	6.1–7.8			FACU
Vernonia arkansana	Arkansas ironweed	Asteraceae [sunflower]	Late	Pr	6	○	—			FAC
Vernonia baldwinii	Baldwin's ironweed	Asteraceae [sunflower]	Mid	Pr	5	○	6.1–7.8			UPL
Vernonia gigantea	Tall ironweed	Asteraceae [sunflower]	Mid	Pr	5	○	5.6–8.2			FAC
Vernonia missurica	Missouri ironweed	Asteraceae [sunflower]	Mid	Pr	4	○	5.6–8.2			FACU
Vernonia texana	Texas ironweed	Asteraceae [sunflower]	Mid	Pr	4	◐	—			FACU
Veronicastrum virginicum	Culver's root	Scrophulariaceae [figwort]	Mid	Wh	4	○	4.8–8.8			FACU
Vicia caroliniana	Carolina wood vetch	Fabaceae [bean]	Mid	Wh	1	◐	4.9–7.9			FACU
Viola palmata	Three-lobe violet	Violaceae [violet]	Early	Pr	0.4	◐	—			FACU
Viola pedata	Bird's-foot violet	Violaceae [violet]	Early	Pr	0.5	◐	< 6.8			FACU & UPL
Viola sagittata	Arrow-leaf violet	Violaceae [violet]	Early	Pr	0.7	◐	—			FACW & FAC
Viola sororia	Woolly blue violet	Violaceae [violet]	Early	Pr	0.4	◐	6.0–7.8			FAC
Zizia aptera	Heartleaf meadow parsnip	Apiaceae [parsley]	Early	Ye	2	●	5.6–8.2			FAC
Zizia aurea	Golden Alexanders	Apiaceae [parsley]	Early	Ye	3	◐	5.6–8.2			FAC

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

1. Thrips- or midge-pollinated.
2. Hemiparasitic on a variety of other plants (forbs and grasses).
3. Annual (rarely biennial)
4. *Opuntia humifusa* in the Midwest has recently been renamed and/or split into *O. cespitosa*, *O. macrorhiza*, and *O. nemoralis*.
5. Although technically a shrub, *Rosa carolina* is included here due to its small stature.
6. Although vines, they are small twining annuals included in forb seed mixes (see *Table B5: Native Vines for Pollinators on page 92*).

Table B2: Native Grasses, Sedges, and Rushes for Pollinators

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]								
Andropogon gerardii	Big bluestem	Poaceae [grass]	Mid	Ye	6	○	6.0–7.5			FAC
Andropogon ternarius	Splitbeard bluestem	Poaceae [grass]	Late	Br	4	◐	< 6.0–8.0			FACU
Andropogon virginicus	Broomsedge	Poaceae [grass]	Late	Ye	3	○	4.7–9.0			FACU
Aristida purpurascens	Arrowfeather three-awn	Poaceae [grass]	Mid–Late	Wh	2	◐	—			FAC & UPL
Bouteloua curtipendula	Side oats grama	Poaceae [grass]	Late	Ye	3	○	5.5–8.5			UPL
Brachyelytrum erectum	Bearded shorthusk	Poaceae [grass]	Mid–Late	Cr	3.5	●	—			FACU
Carex albicans	Whitetinge sedge	Cyperaceae [sedge]	Early	Cr	2	◐–●	—			FAC & UPL
Carex annectens	Yellowfruit sedge	Cyperaceae [sedge]	Early–Mid	Gr	3	◐	—			FACW
Carex bushii	Bush's sedge	Cyperaceae [sedge]	Early	Gr	2	◐	5.8–7.5			FACW
Carex cherokeensis	Cherokee sedge	Cyperaceae [sedge]	Early–Mid	Gr	1	◐	6.1–7.3			FACW
Carex crinita	Saw-awn sedge	Cyperaceae [sedge]	Early	Gr	5	◐	4.0–7.5			OBL & FACW
Carex frankii	Frank's sedge	Cyperaceae [sedge]	Early	Gr	2	●	5.9–7.2			OBL
Carex glaucodea	Blue sedge	Cyperaceae [sedge]	Early	Gr	<1	◐	—			FACW & FAC
Carex hirsutella	Hairy-leaved sedge	Cyperaceae [sedge]	Early	Ye, Gr, Br	2	◐	—			UPL
Carex lupulina	Hop sedge	Cyperaceae [sedge]	Early	Gr	4	◐	6.2–7.0			OBL
Carex lurida	Shallow sedge	Cyperaceae [sedge]	Late	Gr	3	◐	4.9–6.8			OBL
Carex muehlenbergii	Muhlenberg's sedge	Cyperaceae [sedge]	Mid	Gr	3	○	—			UPL
Carex nigromarginata	Black-edge sedge	Cyperaceae [sedge]	Early–Mid	Gr	1	●	—			FACU & UPL
Carex squarrosa	Squarrose sedge	Cyperaceae [sedge]	Early	Gr	3	○–●	5.6–7.3			FACW
Carex typhina	Cattail sedge	Cyperaceae [sedge]	Mid	Ye, Gr, Br	2	●	5.7–7.0			OBL & FACW
Carex vulpinoidea	Fox sedge	Cyperaceae [sedge]	Mid	Gr	3	◐	6.8–8.9			OBL & FACW
Chasmanthium latifolium	River oats	Poaceae [grass]	Mid	Gr	4	◐–●	< 6.8			FACW & FAC
Chasmanthium sessiliflorum	Longleaf wood oats	Poaceae [grass]	Late	Ye	5	○	5.5–7.2			FAC
Danthonia spicata	Poverty oatgrass	Poaceae [grass]	Early–Mid	Cr	0.5	○–●	4.5≥7			UPL
Diarrhena obovata	Beak-grain	Poaceae [grass]	Mid–Late	Gr	3	◐–●	—			FACW & FAC
Dichanthelium clandestinum	Deer tongue panic grass	Poaceae [grass]	Mid	Gr	2	○	4.0–7.5			FACW & FAC
Elymus glabriflorus	Southeastern wildrye	Poaceae [grass]	Mid	Gr	4	○–◐	—			UPL
Elymus hystrix	Bottlebrush grass	Poaceae [grass]	Mid	Gr	5	◐	6.1–6.5			UPL
Elymus virginicus	Virginia wildrye	Poaceae [grass]	Early	Ye	3	●	5.0–7.0			FACW
Glyceria striata	Fowl manna grass	Poaceae [grass]	Mid	Gr	6	●	4.0–8.0			OBL
Juncus effusus[1]	Common rush	Juncaceae [rush]	Late	Gr, Br	4	○	4.0–6.0			OBL & FACW
Leersia oryzoides	Rice cut grass	Poaceae [grass]	Mid	Gr	5	○	5.1–8.8			OBL
Muhlenbergia capillaris	Hair-awn muhly	Poaceae [grass]	Late	Pk, Pr	3	○	5.8–6.8			FACW & FAC
Panicum capillare	Witchgrass	Poaceae [grass]	Mid	Gr	3	○	5.5–7.8			FAC
Panicum virgatum	Switchgrass	Poaceae [grass]	Late	Gr, Br	6	◐	4.5–8.0			FAC
Schizachyrium scoparium	Little bluestem	Poaceae [grass]	Late	Ye	3	○	5.0–8.4			UPL
Scirpus atrovirens	Green bulrush	Cyperaceae [sedge]	Mid	Gr, Br	6	○	4.0–8.0			OBL
Scirpus cyperinus	Woolgrass	Cyperaceae [sedge]	Mid	Gr, Br	5	○	4.8–7.2			OBL & FACW
Sorghastrum nutans	Indiangrass	Poaceae [grass]	Late	Ye	6	○–●	4.8–8.0			FACU
Spartina pectinata	Prairie cordgrass	Poaceae [grass]	Mid	Ye	8	○	6.0–8.5			OBL & FACW
Sporobolus clandestinus	Rough dropseed	Poaceae [grass]	Late	Br	4	○	> 7.4			UPL
Sporobolus compositus	Tall dropseed	Poaceae [grass]	Late	Gr	5	○	5.5–7.0			UPL

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS

*See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

Table B2: Native Grasses, Sedges, and Rushes for Pollinators CONTINUED

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]					PH RANGE	POLLINATOR ⓘ		
			❀	🎨		●			💧	🌿
Sporobolus cryptandrus	Sand dropseed	Poaceae [grass]	Mid	Ye	3	○	6.6–8.0		💧–💧	UPL
Sporobolus heterolepis	Prairie dropseed	Poaceae [grass]	Mid	Pk, Ye, Gr, Br	2.3	◐	6.0–7.2		💧	UPL
Tridens flavus	Purple top tridens	Poaceae [grass]	Late	Pr	2.5	○	4.5–6.5		💧	FACU
Tripsacum dactyloides	Eastern gama grass	Poaceae [grass]	Early–Late	Br	5	○	5.1–7.5		💧–💧	FACW & FAC

KEY*: ❀ BLOOM PERIOD(S) 🎨 FLOWER COLOR HEIGHT AT MATURITY ● SHADE TOLERANCE ⓘ POLLINATOR PREFERENCE 💧 DRAINAGE 🌿 WETLAND STATUS *See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

1. *Juncus interior*, *J. marginatus*, *J. tenuis*, and *J. validus* are also common in Arkansas.

Table B3: Native Shrubs and Small Trees for Pollinators

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]					PH RANGE	POLLINATOR ⓘ		
			❀	🎨		●			💧	🌿
Amelanchier arborea[1]	Serviceberry	Rosaceae [rose]	Very Early	Wh	50	●	4.8–7.5		💧–💧	FAC
Amorpha canescens	Leadplant	Fabaceae [bean]	Mid	Bl, Pr	4	○–◐	5.5–8.0		💧	UPL
Amorpha fruticosa	False indigo bush	Fabaceae [bean]	Mid	Pr	15	○	5.0–8.5		💧–💧	FACW
Asimina triloba[1]	Pawpaw	Annonaceae [custard-apple]	Very Early	Pr	30	●	4.7–7.2		💧–💧	FACU
Callicarpa americana	American beautyberry	Verbenaceae [verbena]	Mid	Gr	6	◐	4.8–7.0		💧–💧	FACU
Ceanothus americanus	New Jersey tea	Rhamnaceae [buckthorn]	Mid	Wh	3	●	4.3–6.5		💧–💧	FACU
Cephalanthus occidentalis	Buttonbush	Rubiaceae [coffee]	Mid–Late	Wh	20	●	4.7–8.6		💧	OBL
Chionanthus virginicus[1]	White fringetree	Oleaceae [olive]	Early	Wh	30	●	4.5–6.5		💧–💧	FACW & FAC
Cornus drummondii	Roughleaf dogwood	Cornaceae [dogwood]	Early	Wh	16	◐	4.5–7.5		💧–💧	FAC
Cornus foemina	Smooth dogwood	Cornaceae [dogwood]	Early	Wh	20	◐	5.8–7.2		💧–💧	FACW
Crataegus crus-galli	Cockspur hawthorn	Rosaceae [rose]	Early	Wh	30	◐	4.5–7.2		💧–💧	FAC
Crataegus marshallii[1]	Parsley hawthorn	Rosaceae [rose]	Early	Wh	25	●	5.8–7.2		💧–💧	FAC
Euonymus americanus	Strawberry bush	Celastraceae [staff-tree]	Early–Mid	Gr	12	◐	6.0–7.0		💧–💧	FAC
Halesia carolina	Carolina silverbell	Styracaceae [styrax]	Early	Wh	30	●	4.7–7.0		💧	FACU
Hamamelis vernalis[1]	Ozark witch-hazel	Hamamelidaceae [witch-hazel]	Very Early	Gr	15	◐	< 6.8		💧–💧	FACU
Hamamelis virginiana[1]	Fall witch-hazel	Hamamelidaceae [witch-hazel]	Late	Or, Ye, Gr, Br	35	●	< 6.8		💧	FACU
Hydrangea arborescens	Wild hydrangea	Hydrangeaceae [hydrangea]	Mid	Wh & Gr	6	◐	5.0–8.0		💧	FACU & UPL
Hypericum prolificum	Shrubby St. John's wort	Clusiaceae [mangosteen]	Mid to Late	Ye	3	●	6.8–7.2		💧–💧	FACW & FAC
Ilex ambigua[1]	Carolina holly	Aquifoliaceae [holly]	Early	Wh	18	◐	< 6.8		💧	UPL
Ilex decidua[1]	Deciduous holly	Aquifoliaceae [holly]	Very Early	Wh	30	◐	3.5–6.5		💧–💧	FACW
Ilex opaca	American holly	Aquifoliaceae [holly]	Early–Mid	Wh & Gr	60	○–●	< 6.8		💧	FACW & FAC
Itea virginica	Virginia sweetspire	Grossulariaceae [gooseberry]	Early–Mid	Wh	8	◐	< 6.8		💧	OBL & FACW
Lindera benzoin	Spicebush	Lauraceae [laurel]	Early	Ye	12	●	4.5–6.0		💧–💧	FAC
Physocarpus opulifolius[1]	Eastern ninebark	Rosaceae [rose]	Early–Mid	Pr	10	○	4.5–6.5		💧–💧	FACW
Prunus angustifolia[1]	Chickasaw plum	Rosaceae [rose]	Very Early	Wh	30	○	5.6–7.5		💧–💧	UPL
Prunus mexicana	Mexican plum	Rosaceae [rose]	Very Early	Wh, Pk	35	◐	4.5–7.0		💧	UPL
Ptelea trifoliata[1]	Wafer ash	Rutaceae [rue]	Early–Mid	Cr	25	◐	4.8–7.0		💧	FACU
Rhus aromatica	Fragrant sumac	Anacardiaceae [sumac]	Early	Ye	10	◐	6.8–7.2		💧–💧	UPL
Rhus copallinum	Winged sumac	Anacardiaceae [sumac]	Late	Ye	20	○	4.5–6.0		💧–💧	FACU
Rhus glabra	Smooth sumac	Anacardiaceae [sumac]	Mid	Wh, Ye, Gr, Br	20	○–●	6.8–7.2		💧	UPL
Rosa carolina	Carolina rose	Rosaceae [rose]	Early–Mid	Pk	3	◐	< 6.8		💧	FACU

KEY*: ❀ BLOOM PERIOD(S) 🎨 FLOWER COLOR HEIGHT AT MATURITY ● SHADE TOLERANCE ⓘ POLLINATOR PREFERENCE 💧 DRAINAGE 🌿 WETLAND STATUS *See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

Table B3: Native Shrubs and Small Trees for Pollinators CONTINUED

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]	BLOOM	COLOR	HEIGHT	SHADE	PH RANGE	POLLINATOR	DRAINAGE	WETLAND
Rubus allegheniensis	Allegheny blackberry	Rosaceae [rose]	Early–Mid	Wh	6	◯	4.6–7.5			FACU & UPL
Salix humilis	Prairie willow	Salicaceae [willow]	Very Early–Mid	Ye	10	◐	5.9–7.0			FACU
Sambucus nigra* ssp. *canadensis	Common elderberry	Caprifoliaceae [honeysuckle]	Mid	Wh	6	◐	6.8–7.2			UPL
Staphylea trifolia[1]	Bladdernut	Staphyleaceae [bladdernut]	Early	Wh	15	●	6.8–7.2			FAC
Vaccinium arboreum[1]	Farkleberry	Ericaceae [heath]	Early–Mid	Wh	25	◐	4.0–7.0			FACU
Vaccinium elliottii[2]	Elliot's blueberry	Ericaceae [heath]	Very Early–Early	Wh	10	◯	4.7–7.5			FACW
Vaccinium fuscatum[2]	Black highbush blueberry	Ericaceae [heath]	Very Early–Early	Wh	10	◯	4.7–7.5			FACW
Vaccinium pallidum	Lowbush blueberry	Ericaceae [heath]	Very Early	Wh	2	◯	4.1–6.9			UPL
Vaccinium stamineum	Deerberry	Ericaceae [heath]	Early–Mid	Wh	6	◐	4.0–7.0			FACU
Vaccinium virgatum[2]	Highbush blueberry	Ericaceae [heath]	Very Early	Wh	10	◯	4.7–7.5			FACW
Viburnum dentatum	Southern arrowwood	Caprifoliaceae [honeysuckle]	Mid	Wh	10	◯–●	< 6.8			FAC
Viburnum rufidulum[1]	Rusty blackhaw	Caprifoliaceae [honeysuckle]	Early	Wh	25	◐	<6.0–8.0			UPL
Viburnun prunifolium	Blackhaw viburnum	Caprifoliaceae [honeysuckle]	Very Early	Wh	16	●	4.8–7.5			FACU

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS

*See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

1. Growth habit can be shrub or tree.
2. *Vaccinium elliottii*, *V. fuscatum*, and *V. virgatum* are sometimes lumped taxonomically with the more eastern *V. corymbosum*.

Table B4: Native Trees for Pollinators

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]	BLOOM	COLOR	HEIGHT	SHADE	PH RANGE	POLLINATOR	DRAINAGE	WETLAND
Acer rubrum	Red maple	Aceraceae [maple]	Very Early	Rd	90	●	4.5–7.5			FAC
Acer saccharum	Sugar maple	Aceraceae [maple]	Early	Gr	100	●	3.7–7.9			UPL
Aesculus glabra	Ohio buckeye	Hippocastanaceae [horse-chestnut]	Early	Gr	68	●	5.0–7.1			FACU
Aesculus pavia	Red buckeye	Hippocastanaceae [horse-chestnut]	Early	Rd	25	●	3.5–7.0			FAC
Asimina triloba[1]	Pawpaw	Annonaceae [custard-apple]	Very Early	Pr	30	●	4.7–7.2			FACU
Castanea pumila	Allegheny chinquapin	Fagaceae [beech]	Mid	Ye	20	◐	4.5–6.6			UPL
Celtis laevigata	Sugarberry	Ulmaceae [elm]	Early	Gr	100	●	4.4–7.7			FACW
Celtis occidentalis	Hackberry	Ulmaceae [elm]	Very Early	Gr	100	●	6.0–7.8			FACU
Celtis tenuifolia	Dwarf hackberry	Ulmaceae [elm]	Early	Wh	36	◯	7.0–8.5			UPL
Cercis canadensis[1]	Eastern redbud	Fabaceae [bean]	Very Early	Pr	30	●	5.0–7.8			FACU
Cladrastis kentukea	Yellowwood	Fabaceae [bean]	Mid	Gr	25	◐	4.8–7.5			UPL
Cornus florida	Flowering dogwood	Cornaceae [dogwood]	Early	Wh	36	●	4.8–7.7			FACU
Diospyros virginiana	Persimmon	Ebenaceae [ebony]	Early	Ye	50	●	4.7–7.5			FAC
Gymnocladus dioicus	Kentucky coffeetree	Fabaceae [bean]	Early–Mid	Gr	100	◯	6.0–8.0			UPL
Liriodendron tulipifera[1]	Tuliptree	Magnoliaceae [magnolia]	Mid	Ye	120	◯	4.5–6.5			FACU
Malus angustifolia	Southern crabapple	Rosaceae [rose]	Early	Pk	30	◐	5.7–8.2			UPL
Morus rubra[1]	Red mulberry	Moraceae [mulberry]	Early	Gr	70	◐	5.0–7.0			FAC
Nyssa sylvatica	Blackgum	Cornaceae [dogwood]	Early	Wh	95	●	4.5–6.0			FAC
Prunus serotina	Black cherry	Rosaceae [rose]	Early	Wh	110	◯	4.0–7.5			FACU
Robinia pseudoacacia	Black locust	Fabaceae [bean]	Early–Mid	Wh	70	◐	4.0–7.5			FACU
Salix caroliniana[1]	Coastal Plain willow	Salicaceae [willow]	Very Early–Mid	Gr	33	◐	4.5–8.8			OBL

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS

*See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

Table B4: Native Trees for Pollinators CONTINUED

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]	BLOOM PERIOD(S)	FLOWER COLOR	HEIGHT AT MATURITY	SHADE TOLERANCE	PH RANGE	POLLINATOR	DRAINAGE	WETLAND STATUS
Salix nigra	Black willow	Salicaceae [willow]	Very Early–Mid	Gr	65	◯	4.8–8.0			FACW
Sapindus saponaria	Soapberry	Sapindaceae [soapberry]	Early	Wh	20	◐	7.0–8.5			FACU
Sassafras albidum	Sassafras	Lauraceae [laurel]	Very Early	Ye	75	●	4.5–7.3			FACU
Tilia americana	American basswood	Tiliaceae [linden]	Mid	Ye	100	◐	4.5–7.5			UPL
Zanthoxylum clava-herculis	Toothache tree	Rutaceae [rue]	Early	Gr	72	◯	6.6–7.5			FAC

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

1. Growth habit can be shrub or tree.
2. Native in Arkansas only on Crowley's Ridge.

Table B5: Native Vines for Pollinators

SCIENTIFIC NAME	COMMON NAME	PLANT FAMILY [COMMON NAME]	BLOOM PERIOD(S)	FLOWER COLOR	HEIGHT AT MATURITY	SHADE TOLERANCE	PH RANGE	POLLINATOR	DRAINAGE	WETLAND STATUS
Aristolochia tomentosa	Dutchman's pipevine	Aristolochiaceae [birthwort]	Early	Gr/Ye	70	●	5.0–7.5			FAC
Bignonia capreolata	Crossvine	Bignoniaceae [trumpet-creeper]	Early	Rd	60	◐	5.0–6.5			FAC
Campsis radicans	Trumpet creeper	Bignoniaceae [trumpet-creeper]	Mid	Ye	3	◯	5.5–8.5			FAC
Celastrus scandens	American bittersweet	Celastraceae [staff-tree]	Early	Wh	15	●	5.0–7.5			FACU
Clematis versicolor	Pale leather flower	Ranunculaceae [buttercup]	Early–Mid	Pk	16	◐	> 7.0			UPL
Clematis virginiana	Virgin's-bower	Ranunculaceae [buttercup]	Mid–Late	Wh	6	◐	5.0–8.0			FAC
Cynanchum laeve	Sandvine milkweed	Apocynaceae [dogbane]	Mid–Late	Cr	40	◐	5.5–7.5			FAC
Gelsemium sempervirens	Carolina jessamine	Loganiaceae [logania]	Early	Ye	36	◐	5.6–8.5			FAC
Gonolobus suberosus	Anglepod	Apocynaceae [dogbane]	Mid	Gr	10	◐	5.6–7.5			FACW
Ipomoea pandurata	Wild potato vine	Convolvulaceae [morning glory]	Mid	Wh	10	●	6.1–7.8			FACU
Lonicera flava	Yellow honeysuckle	Caprifoliaceae [honeysuckle]	Early	Ye	20	◯	5.5–7.5			UPL
Lonicera sempervirens	Coral honeysuckle	Caprifoliaceae [honeysuckle]	Early	Rd	16	●	6.0–8.5			FACU
Matelea decipiens	Climbing milkweed vine	Apocynaceae [dogbane]	Early	Ma	6	●	7.0–8.5			FACU
Parthenocissus quinquefolia	Virginia creeper	Vitaceae [grape]	Early	Gr	50	●	5.0–7.5			FACU
Passiflora incarnata	Purple passion-flower	Passifloraceae [passion-flower]	Mid	Pr	6	◐	6.1–7.5			FACU
Passiflora lutea	Yellow passion-flower	Passifloraceae [passion-flower]	Mid	Ye	16	●	5.0–7.5			FACU
Rosa setigera[1]	Prairie rose	Rosaceae [rose]	Early–Mid	Pk	16	◯	4.5–8.0			FACU
Vitis rotundifolia	Muscadine	Vitaceae [grape]	Mid	Ye	90	◐	6.0–8.0			FAC
Wisteria frutescens	American wisteria	Fabaceae [bean]	Early	Pr	50	●	4.0–7.0			FACW

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See PLANT TABLE NOTES AND DEFINITIONS on page 72 for more detailed information.

1. Climbing shrub.

Table B6: Plants with Bee, Butterfly, and Moth Specialist Relationships

Data for this list are organized by plant family and include only species from Tables B1 to B5. Data were collected from the Lady Bird Johnson Wildflower Center's *Recommended Species Lists: Plants for Pollinators*, lists provided by the Xerces Society and Butterflies and Moths of North America (BAMONA), and from Jarrod Fowler and Sam Droege's *Pollen Specialist Bees of the Eastern United States*. While butterfly and moth caterpillars may eat various parts of a plant, bee specialists are pollen specialists, consuming pollen from only one species or genus (monolectic), or various species within one family (oligolectic). Bee specialists may collect nectar from a variety of plants.

Although here we list relationships based on plant family and genus, many of these insects have not been documented on all the species within a genus or all the genera within each family. Specialist relationships can vary greatly regionally, as well. For the aster family (Asteraceae), there are many aster family specialists that vary in visiting one species, genus, or family. Due to the very large number of **aster specialist bees** (), we include only bee families and genera (not species): Andrenidae (*Andrena*, *Calliopsis*, *Pseudopanurgus*), Apidae (*Anthophorula*, *Melissodes*, *Svastra*), Colletidae (*Colletes*), Halictidae (*Dieunomia*), Megachilidae (*Ashmeadiella*, *Hesperapis*, *Megachile*, *Paranthidium*, *Trachusa*). Where the specific plant species or genus is listed, or the specific epithet of the bee name suggests a relationship, we have also included that within the plant species row. See Fowler & Droege (2020) for more details and references.

In addition, we have also included three important pollinator-plant relationships that do not techinically qualify as true specializations. First, while no specialist relationships are documented for **grasses** (), bees often collect pollen from grasses in flower and bumble bees (*Bombus* spp.) frequently nest below lodged native warm-season grasses—protected from predators and rain by the grass thatch. Second, due to their economic importance in passionfruit production in Mexico, **nesting blocks** () **are provided for large carpenter bees** (*Xylocopa* spp.) even though they are not oligolectic (specialists). Thirdly, though they are not known as specialists, *Megachile exilis* and *M. mucida* are **commonly found visiting pea family (Fabaceae) flowers** (). Please note that there are many additional plant-insect host relationships not documented here.

PLANT FAMILY [COMMON NAME]	GENUS[1]	COMMON NAME	BEE ()[2] AND BUTTERFLY & MOTH ()[3] SPECIALISTS
Acanthaceae [acanthus family]	*Ruellia*	Wild petunia	common buckeye (*Junonia coenia*)
Aceraceae [maple family]	*Acer*	Maple	rosy maple moth (*Dryocampa rubicunda*)
Agavoideae* [century-plant or agave family]	*Manfreda virginica*[4]	False aloe	[* The agave family has been reclassified as a subfamily of Asparagaceae]
Anacardiaceae [sumac or cashew family]	*Rhus*	Sumac	red-banded hairstreak (*Calycopis cecrops*), banded hairstreak (*Satyrium calanus*)
Annonaceae [custard-apple family]	*Asimina*	Pawpaw	pawpaw sphinx (*Dolba hyloeus*), zebra swallowtail (*Protographium marcellus*)
Apiaceae [carrot or parsley family, umbellifers]	*Eryngium*	Eryngo & rattlesnake master	rattlesnake master borer moth (*Papaipema eryngii*)
	Polytaenia texana	Prairie parsley	black swallowtail (*Papilio polyxenes*)
	Zizia	Zizia & meadow parsnip	*Andrena ziziae* | black swallowtail
Apocynaceae [dogbane family]	*Asclepias*	Milkweed	queen (*Danaus gilippus*), monarch (*D. plexippus*), milkweed tussock moth (*Euchaetes egle*)
	Cynanchum laeve	Sandvine milkweed	queen, monarch, milkweed tussock moth
	Gonolobus suberosus	Anglepod	queen, monarch, milkweed tussock moth
	Matelea	Climbing milkweed vine	queen, monarch, milkweed tussock moth
Aquifoliaceae [holly family]	*Ilex*	Holly	*Colletes banksi*
Aristolochiaceae [birthwort family]	*Aristolochia*	Pipevine	pipevine swallowtail (*Battus philenor*)
Asteraceae [aster, sunflower, or composite family]	*Achillea millefolium*	Yarrow	
	Arnoglossum	Indian plantain	
	Bidens	Beggarticks & tickseed	*Dieunomia heteropoda*
	Boltonia	Doll's daisy & false aster	
	Brickellia	False boneset	
	Conoclinium coelestinum	Blue mistflower	
	Coreopsis	Coreopsis	
	Echinacea	Purple coneflower	
	Eupatorium	Boneset & thoroughwort	
	Fleischmannia incarnata	Pink thoroughwort	
	Eurybia hemispherica	Swamp aster	*Andrena asteris, A. asteroides, A. hirticincta, A. nubecula, A. simplex, Anthophorula asteris, Colletes simulans, Pseudopanurgus aestivalis*
	Gaillardia	Blanketflower	
	Grindelia	Gumweed	
	Helenium	Sneezeweed	
	Helianthus	Sunflower	*Andrena accepta, A. aliciae, A. helianthi, Dieunomia heteropoda, Perdita bequaerti, Pseudopanugus* spp., *Melissodes agilis, M. trinodis, Svastra petulca, Paranthidium jugatorium, Megachile parallela, Ashmeadiella bucconis* | gorgone checkerspot (*Chlosyne gorgone*), silvery checkerspot (*C. nycteis*), painted lady (*Vanessa cardui*)
	Heliopsis	False sunflower	*Andrena accepta, A. aliciae, A. helianthi, Dieunomia heteropoda, Perdita bequaerti, Pseudopanugus* spp., *Melissodes agilis, M. trinodis, Svastra petulca, Paranthidium jugatorium, Megachile parallela, Ashmeadiella bucconis*
	Liatris	Blazing star	| *Papaipema* and *Schinia* moths
	Packera	Roundleaf ragwort	
	Palafoxia	Spanish needles	

KEY: Caterpillar host plant | Pollinated by sphinx moths (Sphingidae) | Specialist bee | Aster specialist* | Grasses* | Xylocopa SPP.* | Megachile SPP.* | *See introductory text above for more information.

Table B6: Plants with Bee, Butterfly, and Moth Specialist Relationships CONTINUED

PLANT FAMILY [COMMON NAME]	GENUS[1]	COMMON NAME	BEE ( )[2] AND BUTTERFLY & MOTH ( )[3] SPECIALISTS
Asteraceae [aster, sunflower, or composite family] CONTINUED	*Parthenium integrifolium*	Wild quinine	
	Plectocephalus americana	American basket-flower	
	Ratibida	Coneflower	*Andrena rudbeckiae*
	Rudbeckia	Black-eyed Susan & relatives	*Andrena rudbeckiae* | gorgone checkerspot, bordered patch (*Chlosyne lacinia*)
	Silphium	Rosinweed & cup plant	
	Smallanthus uvedalia	Bear's-foot & leafcup	
	Solidago	Goldenrod	*Andrena asteris, A. braccata, A. canadensis, A. hirticincta, A. nubecula, A. placata, A. simplex, Colletes simulans, C. solidaginis, Melissodes fumosus, Pseudopanurgus solidaginis*
	Symphyotrichum	Aster	*Andrena asteris, A. asteroides, A. hirticincta, A. nubecula, A. simplex, Anthophorula asteris, Colletes simulans, Pseudopanurgus aestivalis* | pearl crescent (*Phyciodes tharos*)
	Verbesina	Wingstem	| gold moth (*Axia olga*), silvery checkerspot
	Vernonia	Ironweed	| painted lady
Bignoniaceae [trumpet-creeper family]	*Campsis radicans*	Trumpet creeper	plebeian sphinx (*Paratrea plebeja*)
Cactaceae [cactus family]	*Opuntia*	Prickly pear	*Lithurgopsis gibbosus, Melissodes mitchelli*
Campanulaceae [bellflower or bluebell family]	*Campanula americana*	Tall bellflower	*Colletes brevicornis*
Caprifoliaceae [honeysuckle family]	*Lonicera sempervirens*	Coral honeysuckle	spring azure (*Celastrina ladon*), snowberry clearwing (*Hemaris diffinis*)
	Viburnum	Viburnum & arrowwood	spring azure, snowberry clearwing
Convolvulaceae [morning glory or bindweed family]	*Ipomoea*	Wild potato vine & relatives	*Cemolobus ipomoea, Melitoma taurea, Xenoglossa kansensis*
Cornaceae [dogwood family]	*Cornus*	Dogwood	*Andrena fragilis, A. integra, A. platyparia* | spring azure
Cyperaceae [sedge family]	*Scirpus*	Woolgrass	dion skipper (*Euphyes dion*)
Ericaceae [heath family]	*Vaccinium*	Blueberry & relatives	*Habropoda laboriosa, Melitta americana, Panurginus atramontensis, Perdita obscurata*
Fabaceae [pea, bean, or legume family]	*Amorpha*	False indigo & leadplant	*Hoplitis micheneri* | hoary edge (*Achalarus lyciades*), silver-spotted skipper (*Epargyreus clarus*), gray hairstreak (*Strymon melinus*), southern dogface (*Zerene cesonia*)
	Astragalus	Milkvetch	
	Baptisia	Wild indigo	| frosted elfin (*Callophrys irus*), wild indigo duskywing (*Erynnis baptisiae*)
	Cercis canadensis	Eastern redbud	*Habropoda laboriosa*
	Chamaecrista	Sensitive pea & partridge pea	| cloudless sulphur (*Phoebis sennae*)
	Crotalaria	Rattlebox	
	Dalea	Prairie clover	
	Desmanthus	Bundleflower	
	Desmodium	Tick-trefoil & beggar's lice	
	Gymnocladus	Kentucky coffeetree	| bicolored honey locust moth (*Sphingicampa bicolor*), bisected honey locust moth (*S. bisecta*)
	Lespedeza	Lespedeza	| eastern tailed blue (*Cupido comyntas*), silver-spotted skipper, gray hairstreak
	Mimosa	Sensitive briar & powderpuff	
	Orbexilum	Snakeroot	
	Pediomelum	Scurf pea	
	Robinia pseudoacacia	Black locust	
	Senna	Senna	| sleepy orange (*Eurema nicippe*)
	Strophostyles	Fuzzy bean & wild bean	*Megachile integra, Trachusa dorsalis*
	Tephrosia	Goat's rue & hoary pea	
	Vicia	Vetch & wood vetch	
	Wisteria frutescens	American wisteria	| marine blue (*Leptotes marina*)
Fagaceae [beech or oak family]	*Quercus*	Oak	gray hairstreak
Geraniaceae [geranium family]	*Geranium*	Wild geranium	*Andrena distans, A. geranii*
Hydrangeaceae [hydrangea family]	*Hydrangea*	Wild hydrangea	hydrangea sphinx (*Darapsa versicolor*)
Lamiaceae [mint family]	*Agastache nepetoides*	Yellow giant hyssop	common buckeye

KEY: Caterpillar host plant | Pollinated by sphinx moths (Sphingidae) | Specialist bee | Aster specialist* | Grasses* | Xylocopa SPP.* | Megachile SPP.* | *See introductory text above for more information.

Table B6: Plants with Bee, Butterfly, and Moth Specialist Relationships CONTINUED

PLANT FAMILY [COMMON NAME]	GENUS[1]	COMMON NAME	BEE (🐝)[2] AND BUTTERFLY & MOTH (🦋)[3] SPECIALISTS
Lamiaceae [mint family] CONTINUED	*Monarda*	Bergamot & beebalm	🐝 *Dufourea monardae, Perdita gerhardi, Protandrena abdominalis*
Lauraceae [laurel family]	*Lindera*	Spicebush	🦋 eastern tiger swallowtail (*Papilio glaucus*), spicebush swallowtail (*P. troilus*), promethea silkmoth (*Callosamia promethea*)
	Sassafras albidum	Sassafras	🦋 eastern tiger & spicebush swallowtails, imperial moth (*Eacles imperialis*), promethea silkmoth, sassafras caloptilia moth (*Caloptilia sassafrasella*)
Linaceae [flax family]	*Linum*	Flax	🦋 variegated fritillary (*Euptoieta claudia*)
Magnoliaceae [magnolia family]	*Liriodendron tulipifera*	Tuliptree	🦋 tuliptree silkmoth (*Callosamia angulifera*), eastern tiger swallowtail
Malvaceae [mallow or hibiscus family]	*Callirhoe*	Poppy mallow	🐝 *Diadasia afflica*
	Hibiscus	Rose mallow	🐝 *Ptilothrix bombiformis*
Moraceae [mulberry family]	*Morus rubra*	Red mulberry	🦋 red admiral (*Vanessa atalanta*)
Oleaceae [olive family]	*Chionanthus virginicus*	White fringetree	🦋 rustic sphinx (*Manduca rustica*)
	Fraxinus	Ash	🦋 Canadian sphinx (*Sphinx canadensis*), eastern tiger swallowtail, hickory hairstreak (*Satyrium caryaevorus*), mourning cloak (*Nymphalis antiopa*), viceroy (*Limenitis archippus*), orange sulphur (*Colias eurytheme*)
Onagraceae [evening primrose family]	*Oenothera*	Evening primrose	🐝 *Lasioglossum oenotherae, Megachile oenotherae, Melissodes fimbriatus*
Papaveraceae [poppy family]	*Sanguinaria canadensis*	Bloodroot	🐝 *Megachile oenotherae, Melissodes fimbriatus*
Passifloraceae [passion-flower family]	*Passiflora*	Passion-flower	⊞ | 🦋 Gulf fritillary (*Agraulis vanillae*), red-banded hairstreak, variegated fritillary (*Euptoieta claudia*), banded hairstreak
	Passiflora lutea	Yellow passion-flower	🐝 *Pseudopanurgus passiflorae* | 🦋 Julia heliocninan (*Dryas iulia*)
Poaceae [grass family]	*Andropogon*	Broomsedge & relatives	🌾 | 🦋 Delaware skipper (*Anatrytone logan*), arogos skipper (*Atrytone arogos*)
	Bouteloua	Grama	🌾 | 🦋 Leonard's skipper (*Hesperia leonardus*)
	Chasmanthium	River oats & relatives	🌾 | 🦋 common roadside skipper (*Amblyscirtes reversa*)
	Panicum	Switchgrass	🌾 | 🦋 Delaware skipper
	Schizachyrium scoparium	Little bluestem	🌾 | 🦋 arogos skipper, dusted skipper (*Atrytonopsis hianna*), ottoe skipper (*Hesperia ottoe*), crossline skipper (*Polites origenes*)
	Sorghastrum	Indiangrass	🌾 | 🦋 pepper and salt skipper (*Amblyscirtes hegon*), Georgia satyr (*Neonympha areolatus*)
	Tridens	Purple top	🌾 | 🦋 common wood-nymph (*Cercyonis pegala*), broad-winged skipper (*Poanes viator*), crossline skipper (*Polites origenes*), little glassywing (*Pompeius verna*)
	Tripsacum dactyloides	Eastern gama grass	🌾 | 🦋 byssus skipper (*Problema byssus*)
Polemoniaceae [phlox family]	*Polemonium reptans*	Jacob's-ladder	🐝 *Andrena polemonii*
Pontederiaceae [water-hyacinth family]	*Pontederia cordata*	Pickerelweed	🐝 *Dufourea novaeangliae, Florilegus condignus*
Rhamnaceae [buckthorn family]	*Ceanothus*	New Jersey tea	🐝 *Pseudopanurgus pauper, P. virginicus* | 🦋 summer azure (*Celastrina neglecta*), spring azure, mottled duskywing (*Erynnis martialis*)
Rosaceae [rose family]	*Crataegus*	Hawthorn	🐝 *Andrena crataegi*
	Fragaria virginiana	Wild strawberry	🐝 *Andrena melanochroa, A. ziziaeformis, Panurginus potentillae* | 🦋 gray hairstreak
	Prunus	Cherry & plum	🦋 eastern tiger swallowtails, viceroy
Rutaceae [rue family]	*Ptelea trifoliata*	Wafer ash	🦋 eastern tiger swallowtail, giant swallowtail (*Papilio cresphontes*)
Salicaceae [willow family]	*Salix*	Willow	🐝 *Andrena andrenoides, A. bisalicis, A. erythrogaster, A. frigida, A. illinoensis, A. macoupinensis, A. mariae, A. nida, A. nigrae, A. salictaria, A. sigmundi* | 🦋 green comma (*Polygonia faunus*), mourning cloak, viceroy
Saxifragaceae [saxifrage family]	*Heuchera*	Alumroot	🐝 *Colletes aestivalis*
Scrophulariaceae [figwort family]	*Agalinis*	False foxglove	🐝 *Anthophorula micheneri, Perdita gerardiae* | 🦋 common buckeye
	Castilleja coccinea	Indian paintbrush	🦋 common buckeye, checkerspot species (documented in other states), phyllira tiger moth (*Grammia phyllira*)
	Mimulus	Monkey flower	🦋 common buckeye
	Penstemon	Beardtongue	🐝 *Osmia distincta* | 🦋 dotted checkerspot (*Poladryas minuta*) [not shown as in AR in BAMONA]
Styracaceae [styrax family]	*Halesia*	Silverbell	🐝 *Anthophorula micheneri, Perdita gerardiae* | 🦋 eastern comma (*Polygonia comma*), eastern tiger swallowtail, mourning cloak, red-spotted purple (*Limenitis arthemis*), viceroy
Verbenaceae [verbena family]	*Verbena*	Vervain	🐝 *Calliopsis nebraskensis* | 🦋 common buckeye
Violaceae [violet family]	*Viola*	Violet	🐝 *Andrena violae* | 🦋 great spangled fritillary (*Speyeria cybele*), regal fritillary (*S. idalia*)
Vitaceae [grape family]	*Parthenocissus quinquefolia*	Virginia creeper	🦋 eight-spotted forester moth (*Alypia octomaculata*), Virginia creeper sphinx (*Darapsa myron*)

KEY: 🦋 **Caterpillar host plant** **Pollinated by sphinx moths (Sphingidae)** 🐝 **Specialist bee** **Aster specialist*** 🌾 **Grasses*** ⊞ **Xylocopa SPP.*** **Megachile SPP.*** ***See introductory text above for more information.**

1. **SPECIES** is listed instead of genus when only one species is found in AR.
2. **BEE SPECIALISTS (🐝)** consume pollen from only one species, genus or family, included from Fowler & Droege 2020 when listed as present in AR or adjacent states
3. **BUTTERFLY & MOTH SPECIALIST (🦋)**—Caterpillar host plants can vary greatly by region—see Wagner 2005. There are many more Lepidoptera specialists than listed here. The *Federal Highway Administration Ecoregional Revegetation App* lists many additional larval host relationships.

Cover Crop, Other Annuals, and Herb Species Lists

While planting native plants has the greatest benefit for native pollinators and other wildlife, annual cover crops and ornamentals, as well as herbs cultivated for home use or sale can be important complements to native plantings and natural areas on farms. For pollinators, we generally focus on flowering plants that require insect pollination, but bees and other insects often collect pollen from grasses, oaks, and other wind-pollinated plants. Such resources can be especially important in the earliest and latest parts of the growing season. Many herbs have extended bloom periods and even flower during droughts, providing vital resources and potentially valuable phytochemicals that support the immune systems of pollinators such as menthol and thymol (also found in some native species).

Table B7 highlights cover crop species typically grown in Arkansas due to their proven success in the state. Most of the University of Arkansas Cooperative Extension resources on cover crops focus on cool-season (winter) covers grouped into cool-season cereals (grasses) and broadleaves (forbs and legumes) that are planted in late summer to early November (refer to the University of Arkansas publications for specific planting date recommendations) to protect and enhance soil quality for row crops. Many additional (warm-season or summer) species may be planted throughout the growing season providing multiple benefits, as well as potential additional income (see Table B8 and B9). To highlight the additional value such plantings provide for agriculturally beneficial insects, we call them "insectary plantings" or "insectaries." For details on other species worth considering for their value to pollinators, see:

USDA PLANTS Database (*USDA–NRCS 2019)
https://plants.usda.gov

SARE's *Cover Cropping for Pollinators and Other Beneficial Insects*
www.sare.org/Learning-Center/Bulletins/Cover-Cropping-for-Pollinators-and-Beneficial-Insects

SARE's more general cover crop resources
www.sare.org/Learning-Center/Books/Building-Soils-for-Better-Crops-3rd-Edition/Text-Version/Cover-Crops

Southern & Midwest Cover Crops Councils cover crop information sheets
https://southerncovercrops.org/ and

http://mccc.msu.edu/

Rodale Institute's *How to Plant Insectary Strips and Which Plants to Use*
https://rodaleinstitute.org/science/articles/tips-and-steps-to-planting-insectary-strips-for-organic-pest-management

Arkansas (or nearby) resources on cover crops, other crops, annuals and herbs that can serve as insectary plantings:

Cover Crop Species Adapted to North-Central West Texas and Southwestern Oklahoma:
- ***Summer*** (*Carr & Rea 2014)**:** www.blogs.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/txpmcsr12573.pdf
- ***Winter*** (*Carr & Rea 2015)**:** www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/txpmcsr12635.pdf

Warm-season cover crops and planting specifications, Technical Note No: TX-PM-16-01 (*TX–PMC 2016)
www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/etpmctn12917.pdf

Arkansas planting guides
- ***Spring and summer:*** www.uaex.edu/yard-garden/vegetables/docs/planting-dates-spring-summer-vegetables.pdf
- ***Fall:*** www.uaex.edu/yard-garden/vegetables/docs/planting-dates-fall-vegetables.pdf

Cover crop establishment and potential benefits to Arkansas Farmers (*Humphreys 2016)

**This is focused on winter cover crops for row crop production.*
http://scholarworks.uark.edu/etd/1867

Cover crops require planning for success (*Roberts 2015)
**Part 1 in a series.*
www.arkansas-crops.com/2015/08/25/require-planning-success/

Growing Herbs in Arkansas (*UAEX 2020b)
www.uaex.edu/yard-garden/in-the-garden/herbs.aspx

***Home gardening series: Beans.* FSA-6003.** (*Anderson 2009a)
www.uaex.edu/publications/PDF/FSA-6003.pdf

Summer cover crop trial (*Hotz 2018)
**This trial was conducted at the University of Arkansas Vegetable Research Station in Alma, Arkansas, with a planting on May 9, 2018.*
www.uaex.edu/farm-ranch/crops-commercial-horticulture/horticulture/ar-fruit-veg-nut-update-blog/posts/2018summercovercroptrial.aspx.

***Understanding cover crops.* FS2156.** (*Roberts et al. 2018)
www.uaex.edu/publications/pdf/FScA-2156.pdf

Winter cover crop planting considerations (*Roberts 2019)
**This document highlights species recommended for winter cover, as well as species not recommended due to their potential weediness or unsuitability for tolerating Arkansas winter conditions.*
www.arkansas-crops.com/2019/09/19/winter-planting-considerations/

Year-round Home Garden Chart (*Njue 2016)
www.uaex.edu/publications/pdf/MP422.pdf

Cover Crops and Other Annuals for Pollinator Plantings

Cover crops and annual wildflowers can provide pollen, nectar, and shelter for pollinators, predators, and parasitoids that help improve pollination and pest management. They also help improve soil health, adding nutrients, penetrating soil depths, and supporting diverse micro-organisms that help ensure healthy plant growth.

When choosing cover crops, other annuals, and herbs to support pollinators and other wildlife, keep in mind these ecological principles:

- Conventional use of covers is primarily aimed at boosting subsequent cash crop production. We know less about costs/benefits when also considering value to pollinators, natural enemies of pests, and other wildlife values. Allowing cover crops to flower for pollinators and other wildlife can improve yield of pollinated crops and reduce pest problems for all crops.

* Recommended resource is also cited in *References*

- For pollinators and natural enemies of pests, simply leaving fallow can provide many of the benefits provided by planted covers.
- To reduce disease and pest problems for cash crops, choose covers that are not related to the cash crop that will subsequently be planted. For example, do not use brassica covers like kale or turnips when the subsequent cash crop is canola/rape; use legumes and broadleaf covers prior to corn, but not grasses.
- Insectary plantings, whether annual or perennial, are a growing agritourism tool when designed to complement or enhance the beauty of farmscapes.

Note that using grasses alone is not recommended for supporting pollinators, though valuable for supporting soil health and many other beneficial insects. When planting grass covers for pollinators and other beneficial insects, include flowering broadleaf species whenever possible to provide nectar, as well as pollen. When managing cover crop species using a roller crimper, keep in mind crimpers are more effective for killing grasses and other upright covers than vining species like cowpea and Austrian winter pea.

Data for the following tables were drawn largely from Cover Cropping for Pollinators and Beneficial Insects, Understanding Cover Crops, and the Southern Cover Crops Council website (see links above). Some seeding rate information is from *PB378 Forage & Field Crop Seeding Guide for Tennessee*.

Table B7: Cover Crops Recommended for Arkansas That Support Pollinators and Natural Enemies of Pests[1]

SEASON	CROP	COMMON NAME	SCIENTIFIC NAME	PLANTING[2]	↻	LBS/AC[3]	DEPTH[4]
WARM SEASON	GRASS/CEREAL	Millet, proso	*Panicum mileaceum*	Apr–Jul	A	10–30	0.5
		Millet, pearl	*Pennisetum glaucum*	May–mid-Jun	A	10–30	0.5
		Sorghum/sudangrass	*Sorghum × drummondii*	May–mid-Jun	A	10–40	1.5
	LEGUME	Lablab	*Lablab purpureus*	mid-Apr–Jun	A	40	0.5-1.5
		Pea, cowpea / purple hull[5]	*Vigna unguiculata*	mid-Apr–Jun	A	50–100	1
		Soybean	*Glycine max*	Apr–Jul	A	35–150	1
	FORB/ BROADLEAF	Buckwheat	*Fagopyrum esculentum*	Apr–mid-May	A	50–60	0.5-1.5
		Sesame	*Sesamum orientale*	May–mid-Jun	A	6	0.25
		Sunflower	*Helianthus annuus*	when soil ≥45°F	A	15	0.5
COOL SEASON	GRASS/CEREAL	Oats	*Avena sativa*	Sep–Nov	A	45-55	0.5-1.5
		Oats, black	*Avena strigosa*	Sep–Nov	A	45-55	0.5-1.5
		Barley	*Hordeum vulgare*	mid-Sep–mid-Nov	A	35-50	0.75-2
		Rye, cereal	*Secale cereale*	late Aug–mid-Nov	A	35-50	0.75-2
		Wheat	*Triticum aestivum*	Sep–early Nov	A	35-50	0.5-1.5
		Triticale	*× Triticosecale*	Sep–Nov	A	35-50	0.75-2
	LEGUME	Lupine, sweet blue[6]	*Lupinus angustifolius*	late Aug–mid-Sep	A	70	≤1"
		Pea, Austrian winter	*Pisum arvense*	mid-Aug–early Nov	A	30-50	1.5-3
		Clover, red[7]	*Trifolium pratense*	mid-Oct–mid-Nov	P	5–15	0.25-0.5
	FORB/ BROADLEAF	Kale	*Brassica oleracea var. sabellica*	Aug–Oct	B	8-15	0.25-0.75
		Turnip	*Brassica rapa*	late Jul–early Oct	B	8-15	0.25-0.75
		Radish, tillage	*Raphanus sativus*	Sep–Oct	B	8-15	0.25-0.75
		Radish, oilseed	*Raphanus sativus*	late Jul–mid-Oct	B	8-15	0.25-0.75

↻ **LIFE CYCLE**—Annual (A), perennial (P), biennial (B).

1. Based on research by University of Arkansas researchers Paige Hickman, Dr. Jackie Lee, and Dr. Amanda McWhirt for fruit and vegetable production, and Dr. Trenton Roberts for row crop production.
2. **PLANTING PERIOD**
3. **SEEDING RATE (LBS/AC)**—Single species rates drilled. Reduce rates for mixes; increase if broadcasting. Note that mixes may be best for supporting beneficial insects.
4. **SEEDING DEPTH**
5. (A.K.A. black-eyed pea). Common varieties include Iron Clay (A.K.A. Iron & Clay) and Red Ripper.
6. Often included in cover crop mixes, but may be killed in cold winters.
7. Additional species of clover are included in *Crops Needing or Benefitting from Pollination in Arkansas*. Also see *Annual and Perennial Forage Clovers of Arkansas* (https://www.uaex.edu/publications/pdf/FSA-3137.pdf)

Other non-native, non-invasive annual flowers not included above that are especially good for pollinators, predators, and parasitoids and can also be cut or container grown for fresh market sales include ageratum, asters, cosmos, cleome, lantana, marigolds, Mexican sunflower (*Tithonia rutondifolia*), poppy, other *Salvias* (check www.invasive.org/ to avoid using species invasive in the region), verbena, and zinnia. Some ornamental bulbs are also recommended to support beneficial insects, such as *Allium* spp. (ornamental onions), camas (*Camassia* spp.), crocus (*Crocus* spp.), lilies (*Lilium* spp.), and scilla (*Scilla* spp.), many of which have native relatives in Arkansas.

Table B8: Additional Cover Crops for Pollinators and Natural Enemies of Crop Pests That May Grow Well in Arkansas[1]

SEASON	CROP	COMMON NAME	SCIENTIFIC NAME	PLANTING[2]	↻	LBS/AC[3]	DEPTH[4]
WARM SEASON	GRASS/ CEREAL	Teff	*Eragrostis tef*	May–MID-Jun	A	5–10	0.5
		Millet, foxtail	*Setaria italica*	Apr–Jul	A	10–30	0.5
	LEGUME	Showy partridge pea[4]	*Chamaecrista fasciculata*	LT. winter–LT. spring	A	10–15	0.25–0.5
		Sensitive partridge pea[4]	*Chamaecrista nictitans*	LT. winter–LT. spring	A	10–15	0.25–0.75
		Chickpea	*Cicer arietinum*	~at / just before last frost date	A	80–150	1.5
		Mung bean	*Vigna radiata*	after danger of frost	A	15–20	1–3
	FORB/ BROADLEAF	Amaranth[5]	*Amaranthus* spp.	May–MID-Jun	A	1	0.25
		Safflower	*Carthamus tinctorius*	when soil ≥40°F	A	20–25	1
		Chicory	*Cichorium intybus*	May	A	3–4	0.5
		Cilantro / coriander	*Coriandrum sativum*	LT. spring	A	25–100	0.25–0.5
		Alyssum, sweet	*Lobularia maritima*	EA. spring–EA. / LT. summer	A	2–3	<.025
COOL SEASON	LEGUME	Vetch, chickling	*Lathyrus sativus*	LT. summer or EA. spring	A	50–60	1
		Lentil	*Lens culinaris*	V.E. spring (2–3 weeks before last frost)	A	40–80	0.5
		Sainfoin	*Onobrychis viciifoia*	fall or EA. spring	P	34	0.25–0.75
		Alfalfa[6]	*Medicago sativa*	Mar–May, MID-Aug–MID-Sep	P	15–25	0.25–0.5
		Clover, berseem	*Trifolium alexandrinum*	MID-Oct–MID-Nov[7]	A	15–20	0.25
		Clover, kura	*Trifolium ambiguum*	MID-Oct–MID-Nov[7]	P	5–15	0.25
		Clover, strawberry	*Trifolium fragiferum*	MID-Oct–MID-Nov[7]	P	5–15	0.25
		Clover, rose	*Trifolium hirtum*	MID-Oct–MID-Nov[7]	A	5–15	0.25
		Clover, crimson[8]	*Trifolium incarnatum*	MID-Oct–MID-Nov[7]	A	10–30	0.25
		Clover, white	*Trifolium repens*	MID-Oct–MID-Nov[7]	P	5–15	0.25
		Clover, subterranean	*Trifolium subterraneum*	MID-Oct–MID-Nov[7]	A	10–15	0.25
		Vetch, purple	*Vicia americana*	fall	P	20–40	1–2
		Fava bean	*Vicia faba*	V.E. spring	A	60–80	2–4
		Vetch, common or garden	*Vicia sativa*	fall	A	33	1–2
	FORB/ BROADLEAF	Dill	*Anethum graveolens*	after danger of frost	A	5–8	0.25
		Beet	*Beta bulgaris*	MID-Mar–Jun, MID-Jul–mid-Oct	B	7–15	1
		Canola[9]	*Brassica napus*	MID-Sep–MID-Oct	A	3–10	0.5
		Carrot	*Daucus carota* ssp. *sativus*	MID-Feb–EA. Apr	B	3–4	0.25-0.5
		Meadowfoam, white	*Limnanthes alba*	fall, when soil <60°F	A	15–40	0.25–0.75
		Flax, common	*Linum usitatissimum*	V.E. spring	A	25–35	0.25–0.5
		Phacelia, lacy[10]	*Phacelia tanacetifolia*	LT. summer, EA. spring	A	10–15	0.25
		Mustard, white, yellow, or tame	*Sinapis alba*	LT. summer, EA. spring	A	5–15	0.5

↻ **LIFE CYCLE**—Annual (A), perennial (P), biennial (B).

1. From *Cover Cropping for Pollinators and Beneficial Insects*. Species known to be invasive were omitted (https://plants.usda.gov/java/invasiveOne or https://www.invasiveplantatlas.org/).
2. **PLANTING PERIOD**—Very early (V.E.); Early (EA.), Mid (MID-), Late (LT.)
3. Single species rates drilled. Reduce rates for mixes; increase if broadcasting. Note: mixes may be best for supporting beneficial insects.
4. Native species.
5. Ancient amaranths (edible and not aggressive weeds) include *Amaranthus caudatus*, *A. cruentus*, and *A. hypochondriacus*.
6. Alfalfa may be planted in late summer for winter cover, but needs 6 to 8 weeks growth to be well established before a freeze.
7. According to Philipp et al (2013), planting dates for clovers in Arkansas are: Sep–Nov in prepared seedbeds and mid-Oct–mid-Nov in sod.
8. Not generally recommended because it has the potential to reseed and become weedy in Arkansas.
9. Be sure to terminate before goes to seed. Can be difficult to terminate with herbicide and, if left to seed, may become a nuisance weed. See https://www.uaex.edu/publications/PDF/FSA-2154.pdf for recommended varieties.
10. Extension trials in Arkansas found difficult to establish. Growers with similar ecological conditions in the eastern U.S. have had greatest success with late summer (for late fall bee forage) and very early spring/late winter plantings.

Herbs for Pollinator Plantings

Many perennial and annual herbs, though generally non-native, can provide valuable forage for pollinators, predators, and parasitoids that benefit farm production. Some are alternative host plants for native butterfly caterpillars, producing similar phytochemicals as the native host plants. For example, plants in the parsley family host the black swallowtail butterfly caterpillar: parsley, caraway, chervil, dill, fennel, and rue. Consider including annual herbs in cover crop mixes or planting perennial herbs in permanent field borders or other perennial plantings in your farmscape.

Table B9: Herbs (Annual and Perennial) That Provide Forage and Habitat for Pollinators, Predators, and Parasitoids

Data drawn from *Growing Herbs in Arkansas* (www.uaex.edu/yard-garden/in-the-garden/herbs.aspx).

COMMON NAME	SCIENTIFIC NAME	↻	HERB | OTHER	NATIVE / RELATIVE[1]
Angelica[2]	*Angelica archangelica*	P		*A. venenosa*
Anise	*Pimpinella anisum*	A		
Anise hyssop	*Agastache foeniculum*	P		*A. nepetoides*, *A. scrophulariifolia*
Artemisia	*Artemisia* spp.	P		Native spp. west and north of AR.
Basil, sweet	*Ocimum basilicum*	A		*O. campechianum* native in FL.
Bee balm	*Monarda didyma*	P		Several native spp. See Notes[3]
Borage	*Borago officinalis*	A		
Burnet, salad	*Sanguisorba minor*	P		*S. annua* native to AR, other spp. north.
Calendula, pot marigold	*Calendula officinalis*	A		
Caraway[4]	*Carum carvi*	A, B		
Catnip	*Nepeta cataria*	P		
Chamomile	*Chamaemelum nobile*	P		
Chamomile, sweet false	*Matricaria recutita*	A		*M. occidentalis* native in CA.
Chervil	*Anthriscus cerefolium*	A		
Chives	*Allium schoenoprasum*	P		Considered native & introduced[5]
Clary sage	*Salvia sclarea*	A, B		
Comfrey	*Symphytum officinale*	P		*S.* x *uplandicum* native in Canada.
Cilantro / coriander[6]	*Coriandrum sativum*	A		
Costmary	*Tanacetum balsamita*	P		Relatives native in CA & Canada.
Dill	*Anethum graveolens*	A		
Echinacea (A.K.A. purple coneflower)	*Echinacea angustifolia*	P		Native in AR[7].
Fennel	*Foeniculum vulgare*	P		
Feverfew	*Tanacetum parthenium*	P		Relatives native in CA & Canada.
Geranium, scented	*Pelargonium spp.*	P		
Germander	*Teucrium chamaedrys*	P		*T. canadense* native in AR. Other spp. west.
Horehound	*Marrubium vulgare*	P		
Hyssop	*Hyssopus officinalis*	P		
Lavender	*Lavandula angustifolia*	P		
Lemon balm	*Melissa officinalis*	P		American false pennyroyal (*Hedeoma pulegioides*) was previously *Melissa.*
Lemon verbena	*Aloysia triphylla*	P		*Aloysia* natives west of AR.
Lovage	*Levisticum officinale*	P		Wild lovage, *Ligusticum canadense*, is native in AR.

KEY—HERB: Edible | Edible flower | Edible leaf | Edible root | Edible seed | Edible stem | Medicinal | Seasoning | Tea | OTHER: Craft | Fresh market

*See Notes below for more information.

Table B9: Herbs (Annual and Perennial) That Provide Forage and Habitat for Pollinators, Predators, and Parasitoids CONTINUED

COMMON NAME	SCIENTIFIC NAME	↻	HERB | OTHER	NATIVE / RELATIVE[1]
Marjoram, sweet marjoram[8]	*Origanum majorana*	P		
Nasturtium	*Tropaeolum* spp.	A		
Oregano	*Origanum vulgare* (ssp. *hirtum*)	P		
Parsley	*Petroselinum crispum*	A, B		
Peppermint	*Mentha* x *piperita*	P		One rare species in AR.
Rosemary	*Rosemarinus officinalis*	P		
Rue	*Ruta graveolens*	P		
Sage	*Salvia officinalis*	P		
Sage, pineapple	*Salvia elegans*	P		*S. azurea*, *S. lyrata*, *S. reflexa* native in AR.
Santolina	*Santolina chamaecyparissus*	P		
Sorrel	*Rumex* spp.	P		Two rare spp. in AR. Some *Rumex* invasive.
Southernwood	*Artemisia abrotanum*	P		Native spp. west and north of AR.
Spearmint	*Mentha spicata*	P		One rare species in AR.
Summer savory	*Satureja hortensis*	A		
Sweet woodruff[9]	*Galium odoratum*	P		7 *Galium* spp. native in AR.
Tansy[10]	*Tanacetum vulgare*	P		Relatives native in CA & Canada.
Tarragon	*Artemisia dracunculus*	P		Native spp. west and north of AR.
Thyme	*Thymus vulgaris*	P		
Valerian	*Valeriana officinalis*	P		
Winter savory	*Satureja montana*	P		
Yarrow	*Achillea millefolium*	P		

KEY—HERB: Edible | Edible flower | Edible leaf | Edible root | Edible seed | Edible stem | Medicinal | Seasoning | Tea | OTHER: Craft | Fresh market
***See Notes below for more information.**

↻ Life Cycle—Annual (A), perennial (P), biennial (B).

* Herb—Culinary or medicinal uses: **edible**, **edible flower**, **edible leaf**, **edible root**, **edible seed**, **edible stem**, **medicinal**, **seasoning**, **tea**. See *Growing Herbs in Arkansas* website (above) for additional details on uses. Species invasive in Arkansas not included here.

† **OTHER** Uses—**craft** use including decoration, dye, potpourris, or fragrance/oil extraction, **fresh market** such as for cut flower, herb, medicinal, or other ornamental use.

1. There may be connections between native pollinators that evolved with native plants and related herbs. Shown here: native in Arkansas, other species in same genus found in Arkansas, or other natives found in other parts of North America.
2. **Caution:** *Angelica* closely resembles poisonous water hemlock.
3. *M. bradburiana, M. citriodora, M. fistulosa, M. punctata, M. russeliana*
4. Caraway is listed as a noxious weed in Colorado.
5. Considered native and introduced—*A. canadense, A. cernuum, A. drummondii, A. stellatatum, A. tricoccum* native in AR.
6. The dried seeds (spice) are called coriander and the fresh leaves (herb) are called cilantro.
7. *E. pallida, E. paradoxa, E. purpurea, E. sanguinea* native in AR.
8. Marjoram was in the genus *Majorana*, but is now considered the same species as sweet marjoram (*Origanum*)
9. Some *Galium* spp., bedstraw, historically used as mattress filling, partly for pleasant fragrance.
10. Some species are toxic to people and/or cattle.

Pollinator-Friendly Crops to Enhance Crop Rotation Diversity

As of March 2020, through the Conservation Stewardship Program (CSP), Arkansas NRCS offers technical and financial support to eligible farmers who improve their existing crop rotation by adding pollinator-friendly crops into the rotation. This improvement is referred to as Conservation Enhancement Activity E328J: Improved crop rotation to provide benefits to pollinators. Pollinator-friendly crops are those that provide ample amounts of nectar and/or pollen for pollinators to forage on. Each year, the pollinator-friendly crop will be planted on a minimum of 5% of cropland acres contained within the agricultural operation. These crops can be harvested for sale or can be grown as cover crops, but to meet the purpose and definition of a pollinator-friendly crop, these crops must be allowed to bloom prior to harvest or termination. Additionally, so as to protect pollinators, use of insecticides is limited for the pollinator-friendly crop.

The table below represents the official list of pollinator-friendly crops with regards to Conservation Enhancement Activity E328J in Arkansas as of March 2020. However, Arkansas NRCS may revise the official list at any time, so please consult Arkansas NRCS for the current official list and for more information on this enhancement activity.

Table B10: Pollinator-Friendly Crops to Enhance Flowering Diversity in Crop Rotations

CROP	PRIMARY USE
Alfalfa	harvestable
Alyssum, sweet	cover crop
Basil	harvestable
Bean, bush and pole	harvestable
Bean, fava	harvestable
Borage	harvestable
Buckwheat	harvestable
Canola	harvestable
Cantaloupe	harvestable
Chickpea	harvestable
Chicory	cover crop
Cilantro / coriander	harvestable
Clover, alsike	cover crop
Clover, berseem	cover crop
Clover, crimson	cover crop
Clover, kura	cover crop
Clover, red	cover crop
Clover, rose	cover crop
Clover, strawberry	cover crop
Clover, subterranean	cover crop
Clover, white	cover crop
Cowpea	harvestable
Cucumber	harvestable
Cut flowers (e.g., cosmos, zinnias)	harvestable
Dill	harvestable
Eggplant	harvestable
Fennel	harvestable
Flax	harvestable
Garlic	harvestable
Lablab	cover crop
Lentil	harvestable
Lupine, sweet blue	cover crop
Meadowfoam	cover crop
Melon	harvestable
Milkvetch	cover crop
Okra	harvestable
Partridge Pea	cover crop
Partridge Pea, small	cover crop
Pea, Austrian winter	cover crop
Pea, garden	harvestable
Pea, purple hull (A.K.A. black-eyed pea)	harvestable
Pepper	harvestable
Pumpkin	harvestable
Radish, oilseed/tillage	cover crop
Safflower	harvestable
Sanfoin	cover crop
Sesame	harvestable
Squash	harvestable
Strawberry	harvestable
Sunflower	harvestable
Tomato	harvestable
Turnip	cover crop
Vetch, Cahaba	cover crop
Vetch, chickling	cover crop
Vetch, common or garden	cover crop
Vetch, hairy	cover crop
Vetch, purple	cover crop
Watermelon	harvestable

Index of Crop Names

Since most people are familiar with common crops and weeds, we did not include scientific names for those within the handbook chapters. We also thought it might be helpful to know where to find references to specific crops, so have included an index for where crops are referenced in the handbook.

Table B11. Arkansas Crop-Pollinator Relationships

COMMON NAME	SCIENTIFIC NAME	PLANT FAMILY [COMMON NAME]	USE	FURTHER INFORMATION†	POLLINATION	NATIVE (OR NATIVE RELATIVES)[1]
Alfalfa	*Medicago sativa*	Fabaceae [bean]	harvestable		!	—
Almond	*Prunus dulcis*	Rosaceae [rose]	harvestable	4; 46	!	8 natives are plums and cherries[4]
Alyssum, sweet	*Lobularia maritima*	Brassicaceae [mustard]	cover crop			—
Apple	*Malus pumila*	Rosaceae [rose]	harvestable	1; 4; 7; 22; 43	!	*M. angustifolia*^2, *M. ioensis*[2]
Apricot	*Prunus armeniaca*	Rosaceae [rose]	harvestable	4	!	8 natives are plums and cherries[4]
Aronia berries	*Aronia* (*Photinia*) spp.	Rosaceae [rose]	harvestable	4	!	Native
Basil, sweet	*Ocimum basilicum*	Lamiaceae [mint]	harvestable	44		Native relative in FL
Bean, bush / pole	*Phaseolus vulgaris*	Fabaceae [bean]	harvestable	6		*P. polystachils*; native relatives in other states
Beans, lima / snap	*Phaseolus* spp.	Fabaceae [bean]	harvestable	4; 6		*P. polystachils*; native relatives in other states
Black raspberry	*Rubus occidentalis*	Rosaceae [rose]	harvestable	4; 31; 42; 51	!	Native; 15 other native species in Arkansas[5]
Blackberry (including marionberry)	*Rubus* spp.	Rosaceae [rose]	harvestable	4; 6; 16; 31; 42; 51	!	16 native *Rubus* spp. in Arkansas[5]
Blueberry	*Vaccinium corymbosum* & hybrids	Ericaceae [heath]	harvestable	4; 5; 42	! [blueberry bee]	Native; 5 other native species in Arkansas[6]
Borage	*Borago officinalis*	Boraginaceae [borage]	harvestable			—
Buckwheat	*Fagopyrum esculentum*	Polygonaceae [buckwheat]	harvestable	2; 8; 44; 52		—
Canola	*Brassica* spp.	Brassicaceae [mustard]	harvestable	4		—
Cantaloupe	*Cucumis melo* var. *cantalupensis*	Cucurbitaceae [gourd]	harvestable		! [squash bee]	—
Carrots	*Daucus carota* ssp. *sativus*	Apiaceae [parsley]	harvestable	4	!	*D. pusillus*
Cherry	*Prunus* spp.	Rosaceae [rose]	harvestable	4; 17; 51	!	8 natives (some are plums)[4]
Chickpea	*Cicer arietinum*	Fabaceae [bean]	harvestable			—
Chicory	*Cichorium intybus*	Asteraceae [sunflower]	cover crop			—
Cilantro / coriander	*Coriandrum sativum*	Apiaceae [parsley]	harvestable		(coriander)	—
Clover, alsike	*Trifolium hybridum*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Clover, berseem	*Trifolium alexandrinum*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Clover, crimson	*Trifolium incarnatum*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Clover, kura	*Trifolium ambiguum*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Clover, red	*Trifolium pratense*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Clover, rose	*Trifolium hirtum*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Clover, strawberry	*Trifolium fragiferum*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Clover, subterranean	*Trifolium subterraneum*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Clover, white	*Trifolium repens*	Fabaceae [bean]	cover crop			*T. carolinianum, T. reflexum*
Corn	*Zea mays*	Poaceae [grass]	harvestable	24; 27		—
Cotton	*Gossypium* spp.	Malvaceae [mallow]	harvestable	4; 6; 24; 27	[rosemallow bee]	*G. hirsutum* native in FL and adventive[3] in AR
Cucumber	*Cucumis sativus*	Cucurbitaceae [gourd]	harvestable	4	! / [squash bees]	—
Dill	*Anethum graveolens*	Apiaceae [parsley]	harvestable	6	!	—
Eggplant	*Solanum melongena*	Solanaceae [nightshade]	harvestable	4; 35	!	*S. ptychanthum* (some spp. noxious)
Elderberry, common	*Sambucus nigra* ssp. *canadensis*	Adoxaceae [arrow-wood]	harvestable	4; 16; 31	!	Native relative in other states, *S. racemosa* is poisonous
Fava bean	*Vicia faba*	Fabaceae [bean]	harvestable			*V. caroliniana, V. ludoviciana, V. minutiflora*
Fennel	*Foeniculum vulgare*	Apiaceae [parsley]	harvestable			—

KEY†: ! Crop requires pollinators; Supports/attracts natural enemies; Crop produces more or better-quality SEED with pollinators; Crop produces more or better-quality FRUIT with pollinators; *See Table B11 Notes: on page 110 for more information

Supporting [...]; Reducing [...]; Table 2; Table 4; Table 6; Table B3; Table B4; Table B6; Table B7; Table B8; Table B9; Table B10; Supports specialist bees / Appendix F

Table B11. Arkansas Crop-Pollinator Relationships CONTINUED

COMMON NAME	SCIENTIFIC NAME	PLANT FAMILY [COMMON NAME]	USE	FURTHER INFORMATION†	POLLINATION	NATIVE (OR NATIVE RELATIVES)[1]
Flax, common	*Linum usitatissimum*	Linaceae [flax]	harvestable	☆		*L. lewisii, L. medium, L. striatum, L. sulcatum*
Garlic	*Allium sativum*	Amaryllidaceae [amaryllis]	harvestable			*A. stellatum* (some spp. noxious)
Jerusalem artichoke	*Helianthus tuberosus*	Asteraceae [sunflower]	harvestable	4		Native; 11 other native spp. in Arkansas[7]
Lablab	*Lablab purpureus*	Fabaceae [bean]	cover crop	★		—
Lentil	*Lens culinaris*	Fabaceae [bean]	harvestable	☆		—
Lupine, sweet blue	*Lupinus angustifolius*	Fabaceae [bean]	cover crop	★		*L. texensis* (rare)
Meadowfoam	*Limnanthes* spp.	Limnanthaceae [meadowfoam]	cover crop	☆		Native relatives in Pacific coast states
Melon (cantaloupe, honeydew, and muskmelon)	*Cucumis melo*	Cucurbitaceae [gourd]	harvestable	| 4	[squash bees]	—
Milkvetch	*Astragalus* spp.	Fabaceae [bean]	cover crop			*A. canadensis, A. crassicarpus, A. distortus, A. nutallianus* (rare)
Okra	*Abelmoschus esculentus*	Malvaceae [mallow]	harvestable	| 4	[rosemallow bee]	—
Partridge pea, sensitive / small	*Chamaecrista nictitans*	Fabaceae [bean]	cover crop	☆		Native
Partridge pea, showy	*Chamaecrista fasciculata*	Fabaceae [bean]	cover crop	☆		Native
Pea, Austrian winter	*Pisum arvense*	Fabaceae [bean]	cover crop	★		—
Pea, cowpea / purple hull (a.k.a. black-eyed pea)	*Vigna unguiculata*	Fabaceae [bean]	harvestable	★ | 4; 6		Native relatives in coastal plain of Gulf states and FL
Pea, garden	*Pisum sativum*	Fabaceae [bean]	harvestable			—
Peach & nectarine	*Prunus persica*	Rosaceae [rose]	harvestable	| 2; 4; 7		8 natives are plums and cherries[4]
Peanut	*Arachis hypogaea*	Fabaceae [bean]	harvestable	| 24; 28		—
Pear	*Pyrus* spp.	Rosaceae [rose]	harvestable			—
Pepper (Bell, chili, pimiento, and others)	*Capsicum annuum*	Solanaceae [nightshade]	harvestable	| 4		—
Persimmon	*Diospyros virginiana*	Ebenaceae [ebony]	harvestable	| 4		Native
Plum	*Prunus* spp.	Rosaceae [rose]	harvestable	| 4; 7		8 natives (some are cherries)[4]
Pomegranate	*Punica granatum*	Lythraceae [loosestrife]	harvestable	4		—
Pumpkin	*Cucurbita* spp.	Cucurbitaceae [gourd]	harvestable	| 4; 31	[squash bees]	*C. foetidissima, C. melopepo*
Radish, oilseed/tillage	*Raphanus sativus*	Brassicaceae [mustard]	cover crop	★		—
Rice	*Oryza sativa*	Poaceae [grass]	harvestable	| 24; 27		
Safflower	*Carthamus tinctorius*	Asteraceae [sunflower]	harvestable	☆		—
Sainfoin	*Onobrychis* spp.	Fabaceae [bean]	cover crop	☆		—
Seed (sunflower for oil and seed, other flowers, and vegetables)			harvestable	See sunflower, radish, carrot, etc. | 4		—
Sesame	*Sesamum orientale*	Pedaliaceae [sesame]	harvestable	★ | 6		—
Soybean	*Glycine max*	Fabaceae [bean]	harvestable	| 24; 26; 31; 32		—
Squash	*Cucurbita* spp.	Cucurbitaceae [gourd]	harvestable	| 4	[squash bees]	*C. foetidissima, C. melopepo*
Strawberry	*Fragaria* spp.	Rosaceae [rose]	harvestable	| 4; 7	/	*F. virginiana*
Sunflower	*Helianthus annuus*	Asteraceae [sunflower]	harvestable	★		Native; 11 other native spp. in Arkansas[7]
Tomato	*Solanum lycopersicum*	Solanaceae [nightshade]	harvestable	| 4; 5	/	*S. ptychanthum* (some spp. noxious)
Turnip	*Brassica rapa*	Brassicaceae [mustard]	cover crop	★		—
Vetch, Cahaba	*Vicia sativa* × *Vicia cordata*	Fabaceae [bean]	cover crop			*V. caroliniana, V. ludoviciana, V. minutiflora*
Vetch, chickling	*Lathyrus sativus*	Fabaceae [bean]	cover crop	☆		*L. venosus*
Vetch, common or garden	*Vicia sativa*	Fabaceae [bean]	cover crop	☆		*V. caroliniana, V. ludoviciana, V. minutiflora*
Vetch, hairy	*Vicia villosa*	Fabaceae [bean]	cover crop			*V. caroliniana, V. ludoviciana, V. minutiflora*
Vetch, purple	*Vicia americana*	Fabaceae [bean]	cover crop	☆		*V. caroliniana, V. ludoviciana, V. minutiflora*
Watermelon	*Citrullus lanatus*	Cucurbitaceae [gourd]	harvestable	| 4	[squash bees]	—

KEY†: Crop requires pollinators · Supports/attracts natural enemies · Crop produces more or better-quality SEED with pollinators · Crop produces more or better-quality FRUIT with pollinators · Supporting [...] · Reducing [...] · Table 2 · Table 4 · Table 6 · Table B3 · Table B4 · Table B6 · Table B7 · Table B8 · Table B9 · Table B10 · Supports specialist bees / Appendix F

*See Table B11 Notes: on page 110 for more information

Table B11 Notes:

* This list does not include many cut flowers that can also be grown as crops in Arkansas

† **FURTHER INFORMATION** Sources:

- G. Supporting Diversity in Row Crop Systems
- Reducing Negative Impacts of Pesticides in Row Crops Brings Higher Yields
- Table 2: Blooming Periods for Common Native Trees and Shrubs in Arkansas
- Table 4: Blooming Periods for Common Specialty Crops
- Table 6: NRCS Supporting Conservation Practices for Pollinator Habitat Establishment in Arkansas
- Table B3: Native Shrubs and Small Trees for Pollinators
- Table B4: Native Trees for Pollinators
- Table B6: Plants with Bee, Butterfly, and Moth Specialist Relationships
- Table B7: Cover Crops Recommended for Arkansas That Support Pollinators and Natural Enemies of Pests[1]
- Table B8: Additional Cover Crops for Pollinators and Natural Enemies of Crop Pests That May Grow Well in Arkansas[1]
- Table B9: Herbs (Annual and Perennial) That Provide Forage and Habitat for Pollinators, Predators, and Parasitoids
- Table B10: Pollinator-Friendly Crops to Enhance Flowering Diversity in Crop Rotations
- Appendix F: Common & Specialist Bees of Arkansas

1. There may be connections between pollinators of native plants and related crops. See BONAP.org or the *Atlas of Vascular Plants of Arkansas* for distribution. “Native relative” here indicates not native in Arkansas, but plants in same genus grow in other parts of the United States. There may be additional relatives in the family (different genera) growing in Arkansas.
2. Used to make jelly.
3. Adventive means it is locally or temporarily naturalized, but conditions for spread not likely present.
4. Native *Prunus* spp.: *P. angustifolia, P. caroliniana, P. mexicana, P. serotina, P. umbellata, P. virginiana* (*P. americana* and *P gracilis* are rare in AR)
5. Native *Rubus* spp.: *R. aboriginum, R. allegheniensis, R. alumnus, R. argutus, R. bushii, R. flagellaris, R. frondosus, R. leviculus, R. meracus*, *R. mollior,* (*R. occidentalis*), *R. pascuus, R. pensilvanicus, R. roribaccus, R. suus, R. trivialis*
6. Native *Vaccinium* spp.: *V. arboreum, (V. corymbosum), V. elliottii, V. fuscatum, V. pallidum, V. stamineum*
7. Native *Helianthus* spp.: *H. angustifolius*, (*H. annuus*), *H. decapetalus, H. divaricatus, H. grosseserratus, H. hirsutus, H. microcephalus, H. mollis, H. occidentalis, H. pauciflorus* (rare), *H. strumosus*, (*H. tuberosus*)

Appendix C: Seed Mixes

Seed Mix Specifications

The seed mixes in this handbook have been designed to be 30 seeds per square foot (PLS/ft^2). If a seed company does not have some of the species identified in the seed mix, they can simply be dropped without replacement as long as the mix is still at or above 25 PLS/ft^2. This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If plants identified in pollinator mixes are not available and replacements must be made, select plants from this handbook that have the same bloom periods and growing requirements as the unavailable species (see *Appendix B: Species Lists* for appropriate alternatives).

Planner Note

Some seed vendors will not have every species included in the Arkansas seed mixes. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

For ease of use, you can print each mix on a single page, double-sided. Additional details about the regions have been included with each seed mix sheet. If you are unsure as to which seed mix is appropriate, contact the Arkansas USDA NRCS: www.ar.nrcs.usda.gov for assistance.

Recommended Seed Mixes:

1. Arkansas Coastal Plains Seed Mix
2. Arkansas Delta Seed Mix
3. Arkansas Ouachita & Blackland Prairie Seed Mix
4. Arkansas Ozarks Seed Mix
5. Arkansas River Valley Seed Mix

Figure 56—*clockwise from top left:* Diverse native plants found in this remnant prairie (A) can provide resources for a various pollinators and beneficial insects. Shown: black swallowtail (*Papilio polyxenes*) on *Liatris* sp. (B); Phaon crescent butterfly (*Phyciodes phaon*) on *Rudbeckia* sp. (C); ambush bug (*Phymata* sp.) on *Monarda* sp. (D); sweat bee (Halictidae) on *Siphium* flower (E); great purple hairstreak (*Atlides halesus*) on rattlesnake master (*Eryngium yuccafolium*, F); green lacewings (*Chrysoperla* sp.) on *Ratibida* sp. (G). (Photos: Ryan Diener, Quail Forever [A, C, E]; Steve Duzan [B, F]; Sarah Foltz Jordan, Xerces Society [D, G].)

Arkansas Coastal Plains Seed Mix

The Gulf Coastal Plain Natural Division is in southwestern and southcentral Arkansas, and is dominated by pine forest, much of which is now managed for timber production. The Coastal Plain of Arkansas, part of the West Gulf Coastal Plain ecoregion, was historically a flowing mosaic of blackland prairies, wet prairies, open woodlands, pine savannas, and bottomland hardwoods. Certain regions supported very open woodland or savanna with a diverse herbaceous understory.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% of Mix	Weight	Spp.
GRASSES	7.047	24.51%	1.420	9
FORBS	21.706	75.49%	1.786	51
Spring-blooming	—	8.93%	—	4
Summer-blooming	—	46.81%	—	30
Fall-blooming	—	19.75%	—	17
TOTALS	28.753	100.00%	3.206	60

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% of Mix	Weight	Notes
Big bluestem	*Andropogon gerardii*	1.136	3.95%	0.300	
Eastern gama grass	*Tripsacum dactyloides*	0.019	0.07%	0.110	
Fox sedge	*Carex vulpinoidea*	0.893	3.11%	0.030	
Indiangrass	*Sorghastrum nutans*	1.136	3.95%	0.300	
Little bluestem	*Schizachyrium scoparium*	2.204	7.66%	0.400	
River oats	*Chasmanthium latifolium*	0.103	0.36%	0.050	
Switchgrass	*Panicum virgatum*	0.060	0.21%	0.010	
Tall dropseed	*Sporobolus compositus*	1.220	4.24%	0.070	
Virginia wildrye	*Elymus virginicus*	0.275	0.96%	0.150	
Ashy sunflower	*Helianthus mollis*	0.026	0.09%	0.010	
Bigflower coreoposis	*Coreopsis grandiflora*	0.269	0.94%	0.030	
Black-eyed Susan	*Rudbeckia hirta*	1.085	3.77%	0.030	
Brown-eyed Susan	*Rudbeckia triloba*	0.230	0.80%	0.020	
Butterfly milkweed	*Asclepias tuberosa*	0.217	0.75%	0.135	
Cardinal flower	*Lobelia cardinalis*	2.074	7.21%	0.008	
Common boneset	*Eupatorium perfoliatum*	0.992	3.45%	0.015	
Common evening primrose	*Oenothera biennis*	0.474	1.65%	0.015	
Common milkweed	*Asclepias syriaca*	0.188	0.65%	0.127	
Compass plant	*Silphium laciniatum*	0.003	0.01%	0.006	
False aster	*Boltonia asteroides*	1.421	4.94%	0.030	
Foxglove beardtongue	*Penstemon digitalis*	0.478	1.66%	0.013	
Goat's rue	*Tephrosia virginiana*	0.007	0.02%	0.009	
Golden Alexanders	*Zizia aurea*	0.039	0.14%	0.010	
Gray goldenrod	*Solidago nemoralis*	0.417	1.45%	0.018	
Illinois bundleflower	*Desmanthus illinoensis*	0.585	2.04%	0.300	
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.015	3.53%	0.200	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	/ FT²	% OF MIX	WEIGHT	NOTES
Lemon mint	*Monarda citriodora*	0.661	2.30%	0.020	
Ohio spiderwort	*Tradescantia ohiensis*	0.021	0.07%	0.007	
Ox-eye false sunflower	*Heliopsis helianthoides*	0.101	0.35%	0.035	
Pale purple coneflower	*Echinacea pallida*	0.024	0.08%	0.010	
Plains coreopsis	*Coreopsis tinctoria*	1.036	3.60%	0.014	
Prairie blazing star	*Liatris pycnostachya*	0.022	0.08%	0.008	
Purple coneflower	*Echinacea purpurea*	0.266	0.92%	0.100	
Purple prairie clover	*Dalea purpurea*	1.281	4.46%	0.200	
Rattlesnake master	*Eryngium yuccifolium*	0.041	0.14%	0.010	
Rosinweed	*Silphium integrifolium*	0.006	0.02%	0.006	
Rough blazing star	*Liatris aspera*	0.038	0.13%	0.007	
Roundhead lespedeza	*Lespedeza capitata*	0.040	0.14%	0.010	
Sawtooth sunflower	*Helianthus grosseserratus*	0.145	0.50%	0.010	
Seedbox	*Ludwigia alternifolia*	1.910	6.64%	0.004	
Sensitive briar	*Mimosa quadrivalvis* var. *nuttalli*	0.005	0.02%	0.008	
Showy goldenrod	*Solidago speciosa*	0.279	0.97%	0.008	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.52%	0.100	
Slender lespedeza	*Lespedeza virginica*	0.037	0.13%	0.010	
Slender mountain mint	*Pycnanthemum tenuifolium*	1.666	5.79%	0.012	
Smooth blue aster	*Symphyotrichum laeve*	0.186	0.65%	0.008	
Sneezeweed	*Helenium autumnale*	0.168	0.58%	0.005	
Spotted beebalm	*Monarda punctata*	0.200	0.70%	0.005	
Stiff goldenrod	*Solidago rigida* ssp. *rigida*	0.463	1.61%	0.020	
Sweet black-eyed Susan	*Rudbeckia subtomentosa*	0.163	0.57%	0.010	
Tall bellflower	*Campanula americana*	0.250	0.87%	0.004	
Tall coreopsis	*Coreopsis tripteris*	0.023	0.08%	0.005	
Tall ironweed	*Vernonia gigantea*	0.115	0.40%	0.005	
Tickseed sunflower	*Bidens aristosa*	0.149	0.52%	0.050	
White prairie clover	*Dalea candida*	0.223	0.78%	0.035	
White wild indigo	*Baptisia alba*	0.004	0.01%	0.006	
Whorled milkweed	*Asclepias verticillata*	0.004	0.01%	0.001	
Wild bergamot	*Monarda fistulosa*	1.373	4.78%	0.050	
Wild quinine	*Parthenium integrifolium*	0.026	0.09%	0.010	
Yarrow	*Achillea millefolium*	1.113	3.87%	0.017	
	TOTALS	28.753	100.00%	3.206	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

Arkansas Delta Seed Mix

The Delta Natural Division (also known as the Mississippi Alluvial Plain) once was dominated by vast bottomland hardwood forests, but most of those forests were cleared, drained, and replaced with large crop fields characterized by deep, rich soil. The region was also home to extensive grasslands, such as the Grand Prairie, that occupied over half a million acres in the Delta. Unique elevated woodlands also existed on the higher terraces outside of the floodplains in the Delta. The sites include oak, and rarely pine, flatwoods on clay soils and upland oak woodlands or savannas on sandy or loamy soils.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% of Mix	Weight	Spp.
GRASSES	7.289	25.10%	1.610	6
FORBS	21.754	74.90%	1.899	40
Spring-blooming	—	10.34%	—	5
Summer-blooming	—	48.63%	—	22
Fall-blooming	—	15.93%	—	13
TOTALS	29.043	100.00%	3.509	46

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% of Mix	Weight	Notes
Big bluestem	*Andropogon gerardii*	1.515	5.22%	0.400	
Fox sedge	*Carex vulpinoidea*	0.596	2.05%	0.020	
Indiangrass	*Sorghastrum nutans*	1.515	5.22%	0.400	
Little bluestem	*Schizachyrium scoparium*	3.306	11.38%	0.600	
River oats	*Chasmanthium latifolium*	0.083	0.28%	0.040	
Virginia wildrye	*Elymus virginicus*	0.275	0.95%	0.150	
Ashy sunflower	*Helianthus mollis*	0.026	0.09%	0.010	
Black-eyed Susan	*Rudbeckia hirta*	1.447	4.98%	0.040	
Butterfly milkweed	*Asclepias tuberosa*	0.193	0.66%	0.120	
Cardinal flower	*Lobelia cardinalis*	1.296	4.46%	0.005	
Common boneset	*Eupatorium perfoliatum*	1.653	5.69%	0.025	
Common evening primrose	*Oenothera biennis*	0.474	1.63%	0.015	
Common milkweed	*Asclepias syriaca*	0.222	0.76%	0.150	
Cream wild indigo	*Baptisia bracteata*	0.001	0.00%	0.001	
Culver's root	*Veronicastrum virginicum*	1.084	3.73%	0.004	
False aster	*Boltonia asteroides*	0.474	1.63%	0.010	
Foxglove beardtongue	*Penstemon digitalis*	0.736	2.53%	0.020	
Golden Alexanders	*Zizia aurea*	0.079	0.27%	0.020	
Gray goldenrod	*Solidago nemoralis*	0.116	0.40%	0.005	
Hoary vervain	*Verbena stricta*	0.894	3.08%	0.070	
Illinois bundleflower	*Desmanthus illinoensis*	0.488	1.68%	0.250	
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.522	5.24%	0.300	
Lemon mint	*Monarda citriodora*	1.322	4.55%	0.040	
New Jersey tea	*Ceanothus americanus*	0.003	0.01%	0.001	
Ohio spiderwort	*Tradescantia ohiensis*	0.029	0.10%	0.010	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	/ FT^2	% OF MIX	WEIGHT	NOTES
Ox-eye false sunflower	*Heliopsis helianthoides*	0.202	0.70%	0.070	
Pale purple coneflower	*Echinacea pallida*	0.097	0.34%	0.040	
Plains coreopsis	*Coreopsis tinctoria*	0.666	2.29%	0.009	
Prairie blazing star	*Liatris pycnostachya*	0.041	0.14%	0.015	
Purple coneflower	*Echinacea purpurea*	0.531	1.83%	0.200	
Purple Joe Pye weed	*Eutrochium purpureum*	0.386	1.33%	0.025	
Rattlesnake master	*Eryngium yuccifolium*	0.102	0.35%	0.025	
Rosinweed	*Silphium integrifolium*	0.007	0.02%	0.007	
Rough blazing star	*Liatris aspera*	0.027	0.09%	0.005	
Roundhead lespedeza	*Lespedeza capitata*	0.080	0.28%	0.020	
Sawtooth sunflower	*Helianthus grosseserratus*	0.289	1.00%	0.020	
Seedbox	*Ludwigia alternifolia*	1.910	6.58%	0.004	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.51%	0.100	
Slender lespedeza	*Lespedeza virginica*	0.037	0.13%	0.010	
Slender mountain mint	*Pycnanthemum tenuifolium*	2.499	8.61%	0.018	
Tall coreopsis	*Coreopsis tripteris*	0.092	0.32%	0.020	
Tickseed sunflower	*Bidens aristosa*	0.164	0.57%	0.055	
White prairie clover	*Dalea candida*	0.638	2.20%	0.100	
Wild bergamot	*Monarda fistulosa*	1.098	3.78%	0.040	
Wild quinine	*Parthenium integrifolium*	0.026	0.09%	0.010	
Yarrow	*Achillea millefolium*	0.655	2.25%	0.010	
	TOTALS	29.043	100.00%	3.509	

KEY: PLS—Pure Live Seed / FT^2—PLS per square foot % OF MIX by PLS / FT^2 WEIGHT—PLS lbs/acre SPP.—Species Richness

Arkansas Ouachita & Blackland Prairie Seed Mix

This natural division is in west-central Arkansas, and features numerous long, rocky ridges that are often covered with mixed stands of hardwoods and short-leaf pine (Pinus echinata). The valleys between the ridges are often large enough to support large crop fields and pastures. The south-facing slopes and ridgetops of the Ouachitas historically supported open woodland and savanna, with glades occurring in the most rocky and shallowest soils. The moister north facing slopes of the ridges naturally support more dense woodland and forest.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% of Mix	Weight	Spp.
GRASSES	6.998	24.53%	1.665	9
FORBS	21.530	75.47%	1.682	56
Spring-blooming	—	8.44%	—	6
Summer-blooming	—	47.04%	—	31
Fall-blooming	—	19.99%	—	19
TOTALS	28.528	100.00%	3.347	65

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% of Mix	Weight	Notes
Big bluestem	*Andropogon gerardii*	1.136	3.98%	0.300	
Canada wildrye	*Elymus canadensis*	0.262	0.92%	0.100	
Indiangrass	*Sorghastrum nutans*	1.136	3.98%	0.300	
Little bluestem	*Schizachyrium scoparium*	2.479	8.69%	0.450	
River oats	*Chasmanthium latifolium*	0.103	0.36%	0.050	
Side oats grama	*Bouteloua curtipendula*	0.941	3.30%	0.250	
Splitbeard bluestem	*Andropogon ternarius*	0.124	0.43%	0.025	
Tall dropseed	*Sporobolus compositus*	0.523	1.83%	0.030	
Virginia wildrye	*Elymus virginicus*	0.293	1.03%	0.160	
Bigflower coreoposis	*Coreopsis grandiflora*	0.627	2.20%	0.070	
Black-eyed Susan	*Rudbeckia hirta*	0.904	3.17%	0.025	
Brown-eyed Susan	*Rudbeckia triloba*	0.402	1.41%	0.035	
Butterfly milkweed	*Asclepias tuberosa*	0.243	0.85%	0.151	
Cardinal flower	*Lobelia cardinalis*	1.296	4.54%	0.005	
Common boneset	*Eupatorium perfoliatum*	1.124	3.94%	0.017	
Common evening primrose	*Oenothera biennis*	0.663	2.33%	0.021	
Common milkweed	*Asclepias syriaca*	0.157	0.55%	0.106	
Compass plant	*Silphium laciniatum*	0.003	0.01%	0.006	
Cream wild indigo	*Baptisia bracteata*	0.001	0.00%	0.001	
Culver's root	*Veronicastrum virginicum*	1.355	4.75%	0.005	
Cup plant	*Silphium perfoliatum*	0.003	0.01%	0.005	
Foxglove beardtongue	*Penstemon digitalis*	0.368	1.29%	0.010	
Goat's rue	*Tephrosia virginiana*	0.004	0.01%	0.005	
Golden Alexanders	*Zizia aurea*	0.039	0.14%	0.010	
Gray goldenrod	*Solidago nemoralis*	0.231	0.81%	0.010	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	/ FT^2	% OF MIX	WEIGHT	NOTES
Gray-headed coneflower	*Ratibida pinnata*	0.194	0.68%	0.020	
Great blue lobelia	*Lobelia siphilitica*	1.286	4.51%	0.007	
Hoary vervain	*Verbena stricta*	0.383	1.34%	0.030	
Illinois bundleflower	*Desmanthus illinoensis*	0.390	1.37%	0.200	
Indian paintbrush	*Castilleja coccinea*	0.022	0.08%	0.003	
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.015	3.56%	0.200	
Maryland senna	*Senna marilandica*	0.005	0.02%	0.010	
New England aster	*Symphyotrichum novae-angliae*	0.177	0.62%	0.007	
Obedient plant	*Physostegia virginiana*	0.012	0.04%	0.003	
Ohio spiderwort	*Tradescantia ohiensis*	0.029	0.10%	0.010	
Ox-eye false sunflower	*Heliopsis helianthoides*	0.144	0.51%	0.050	
Pale purple coneflower	*Echinacea pallida*	0.097	0.34%	0.040	
Plains coreopsis	*Coreopsis tinctoria*	0.962	3.37%	0.013	
Prairie blazing star	*Liatris pycnostachya*	0.019	0.07%	0.007	
Purple coneflower	*Echinacea purpurea*	0.266	0.93%	0.100	
Purple prairie clover	*Dalea purpurea*	0.256	0.90%	0.040	
Rattlesnake master	*Eryngium yuccifolium*	0.020	0.07%	0.005	
Rosinweed	*Silphium integrifolium*	0.010	0.04%	0.011	
Rough blazing star	*Liatris aspera*	0.038	0.13%	0.007	
Roundhead lespedeza	*Lespedeza capitata*	0.040	0.14%	0.010	
Sawtooth sunflower	*Helianthus grosseserratus*	0.145	0.51%	0.010	
Seedbox	*Ludwigia alternifolia*	1.910	6.70%	0.004	
Sensitive briar	*Mimosa quadrivalvis* var. *nuttalli*	0.003	0.01%	0.005	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.52%	0.100	
Sky blue aster	*Symphyotrichum oolentangiense*	0.059	0.21%	0.002	
Slender lespedeza	*Lespedeza virginica*	0.055	0.19%	0.015	
Slender mountain mint	*Pycnanthemum tenuifolium*	2.083	7.30%	0.015	
Smooth blue aster	*Symphyotrichum laeve*	0.047	0.16%	0.002	
Spotted beebalm	*Monarda punctata*	0.100	0.35%	0.007	
Stiff goldenrod	*Solidago rigida* ssp. *rigida*	0.232	0.81%	0.010	
Tall coreopsis	*Coreopsis tripteris*	0.092	0.32%	0.020	
Tall ironweed	*Vernonia gigantea*	0.115	0.40%	0.010	
Tickseed sunflower	*Bidens aristosa*	0.149	0.52%	0.050	
Upright prairie coneflower	*Ratibida columnifera*	0.846	2.97%	0.050	
White prairie clover	*Dalea candida*	0.319	1.12%	0.050	
White wild indigo	*Baptisia alba*	0.004	0.01%	0.006	
Whorled milkweed	*Asclepias verticillata*	0.004	0.01%	0.001	
Wild bergamot	*Monarda fistulosa*	1.098	3.85%	0.040	
Wild quinine	*Parthenium integrifolium*	0.026	0.09%	0.010	
Yarrow	*Achillea millefolium*	1.309	4.59%	0.020	
	TOTALS	28.528	100.00%	3.347	

KEY: PLS—Pure Live Seed / FT^2—PLS per square foot % OF MIX by PLS / FT^2 WEIGHT—PLS lbs/acre SPP.—Species Richness

Arkansas Ozarks Seed Mix

The Ozark Highlands Ecoregion is the northern portion of the larger Ozark Plateau. It is lower in elevation and in general less rugged than the Boston Mountains. Historically the flat to gently rolling portions of the Ozark Highlands supported scattered treeless prairies and extensive oak savannas and woodlands, while the more dissected portions supported a variety of open woodlands and mesic forests. Extensive glades on limestone, dolomite, and sandstone occur in some regions. As with many regions of Arkansas, the less rugged areas of the Ozark Highlands are largely converted to non-native pasture.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% of Mix	Weight	Spp.
GRASSES	7.356	25.62%	1.734	9
FORBS	21.360	74.38%	1.691	59
Spring-blooming	—	9.42%	—	8
Summer-blooming	—	43.30%	—	33
Fall-blooming	—	21.67%	—	18
TOTALS	28.716	100.00%	3.425	68

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% of Mix	Weight	Notes
Big bluestem	*Andropogon gerardii*	1.136	3.96%	0.300	
Canada wildrye	*Elymus canadensis*	0.393	1.37%	0.150	
Fox sedge	*Carex vulpinoidea*	0.268	0.93%	0.009	
Indiangrass	*Sorghastrum nutans*	1.136	3.96%	0.300	
Little bluestem	*Schizachyrium scoparium*	2.479	8.63%	0.450	
River oats	*Chasmanthium latifolium*	0.103	0.36%	0.050	
Side oats grama	*Bouteloua curtipendula*	1.129	3.93%	0.300	
Tall dropseed	*Sporobolus compositus*	0.436	1.52%	0.025	
Virginia wildrye	*Elymus virginicus*	0.275	0.96%	0.150	
Ashy sunflower	*Helianthus mollis*	0.013	0.04%	0.005	
Bigflower coreoposis	*Coreopsis grandiflora*	0.224	0.78%	0.025	
Black-eyed Susan	*Rudbeckia hirta*	0.904	3.15%	0.025	
Blue wild indigo	*Baptisia australis*	0.004	0.01%	0.007	
Brown-eyed Susan	*Rudbeckia triloba*	0.230	0.80%	0.020	
Butterfly milkweed	*Asclepias tuberosa*	0.215	0.75%	0.134	
Canada milkvetch	*Astragalus canadensis*	0.186	0.65%	0.030	
Cardinal flower	*Lobelia cardinalis*	1.037	3.61%	0.004	
Common boneset	*Eupatorium perfoliatum*	0.992	3.45%	0.015	
Common evening primrose	*Oenothera biennis*	0.632	2.20%	0.020	
Common milkweed	*Asclepias syriaca*	0.187	0.65%	0.126	
Compass plant	*Silphium laciniatum*	0.002	0.01%	0.004	
Cream wild indigo	*Baptisia bracteata*	0.001	0.00%	0.001	
Culver's root	*Veronicastrum virginicum*	1.084	3.77%	0.004	
Foxglove beardtongue	*Penstemon digitalis*	0.552	1.92%	0.015	
Goat's rue	*Tephrosia virginiana*	0.007	0.02%	0.009	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	/ FT^2	% OF MIX	WEIGHT	NOTES
Golden Alexanders	*Zizia aurea*	0.020	0.07%	0.005	
Gray goldenrod	*Solidago nemoralis*	0.255	0.89%	0.011	
Gray-headed coneflower	*Ratibida pinnata*	0.145	0.51%	0.015	
Great blue lobelia	*Lobelia siphilitica*	1.653	5.76%	0.009	
Hoary vervain	*Verbena stricta*	0.383	1.33%	0.030	
Illinois bundleflower	*Desmanthus illinoensis*	0.390	1.36%	0.200	
Indian paintbrush	*Castilleja coccinea*	0.022	0.08%	0.003	
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.015	3.53%	0.200	
New England aster	*Symphyotrichum novae-angliae*	0.253	0.88%	0.010	
New Jersey tea	*Ceanothus americanus*	0.010	0.04%	0.004	
Obedient plant	*Physostegia virginiana*	0.020	0.07%	0.005	
Ohio spiderwort	*Tradescantia ohiensis*	0.018	0.06%	0.006	
Ox-eye false sunflower	*Heliopsis helianthoides*	0.150	0.52%	0.052	
Pale beardtongue	*Penstemon pallidus*	0.130	0.45%	0.002	
Pale purple coneflower	*Echinacea pallida*	0.100	0.35%	0.041	
Plains coreopsis	*Coreopsis tinctoria*	0.962	3.35%	0.013	
Prairie blazing star	*Liatris pycnostachya*	0.019	0.07%	0.007	
Purple coneflower	*Echinacea purpurea*	0.398	1.39%	0.150	
Purple Joe Pye weed	*Eutrochium purpureum*	0.108	0.38%	0.007	
Purple prairie clover	*Dalea purpurea*	0.480	1.67%	0.075	
Rattlesnake master	*Eryngium yuccifolium*	0.029	0.10%	0.007	
Rosinweed	*Silphium integrifolium*	0.005	0.02%	0.005	
Rough blazing star	*Liatris aspera*	0.022	0.08%	0.004	
Roundhead lespedeza	*Lespedeza capitata*	0.040	0.14%	0.010	
Sawtooth sunflower	*Helianthus grosseserratus*	0.145	0.50%	0.010	
Seedbox	*Ludwigia alternifolia*	1.910	6.65%	0.004	
Sensitive briar	*Mimosa quadrivalvis* var. *nuttalli*	0.005	0.02%	0.008	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.52%	0.100	
Slender lespedeza	*Lespedeza virginica*	0.055	0.19%	0.015	
Slender mountain mint	*Pycnanthemum tenuifolium*	1.944	6.77%	0.014	
Smooth blue aster	*Symphyotrichum laeve*	0.070	0.24%	0.003	
Sneezeweed	*Helenium autumnale*	0.235	0.82%	0.007	
Stiff goldenrod	*Solidago rigida* ssp. *rigida*	0.394	1.37%	0.017	
Sweet black-eyed Susan	*Rudbeckia subtomentosa*	0.327	1.14%	0.020	
Tall bellflower	*Campanula americana*	0.312	1.09%	0.005	
Tall coreopsis	*Coreopsis tripteris*	0.028	0.10%	0.006	
Tickseed sunflower	*Bidens aristosa*	0.140	0.49%	0.047	
White prairie clover	*Dalea candida*	0.319	1.11%	0.050	
White wild indigo	*Baptisia alba*	0.001	0.00%	0.001	
Whorled milkweed	*Asclepias verticillata*	0.004	0.01%	0.001	
Wild bergamot	*Monarda fistulosa*	1.098	3.83%	0.040	
Wild quinine	*Parthenium integrifolium*	0.021	0.07%	0.008	
Yarrow	*Achillea millefolium*	1.309	4.56%	0.020	
	TOTALS	28.716	100.00%	3.425	

KEY: PLS—Pure Live Seed / FT^2—PLS per square foot % OF MIX by PLS / FT^2 WEIGHT—PLS lbs/acre SPP.—Species Richness

Arkansas River Valley Seed Mix

The Arkansas Valley Natural Division separates the Ozark Plateau in the north from the Ouachita Mountains in the south. Due to this valley's large amount of flat land, good soil and water, much of it is large-scale cropland or pasture. Historically, the Arkansas Valley contained large swaths of tallgrass prairie that transitioned to savanna and open woodland as it went up the hills. In contrast to the broad plains, the Arkansas Valley also includes high ridges and mesas, including the state's highest peak, Mount Magazine.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% of Mix	Weight	Spp.
GRASSES	7.316	25.97%	1.760	9
FORBS	20.850	74.03%	1.623	58
Spring-blooming	—	8.57%	—	6
Summer-blooming	—	41.94%	—	32
Fall-blooming	—	23.62%	—	20
TOTALS	28.166	100.00%	3.383	67

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% of Mix	Weight	Notes
Big bluestem	*Andropogon gerardii*	1.136	4.02%	0.300	
Canada wildrye	*Elymus canadensis*	0.262	0.93%	0.100	
Eastern gama grass	*Tripsacum dactyloides*	0.010	0.04%	0.060	
Indiangrass	*Sorghastrum nutans*	1.136	4.02%	0.300	
Little bluestem	*Schizachyrium scoparium*	2.204	7.79%	0.400	
River oats	*Chasmanthium latifolium*	0.103	0.37%	0.050	
Side oats grama	*Bouteloua curtipendula*	1.318	4.66%	0.350	
Tall dropseed	*Sporobolus compositus*	0.872	3.08%	0.050	
Virginia wildrye	*Elymus virginicus*	0.275	0.97%	0.150	
Ashy sunflower	*Helianthus mollis*	0.010	0.04%	0.004	
Bigflower coreoposis	*Coreopsis grandiflora*	0.314	1.11%	0.035	
Black-eyed Susan	*Rudbeckia hirta*	1.085	3.84%	0.030	
Blue wild indigo	*Baptisia australis*	0.005	0.02%	0.009	
Brown-eyed Susan	*Rudbeckia triloba*	0.344	1.22%	0.030	
Butterfly milkweed	*Asclepias tuberosa*	0.212	0.75%	0.132	
Canada milkvetch	*Astragalus canadensis*	0.124	0.44%	0.020	
Cardinal flower	*Lobelia cardinalis*	1.815	6.42%	0.007	
Common boneset	*Eupatorium perfoliatum*	1.058	3.74%	0.016	
Common evening primrose	*Oenothera biennis*	0.474	1.68%	0.015	
Common milkweed	*Asclepias syriaca*	0.185	0.65%	0.125	
Compass plant	*Silphium laciniatum*	0.003	0.01%	0.006	
Culver's root	*Veronicastrum virginicum*	1.355	4.79%	0.005	
Cup plant	*Silphium perfoliatum*	0.005	0.02%	0.009	
Foxglove beardtongue	*Penstemon digitalis*	0.552	1.95%	0.015	
Goat's rue	*Tephrosia virginiana*	0.007	0.02%	0.009	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	/ FT²	% OF MIX	WEIGHT	NOTES
Golden Alexanders	*Zizia aurea*	0.020	0.07%	0.005	
Gray goldenrod	*Solidago nemoralis*	0.301	1.06%	0.013	
Gray-headed coneflower	*Ratibida pinnata*	0.194	0.68%	0.020	
Great blue lobelia	*Lobelia siphilitica*	1.469	5.20%	0.008	
Hoary vervain	*Verbena stricta*	0.702	2.48%	0.055	
Illinois bundleflower	*Desmanthus illinoensis*	0.390	1.38%	0.200	
Indian paintbrush	*Castilleja coccinea*	0.022	0.08%	0.003	
Lanceleaf coreopsis	*Coreopsis lanceolata*	0.862	3.05%	0.170	
Maryland senna	*Senna marilandica*	0.005	0.02%	0.010	
New England aster	*Symphyotrichum novae-angliae*	0.126	0.45%	0.005	
New Jersey tea	*Ceanothus americanus*	0.005	0.02%	0.002	
Obedient plant	*Physostegia virginiana*	0.020	0.07%	0.005	
Ohio spiderwort	*Tradescantia ohiensis*	0.024	0.08%	0.008	
Ox-eye false sunflower	*Heliopsis helianthoides*	0.144	0.51%	0.050	
Pale purple coneflower	*Echinacea pallida*	0.049	0.17%	0.020	
Plains coreopsis	*Coreopsis tinctoria*	0.962	3.40%	0.013	
Prairie blazing star	*Liatris pycnostachya*	0.019	0.07%	0.007	
Purple coneflower	*Echinacea purpurea*	0.266	0.94%	0.100	
Purple prairie clover	*Dalea purpurea*	0.640	2.26%	0.100	
Rattlesnake master	*Eryngium yuccifolium*	0.041	0.14%	0.010	
Rosinweed	*Silphium integrifolium*	0.009	0.03%	0.010	
Rough blazing star	*Liatris aspera*	0.027	0.10%	0.005	
Roundhead lespedeza	*Lespedeza capitata*	0.040	0.14%	0.010	
Sawtooth sunflower	*Helianthus grosseserratus*	0.145	0.51%	0.010	
Seedbox	*Ludwigia alternifolia*	1.433	5.07%	0.003	
Sensitive briar	*Mimosa quadrivalvis* var. *nuttalli*	0.003	0.01%	0.004	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.53%	0.100	
Sky blue aster	*Symphyotrichum oolentangiense*	0.029	0.10%	0.001	
Slender mountain mint	*Pycnanthemum tenuifolium*	1.388	4.91%	0.010	
Smooth blue aster	*Symphyotrichum laeve*	0.047	0.16%	0.002	
Sneezeweed	*Helenium autumnale*	0.202	0.71%	0.006	
Spotted beebalm	*Monarda punctata*	0.100	0.35%	0.003	
Stiff goldenrod	*Solidago rigida* ssp. rigida	0.579	2.05%	0.025	
Tall bellflower	*Campanula americana*	0.250	0.88%	0.004	
Tall coreopsis	*Coreopsis tripteris*	0.046	0.16%	0.010	
Tickseed sunflower	*Bidens aristosa*	0.149	0.53%	0.050	
White prairie clover	*Dalea candida*	0.128	0.45%	0.020	
White wild indigo	*Baptisia alba*	0.005	0.02%	0.008	
Whorled milkweed	*Asclepias verticillata*	0.004	0.01%	0.001	
Wild bergamot	*Monarda fistulosa*	0.961	3.40%	0.035	
Wild quinine	*Parthenium integrifolium*	0.039	0.14%	0.015	
Yarrow	*Achillea millefolium*	1.309	4.63%	0.020	
	TOTALS	**28.166**	**100.00%**	**3.383**	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

Appendix D: Sources of Plant Materials

The following tables list native seed vendors and plant nurseries, provided as a courtesy to clients and planners; listing does not constitute an endorsement or certify acceptable quality of the products sold. The vendor lists were generated from the Lady Bird Johnson Wildflower Center's list of nurseries that can be searched by city, state, or zip code www.wildflower.org/suppliers/ (some offer discounts for members of the wildflower center).

Seeds and plants sourced regionally (seed or original stock from a local source), when planted in appropriate conditions, have a better chance of survival since they are adapted to local climate cycles. Some vendors maintain source records and it is worth inquiring if locally sourced materials are available (they do not always list this information on websites or availability lists).

Native seed or plant availability can vary greatly from year to year, so it is prudent to place orders in advance with a shipping date shortly before the scheduled planting. If planting seeds, it is best to ask that the seeds not be mixed in advance, so that seeds of a similar size or for various moisture or sunlight requirements can be planted separately. Some companies may charge additional fees for custom mixes.

Nurseries may specialize in shrubs, trees, herbaceous plants or seed. Always request pure live and certified seed when available (see Chapter 5).

When receiving financial assistance via NRCS-administered private landowner conservation programs, such as the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), or the Conservation Reserve Program (CRP), always ensure the seeds or plant materials meet conservation practice requirements. Consult with technical specialists at your local NRCS Service Center prior to purchase to determine if the mixes meet the bloom period or program requirements necessary for Arkansas.

USDA NRCS Plant Materials Center

The Booneville Plant Materials Center (PMC) has resources specific to the region www.nrcs.usda.gov/wps/portal/nrcs/publications/plantmaterials/pmc/southeast/arpmc/pub/. The Booneville Plant Materials Center (ARPMC) is co-located with the Agricultural Research Service at the Dale Bumpers Small Farm Research Center six miles south of Booneville Arkansas on State Highway 23. The ARPMC develops plants and plant science technology to address conservation issues in areas from the rugged Ozarks to the western coastal plain. The Center serves portions of Arkansas, Missouri, and Oklahoma.

Planner Note

Not all commercial pollinator mixes are created equal. Always check mixes from commercial sources (premade mixes from big box stores, local farm and feed stores, online ordering sites that are not directly from native seed companies) to ensure that the species included are native to Arkansas and that the mix provides sustained blooming throughout the growing season (i.e., multiple species that bloom per season in the growing period). Also check to make sure that annuals and biennials do not make up more than 15% of the mix. Some have been seen to be over 50% annual species, which will greatly reduce the diversity and abundance of perennial plants over time. Many of these over the counter mixes also contain non-native species that should not be used. These mixes can cause issues because they do not meet program requirements and will cause more time, effort, and money to be expended by the landowner to correct it.

Seed and Plant Vendors

There are many Arkansas and regional nurseries that provide native plants and seeds. Some natives are more expensive than some non-native horticultural species, depending on availability, growth needs (slower growing plants may cost more). Many, particularly among shrubs and trees, have long been available from conventional nurseries and are relatively inexpensive. It is important to compare prices and attempt to obtain plants from providers within your USDA climate zone and ensure that the stock is hardy for the area planned. Consider species, stock types, sizes, and prices when deciding upon the plants to purchase. One of the most useful tools for locating and finding local nurseries is found here: www.findnurseries.com. A simple internet search will yield additional native seed and nursery sources.

Below are lists of regional seed producers and plant producers (including a plant broker), as well as gardens and a sanctuary that showcase native plants. Seed producers are grouped together, while plant producers are grouped by state. The list of growers includes those from Arkansas and surrounding states: Kansas, Kentucky, Louisiana, Missouri, Mississippi, Oklahoma, Tennessee, and Texas. The percent of a vendor's stock that is native is included when such information was available.

Seed Vendors

Not all of the seed companies listed below will have every species found in the recommended seed mixes. Some sell non-native species (do not allow them to sell you non-native seed for NRCS programs).

Bamert Seed Company
1897 Cr 1018, Muleshoe, TX 79347
800-262-9892 | www.bamertseed.com
Retail, Wholesale | Percent native: 75% | Region: Southwest

De Lange Seed, Inc.
P.O. Box 7, Girard, KS 66743
620-724-6223 | www.delangeseed.com
Retail, Wholesale | Percent native: 25% | Region: Midwest

Feyh Farm Seed Co.
26401 Fairfield Rd, Alma, KS 66401
785-765-3415 | www.feyhfarmseed.com
Retail, Wholesale | Percent native: 75% | Region: Midwest

Hamilton Native Outpost*
16789 Brown Road, Elk Creek, MO 65464
417-967-2190 | www.hamiltonseed.com
Retail, Wholesale | Percent native: 100% | Region: Midwest

Heartland Seed of Missouri*
113 Welch Rd, Eolia, MO 63344
866-476-7999 | www.heartlandseed.com
Retail, Wholesale | Percent native: 100% | Region: Midwest

Johnston Seed Co.
319 West Chestnut, P.O. Box 1392, Enid, OK 73702
800-375-4613 .(580) 233-5800
www.johnstonseed.com
Retail, Wholesale | Region: Southwest

Kansas Native Plants*
6800 SW Fountaindale Rd, Topeka, KS 66614
785-806-6917
www.kansasnativeplants.com
Percent native: 100% | Region: Midwest

Lick Skillet Seeds, Inc.
22324 State Hwy HH, Gallatin, MO 64640
660-663-3095 | www.lickskilletseeds.com
Retail, Wholesale | Percent native: 25% | Region: Midwest

Missouri Wildflower Nursery*
9814 Pleasant Hill Road, Jefferson City, MO 65109
573-496-3492 | www.mowildflowers.net
Retail, Wholesale | Percent native: 100% | Region: Midwest

Native American Seed
PO Box 285, Junction, TX 76849
800-728-4043 | www.seedsource.com
Retail, Wholesale | Percent native: 100% | Region: Southwest

Pheasants Forever and Quail Forever Habitat Store
Lincoln, IL 68516, 844-733-3669 | www.pfhabitatstore.com
Retail, Wholesale | Percent native: 100% | Region: Midwest, Southeast, Northern

Pure Air Natives, Inc.
4630 West Florissant Ave., St. Louis, MO 63115
636-357-6433 | www.pureairnatives.com
Retail, Wholesale | Percent native: 100% | Region: Midwest

Roundstone Native Seed, LLC*
9764 Raider Hollow Road, Upton, KY 42784
270-531-3034 | www.roundstoneseed.com
Retail, Wholesale | Percent native: 100% | Region: Southeast

Sharp Bros. Seed Co.
202 S. Sycamore, Healy, KS 67850
800-462-8483. (620) 398-2231
www.sharpseed.com
Retail, Wholesale | Percent native: 50% | Region: Midwest

Star Seed, Inc.
101 Industrial Ave., Osbourne, KS 67473
800-782-7311 | www.gostarseed.com
Retail, Wholesale | Percent native: 75% | Region: Midwest

Turner Seed Co.
211 County Road 151, Breckenridge, TX 76424
800-722-8616 | www.turnerseed.com
Retail, Wholesale | Percent native: 50% | Region: Southwest

Plant Vendors

(organized by state, then alphabetically by name)

Izel Plants
410-989-3721 | www.izelplants.com
Izel Plants is a wholly online company that brokers landscape plugs for restoration plantings, so is not included within a specific state.
Percent native: 100% | Region: Mid-Atlantic

Arkansas

Arkansas Department of Agriculture/ Baucum Nursery
1402 Hwy 391 N, North Little Rock, AR 72117
501-907-2485 | www.aad.arkansas.gov/order-seedlings
Percent native: 75% | Region: Southeast
Sells tree and shrub seedlings

Pine Ridge Gardens
832 Sycamore Rd., London, AR 72847
501-293-4359 | www.pineridgegardens.com
Retail, Wholesale | Percent native: 100% | Region: Southeast

* Sells seed packets to be used in a garden setting

Kansas

Grimms Gardens, LLC
2991 Goldfinch Rd, Hiawatha, KS 66434
888-459-2586 | www.grimmsgardens.com

Retail | Percent native: 10% | Region: Midwest

Kansas Forest Service
2610 Claflin Rd., Manhattan, KS 66502-1798
785-532-3300 | www.kansasforests.org

Percent native: 75% | Region: Midwest
Sells bareroot and containerized tree and shrub seedlings

Kentucky

Ironweed Native Plant Nursery
203 S. High St., Columbia, KY 42728
270-384-1352 | www.ironweednursery.com

Retail, Wholesale | Percent native: 75% | Region: Mid-Atlantic

Kelly Nursery LLC
1800 East Hickman Rd, Nicholasville, KY 40356
859-333-3794 | www.kellynurseryllc.com

Wholesale only | Percent native: 25% | Region: Mid-Atlantic

Missouri

Easywildflowers
PO Box 522, Willow Springs, MO 65793
417-469-2611 | www.easywildflowers.com

Retail | Percent native: 100% | Region: Midwest

Missouri Department of Conservation/ George O. White State Forest Nursery
14027 Shafer Road, Licking, MO 65542
573-674-3229 | www.mdc.mo.gov/trees-plants/tree-seedlings/about-missouris-state-forest-nursery

Percent native: 75% | Region: Midwest
Sells tree and shrub seedlings

Missouri Wildflowers Nursery LLC
9814 Pleasant Hill Rd, Jefferson City, MO 65109
573-496-3492 | www.mowildflowers.net

Retail | Percent native: 100% | Region: Midwest

Prairie Hill Farm
877 CR 263, Auxvasse, MO 65231
573-387-4680 | www.prairiehillfarm.biz/

Wholesale | Percent native: 75% | Region: Midwest

Forrest Keeling Nursery, Inc.
P.O. Box 135, 88 Forrest Keeling Ln., Elsberry, MO 63343
800-356-2401 | www.fknursery.com

Wholesale | Percent native: 75% | Region: Midwest
Primarily sells trees and shrubs

Tennessee

Blankenship Farms and Nursery
1151 Petigap Rd, McMinnville, TN 37110
931-205-9783 | www.blankenshipfarmsandnursery.com

Wholesale | Percent native: 50% | Region: Southeast
Sells container trees and shrubs

Hillis Nursery Co., Inc.
92 Gardner Rd, McMinnville, TN 37110
931-668-4364 | www.hillisnursery.com

Wholesale | Percent native: 25% | Region: Southeast

Texas

Countryside Trees
290 Meadow Glade, San Antonio, TX 78227
210-674-1693 | www.countrysidetrees.com

Retail, Wholesale | Percent native: 50% | Region: Southwest
Sells container oak trees

Eco Blossom Nursery
3037 Joyce Dr, Fort Worth, TX 76116
817-720-5970 | www.ecoblossom.com

Retail | Percent native: 50% | Region: Southwest

Regional Native Plant Gardens/Arboreta

Ozark Native Garden
% Botanical Gardens of the Ozarks
4703 N. Crossover Road, Fayetteville, AR 72764
479-750-2620 | www.bgozarks.org/

Retail (annual plant sale) | Percent native: <75% | Region: Southeast

Crosby Arboretum
370 Ridge Road, Picayune, MS 39466
601-799-2311 | www.crosbyarboretum.msstate.edu

Retail | Percent native: 75% | Region: Southeast

Heard Natural Science Museum & Wildlife Sanctuary
1 Nature Place, McKinney, TX 75069
972-562-5566 | www.heardmuseum.org

Retail | Percent native: 75% | Region: Southwest

Lady Bird Johnson Wildflower Center
4801 La Crosse Ave., Austin, TX 78739
512-232-0100 | www.wildflower.org/

Retail | Percent native: 100% | Region: Southwest

Appendix E: Herbicide Residual Times

Herbicides[*]* and the number of months needed before planting pollinator habitat after the last herbicide application:

Anthem ..... 18 months

Authority Assist ..... 30 months

Callisto ..... 18 months

Dicamba ..... 4 months

Dual II Magnum ..... 12 months

Extreme ..... 40 months

FirstRate ..... 18 months

Flexstar GT 3.5 ..... 18 months

Glyphosate ..... 0 months

Hornet WDG ..... 26 months

Impact ..... 18 months

Liberty 280 SL ..... 6 months

OpTill or OpTill PRO ..... 40 months

Outlook ..... 4 months

Princep 4L ..... 18+ months

Pursuit ..... 40 months

Starane Flex ..... 12 months

Stinger ..... 18 months

Surestart ..... 26 months

* This herbicide summary is incomplete and does not contain all of the pre- and post-emergent herbicides that will have a negative impact on the establishment of pollinator habitat.

Appendix F: Common & Specialist Bees of Arkansas

The following table outlines bee genera that could be found in Arkansas. Individual life history details for certain species may vary from the general genus-level characteristics described here. This list provides planners and clients a general overview of native bees. For those interested in learning more about the bees on their land or in their communities, BugGuide.net and the apps iNaturalist and Seek by iNaturalist are excellent tools for identification. Any photographs you share with those projects will help to document bee diversity in Arkansas and could help improve future conservation planning.

Appendix F Notes:

1. Panurgine bees (members of the subfamily Panurginae) are often smaller, less hairy, and bearing yellow or cream markings on various parts of their bodies.
2. "Pseudo" meaning false + Panurgus (an Old World genus colloquially referred to as "shaggy bees" in English across Europe—see Templ et al 2019, Falk 2019, or iNaturalist 2020)
3. Subsocial means that females remain with developing brood.
4. All male bees have one extra antennal segment, but in "long-horned" bees, the male antennae are elongated. Males use their antennae like noses to find females.
5. A Cleptoparasite, A.K.A. "cuckoo" bee, is a nest parasite, laying eggs in the brood cells of other bees.
6. All Megachilidae except the cleptoparasitic species have pollen-carrying hairs on their belly—most other bees have pollen-carrying hairs on their legs. Carrying pollen on the abdomen may make depositing pollen in a narrow cavity easier.
7. Often abundant when found (but rarely seen).

FAMILY	GENUS	NESTING | SOCIALITY | TIMING | ABUNDANCE	COMMON NAME	DESCRIPTION & NOTES
ANDRENIDAE Andrenid, Mining, or Miner Bees	*Andrena*	Ground | Solitary & Communal | All season (mostly Sp) | Abundant	Andrenid or mining bees	This genus comprises close to ⅛ of the species in eastern North America, with more than 60 in AR. Important pollinators of early spring flowering crops like apple, blueberry, and plum.
	Anthemurgus	Ground | Solitary, but gregarious | Late Sp & Su | Local	Passion-flower bees	Only one species in North America, *A. passiflorae*, pollen specialist of yellow passion-flower, *Passiflora lutea* (where mating occurs).
	Calliopsis	Ground | Solitary, but gregarious | Su | Abundant	Mining, panurgine[1], or calliopsine bees	Often have yellow or white markings on their faces and hairy bodies. Males have yellow legs. Most are pollen specialists.
	Panurginus	Ground | Solitary, but gregarious | Sp | Rare	Panurgine, mining, or confluent-miner bees	Tiny. Small, dark, with yellow on the faces and legs of some males. May confuse with *Calliopsis*, but not hairy. Many are pollen specialists. Some nest in large aggregations.
	Perdita	Ground | Solitary | Su & Fa | Local	Mining, panurgine[1], or fairy bees	Tiny, with light markings between eyes, few hairs. Nest in very sandy habitats. Includes the smallest bee in N. America. The name means "lost," possibly reflecting difficulty in keeping track of such tiny bees.
	Protandrena	Ground | Solitary & Communal | Su | Local	Mining, panurgine[1], protandrenine, or bare-miner* bees	Somewhat large for Panurginae subfamily (up to 0.5"), with yellow markings on face, legs, and thorax, little hair. Some specialists. Some nest aggregation. Found only in the Americas.
	Pseudopanurgus	Ground | Solitary | Fa | Rare	Mining, panurgine[1], or false shaggy bees[2]	Tiny, sparse body hair. Males with bright yellow faces below antennae (on clypeus). Often aggregate nests.
APIDAE Bumble, Carpenter, Honey, Longhorned, and Squash Bees	*Anthophora*	Wood & ground | Solitary | Sp & Su | Local	Anthophorid, chimney, miner, or digger bees	Can resemble small bumble bees, but females have hairier hind legs and males have white face patches. Females often aggregate nests. Come evening, males often sleep in aggregations on plants.
	Apis	Hives | Social | All season | Abundant	Honey bees	*A. mellifera* is the only *Apis* species in U.S. and most important managed bee in U.S. Non-native, introduced from Europe. "Apis" is Latin for bee."Melli" and "ferre" are Greek for honey and to bear (carry).
	Bombus	Rodent burrows, large cavities | Social | All season | Abundant	Bumble bees	Name from Greek for "buzzing sound." Among the most effective pollinators, with about 8 species documented in AR. The endangered rusty patched (*B. affinis*) is found in AR (first bee to be listed as endangered in the continental U.S.).
	Ceratina	Stems (old wood with existing cavity) | Solitary & Subsocial[3] | All season | Abundant	Small carpenter bees	Squarrish rump, very dark blue or green coloration, and relatively few hairs make somewhat easy to recognize to genus. Females guard nest cells and check on developing brood (young).
	Eucera	Ground | Solitary | Su & Fa | Common	Long-horned[4] or sunflower bees	Often associated with sunflowers and related species. Relatively chunky bodies with very hairy legs (described as looking like "chaps.")
	Habropoda	Muddy streambanks | Solitary | Sp | Local	Southeastern blueberry bee	*H. laboriosa* is the only species in AR. A specialist on heath (blueberry, huckleberry, and cranberry). Locally abundant near those flowers. Look similar to bumble bees, but males with white patches on their faces. May confuse with *Anthophora*, but active only in early spring when blueberry is in flower.
	Melissodes	Ground | Solitary | Su & Fa | Common	Long-horned[4] bees	Often associated with sunflowers and related species. Males sometimes form sleeping aggregations, clustering together on a plant stem. Females often in large nest aggregations.
	Melitoma	Ground | Solitary | Su | Local	Mallow or chimney bees	Pollen specialist of native morning glories, *Ipomoea* spp. They moisten soil when excavating nests and create small "chimneys' of mud around nest entrance. Easy to recognize at host flower due to distinctive black/white striped abdomen.
	Nomada	Cleptoparasite[5] | N/A | All season | Abundant	Nomad cuckoo bees	Targets primarily *Andrena*, also parasitizes *Agapostemon*, *Eucera*, and *Melitta*. Usually black and yellow, hairless and wasp-like in appearance.
	Peponapis	Ground | Solitary | Su | Common	Squash bees	Specialize on cucurbits (squash, pumpkin, cucumber, melon) pollen. Females nest near host plants and males often sleep in the flowers (that generally close by noon).
	Ptilothrix	Ground | Solitary | Su | Common	Rose mallow, hibiscus, hibiscus turret, okra, cotton, or eastern digger bee	(*P. bombiformis*) is the only species east of the Mississippi. Specialize on mallow family flowers. Form nests like *Melitoma* (chimneys). Easy to recognize on host flowers. Closely resemble bumble bees, but do not have pollen baskets (corbiculae).
	Svastra	Ground | Solitary | Su | Common	Long-horned[4] or sunflower bees	Often associated with sunflowers and related species. Similar in appearance to *Eucera*.
	Triepeolus	Cleptoparasite[5] | N/A | Su & Fa | Local	Cuckoo nomad bees	Targets diverse bees (mainly in the Apidae family) with very short hairs forming beautiful and distinctive black and white patterns. Resemble wasps.
	Xenoglossa	Ground | Solitary | Su | Common	Squash or large squash bees	Like *Peponapis* in appearance, foraging, and nesting—but their bodies may be stouter. Starts foraging as early as 4 a.m. Male has more pronounced yellow marking on his face than *Peponapis* male.
	Xylocopa	Wood (western species use other sites) | Nest sharing | All season | Common	Large carpenter bees	The eastern carpenter bee (*X. virginica*) is the only species in AR. Larger eyes and "shiny hinies" vs. bumble bees. Carry pollen on long hairs (vs. bumble bees in a pollen basket that creates a large lump of pollen). Social behaviors include mothers feeding offspring, and overwintering together.
COLLETIDAE Collectid, Cellophane, Plasterer, or Masked Bees	*Colletes*	Ground | Solitary | All season | Common	Polyester or cellophane bees	Nests are lined with a waterproof cellophane-like glandular secretion. Females leave soupy-like provisions (carried in their crop) rather than a dry ball of pollen and nectar for their young. Often hairy and nesting in aggregations.
	Hylaeus	Stems & ground | Solitary | Su | Common	Yellow-faced or masked bees	Typically very small, wasp-like in appearance without many hairs (they carry pollen and nectar in their stomachs). Species in this genus were the first bees to be listed as endangered in the U.S. (in Hawaii). Name means "of the woods" where they nest (in beetle tunnels and pithy plant stems), as well as rocky and earthen banks, lining cells with cellophane like materials (like *Colletes*).

KEY: NESTING Site | SOCIALITY | TIMING—Time of Year: Spring (Sp), Summer (Su), Fall (Fa) | ABUNDANCE

Appendix F: Common & Specialist Bees of Arkansas CONTINUED

FAMILY	GENUS	NESTING | SOCIALITY | TIMING | ABUNDANCE	COMMON NAME	DESCRIPTION & NOTES
HALICTIDAE Halictid or Sweat Bees	*Agapostemon*	Ground | Communal & Solitary | All season | Common	Metallic green striped-sweat bees	Easy to identify those with green thorax and black abdomen with white (male) or yellow (female) stripes. In 3 spp., the females are all green.
	Augochlora	Wood (under bark, in rotting dead wood) | Solitary | Sp & Su | Common	Metallic green sweat bees	The pure green sweat bee (*A. pura*), is the only species documented in AR. May have 2 or 3 generations in one year (seen all summer).
	Augochlorella	Ground | Social | All season | Common	Metallic green sweat bees	Generations overlap, with one queen each generation, and daughters helping provision nest cells.
	Augochloropsis	Ground | Nest sharing | Su | Local	Metallic green sweat bees	Among the most spectacular of the metallic green sweat bees—shiny green tinged with blue, violet, and gold.
	Halictus	Ground | Social & Solitary | All summer | Abundant	Halictid, sweat, or furrow bees	May nest as solitary individuals or in colonies depending on environmnetal conditions (floral abundance and temperature may play a role). Males may form sleeping aggregations, clustering together on a plant stem.
	Lasioglossum	Ground | Communal & Social | All season | Abundant	Sweat or base-banded furrow bees	Large genus with many common species, but often overlooked due to their small size.
	Sphecodes	Cleptoparasite[5] | N/A | All season | Abundant	Cuckoo or blood bees	Targets primarily other Halictidae, also parasitizes *Andrena*, *Colletes*, and *Perdita*. Usually with red abdomen, hairless and wasp-like in appearance.
MEGACHILIDAE[6] Megachilid, Chimney, Leafcutter, Mason, Resin, and Woolcarder Bees	*Anthidium*	Wood, plant stems, or ground | Solitary | Sp & Su | Uncommon	Woolcarder bees	Females collect plant hairs for nesting. Males are very territorial. Two are introduced species. Distinct yellow and black coloration.
	Anthidiellum	Plant stems | Solitary | Su | Uncommon	Resin bees	Many construct nest cells of resin on the outside of twigs. Resemble *Anthidium*, but are smaller.
	Chelostoma	Wood & stone cavities | Solitary | Su | Common	Leafcutter, resin, mason, and scissor bees	Though 3 spp. found east of the Missisippi, one documented in the region, *C. californicum*. Black and slender (elongated thorax). Pollen specialists, but visit diverse flowers for nectar.
	Coelioxys	Cleptoparasite[5] | N/A | Su | Common	Cuckoo leafcutter or sharp-tailed bees	Targets primarily *Megachile*. Closely resemble *Megachile*, but the tip of their abodomen is pointy and may have other defensive protrusions on other areas of their bodies. The name *Coelioxys* comes from Greek for "sharp belly."
	Heriades	Wood & stone cavities | Solitary | Su | Uncommon	Resin bees	Somewhat easy to recognize from two features of their abdomens: noticeable ridges on top and a tendency to tuck ("j" shape).
	Hoplitis	Wood, stone cavities, masonry | Solitary | Su | Local	Small or lesser mason bees	Like other "mason" bees, they use diverse locations and materials for nesting, including pebbles or plant materials. Relatively small (usually <0.5") ranging in color from black to metallic green. Some pollen specialists.
	Megachile	Wood, ground, & stone cavities | Solitary | Su | Local	Leafcutter bees	Some spp. clip circular leaf or petal sections to line their nests, and to seal off nest entrances. Relatively large heads hold the large leaf-cutting mandibles.
	Osmia	Wood & stone cavities | Solitary | Sp & Su | Abundant	Mason, blue orchard, or leafcutter bees	Nest entrances closed with mud or masticated leaf pieces. One native species, the blue orchard bee (*O. lignaria*), is "managed" (nest materials provided and pupae collected for release each year by fruit growers).
	Paranthidium	Ground | Solitary | Su | Rare	Resin or anthidiine bees	Only one species (*P. jugatorium*) is found in N. America. Easy to recognize by bold black and yellow coloration along with pollen-filled abdominal hairs (on females). Similar in appearance to woolcarder bees, but smaller. Often forage on aster family flowers. Sometimes place pebbles between resin walls separating cells.
	Stelis	Cleptoparasite[5] | N/A | Su | Uncommon	Cuckoo or dark bees	Targets diverse bees, mainly in the Megachilidae family. Unlike other cuckoo bees, their thorax may be relatively hairy. Dark metallic blue or green to black, with ivory, yellow, or white markings on their abdomens.
MELITTIDAE Melittid Bees	*Macropis*	Ground | Solitary | Su | Local	Yellow loosestrife bees	Specialize on loosestrife (*Lysimachia* spp.), flower oils and pollen, carrying very large loads on their legs.
	Melitta	Ground | Solitary | Sp | Rare[7]	Melittid bees	Name from Greek for "honey" and "small." Many pollen specialists on distantly related flowers, but those in this region are all heath family specialists, on blueberry and deerberry (*Vaccinium* spp.) and staggerbush or maleberry (*Lyonia* spp.).

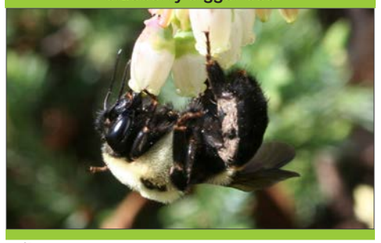
KEY: NESTING Site | SOCIALITY | TIMING—Time of Year: Spring (Sp), Summer (Su), Fall (Fa) | ABUNDANCE

References: Ascher & Pickering 2020; Bartlett 2003; LeBuhn 2012; Moisset 2010; Packer et al. 2007; Wilson & Carril 2015; Templ et al. 2019; Falk 2019; iNaturalist 2020; Vaughan et al. 2015; Cane 1994; Cane 1997; USDA–NAL 2015; BugGuide 2020; Simpson 2010. Note: Information revised by Nancy Lee Adamson and Sara Morris referring primarily to Wilson and Carril (2015). Original table by Harry W. Godwin / USDA-ARS Appalachian Farming System Research Center and Eric Lee-Mader / The Xerces Society) for the West Virginia NRCS Pollinator Handbook (2012).

Figure 57—***left to right:*** Bees documented in Arkansas recently include the sweat bees (*Halictus ligatus*) and (*Agapostemon splendens*), both in the Halictidae family and relatively common. The northern rotund-resin bee (*Anthidiellum notatum*) is in the leafcutter family, Megachilidae, whose females can be recognized by the pollen carrying hairs (scopa) on their bellies (other bees have scopal hairs on their legs). Leafcutter bees also have relatively large heads since they use their jaws to cut leaves or collect plant hairs for their nests. (Photos: Coleman Z. Little, University of Central Arkansas.)

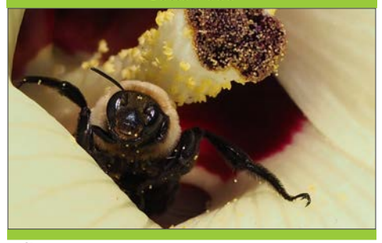
Figure 58—***Specialist Bees of Arkansas Crops:*** The majority of bees—including the social species—are **generalists** that gather nectar and pollen from a wide range of flower types and species. **Specialist bees** rely on a single plant species, or a closely related group of plants, for pollen. Because these specialists have co-evolved with their host plants, their life cycles are often closely tied (adults emerge when the plants are flowering) and they are sometimes the most effective pollinators for their hosts. Below are three important specialist bees that may be found pollinating Arkansas crops.

BLUEBERRY BEE (*Habropoda laboriosa*)
A.K.A. Southeastern blueberry bee, blueberry digger bee



Vaccinium spp.—a single female may be responsible for up to 6,000 blueberries | Deep, well-drained, sandy soil | May be the most abundant pollinators seen on blueberry flowers. (Photo: Jolie Goldenetz-Dollar, Xerces Society.)

OKRA BEE (*Ptilothrix bombiformis*)
A.K.A. hibiscus bee, rosemallow bee, cotton bee



Mallow or hibiscus family—common pollinators of okra and cotton | Hard-packed soil near a water source—such as roads and levees | They may be locally abundant. (Photo: Nancy Lee Adamson.)

SQUASH BEES (*Peponapis pruinosa*[1] & *Xenoglossa* spp.[2]) A.K.A. eastern cucurbit bee[1] & large squash bee[2]

Cucurbitae—squash, pumpkin, cucumber, musk melons, watermelon | Females frequently nest in the ground 6–12" directly underneath host plants | They may be locally abundant. (Photo: Susan Ellis, Bugwood.org.)

Appendix G: Additional Literature by Subject

Following are additional references that may be of interest for pollinator and other wildlife habitat planning and conservation in Arkansas and the surrounding region.

Arkansas Agriculture, Crop and Soil

An Ozark Culinary History: Northwest Arkansas Traditions from Corn Dodgers to Squirrel Meatloaf
www.arkansasonline.com/news/2019/jan/05/honey-seller-faults-dicamba-in-closing-/

Arkansas specialty crop industry: economic contribution and characteristics
https://cpb-us-e1.wpmucdn.com/wordpressua.uark.edu/dist/9/350/files/2018/06/Spec.-Crop-Report_ResearchReport_final_lae_COVER-tb270l.pdf

Arkansas is sesame savvy
www.farmflavor.com/arkansas/arkansas-ag-products/sesame-savvy/

Sesame opens up possibilities for non-irrigated land
www.uaex.edu/media-resources/news/docs/07-12-2013-Sesame-opens-up-possibilities.pdf

Spiders of the Arkansas cotton field
Whitcomb et al. 1963. *Annals of the Entomological Society of America* 56(5):653-660.

Arkansas IPM/Conservation Biocontrol

Quantifying the impact of excluding insecticide classes from cotton Integrated Pest Management Programs in the US Mid-South.
North et al. 2018. *Journal of Economic Entomology* 112(1):341-348.

Arkansas Natural History

Arkansas butterflies and moths, 2nd Ed
Spencer & Simons 2014. University of Arkansas Press.

Bobwhite quail populations declining across Arkansas
www.farmprogress.com/bobwhite-quail-populations-declining-across-arkansas

Bringing Back Bobwhites: A Landowner's Guide, MP506
www.uaex.edu/publications/pdf/MP506.pdf

Bumble bees of Arkansas (Hymenoptera, Apidae, Bombinae)
https://scholarworks.uark.edu/cgi/viewcontent.cgi?article=3108&context=jaas

The bumble bees (Hymenoptera: Apidae: *Bombus*) of Arkansas, fifty years later
https://pdfs.semanticscholar.org/4e0f/20b33d767e121df0ecda9ec29c0f910a6800.pdf

Checklist of bees (Hymenoptera: Apoidea) from managed emergent wetlands in the lower Mississippi Alluvial Valley of Arkansas
doi:10.3897/BDJ.6.e24071

Endemic flora and fauna of Arkansas
https://scholarworks.uark.edu/cgi/viewcontent.cgi?referer=https://scholar.google.com/&httpsredir=1&article=2572&context=jaas

Ozark forest forensics
Pallet & Stephenson 2019. The Ozark Society.

Habitat Assessment

Arkansas Wildlife Habitat Evaluation Guide for Pollinators
https://efotg.sc.egov.usda.gov/references/public/AR/AR_Pollinator_WHEG_fillable_form.pdf

Pollinator Habitat Assessment Guides
https://www.xerces.org/publications/hags

Habitat Management and Plant Materials

Attracting Native Pollinators
Mäder et al. 2011. Storey Publishing. North Adams, MA.

Conservation Security Program Job Sheet: *Nectar Corridors*, Plant Management EPL 41
https://plants.usda.gov/pollinators/Plant_Management_for_Nectar_Corridors_EPL41.pdf

Creating native landscapes in the Northern Great Plains and Rocky Mountains
www.mt.nrcs.usda.gov/technical/ecs/plants/xeriscp/

Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms. 3rd Ed
www.xerces.org/publications/guidelines/farming-for-bees

Farming with Native Beneficial Insects: Ecological Pest Control Solutions
Lee-Mäder 2014. Storey Publishing.

Habitat Planning for Beneficial Insects: Guidelines for Conservation Biological Control
www.xerces.org/publications/guidelines/habitat-planning-for-beneficial-insects

Nesting & Overwintering Habitat for Pollinators & Other Beneficial Insects
https://www.xerces.org/publications/fact-sheets/nesting-overwintering-habitat

***Plant Species with Rooting Ability from Live Hardwood Materials for Use in Soil Bioengineering Techniques* (Technical Note-No. 1, Plant Materials Program)**
www.plant-materials.nrcs.usda.gov/pubs/mipmctn7266.pdf

Technical Reference 1730-3. *Landscaping with Native Plants of the Intermountain Region*
https://idahonativeplants.org/Guides/cover_p7.pdf

Natural History

A Field Guide to Eastern Butterflies
Opler & Malikul 1998. Peterson Field Guide Series. New York: Sponsored by the National Audubon Society, the National Wildlife Federation and the Roger Tory Peterson Institute, 1992 and 1998.

Discover Life bee species guide and world checklist (Hymenoptera: Apoidea: Anthophila)
www.discoverlife.org/mp/20q?guide=Apoidea_species

***How to Know the Beetles*, 2nd Ed**
Arnett et al. 1981. William C Brown Publishers, Dubuque, IA.

Tropical Deforestation Alters Hummingbird Movement Patterns
Hadley & Betts 2009. Department of Forest Ecosystems and Society, Oregon State University, Corvallis, OR.

Pasture and Rangeland Management/Forage (Cover) and Field Crops

PB378 Forage & Field Crop Seeding Guide for Tennessee
http://trace.tennessee.edu/utk_agexcrop/41

Rangeland Management for Pollinators
Black et al. 2011. *Rangelands* 33(3):9-13.

Pesticides and Non-Target Impacts

Impacts of agricultural herbicide use on terrestrial wildlife in temperate landscapes: a review with special reference to North America
Freemar & Boutin 1995. *Agriculture, Ecosystems & Environment* 52(2-3):67-91.

Non-target effects of pesticides on organisms inhabiting agroecosystems.
http://dx.doi.org/10.3389/fenvs.2019.00075

Toxicity of Insecticide-Contaminated Soil Used in the Treatment of Cotton Seeds to Bees
de Souza et al. 2018. *Journal of Agricultural Science* 10(10):189–196.

Plant Species Lists

Home gardening series: Carrots
www.uaex.edu/publications/PDF/FSA-6064.pdf

Native plants for your Arkansas Garden
www.naturalheritage.com/_literature_128296/Native_Plants_for_Your_Arkansas_Garden

Forage and biomass planting
www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1080494.pdf

***Melitara prodenialis* Walker on prickly pear in Arkansas**
Carlton & Kring 1994. *The Southwestern Entomologist* 19(1):23-31.

Field guide to the broad-leaved herbaceous plants of South Texas used by livestock and wildlife
Everitt et al. 1999. Texas Tech University Press, Lubbock.

Pollen Specialist Bees of the Eastern United States
https://jarrodfowler.com/specialist_bees.html

Shrubs and the pollinators who love them
Gagliardi & Walker 2018. *Arnoldia* 75(4):17-28.

Atlas of the Vascular Plants of Arkansas
Gentry et al. 2013. University of Arkansas Herbarium, Fayetteville.

Southeastern Flora (southeastern US plant identification website)
www.southeasternflora.com/

HOSTS: Database of the world's Lepidopteran hostplants
www.nhm.ac.uk/our-science/data/hostplants/search/index.dsml

Trees, Shrubs, & Vines of Arkansas
Hunter 2000a. University of Arkansas Press.

Wildflowers of Arkansas
Hunter 2000b. University of Arkansas Press.

The Biota of North America Program (BONAP)
http://bonap.net/napa

Growing alfalfa in the south
www.alfalfa.org/pdf/alfalfainthesouth.pdf

Recommended Species Lists: Plants for Pollinators
Lady Bird Johnson Wildflower Center. Lists provided by the Xerces Society and Butterflies and Moths of North America (BAMONA). www.wildflower.org/collections

***Celastrus scandens* L. American bittersweet**
https://data.fs.usda.gov/research/pubs/iitf/iitf_gtr026.pdf

***Hamamelis vernalis* (Ozark witch hazel)—a Pollination Paradox**
https://monativeplants.org/wp-content/uploads/petal-pusher/PP-33-5-2018-09.pdf

Native Seed Network
www.nativeseednetwork.org

Alternative field crops manual: Meadowfoam
https://hort.purdue.edu/newcrop/afcm/meadowfoam.html

The muscadine grape: botany, viticulture, history, and current industry
Olien 1990. *HortScience* 25(7):732-739.

Alternative field crops manual: Chickpea
https://hort.purdue.edu/newcrop/afcm/chickpea.html

A review of research needs for pollinators in managed conifer forests
https://doi.org/10.1093/jofore/fvy052

Chickling vetch (*Lathyrus sativus*)
www.southwestseed.com/cover-crop/chickling-vetch/

The PLANTS Database
USDA, NRCS. http://plants.usda.gov

Appendix H: Additional Information

Information on pollinator habitat conservation is available from diverse sources. Arkansas NRCS staff is required to utilize only approved technical information provided by state staff and located within the Field Office Technical Guide (FOTG) https://efotg.sc.egov.usda.gov/#/. Contact the NRCS state staff if there are questions regarding the information's applicability to Farm Bill programs or conservation planning.

Arkansas USDA NRCS: www.ar.nrcs.usda.gov

Arkansas State Resource Assessment (www.bit.ly/ARNRCSResourceAssessment)

For private landowners and agency staff, support for various aspects of pollinator habitat may be obtained by contacting individuals responsible for technical or programmatic support. It is always best to start with the most local of contacts to ensure that the information provided is accurate. Non-NRCS personnel should always contact the local NRCS field office and/or the USDA Service Center.

Arkansas NRCS Local and State Technical Support

CONTACT	TITLE	AGENCY	LOCATION	INFORMATION
—	Local NRCS Conservationist	NRCS	Local USDA Service Center	www.ar.nrcs.usda.gov Click on "Contact Us"
James Baker	NRCS State Biologist	NRCS	Little Rock, AR	(501) 301-3142
Troyce Barnett	NRCS State Agronomist	NRCS	Little Rock, AR	(501) 301-3175
Ryan Diener	Partner Biologist/Arkansas Quail Forever State Coordinator	NRCS/Quail Forever	Little Rock, AR	(501) 301-3129
Leslie Cooper	Partner Biologist/Arkansas Monarch & Pollinator Coordinator	NRCS/Quail Forever	Little Rock, AR	(501) 301-3169

Arkansas NRCS Farm Bill Programmatic Support

Support for various Farm Bill questions may be addressed by:

AGENCY	PROGRAM	CONTACT	LOCATION	INFORMATION
Natural Resources Conservation Service (NRCS)	Environmental Quality Incentives Program (EQIP)	State Program Managers	Little Rock, AR	www.ar.nrcs.usda.gov
	Conservation Stewardship Program (CSP)			
	Agricultural Conservation Easement Program (ACEP)			
Farm Services Agency (FSA)	Conservation Reserve Program (CRP)	State Program Manager	Little Rock, AR	www.fsa.usda.gov
Arkansas Natural Heritage Commission (ANHC)	Natural Areas	Habitat Coordinator	Little Rock, AR	www.naturalheritage.com/

Regional Technical Support

AGENCY	CONTACT	LOCATION	INFORMATION
USDA-NRCS Central National Technology Support Center	Ray Moranz, Grazing Lands Pollinator Ecologist	Stillwater, OK	www.nrcs.usda.gov/wps/portal/nrcs/main/national/cntsc

Regional staff should be contacted by state staff

USDA Pollinator Resources

USDA-NRCS Pollinator Resources: www.nrcs.usda.gov/pollinators

This site has links to resources for monarch butterflies, native and honey bees, backyard conservation, pollinator habitat in pastures, the Plant Materials Program pollinator publications, and the PLANTS Database list of all NRCS pollinator documents.

USDA-NRCS Pollinator and Other Beneficial Insect Technical Notes

Agronomy Technical Note No. 5—*Pest Management in the Conservation Planning Process* (February 2011)
https://efotg.sc.egov.usda.gov/references/public/UT/PestManagementintheConservationPlanningProcess.pdf

Agronomy Technical Note No. 9—*Preventing or Mitigating Potential Negative Impacts of Pesticides on Pollinators Using Integrated Pest Management and Other Conservation Practices* (February 2014)
https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=34828.wba

Technical Note Number 78—*Using 2014 Farm Bill Programs for Pollinator Conservation* (May 2015)
https://directives.sc.egov.usda.gov/opennonwebcontent.aspx?content=38006.wba

USDA National Agroforestry Center Wildlife and Pollinator Resources: www.fs.usda.gov/nac/topics/wildlife-pollinators.php

U.S. Forest Service Pollinator Information: www.fs.fed.us/wildflowers/pollinators/index.shtml

***A Win-Win on Agricultural Lands: Creating Wildlife Habitat Through Agroforestry* (2014)**
www.fs.usda.gov/nac/assets/documents/research/publications/2014WinWinOnAgriculturalLandsGaryBentrup.pdf

***Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways* (September 2008)**
www.fs.usda.gov/nac/buffers/docs/conservation_buffers.pdf

***Enhancing Nest Sites for Native Bee Crop Pollinators* (February 2007)**
www.fs.usda.gov/nac/assets/documents/agroforestrynotes/an34g08.pdf

***How Does Agroforestry Help Crop Pollination?* (June 2016)**
www.fs.usda.gov/nac/assets/documents/workingtrees/infosheets/WTInfoSheetCropPollinationJune2016.pdf

***Improving Forage For Native Bee Crop Pollinators* (August 2006)**
www.fs.usda.gov/nac/assets/documents/agroforestrynotes/an33g07.pdf

***Learn How You Can Use Agroforestry Practices to Help Pollinators* (March 2015)**
www.fs.usda.gov/nac/assets/documents/insideagroforestry/IA_vol23issue2_pollinators.pdf

***Riparian Forest Buffers* (February 2017)**
www.fs.usda.gov/nac/assets/documents/agroforestrynotes/an49rfb01.pdf

***Role of Agroforestry in Supporting Pollinators* webinar (October 2018)**
www.conservationwebinars.net/webinars/role-of-agroforestry-in-supporting-pollinators/

***Using Agroforestry Practices to Reduce Pesticide Risks to Pollinators & Other Agriculturally Beneficial Insects* (June 2017)**
www.fs.usda.gov/nac/assets/documents/agroforestrynotes/an35g09.pdf

***Windbreaks designed with pollinators in mind* (January 2012)**
www.fs.usda.gov/nac/documents/insideagroforestry/vol20issue1.pdf

***Working Trees for Pollinators* (January 2016)**
www.fs.usda.gov/nac/assets/documents/workingtrees/brochures/WTPollinators.pdf

Wildlife and Watershed Focused Agroforestry (also benefiting pollinators) *Working Trees for Wildlife* (2014)
www.fs.usda.gov/nac/assets/documents/workingtrees/brochures/wtw.pdf

***Working Trees for Water Quality* (2012)**
www.fs.usda.gov/nac/assets/documents/workingtrees/brochures/wtwq.pdf

Wildlife Habitat Council and NRCS: www.wildlifehc.org

***Integrated Pest Management (IPM) and Wildlife* (April 2004)**
https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=18487.wba

***Native Pollinators* (February 2006)**
https://plants.usda.gov/pollinators/Native_Pollinators.pdf

Arkansas Wildlife Habitat Conservation Agencies and Other Resources

Arkansas Game and Fish Commission Private Lands Program
www.agfc.com/en/wildlife-management/private-lands-program/

Arkansas Wildlife Action Plan
https://www.agfc.com/en/wildlife-management/awap/the-plan/

Financial Assistance for Wildlife Habitat
www.uaex.edu/publications/PDF/fsa-9104.pdf

Arkansas Monarch Conservation Partnership
http://arkansasmonarchs.org/

Arkansas Partners for Fish and Wildlife
www.fws.gov/arkansas-es/proj_pfw.html

Arkansas Land Conservation Assistance Network
ArkansasLandCAN: www.arkansaslandcan.org/

Arkansas Quail (and Pheasants) Forever
Search for local chapters and biologists using your zip code.
www.quailforever.org/ and www.pheasantsforever.org/

Planting Guidelines from Other Arkansas Organizations

Arkansas Natural Heritage Commission Native Plants and Gardening
www.naturalheritage.com/Education/native-plants

Federal Highway Administration Ecoregional Revegetation App
www.nativerevegetation.org/era/

Growing Native Plants in the Arkansas Landscape
https://onlyinark.com/homegrown/growing-native-plants/

Wildlife Habitat Management for Arkansas Landowners
www.uaex.edu/publications/PDF/MP483.pdf

Arkansas Agriculture, Crop, Soil, and Pollinator Related Websites

(these are largely University of Arkansas Cooperative Extension links)

Arkansas Agricultural History
www.butlercenter.org/agriculture-in-arkansas/

Arkansas Grown
www.arkansasgrown.org/

Arkansas Pollinator Resources
www.uaex.edu/farm-ranch/special-programs/beekeeping/pollinators.aspx

Arkansas Field Crop Pest Management
Including bioinsecticides: www.uaex.edu/farm-ranch/pest-management/insect/field-crops.aspx

Arkansas Row Crops and Commercial Horticulture
www.uaex.edu/farm-ranch/crops-commercial-horticulture/

Arkansas Soil Testing & Research Laboratory
aaes.uark.edu/technical-services/soil-testing-and-research-laboratory/

Arkansas Water Quality Laboratory
https://arkansas-water-center.uark.edu/water-quality-lab.php

Arkansas vegetable planting times
From Urban Farmer: www.ufseeds.com/learning/planting-schedules/arkansas-vegetable-planting-calendar/

Arkansas Natural History Websites

Arkansas Natural Heritage Commission
www.naturalheritage.com/

Poster series: Natural Communities of Arkansas: www.naturalheritage.com/Education/natural-communities-poster-series

iNaturalist Arkansas groups related to pollinators and other arthropods or habitat

- **Arkansas Ants, Bees, Wasps and Sawflies:** www.inaturalist.org/lists/763999-Arkansas-Ants--Bees--Wasps-and-Sawflies
- **Arkansas Monarch Mapping Project:** www.inaturalist.org/projects/arkansas-monarch-mapping-project
- **Arkansas River Valley:** www.inaturalist.org/places/arkansas-river-valley
- **Arkansas Valley Plains:** www.inaturalist.org/places/arkansas-valley-plains
- **Arthropods of Arkansas:** www.inaturalist.org/projects/arthropods-of-arkansas
- **Arkansas Quail Mapping Project:** www.inaturalist.org/projects/arkansas-quail-mapping-project
- **Bees of Arkansas:** www.inaturalist.org/projects/bees-of-arkansas
- **Biodiversity of Arkansas:** www.inaturalist.org/projects/biodiversity-of-arkansas

Ozark Natural History Foundation
www.ozarksociety.net/foundation/

Flora and Physiographic Provinces of Arkansas

Arkansas Natural Heritage Commission Ecoregion Descriptions
www.naturalheritage.com/Education/ecoregions-natural-divisions-of-arkansas

Encyclopedia of Arkansas
https://encyclopediaofarkansas.net/entries/geography-and-geology-401

Index of the Vascular Flora of Arkansas
Photo Gallery by Craig Frasier: www.pbase.com/cmf46/index_of_arkansa_native_wildflowers

Vascular Flora of Arkansas Project
c/o Arkansas Native Plant Society: https://anps.org/2011/08/29/vascular-flora-of-arkansas/

Wikipedia List of Flora of Arkansas
https://en.wikipedia.org/wiki/List_of_flora_of_Arkansas

Arkansas Prescribed Fire Resources

Arkansas Prescribed Fire Council
www.facebook.com/ArPrescribedFireCouncil/

Arkansas Forestry Commission
www.agriculture.arkansas.gov/forestry/

Arkansas Requirements for Certified Prescribed Burn Managers
http://southernfireexchange.org/EdTrain/State/Arkansas_cpbm.html

Fire Restoration in Arkansas
The Nature Conservancy: www.nature.org/en-us/about-us/where-we-work/united-states/arkansas/stories-in-arkansas/fire-restoration-in-arkansas/

Why We Burn: Prescribed Burning as a Management Tool
Arkansas Cooperative Extension: www.uaex.edu/publications/pdf/FSA-5009.pdf

Xerces Society Pollinator Conservation Resource Center: xerces.org/pollinator-resource-center/

In addition to Xerces' pollinator resources developed in collaboration with USDA NRCS and the National Agroforestry Center, Xerces has a large set of pollinator and conservation biocontrol resources.

Pollinator Plants Lists

Pollinator-Friendly Plant Lists
https://xerces.org/pollinator-conservation/plant-lists/

Pollinator Plants: Midwest Region
https://xerces.org/pollinator-conservation/plant-lists/pollinator-plants-midwest-region/

Monarch Nectar Guides
https://xerces.org/monarch-nectar-plants/

Monarch Butterfly Nectar Plant Lists for Conservation Plantings
www.xerces.org/publications/plant-lists/monarch-butterfly-nectar-plant-lists-for-conservation-plantings

Organic Farming Resources: www.xerces.org/organic-farms

Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms
www.xerces.org/guidelines-farming-for-bees/

Habitat Planning for Beneficial Insects
https://xerces.org/habitat-planning-for-beneficial-insects/

Organic-Approved Pesticides: Minimizing Risk to Bees
www.xerces.org/publications/guidelines/organic-pesticides

- ***Common Organic-Allowed Pesticides—A Comparative Overview:*** www.xerces.org/publications/fact-sheets/common-organic-allowed-pesticides

Organic Farming Practices: Reducing Harm to Pollinators from Farming
www.xerces.org/publications/fact-sheets/organic-farming-practices

Organic Site Preparation For Wildflower Establishment
www.xerces.org/publications/guidelines/organic-site-preparation-for-wildflower-establishment

- ***Organic Site Preparation Methods: A Comparative Overview***
  www.xerces.org/publications/fact-sheets/organic-site-preparation-methods-comparative-overview
- ***Organic Site Preparation Timelines & Checklists:***
  www.xerces.org/publications/guidelines/organic-site-preparation-timelines-checklists

Pollinator Management For Organic Seed Producers
www.xerces.org/publications/guidelines/pollinator-management-for-organic-seed-producers

Reducing Pesticides and Conservation Biocontrol

Conservation Biological Control
https://xerces.org/conservationbiocontrol/

Beneficial Insect Scouting Guides
https://www.xerces.org/publications/scouting-guides

Sustainable Pest Management
https://xerces.org/pesticides/

How Neonicotinoids Can Kill Bees
https://xerces.org/neonicotinoids-and-bees/

Impacts of Pesticides on Invertebrates (IPI) Database
A searchable database of annotated research articles:
www.pesticideimpacts.org/

Other Xerces Society Pollinator Resources

Bee City and Bee Campus USA
www.beecityusa.org/

Bumble Bee Conservation
https://xerces.org/bumblebees/

Conserving Bumble Bees—Guidelines for Creating and Managing Habitat for Americas Declining Pollinators
https://xerces.org/bumblebeeguidelines/

Community Science
https://xerces.org/citizen-science/

Change to Protecting Waters from Pesticides
https://xerces.org/pesticides/waters

Endangered Species
https://xerces.org/endangered-species/

Making Room for Native Pollinators—How to Create Habitat for Pollinator Insects on Golf Courses
www.xerces.org/publications/guidelines/making-room-for-native-pollinators

Managing Alternative Pollinators
www.xerces.org/publications/books/managing-alternative-pollinators

Providing Nest Sites for Pollinators
https://xerces.org/providing-nest-sites-for-pollinators/

Pollinators in Natural Areas: A Primer on Habitat Management
www.xerces.org/publications/guidelines/pollinators-in-natural-areas

Pollinator Friendly Parks: How to Enhance Parks, Gardens, and Other Greenspaces for Native Pollinator Insects
https://xerces.org/publications/guidelines/pollinator-friendly-parks

Other Pollinator Resources

Choosing and managing cover crops to support beneficial insects for pest control and pollination **factsheet**
https://southerncovercrops.org/wp-content/uploads/2018/11/Choosing-and-Managing-Cover-Crops-Pest-Protection.pdf

American Honey Plants
https://archive.org/details/americanhoneypla00pell/page/n6

U.S. Fish & Wildlife Service Pollinator Information
www.fws.gov/pollinators/Index.html

UC Berkeley Urban Bee Lab
www.helpabee.org/index.html

North American Pollinator Protection Campaign (NAPPC)
www.pollinator.org

The Economic Challenge Posed by Declining Pollinator Populations
www.whitehouse.gov/the-press-office/2014/06/20/fact-sheet-economic-challenge-posed-declining-pollinator-populations

Habitat Restoration with Native Plants

Native Arkansas Plants for Gardens
www.naturalheritage.com/Education/native-plants

Native Seed Network
Click on "FindSeed" for a map of seed vendors.

www.nativeseednetwork.org

Ozark Native Plants
www.ozarknativeplants.com/

Photographs of native Arkansas plants
www.angelfire.com/ar2/obrien

Prairie Plains Resource Institute
www.prairieplains.org

Selecting Native Plant Materials for Restoration
http://extension.oregonstate.edu/catalog/pdf/em/em8885-e.pdf

Insect Visitors of Illinois Wildflowers
Illinois Wildflowers (Hilty 2019). Note that you are able to search for insects by plant species or vice versa. This website also includes a list of plants used by orioles and the ruby throated hummingbird. www.illinoiswildflowers.info/flower_insects/index.htm

Visual Guide to Louisiana Plants
A Web Based Searchable Plant Database and Photo Gallery of the Plants of Louisiana: www.usgs.gov/centers/wetland-and-aquatic-research-center-warc/science/web-based-searchable-plant-database-and?qt-science_center_objects=0#qt-science_center_objects

Invasive Species

Arkansas Natural Heritage Program invasive species listing
www.invasivespeciesinfo.gov/us/arkansas

Pest Tracker
http://pest.ceris.purdue.edu/states.php

National Invasive Species Council
www.doi.gov/invasivespecies

USDA PLANTS Database Introduced, Invasive, and Noxious Plants
https://plants.usda.gov/java/invasiveOne

University of Arkansas invasive species listing
www.uaex.edu/environment-nature/ar-invasives

Monarch Butterfly Conservation

Arkansas Monarch Conservation Partnership
http://arkansasmonarchs.org/

Monarch Joint Venture
https://monarchjointventure.org/

Monarch Watch
http://monarchwatch.org/blog

Monarch Watch Recovery Plan
http://monarchwatch.org/blog/2014/03/25/monarch-butterfly-recovery-plan

Monarch Foundation
www.saveourmonarchs.org

National Geographic—Monarch Butterfly
http://animals.nationalgeographic.com/animals/bugs/monarch-butterfly

Tracking Monarch Migration
https://journeynorth.org/monarchs

The Wild Center—All About Monarchs
https://wildcenter.org/tag

Xerces Society—Monarch Conservation
www.xerces.org/monarchs

Pesticide Toxicity

Windows Pesticide Screening Tool (WIN-PST)
http://go.usa.gov/Kok

EXTOXNET—The EXtension TOXicology NETwork
http://pmep.cce.cornell.edu/search/profile.cgi

http://extoxnet.orst.edu/

How to Reduce Bee Poisoning from Pesticides
http://extension.oregonstate.edu/catalog/pdf/pnw/pnw591.pdf

Pesticide Risk Tool
https://pesticiderisk.org

Bee Precaution Pesticide Ratings
http://ipm.ucanr.edu/beeprecaution

Appendix I. Glossary

The following is a list of terms you may encounter in this document or when working to support pollinators and habitat conservation.

Arkansas Game and Fish Commission (AGFC)—the state agency responsible for conserving and enhancing Arkansas' fish and wildlife and their habitats while promoting sustainable use, public understanding, and support.

Arkansas Natural Heritage Commission (ANHC)—the state agency focused on science-based conservation to protect Arkansas' biological diversity. ANHC is the states' central repository for data on plants, animals, and natural communities in Arkansas. ANHC manages a **System of Natural Areas**—the best of state's remaining natural communities.

Arkansas Natural Resources Commission (ANRC)—the state agency that establishes policy and makes funding and regulatory decisions relative to soil conservation, nutrient management, water rights, dam safety and water resources planning and development.

Bee pasture or insectary—an area reserved usually near crop production fields comprised of one or more species of annual or perennial plants that provide pollen and nectar resources before, during and outside the time required for pollination of the crop produced, and also supports various predatory and parasitoid insects.

Beetle bank—beetle banks are strips of perennial grasses created by plowing two furrows to create a long narrow embankment or adding soil to long, narrow strips of brush within a farm field. The term highlights the targeted support of predatory ground beetles that prey on soil dwelling pests such as pest nematodes and weed seeds, elevated to provide dry habitat during wet conditions. Other perennial strips or embankments may be called beetle banks, such as unmown strips of grasses, other low-stature vegetation, piled brush, tree trunks, or piled rocks. These areas provide refuge when crops are tilled, protection from other predators and the sun, habitat for prey species, and can also be tremendously valuable for food and shelter for pollinators and many other natural enemies of pests, including birds. Lodged native warm-season grasses are among the best habitats for bumble bees' nests.

Bloom period—typical time of year that a plant will flower. Bloom times are described within this document as Very Early, Early, Mid and Late. They are based on the following timeframes:

- February through March = **Very Early Season**
- April through May = **Early Season**
- May through July = **Mid-Season**
- July through Sept = **Late Season**

Bunchgrass—grass that forms a clump rather than spreading rapidly with runners. These do not typically form sods and are sporadically scattered throughout the landscape. As pollinator habitat they provide attachment points for beneficial insects and egg laying sites. Most are warm-season rather than cool-season grasses. Cool-season grasses tolerate cooler temperatures, bloom early in spring, and set seed in early summer. Warm-season grasses use a different metabolic pathway that conserves water in the heat of summer. Warm-season grasses start growing later in spring, bloom in summer, and set seed in summer to fall. Warm-season grasses may take more than one year to mature (begin flowering).

Burndown—herbicide application to eliminate a grasses or other vegetation prior to establishment of more beneficial species. Sometimes this may refer to a prescribed burn (see also prescribed burning).

Caterpillar—the larval form of a member of the order Lepidoptera (the insect order comprising butterflies and moths). They are mostly herbivorous (they eat plants), with some species being insectivorous. Caterpillars are voracious feeders and many of them are considered pests in agriculture, though recent studies show their importance as crop pollinators. They are also vital in food webs.

Figure 59—Yucca moths (*Tegeticula* spp., circled left) are the primary pollinators of yucca flowers, but their caterpillars (right) are also a primary herbivore—a classic mutualism story in ecology (neither can live without the other). The tiny adults resemble the flower anthers and the caterpillars are often found inside the developing seed pods. (Photos: National Parks Service* [left]; Andy Reago & Chrissy McClarren* [right]—*via flickr..)

Conservation practice—science-based, proven technical criteria for implementation of various techniques to establish, manage, construct or maintain vegetation, structures or natural resources. NRCS plans and assists in installation of conservation practices.

Conservation Reserve Enhancement Program CREP—The Conservation Reserve Enhancement Program (CREP) is an offshoot of the Conservation Reserve Program (CRP) administered by the Farm Service Agency (FSA). CREP targets high-priority conservation issues identified by local, state, or tribal governments or non-governmental organizations. In exchange for removing environmentally sensitive land from production and in return land owners are paid an annual rental rate. Participation is voluntary and the contract period is typically 10–15 years, along with other federal and state incentives as applicable per each CREP agreement. In Arkansas this area is limited in scope. (See also **Conservation Reserve Program**)

Conservation Reserve Program (CRP)—The Conservation Reserve Program (CRP) is a land conservation program administered by the Farm Service Agency (FSA). In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality. Contracts for land enrolled in CRP are 10-15 years in length. The long-term goal of the program is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

Conservation Stewardship Program (CSP)—The Conservation Stewardship Program (CSP) which is administered by NRCS helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resource concerns.

Cover crop—crops planted primarily to manage soil fertility, soil quality, water, weeds, pests, diseases, biodiversity and wildlife; or to prevent erosion and to improve soil quality (often by adding nitrogen and/or creating pores for greater oxygen in the soil). Flowering species provide pollen and nectar. The pollen from many grasses is also eaten by many bees and other agriculturally important pollinators and predators.

Early successional habitat—early successional refers to the plants that grow in newly plowed or otherwise disturbed areas such as idle or fallow land. It may include grasses, forbs, shrubs and saplings. Other farm areas that may have early successional growth include field borders, fencerows, pivot corners, ditch banks, woodland edges, or recently harvested timber stands. While early successional habitat management has often been used to refer to managing established or historic grasslands, prairies, savannas, and thinned or burned woodlands because thinning or burning sets back succession, "open grasslands" may be a more precise description of sites where conservative species (those that take a long time to become established and can be indicators of prairie remnants, such as prairie blazing star (*Liatris pycnostachya*) are found. Remnant prairies are considered late successional, climax communities persisting with the same types of periodic disturbance that maintain early successional habitats, but early successional, weedy species, have been replaced by persistent (conservative) species.

Enhancement—for the purposes of this document, a pollinator enhancement is a planting of woody or herbaceous plants or any other practice that directly affects pollinator habitat by providing additional food, shelter or nest sites for organisms providing pollination services.

Exotic—for the purposes of this document this is defined as a plant occurring in the State that is not native to North America north of Mexico.

Farm Bill Program—general term for any federal program authorized or reauthorized for implementation by the federal government through one of congressional legislation. Examples include EQIP, CSP, CRP, etc.

Farm Service Agency (FSA)—a federal agency of the United States Department of Agriculture which assists with commodity programs, administers farm loans and other services for farmers and agricultural landowners on private lands.

FOTG—the NRCS Field Office Technical Guide. The primary scientific references for NRCS. It contains technical information about the conservation of soil, water, air, and related plant and animal resources. It is accessible by the public at https://efotg.sc.egov.usda.gov/.

Green manure—a type of cover crop grown primarily to add nutrients and organic matter to the soil. They are called "green" manures because they are incorporated into soil after a specific growing period, without composting or being consumed by livestock and later turned into manure.

Integrated pest management (IPM)—integrated pest management (IPM) is an agricultural pest control strategy that utilizes a variety of complementary strategies including cultural management (growing practices) life cycle analysis and chemical management, among others to control organisms that cause agricultural harm.

Introduced—for the purposes of this document it is a plant introduced to Arkansas from outside North America and is now escaped and surviving without cultivation.

Invasive—for the purposes of this document this term is defined as those plants (native or otherwise) that have been known to spread aggressively in habitats where they are not normally found.

Local ecotype—describes a genetically distinct geographic variety, population or race within a species (or among closely related species), which is adapted to specific environmental conditions and capable of interbreeding.

Native plant—for the purposes of this document it is a plant considered to have occurred in Arkansas prior to European settlement and that still occurs naturally within the state.

Natural Resources Conservation Service (NRCS)—a federal agency of the United States Department of Agriculture that assists with implementing strategies to solve soil, water, air, plant and animal resource concerns primarily on private lands.

Nectar—a sweet liquid secreted by flowers of a plant, which attracts insects or birds that pollinate the flower. It is consumed by pollinators, such as hummingbirds and insects, and gathered by honey bees for making honey.

Nectar corridor—on a large scale, these are pathways of food and movement sustaining migratory species such as monarch butterflies and various hummingbirds across great distances during migration. At a farm planning scale, these areas include ditches, hedgerows, riparian areas, etc. to facilitate movement through and/or provide pollinator resources (nectar, pollen and shelter). These small-scale corridors can cumulatively provide regional, national, and international corridors to support migratory species, while also supporting other wildlife and protecting watersheds.

Non-native—a taxon not found in Arkansas prior to European settlement.

Noxious—an invasive species that has been designated by county, state or national agricultural authorities as one that is injurious to agricultural and/or horticultural crops, natural habitats and/or ecosystems, and/or humans or livestock. Refer to Section II of the Field Office Technical Guide (*see FOTG above*) for a list of those species within Arkansas.

Open grassland—includes newly planted, early successional, remnant prairie, savanna, and the understory habitats of open woodlands. Ecologists encourage the use of this phrase for describing remnant prairies and other historic grassland areas (as opposed to early successional) since natural (historic) grasslands are recognized by the conservative species (those that take a long time to become established and persist only with periodic above-ground disturbance such as fire, flooding, or grazing) they support, such as prairie blazing star (*Liatris pycnostachya*) or rattlesnake master (*Eryngium yuccifolium*). While open grasslands include early successional habitats, early successional sites are characterized by weedy species that decline over time as more conservative species take hold.

Pesticide drift - the physical movement of pesticide droplets or particles through the air at the time of pesticide application or later from the target site to any non-target site.

Plant Materials Center (PMC)—USDA Plant Materials Program centers located in various states. The centers have responsibilities for assembling, testing, releasing, and providing for the commercial production and use of plant materials and plant materials technology for soil, water, and related resource conservation and development. The PMC responsible for this area is located in Booneville, Arkansas (www.nrcs.usda.gov/wps/portal/nrcs/detail/plantmaterials/pmc/southeast/arpmc/).

Pollinator—an organism that transfers pollen from one plant to another, unwittingly aiding the plant in its reproduction. Common pollinators include insects, especially bees, butterflies, and moths, wasps, flies, beetles, and some birds and bats.

Prescribed burn/fire—the planning and use of fire in predetermined areas, under specific environmental conditions, to achieve desired outcomes; one of several ways utilized to maintain open grassland habitats for pollinators. Prescribed, controlled, and planned burns or fires are the same thing.

Pupa—the non-feeding stage between the larva and adult in the metamorphosis of some insects (bees, wasps, flies, moths, butterflies,

beetles) during which the larva undergoes complete transformation from a grub or caterpillar into an adult (sexually mature, usually with wings).

Quail Forever—a non-profit organization dedicated to the conservation of quail, pheasants and other wildlife through habitat improvements, public awareness, education, and land management policies and programs. Quail Forever works in partnership with NRCS and other conservation organizations.

Shrub—perennial, multi-stemmed woody vascular plant that is usually less than 14–15' in height and usually less than 3.0" in diameter at breast height. Shrubs typically have several stems arising from or near the ground, but may besingle-stemmed and/or can be much taller than 15' depending on the species or under certain environmental conditions.

Social bee or wasp—(eusocial) bees or wasps that live in colonies with a queen bee, workers, males, and larvae. Members of the colony work together to build nests, provide food and raise offspring. Only a few native bee and wasp species are social, including bumble bees (*Bombus* spp.), a few sweat bees (Halictidae), and yellow jackets (*Vespula* spp.) and paper wasps (*Polistes* spp.).

Solitary bee or wasp—bees or wasps that after mating prepare and provision their nests alone. Female solitary bees collect nectar and pollen—female solitary wasps collect prey (usually insects or spiders)—and place these provisions in individual brood cells, lay an egg, then seal the cell closed. They never see their young hatch out, eat the provisions, mature, and pupate. The great majority of bee and wasp species are solitary.

Species of Greatest Conservation Need (SGCN)—flora and fauna that may be rare, in decline, or not enough is known about their taxonomy, life history, or conservation status to confirm a healthy population within the state. They are listed in the Arkansas Wildlife Action Plan, identified by the Arkansas Game and Fish Commission in collaboration with regional experts.

Swarming—the process by which a bee colony divides itself, with about half the colony flying away to establish a new nest.

Tree—a woody vascular plant usually greater than 3.0" in diameter at breast height and usually greater than 15' in height (excluding woody vines).

Vine—climbing plant with relatively long stems that can be woody or herbaceous.

Warm-season grass—grasses that grow best when the soil temperature is above 50° F and continue to grow until the soil temperature reaches nearly 90° F (usually May–September). Warm-season grasses use a metabolic pathway that conserves water in the heat of summer. Warm-season grasses start growing later in spring than cool-season species, bloom in summer, and set seed in summer to fall (many cool-season species set seed in early summer). Warm-season grasses may take more than one year to mature (begin flowering).

Windbreak—Windbreaks are plantings of single or multiple rows of trees or shrubs that are established for environmental purposes. Living snow fences are an important variation of windbreaks and shelterbelts in some parts of the country. The height of the tallest row and overall density of foliage and branches of an individual windbreak/shelterbelt influence the size of the nearby area that is protected or sheltered. Sometimes referred to as shelterbelts.

Windows Pesticide Screening Tool (WIN-PST)—an environmental risk screening tool that NRCS field office conservationists, extension agents, crop consultants, pesticide dealers and producers can use it to evaluate the potential of pesticides to move with water and eroded soil/organic matter and affect non-targeted organisms. NRCS Pest Management Policy (November 2001) requires the use of WIN-PST or other NRCS-approved environmental risk analysis tools in supporting the development of the pest management component of a conservation plan.

Xerces Society for Invertebrate Conservation (Xerces)—a nonprofit organization that protects the natural world through the conservation of invertebrates and their habitats. The society takes its name from the now extinct Xerces Blue butterfly (*Glaucopsyche xerces*), the first butterfly known to go extinct in North America as a result of human activities. Xerces works in partnership with NRCS and other conservation organizations.

AR–2020 • October 2020

Arkansas Native Forbs for Pollinators

SCIENTIFIC NAME	COMMON NAME	BLOOM PERIOD(S)	FLOWER COLOR	HEIGHT AT MATURITY	SHADE TOLERANCE	PH	POLLINATOR	DRAINAGE	WETLAND STATUS
Achillea millefolium	Yarrow	Early	Wh	3	◐	6.0–8.0			FACU
Actaea pachypoda	Doll's eyes	Early	Wh	3	●	< 6.8			FACU & UPL
Agalinis fasciculata	Beach false foxglove	Late	Pk, Pr	3	○	< 6.0			FAC
Agastache nepetoides	Yellow giant hyssop	Late	Ye, Gr	6	◐	—			FACW & FAC
Allium canadense* var. *mobilense	Meadow wild onion	Early	Wh, Pk	1	◐	—			UPL
Amsonia ciliata	Bluestar	Early	Bl	2	◐	—			UPL
Amsonia illustris	Shining bluestar	Early	Bl	6	◐	< 6.8			UPL
Amsonia tabernaemontana	Eastern bluestar	Early	Bl, Pr	3	◐	6.0–8.0			FACW & FAC
Anemone americana	Roundlobe hepatica	V. Early	Wh, Pk, Bl, Pr	0.4	●	< 6.8			UPL
Anemone virginiana	Thimbleweed	Mid	Wh, Gr, Br	2	○–◐	< 7.2			FACU
Angelica venenosa	Hairy angelica	Mid	Wh	6	◐	6.1–7.8			UPL
Apocynum cannabinum	Indian hemp	Mid	Wh	3	◐	4.5–7.0			FAC
Aquilegia canadensis	Columbine	Early	Rd, Pk, Ye	2	◐–●	> 6.8			FAC & FACU
***Arisaema dracontium*[1]**	Green dragon	Early	Wh, Ye, Gr, Br	3	○–●	5.6–7.5			FACW
***Arisaema triphyllum*[1]**	Jack-in-the-pulpit	Early	Gr, Pr, Br	3	○–●	> 6.8			FACW
Arnoglossum plantagineum	Groovestem Indian plantain	Late	Wh	5	○–●	6.8–7.2			FACW & FACU
Asarum canadense	Wild ginger	Early	Rd, Gr, Pr, Br	<1	◐–●	< 7.2			FACU & UPL
Asclepias amplexicaulis	Clasping milkweed	Mid	Pk	3	◐	5.0–8.5			UPL
Asclepias hirtella	Tall green milkweed	Mid	Wh, Gr, Br	3	◐	5.1–7.5			UPL
Asclepias perennis	Aquatic milkweed	Mid	Wh, Pk	6	○–◐	—			OBL
Asclepias purpurascens	Purple milkweed	Mid	Pr	4	◐	5.0–8.5			FACU
Asclepias syriaca	Common milkweed	Mid	Pk	5	◐	5.0–7.5			FACU
Asclepias tuberosa	Butterfly milkweed	Mid	Or	3	◐	5.0–7.0			UPL
Asclepias variegata	Redring milkweed	Mid	Wh	4	◐	5.0–7.0			FACU
Asclepias verticillata	Whorled milkweed	Mid	Wh, Gr	3	○–◐	—			FACU
Asclepias viridiflora	Green milkweed	Mid	Gr	3	○	—			UPL
Asclepias viridis	Green antelopehorn milkweed	Early	Wh, Ye, Gr, Pr	2	○	—			UPL
Astragalus canadensis	Canada milkvetch	Mid	Cr	4	◐	6.0–8.0			FAC
Baptisia alba	White wild indigo	Early	Wh	4	○	5.9–7.8			UPL
Baptisia australis	Blue wild indigo	Early	Pr	3	○	5.9–7.8			UPL
Baptisia bracteata	Cream wild indigo	Early	Ye	2	○	5.9–7.8			UPL

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See notes.

SCIENTIFIC NAME	COMMON NAME	BLOOM PERIOD(S)	FLOWER COLOR	HEIGHT AT MATURITY	SHADE TOLERANCE	PH	POLLINATOR	DRAINAGE	WETLAND STATUS
Baptisia nuttalliana	Nuttall's wild indigo	Early	Light Ye	3	◯–◐	—			UPL
Baptisia sphaerocarpa	Yellow wild indigo	Early	Ye	4	◯	—			UPL
Bidens aristosa	Tickseed sunflower	Mid	Ye	3.5	◐	5.0–7.0			FACW
Bidens cernua	Nodding bur marigold	Late	Ye	3.2	◐	5.1–7.0			OBL
Bidens frondosa	Beggartick	Mid	Ye	4	◐	5.2–7.2			FACW
Bidens laevis	Smooth tickseed	Late	Ye	3	◐	5.0–7.0			OBL
Blephilia ciliata	Ohio horsemint	Late	Pr	3	◐	5.1–7.9			UPL
Boltonia asteroides	False aster	Late	Wh	8	◐	5.3–7.0			FACW
Brickellia eupatorioides	False boneset	Mid	Wh	2	◯	5.6–7.8			UPL
Callirhoe digitata	Fringed poppy mallow	Mid	Wh, Rd, Pr	1.5	◯	—			UPL
Callirhoe involucrata	Purple poppy mallow	Early	Wh, Pk, Pr	1	◯–◐	5.5–7.5			UPL
Camassia scilloides	Wild hyacinth	Early	Wh, Bl, Pr	2	◐–●	4.2–6.5			UPL
Campanula americana	Tall bellflower	Mid	Bl, Pr	6	●	5.5–7.5			FACW & FAC
Castilleja coccinea[2]	Indian paintbrush	Mid	Rd, Pk	2	●	4.9–6.8			FAC
Chamaecrista fasciculata	Showy partridge pea	Mid	Ye	3	◯	4.3–6.5			FACU
Chamaecrista nictitans	Sensitive partridge pea	Mid	Ye	1	◯	6.6–7.5			FACU
Conoclinium coelestinum	Blue mistflower	Late	Bl	2	◐	5.5–7.5			UPL
Coreopsis grandiflora	Bigflower coreoposis	Early	Ye	2	◐	6.1–7.8			UPL
Coreopsis lanceolata	Lanceleaf coreopsis	Mid	Ye	2	◯	6.0–7.0			FACU
Coreopsis palmata	Prairie coreopsis	Mid	Ye	2.5	◐	6.1–7.8			UPL
Coreopsis pubescens	Star tickseed	Early	Ye	1	◯	6.1–7.8			FACW & FAC
Coreopsis tinctoria	Plains coreopsis	Early	Ye, Br	3	◐	5.2–7.8			FAC
Coreopsis tripteris	Tall coreopsis	Late	Ye	9	◐	6.1–7.8			FAC
Crotalaria sagittalis	Rattlebox	Mid	Ye	1	◯	4.0–6.0			UPL
Dalea candida	White prairie clover	Mid	Wh	3	◯	—			UPL
Dalea purpurea	Purple prairie clover	Late	Pr	3	◯	5.0–7.9			UPL
Delphinium carolinianum	Carolina larkspur	Early	Wh, Bl, Vi	2	◐	—			UPL
Delphinium tricorne	Dwarf larkspur	Early	Pr	1	●	5.8–7.8			UPL
Desmanthus illinoensis	Illinois bundleflower	Mid	Wh	3	◯	5.0–8.0			UPL
Desmodium canescens	Hoary tick-trefoil	Mid	Pk	3	◯–●	—			UPL
Dodecatheon meadia	Shooting star	Early	Wh	2	●	4.5–7.5			FACU
Echinacea pallida	Pale purple coneflower	Mid	Pk, Pr	1.2	◯	6.5–7.2			UPL

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See notes.

SCIENTIFIC NAME	COMMON NAME					PH	POLLINATOR ⓘ		
Echinacea purpurea	Purple coneflower	Mid	Pr	1	○	6.5–7.2			UPL
Echinacea simulata	Glade coneflower	Mid	Pk, Pr	3	○–◐	6.1–7.8			UPL
Erigeron pulchellus	Robin's-plantain	Early	Wh, Ye, Bl, Pr	1.5	◐	—			FACU
Eryngium yuccifolium	Rattlesnake master	Mid	Wh	6	○	6.6–7.5			FAC
Eupatorium perfoliatum	Common boneset	Late	Wh	6	◐	5.0–7.5			FACW
Eup. rotundifolium var. *ovatum*	Roundleaf thoroughwort	Late	Wh	2	●	5.0–7.0			UPL
Eupatorium rugosum	White snakeroot	Late	Wh	6	◐	5.0–7.5			FAC
Eupatorium serotinum	Late boneset	Late	Wh	3	◐	5.0–7.5			FAC
Euphorbia corollata	Flowering spurge	Mid	Wh	3	○	6.1–7.8			UPL
Eurybia hemispherica	Southern swamp aster	Late	Ye, Pr	3	○	< 7.3			FACU
Eutrochium fistulosum	Common Joe Pye weed	Late	Pr	11	◐	5.0–7.5			FAC
Eutrochium purpureum	Purple Joe Pye weed	Late	Pr	4	◐	5.0–7.5			UPL
Fleischmannia incarnata	Pink thoroughwort	Late	Wh	4	◐	5.0–7.5			FACW
Fragaria virginiana	Wild strawberry	Early	Wh	1	○–◐	5.1–7.8			FACU
Gaillardia aestivalis	Lanceleaf blanketflower	Mid	Wh, Pk, Ye, Pr	2	○	6.1–7.8			UPL
Gaillardia pulchella	Indian blanket	Mid	Rd, Ye, Br	3	○–◐	7.0–8.5			UPL
Geranium maculatum	Wild geranium	Early	Pr	2	◐	5.5–8.5			FACU
Glandularia canadensis	Rose verbena	V. Early	Pk	<1	◐	< 6.8			UPL
Grindelia lanceolata	Spiny-toothed gumweed	Late	Ye	3	○	6.1–8.5			UPL
Helenium autumnale	Sneezeweed	Late	Ye	4	○	4.0–7.0			FACW
Helenium flexuosum	Purple-headed sneezeweed	Mid	Ye	3.2	○	4.5–7.5			FACW & FAC
Helianthus angustifolius	Narrowleaf sunflower	Late	Ye	3	○	4.0–8.0			FACW
Helianthus divaricatus	Woodland sunflower	Mid	Ye	6	○–●	—			UPL
Helianthus grosseserratus	Sawtooth sunflower	Late	Ye	5	○	5.8–7.3			FACW & FAC
Helianthus hirsutus	Hairy woodland sunflower	Late	Ye, Br	1.5	○–◐	—			UPL
Helianthus mollis	Ashy sunflower	Mid	Ye, Br	6	○	—			UPL
Helianthus silphioides	Rosinweed sunflower	Late	Rd, Ye	10	○–◐	—			UPL
Helianthus strumosus	Paleleaf woodland sunflower	Late	Ye	7	○–●	< 6.8			FACU & UPL
Helianthus tuberosus	Jerusalem artichoke	Late	Ye	10	◐	4.0–7.0			FAC
Heliopsis helianthoides	Ox-eye false sunflower	Mid	Ye	5	○–◐	—			FACU & UPL
Heuchera americana	American alumroot	V. Early	Rd, Gr, Pr, Br	3	◐–●	< 6.8			FACU
Hibiscus laevis	Halberd-leaf rose mallow	Mid	Wh, Pk	8	○–◐	5.5–7.2			OBL

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE ⓘ POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See notes.

SCIENTIFIC NAME	COMMON NAME					PH	POLLINATOR ⓘ		
Hibiscus lasiocarpos	Rose mallow	Mid	Wh, Rd, Pk	5	◯	—			UPL
Hydrophyllum virginianum	Shawnee salad	Early	Bl	2	●	5.7–7.5			FAC
Hypoxis hirsuta	Yellow star grass	Early	Ye	0.8	◐	5.2–7.2			FAC
Impatiens capensis	Spotted jewelweed	Mid	Ye	5	●	6.4–7.4			FACW
Iris cristata	Dwarf crested iris	Early	Bl	3	●	< 6.8			UPL
Iris fulva	Copper flag	Early	Rd/Or	3	●	5.0–8.5			OBL
Iris virginica shrevei	Blue flag	Early	Bl	3	●	4.8–7.3			FACW
Lespedeza capitata	Roundhead lespedeza	Late	Pk	4	◯	5.5–6.9			FACU
Lespedeza hirta	Hairy bush clover	Late	Wh	3	◯	5.0–9.0			UPL
Lespedeza procumbens	Trailing lespedeza	Mid	Pk	1	◯	—			UPL
Lespedeza violacea	Violet lespedeza	Mid	Pk/Pr	2	◐	—			UPL
Lespedeza virginica	Slender lespedeza	Late	Pr	3	◐	5.7–9.0			FACU
Liatris aspera	Rough blazing star	Late	Pr	3	◯	5.6–7.5			FACU
Liatris pycnostachya	Prairie blazing star	Mid	Pk	6	◯	6.0–8.5			FACU
Liatris squarrulosa	Appalachian blazing star	Late	Pr	4	◯	5.6–7.5			UPL
Lilium superbum	Turk's cap lilly	Mid	Or	4	◯	5.8–7.8			FACW
Linum medium* var. *texanum	Stiff yellow flax	Mid	Ye	2	◯	—			FACU
Lobelia cardinalis	Cardinal flower	Late	Rd	3	◐	5.8–7.8			FACW
Lobelia puberula	Downy lobelia	Late	Bl	4	◐	5.1–6.5			UPL
Lobelia siphilitica	Great blue lobelia	Late	Bl	3	◐	5.6–7.8			FACW
Ludwigia alternifolia	Seedbox	Mid	Ye	4	◐	< 6.0			OBL
Lysimachia lanceolata	Yellow-loosestrife	Mid	Pr	3	●	5.0–7.0			FAC
Maianthemum racemosum	False Solomon's seal	Early	Wh	3	●	< 6.8			FACU
Manfreda virginica	False aloe	Mid	Gr-Wh	5	◐	—			UPL
Mertensia virginica	Virginia bluebells	V. Early	Bl	2	●	4.5–8.0			FACW
Mimosa quadrivalvis* var. *nuttalli	Sensitive briar	Mid	Pk	1	◐	6.1–7.8			UPL
Mimulus alatus	Monkey flower	Early	Bl/Wh	2	●	6.2–7.8			OBL
Monarda bradburiana	Savanna bergamot	Mid	Pk	2	◐	5.1–7.3			UPL
Monarda citriodora	Lemon mint	Mid	Pk/Wh	2	◐	6.1–7.8			UPL
Monarda fistulosa	Wild bergamot	Mid	La	3	◐	5.6–7.5			FACU
Monarda punctata	Spotted beebalm	Mid	Ye/Pr	3	◐	6.8–7.2			FACU
Monarda russeliana	Russell's beebalm	Mid	Pr/Wh	2	◐	6.1–7.8			UPL

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SCIENTIFIC NAME	COMMON NAME	BLOOM	FLOWER COLOR	HEIGHT	SHADE	PH	POLLINATOR	DRAINAGE	WETLAND
Oenothera biennis	Common evening primrose	Late	Ye	6	◐	4.5–6.0			UPL
Oenothera filiformis[3]	Longflower beeblossom	Mid	Wh	6.5	◐	—			UPL
Oenothera fruticosa	Narrowleaved evening primrose	Mid	Ye	3	○	4.9–6.8			FAC
Oenothera macrocarpa	Missouri evening primrose	Early–Late	Ye	1.5	◐	6.1–7.8			UPL
***Opuntia* spp.**[4]	Prickly pear	Mid	Ye	1	○	6.1–7.5			UPL
Orbexilum pedunculatum	Sampson's snakeroot	Mid	Pr	2.5	◐	5.6–6.0			FACU
Oxalis violacea	Violet wood-sorrel	Early	Vi	1	◐	6.1–7.8			UPL
Packera obovata	Roundleaf ragwort	V. Early	Ye	1.5	●	—			FACU
Palafoxia callosa	Spanish needles	Late	Wh, Pk, Pr	3	○	—			UPL
Parthenium integrifolium	Wild quinine	Mid	Wh	3	◐	5.0–7.5			UPL
Pedicularis canadensis	Wood betony	V. Early	Rd, Ye	1.3	●	4.0–7.0			FACU
Penstemon arkansanus	Arkansas beardtongue	Mid	Wh, Pk	2	○	—			UPL
Penstemon digitalis	Foxglove beardtongue	Early	Pr	4	◐	5.5–7.0			FAC
Penstemon pallidus	Pale beardtongue	Mid	Pk	3	◐	5.6–7.6			FACU
Penstemon tubaeflorus	Prairie beardtongue	Mid	Wh	3	○	6.1–8.5			UPL
Phlox divaricata* var. *laphamii	Woodland phlox	Early	Pr	3	◐	5.5–7.2			FACU
Phlox drummondii	Drummond phlox	V. Early	Wh, Rd, Pk, Pr	1.5	○–◐	< 7.2			UPL
Phlox glaberrima	Smooth phlox	Early	Pk	2	◐	5.0–7.0			FAC
Phlox paniculata	Garden phlox	Mid	Pk, Pr	4	○	6.1–7.8			FACU
Phlox pilosa	Prairie phlox	V. Early	Wh, Pk, Pr	2	○–◐	< 6.8			FACU
Physostegia angustifolia	Narrowleaf obedient plant	Late	Pr	3	○	4.9–7.8			UPL
Physostegia virginiana	Obedient plant	Late	Pr	4	◐	5.8–8.6			FACW
Plectocephalus americana	American basket-flower	Mid	Wh, Pk	5	◐	< 6.8			UPL
Podophyllum peltatum	Mayapple	V. Early	Wh, Pk	1.5	◐–●	< 6.8			FACU
Polemonium reptans	Jacob's-ladder	V. Early	Pk, Bl	1	●	6.8–7.2			FACW & FAC
Polygonatum biflorum	Solomon's seal	V. Early	Wh, Ye, Gr, Br	5	◐–●	< 6.8			FACU
Polytaenia nuttallii	Prairie parsley	Mid	Ye	2	○–◐	—			UPL
Pontederia cordata	Pickerelweed	Mid	Wh, Bl, Pr	3	○–◐	4.9–8.7			OBL
Pycnanthemum albescens	Whiteleaf mountain mint	Late	Wh	4	○–◐	6.8≶7.2			FAC & UPL
Pycnanthemum muticum	Short-toothed mountain mint	Mid	Wh, Rd, Pk, Bl, Pr	3	○–◐	6.1–7.8			FACW & FAC
Pycnanthemum tenuifolium	Slender mountain mint	Mid–Late	Wh	3	○	4.6–7.0			UPL
Pyc. verticillatum* var. *pilosum	Hairy mountain mint	Late	Wh, Pr	4	○–◐	—			FAC & UPL

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SCIENTIFIC NAME	COMMON NAME					PH	POLLINATOR ⓘ		
Ratibida columnifera	Upright prairie coneflower	Mid	Ye & Rd	3	◯	5.9–7.0			UPL
Ratibida pinnata	Gray-headed coneflower	Mid	Ye	4	◯	5.6–6.8			UPL
Rhexia mariana	Maryland meadow beauty	Mid	Pk	2.5	◐	5.1–6.5			OBL & FACW
Rhexia virginica	Virginia meadow beauty	Early–Late	Pk	2	◐	< 6.8			OBL & FACW
Rosa carolina[5]	Carolina rose	Early–Mid	Pk	3	◐	< 6.8			FACU
Rudbeckia amplexicaulis	Clasping coneflower	Mid–Late	Ye	2	◯	6.0–7.5			FAC & FACU
Rud. grandiflora* var. *alismifolia	Rough coneflower	Mid–Late	Ye	6	◐	5.6–7.5			UPL
Rud. grandiflora* var. *grandiflora	Large coneflower	Mid–Late	Ye	6	◐	5.6–7.5			UPL
Rudbeckia hirta	Black-eyed Susan	Late	Or	1	◯	6.0–7.0			FACU
Rudbeckia laciniata	Cutleaf coneflower	Late	Ye	8	●	4.5–7.0			FACW
Rudbeckia missouriensis	Missouri black-eyed Susan	Mid	Ye	2.5	◐	6.1–7.8			FACU & UPL
Rudbeckia subtomentosa	Sweet black-eyed Susan	Mid–Late	Ye	6	◐	5.6–7.5			FAC & FACU
Rudbeckia triloba	Brown-eyed Susan	Late	Ye	6	◯	5.2–7.2			FACU
Ruellia humilis	Hairy wild petunia	Early–Late	La	2.6	●	4.5–7.5			FACU
Ruellia pedunculata	Stalked wild petunia	Early–Late	La	1.5	◐	—			UPL
Salvia azurea	Pitcher sage	Late	Bl	5	◯	6.1–7.8			UPL
Salvia lyrata	Lyreleaf sage	Early	La	1	◐	5.5–7.5			UPL
Sanguinaria canadensis	Bloodroot	V. Early	Wh	0.5	●	5.0–7.0			FACU & UPL
Scrophularia lanceolata	Early figwort	Early	Pr	3	◯	4.5–7.6			FACU
Scutellaria incana	Downy skullcap	Mid–Late	Bl/Pr	3.5	◐	< 6.8			UPL
Sedum ternatum	Wild stonecrop	Early	Wh	<0.5	●	3.9–7.1			UPL
Senna marilandica	Maryland senna	Mid	Ye	4	◐	5.0–7.8			FAC
Silene stellata	Starry campion	Mid	Wh	3	◐	5.5–8.5			UPL
Silene virginica	Firepink	Mid	Rd	1	◐	5.0–7.0			UPL
Silphium asteriscus	Starry rosinweed	Late	Ye	6	◯	5.5–7.2			UPL
Silphium integrifolium	Rosinweed	Late	Ye	6	◯	4.5–7.6			UPL
Silphium laciniatum	Compass plant	Late	Ye	6	◯	4.5–7.6			UPL
Silphium perfoliatum	Cup plant	Late	Ye	6	◯	6.1–7.6			FAC
Silphium terebinthinaceum	Prairie dock	Late	Ye	6	◯	5.1–7.8			FACU
Sisyrinchium angustifolium	Blue-eyed grass	Early	Bl	1.5	◐	5.0–7.0			FACW & FAC
Sisyrinchium campestre	Prairie blue-eyed grass	Early	Bl	1	◯	—			UPL
Smallanthus uvedalia	Bear's-foot	Mid	Ye	10	◯	5.6–7.8			UPL

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SCIENTIFIC NAME	COMMON NAME					PH	POLLINATOR ⓘ		
Solidago altissima	Tall goldenrod	Late	Ye	4	◐	5.2–7.3			UPL
Solidago caesia	Blue-stemmed goldenrod	Mid	Ye	3	◐	5.5–7.0			FACU
Solidago gigantea	Giant goldenrod	Late	Ye	8	◐	4.0–8.0			FACW
Solidago hispida	Hairy goldenrod	Mid	Ye	3	○	> 7.2			UPL
Solidago nemoralis	Gray goldenrod	Mid	Ye	2	○	6.5–7.5			UPL
Solidago odora	Anise–scented goldenrod	Late	Ye	5	○	5.0–6.8			UPL
Solidago petiolaris	Savanna goldenrod	Late	Ye	4	◐	—			UPL
Solidago radula	Rough goldenrod	Late	Ye	3	○	—			UPL
Solidago rigida* ssp. *rigida	Stiff goldenrod	Late	Ye	4	◐	5.0–7.5			UPL
Solidago rugosa	Rough-leaf goldenrod	Mid–Late	Ye	3	○	5.6–7.8			FAC
Solidago ulmifolia	Elm-leaf goldenrod	Mid–Late	Ye	3	◐	—			UPL
Spigelia marilandica	Indian-pink	Early	Rd & Ye	3	◐	< 6.8			UPL
Strophostyles helvola[6]	Pink fuzzy bean	Mid–Late	Pk	10	◐	—			FAC
Strophostyles leiosperma[6]	Slickseed wild bean	Mid–Late	Pk	3	◐	—			UPL
Symphyotrichum anomalum	Manyray aster	Mid–Late	La	2.5	○	—			UPL
Symphyotrichum drummondii	Drummond's aster	Late	Pr	3	●	5.4–7.4			UPL
Symphyotrichum laeve	Smooth blue aster	Late	Wh	3	○	5.9–7.0			UPL
Symphyotrichum lateriflorum	Calico aster	Late	Wh	3	○	5.4–7.4			FAC
Symphyotrichum novae–angliae	New England aster	Late	Pr	4	◐	5.2–7.5			FACW
Symphyotrichum oblongifolium	Aromatic aster	Late	La	3	◐	5.1–6.5			UPL
Symphyotrichum oolentangiense	Sky blue aster	Late	La	4	○	5.1–6.5			UPL
Symphyotrichum patens	Late purple American aster	Late	Pr	3	○	4.9–7.9			UPL
Symphyotrichum pilosum	Frost aster	Late	Wh	3	○	5.4–7.0			UPL
Symphyotrichum praealtum	Willowleaf American aster	Late	Wh	3	○	5.5–7.5			FACW
Tephrosia onobrychoides	Hoary pea	Early	Wh & Pk	2.8	◐	—			UPL
Tephrosia virginiana	Goat's rue	Mid	Pk	3	◐	4.5–7.0			UPL
Teucrium canadense	American germander	Late	Pk	2	◐	6.3–8.0			FACW
Thalictrum dasycarpum	Purple meadow rue	Early	Wh	5	◐	—			FACW & FAC
Thalictrum revolutum	Wax-leaf meadow-rue	Mid	Wh	7	◐	—			FAC
Thalictrum thalictroides	Rue-anemone	Early	Wh	0.7	◐	< 6.8			FACU
Thaspium chapmanii	Hairy–jointed meadow parsnip	Early	Ye	3	◐	5.5–7.5			FACU
Tradescantia ernestiana	Ernest's spiderwort	V. Early–Early	Pk	2	◐	—			UPL

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SCIENTIFIC NAME	COMMON NAME					PH	POLLINATOR ⓘ		
Tradescantia occidentalis	Prairie spiderwort	Mid	Bl/Pr/Wh	2	◐	6.1–7.8			UPL
Tradescantia ohiensis	Ohio spiderwort	Early	Bl	1	◐	4.0–8.0			FAC
Trillium recurvatum	Purple trillium	Early	Ma or Ye	1.5	●	< 6.0–8.0			FACU
Uvularia grandiflora	Large bellwort	Early	Ye	2	●	6.0–7.5			UPL
Uvularia sessilifolia	Sessile bellwort	Early	Ye/Cr	1	●	< 6.0–8.0			FACW & FAC
Verbena hastata	Blue vervain	Late	Bl	5	○	5.1–7.1			FACW
Verbena stricta	Hoary vervain	Late	Bl	4	○	4.0–8.0			UPL
Verbesina alternifolia	Yellow wingstem	Late	Ye	4	◐	5.0–7.0			FAC
Verbesina helianthoides	Yellow crownbeard	Mid	Ye	2	○	5.0–7.5			UPL
Verbesina virginica	White crownbeard	Late	Wh	5	◐	6.1–7.8			FACU
Vernonia arkansana	Arkansas ironweed	Late	Pr	6	○	—			FAC
Vernonia baldwinii	Baldwin's ironweed	Mid	Pr	5	○	6.1–7.8			UPL
Vernonia gigantea	Tall ironweed	Mid	Pr	5	○	5.6–8.2			FAC
Vernonia missurica	Missouri ironweed	Mid	Pr	4	○	5.6–8.2			FACU
Vernonia texana	Texas ironweed	Mid	Pr	4	◐	—			FACU
Veronicastrum virginicum	Culver's root	Mid	Wh	4	○	4.8–8.8			FACU
Vicia caroliniana	Carolina wood vetch	Mid	Wh	1	◐	4.9–7.9			FACU
Viola palmata	Three-lobe violet	Early	Pr	0.4	◐	—			FACU
Viola pedata	Bird's-foot violet	Early	Pr	0.5	◐	< 6.8			FACU & UPL
Viola sagittata	Arrow-leaf violet	Early	Pr	0.7	◐	—			FACW & FAC
Viola sororia	Woolly blue violet	Early	Pr	0.4	◐	6.0–7.8			FAC
Zizia aptera	Heartleaf meadow parsnip	Early	Ye	2	●	5.6–8.2			FAC
Zizia aurea	Golden Alexanders	Early	Ye	3	◐	5.6–8.2			FAC

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* This table was adapted from "Table B1: Native Forbs for Pollinators" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information on the abbreviations and symbols used here, please see original source.

1. Thrips- or midge-pollinated.
2. Hemiparasitic on a variety of other plants (forbs and grasses).
3. Annual (rarely biennial)
4. *Opuntia humifusa* in the Midwest has recently been renamed and/or split into *O. cespitosa*, *O. macrorhiza*, and *O. nemoralis*.
5. Although technically a shrub, *Rosa carolina* is included here due to its small stature.
6. Although vines, they are small twining annuals included in forb seed mixes (see "Table B5: Native Vines for Pollinators" in the *Arkansas Pollinator Conservation Planning Handbook*).

Arkansas Native Grasses, Sedges, and Rushes for Pollinators

SCIENTIFIC NAME	COMMON NAME					PH	POLLINATOR ⓘ		
Andropogon gerardii	Big bluestem	Mid	Ye	6	○	6.0–7.5			FAC
Andropogon ternarius	Splitbeard bluestem	Late	Br	4	◐	< 6.0–8.0			FACU
Andropogon virginicus	Broomsedge	Late	Ye	3	○	4.7–9.0			FACU
Aristida purpurascens	Arrowfeather three-awn	Mid–Late	Wh	2	◐	—			FAC & UPL
Bouteloua curtipendula	Side oats grama	Late	Ye	3	○	5.5–8.5			UPL
Brachyelytrum erectum	Bearded shorthusk	Mid–Late	Cr	3.5	●	—			FACU
Carex albicans	Whitetinge sedge	Early	Cr	2	◐–●	—			FAC & UPL
Carex annectens	Yellowfruit sedge	Early–Mid	Gr	3	◐	—			FACW
Carex bushii	Bush's sedge	Early	Gr	2	◐	5.8–7.5			FACW
Carex cherokeensis	Cherokee sedge	Early–Mid	Gr	1	◐	6.1–7.3			FACW
Carex crinita	Saw-awn sedge	Early	Gr	5	◐	4.0–7.5			OBL & FACW
Carex frankii	Frank's sedge	Early	Gr	2	●	5.9–7.2			OBL
Carex glaucodea	Blue sedge	Early	Gr	<1	◐	—			FACW & FAC
Carex hirsutella	Hairy-leaved sedge	Early	Ye, Gr, Br	2	◐	—			UPL
Carex lupulina	Hop sedge	Early	Gr	4	◐	6.2–7.0			OBL
Carex lurida	Shallow sedge	Late	Gr	3	◐	4.9–6.8			OBL
Carex muehlenbergii	Muhlenberg's sedge	Mid	Gr	3	○	—			UPL
Carex nigromarginata	Black-edge sedge	Early–Mid	Gr	1	●	—			FACU & UPL
Carex squarrosa	Squarrose sedge	Early	Gr	3	○–●	5.6–7.3			FACW
Carex typhina	Cattail sedge	Mid	Ye, Gr, Br	2	●	5.7–7.0			OBL & FACW
Carex vulpinoidea	Fox sedge	Mid	Gr	3	◐	6.8–8.9			OBL & FACW
Chasmanthium latifolium	River oats	Mid	Gr	4	◐–●	< 6.8			FACW & FAC
Chasmanthium sessiliflorum	Longleaf wood oats	Late	Ye	5	○	5.5–7.2			FAC
Danthonia spicata	Poverty oatgrass	Early–Mid	Cr	0.5	○–●	4.5≥7			UPL
Diarrhena obovata	Beak-grain	Mid–Late	Gr	3	◐–●	—			FACW & FAC
Dichanthelium clandestinum	Deer tongue panic grass	Mid	Gr	2	○	4.0–7.5			FACW & FAC
Elymus glabriflorus	Southeastern wildrye	Mid	Gr	4	○–◐	—			UPL
Elymus hystrix	Bottlebrush grass	Mid	Gr	5	◐	6.1–6.5			UPL
Elymus virginicus	Virginia wildrye	Early	Ye	3	●	5.0–7.0			FACW
Glyceria striata	Fowl manna grass	Mid	Gr	6	●	4.0–8.0			OBL
Juncus effusus[1]	Common rush	Late	Gr, Br	4	○	4.0–6.0			OBL & FACW

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SCIENTIFIC NAME	COMMON NAME					PH	POLLINATOR ⓘ		
Leersia oryzoides	Rice cut grass	Mid	Gr	5	◯	5.1–8.8			OBL
Muhlenbergia capillaris	Hair-awn muhly	Late	Pk, Pr	3	◯	5.8–6.8			FACW & FAC
Panicum capillare	Witchgrass	Mid	Gr	3	◯	5.5–7.8			FAC
Panicum virgatum	Switchgrass	Late	Gr, Br	6	◐	4.5–8.0			FAC
Schizachyrium scoparium	Little bluestem	Late	Ye	3	◯	5.0–8.4			UPL
Scirpus atrovirens	Green bulrush	Mid	Gr, Br	6	◯	4.0–8.0			OBL
Scirpus cyperinus	Woolgrass	Mid	Gr, Br	5	◯	4.8–7.2			OBL & FACW
Sorghastrum nutans	Indiangrass	Late	Ye	6	◯–●	4.8–8.0			FACU
Spartina pectinata	Prairie cordgrass	Mid	Ye	8	◯	6.0–8.5			OBL & FACW
Sporobolus clandestinus	Rough dropseed	Late	Br	4	◯	> 7.4			UPL
Sporobolus compositus	Tall dropseed	Late	Gr	5	◯	5.5–7.0			UPL
Sporobolus cryptandrus	Sand dropseed	Mid	Ye	3	◯	6.6–8.0			UPL
Sporobolus heterolepis	Prairie dropseed	Mid	Pk, Ye, Gr, Br	2.3	◐	6.0–7.2			UPL
Tridens flavus	Purple top tridens	Late	Pr	2.5	◯	4.5–6.5			FACU
Tripsacum dactyloides	Eastern gama grass	Early–Late	Br	5	◯	5.1–7.5			FACW & FAC

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE ⓘ POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See below.

* This table was adapted from "Table B2: Native Grasses, Sedges, and Rushes for Pollinators" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information on the abbreviations and symbols used here, please see original source.

1. *Juncus interior*, *J. marginatus*, *J. tenuis*, and *J. validus* are also common in Arkansas.

Arkansas Native Shrubs and Small Trees for Pollinators

SCIENTIFIC NAME	COMMON NAME	BLOOM PERIOD(S)	FLOWER COLOR	HEIGHT AT MATURITY	SHADE TOLERANCE	PH	POLLINATOR ⓘ	DRAINAGE	WETLAND STATUS
Amelanchier arborea[1]	Serviceberry	V. Early	Wh	50	●	4.8–7.5			FAC
Amorpha canescens	Leadplant	Mid	Bl, Pr	4	○–◐	5.5–8.0			UPL
Amorpha fruticosa	False indigo bush	Mid	Pr	15	○	5.0–8.5			FACW
Asimina triloba[1]	Pawpaw	V. Early	Pr	30	●	4.7–7.2			FACU
Callicarpa americana	American beautyberry	Mid	Gr	6	◐	4.8–7.0			FACU
Ceanothus americanus	New Jersey tea	Mid	Wh	3	●	4.3–6.5			FACU
Cephalanthus occidentalis	Buttonbush	Mid–Late	Wh	20	●	4.7–8.6			OBL
Chionanthus virginicus[1]	White fringetree	Early	Wh	30	●	4.5–6.5			FACW & FAC
Cornus drummondii	Roughleaf dogwood	Early	Wh	16	◐	4.5–7.5			FAC
Cornus foemina	Smooth dogwood	Early	Wh	20	◐	5.8–7.2			FACW
Crataegus crus-galli	Cockspur hawthorn	Early	Wh	30	◐	4.5–7.2			FAC
Crataegus marshallii[1]	Parsley hawthorn	Early	Wh	25	●	5.8–7.2			FAC
Euonymus americanus	Strawberry bush	Early–Mid	Gr	12	◐	6.0–7.0			FAC
Halesia carolina	Carolina silverbell	Early	Wh	30	●	4.7–7.0			FACU
Hamamelis vernalis[1]	Ozark witch-hazel	V. Early	Gr	15	◐	< 6.8			FACU
Hamamelis virginiana[1]	Fall witch-hazel	Late	Or, Ye, Gr, Br	35	●	< 6.8			FACU
Hydrangea arborescens	Wild hydrangea	Mid	Wh & Gr	6	◐	5.0–8.0			FACU & UPL
Hypericum prolificum	Shrubby St. John's wort	Mid to Late	Ye	3	●	6.8–7.2			FACW & FAC
Ilex ambigua[1]	Carolina holly	Early	Wh	18	◐	< 6.8			UPL
Ilex decidua[1]	Deciduous holly	V. Early	Wh	30	◐	3.5–6.5			FACW
Ilex opaca	American holly	Early–Mid	Wh & Gr	60	○–●	< 6.8			FACW & FAC
Itea virginica	Virginia sweetspire	Early–Mid	Wh	8	◐	< 6.8			OBL & FACW
Lindera benzoin	Spicebush	Early	Ye	12	●	4.5–6.0			FAC
Physocarpus opulifolius[1]	Eastern ninebark	Early–Mid	Pr	10	○	4.5–6.5			FACW
Prunus angustifolia[1]	Chickasaw plum	V. Early	Wh	30	○	5.6–7.5			UPL
Prunus mexicana	Mexican plum	V. Early	Wh, Pk	35	◐	4.5–7.0			UPL
Ptelea trifoliata[1]	Wafer ash	Early–Mid	Cr	25	◐	4.8–7.0			FACU
Rhus aromatica	Fragrant sumac	Early	Ye	10	◐	6.8–7.2			UPL
Rhus copallinum	Winged sumac	Late	Ye	20	○	4.5–6.0			FACU
Rhus glabra	Smooth sumac	Mid	Wh, Ye, Gr, Br	20	○–●	6.8–7.2			UPL
Rosa carolina	Carolina rose	Early–Mid	Pk	3	◐	< 6.8			FACU

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE ⓘ POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See below.

SCIENTIFIC NAME	COMMON NAME					PH	POLLINATOR ⓘ		
Rubus allegheniensis	Allegheny blackberry	Early–Mid	Wh	6	◯	4.6–7.5		FACU & UPL
Salix humilis	Prairie willow	V. Early–Mid	Ye	10	◐	5.9–7.0		FACU
Sambucus nigra* ssp. *canadensis	Common elderberry	Mid	Wh	6	◐	6.8–7.2		UPL
***Staphylea trifolia*[1]**	Bladdernut	Early	Wh	15	●	6.8–7.2		FAC
***Vaccinium arboreum*[1]**	Farkleberry	Early–Mid	Wh	25	◐	4.0–7.0		FACU
***Vaccinium elliottii*[2]**	Elliot's blueberry	V. Early–Early	Wh	10	◯	4.7–7.5		FACW
***Vaccinium fuscatum*[2]**	Black highbush blueberry	V. Early–Early	Wh	10	◯	4.7–7.5		FACW
Vaccinium pallidum	Lowbush blueberry	V. Early	Wh	2	◯	4.1–6.9		UPL
Vaccinium stamineum	Deerberry	Early–Mid	Wh	6	◐	4.0–7.0		FACU
***Vaccinium virgatum*[2]**	Highbush blueberry	Very Early	Wh	10	◯	4.7–7.5		FACW
Viburnum dentatum	Southern arrowwood	Mid	Wh	10	◯–●	< 6.8		FAC
***Viburnum rufidulum*[1]**	Rusty blackhaw	Early	Wh	25	◐	<6.0–8.0		UPL
Viburnun prunifolium	Blackhaw viburnum	V. Early	Wh	16	●	4.8–7.5		FACU

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See below.

* This table was adapted from "Table B3: Native Shrubs and Small Trees for Pollinators" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information on the abbreviations and symbols used here, please see original source.

1. Growth habit can be shrub or tree.
2. *Vaccinium elliottii*, *V. fuscatum*, and *V. virgatum* are sometimes lumped taxonomically with the more eastern *V. corymbosum*.

Arkansas Native Trees for Pollinators

SCIENTIFIC NAME	COMMON NAME	BLOOM PERIOD(S)	FLOWER COLOR	HEIGHT AT MATURITY	SHADE TOLERANCE	PH	POLLINATOR PREFERENCE	DRAINAGE	WETLAND STATUS
Acer rubrum	Red maple	V. Early	Rd	90	●	4.5–7.5			FAC
Acer saccharum	Sugar maple	Early	Gr	100	●	3.7–7.9			UPL
Aesculus glabra	Ohio buckeye	Early	Gr	68	●	5.0–7.1			FACU
Aesculus pavia	Red buckeye	Early	Rd	25	●	3.5–7.0			FAC
Asimina triloba[1]	Pawpaw	V. Early	Pr	30	●	4.7–7.2			FACU
Castanea pumila	Allegheny chinquapin	Mid	Ye	20	◐	4.5–6.6			UPL
Celtis laevigata	Sugarberry	Early	Gr	100	●	4.4–7.7			FACW
Celtis occidentalis	Hackberry	V. Early	Gr	100	●	6.0–7.8			FACU
Celtis tenuifolia	Dwarf hackberry	Early	Wh	36	○	7.0–8.5			UPL
Cercis canadensis[1]	Eastern redbud	V. Early	Pr	30	●	5.0–7.8			FACU
Cladrastis kentukea	Yellowwood	Mid	Gr	25	◐	4.8–7.5			UPL
Cornus florida	Flowering dogwood	Early	Wh	36	●	4.8–7.7			FACU
Diospyros virginiana	Persimmon	Early	Ye	50	●	4.7–7.5			FAC
Gymnocladus dioicus	Kentucky coffeetree	Early–Mid	Gr	100	○	6.0–8.0			UPL
Liriodendron tulipifera[1]	Tuliptree	Mid	Ye	120	○	4.5–6.5			FACU
Malus angustifolia	Southern crabapple	Early	Pk	30	◐	5.7–8.2			UPL
Morus rubra[1]	Red mulberry	Early	Gr	70	◐	5.0–7.0			FAC
Nyssa sylvatica	Blackgum	Early	Wh	95	●	4.5–6.0			FAC
Prunus serotina	Black cherry	Early	Wh	110	○	4.0–7.5			FACU
Robinia pseudoacacia	Black locust	Early–Mid	Wh	70	◐	4.0–7.5			FACU
Salix caroliniana[1]	Coastal Plain willow	V. Early–Early	Gr	33	◐	4.5–8.8			OBL
Salix nigra	Black willow	V. Early–Early	Gr	65	○	4.8–8.0			FACW
Sapindus saponaria	Soapberry	Early	Wh	20	◐	7.0–8.5			FACU
Sassafras albidum	Sassafras	V. Early	Ye	75	●	4.5–7.3			FACU
Tilia americana	American basswood	Mid	Ye	100	◐	4.5–7.5			UPL
Zanthoxylum clava-herculis	Toothache tree	Early	Gr	72	○	6.6–7.5			FAC

KEY*: BLOOM PERIOD(S) FLOWER COLOR HEIGHT AT MATURITY SHADE TOLERANCE POLLINATOR PREFERENCE DRAINAGE WETLAND STATUS *See below.

* This table was adapted from "Table B4: Native Trees for Pollinators" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information on the abbreviations and symbols used here, please see original source.

1. Growth habit can be shrub or tree.
2. Native in Arkansas only on Crowley's Ridge.

Arkansas Native Vines for Pollinators

SCIENTIFIC NAME	COMMON NAME	BLOOM PERIOD(S)	FLOWER COLOR	HEIGHT AT MATURITY	SHADE TOLERANCE	PH	POLLINATOR ⓘ	DRAINAGE	WETLAND STATUS
Aristolochia tomentosa	Dutchman's pipevine	Early	Gr/Ye	70	●	5.0–7.5			FAC
Bignonia capreolata	Crossvine	Early	Rd	60	◐	5.0–6.5			FAC
Campsis radicans	Trumpet creeper	Mid	Ye	3	○	5.5–8.5			FAC
Celastrus scandens	American bittersweet	Early	Wh	15	●	5.0–7.5			FACU
Clematis versicolor	Pale leather flower	Early–Mid	Pk	16	◐	> 7.0			UPL
Clematis virginiana	Virgin's-bower	Mid–Late	Wh	6	◐	5.0–8.0			FAC
Cynanchum laeve	Sandvine milkweed	Mid–Late	Cr	40	◐	5.5–7.5			FAC
Gelsemium sempervirens	Carolina jessamine	Early	Ye	36	◐	5.6–8.5			FAC
Gonolobus suberosus	Anglepod	Mid	Gr	10	◐	5.6–7.5			FACW
Ipomoea pandurata	Wild potato vine	Mid	Wh	10	●	6.1–7.8			FACU
Lonicera flava	Yellow honeysuckle	Early	Ye	20	○	5.5–7.5			UPL
Lonicera sempervirens	Coral honeysuckle	Early	Rd	16	●	6.0–8.5			FACU
Matelea decipiens	Climbing milkweed vine	Early	Ma	6	●	7.0–8.5			FACU
Parthenocissus quinquefolia	Virginia creeper	Early	Gr	50	●	5.0–7.5			FACU
Passiflora incarnata	Purple passion-flower	Mid	Pr	6	◐	6.1–7.5			FACU
Passiflora lutea	Yellow passion-flower	Mid	Ye	16	●	5.0–7.5			FACU
Rosa setigera[1]	Prairie rose	Early–Mid	Pk	16	○	4.5–8.0			FACU
Vitis rotundifolia	Muscadine	Mid	Ye	90	◐	6.0–8.0			FAC
Wisteria frutescens	American wisteria	Early	Pr	50	●	4.0–7.0			FACW

KEY*: BLOOM PERIOD(S) · FLOWER COLOR · HEIGHT AT MATURITY · SHADE TOLERANCE · POLLINATOR PREFERENCE · DRAINAGE · WETLAND STATUS · *See below.

* This table was adapted from "Table B5: Native Vines for Pollinators" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information on the abbreviations and symbols used here, please see original source.

1. Climbing shrub.

Arkansas Plants with Bee, Butterfly, and Moth Specialist Relationships

Data for this list are organized by plant family and include only species from Tables B1 to B5 of the *Arkansas Pollinator Conservation Planning Handbook* (see notes below). Data were collected from the Lady Bird Johnson Wildflower Center's *Recommended Species Lists: Plants for Pollinators*, lists provided by the Xerces Society and Butterflies and Moths of North America (BAMONA), and from Jarrod Fowler and Sam Droege's *Pollen Specialist Bees of the Eastern United States*. While butterfly and moth caterpillars may eat various parts of a plant, bee specialists are pollen specialists, consuming pollen from only one species or genus (monolectic), or various species within one family (oligolectic). Bee specialists may collect nectar from a variety of plants.

Although here we list relationships based on plant family and genus, many of these insects have not been documented on all the species within a genus or all the genera within each family. Specialist relationships can vary greatly regionally, as well. For the aster family (Asteraceae), there are many aster family specialists that vary in visiting one species, genus, or family. Due to the very large number of **aster specialist bees** (), we include only bee families and genera (not species): Andrenidae (*Andrena*, *Calliopsis*, *Pseudopanurgus*), Apidae (*Anthophorula*, *Melissodes*, *Svastra*), Colletidae (*Colletes*), Halictidae (*Dieunomia*), Megachilidae (*Ashmeadiella*, *Hesperapis*, *Megachile*, *Paranthidium*, *Trachusa*). Where the specific plant species or genus is listed, or the specific epithet of the bee name suggests a relationship, we have also included that within the plant species row. See Fowler & Droege (2020) for more details and references.

Broad Specialists*—In addition, we have also included three important pollinator-plant relationships that do not techinically qualify as true specializations. First, while no specialist relationships are documented for **grasses** (), bees often collect pollen from grasses in flower and bumble bees (*Bombus* spp.) frequently nest below lodged native warm-season grasses—protected from predators and rain by the grass thatch. Second, due to their economic importance in passionfruit production in Mexico, **nesting blocks** () **are provided for large carpenter bees** (*Xylocopa* spp.) even though they are not oligolectic (specialists). Thirdly, though they are not known as specialists, *Megachile exilis* and *M. mucida* are **commonly found visiting pea family (Fabaceae) flowers** (). Please note that there are many additional plant-insect host relationships not documented here.

PLANT FAMILY	GENUS[1]	COMMON NAME	BEE ()[2] AND BUTTERFLY & MOTH ()[3] SPECIALISTS
Acanthaceae	*Ruellia*	Wild petunia	common buckeye (*Junonia coenia*)
Aceraceae	*Acer*	Maple	rosy maple moth (*Dryocampa rubicunda*)
Agavoideae*	*Manfreda virginica*[4]	False aloe	[*The agave family has been reclassified as a subfamily of Asparagaceae]
Anacardiaceae	*Rhus*	Sumac	red-banded hairstreak (*Calycopis cecrops*), banded hairstreak (*Satyrium calanus*)
Annonaceae	*Asimina*	Pawpaw	pawpaw sphinx (*Dolba hyloeus*), zebra swallowtail (*Protographium marcellus*)
Apiaceae	*Eryngium*	Eryngo & rattlesnake master	rattlesnake master borer moth (*Papaipema eryngii*)
	Polytaenia texana	Prairie parsley	black swallowtail (*Papilio polyxenes*)
	Zizia	Zizia & meadow parsnip	*Andrena ziziae* | black swallowtail
Apocynaceae	*Asclepias*	Milkweed	queen (*Danaus gilippus*), monarch (*D. plexippus*), milkweed tussock moth (*Euchaetes egle*)
	Cynanchum laeve	Sandvine milkweed	queen, monarch, milkweed tussock moth
	Gonolobus suberosus	Anglepod	queen, monarch, milkweed tussock moth
	Matelea	Climbing milkweed vine	queen, monarch, milkweed tussock moth
Aquifoliaceae	*Ilex*	Holly	*Colletes banksi*
Aristolochiaceae	*Aristolochia*	Pipevine	pipevine swallowtail (*Battus philenor*)
Asteraceae	*Achillea millefolium*	Yarrow	
	Arnoglossum	Indian plantain	
	Bidens	Beggarticks & tickseed	*Dieunomia heteropoda*
	Boltonia	Doll's daisy & false aster	
	Brickellia	False boneset	

KEY[†]: Caterpillar host plant | Pollinated by sphinx moths (Sphingidae) | Specialist bee | Aster specialist* | Grasses* | Xylocopa spp.* | Megachile spp.*

PLANT FAMILY	GENUS[1]	COMMON NAME	BEE (🐝)[2] AND BUTTERFLY & MOTH (🦶)[3] SPECIALISTS
Asteraceae	*Conoclinium coelestinum*	Blue mistflower	
	Coreopsis	Coreopsis	
	Echinacea	Purple coneflower	
	Eupatorium	Boneset & thoroughwort	
	Fleischmannia incarnata	Pink thoroughwort	
	Eurybia hemispherica	Swamp aster	*Andrena asteris, A. asteroides, A. hirticincta, A. nubecula, A. simplex, Anthophorula asteris, Colletes simulans, Pseudopanurgus aestivalis*
	Gaillardia	Blanketflower	
	Grindelia	Gumweed	
	Helenium	Sneezeweed	
	Helianthus	Sunflower	*Andrena accepta, A. aliciae, A. helianthi, Dieunomia heteropoda, Perdita bequaerti, Pseudopanugus* spp., *Melissodes agilis, M. trinodis, Svastra petulca, Paranthidium jugatorium, Megachile parallela, Ashmeadiella bucconis* | gorgone checkerspot (*Chlosyne gorgone*), silvery checkerspot (*C. nycteis*), painted lady (*Vanessa cardui*)
	Heliopsis	False sunflower	*Andrena accepta, A. aliciae, A. helianthi, Dieunomia heteropoda, Perdita bequaerti, Pseudopanugus* spp., *Melissodes agilis, M. trinodis, Svastra petulca, Paranthidium jugatorium, Megachile parallela, Ashmeadiella bucconis*
	Liatris	Blazing star	| *Papaipema* and *Schinia* moths
	Packera	Roundleaf ragwort	
	Palafoxia	Spanish needles	
	Parthenium integrifolium	Wild quinine	
	Plectocephalus americana	American basket-flower	
	Ratibida	Coneflower	*Andrena rudbeckiae*
	Rudbeckia	Black-eyed Susan & relatives	*Andrena rudbeckiae* | gorgone checkerspot, bordered patch (*Chlosyne lacinia*)
	Silphium	Rosinweed & cup plant	
	Smallanthus uvedalia	Bear's-foot & leafcup	
	Solidago	Goldenrod	*Andrena asteris, A. braccata, A. canadensis, A. hirticincta, A. nubecula, A. placata, A. simplex, Colletes simulans, C. solidaginis, Melissodes fumosus, Pseudopanurgus solidaginis*
	Symphyotrichum	Aster	*Andrena asteris, A. asteroides, A. hirticincta, A. nubecula, A. simplex, Anthophorula asteris, Colletes simulans, Pseudopanurgus aestivalis* | pearl crescent (*Phyciodes tharos*)
	Verbesina	Wingstem	| gold moth (*Axia olga*), silvery checkerspot
	Vernonia	Ironweed	| painted lady
Bignoniaceae	*Campsis radicans*	Trumpet creeper	plebeian sphinx (*Paratrea plebeja*)
Cactaceae	*Opuntia*	Prickly pear	*Lithurgopsis gibbosus, Melissodes mitchelli*

KEY†: Caterpillar host plant | Pollinated by sphinx moths (Sphingidae) | Specialist bee | Aster specialist* | Grasses* | Xylocopa spp.* | Megachile spp.*

PLANT FAMILY	GENUS[1]	COMMON NAME	BEE ( )[2] AND BUTTERFLY & MOTH ( )[3] SPECIALISTS
Campanulaceae	*Campanula americana*	Tall bellflower	*Colletes brevicornis*
Caprifoliaceae	*Lonicera sempervirens*	Coral honeysuckle	spring azure (*Celastrina ladon*), snowberry clearwing (*Hemaris diffinis*)
	Viburnum	Viburnum & arrowwood	spring azure, snowberry clearwing
Convolvulaceae	*Ipomoea*	Wild potato vine & relatives	*Cemolobus ipomoea, Melitoma taurea, Xenoglossa kansensis*
Cornaceae	*Cornus*	Dogwood	*Andrena fragilis, A. integra, A. platyparia* | spring azure
Cyperaceae	*Scirpus*	Woolgrass	dion skipper (*Euphyes dion*)
Ericaceae	*Vaccinium*	Blueberry & relatives	*Habropoda laboriosa, Melitta americana, Panurginus atramontensis, Perdita obscurata*
Fabaceae	*Amorpha*	False indigo & leadplant	*Hoplitis micheneri* | hoary edge (*Achalarus lyciades*), silver-spotted skipper (*Epargyreus clarus*), gray hairstreak (*Strymon melinus*), southern dogface (*Zerene cesonia*)
	Astragalus	Milkvetch	
	Baptisia	Wild indigo	| frosted elfin (*Callophrys irus*), wild indigo duskywing (*Erynnis baptisiae*)
	Cercis canadensis	Eastern redbud	*Habropoda laboriosa*
	Chamaecrista	Sensitive pea & partridge pea	| cloudless sulphur (*Phoebis sennae*)
	Crotalaria	Rattlebox	
	Dalea	Prairie clover	
	Desmanthus	Bundleflower	
	Desmodium	Tick-trefoil & beggar's lice	
	Gymnocladus	Kentucky coffeetree	| bicolored honey locust moth (*Sphingicampa bicolor*), bisected honey locust moth (*S. bisecta*)
	Lespedeza	Lespedeza	| eastern tailed blue (*Cupido comyntas*), silver-spotted skipper, gray hairstreak
	Mimosa	Sensitive briar & powderpuff	
	Orbexilum	Snakeroot	
	Pediomelum	Scurf pea	
	Robinia pseudoacacia	Black locust	
	Senna	Senna	| sleepy orange (*Eurema nicippe*)
	Strophostyles	Fuzzy bean & wild bean	*Megachile integra, Trachusa dorsalis*
	Tephrosia	Goat's rue & hoary pea	
	Vicia	Vetch & wood vetch	
	Wisteria frutescens	American wisteria	| marine blue (*Leptotes marina*)
Fagaceae	*Quercus*	Oak	gray hairstreak
Geraniaceae	*Geranium*	Wild geranium	*Andrena distans, A. geranii*
Hydrangeaceae	*Hydrangea*	Wild hydrangea	hydrangea sphinx (*Darapsa versicolor*)

KEY†: Caterpillar host plant | Pollinated by sphinx moths (Sphingidae) | Specialist bee | Aster specialist* | Grasses* | Xylocopa SPP.* | Megachile SPP.*

PLANT FAMILY	GENUS[1]	COMMON NAME	BEE (🐝)[2] AND BUTTERFLY & MOTH (🐛)[3] SPECIALISTS
Lamiaceae	*Agastache nepetoides*	Yellow giant hyssop	🐛 common buckeye
	Monarda	Bergamot & beebalm	🐝 *Dufourea monardae, Perdita gerhardi, Protandrena abdominalis*
Lauraceae	*Lindera*	Spicebush	🐛 eastern tiger swallowtail (*Papilio glaucus*), spicebush swallowtail (*P. troilus*), promethea silkmoth (*Callosamia promethea*)
	Sassafras albidum	Sassafras	🐛 eastern tiger & spicebush swallowtails, imperial moth (*Eacles imperialis*), promethea silkmoth, sassafras caloptilia moth (*Caloptilia sassafrasella*)
Linaceae	*Linum*	Flax	🐛 variegated fritillary (*Euptoieta claudia*)
Magnoliaceae	*Liriodendron tulipifera*	Tuliptree	🐛 tuliptree silkmoth (*Callosamia angulifera*), eastern tiger swallowtail
Malvaceae	*Callirhoe*	Poppy mallow	🐝 *Diadasia afflica*
	Hibiscus	Rose mallow	🐝 *Ptilothrix bombiformis*
Moraceae	*Morus rubra*	Red mulberry	🐛 red admiral (*Vanessa atalanta*)
Oleaceae	*Chionanthus virginicus*	White fringetree	🐛 rustic sphinx (*Manduca rustica*)
	Fraxinus	Ash	🐛 Canadian sphinx (*Sphinx canadensis*), eastern tiger swallowtail, hickory hairstreak (*Satyrium caryaevorus*), mourning cloak (*Nymphalis antiopa*), viceroy (*Limenitis archippus*), orange sulphur (*Colias eurytheme*)
Onagraceae	*Oenothera*	Evening primrose	🐝 *Lasioglossum oenotherae, Megachile oenotherae, Melissodes fimbriatus*
Papaveraceae	*Sanguinaria canadensis*	Bloodroot	🐝 *Megachile oenotherae, Melissodes fimbriatus*
Passifloraceae	*Passiflora*	Passion-flower	🐝 | 🐛 Gulf fritillary (*Agraulis vanillae*), red-banded hairstreak, variegated fritillary (*Euptoieta claudia*), banded hairstreak
	Passiflora lutea	Yellow passion-flower	🐝 *Pseudopanurgus passiflorae* | 🐛 Julia heliocninan (*Dryas iulia*)
Poaceae	*Andropogon*	Broomsedge & relatives	🌾 | 🐛 Delaware skipper (*Anatrytone logan*), arogos skipper (*Atrytone arogos*)
	Bouteloua	Grama	🌾 | 🐛 Leonard's skipper (*Hesperia leonardus*)
	Chasmanthium	River oats & relatives	🌾 | 🐛 common roadside skipper (*Amblyscirtes reversa*)
	Panicum	Switchgrass	🌾 | 🐛 Delaware skipper
	Schizachyrium scoparium	Little bluestem	🌾 | 🐛 arogos skipper, dusted skipper (*Atrytonopsis hianna*), ottoe skipper (*Hesperia ottoe*), crossline skipper (*Polites origenes*)
	Sorghastrum	Indiangrass	🌾 | 🐛 pepper and salt skipper (*Amblyscirtes hegon*), Georgia satyr (*Neonympha areolatus*)
	Tridens	Purple top	🌾 | 🐛 common wood-nymph (*Cercyonis pegala*), broad-winged skipper (*Poanes viator*), crossline skipper (*Polites origenes*), little glassywing (*Pompeius verna*)
	Tripsacum dactyloides	Eastern gama grass	🌾 | 🐛 byssus skipper (*Problema byssus*)
Polemoniaceae	*Polemonium reptans*	Jacob's-ladder	🐝 *Andrena polemonii*
Pontederiaceae	*Pontederia cordata*	Pickerelweed	🐝 *Dufourea novaeangliae, Florilegus condignus*
Rhamnaceae	*Ceanothus*	New Jersey tea	🐝 *Pseudopanurgus pauper, P. virginicus* | 🐛 summer azure (*Celastrina neglecta*), spring azure, mottled duskywing (*Erynnis martialis*)

KEY†: 🐛 Caterpillar host plant | Pollinated by sphinx moths (Sphingidae) | 🐝 Specialist bee | Aster specialist* | 🌾 Grasses* | Xylocopa spp.* | Megachile spp.*

PLANT FAMILY	GENUS[1]	COMMON NAME	BEE (🐝)[2] AND BUTTERFLY & MOTH (🐛)[3] SPECIALISTS
Rosaceae	*Crataegus*	Hawthorn	🐝 *Andrena crataegi*
	Fragaria virginiana	Wild strawberry	🐝 *Andrena melanochroa, A. ziziaeformis, Panurginus potentillae* | 🐛 gray hairstreak
	Prunus	Cherry & plum	🐛 eastern tiger swallowtail, viceroy
Rutaceae	*Ptelea trifoliata*	Wafer ash	🐛 eastern tiger swallowtail, giant swallowtail (*Papilio cresphontes*)
Salicaceae	*Salix*	Willow	🐝 *Andrena andrenoides, A. bisalicis, A. erythrogaster, A. frigida, A. illinoensis, A. macoupinensis, A. mariae, A. nida, A. nigrae, A. salictaria, A. sigmundi* | 🐛 green comma (*Polygonia faunus*), mourning cloak, viceroy
Saxifragaceae	*Heuchera*	Alumroot	🐝 *Colletes aestivalis*
Scrophulariaceae	*Agalinis*	False foxglove	🐝 *Anthophorula micheneri, Perdita gerardiae* | 🐛 common buckeye
	Castilleja coccinea	Indian paintbrush	🐛 common buckeye, checkerspot species (documented in other states), phyllira tiger moth (*Grammia phyllira*)
	Mimulus	Monkey flower	🐛 common buckeye
	Penstemon	Beardtongue	🐝 *Osmia distincta* | 🐛 dotted checkerspot (*Poladryas minuta*) [not shown as in AR in BAMONA]
Styracaceae	*Halesia*	Silverbell	🐝 *Anthophorula micheneri, Perdita gerardiae* | 🐛 eastern comma (*Polygonia comma*), eastern tiger swallowtail, mourning cloak, red-spotted purple (*Limenitis arthemis*), viceroy
Verbenaceae	*Verbena*	Vervain	🐝 *Calliopsis nebraskensis* | 🐛 common buckeye
Violaceae	*Viola*	Violet	🐝 *Andrena violae* | 🐛 great spangled fritillary (*Speyeria cybele*), regal fritillary (*S. idalia*)
Vitaceae	*Parthenocissus quinquefolia*	Virginia creeper	🐛 eight-spotted forester moth (*Alypia octomaculata*), Virginia creeper sphinx (*Darapsa myron*)

KEY†: 🐛 Caterpillar host plant | Pollinated by sphinx moths (Sphingidae) | 🐝 Specialist bee | Aster specialist* | Grasses* | Xylocopa spp.* | Megachile spp.*

* See Broad Specialists text in introduction above for more information.

† This table was adapted from "Table B6: Plants with Bee, Butterfly, and Moth Specialist Relationships" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information on the abbreviations and symbols used here, please see original source.

1. **SPECIES** is listed instead of genus when only one species is found in AR.
2. **BEE SPECIALISTS (🐝)** consume pollen from only one species, genus or family, included from Fowler & Droege 2020 when listed as present in AR or adjacent states
3. **BUTTERFLY & MOTH SPECIALIST (🐛)**—Caterpillar host plants can vary greatly by region—see Wagner 2005. There are many more Lepidoptera specialists than listed here. The *Federal Highway Administration Ecoregional Revegetation App* lists many additional larval host relationships.

Pollinator-Friendly Crops to Enhance Crop Rotation Diversity in Arkansas*

As of March 2020, through the Conservation Stewardship Program (CSP), Arkansas NRCS offers technical and financial support to eligible farmers who improve their existing crop rotation by adding pollinator-friendly crops into the rotation. This improvement is referred to as Conservation Enhancement Activity E328J: Improved crop rotation to provide benefits to pollinators. Pollinator-friendly crops are those that provide ample amounts of nectar and/or pollen for pollinators to forage on. Each year, the pollinator-friendly crop will be planted on a minimum of 5% of cropland acres contained within the agricultural operation. These crops can be harvested for sale or can be grown as cover crops, but to meet the purpose and definition of a pollinator-friendly crop, these crops must be allowed to bloom prior to harvest or termination. Additionally, so as to protect pollinators, use of insecticides is limited for the pollinator-friendly crop.

The table below represents the official list of pollinator-friendly crops with regards to Conservation Enhancement Activity E328J in Arkansas as of March 2020. However, Arkansas NRCS may revise the official list at any time, so please consult Arkansas NRCS for the current official list and for more information on this enhancement activity.

CROP	PRIMARY USE
Alfalfa	harvestable
Alyssum, sweet	cover crop
Basil	harvestable
Bean, bush and pole	harvestable
Bean, fava	harvestable
Borage	harvestable
Buckwheat	harvestable
Canola	harvestable
Cantaloupe	harvestable
Chickpea	harvestable
Chicory	cover crop
Cilantro / coriander	harvestable
Clover, alsike	cover crop
Clover, berseem	cover crop
Clover, crimson	cover crop
Clover, kura	cover crop
Clover, red	cover crop
Clover, rose	cover crop
Clover, strawberry	cover crop
Clover, subterranean	cover crop
Clover, white	cover crop
Cowpea	harvestable
Cucumber	harvestable
Cut flowers (e.g., cosmos, zinnias)	harvestable
Dill	harvestable
Eggplant	harvestable
Fennel	harvestable
Flax	harvestable
Garlic	harvestable

CROP	PRIMARY USE
Lablab	cover crop
Lentil	harvestable
Lupine, sweet blue	cover crop
Meadowfoam	cover crop
Melon	harvestable
Milkvetch	cover crop
Okra	harvestable
Partridge Pea	cover crop
Partridge Pea, small	cover crop
Pea, Austrian winter	cover crop
Pea, garden	harvestable
Pea, purple hull (A.K.A. black-eyed pea)	harvestable
Pepper	harvestable
Pumpkin	harvestable
Radish, oilseed/tillage	cover crop
Safflower	harvestable
Sanfoin	cover crop
Sesame	harvestable
Squash	harvestable
Strawberry	harvestable
Sunflower	harvestable
Tomato	harvestable
Turnip	cover crop
Vetch, Cahaba	cover crop
Vetch, chickling	cover crop
Vetch, common or garden	cover crop
Vetch, hairy	cover crop
Vetch, purple	cover crop
Watermelon	harvestable

* This table was adapted from "Table B10: Pollinator-Friendly Crops to Enhance Flowering Diversity in Crop Rotations" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information, please see original source.

Arkansas Crop-Pollinator Relationships

COMMON NAME	SCIENTIFIC NAME	USE*	FURTHER INFO†	POLLINATION	NATIVE (OR NATIVE RELATIVES)[1]
Alfalfa	*Medicago sativa*	HVT	NRCS CP†, CC†, Enhances crop rotations†	Req. pollinators	—
Almond	*Prunus dulcis*	HVT	—	Req. pollinators	8 natives are plums and cherries[4]
Alyssum, sweet	*Lobularia maritima*	CC	CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators, Supports/attracts natural enemies	—
Apple	*Malus pumila*	HVT	Specialty crop	Req. pollinators, Supports/attracts natural enemies	*M. angustifolia*[2], *M. ioensis*[2]
Apricot	*Prunus armeniaca*	HVT	—	Req. pollinators	8 natives are plums and cherries[4]
Aronia berries	*Aronia* (*Photinia*) spp.	HVT	—	Req. pollinators	Native
Basil, sweet	*Ocimum basilicum*	HVT	Edible/medicinal†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators, Supports/attracts natural enemies	Native relative in FL
Bean, bush / pole	*Phaseolus vulgaris*	HVT	Enhances crop rotations†	Produces more or better-quality FRUIT w/ pollinators	*P. polystachils*; native spp. in other states
Beans, lima / snap	*Phaseolus* spp.	HVT	—	Produces more or better-quality FRUIT w/ pollinators	*P. polystachils*; native spp. in other states
Black raspberry	*Rubus occidentalis*	HVT	—	Req. pollinators, Supports/attracts natural enemies	Native; 15 other native spp. in AR[5]
Blackberry (including marionberry)	*Rubus* spp.	HVT	Specialty crop, Shrub/small tree†	Req. pollinators, Supports/attracts natural enemies	16 native *Rubus* spp. in AR[5]
Blueberry	*Vaccinium corymbosum* & hybrids	HVT	Specialty crop, Shrub/small tree†, Host plant†, Supports specialist bees†	Req. pollinators, BLUEBERRY BEE	Native; 5 other native spp. in AR[6]
Borage	*Borago officinalis*	HVT	Edible/medicinal†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	—
Buckwheat	*Fagopyrum esculentum*	HVT	Recommended CC†, Enhances crop rotations†	Supports/attracts natural enemies	—
Canola	*Brassica* spp.	HVT	CC†, Enhances crop rotations†	Produces more or better-quality FRUIT w/ pollinators	—
Cantaloupe	*Cucumis melo* var. *cantalupensis*	HVT	Supports specialist bees†, Enhances crop rotations†	Req. pollinators, SQUASH BEE	—
Carrots	*Daucus carota* ssp. *sativus*	HVT	CC†	Req. pollinators, Supports/attracts natural enemies	*D. pusillus*
Cherry	*Prunus* spp.	HVT	Tree†, Host plant†	Req. pollinators, Supports/attracts natural enemies	8 natives (some are plums)[4]
Chickpea	*Cicer arietinum*	HVT	CC†, Enhances crop rotations†	Produces more or better-quality FRUIT w/ pollinators	—
Chicory	*Cichorium intybus*	CC	CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	—
Cilantro / coriander	*Coriandrum sativum*	HVT	CC†, Edible/medicinal†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators (coriander), Supports/attracts natural enemies	—
Clover, alsike	*Trifolium hybridum*	CC	NRCS CP†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*
Clover, berseem	*Trifolium alexandrinum*	CC	NRCS CP†, CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*
Clover, crimson	*Trifolium incarnatum*	CC	NRCS CP†, CC†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*
Clover, kura	*Trifolium ambiguum*	CC	NRCS CP†, CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*
Clover, red	*Trifolium pratense*	CC	NRCS CP†, CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*
Clover, rose	*Trifolium hirtum*	CC	NRCS CP†, CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*
Clover, strawberry	*Trifolium fragiferum*	CC	NRCS CP†, CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*
Clover, subterranean	*Trifolium subterraneum*	CC	NRCS CP†, CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*
Clover, white	*Trifolium repens*	CC	NRCS CP†, CC†, Enhances crop rotations†	Produces more or better-quality SEED w/ pollinators	*T. carolinianum, T. reflexum*

KEY

Req. pollinators · Supports/attracts natural enemies · Produces more or better-quality SEED w/ pollinators · Produces more or better-quality FRUIT w/ pollinators · Specialty crop · NRCS CP† · Shrub/small tree† · Tree† · Host plant† · Recommended CC† · CC† · Edible/medicinal† · Enhances crop rotations† · Supports specialist bees†

COMMON NAME	SCIENTIFIC NAME	USE*	FURTHER INFO†	POLLINATION	NATIVE (OR NATIVE RELATIVES)[1]
Corn	*Zea mays*	HVT	—		—
Cotton	*Gossypium* spp.	HVT		ROSEMALLOW BEE	*G. hirsutum* native in FL & adventive[3] in AR
Cucumber	*Cucumis sativus*	HVT		/ SQUASH BEES	—
Dill	*Anethum graveolens*	HVT			—
Eggplant	*Solanum melongena*	HVT			*S. ptychanthum* (some spp. noxious)
Elderberry, common	*Sambucus nigra* ssp. *canadensis*	HVT			Native spp. in other states; *S. racemosa* poisonous
Fava bean	*Vicia faba*	HVT			*V. caroliniana, V. ludoviciana, V. minutiflora*
Fennel	*Foeniculum vulgare*	HVT			—
Flax, common	*Linum usitatissimum*	HVT			*L. lewisii, L. medium, L. striatum, L. sulcatum*
Garlic	*Allium sativum*	HVT			*A. stellatum* (some spp. noxious)
Jerusalem artichoke	*Helianthus tuberosus*	HVT	—		Native; 11 other native spp. in AR[7]
Lablab	*Lablab purpureus*	CC			—
Lentil	*Lens culinaris*	HVT			—
Lupine, sweet blue	*Lupinus angustifolius*	CC			*L. texensis*[8]
Meadowfoam	*Limnanthes* spp.	CC			Native spp. in Pacific coast states
Melon (cantaloupe, honeydew, and muskmelon)	*Cucumis melo*	HVT		SQUASH BEES	—
Milkvetch	*Astragalus* spp.	CC			*A. canadensis, A. crassicarpus, A. distortus, A. nutallianus*[8]
Okra	*Abelmoschus esculentus*	HVT		ROSEMALLOW BEE	—
Partridge pea, sensitive / small	*Chamaecrista nictitans*	CC			Native
Partridge pea, showy	*Chamaecrista fasciculata*	CC			Native
Pea, Austrian winter	*Pisum arvense*	CC			—
Pea, cowpea / purple hull (a.k.a. black-eyed pea)	*Vigna unguiculata*	HVT			Native spp. in Gulf states coastal plain & FL
Pea, garden	*Pisum sativum*	HVT			—
Peach & nectarine	*Prunus persica*	HVT			8 natives are plums and cherries[4]
Peanut	*Arachis hypogaea*	HVT	—		—
Pear	*Pyrus* spp.	HVT			—
Pepper (Bell, chili, pimiento, and others)	*Capsicum annuum*	HVT			—
Persimmon	*Diospyros virginiana*	HVT			Native
Plum	*Prunus* spp.	HVT			8 natives (some are cherries)[4]
Pomegranate	*Punica granatum*	HVT	—		—
Pumpkin	*Cucurbita* spp.	HVT		SQUASH BEES	*C. foetidissima, C. melopepo*

KEY Req. pollinators · Supports/attracts natural enemies · Produces more or better-quality SEED w/ pollinators · Produces more or better-quality FRUIT w/ pollinators · Specialty crop · NRCS CP† · Shrub/small tree† · Tree† · Host plant† · Recommended CC† · CC† · Edible/medicinal† · Enhances crop rotations† · Supports specialist bees†

COMMON NAME	SCIENTIFIC NAME	USE*	FURTHER INFO†	POLLINATION	NATIVE (OR NATIVE RELATIVES)[1]
Radish, oilseed/tillage	*Raphanus sativus*	CC	★		—
Rice	*Oryza sativa*	HVT	—	—	—
Safflower	*Carthamus tinctorius*	HVT	☆		—
Sainfoin	*Onobrychis* spp.	CC	☆		—
Seed (sunflower for oil and seed, other flowers, and vegetables)	See sunflower, radish, carrot, etc.	HVT	—		—
Sesame	*Sesamum orientale*	HVT	★		—
Soybean	*Glycine max*	HVT	—		—
Squash	*Cucurbita* spp.	HVT		SQUASH BEES	*C. foetidissima, C. melopepo*
Strawberry	*Fragaria* spp.	HVT		/	*F. virginiana*
Sunflower	*Helianthus annuus*	HVT	★		Native; 11 other native spp. in AR[7]
Tomato	*Solanum lycopersicum*	HVT		/	*S. ptychanthum* (some spp. noxious)
Turnip	*Brassica rapa*	CC	★		—
Vetch, Cahaba	*Vicia sativa* × *V. cordata*	CC			*V. caroliniana, V. ludoviciana, V. minutiflora*
Vetch, chickling	*Lathyrus sativus*	CC	☆		*L. venosus*
Vetch, common or garden	*Vicia sativa*	CC	☆		*V. caroliniana, V. ludoviciana, V. minutiflora*
Vetch, hairy	*Vicia villosa*	CC			*V. caroliniana, V. ludoviciana, V. minutiflora*
Vetch, purple	*Vicia americana*	CC	☆		*V. caroliniana, V. ludoviciana, V. minutiflora*
Watermelon	*Citrullus lanatus*	HVT		SQUASH BEES	—

KEY: Req. pollinators; Supports/attracts natural enemies; Produces more or better-quality SEED w/ pollinators; Produces more or better-quality FRUIT w/ pollinators; Specialty crop; NRCS CP†; Shrub/small tree†; Tree†; Host plant†; Recommended CC†; CC†; Edible/medicinal†; Enhances crop rotations†; Supports specialist bees†

† **FURTHER INFORMATION**—This table was adapted from "Table B11. Arkansas Crop-Pollinator Relationships" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For additional details, please consult these sections of the handbook:

- *Table 6: NRCS Supporting Conservation Practices for Pollinator Habitat Establishment in Arkansas*
- *Table B3: Native Shrubs and Small Trees for Pollinators*
- *Table B4: Native Trees for Pollinators*
- *Table B6: Plants with Bee, Butterfly, and Moth Specialist Relationships*
- *Table B7: Cover Crops Recommended for Arkansas That Support Pollinators and Natural Enemies of Pests*
- *Table B8: Additional Cover Crops for Pollinators and Natural Enemies of Crop Pests That May Grow Well in Arkansas*
- *Table B9: Herbs (Annual and Perennial) That Provide Forage and Habitat for Pollinators, Predators, and Parasitoids*
- *Table B10: Pollinator-Friendly Crops to Enhance Flowering Diversity in Crop Rotations*
- *Appendix F: Common & Specialist Bees of Arkansas*

* **USE**—harvest (HVT), cover crop (CC). **Note:** This list does not include many cut flowers that can also be grown as crops in Arkansas.

1. There may be connections between pollinators of native plants and related crops. See BONAP.org or the *Atlas of Vascular Plants of Arkansas* for distribution. "Native relative" here indicates not native in Arkansas, but plants in same genus grow in other parts of the United States. There may be additional relatives in the family (different genera) growing in Arkansas.
2. Used to make jelly.
3. Adventive means it is locally or temporarily naturalized, but conditions for spread not likely present.
4. Native *Prunus* spp.: *P. angustifolia, P. caroliniana, P. mexicana, P. serotina, P. umbellata, P. virginiana* (*P. americana* and *P gracilis* are rare in AR)
5. Native *Rubus* spp.: *R. aboriginum, R. allegheniensis, R. alumnus, R. argutus, R. bushii, R. flagellaris, R. frondosus, R. leviculus, R. meracus, R. mollior,* (*R. occidentalis*), *R. pascuus, R. pensilvanicus, R. roribaccus, R. suus, R. trivialis*
6. Native *Vaccinium* spp.: *V. arboreum, (V. corymbosum), V. elliottii, V. fuscatum, V. pallidum, V. stamineum*
7. Native *Helianthus* spp.: *H. angustifolius*, (*H. annuus*), *H. decapetalus, H. divaricatus, H. grosseserratus, H. hirsutus, H. microcephalus, H. mollis, H. occidentalis, H. pauciflorus* (rare), *H. strumosus*, (*H. tuberosus*)
8. Rare

Common & Specialist Bees of Arkansas

The following table outlines bee genera that could be found in Arkansas. Individual life history details for certain species may vary from the general genus-level characteristics described here. This list provides planners and clients a general overview of native bees. For those interested in learning more about the bees on their land or in their communities, BugGuide.net and the apps iNaturalist and Seek by iNaturalist are excellent tools for identification. Any photographs you share with those projects will help to document bee diversity in Arkansas and could help improve future conservation planning.

Left to right: Bees documented in Arkansas recently include the sweat bees (*Halictus ligatus*) and (*Agapostemon splendens*), both in the Halictidae family and relatively common. The northern rotund-resin bee (*Anthidiellum notatum*) is in the leafcutter family, Megachilidae, whose females can be recognized by the pollen carrying hairs (scopa) on their bellies (other bees have scopal hairs on their legs). Leafcutter bees also have relatively large heads since they use their jaws to cut leaves or collect plant hairs for their nests. (Photos: Coleman Z. Little, University of Central Arkansas.)

FAMILY	GENUS • COMMON NAME • NESTING | SOCIALITY | TIMING | ABUNDANCE • DESCRIPTION & NOTES†
ANDRENIDAE Andrenid, Mining, or Miner Bees	***Andrena*** • **Andrenid or mining bees** • Ground | Solitary & Communal | All season (mostly Sp) | Abundant • This genus comprises close to one fifth of the species in eastern North America, with more than 60 in AR. Important pollinators of early spring flowering crops like apple, blueberry, and plum.
	Anthemurgus • **Passion-flower bees** • Ground | Solitary, but gregarious | Late Sp & Su | Local • Only one species in North America, *A. passiflorae*, pollen specialist of yellow passion-flower, *Passiflora lutea* (where mating occurs).
	Calliopsis • **Mining, panurgine[1], or calliopsine bees** • Ground | Solitary, but gregarious | Su | Abundant • Often have yellow or white markings on their faces and hairy bodies. Males have yellow legs. Most are pollen specialists.
	Panurginus • **Panurgine, mining, or confluent-miner bees** • Ground | Solitary, but gregarious | Sp | Rare • Tiny. Small, dark, with yellow on the faces and legs of some males. May confuse with *Calliopsis*, but not hairy. Many are pollen specialists. Some nest in large aggregations.
	Perdita • **Mining, panurgine[1], or fairy bees** • Ground | Solitary | Su & Fa | Local • Tiny, with light markings between eyes, few hairs. Nest in very sandy habitats. Includes the smallest bee in N. America. The name means "lost," possibly reflecting difficulty in keeping track of such tiny bees.
	Protandrena • **Mining, panurgine[1], protandrenine, or bare-miner bees** • Ground | Solitary & Communal | Su | Local • Somewhat large for Panurginae subfamily (up to 0.5"), with yellow markings on face, legs, and thorax, little hair. Some specialists. Some nest aggregation. Found only in the Americas.
	Pseudopanurgus • **Mining, panurgine[1], or false shaggy bees[2]** • Ground | Solitary | Fa | Rare • Tiny, sparse body hair. Males with bright yellow faces below antennae (on clypeus). Often aggregate nests.
APIDAE Bumble, Carpenter, Honey, Longhorned, and Squash Bees	***Anthophora*** • **Anthophorid, chimney, miner, or digger bees** • Wood & ground | Solitary | Sp & Su | Local • Can resemble small bumble bees, but females have hairier hind legs and males have white face patches. Females often aggregate nests. Come evening, males often sleep in aggregations on plants.
	Apis • **Honey bees** • Hives | Social | All season | Abundant • *A. mellifera* is the only *Apis* species in U.S. and most important managed bee in U.S. Non-native, introduced from Europe. "Apis" is Latin for bee."Melli" and "ferre" are Greek for honey and to bear (carry).
	Bombus • **Bumble bees** • Rodent burrows, large cavities | Social | All season | Abundant • Name from Greek for "buzzing sound." Among the most effective pollinators, with about 8 species documented in AR. The endangered rusty patched (*B. affinis*) is found in AR (first bee to be listed as endangered in the continental U.S.).
(CONTINUED ON NEXT PAGE)	***Ceratina*** • **Small carpenter bees** • Stems (old wood with existing cavity) | Solitary & Subsocial[3] | All season | Abundant • Squarrish rump, very dark blue or green coloration, and relatively few hairs make somewhat easy to recognize to genus. Females guard nest cells and check on developing brood (young).

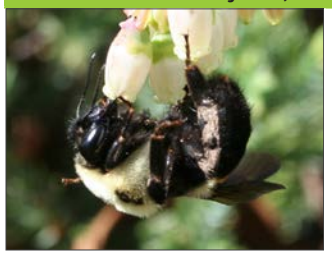
KEY: **NESTING** Site **SOCIALITY** **TIMING—Time of Year: Spring (Sp), Summer (Su), Fall (Fa)** **ABUNDANCE**

FAMILY	GENUS • COMMON NAME • NESTING | SOCIALITY | TIMING | ABUNDANCE • DESCRIPTION & NOTES†
APIDAE CONTINUED	***Eucera*** **• Long-horned[4] or sunflower bees** • Ground | Solitary | Su & Fa | Common • Often associated with sunflowers and related species. Relatively chunky bodies with very hairy legs (described as looking like "chaps.")
	Habropoda **• Southeastern blueberry bee** • Muddy streambanks | Solitary | Sp | Local • *H. laboriosa* is the only species in AR. A specialist on heath (blueberry, huckleberry, and cranberry). Locally abundant near those flowers. Look similar to bumble bees, but males with white patches on their faces. May confuse with *Anthophora*, but active only in early spring when blueberry is in flower.
	Melissodes **• Long-horned[4] bees** • Ground | Solitary | Su & Fa | Common • Often associated with sunflowers and related species. Males sometimes form sleeping aggregations, clustering together on a plant stem. Females often in large nest aggregations.
	Melitoma **• Mallow or chimney bees** • Ground | Solitary | Su | Local • Pollen specialist of native morning glories, *Ipomoea* spp. They moisten soil when excavating nests and create small "chimneys' of mud around nest entrance. Easy to recognize at host flower due to distinctive black/white striped abdomen.
	Nomada **• Nomad cuckoo bees** • Cleptoparasite[5] | N/A | All season | Abundant • Targets primarily *Andrena*, also parasitizes *Agapostemon*, *Eucera*, and *Melitta*. Usually black and yellow, hairless and wasp-like in appearance.
	Peponapis **• Squash bees** • Ground | Solitary | Su | Common • Specialize on cucurbits (squash, pumpkin, cucumber, melon) pollen. Females nest near host plants and males often sleep in the flowers (that generally close by noon).
	Ptilothrix **• Rose mallow, hibiscus, hibiscus turret, okra, cotton, or eastern digger bee** • Ground | Solitary | Su | Common • (*P. bombiformis*) is the only species east of the Mississippi. Specialize on mallow family flowers. Form nests like *Melitoma* (chimneys). Easy to recognize on host flowers. Closely resemble bumble bees, but do not have pollen baskets (corbiculae).
	Svastra **• Long-horned[4] or sunflower bees** • Ground | Solitary | Su | Common • Often associated with sunflowers and related species. Similar in appearance to *Eucera*.
	Triepeolus **• Cuckoo nomad bees** • Cleptoparasite[5] | N/A | Su & Fa | Local • Targets diverse bees (mainly in the Apidae family) with very short hairs forming beautiful and distinctive black and white patterns. Resemble wasps.
	Xenoglossa **• Squash or large squash bees** • Ground | Solitary | Su | Common • Like *Peponapis* in appearance, foraging, and nesting—but their bodies may be stouter. Starts foraging as early as 4 a.m. Male has more pronounced yellow marking on his face than *Peponapis* male.
	Xylocopa **• Large carpenter bees** • Wood (western species use other sites) | Nest sharing | All season | Common • The eastern carpenter bee (*X. virginica*) is the only species in AR. Larger eyes and "shiny hinies" vs. bumble bees. Carry pollen on long hairs (vs. bumble bees in a pollen basket that creates a large lump of pollen). Social behaviors include mothers feeding offspring, and overwintering together.

KEY: **NESTING** Site **SOCIALITY** **TIMING—Time of Year: Spring (Sp), Summer (Su), Fall (Fa)** **ABUNDANCE**

Specialist Bees of Arkansas Crops: The majority of bees—including the social species—are **generalists** that gather nectar and pollen from a wide range of flower types and species. **Specialist bees** rely on a single plant species, or a closely related group of plants, for pollen. Because these specialists have co-evolved with their host plants, their life cycles are often closely tied (adults emerge when the plants are flowering) and they are sometimes the most effective pollinators for their hosts. Below are three important specialist bees that may be found pollinating Arkansas crops.

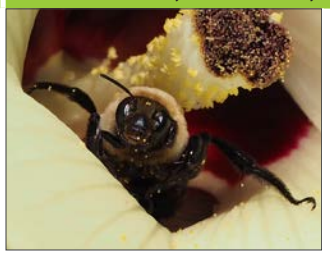
BLUEBERRY BEE (*Habropoda laboriosa*) a.k.a. Southeastern blueberry bee, blueberry digger bee



- *Vaccinium* spp.—a single female may be responsible for up to 6,000 blueberries
- Deep, well-drained, sandy soil
- May be the most abundant pollinators seen on blueberry flowers.

(Photo: Jolie Goldenetz-Dollar, Xerces Society.)

OKRA BEE (*Ptilothrix bombiformis*) a.k.a. hibiscus bee, hibiscus turret, rose mallow, cotton, or eastern digger bee



- Mallow or hibiscus family—common pollinators of okra and cotton
- Hard-packed soil near a water source—such as roads and levees
- They may be locally abundant.

(Photo: Nancy Lee Adamson.)

SQUASH BEES (*Peponapis pruinosa*[1] & *Xenoglossa* spp.[2]) a.k.a. eastern cucurbit bee[1] & large squash bee[2]

- Cucurbitae—squash, pumpkin, cucumber, musk melons, watermelon
- Females frequently nest in the ground 6–12" directly underneath host plants
- They may be locally abundant.

(Photo:SusanEllis,Bugwood.org.)

FAMILY	GENUS • COMMON NAME • NESTING | SOCIALITY | TIMING | ABUNDANCE • DESCRIPTION & NOTES†
COLLETIDAE **Collectid, Cellophane, Plasterer, or Masked Bees**	***Colletes*** • **Polyester or cellophane bees** • Ground | Solitary | All season | Common • Nests are lined with a waterproof cellophane-like glandular secretion. Females leave soupy-like provisions (carried in their crop) rather than a dry ball of pollen and nectar for their young. Often hairy and nesting in aggregations.
	Hylaeus • **Yellow-faced or masked bees** • Stems & ground | Solitary | Su | Common • Typically very small, wasp-like in appearance without many hairs (they carry pollen and nectar in their stomachs). Species in this genus were the first bees to be listed as endangered in the U.S. (in Hawaii). Name means "of the woods" where they nest (in beetle tunnels and pithy plant stems), as well as rocky and earthen banks, lining cells with cellophane like materials (like *Colletes*).
HALICTIDAE **Halictid or Sweat Bees**	***Agapostemon*** • **Metallic green striped-sweat bees** • Ground | Communal & Solitary | All season | Common • Easy to identify those with green thorax and black abdomen with white (male) or yellow (female) stripes. In three species, the females are all green.
	Augochlora • **Metallic green sweat bees** • Wood (under bark, in rotting dead wood) | Solitary | Sp & Su | Common • The pure green sweat bee (*A. pura*), is the only species documented in AR. May have 2 or 3 generations in one year (seen all summer).
	Augochlorella • **Metallic green sweat bees** • Ground | Social | All season | Common • Generations overlap, with one queen each generation, and daughters helping provision nest cells.
	Augochloropsis • **Metallic green sweat bees** • Ground | Nest sharing | Su | Local • Among the most spectacular of the metallic green sweat bees—shiny green tinged with blue, violet, and gold.
	Halictus • **Halictid, sweat, or furrow bees** • Ground | Social & Solitary | All summer | Abundant • May nest as solitary individuals or in colonies depending on environmnetal conditions (floral abundance and temperature may play a role). Males may form sleeping aggregations, clustering together on a plant stem.
	Lasioglossum • **Sweat or base-banded furrow bees** • Ground | Communal & Social | All season | Abundant • Large genus with many common species, but often overlooked due to their small size.
	Sphecodes • **Cuckoo or blood bees** • Cleptoparasite[5] | N/A | All season | Abundant • Targets primarily other Halictidae, also parasitizes *Andrena*, *Colletes*, and *Perdita*. Usually with red abdomen, hairless and wasp-like in appearance.
MEGACHILIDAE[6] **Megachilid, Chimney, Leafcutter, Mason, Resin, and Woolcarder Bees** (CONTINUED ON NEXT PAGE)	***Anthidium*** • **Woolcarder bees** • Wood, plant stems, or ground | Solitary | Sp & Su | Uncommon • Females collect plant hairs for nesting. Males are very territorial. Two are introduced species. Distinct yellow and black coloration.
	Anthidiellum • **Resin bees** • Plant stems | Solitary | Su | Uncommon • Many construct nest cells of resin on the outside of twigs. Resemble *Anthidium*, but are smaller.
	Chelostoma • **Leafcutter, resin, mason, and scissor bees** • Wood & stone cavities | Solitary | Su | Common • Though 3 species found east of the Missisippi, one documented in the region, *C. californicum*. Black and slender (elongated thorax). Pollen specialists, but visit diverse flowers for nectar.
	Coelioxys • **Cuckoo leafcutter or sharp-tailed bees** • Cleptoparasite[5] | N/A | Su | Common • Targets primarily *Megachile*. Closely resemble *Megachile*, but the tip of their abodomen is pointy and may have other defensive protrusions on other areas of their bodies. The name *Coelioxys* comes from Greek for "sharp belly."
	Heriades • **Resin bees** • Wood & stone cavities | Solitary | Su | Uncommon • Somewhat easy to recognize from two features of their abdomens: noticeable ridges on top and a tendency to tuck ("j" shape).
	Hoplitis • **Small or lesser mason bees** • Wood, stone cavities, masonry | Solitary | Su | Local • Like other "mason" bees, they use diverse locations and materials for nesting, including pebbles or plant materials. Relatively small (usually <0.5") ranging in color from black to metallic green. Some pollen specialists.
	Megachile • **Leafcutter bees** • Wood, ground, & stone cavities | Solitary | Su | Local • Some spp. clip circular leaf or petal sections to line their nests, and to seal off nest entrances. Relatively large heads hold the large leaf-cutting mandibles.
	Osmia • **Mason, blue orchard, or leafcutter bees** • Wood & stone cavities | Solitary | Sp & Su | Abundant • Nest entrances closed with mud or masticated leaf pieces. One native species, the blue orchard bee (*O. lignaria*), is "managed" (nest materials provided and pupae collected for release each year by fruit growers).

KEY: NESTING Site SOCIALITY TIMING—Time of Year: Spring (Sp), Summer (Su), Fall (Fa) ABUNDANCE

FAMILY	GENUS • COMMON NAME • NESTING | SOCIALITY | TIMING | ABUNDANCE • DESCRIPTION & NOTES†
MEGACHILIDAE[6] CONTINUED	***Paranthidium*** • **Resin or anthidiine bees** • Ground | Solitary | Su | Rare • Only one species (*P. jugatorium*) is found in N. America. Easy to recognize by bold black and yellow coloration along with pollen-filled abdominal hairs (on females). Similar in appearance to woolcarder bees, but smaller. Often forage on aster family flowers. Sometimes place pebbles between resin walls separating cells.
	Stelis • **Cuckoo or dark bees** • Cleptoparasite[5] | N/A | Su | Uncommon • Targets diverse bees, mainly in the Megachilidae family. Unlike other cuckoo bees, their thorax may be relatively hairy. Dark metallic blue or green to black, with ivory, yellow, or white markings on their abdomens.
MELITTIDAE Melittid Bees	***Macropis*** • **Yellow loosestrife bees** • Ground | Solitary | Su | Local • Specialize on loosestrife (*Lysimachia* spp.), flower oils and pollen, carrying very large loads on their legs.
	Melitta • **Melittid bees** • Ground | Solitary | Sp | Rare[7] • Name from Greek for "honey" and "small." Many pollen specialists on distantly related flowers, but those in this region are all heath family specialists, on blueberry and deerberry (*Vaccinium* spp.) and staggerbush or maleberry (*Lyonia* spp.).

KEY: **NESTING** Site **SOCIALITY** **TIMING—Time of Year: Spring (Sp), Summer (Su), Fall (Fa)** **ABUNDANCE**

† This table was adapted from "Appendix F: Common & Specialist Bees of Arkansas" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov).

1. Panurgine bees (members of the subfamily Panurginae) are often smaller, less hairy, and bearing yellow or cream markings on various parts of their bodies.
2. "Pseudo" meaning false + Panurgus (an Old World genus colloquially referred to as "shaggy bees" in English across Europe—see Templ et al 2019, Falk 2019, or iNaturalist 2020)
3. Subsocial means that females remain with developing brood.
4. All male bees have one extra antennal segment, but in "long-horned" bees, the male antennae are elongated. Males use their antennae like noses to find females.
5. A Cleptoparasite, A.K.A. "cuckoo" bee, is a nest parasite, laying eggs in the brood cells of other bees.
6. All Megachilidae except the cleptoparasitic species have pollen-carrying hairs on their belly—most other bees have pollen-carrying hairs on their legs. Carrying pollen on the abdomen may make depositing pollen in a narrow cavity easier.
7. Often abundant when found (but rarely seen).

References: Ascher & Pickering 2020; Bartlett 2003; LeBuhn 2012; Moisset 2010; Packer et al. 2007; Wilson & Carril 2015; Templ et al. 2019; Falk 2019; iNaturalist 2020; Vaughan et al. 2015; Cane 1994; Cane 1997; USDA–NAL 2015; BugGuide 2020; Simpson 2010. Note: Information revised by Nancy Lee Adamson and Sara Morris referring primarily to Wilson and Carril (2015). Original table by Harry W. Godwin / USDA-ARS Appalachian Farming System Research Center and Eric Lee-Mader / The Xerces Society) for the West Virginia NRCS Pollinator Handbook (2012).

Arkansas Coastal Plains Seed Mix*

The Gulf Coastal Plain Natural Division is in southwestern and southcentral Arkansas, and is dominated by pine forest, much of which is now managed for timber production. The Coastal Plain of Arkansas, part of the West Gulf Coastal Plain ecoregion, was historically a flowing mosaic of blackland prairies, wet prairies, open woodlands, pine savannas, and bottomland hardwoods. Certain regions supported very open woodland or savanna with a diverse herbaceous understory.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% of Mix	Weight	Spp.
GRASSES	7.047	24.51%	1.420	9
FORBS	21.706	75.49%	1.786	51
Spring-blooming	—	8.93%	—	4
Summer-blooming	—	46.81%	—	30
Fall-blooming	—	19.75%	—	17
TOTALS	28.753	100.00%	3.206	60

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% of Mix	Weight	Notes
Big bluestem	*Andropogon gerardii*	1.136	3.95%	0.300	
Eastern gama grass	*Tripsacum dactyloides*	0.019	0.07%	0.110	
Fox sedge	*Carex vulpinoidea*	0.893	3.11%	0.030	
Indiangrass	*Sorghastrum nutans*	1.136	3.95%	0.300	
Little bluestem	*Schizachyrium scoparium*	2.204	7.66%	0.400	
River oats	*Chasmanthium latifolium*	0.103	0.36%	0.050	
Switchgrass	*Panicum virgatum*	0.060	0.21%	0.010	
Tall dropseed	*Sporobolus compositus*	1.220	4.24%	0.070	
Virginia wildrye	*Elymus virginicus*	0.275	0.96%	0.150	
Ashy sunflower	*Helianthus mollis*	0.026	0.09%	0.010	
Bigflower coreoposis	*Coreopsis grandiflora*	0.269	0.94%	0.030	
Black-eyed Susan	*Rudbeckia hirta*	1.085	3.77%	0.030	
Brown-eyed Susan	*Rudbeckia triloba*	0.230	0.80%	0.020	
Butterfly milkweed	*Asclepias tuberosa*	0.217	0.75%	0.135	
Cardinal flower	*Lobelia cardinalis*	2.074	7.21%	0.008	
Common boneset	*Eupatorium perfoliatum*	0.992	3.45%	0.015	
Common evening primrose	*Oenothera biennis*	0.474	1.65%	0.015	
Common milkweed	*Asclepias syriaca*	0.188	0.65%	0.127	
Compass plant	*Silphium laciniatum*	0.003	0.01%	0.006	
False aster	*Boltonia asteroides*	1.421	4.94%	0.030	
Foxglove beardtongue	*Penstemon digitalis*	0.478	1.66%	0.013	
Goat's rue	*Tephrosia virginiana*	0.007	0.02%	0.009	
Golden Alexanders	*Zizia aurea*	0.039	0.14%	0.010	
Gray goldenrod	*Solidago nemoralis*	0.417	1.45%	0.018	
Illinois bundleflower	*Desmanthus illinoensis*	0.585	2.04%	0.300	
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.015	3.53%	0.200	
Lemon mint	*Monarda citriodora*	0.661	2.30%	0.020	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	● / FT²	% OF MIX	WEIGHT	NOTES
Ohio spiderwort	*Tradescantia ohiensis*	0.021	0.07%	0.007	
Ox-eye false sunflower	*Heliopsis helianthoides*	0.101	0.35%	0.035	
Pale purple coneflower	*Echinacea pallida*	0.024	0.08%	0.010	
Plains coreopsis	*Coreopsis tinctoria*	1.036	3.60%	0.014	
Prairie blazing star	*Liatris pycnostachya*	0.022	0.08%	0.008	
Purple coneflower	*Echinacea purpurea*	0.266	0.92%	0.100	
Purple prairie clover	*Dalea purpurea*	1.281	4.46%	0.200	
Rattlesnake master	*Eryngium yuccifolium*	0.041	0.14%	0.010	
Rosinweed	*Silphium integrifolium*	0.006	0.02%	0.006	
Rough blazing star	*Liatris aspera*	0.038	0.13%	0.007	
Roundhead lespedeza	*Lespedeza capitata*	0.040	0.14%	0.010	
Sawtooth sunflower	*Helianthus grosseserratus*	0.145	0.50%	0.010	
Seedbox	*Ludwigia alternifolia*	1.910	6.64%	0.004	
Sensitive briar	*Mimosa quadrivalvis* var. *nuttalli*	0.005	0.02%	0.008	
Showy goldenrod	*Solidago speciosa*	0.279	0.97%	0.008	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.52%	0.100	
Slender lespedeza	*Lespedeza virginica*	0.037	0.13%	0.010	
Slender mountain mint	*Pycnanthemum tenuifolium*	1.666	5.79%	0.012	
Smooth blue aster	*Symphyotrichum laeve*	0.186	0.65%	0.008	
Sneezeweed	*Helenium autumnale*	0.168	0.58%	0.005	
Spotted beebalm	*Monarda punctata*	0.200	0.70%	0.005	
Stiff goldenrod	*Solidago rigida* ssp. *rigida*	0.463	1.61%	0.020	
Sweet black-eyed Susan	*Rudbeckia subtomentosa*	0.163	0.57%	0.010	
Tall bellflower	*Campanula americana*	0.250	0.87%	0.004	
Tall coreopsis	*Coreopsis tripteris*	0.023	0.08%	0.005	
Tall ironweed	*Vernonia gigantea*	0.115	0.40%	0.005	
Tickseed sunflower	*Bidens aristosa*	0.149	0.52%	0.050	
White prairie clover	*Dalea candida*	0.223	0.78%	0.035	
White wild indigo	*Baptisia alba*	0.004	0.01%	0.006	
Whorled milkweed	*Asclepias verticillata*	0.004	0.01%	0.001	
Wild bergamot	*Monarda fistulosa*	1.373	4.78%	0.050	
Wild quinine	*Parthenium integrifolium*	0.026	0.09%	0.010	
Yarrow	*Achillea millefolium*	1.113	3.87%	0.017	
	TOTALS	**28.753**	**100.00%**	**3.206**	

KEY: PLS—Pure Live Seed ● / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

* This seed mix was extracted from "Appendix C: Seed Mixes" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information, please see original source.

Arkansas Delta Seed Mix*

The Delta Natural Division (also known as the Mississippi Alluvial Plain) once was dominated by vast bottomland hardwood forests, but most of those forests were cleared, drained, and replaced with large crop fields characterized by deep, rich soil. The region was also home to extensive grasslands, such as the Grand Prairie, that occupied over half a million acres in the Delta. Unique elevated woodlands also existed on the higher terraces outside of the floodplains in the Delta. The sites include oak, and rarely pine, flatwoods on clay soils and upland oak woodlands or savannas on sandy or loamy soils.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% of Mix	Weight	Spp.
GRASSES	7.289	25.10%	1.610	6
FORBS	21.754	74.90%	1.899	40
Spring-blooming	—	10.34%	—	5
Summer-blooming	—	48.63%	—	22
Fall-blooming	—	15.93%	—	13
TOTALS	29.043	100.00%	3.509	46

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% of Mix	Weight	Notes
Big bluestem	*Andropogon gerardii*	1.515	5.22%	0.400	
Fox sedge	*Carex vulpinoidea*	0.596	2.05%	0.020	
Indiangrass	*Sorghastrum nutans*	1.515	5.22%	0.400	
Little bluestem	*Schizachyrium scoparium*	3.306	11.38%	0.600	
River oats	*Chasmanthium latifolium*	0.083	0.28%	0.040	
Virginia wildrye	*Elymus virginicus*	0.275	0.95%	0.150	
Ashy sunflower	*Helianthus mollis*	0.026	0.09%	0.010	
Black-eyed Susan	*Rudbeckia hirta*	1.447	4.98%	0.040	
Butterfly milkweed	*Asclepias tuberosa*	0.193	0.66%	0.120	
Cardinal flower	*Lobelia cardinalis*	1.296	4.46%	0.005	
Common boneset	*Eupatorium perfoliatum*	1.653	5.69%	0.025	
Common evening primrose	*Oenothera biennis*	0.474	1.63%	0.015	
Common milkweed	*Asclepias syriaca*	0.222	0.76%	0.150	
Cream wild indigo	*Baptisia bracteata*	0.001	0.00%	0.001	
Culver's root	*Veronicastrum virginicum*	1.084	3.73%	0.004	
False aster	*Boltonia asteroides*	0.474	1.63%	0.010	
Foxglove beardtongue	*Penstemon digitalis*	0.736	2.53%	0.020	
Golden Alexanders	*Zizia aurea*	0.079	0.27%	0.020	
Gray goldenrod	*Solidago nemoralis*	0.116	0.40%	0.005	
Hoary vervain	*Verbena stricta*	0.894	3.08%	0.070	
Illinois bundleflower	*Desmanthus illinoensis*	0.488	1.68%	0.250	
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.522	5.24%	0.300	
Lemon mint	*Monarda citriodora*	1.322	4.55%	0.040	
New Jersey tea	*Ceanothus americanus*	0.003	0.01%	0.001	
Ohio spiderwort	*Tradescantia ohiensis*	0.029	0.10%	0.010	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	/ FT²	% OF MIX	WEIGHT	NOTES
Ox-eye false sunflower	*Heliopsis helianthoides*	0.202	0.70%	0.070	
Pale purple coneflower	*Echinacea pallida*	0.097	0.34%	0.040	
Plains coreopsis	*Coreopsis tinctoria*	0.666	2.29%	0.009	
Prairie blazing star	*Liatris pycnostachya*	0.041	0.14%	0.015	
Purple coneflower	*Echinacea purpurea*	0.531	1.83%	0.200	
Purple Joe Pye weed	*Eutrochium purpureum*	0.386	1.33%	0.025	
Rattlesnake master	*Eryngium yuccifolium*	0.102	0.35%	0.025	
Rosinweed	*Silphium integrifolium*	0.007	0.02%	0.007	
Rough blazing star	*Liatris aspera*	0.027	0.09%	0.005	
Roundhead lespedeza	*Lespedeza capitata*	0.080	0.28%	0.020	
Sawtooth sunflower	*Helianthus grosseserratus*	0.289	1.00%	0.020	
Seedbox	*Ludwigia alternifolia*	1.910	6.58%	0.004	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.51%	0.100	
Slender lespedeza	*Lespedeza virginica*	0.037	0.13%	0.010	
Slender mountain mint	*Pycnanthemum tenuifolium*	2.499	8.61%	0.018	
Tall coreopsis	*Coreopsis tripteris*	0.092	0.32%	0.020	
Tickseed sunflower	*Bidens aristosa*	0.164	0.57%	0.055	
White prairie clover	*Dalea candida*	0.638	2.20%	0.100	
Wild bergamot	*Monarda fistulosa*	1.098	3.78%	0.040	
Wild quinine	*Parthenium integrifolium*	0.026	0.09%	0.010	
Yarrow	*Achillea millefolium*	0.655	2.25%	0.010	
	TOTALS	29.043	100.00%	3.509	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

* This seed mix was extracted from "Appendix C: Seed Mixes" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information, please see original source.

Arkansas Ouachita & Blackland Prairie Seed Mix*

This natural division is in west-central Arkansas, and features numerous long, rocky ridges that are often covered with mixed stands of hardwoods and short-leaf pine (Pinus echinata). The valleys between the ridges are often large enough to support large crop fields and pastures. The south-facing slopes and ridgetops of the Ouachitas historically supported open woodland and savanna, with glades occurring in the most rocky and shallowest soils. The moister north facing slopes of the ridges naturally support more dense woodland and forest.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% OF MIX	WEIGHT	SPP.
GRASSES	6.998	24.53%	1.665	9
FORBS	21.530	75.47%	1.682	56
SPRING-BLOOMING	—	8.44%	—	6
SUMMER-BLOOMING	—	47.04%	—	31
FALL-BLOOMING	—	19.99%	—	19
TOTALS	28.528	100.00%	3.347	65

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% OF MIX	WEIGHT	NOTES
Big bluestem	*Andropogon gerardii*	1.136	3.98%	0.300	
Canada wildrye	*Elymus canadensis*	0.262	0.92%	0.100	
Indiangrass	*Sorghastrum nutans*	1.136	3.98%	0.300	
Little bluestem	*Schizachyrium scoparium*	2.479	8.69%	0.450	
River oats	*Chasmanthium latifolium*	0.103	0.36%	0.050	
Side oats grama	*Bouteloua curtipendula*	0.941	3.30%	0.250	
Splitbeard bluestem	*Andropogon ternarius*	0.124	0.43%	0.025	
Tall dropseed	*Sporobolus compositus*	0.523	1.83%	0.030	
Virginia wildrye	*Elymus virginicus*	0.293	1.03%	0.160	
Bigflower coreoposis	*Coreopsis grandiflora*	0.627	2.20%	0.070	
Black-eyed Susan	*Rudbeckia hirta*	0.904	3.17%	0.025	
Brown-eyed Susan	*Rudbeckia triloba*	0.402	1.41%	0.035	
Butterfly milkweed	*Asclepias tuberosa*	0.243	0.85%	0.151	
Cardinal flower	*Lobelia cardinalis*	1.296	4.54%	0.005	
Common boneset	*Eupatorium perfoliatum*	1.124	3.94%	0.017	
Common evening primrose	*Oenothera biennis*	0.663	2.33%	0.021	
Common milkweed	*Asclepias syriaca*	0.157	0.55%	0.106	
Compass plant	*Silphium laciniatum*	0.003	0.01%	0.006	
Cream wild indigo	*Baptisia bracteata*	0.001	0.00%	0.001	
Culver's root	*Veronicastrum virginicum*	1.355	4.75%	0.005	
Cup plant	*Silphium perfoliatum*	0.003	0.01%	0.005	
Foxglove beardtongue	*Penstemon digitalis*	0.368	1.29%	0.010	
Goat's rue	*Tephrosia virginiana*	0.004	0.01%	0.005	
Golden Alexanders	*Zizia aurea*	0.039	0.14%	0.010	
Gray goldenrod	*Solidago nemoralis*	0.231	0.81%	0.010	
Gray-headed coneflower	*Ratibida pinnata*	0.194	0.68%	0.020	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	/ FT²	% OF MIX	WEIGHT	NOTES
Great blue lobelia	*Lobelia siphilitica*	1.286	4.51%	0.007	
Hoary vervain	*Verbena stricta*	0.383	1.34%	0.030	
Illinois bundleflower	*Desmanthus illinoensis*	0.390	1.37%	0.200	
Indian paintbrush	*Castilleja coccinea*	0.022	0.08%	0.003	
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.015	3.56%	0.200	
Maryland senna	*Senna marilandica*	0.005	0.02%	0.010	
New England aster	*Symphyotrichum novae-angliae*	0.177	0.62%	0.007	
Obedient plant	*Physostegia virginiana*	0.012	0.04%	0.003	
Ohio spiderwort	*Tradescantia ohiensis*	0.029	0.10%	0.010	
Ox-eye false sunflower	*Heliopsis helianthoides*	0.144	0.51%	0.050	
Pale purple coneflower	*Echinacea pallida*	0.097	0.34%	0.040	
Plains coreopsis	*Coreopsis tinctoria*	0.962	3.37%	0.013	
Prairie blazing star	*Liatris pycnostachya*	0.019	0.07%	0.007	
Purple coneflower	*Echinacea purpurea*	0.266	0.93%	0.100	
Purple prairie clover	*Dalea purpurea*	0.256	0.90%	0.040	
Rattlesnake master	*Eryngium yuccifolium*	0.020	0.07%	0.005	
Rosinweed	*Silphium integrifolium*	0.010	0.04%	0.011	
Rough blazing star	*Liatris aspera*	0.038	0.13%	0.007	
Roundhead lespedeza	*Lespedeza capitata*	0.040	0.14%	0.010	
Sawtooth sunflower	*Helianthus grosseserratus*	0.145	0.51%	0.010	
Seedbox	*Ludwigia alternifolia*	1.910	6.70%	0.004	
Sensitive briar	*Mimosa quadrivalvis* var. *nuttalli*	0.003	0.01%	0.005	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.52%	0.100	
Sky blue aster	*Symphyotrichum oolentangiense*	0.059	0.21%	0.002	
Slender lespedeza	*Lespedeza virginica*	0.055	0.19%	0.015	
Slender mountain mint	*Pycnanthemum tenuifolium*	2.083	7.30%	0.015	
Smooth blue aster	*Symphyotrichum laeve*	0.047	0.16%	0.002	
Spotted beebalm	*Monarda punctata*	0.100	0.35%	0.007	
Stiff goldenrod	*Solidago rigida* ssp. *rigida*	0.232	0.81%	0.010	
Tall coreopsis	*Coreopsis tripteris*	0.092	0.32%	0.020	
Tall ironweed	*Vernonia gigantea*	0.115	0.40%	0.010	
Tickseed sunflower	*Bidens aristosa*	0.149	0.52%	0.050	
Upright prairie coneflower	*Ratibida columnifera*	0.846	2.97%	0.050	
White prairie clover	*Dalea candida*	0.319	1.12%	0.050	
White wild indigo	*Baptisia alba*	0.004	0.01%	0.006	
Whorled milkweed	*Asclepias verticillata*	0.004	0.01%	0.001	
Wild bergamot	*Monarda fistulosa*	1.098	3.85%	0.040	
Wild quinine	*Parthenium integrifolium*	0.026	0.09%	0.010	
Yarrow	*Achillea millefolium*	1.309	4.59%	0.020	
	TOTALS	**28.528**	**100.00%**	**3.347**	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

* This seed mix was extracted from "Appendix C: Seed Mixes" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information, please see original source.

Arkansas Ozarks Seed Mix*

The Ozark Highlands Ecoregion is the northern portion of the larger Ozark Plateau. It is lower in elevation and in general less rugged than the Boston Mountains. Historically the flat to gently rolling portions of the Ozark Highlands supported scattered treeless prairies and extensive oak savannas and woodlands, while the more dissected portions supported a variety of open woodlands and mesic forests. Extensive glades on limestone, dolomite, and sandstone occur in some regions. As with many regions of Arkansas, the less rugged areas of the Ozark Highlands are largely converted to non-native pasture.

Seed Mix Specifications

FORM BloomPeriod	/ FT²	% of Mix	Weight	Spp.
GRASSES	7.356	25.62%	1.734	9
FORBS	21.360	74.38%	1.691	59
Spring-blooming	—	9.42%	—	8
Summer-blooming	—	43.30%	—	33
Fall-blooming	—	21.67%	—	18
TOTALS	28.716	100.00%	3.425	68

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 /FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	/ FT²	% of Mix	Weight	Notes
Big bluestem	*Andropogon gerardii*	1.136	3.96%	0.300	
Canada wildrye	*Elymus canadensis*	0.393	1.37%	0.150	
Fox sedge	*Carex vulpinoidea*	0.268	0.93%	0.009	
Indiangrass	*Sorghastrum nutans*	1.136	3.96%	0.300	
Little bluestem	*Schizachyrium scoparium*	2.479	8.63%	0.450	
River oats	*Chasmanthium latifolium*	0.103	0.36%	0.050	
Side oats grama	*Bouteloua curtipendula*	1.129	3.93%	0.300	
Tall dropseed	*Sporobolus compositus*	0.436	1.52%	0.025	
Virginia wildrye	*Elymus virginicus*	0.275	0.96%	0.150	
Ashy sunflower	*Helianthus mollis*	0.013	0.04%	0.005	
Bigflower coreoposis	*Coreopsis grandiflora*	0.224	0.78%	0.025	
Black-eyed Susan	*Rudbeckia hirta*	0.904	3.15%	0.025	
Blue wild indigo	*Baptisia australis*	0.004	0.01%	0.007	
Brown-eyed Susan	*Rudbeckia triloba*	0.230	0.80%	0.020	
Butterfly milkweed	*Asclepias tuberosa*	0.215	0.75%	0.134	
Canada milkvetch	*Astragalus canadensis*	0.186	0.65%	0.030	
Cardinal flower	*Lobelia cardinalis*	1.037	3.61%	0.004	
Common boneset	*Eupatorium perfoliatum*	0.992	3.45%	0.015	
Common evening primrose	*Oenothera biennis*	0.632	2.20%	0.020	
Common milkweed	*Asclepias syriaca*	0.187	0.65%	0.126	
Compass plant	*Silphium laciniatum*	0.002	0.01%	0.004	
Cream wild indigo	*Baptisia bracteata*	0.001	0.00%	0.001	
Culver's root	*Veronicastrum virginicum*	1.084	3.77%	0.004	
Foxglove beardtongue	*Penstemon digitalis*	0.552	1.92%	0.015	
Goat's rue	*Tephrosia virginiana*	0.007	0.02%	0.009	
Golden Alexanders	*Zizia aurea*	0.020	0.07%	0.005	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	/ FT²	% OF MIX	WEIGHT	NOTES
Gray goldenrod	*Solidago nemoralis*	0.255	0.89%	0.011	
Gray-headed coneflower	*Ratibida pinnata*	0.145	0.51%	0.015	
Great blue lobelia	*Lobelia siphilitica*	1.653	5.76%	0.009	
Hoary vervain	*Verbena stricta*	0.383	1.33%	0.030	
Illinois bundleflower	*Desmanthus illinoensis*	0.390	1.36%	0.200	
Indian paintbrush	*Castilleja coccinea*	0.022	0.08%	0.003	
Lanceleaf coreopsis	*Coreopsis lanceolata*	1.015	3.53%	0.200	
New England aster	*Symphyotrichum novae-angliae*	0.253	0.88%	0.010	
New Jersey tea	*Ceanothus americanus*	0.010	0.04%	0.004	
Obedient plant	*Physostegia virginiana*	0.020	0.07%	0.005	
Ohio spiderwort	*Tradescantia ohiensis*	0.018	0.06%	0.006	
Ox-eye false sunflower	*Heliopsis helianthoides*	0.150	0.52%	0.052	
Pale beardtongue	*Penstemon pallidus*	0.130	0.45%	0.002	
Pale purple coneflower	*Echinacea pallida*	0.100	0.35%	0.041	
Plains coreopsis	*Coreopsis tinctoria*	0.962	3.35%	0.013	
Prairie blazing star	*Liatris pycnostachya*	0.019	0.07%	0.007	
Purple coneflower	*Echinacea purpurea*	0.398	1.39%	0.150	
Purple Joe Pye weed	*Eutrochium purpureum*	0.108	0.38%	0.007	
Purple prairie clover	*Dalea purpurea*	0.480	1.67%	0.075	
Rattlesnake master	*Eryngium yuccifolium*	0.029	0.10%	0.007	
Rosinweed	*Silphium integrifolium*	0.005	0.02%	0.005	
Rough blazing star	*Liatris aspera*	0.022	0.08%	0.004	
Roundhead lespedeza	*Lespedeza capitata*	0.040	0.14%	0.010	
Sawtooth sunflower	*Helianthus grosseserratus*	0.145	0.50%	0.010	
Seedbox	*Ludwigia alternifolia*	1.910	6.65%	0.004	
Sensitive briar	*Mimosa quadrivalvis* var. *nuttalli*	0.005	0.02%	0.008	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.52%	0.100	
Slender lespedeza	*Lespedeza virginica*	0.055	0.19%	0.015	
Slender mountain mint	*Pycnanthemum tenuifolium*	1.944	6.77%	0.014	
Smooth blue aster	*Symphyotrichum laeve*	0.070	0.24%	0.003	
Sneezeweed	*Helenium autumnale*	0.235	0.82%	0.007	
Stiff goldenrod	*Solidago rigida* ssp. *rigida*	0.394	1.37%	0.017	
Sweet black-eyed Susan	*Rudbeckia subtomentosa*	0.327	1.14%	0.020	
Tall bellflower	*Campanula americana*	0.312	1.09%	0.005	
Tall coreopsis	*Coreopsis tripteris*	0.028	0.10%	0.006	
Tickseed sunflower	*Bidens aristosa*	0.140	0.49%	0.047	
White prairie clover	*Dalea candida*	0.319	1.11%	0.050	
White wild indigo	*Baptisia alba*	0.001	0.00%	0.001	
Whorled milkweed	*Asclepias verticillata*	0.004	0.01%	0.001	
Wild bergamot	*Monarda fistulosa*	1.098	3.83%	0.040	
Wild quinine	*Parthenium integrifolium*	0.021	0.07%	0.008	
Yarrow	*Achillea millefolium*	1.309	4.56%	0.020	
	TOTALS	**28.716**	**100.00%**	**3.425**	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

* This seed mix was extracted from "Appendix C: Seed Mixes" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information, please see original source.

Arkansas River Valley Seed Mix*

The Arkansas Valley Natural Division separates the Ozark Plateau in the north from the Ouachita Mountains in the south. Due to this valley's large amount of flat land, good soil and water, much of it is large-scale cropland or pasture. Historically, the Arkansas Valley contained large swaths of tallgrass prairie that transitioned to savanna and open woodland as it went up the hills. In contrast to the broad plains, the Arkansas Valley also includes high ridges and mesas, including the state's highest peak, Mount Magazine.

Seed Mix Specifications

FORM BloomPeriod	● / FT²	% OF MIX	WEIGHT	SPP.
GRASSES	7.316	25.97%	1.760	9
FORBS	20.850	74.03%	1.623	58
SPRING-BLOOMING	—	8.57%	—	6
SUMMER-BLOOMING	—	41.94%	—	32
FALL-BLOOMING	—	23.62%	—	20
TOTALS	28.166	100.00%	3.383	67

Planner Note

This seed mix has been designed to be about 30 seeds per square foot (●/FT²). If a seed company does not have some of the species listed, they can simply be dropped without replacement as long as the mix is still at or above 25 ●/FT². This will ease the ordering process for landowners and help ensure that unwanted or non-native species are not substituted in the seed mix. If replacements must be made, select plants from the *Arkansas NRCS Pollinator Conservation Handbook* that have the same bloom periods and growing requirements as the unavailable species.

Some seed vendors will not have every species included in this seed mix. It's important to consult with a local biologist to approve any changes that a vendor may have made to the seed mix (i.e., adding, removing, or substituting species or changing rates).

COMMON NAME	SCIENTIFIC NAME	● / FT²	% OF MIX	WEIGHT	NOTES
Big bluestem	*Andropogon gerardii*	1.136	4.02%	0.300	
Canada wildrye	*Elymus canadensis*	0.262	0.93%	0.100	
Eastern gama grass	*Tripsacum dactyloides*	0.010	0.04%	0.060	
Indiangrass	*Sorghastrum nutans*	1.136	4.02%	0.300	
Little bluestem	*Schizachyrium scoparium*	2.204	7.79%	0.400	
River oats	*Chasmanthium latifolium*	0.103	0.37%	0.050	
Side oats grama	*Bouteloua curtipendula*	1.318	4.66%	0.350	
Tall dropseed	*Sporobolus compositus*	0.872	3.08%	0.050	
Virginia wildrye	*Elymus virginicus*	0.275	0.97%	0.150	
Ashy sunflower	*Helianthus mollis*	0.010	0.04%	0.004	
Bigflower coreoposis	*Coreopsis grandiflora*	0.314	1.11%	0.035	
Black-eyed Susan	*Rudbeckia hirta*	1.085	3.84%	0.030	
Blue wild indigo	*Baptisia australis*	0.005	0.02%	0.009	
Brown-eyed Susan	*Rudbeckia triloba*	0.344	1.22%	0.030	
Butterfly milkweed	*Asclepias tuberosa*	0.212	0.75%	0.132	
Canada milkvetch	*Astragalus canadensis*	0.124	0.44%	0.020	
Cardinal flower	*Lobelia cardinalis*	1.815	6.42%	0.007	
Common boneset	*Eupatorium perfoliatum*	1.058	3.74%	0.016	
Common evening primrose	*Oenothera biennis*	0.474	1.68%	0.015	
Common milkweed	*Asclepias syriaca*	0.185	0.65%	0.125	
Compass plant	*Silphium laciniatum*	0.003	0.01%	0.006	
Culver's root	*Veronicastrum virginicum*	1.355	4.79%	0.005	
Cup plant	*Silphium perfoliatum*	0.005	0.02%	0.009	
Foxglove beardtongue	*Penstemon digitalis*	0.552	1.95%	0.015	
Goat's rue	*Tephrosia virginiana*	0.007	0.02%	0.009	
Golden Alexanders	*Zizia aurea*	0.020	0.07%	0.005	

KEY: PLS—Pure Live Seed ● / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

COMMON NAME	SCIENTIFIC NAME	PLS / FT²	% OF MIX	WEIGHT	NOTES
Gray goldenrod	*Solidago nemoralis*	0.301	1.06%	0.013	
Gray-headed coneflower	*Ratibida pinnata*	0.194	0.68%	0.020	
Great blue lobelia	*Lobelia siphilitica*	1.469	5.20%	0.008	
Hoary vervain	*Verbena stricta*	0.702	2.48%	0.055	
Illinois bundleflower	*Desmanthus illinoensis*	0.390	1.38%	0.200	
Indian paintbrush	*Castilleja coccinea*	0.022	0.08%	0.003	
Lanceleaf coreopsis	*Coreopsis lanceolata*	0.862	3.05%	0.170	
Maryland senna	*Senna marilandica*	0.005	0.02%	0.010	
New England aster	*Symphyotrichum novae-angliae*	0.126	0.45%	0.005	
New Jersey tea	*Ceanothus americanus*	0.005	0.02%	0.002	
Obedient plant	*Physostegia virginiana*	0.020	0.07%	0.005	
Ohio spiderwort	*Tradescantia ohiensis*	0.024	0.08%	0.008	
Ox-eye false sunflower	*Heliopsis helianthoides*	0.144	0.51%	0.050	
Pale purple coneflower	*Echinacea pallida*	0.049	0.17%	0.020	
Plains coreopsis	*Coreopsis tinctoria*	0.962	3.40%	0.013	
Prairie blazing star	*Liatris pycnostachya*	0.019	0.07%	0.007	
Purple coneflower	*Echinacea purpurea*	0.266	0.94%	0.100	
Purple prairie clover	*Dalea purpurea*	0.640	2.26%	0.100	
Rattlesnake master	*Eryngium yuccifolium*	0.041	0.14%	0.010	
Rosinweed	*Silphium integrifolium*	0.009	0.03%	0.010	
Rough blazing star	*Liatris aspera*	0.027	0.10%	0.005	
Roundhead lespedeza	*Lespedeza capitata*	0.040	0.14%	0.010	
Sawtooth sunflower	*Helianthus grosseserratus*	0.145	0.51%	0.010	
Seedbox	*Ludwigia alternifolia*	1.433	5.07%	0.003	
Sensitive briar	*Mimosa quadrivalvis* var. *nuttalli*	0.003	0.01%	0.004	
Showy partridge pea	*Chamaecrista fasciculata*	0.149	0.53%	0.100	
Sky blue aster	*Symphyotrichum oolentangiense*	0.029	0.10%	0.001	
Slender mountain mint	*Pycnanthemum tenuifolium*	1.388	4.91%	0.010	
Smooth blue aster	*Symphyotrichum laeve*	0.047	0.16%	0.002	
Sneezeweed	*Helenium autumnale*	0.202	0.71%	0.006	
Spotted beebalm	*Monarda punctata*	0.100	0.35%	0.003	
Stiff goldenrod	*Solidago rigida* ssp. rigida	0.579	2.05%	0.025	
Tall bellflower	*Campanula americana*	0.250	0.88%	0.004	
Tall coreopsis	*Coreopsis tripteris*	0.046	0.16%	0.010	
Tickseed sunflower	*Bidens aristosa*	0.149	0.53%	0.050	
White prairie clover	*Dalea candida*	0.128	0.45%	0.020	
White wild indigo	*Baptisia alba*	0.005	0.02%	0.008	
Whorled milkweed	*Asclepias verticillata*	0.004	0.01%	0.001	
Wild bergamot	*Monarda fistulosa*	0.961	3.40%	0.035	
Wild quinine	*Parthenium integrifolium*	0.039	0.14%	0.015	
Yarrow	*Achillea millefolium*	1.309	4.63%	0.020	
	TOTALS	**28.166**	**100.00%**	**3.383**	

KEY: PLS—Pure Live Seed / FT²—PLS per square foot % OF MIX by PLS / FT² WEIGHT—PLS lbs/acre SPP.—Species Richness

* This seed mix was extracted from "Appendix C: Seed Mixes" in the *Arkansas Pollinator Conservation Planning Handbook*, available from the NRCS Field Office Technical Guide (https://efotg.sc.egov.usda.gov). For more information, please see original source.