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Kentucky Pollinator Handbook

A Field Office Technical Guide Reference for the Management of Pollinators and their Habitats

A publication of NRCS Ecological Sciences in conjunction with Kentucky Department of Fish and Wildlife Resources, The Xerces Society for Invertebrate Conservation and The Nature Conservancy

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Cover Photo: Picture of a two-year old Conservation Reserve Program (CRP) pollinator planting (CP42) in Russell County, KY.

Photo: *N. Adamson*

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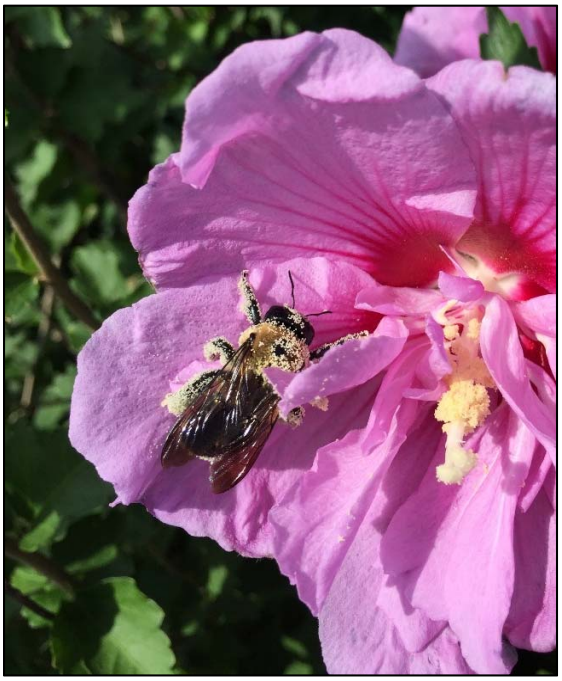
Introduction

The work of bees and other pollinators is something that touches us all through the food we eat, the clothes we wear and the landscapes we enjoy. Pollinators are an integral part of our environment and vital for our agricultural systems; they ensure production of at least 35% of the world's food crops. Global animal pollinators include bees, butterflies, moths, some wasps, flies, beetles, ants, bats and hummingbirds. There are an estimated 20,000 species of bees worldwide, with approximately 4,000 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, recent research has highlighted the importance of diverse wild pollinators, especially native bees, in crop production. With declines of honey bee colonies because of disease and other factors, the need for supporting diverse pollinators grows even more important to the future of agriculture. Native bees provide free pollination services, but require habitat that includes nesting sites and sources of pollen and nectar throughout the growing season, in addition to the crops needing pollination. They are often specialized for foraging on particular flowers, such as squash, berries, or orchard crops. This specialization results in more efficient pollination and the production of larger and more abundant fruit from certain crops. Native bees contribute an estimated three billion dollars' worth of crop pollination annually to the U.S. economy.



This bumble bee (*Bombus spp.*) in Woodford County, KY shows why native bees are excellent pollinators by moving pollen from one flower to another.
Photo: *C. Shrader* NRCS KY

The Natural Resources Conservation Service (NRCS) can assist landowners by suggesting locally appropriate plants and crop management that provides areas for foraging (nectar and pollen sources) and nesting for organisms that provide pollination services. These plantings and crop management approaches also support a diversity of other beneficial insect predators and parasitoids that help reduce crop pest populations.

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 tool to provide guidance to NRCS planners. It may be provided to landowners who have an interest in establishing and maintaining pollinator habitat. It focuses on native bees, the most important pollinators in temperate North America; but also addresses the habitat needs of butterflies and, to a lesser degree, hummingbirds and other beneficial insects. Note that by providing habitat for native bees and butterfly species, habitat for European honey bees is also provided. This handbook contains references for assisting landowners and providing sound information regarding the application of conservation practices to restore, enhance or create habitat for organisms that provide pollination services. *References and information within this book will be updated and additional materials will be provided periodically as they become available through revisions or supplements by NRCS.*

Hummingbirds provide some minor pollination services by utilizing nectar producing flowers such as this cardinal flower (*Lobelia cardinalis*). **Photo:** *Sue Chaplin* http://bybio.wordpress.com

Pollination Services in Kentucky

Why should you care about pollinators? Over one hundred crop species in North America require a visit from an insect pollinator to be productive and approximately one out of every four mouthfuls of food or beverage consumed requires insect pollination. Directly and indirectly, insect pollinated crops in North America are worth almost $30 billion annually – including food, medicines, dyes, and fabric fibers.

In temperate zones, most showy flowers are pollinated by insects, especially bees. Almost all herbaceous wildflowers are insect pollinated, and several trees and shrubs, including the dogwoods, redbud, wild plums, sassafras, spicebush, the magnolias and many willows. Most native insect pollinated plants are adapted to a specific group of pollinators that are active at a specific time of the year. Many insects co-evolved with plants, developing the proper size and body construction to carry pollen to more effectively pollinate the plant. Without native pollinators, plant diversity and the ecosystems it supports, would be greatly reduced causing a cascade effect on other species survival. As plants are the basis of terrestrial food webs, their reproduction is essential for the integrity of the system. Their reproduction depends on native pollinators.

Insects and flowering plants diversified and evolved together, resulting in the most widespread occurrence of mutual interdependence in the natural world. The shape, position, chemical and visual attributes of the flower determines which type of pollinator is most likely to be attracted to it. Bee pollinated flowers are usually open and accessible, but many are irregular in shape such as legumes, often requiring bees to disturb petals and other structures to gain access to nectar. This in turn leads to picking up or dropping off pollen and ensures pollination in the process. Ultraviolet patches and lines on petals of some flowers guide bees to nectar and pollen. Flower species that have broad flower heads or large flowers that are elevated above surrounding vegetation, such as milkweeds, attract butterflies. Flies are significant in pollinating several trees, including sassafras, and are attracted to small, open shallow blooms. Other fly or beetle species are attracted to the rancid smelling blooms of skunk cabbage, red trillium and jack-in-the-pulpit, mistaking them for carrion on which to lay eggs. Hummingbirds are especially attracted to red tubular flowers that grow in the open such as bee balm and phlox. 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.

The process of pollination is required to provide the fruits that other organisms depend upon as food.
Photo: *C. Shrader, NRCS KY*

However, where cropping intensity is high, farms often do not have adequate nearby habitat to support native pollinators. To ensure adequate pollination services, producers rely on European honey bees, which can be moved into crop fields, as needed. In other parts of the country agricultural producers may pay large rental fees to pollinate the crops that they raise. Research shows that native bees are important pollinators in agricultural fields as long as enough habitat is available to support them. On occasion, natural habitat also supports wild (feral) colonies of honey bees in Kentucky; however the frequency is rare.

A wild house honey-tree (for feral bees).

Photo: *Sue Olcott,*

Pollinators have been declining worldwide. European honey bee hive failures are a worrisome and well documented occurrence. Some native bees and other pollinators are also declining. 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 become very expensive. These rates have increased in some cases due to the cost of rearing European honey bees and maintaining viable colonies due to the presence of parasitic mites and effects of colony collapse disorder (CCD). In Kentucky, with some care and planning, native pollinators can flourish using straightforward and simple practices to provide foraging plants and nesting sites.

Pollinator Diversity

Kentucky is blessed with abundant diversity of landscapes varying in topography, elevation, climate and aspect. The state's diverse geology and topography make it rich in ecological communities, ranging from rich floodplains to mountain forests, prairie remnants, barrens, glades and diverse riparian and bottomland wetland ecosystems. The plant and animal life in Kentucky, from the bottomland swamps in the west to the rich Appalachian forests in the east, is extraordinary as well as beautiful. These ecosystems woven together form a biologically diverse web of life that is unique to the Commonwealth. The state's ecosystems are teeming with a diversity of native species from black throated green warblers to lizard skin liverworts. Some of these species are found nowhere else in the world. The aquatic systems of the state are home to rainbow darters, ghost crayfish, salamander mussels 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 provide pollination services to support these ecosystems, agriculture and produce food for wildlife.

Bumblebee (*Bombus* sp.) **on tall bellflower** (*Campanula americana*)**.**
Photo: *C. Shrader NRCS*

Given the demise of many managed honey bee colonies, it is important to support the diverse wild pollinators upon which many growers rely. 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 the Appalachian region, bumble bees are especially important for pollination since they are active when the climate is too cool and wet for many other bees. In addition, native bees are sometimes more efficient than honey bees for specific crops. Some bees are able to buzz-pollinate flowers. They can vibrate their wing muscles at the frequency needed to release pollen from the anthers of certain flowers. Plants, such as tomatoes, cranberries, and blueberries, may produce larger and more abundant fruit when buzz pollinated.

Most native bees are solitary (not living in colonies) and unlikely to sting since they do not have young and 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 they are visiting flowers, they are not defensive and do not sting unless stepped on or caught. Most wasps are also solitary, and although they do pollinate some flowers, are considered beneficial primarily because they are fantastic predators of crop and home garden pests.

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 thousand to 300 thousand, by far the vast majority of these species are insects. There are four main groups of pollinating insects briefly described below. They include: the *Hymenoptera* (bees) *Lepidoptera* (butterflies and moths), *Diptera* (true flies), and *Coleoptera* (beetles). Many other insects can be pollinators, however the pollination services provided is either negligent, the habitat is not feasible or practical to provide, or the presence of the species is ubiquitous

1. Bees (Hymenoptera)

Bees are by far the most important group of pollinating insects. With the exception of a few species of wasps, bees are the only insects that deliberately gather pollen to bring back to their young. They also exhibit a behavior known as flower constancy. This is the return to the same species of plants during one and on repeated foraging trips. Bees may visit literally hundreds of flowers on a given foraging trip transferring pollen along the way. Since bees actively gather pollen, they are in immediate contact with the anthers of the flower and are far better at the transfer of pollen than other insects.

Bees are distinguished by a smaller thorax (waist) with two pairs of wings. They have long antennae as compared to flies and their mouths are long and cylindrical. Bees have hair all over their body which are branched or feathered. These can be very specialized for carrying pollen. These hairs, called scopa, can be located on their hind leg or on the abdomen. Honey bees and bumble bees have pollen baskets on their legs called corbicula.

From left to right: squash bees (*Peponapis* sp.) **on a squash blossom and a longhorn bee** (*Melissodes* sp.) **on Long – Stalk Tickseed** (*Coreopsis lanceolata*)**.** **Photo:** *Nancy Adamson, The Xerces Society*

2. Beetles (Coleoptera)

A ladybird beetle on milkweed (*A. incarnata*).
Photo: Nancy Adamson, The Xerces Society

Beetles are one of the oldest pollinating insect orders. Beetles are easily recognized by having a hard exoskeleton and their front wings are covered by this same material that is folded along their back. There are over 340 thousand species of beetles in the world. Some estimates say that about every fifth living thing on earth is a beetle. They are important plant pollinators for some species, especially those with bowl shaped flowers that allow beetles to forage within the flower parts and move pollen around and among the flowers. Some beetles actually use pollen as a food source while others are looking for other insects as prey that are visiting flowers. Some beetles actually eat the flower parts. Several flowers have evolved to attract beetles by giving off odors that entice beetles. The skunk cabbage (*Symplocarpus foetidus*) common in Kentucky wetlands, exhibits this characteristic to attract beetles and flies as well.

3. Flies (Diptera)

Flies are one of the largest groups of insects on earth. They are extremely variable in size and appearance. They are very frequent visitors to flowers where they may provide pollination services. Flies do not get the credit for being good pollinators since their diets are much more variable than bees. Adult and larval flies can be voracious predators of other insects that are on flowers such as aphids. They are very important during wet and cool conditions. In Europe, syrphid flies are often monitored along with bees during crop pollination research. In the U.S. they are important as pollinators for such things as carrots. Most flies are actively seeking a nectar source from flowers. Some flowers and trees alike are adapted to attract flies by being scented like rotting meat to attract them. Flies often try to imitate other insects, especially bees. This gives them an advantage over some predators.

Common house fly pollinating coltsfoot (*Tussilago fafara*).
Photo: Wikimedia

Flies' antennae are much more variable than bee or wasp antennae, often shorter and stubbier; also, flies have one pair of wings (bees have two pair). Fly mouthparts are also very different from bees, called sucking mouthparts. The eyes of the fly are very large and bulbous as compared with the bee. Flies are far less hairy than bees, which is one reason why they are somewhat less effective at pollination.

Syrphid fly on spiderwort (*Tradescantia* spp).
Photo: Nancy Adamson, The Xerces Society

4. Butterflies/Moths (Lepidoptera)

The Lepidoptera is an order of insects that is one of the most widespread and widely recognizable insect orders in the world encompassing moths and the three superfamilies of butterflies, skipper butterflies, and moth-butterflies. The Lepidoptera show many variations of the basic body structure that have evolved to gain advantages over other insects. Butterflies are probably the most recognized and conspicuous insects and therefore most noticeable pollinators on the planet. They start their life as a larvae with only chewing mouthparts and end their lives without the ability to chew, only drinking liquids. They use differing strategies to survive the winter including migration, overwintering as eggs and even as adults in various parts of the world. In general, moths are dull colored while butterflies are brightly colored. Moths typically tend to be active during the night and butterflies are active in daylight, but there are exceptions.

Fritillary on butterfly milkweed (*Asclepias tuberosa*)
Photo: Nancy Adamson, The Xerces Society

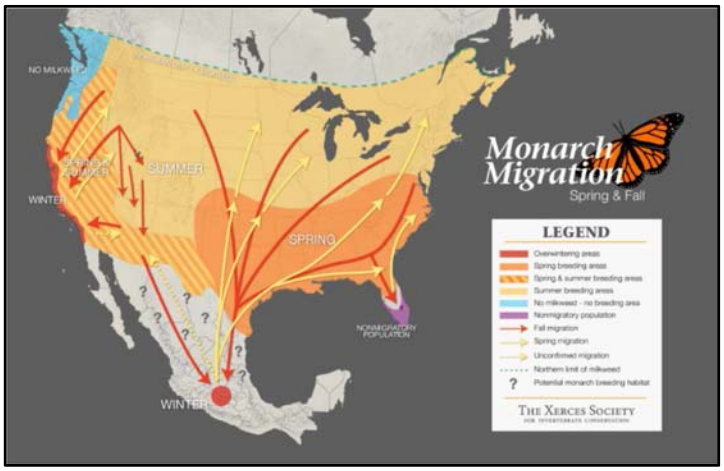
Food sources for moths and butterflies should always include plants that provide leaves and tissue for the larvae as well as nectar for adults. Butterfly gardens and waystations for migratory monarchs have proven to be popular and meaningful ways the public can assist in pollinator habitat creation and education without a large expense and relatively small landscape footprint.

The Monarch Butterfly

The Monarch butterfly (*Danaus plexippus*) is probably the most well-known butterfly in North America. The most significant populations occur in North America including Mexico where they are divided into two populations, east and west of the Rocky Mountains. The eastern population is the largest and winters in a single region – the forested mountains of central Mexico. There is a small non-migratory population wintering in Florida.

A Monarch butterfly on goldenrod (*Solidago* spp.).
Photo: G. Barickman, NRCS

Around the middle of March each year, Monarch butterflies usually begin to mate and often start moving around in their overwintering sites. As the days grow longer and winter comes to a close, they become more and more active and leave their roosts to fly north and east 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 up in the spring, they will not be able to lay their eggs and continue the cycle. Female Monarchs lay eggs on suitable milkweed plants they find as they fly and then die. Soon, the first spring caterpillars hatch and change into the familiar orange and black adults. Since each female lays hundreds of eggs, the total number of Monarch butterflies increases throughout the summer to start the journey south again in the fall.



Monarch Habitat Development Project, **The Xerces Society & NRCS** 2015

Individual females lay about 400 eggs and typically lay no more than two eggs on any single milkweed plant. The egg-laying process can last as long as 30 days. The eggs hatch in 9-12 days, and larva feed exclusively on the leaves of milkweed plants. The poisons contained in the milkweed afford the larva some protection from predators. Upon pupation, the new adults (the second generation) continue migration to the north and east. Depending on climatic conditions along the migration routes, 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 the wintering grounds in central Mexico, and the annual cycle is repeated the following spring.

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 the 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.

Monarch Habitat Management

Monarch caterpillar on butterfly milkweed.

Adult Monarch butterfly on coneflower. **Photos:** *Tom Allen, WVDNR*

Monarch habitat should be focused on creation, enhancement and protection of early successional areas containing milkweeds that create corridors throughout an area. At a large landscape level, nectar corridors are pathways of food sources for migratory species such as Monarch butterflies and various hummingbirds scattered along great distances which sustains them during migration. On a smaller (farm planning) scale, these areas are fashioned along ditches, hedgerows, riparian areas, etc. to facilitate movement throughout a pollination area and/or provide pollinator resources in the form of nectar and pollen. Cumulatively, small scale corridors may be beneficial to provide resources in a watershed scale and so on. 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 (*Asclepius* spp.) should be a priority. There are over 100 species of milkweed in North America and approximately thirteen species occur in Kentucky alone.

Due to the nesting and egg laying times for monarchs (and other butterflies and pollinators) management decisions regarding the timing, intensity and technique may need to be altered. Any management of the area should be performed prior to spring Monarch migration which usually appears in KY in mid-April and after the last monarchs have left the area in September.

Management and establishment of these areas may differ slightly from other management techniques for pollinators. For establishment, specialized equipment may be necessary such as no till

drills and fluff boxes to plant milkweed seeds. 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 the **Plant Tables** and **Plant Mixes** section of this document for recommended plants for monarchs.

It is important to stress that mowing removes habitat and insects any time of the year. Mowing in patches ensures that all pollinators always have access to undisturbed patches of habitat until plants and insects can recolonize the mowed area. Milkweeds do not respond well to frequent mowing and will likely disappear if mowing is too frequent.

Herbicide application is usually necessary when planting an area to monarch 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 chemicals will kill monarch larvae. They should be applied with targeted spot treatments instead of a broadcast method. Whenever possible, mechanical removal of shrubs should be used in combination with herbicides to maintain butterfly habitat.

If landowners are interested in starting a monarch waystation for education and pollinator habitat visit www.monarchwatch.org .

Refer to the establishing habitat and **Plant Tables** section of this document for suitable plants and mixes that benefit Monarch butterflies.

It's important to provide milkweeds and other plants for food during all stages of the monarch's life. This is a monarch caterpillar feeding on milkweed.

Photo: *Oak Hairstreak Study*

Pollinator Biology and Habitat

Natural areas on and close to farms can serve as refugia for native wild pollinators. Protecting, enhancing or 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.

Pollinators have three basic habitat needs. 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 blooming times so that flowers are available to forage 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, in order to support a diverse community of bees and other pollinators.

Natural areas with abundant native forbs that flower when the main crop is not in bloom, such as this mixed border including goldenrod and some shrubs adjacent to this apple orchard can support resident pollinator populations through the season.

Photo: *Toby Alexander, NRCS*

Second, they need places to nest. The majority of native bees are solitary, and none 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 in 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 fallen grass. Often, they move into old rodent burrows. Because their nests are started anew each spring by overwintering queens, bumble

bees need both 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 needs may be created enhanced or maintained.

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 rocks or trees
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 or walls
Butterflies and Moths	Egg	Non-feeding stage	Usually on or near larval host plant
	Caterpillar	Leaves of larval host plants	Larval host plants
	Pupa	Non-feeding stage	A protected site 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 Not significant pollinators.		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.

Adapted from: *Native Pollinators. May 2005. Fish and Wildlife Habitat Management Leaflet. No. 34* http://go.usa.gov/Gatk .

Pollinator Conservation and Farm Planning

Habitat enhancement for native pollinators on farms, especially with native plants, provides multiple benefits. In addition to supporting pollinators, native plant habitat will attract beneficial insects that prey on crop pests and may lessen the need for pesticides on the farm. Pollinator habitat (early successional stage or young forest) can also provide habitat for other wildlife, serve as corridors to facilitate movement, help stabilize and build soil, and improve water quality. Conversely it would be prudent for planners to become familiar with locally common agricultural pests and their biology in order to prevent inadvertent increases in those pests when promoting pollinators, though generally maintaining predator populations far outweighs any risk of pest populations increases.

Many of the NRCS conservation practices that we plan and implement on a regular basis can be significant pollinator enhancement practices with simple adjustments aimed at increasing floral diversity or by simply considering different methods of application to the landscape. With a little forethought, these practices can improve the overall aesthetics of the landscape by adding color and structure from early spring to late fall and often over the winter.

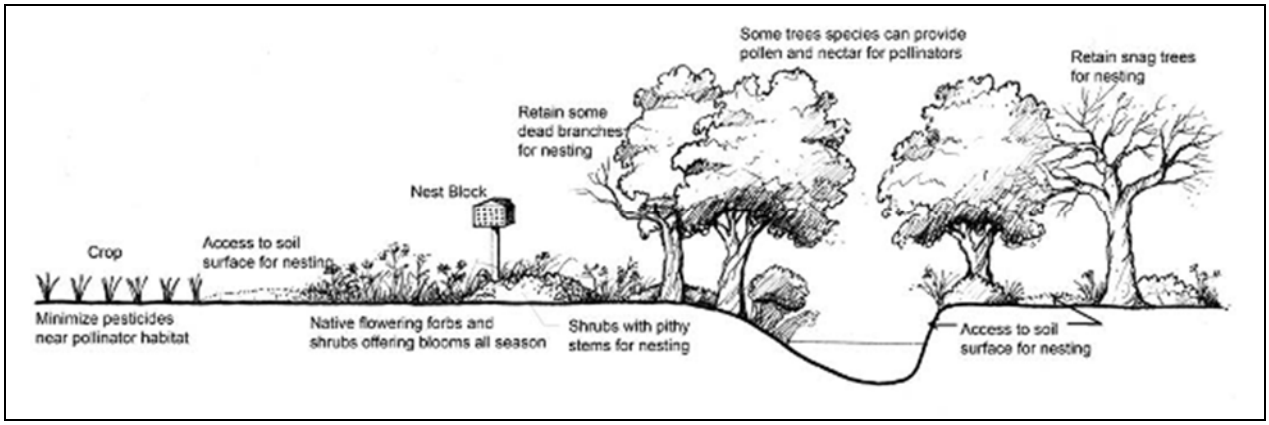
This document provides a four-step approach to pollinator conservation which includes: (1) advice on **recognizing existing pollinator habitat**; (2) steps to **protect pollinators** and existing habitat; (3) methods to **create, further enhance or restore habitat** for pollinators; and (4) methods for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

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 Warren County, KY site.

Photo: *N. Adamson, The Xerces Society*

I. Recognizing Existing Pollinator Habitat

Many landowners may potentially already have an abundance of habitat for native pollinators on or near their land; having semi-natural or 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. Though harder to observe, many forests include floral resources, resins, and nesting sites that also support pollinators. Here we provide advice on recognizing specific habitat resources so that they can be factored into farm planning.



Many existing landscapes already possess food, nesting sites and other critical resources for pollinators.
After: Agroforestry Note – 34: *Enhancing Nest Sites for Native Bee Crop Pollinators*

Existing Plant Composition

Many acres within Kentucky already possess good to excellent plant composition and plant communities that provide pollinator habitat. When assessing pollen and nectar resources, it is important to look at all of the potential plant resources on and around a landowner's or farmer'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 wild pollinators. However, for pollinators to be most productive, nectar and pollen resources are needed outside the period of crop bloom.

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 their crop bloom, mow them during crop bloom, then let them bloom again afterward.

For example, dandelion (*Taraxacum officinale*), clovers (*Trifolium* spp.), and other non-native plants may often serve as good pollinator plants. These type of forbs could be mowed while an

adjacent crop blooms in order to continue to provide nectar and pollen resources without interruption. Of course, one must weigh the benefits to crop pollination against potential negative effects on ground nesting wildlife and native bee populations. As an example for vegetable producers, some portions of those types of crops could be allowed to bolt to continue to provide resources outside and beyond the bloom period. Some crops are secondarily beneficial. In addition to providing pollinator resources, the predators and parasitoids of pests are attracted to the flowers of arugula, chervil, chicory, mustards and other greens and support pest management.

When evaluating existing plant communities on the margins of cropland, a special effort should be made to conserve very early and very late blooming plants. Early flowering plants provide an important food source for bees emerging from hibernation, and late flowering plants help bumble bees build up their energy reserves before entering winter dormancy.

Early successional habitat containing a variety of blooms, color and height is a key to providing resources for pollinators. Remember to consider surrounding landscape including trees, forbs and shrubs for the resources they provide.

Photo: *N. Adamson,* The Xerces Society

Keep in mind that small bees may only fly a couple hundred yards, while large bees, such as bumble bees, easily forage a mile or more from their nest. Therefore, taken together, a diversity of flowering crops, wild plants on field margins, and plants up to a half mile away on adjacent land can provide the sequentially blooming supply of flowers necessary to support a resident population of pollinators.

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 strong populations of those species. 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 co-operate 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.

Most of North America's native bee species (about 70 percent or very 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.

The majority of native bees nest underground as solitary individuals. From above ground, these nests often resemble ant hills. **Photo:** *Eric Mader, The Xerces So-*

Approximately 30 percent (around 1,200 species) of bees in North America are cavity nesters. Generally, cavity nesting bees nest in abandoned beetle tunnels in logs, stumps, and snags. A few 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, even soft pines and yellow poplar (*Liriodendron tulipfera*). Dead limbs, logs, or snags should be preserved wherever possible. Some wood-nesters also use materials such as mud, leaf pieces, or tree resin to construct brood cells in their nests.

Bumble bees are our most well-known native social bee. There are about 45 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. Bunch grasses, including many warm season grasses, provide better nesting habitat than sod-forming grasses like fescue. These native warm season bunch grasses protect bees from predators and rain, yet allow movement, just as they do for other grassland wildlife. Structures such as brush piles, fences or hedgerows, and stone fences also provide nesting habitat for bumble bees.

A secondary benefit of flower-rich foraging habitats is the provision of egg-laying sites for butterflies and moths. These species lay their eggs on the plant on which their larva will feed once it hatches. Some butterflies may rely on plants of a single species or a closely related group of plants (genus) for host-plants. The Monarch butterfly is an example of a species that relies on a single genus of plants, milkweed (*Asclepias* spp.).

Planner Note

When working with landowners that 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 when possible. 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 swallowtail butterflies (*Papilio* spp.) whose larvae can eat a range of trees, shrubs, and forbs. 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.

Fallow areas can be used to provide forage, nesting habitat and refugia for pollinators. Here, several species of butterflies are nectaring butterfly milkweed in Hart County, KY. **Photo:** *M. Hensley*

Existing Areas of Open and Forested Landscapes

Kentucky is characterized by a mosaic of open lands, croplands forest patches and corridors through pasture and hayland. Forested landscapes can provide an abundance of pollinator habitats for a variety of insects and birds. These areas provide refuge and food sources in conjunction with the open areas especially in the early growing season. Trees are often the sole food source for bees in the spring.

Forests are becoming increasingly fragmented, with small pockets of natural landscape (or something approaching natural) surrounded by farms, towns, and roads. That makes it harder for animals to provide their ecosystem services, like pollination. Pollinators have a tough time pollinating in a fragmented forest. There are fewer pollen donors, there are smaller, less diverse pools of pollinators, and those pollinators have a tougher time moving around. In that environment, species that do not rely on animal pollinators could eventually come to dominate the scraps of forests that remain.

Narrow lines of trees such as those bordering crop fields that connect larger swaths of forest could help pollinators do their job. It's known that these living fencerows can themselves sustain substantial biodiversity, but it's not yet known whether they can also act as pollination highways. A recent study shows that corridors can in fact be effective, at least when it comes to hummingbirds. A study in Cost Rica (*Betts and Hadley*, 2009) showed that in a fragmented landscape hummingbirds stuck to flowers in forests and along corridors, avoiding those placed in the exposed open areas. Two species—those with more generalist habitat preferences—were more willing to venture out into the fields. However, as food sources got further from the forest's edge, even the more generalist species were less likely to visit the flowers. While open areas might as well have been a no-fly zone, both corridors and forest fragments were equally likely to serve as pollen conduits.

II. Protecting Pollinators and their Habitat

When farmers and landowners recognize the potential pollinator habitat on their land, they can then work to protect these resources. In addition to conserving the food and nest sources of their resident pollinators, they can take an active role in reducing mortality of the pollinators themselves. While insecticides are an obvious threat to beneficial insects like bees, other common farm operations or disturbance, such as mowing or tilling, can also be lethal to pollinators.

Minimizing Pesticide Use

Pesticide is the larger term for herbicides and insecticides. Obviously, these chemicals can cause harm to both the habitat of pollinators and the pollinators themselves. Even sub-lethal doses can affect their foraging and nesting behaviors, often preventing plant pollination and bee reproduction. Herbicides can kill plants that pollinators depend on when crops are not in bloom, thus reducing the amount of foraging and egg-laying resources available. However, planners and landowners alike should be realize that it is almost always necessary to utilize chemicals (especially herbicides) to establish a meaningful pollinator stand. In an agricultural and urban settings alike domestic grasses ornamental plantings or invasives may dominate the landscape. It is imperative to eradicate and/or control these stands of plants at least in the short term until native pollinator-friendly plants can be established. Herbicides are the most economical and feasible method. It is the purpose of this section to choose the safest and most pollinator-friendly methods to establish/maintain pollinator habitat.

Broad-spectrum chemicals should be avoided if at all possible. If pesticides cannot be avoided, they should be applied directly on target plants to prevent drift. Crops should not be sprayed while in bloom and fields should be kept weed free (or mowed just prior to insecticide applications). This discourages pollinators from venturing into the crop if sprayed outside of the bloom period. Night-time spraying, when bees are not foraging, is one way to reduce bee mortality. Periods of low temperatures may also be beneficial for spraying since many bees are less active in cooler conditions. However, the residual toxicity of many pesticides tends to last longer in cool temperatures. Dewy nights may cause an insecticide to remain wet on the foliage and be more toxic to bees the following morning.

In general, while pesticide labels may list hazards to honey bees, the potential dangers to native bees are often not listed. Many native bees are much smaller in size than honey bees and are affected by lower doses of chemicals. Also, honey bee colonies may be covered or moved from a field, whereas wild bees will continue to forage and nest in areas that have been sprayed.

The use of selective pesticides that target a narrow range of insects, such as *Bacillus thuringiensis* (*Bt*) for moth caterpillars, is one way to reduce or prevent harm to beneficial insects like bees. Generally, dusts and fine powders are more dangerous than liquid formulations. This is in part because the dust and fine particles of the pesticide become trapped in the pollen collecting hairs of bees. The chemicals are consequently fed to developing larvae.

Alternatives to insecticides are also available for some pests, such as pheromones for mating disruption, and kaolin clay barriers for fruit crops. Local University of Kentucky Extension Service personnel may be able to assist with the selection of less toxic pesticides or with the implementation of integrated pest management (IPM) programs. Find out more information at: http://ces.ca.uky.edu/ces/.

Even small amounts of pesticides may be detrimental to pollinators such as this foraging sweat bee (*Agapostemon* sp.).
Photo: *T. Alexander. Vermont NRCS*

Landowners who encourage native plants for pollinator habitat will inevitably be providing habitat that will also host many beneficial insects that help control pests naturally. This may result in less dependency of pesticide application.

In addition to providing pollinator habitat, windbreaks, hedgerows, and conservation buffers can be effective barriers to reduce pesticide drift from adjacent fields. 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. Spray drift can occur as either spray droplets or vapors. Factors effecting drift include weather, method of application, equipment settings, and spray formulation.

Weather related drift increases with temperature, wind velocity, convection air currents, and during temperature inversions. Wind related drift can be minimized by spraying during early morning or in the evening when wind velocity is often lower. However, even a light wind can cause considerable 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.

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.

Planner Note

Consider using vegetated screens in areas where pesticides are utilized or bees are foraging. Conservation practices such as hedgerows or windbreaks and vegetated barriers 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 are excellent.

Similarly, during temperature inversions spray droplets become trapped in a cool lower air mass and move laterally along the ground. Inversions often occur when cool night temperatures follow high day temperatures. These are usually 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.

Spray application methods and equipment settings also strongly influence the potential for drift. Since small droplets are most likely to drift the longest distances, aerial applications and mist blowers should be avoided where feasible. 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 it is 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.

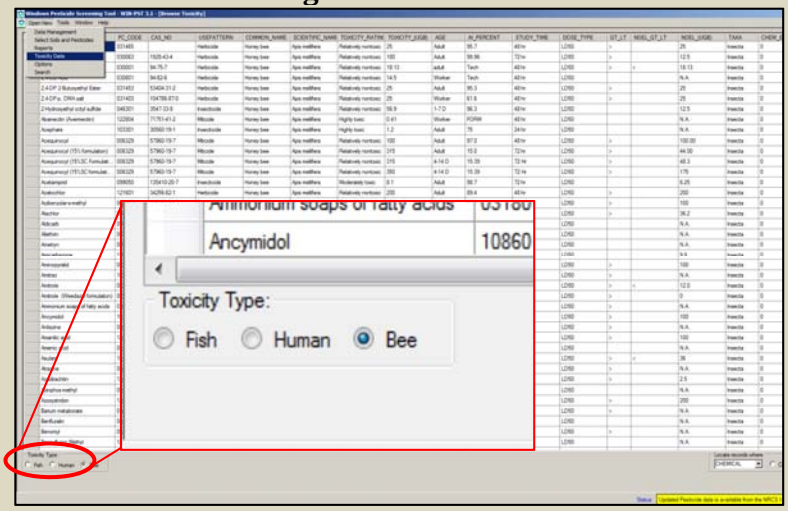
Formulation	Hazard Level to Pollinators
Dust	Worst
Wettable Powder	
Flowable Emulsifiable Concentrate	
Soluble Powder Solution	
Granular	Least

Pesticide hazard levels to pollinators adapted from Agroforestry Note No. 35 *Pesticide Considerations for Native Bees in Agroforestry*, **June 2007. USDA**

If pesticide use is an integral part of the farm operation and it is not practical to eliminate from the operation, landowners should be provided risk assessments using NRCS protocols such as a pesticide screening tool (i.e. Win-PST). This risk assessment is based on the soils and pesticides used in the operation. See the planner note entitled **NRCS Pesticide Planning & Risk Assessment** for more information.

Planner Note

NRCS Pesticide Planning & Risk Assessment



Glufosinate-ammonium	128850	77182-82-2	Herbicide	Honey bee	Apis mellifera	Relatively nontoxic	100
Glyphosate (MON 77360 form	103601	38641-94-0	Herbicide	Honey bee	Apis mellifera	Relatively nontoxic	100
Glyphosate isopropylamine salt	103601	38641-94-0	Herbicide	Honey bee	Apis mellifera	Relatively nontoxic	100
Halofenozide	121020	112226-61-6	Insecticide	Honey bee	Apis mellifera	Relatively nontoxic	100
Halosulfuron methyl	128721	100784-20-1	Herbicide	Honey bee	Apis mellifera	Relatively nontoxic	100
Hexazinone	107201	51235-04-2	Herbicide	Honey bee	Apis mellifera	Relatively nontoxic	100
Hexythiazox	128849	78587-05-0	Miticide	Honey bee	Apis mellifera	Relatively nontoxic	200
Hydramethylnon	118401	67485-29-4	Insecticide	Honey bee	Apis mellifera	Relatively nontoxic	67
ICIS-0748	119002	81052-29-1	Growth Reg.	Honey bee	Apis mellifera	Relatively nontoxic	100
Imazamethabenz	128842	81405-85-8	Insecticide	Honey bee	Apis mellifera	Relatively nontoxic	100
Imazamox	129171	114311-32-9	Herbicide	Honey bee	Apis mellifera	Relatively nontoxic	24

Computer screenshots of NRCS WinPST 3.1 toxicity data. Data is updated periodically and landowners should always follow label instructions.

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* (developed in cooperation with The Xerces Society). This document along with the Windows Pesticide Screening Tool (WinPST) can provide a good assessment of the risks for certain pesticides. WinPST provides a report for many of the common pesticides and their relative toxicity to bees.

Managed honey bees used for pollination or honey production can be moved; however, native bees cannot. Many of the pesticides have little or no known information regarding their toxicity to native bees. The information that the WinPST tool provides is focused mainly on honey bees because toxicity to honey bees is part of the chemical safety screening process. It can be safe to assume that the toxicity to native bees may be different than those identified for honey bees. Native bees are often smaller and may be more sensitive to smaller doses of chemicals. In addition, the various stages of insects may tolerate chemicals very differently from adult honeybees.

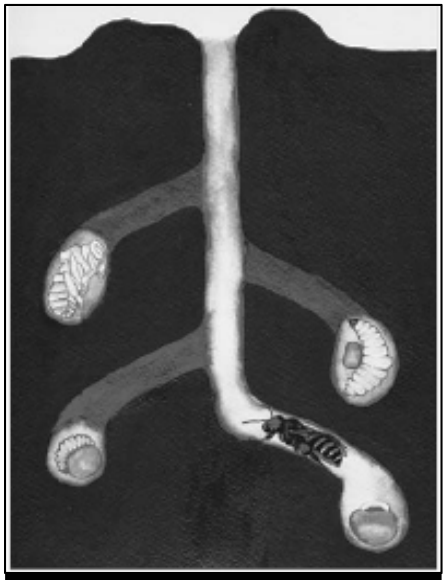
The WinPST tool should always be utilized when determining the risk to using pesticides for either establishment or maintenance of habitat. Many of the herbicides utilized are listed as *relatively nontoxic* to honey bees. However, planners should always follow all label directions and cautions and apply according to the label instructions. If there are multiple herbicides available that will provide the same desired effect, select the product that is the least toxic to bees shown in the tool. Landowners should consult UK Cooperative Extension to have the risk of any pesticides used assessed. The use of pesticides is often necessary. The benefits of one or two season's use of herbicides to establish good native stands generally outweighs any harm if utilized according to the label and performed in accordance with a management plan.

Minimizing the Impact of Mowing, Haying or Grazing

Disturbance is part of a management regime of many organisms. Disturbance in a farm setting is often frequent and abrupt. Many of the pollinators that exist in this region utilize early successional habitats for egg-laying and foraging. Early successional habitat is dependent upon disturbance. Disturbance in a farm setting occurs as tilling, mowing, haying, grazing, etc. When developing disturbance strategies with pollinators in mind, it is important to consider the timing, amount and intensity of the disturbance.

A general rule is that only 25% to 33% of pollinator habitat should be disturbed by mowing, grazing, or haying at any one time in order to protect overwintering pollinators, foraging larvae and adults, as well as other wildlife. If that is not feasible, never disturb more than 50% of an entire area in one season. The area disturbed should not totally eliminate a resource critical to pollinator habitat such as the only area providing pollen nectar resources during a given period. This will allow for re-colonization of the disturbed area from nearby undisturbed refugia, an important factor in the recovery of pollinator populations after disturbance. In order to maximize foraging and egg-laying opportunities, maintenance activities should be avoided while plants are in flower. Ideally, mowing in areas where pollinator habitat is important should be done only in the late fall or early winter.

If mowing is required, it could be performed during evening hours, closer to dusk. Bees are less active during this time of day. However, be careful to avoid mowing at night time for less disturbance of ground nesting songbirds. This is even true for homeowners and backyard managers that are concerned about adversely affecting pollinators by mowing lawns ad odd areas.



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.

Illustration courtesy Sarina Jepsen – The Xerces Society, Agroforestry Note 32. (August 2006)

Protecting Ground Nesting Bees

In order to protect nest sites of ground-nesting bees, tilling or other disturbance of bare or partially bare ground that may be occupied by nesting bees should be avoided. Grazing such areas may also disturb ground nests. Similarly, using fumigants like Chloropicrin for the control of soil-borne crop pathogens (such as *Verticillium* wilt), or covering large areas with plastic mulch could be detrimental to beneficial ground nesting insects like bees. Weed control alternatives to tillage include the use of selective crop herbicides and hooded sprayers for between row herbicide applications.

Protecting Tunnel Nesting Bees

Tunnel nesting bees will make their homes in the abandoned tunnels of wood-boring beetles and the pithy centers of many woody plant stems. Allowing snags and dead trees to stand (so long as they do not pose a risk to property or people) and protecting shrubs with pithy or hollow stems,

such as elderberry (*Sambucus* spp.), raspberry and blackberry (*Rubus* spp.), boxelder (*Acer negundo*), and sumac (*Rhus* spp.) will provide nesting opportunities for these solitary bees.

Supporting Managed Honey Bees

With a social structure consisting of a single queen, her daughter-workers, and male drones whose only purpose is to mate, honey bees represent what most people think of when bees are discussed. Their habit of producing useful products like excess honey and wax has inspired people to keep them in man-made hives since at least 900 BC. While not native to North America, the European honey bee (*Apis mellifera*) remains a crucial agricultural pollinator. 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. Swarming is the process by which an overgrown colony divides with half the colony flying away to establish a new nest.

People have been keeping honey bees in man-made hives since 900 BC. **Photo:** *USDA*

Unfortunately the subsequent accidental introduction of several major parasitic mites and bee diseases has slowly devastated both feral and managed honey bees in the United States. Habitat degradation and pesticide issues have also taken a dramatic toll on honey bee populations. The result is that with the exception of feral Africanized honey bees, which escaped from a research facility in Brazil in 1957 and slowly moved north through the southwestern U.S. few feral honey bees exist in North America. Similarly, the number of managed honey bee hives in the U.S. has declined by 50% since 1945, while the amount of crop acreage requiring bee pollination continues to rise.

There are several theories about the decline of managed honey bees. They range in bad genetics, to new pesticide developments and diseases. Recent studies have pointed toward the increased use of a group of pesticides known as neonictanoids. While this may be a contributing factor for decline, there are most likely several reasons resulting in a cumulative effect.

Beekeepers have also suffered in recent years due to declining honey prices, the result of low cost imported honey. As a result, many commercial beekeepers have increasingly turned to a pollination-for-hire business model, making much of their income by renting bees to growers who need their crops pollinated. The advantage of honey bees to growers is they can be transported long distances and because of their perennial nature, they can rapidly be deployed in large numbers at any time of year.

Solutions to the many parasite and disease problems facing honey bees will require additional research and new management practices. The issue of habitat degradation however, can be addressed now. The same habitat enhancement guidelines that promote native bee populations also

promote honey bee populations and honey bee health. The critical factor for all bees is the presence of abundant pollen and nectar sources throughout spring, summer and fall.

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 floral resources for managed bees.

One habitat requirement for honey bees that is generally not as critical for native bees is access to water. Honey bees require 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.

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III. Enhancing and Developing New Pollinator Habitat

Landowners who want to take a more active role in increasing the population of resident pollinators can increase the available foraging habitat to include a range of plants that bloom and provide abundant sources of pollen and nectar throughout spring, summer and fall.

Such habitat can take the form of designated pollinator meadows or bee pastures, nectar corridors, demonstration gardens, orchard understory plantings, hedgerows and windbreaks with flowering trees and shrubs, riparian re-vegetation efforts, flowering cover crops, green manures, field borders and other similar efforts.

Diverse plantings of native forbs, such as wild indigo (*Baptisia alba*) should be prioritized to support the greatest abundance and diversity of pollinators.

Photo: *Eric Mader, The Xerces Society*

Locally native plants are preferred over non-native plants due to their adaptations to local soil and climatic conditions, greater wildlife value, and their mutually beneficial co-evolution with native pollinators. However, non-native plants could be suitable on disturbed sites, for specialty uses such as cover cropping or where native plant sources are not available. Mixtures of native and non-native plants could be possible, so long as non-native species are naturalized and not invasive. It should be noted that a number of common, naturalized species such as birdsfoot trefoil (*Lotus corniculatus*), white clovers (*Trifolium* spp.) and alfalfa (*Medicago sativa*) provide a good source of nectar to pollinators and are easily established, particularly in an agricultural setting.

A. SITE SELECTION

Site selection for installing new pollinator enhancement habitat should begin with a thorough assessment of exposure (including aspect and plant shade) and soil conditions, but also must take into account land use and available resources.

Aspect - In general, areas of level ground, with full sun throughout the day and good air circulation offer the most flexibility. East and south-facing slopes may also be acceptable as long as erosion is controlled during the installation process. Unless the site is located near a large body of water, west-facing slopes in many climates are often subjected to hot afternoon sunlight, and drying winds. Under such conditions west-facing slopes should be utilized to provide nest sites for ground nesting bees and bumble bees.

Sun Exposure - Since some plants require full sun or shaded conditions to thrive, the planting design should allow for sun-loving plants to remain in full sun as the habitat matures. Plantings

may also be installed in several phases. For example, if trees and shrubs are concurrently planned or utilized, they should be allowed to completely develop an over-story prior to planting shade-loving herbaceous plants below. Generally, shade intolerant plants will flower more and provide greater amounts of nectar and pollen, when they receive more sunlight than when they are partially shaded. Consider the area of establishment carefully. Consider the short term conditions and the long term conditions once the planting has matured. A site that is open and sunny now, may close up and become shady as plants mature and spread.

Soil Characteristics - Soil type is an important consideration when selecting a site. 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 will 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/ . Planning should emphasize those plants that will be adapted for the particular soil conditions and moisture regimes anticipated.

Fertility, soil pathogens, the presence of rhizobium bacteria, and previous herbicide use should also be considered during the planning process. Soil fertility will be most critical during early plant establishment, especially on previously cropped lands. As the habitat matures, few if any inputs should be required, especially if native plants are selected.

Similarly, some previously cropped areas may harbor soil-borne pathogens that could inhibit plant development. Where such conditions are known to exist, 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, specially inoculated seed is often available. It is always a good idea to use inoculated seed to obtain the maximum germination. Finally, pesticide residues or herbicides like atrazine and trifluralin can inhibit seed germination. These chemicals, soil pathogens, beneficial microorganisms and soil fertility can all be tested for by state, and extension soil laboratories. At a minimum, a soil test is recommended to determine fertility prior to establishment, and then periodically (2-5 years) after establishment.

Honey bee gathering pollen on beggarticks (*Bidens* spp.).
Photo: *Bob Peterson*

Adjacent Land Use - Adjacent plant communities and existing land use on neighboring lands must also be considered. Even if weeds are eliminated prior to planting, the presence of invasive plants adjacent to a restored habitat may result in a persistent problem requiring continuous maintenance and management. Adjacent cropland may also present a challenge unless the enhancement site is protected from pesticide drift. Adjacent crops may change seasonally, so it is important to consider the timing of floral resources and coordinate resources accordingly.

Marginal Land - Some otherwise marginal land, such as drainage ways waterways and buffer systems may be suited for pollinator plantings. While trees may be problematic on such sites, forbs will not prevent future maintenance and these sites may actually help absorb excess nutrients from wastewater.

Ditches, field buffer strips and borders, and even grassed waterways can be planted with pollinator-friendly plants rather than or in conjunction with grass. Legumes such as clover and alfalfa along with grasses could be utilized in these types of situations.

Size and Shape - Generally, the larger the planting area, the greater the potential benefit to pollinator species. Ideally, an area considered for enhancement should be at least one fourth ($^1/_4$) to one-half ($^1/_2$) acre in size, with two acres or more providing even greater benefits. With herbaceous plantings, large, square planting blocks will minimize the edge around the enhancement site and thus reduce susceptibility to invasion by weeds surrounding the perimeter. However, linear corridor plantings (e.g. along a stream or a hedgerow, or a crop border) will often be more practical. Where these linear plantings are installed, a minimum width of 10 feet should be considered. However, certain conservation practice standards 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.

Regardless of planting shape, to build sufficient resident pollinator numbers for reliable pollination services in cropland settings, consider requiring one or two acres for every 25 acres of cropped field.

This clearwing sphinx moth (*Hemaris tityus*.) is a member of the Lepidoptera (moths and butterflies). They are often mistaken for hummingbirds and are some of the fastest fliers.

Photo: Nancy Adamson

Planner Note

When eight or more species of plants with different bloom times are grouped together at a single site they tend to attract a significantly greater abundance and diversity of bee species.

B. HABITAT DESIGN

When designing a pollinator planting, first consider the overall landscape and how the new habitat will function with adjacent crops and cropland. From there, focus on the specifics of the planting such as species diversity, bloom time, plant density and the inclusion of grasses for weed control and soil stabilization.

Habitat designs for pollinators need to incorporate many considerations and utilize open sunny areas. **Photo:** *M. Hensley*

Landscape Considerations - The first step in good habitat design is the consideration of how the area you are working with fits-in (functions) with the adjacent landscape features. Attempt to place new habitat close enough to crops requiring pollination to be of significant value. Flight distances of small native bees might be as little as 500 feet, while larger bumble bees may forage up to a mile away from their nest. This may require some general understanding of the types of bees or other pollinators currently within the local area. Thus, crops that depend heavily upon bumble bees for pollination, such as cranberries or blueberries, might still benefit from pollinator habitat located some distance from the field. It should be noted however, that even bumble bees prefer habitat as close to the crop as possible. This sort of arrangement would minimize the encroachment of unwanted pollinator plants into crops while still supporting a strong local population of bees.

Similarly, the new habitat should be located as closely as possible to any existing pollinator populations that may inhabit the new area. Fallow or natural areas, existing abandoned fields, or unmanaged landscapes can all make a good starting place for habitat enhancement. In some cases these areas may already have abundant nest sites, such as fallen trees or bare ground, but only lack the floral resources to support a larger pollinator population. Be aware of these existing habitats and consider improving them with additional pollinator plants, nesting sites, protection or exclusion from livestock or construction of habitat areas adjacent to them.

When pollinator habitat is considered to assist in crop production habitat areas should be planned no farther away than ½ mile from the insect pollinated crop. Smaller plantings and potential nesting areas should be located throughout the area or farm and ideally separated by no more than 500 feet.

Diverse Plantings - Diversity is a critical factor in the design of pollinator enhancement areas. Flowers should be available throughout the entire growing season; or at least whenever adjacent crops needing pollination are not in bloom. It is desirable to include a diversity of plants with

different flower colors, sizes and shapes, varying plant heights and growth habits to encourage and benefit the greatest numbers and diversity of pollinators. Most bee species are generalists, which mean 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.

Choose plants with a variety of flower shapes in order to attract a diversity of pollinators. Some flowers appear almost closed which require bees to crawl inside the petals to obtain nectar rewards. Other species are long and tubular shaped requiring insects like butterflies that have long tongues to obtain the resources.

Color is another important consideration. Bees typically visit flowers that are purple, violet, yellow, white, and blue. Butterflies visit a similarly wide range of colors including red, whereas flies are primarily attracted to white and yellow flowers. Thus, 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.

Native milkweeds (*Asclepias* spp.) are vital as food for bees as well as larval and adult feeding sites for butterflies.
Photo: *C. Shrader NRCS*

Natural ecosystems are typically comprised of many species of plants and animals. Diverse plantings that resemble natural native plant communities are also the most likely to resist pest, disease and weed epidemics; and thus will confer the most pollinator benefits over the greatest amount of time. Species found in association with each other in local natural areas are likely to have the same light, moisture, and nutrient needs such that when these species are put into plantings they are more likely to form stable communities

Plant Density and Bloom Time - Plant diversity should also be measured by the number of plants flowering at any given time. Research has found that when eight or more species of plants with different bloom times are grouped together at a single site, they tend to attract a significantly greater abundance and diversity of bee species. In some studies, bee diversity continues to rise with increasing plant diversity and only starts to level out when twenty or more different flower species occur at a single site.

Therefore, at least three different pollinator plants within each of three blooming periods are recommended (i.e. very early and early, mid or late season). Refer to the plant tables in the Appendix of this document for a list of species and corresponding bloom periods.

Under this criterion, at least nine blooming plants should be established in pollinator enhancement sites. The exception to this is that when only woody species are established for pollinators, it is acceptable to establish species using the bloom period as very early, early and mid since there are so relatively few late blooming woody species. Be aware that establishment of trees without including an herbaceous component is not the most beneficial method to enhance a pollinator area. Herbaceous species are absolutely critical to ensuring that nectar and pollen resources are available throughout the season.

Season	Bloom Time
Very Early	March to April
Early	March through May
Mid	May through July
Late	July through Sept (or later)

It is especially important to include woody and herbaceous 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. 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.

Quick Blooming Reference to Common Native Trees and Shrubs in Kentucky

TREES			SHRUBS		
Name (Genus) [1]	**Approximate Flowering Period in Kentucky [2]**		**Name (Genus) [1]**	**Approximate Flowering Period in Kentucky [2]**	
Willow (*Salix* sp.)	March to May	Very Early	Redbud (*Cercis* sp.)	March to April	Very Early
Serviceberry (*Amelanchier* sp.)	March to May	Very Early	Paw-Paw (*Asimina* sp)	March April	Very Early
Red Maple (*Acer rubrum*)	March to April	Very Early	Hawthorn (*Crataegus* sp.)	May	Mid
Blackgum (*Nyssa sylvatica*)	April to May	Early	Elderberry [3] (*Sambucus* sp.)	April to July	Mid
Cherry (*Prunus* sp.)	May	Early	Blueberries (*Vaccinium* sp.)	May to June	Mid
Black Locust (*Robinia* sp)	May to June	Mid	Wild Rose (*Rosa* sp.)	May to July	Mid
Tulip Poplar (*Liriodendron* sp.)	May	Mid	Rhododendron (*Rhododendron* sp.)	June to July	Mid
Basswood (*Tilia* sp.)	June	Mid	Spiraea (*Spiraea* sp.)	June to September	Late
Sourwood (*Oxydendron* sp.)	July to Aug	Late	Raspberries [3] (*Rubus* sp.)	Spring to Summer	Late

[1]Check sources for species and varieties that are adapted to the local climate and condition.

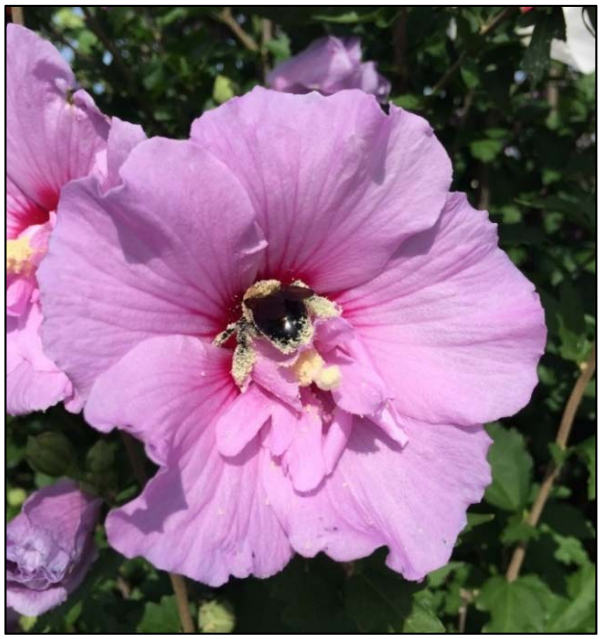
[2]The actual flowering period depends upon the species, year-to-year variations and other factors. It may actually last only a short portion of the period listed. It is important to consult with plant experts to develop a list of overlapping bloom times.

[3]When twigs are clipped on these plants, the soft pith provides nesting opportunities for small tunnel-nesting bees. Nectar and pollen may or may not be provided in abundance depending on the species.

Clusters of single species should be planted where possible. Herbaceous or woody shrub single species clump-plantings of at least three feet by three feet blocks are more attractive to pollinators than widely scattered species or randomly dispersed small clumps. The goal is for the established blocks to form a solid block of color when in flower. Larger single-species clumps such as a cluster of perennials or shrubs more than twenty-five square feet in size may be ideal for attracting pollinators and providing efficient foraging.

Inclusion of Grasses – Most herbaceous communities naturally occur in conjunction with one or more species of grasses. Typically these ecosystems contain a greater diversity of forbs, but most generally contain at least one dominant grass species in their compositions. In Kentucky, many of the grasses that naturally occur are cool season domesticated grasses like orchardgrass, fescue, timothy or bluegrass. We are familiar with these grasses due to their use for forage or erosion control. However, there are several naturally occurring native warm season grasses that are typically scattered throughout naturally occurring communities. These may include species such as Indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), little bluestem (*Schizachyrium scoparium*), purpletop (*Tridens flavus)* or big bluestem (*Andropogon gerardii).* In general these native grasses (which grow during the warmer months) are much more preferable than cool season grasses which grow quickly in the spring, and thus potentially shade or crowd out developing forbs. Native grasses appear later in the growing season, are considered not ideal forages or erosion control plants by most landowners and are consequently disregarded as having little value. However, these grasses and sedges often provide forage resources for beneficial insects or the larval growth stages of some native butterflies. They also are potential nesting sites for colonies of bumble bees and overwintering sites for beneficial insects, such as predaceous ground beetles. The combination of grasses and forbs also form a tight living mass that over time will resist weed colonization.

When including grasses in your pollinator stands, strive for a plant community that mimics the native ecosystem to maximize pollinator habitat. Therefore, if these naturally occurring species are not readily available, herbaceous plantings could include at least one warm season bunch grass or sedge (on wetter sites). This is in addition to the three or more forbs or shrubs from each of the three bloom-periods. This scenario results in a ten (10) plant species per planting. Acceptable bunch grasses are included within the Plant Tables in this document and in the recommended species mixes. The table below also shows appropriate species to include in plantings and during evaluation of habitat.



In Kentucky, bumble bees are some of the earliest foragers. The body hairs are efficient in collecting and transporting pollen. **Photo**: *C. Shrader NRCS*

Care should be taken that grasses do not dominate pollinator sites. Anecdotal evidence sug-

gests that tall grasses crowd out forbs more easily than short grasses, and that cool season grasses are more competitive against many forbs than warm season grasses. Seeding rates for grasses should never exceed seeding rates for forbs. As a general rule sedges or grasses should comprise no more than ten percent of the total seeding mixture. Planting in the fall should also favor forb development over grasses.

Habitats that supports pollinators also provides habitat for many other beneficial insects, wildlife and increases overall biodiversity. This clearwing moth (*Hemaris* sp.**) is nectaring on a common milkweed (***Asclepias* sp.**) in Hart County, KY.**

Photo: *M. Hensley*

The use of warm season grasses requires special attention to the details of establishment and management (seedbed preparation, planting and weed control). Full establishment may take as long as three years. The extra effort required to establish these grasses is offset by the wildlife benefits it provides.

There are instances where planting both woody and herbaceous species is appropriate (e.g. riparian areas and other existing corridor landscapes). However, plantings are usually either herbaceous or woody. It is often difficult to establish woody and herbaceous species simultaneously on the same site for a variety of reasons including the shade tolerance requirements, crown spacing, competition and other factors. In most instances it is recommended to establish vegetation in phases.

Planner Note

When establishing native pollinator sites, use three very early/early blooming plant species, three mid-season blooming plants and three late season blooming plants. This ensures that there is sufficient food for pollinators throughout the year. Include a native grass in the community to encourage it to thrive and be more natural. It also provides nesting and overwintering sites for many species of insects.

Native Grasses Suitable for Inclusion in Pollinator Habitat

Common Name	Scientific Name	Comments	
Indiangrass	*Sorghastrum nutans*	**Taller** growing species. Use lower seeding rates with forb and wildflower plantings	Some of these seeds are lighter and more difficult to disperse. They are best if drilled using specialized equipment or established using a broadcast seeder in conjunction with a seed dispersal material.
big bluestem	*Andropogon gerardii*		
Switchgrass	*Panicum virgatum*		This species is very common and cheap but quickly becomes dominant in forb plantings and should be planted in extremely low rates per acre.
little bluestem	*Schizachyrium scoparium*	**Shorter** growing species that tend to be more compatible with forb and wildflower plantings	Some of these seeds are lighter and more difficult to disperse. They are best if drilled using specialized equipment or established using a broadcast seeder in conjunction with a seed dispersal material.
broomsedge	*Andropogon virginicus*		
side oats grama	*Bouteloua curtipendula*		
sedges	*Carex spp.*		
rushes	*Juncus spp.*		

Principal Crops in Kentucky 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 at least the locally important crops being grown in your area. Below is a table of a few common crops. This might assist planners to determine what to establish for periods when pollen and nectar are absent; or when space or landscape factors restrict the amounts of forage provided. There are many different cultivars and varieties of crops. Therefore the bloom time will vary significantly depending on the species, hardiness and variety planted. Planners should discuss the specific plant and rotation to understand the critical time periods for pollination. Note that many crops are wind pollinated (e.g. corn, some bean species, tomatoes and peppers) however insects sometimes assist the pollination process for these crops and habitat should be provided all season long when a part of the system is in this rotation.

Blooming periods for common fruit crops

CROP	BLOOM PERIOD
squash	Mid-June through Late July some species will bloom very late (August)
pumpkin	Mid-June through Late July
apple (orchards)	Mid-April through mid-May Apples can be very diverse. Wild and domesticated apples will vary greatly.
blueberry	**highly variable** – April through mid-May
strawberry	**highly variable** – mid May through early June

Planner Note

When attempting to help crop producers, the NRCS planner should determine the non-flowering period of the crop requiring pollination and then recommend plants that bloom only when the crop is not blooming. This ensures that pollinators are busy pollinating the intended crop and not foraging elsewhere. An example would be an apple crop blooming in mid-May thru early June (mid-bloom period) would require plants that bloom in the early and late blooming periods to support pollinators the remainder of the year.

C. PLANT SELECTION AND SEED SOURCES

First, choose plants with soil and sunlight requirements that are compatible with the site where they will be planted. The plant tables located in the appendix provide a starting point for selecting widely distributed and regionally appropriate pollinator plants. If these plants are not available, other closely related species might serve as suitable replacements. Often these species are listed as spp. in the plant tables at the end of this document. Contact the NRCS, KDFWR or a forester to determine other suitable species. Also, refer to the Tree and Shrub List for Kentucky in Section IV of the NRCS Field Office Technical Guide which includes information related to corridor spacing, soil drainage class, and shade tolerance for several common native woody species. If utilizing spacing from these tables utilize the wider ranges of spacing to allow fuller crown development and increased bloom.

Woody plants may be established for pollinators in a variety of settings. Since hedgerows and 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 season as possible. Many trees and shrubs are available prior to the bloom period of the majority of herbaceous plants and are often the most visited of plants by bees early in the season. Conversely, woody species stop blooming earlier in the growing season and the floral resources then become unavailable for the remainder of the season. Therefore, it is not advisable to depend solely upon woody species to provide pollinator resources.

A black swallowtail (*Papilio polyxenes*) **nectaring on a Turk's Cap lily** (*Lilium superbum*).

Photo: *C. Shrader NRCS*

Many species of woody plants are actually wind pollinated. It is important to utilize trees and shrubs that are known to be pollinated by insects. Examples of species that are wind pollinated are: hickories (*Carya* sp.), Ash (*Fraxinus* sp.) and Oaks (*Quercus* sp.). These species should not be utilized as pollinator beneficial species.

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. Use caution when planting woody species around orchards and certain crops as some species may provide alternate hosts or vectors for plant diseases (e.g. cedar apple rust).

Scarlet Bee Balm (*Monarda didyma*) **is a showy native perennial attractive to many pollinators.**

Photo: *C. Shrader, NRCS*

Woody pollinator plantings should be at least one-half acre (0.5 acres) in size. In reality no significant A woody pollinator mix must also contain at least three species in each that the three blooming periods as discussed above (**very early, early** and **mid)**. Trees and shrubs should be planted in close enough proximity to aid in pollinator access but far enough apart to allow for maximum crown development and bloom. Planting materials may be seedlings, bare root, containerized or balled and burlapped.

Before considering pollinator projects that contain tree plantings, weigh the considerations of seedling, shrub and forb planting protection, maintenance prior to implementation. In Kentucky, usually following a disturbance natural succession and subsequent volunteer species provide primary or secondary pollinator resources. Where possible, take into consideration the availability of these naturally occurring species to minimize the amount of planting and take them into consideration when evaluating the success of pollinator plantings.

Native Plants - Native plants are adapted to the local climate and soil conditions where they naturally occur. Native pollinators are generally adapted to the native plants found in their habitats. Some common horticultural plants do not provide sufficient pollen or nectar rewards to support large pollinator populations. Just because a certain species of horticultural variety of plants produce a large visually attractive flower does not necessarily mean that the plant produces nectar or pollen in necessary quantities to sustain pollinators. In addition, some non-native plants have the ability to invade and colonize new regions at the expense of exiting native plant communities. Often native plants have co-evolved with the pollinators that frequent them and are uniquely adapted to be most efficiently pollinated by those native insects.

Planner Note

Not all commercial pollinator mixes are created equal. Always check mixes from commercial sources to ensure that they provide sustained blooming throughout the year of native plants.

Native and indigenous perennial plants are advantageous because they generally:

1) require fewer fertilizers and do not usually require pesticides for maintenance;
2) may require less water than other non-native plantings;
3) provide permanent shelter and food for wildlife;
4) are less likely to become invasive than non-native plants; and
5) promote biological diversity.

Using native plants will help provide connectivity to existing native plant populations particularly in regions with fragmented habitats. Providing connectivity on a landscape level increases the ability for species to move in response to environmental shifts and increases the genetic variability potential.

The cost of native plants may appear to be more expensive than non-native alternatives when comparing costs at the nursery, but when the costs of maintenance (e.g. weeding, watering, fertilizing) are calculated over the long-term, native plantings can ultimately be more cost-efficient for pollinator enhancement. Native plantings also give the added benefit of enhancing native biological diversity and are the logical choice to enhance native pollinators.

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

Commercially procured seed should be certified according to Kentucky 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. It is always recommended to purchase certified seed when possible.

Transplants - In addition to seed, enhancement sites could be planted with plugs, container grown, containerized, bare-root, live stakes or balled and burlapped stock. NRCS planners should rely on the Kentucky conservation practice (612) Tree/Shrub Establishment or other appropriate standards for more information.

Herbaceous plants purchased as plugs have the advantage of rapid establishment and earlier flowering, although the cost and feasibility of using plugs can be prohibitive for large plantings. Transplanted forbs also typically undergo a period of shock during which they may need mulching and supplemental water to insure survival.

Planner Note

Pollinator planting is expensive and an investment of both time and money. *Careful planning is critical.*

Tricolored bumble bee (*Bombus ternarius*) visiting an apple blossom in New England.

Photo: *C. Stubbs, Univ. of Maine*

Similarly, woody plants may also require mulching and supplemental water after planting. In general, container grown and balled and burlapped woody plants have a higher survival rate and are available in larger sizes. They are typically more expensive than bare-root or containerized plants. Containerized trees and shrubs are plants that were either hand-dug from the ground in a nursery setting, or were harvested as bare-root seedlings, then placed in a container. Although the cost of containerized plants is typically low, they should be examined for sufficient root mass before purchase to ensure successful establishment. The cost of containerized plants may be prohibitive on larger sites.

Live stakes or waddles are cuttings of woody plants made 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 are used in conjunction with willow species in riparian or frequently flooded areas. Hardwood species with rooting ability can be found in NRCS' Plant Materials Technical Note-No. 1 located at: http://www.plant-materials.nrcs.usda.gov/pubs/mipmctn7266.pdf .

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) are generally a poor choice for enhancement areas, because without intensive management, they may 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 are likely to harbor various insect pests and disease spores. Cranberry growers may prefer not to have wild blueberry planted near their operations for similar reasons. It is prudent to be familiar with the crops and their commonly associated diseases within the local area of consideration.

As an example, some common non-native thistles in Kentucky are actually fairly good nectar resources for native bees and butterflies. However, the negative effects of encouraging propagation, the negative perception and the potential proliferation of potentially noxious weeds far outweigh the benefits. For those reasons, some species were not listed in the lists of pollinator plants in the appendix of this document. Similarly, native roses and common yard species like dandelion and plantain were excluded to avoid the same perceived effects. This is not to suggest that these species are not beneficial to pollinators. They should be retained if feasible and evaluated as a beneficial resource where they occur.

Non-Native Plant Materials - While in most cases native plants are preferred, non-native ones may actually be more appropriate for some applications. These include practices that involve cover crops, temporary bee pasture plantings or buffers between crop fields and adjacent native plantings. Often times it is necessary to include non-native or introduced species to fill in gaps of bloom times, provide additional color or provide pollinator resources during cropping sequences. These low cost plantings can also attract beneficial insects; some of which may predate or parasitize crop pests. For more information on suitable non-native plants for pollinators refer to the Plant Tables in the Appendices of this handbook.

Horticultural varieties of some native and non-native species may provide large blooms and attractive colors for people and pollinators alike. However, they frequently do not provide the pollen and nectar rewards of native species.

Photo: *C. Shrader, NRCS*

The tables provide a list of non-natives that are non-invasive and could be used in conjunction with native species in mixes or established as individual stands. Any other non-native species utilized should not be invasive or established at the expense of native plant species. This is not a complete list and there are certainly other species that could be used. Consult with technical specialists to determine the suitability of those species.

Pollinator Plant Mixes – There are numerous commercial pollinator mixes available for sale online and through mail order catalogues. Many of these mixes are excellent and will do an adequate job in providing at least some pollinator benefits. However, some mixes utilize species that often do not meet the bloom requirements set forth in this document; do not contain native plants indigenous to Kentucky; and/or do not provide pollinator resources throughout the growing season. Many commercial mixes are often tailored for aesthetics as opposed to production of pollen and nectar. They frequently contain horticultural varieties of plant species that have been propagated for variations in bloom or color but lack the ability to produce pollinator resources. In addition, these mixes frequently contain non-native species that may be aggressive in native ecosystems. It is important to utilize reputable established nurseries, plant vendors and pollinator mixes to ensure that these mixes contain native species and provide food and nectar throughout the growing season. In addition to the plants/mixes outlined in this document the mixes that have been established by The Xerces Society and are labeled for use in Kentucky are recommended. These mixes are available from The Xerces Society at: http://www.xerces.org/ .

D. CREATING ARTIFICIAL NEST SITES

There are many successful ways to provide nesting sites for different kinds of native bees, from drilled wooden blocks to bundles of reeds to bare ground or adobe bricks. The Xerces Society's book *Attracting Native Pollinators* provides detailed information on how to build artificial nest

sites. Generally, increasing nesting opportunities will result in at least a short-term increase in bee numbers.

Most native 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 prefer smooth packed bare ground. Landowners can create conditions suitable to a variety of species by maximizing areas of undisturbed, untilled ground and/or constructing designated areas of semi-bare ground, or piles of soil stabilized with bunch grasses and wildflowers. Such soil piles might be constructed with soil excavated from drainage ditches or silt traps. Different species of bees prefer different soil conditions, although research shows that many ground nesting bees prefer sandy, loamy sand or sandy loam soils.

In general, these constructed ground nest sites should receive direct sunlight, and dense vegetation should be removed regularly (through very light disking 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.

A mason bee (*Osmia lignaria*) closes off the entrance to its hollow stem nest with mud.
Photo: *Mace Vaughan, The Xerces Society*

Colonization of these nest sites will depend upon which bees are already present in the area, their successful reproduction and population growth, and the suitability of other nearby sites. 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 $^1/_8$ inch in diameter to almost $^1/_2$ inch in diameter, depending on the species.

In contrast to ground-nesting bees, other species such as leafcutter and mason bees naturally nest in beetle tunnels and similar holes in dead trees. Artificial nests for these species can be created by drilling a series of holes into wooden blocks. A range of hole diameters will encourage a diversity of species, providing pollination services over a longer period of time. 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 U.S. to attract and manage large numbers of the non-native alfalfa leafcutter bee. More recently artificial nests have been modified to manage the blue orchard bee (*Osmia 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 year. Such blocks can be constructed by drilling nesting holes between 3/32 and 3/8 inches in diameter, at approximately 3/4 inch centers, into the side of a block 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 inches above the ground. The depth of the hole, however, is critical. Holes less than 1/4 inch diameter should be 3 to 4 inches deep. For holes 1/4 inches or larger, a 5 to 6 inch depth is best. Nest blocks should be hung in a protected location where they receive strong indirect sunlight and are protected from rain. Large blocks tend to be more appealing to bees than small ones, and colonization is often more successful when blocks are attached to a large visible landmark (such as a building), rather than hanging from fence posts or trees.

Hole Diameter	Hole Depth	Height
< 1/4 inch	3 to 4 inches deep	Minimum of 8 inches from ground level
>1/4 inch	5 to 6 inches deep	

Recommended nesting block hole size, depth and height

Under the best circumstances artificial nests can attract large numbers of tunnel-nesting bees and boost their local populations. However, 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 threaten long-term pollinator health.

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 Kentucky conservation practice standard (649) Structures for Wildlife should be followed when recommending these strategies.

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. However, with proper management, these nests can maintain healthy bee populations indefinitely. In order to be sustainable over the long term, artificial nests will require regular maintenance. The use of paper straws to line nesting holes is recommended because bee-occupied straws can be removed, stored and overwintered or destroyed if needed. Empty nest blocks can then be annually 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.

A drilled bee nest block.

Photo: *V. Sanders* – via Pintrest

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, artificial nests could be constructed with bundles of paper straws, cardboard tubes or sections of reed or bamboo cut so that a natural node forms the inner wall of the tunnel.

Planner Note

NRCS planners should always utilize a habitat assessment and thoroughly assess the need and maintenance requirements for any artificial nesting structures before recommending them.

IV. Establishment, Management and Maintenance of Pollinator Habitat

Early successional habitat is a conservation priority in the Northeast because many species of wildlife dependent on this habitat type are experiencing population declines. These habitats are typically transitional and require different levels of disturbance to be maintained. Examples of early successional habitats include weedy areas, grasslands, old fields, shrub thickets, and young forest. Disturbance and management can be accomplished through mowing, burning, brush hogging, disking, cutting, prescribed grazing, herbicide application, timber harvest and combination methods. While existing efforts to create and manage these habitats has been focused on birds and mammals, these areas also provide excellent habitat for pollinators. Early successional habitats provide a diversity of native and naturalized grasses, forbs, shrubs and trees that provide both food (pollen and nectar) and cover.

Old fields often provide a good mix of flowering forbs and woody species. Common and beneficial forbs include dandelion, clovers, vetch, milkweeds, mustards, wild bergamots, mints, goldenrods and asters. Wet areas may have marsh marigold, vervain, white turtlehead, joe-pye weed, and boneset.

Early successional shrubs and trees are found in disturbed forests and shrub communities, but many will colonize old fields as well. Species such as cherry, willow, wild roses, hawthorn, apple, raspberry and blackberry, dogwood, viburnum and meadowsweet provide an important source of nectar and/or pollen. Many of these woody species flower during spring when flowering forbs are scarce, making them very important for successful pollinator reproduction. Finally, early successional habitats with a woody component may provide important nesting habitat for tunnel nesting bees.

Early successional shrubs and trees are found in disturbed forests and edge communities. They provide habitat for pollinators as well as many other species of wildlife including bobwhite quail, cottontail rabbit and many native songbirds.

Photo: R. Alcorn, KDFWR

When creating a new early successional area, focus attention on large 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 with plenty of sun will favor shade intolerant plant species that are often sought by pollinators and other wildlife. To be most effective, new habitat areas should be created adjacent to existing open habitats.

The establishment of new early successional pollinator habitat requires special attention to the details of establishment, management and maintenance. This is a three step process:

1. Seedbed and Site Preparation
2. Planting
3. Stand Maintenance

**Weed suppression must be considered during all phases of pollinator planting.*

Establishment of a large complete self-sustaining pollinator stand may take as long as three years. The extra effort required to establish these species is offset by longevity of the stand and the benefits they provide. Smaller patches of habitat such as backyards or small garden-type plantings will require significantly less effort and maintenance.

WOODY ESTABLISHMENT

Woody establishment for pollinators is seldom sufficient alone to provide the resources pollinators require throughout the growing season. Consider woody establishment only when augmenting existing habitat. Tree and shrub planting and the site preparation is fairly straight forward depending upon the type of material planted. Containerized plants, seedlings or even seeds may be appropriate depending upon the site.

Site preparation will vary depending on the existing site cover and the type of equipment used in planting. Scalping or herbicide application or combination may be required to control exiting vegetation and create a planting area.

Consider the soils, the light and moisture requirement when planting woody species. In addition, think about providing enough room to allow for crown development (trees) and spreading (shrubs). This will allow the maximum amount of area for bloom and production of pollen when the plants are mature. Consider the maximum recommended spacing when planning. Note that planting new species of trees does not immediately solve the lack of pollinator resources. It may take several growing seasons for woody species to mature to the point of providing enough pollen in sufficient quantities to be significant.

Planner Note

Site preparation, establishment and maintenance of trees and shrubs should follow the Kentucky conservation practice standards (612) Tree/ Shrub Establishment and (490) Tree/ Shrub Site Preparation as appropriate.

WOODY STAND MAINTENANCE

In the first years after planting, trees may benefit from additional watering, frequent weed control to reduce competition and in certain areas browse protection. After the trees and shrubs are fully

established maintain the stand by pruning out any dead or diseased limbs to allow for full expansion of the crown. This creates more bloom area and allows a greater opportunity for foraging bees.

HERBACEOUS SEEDBED AND SITE PREPARATION

Native pollinator habitat should be planted by either conventional (disking or broadcasting) or no-till methods. No-till establishment is the preferred method since there is minimum soil disturbance, thus reducing weed competition and soil erosion. Conventional seeding may be used for establishment on areas that have been recently cropped or where weedy competition will be minimal and the risk of erosion is limited.

Great spangled fritillary (*Speyeria cybele.*) **nectaring on swamp milkweed.**

Photo: *S. Olcott, WVDNR*

Any existing cover must be eliminated by herbicide application or tillage. That decision must be made early, as both methods will be the most successful if started in the fall. This is especially important when a site has a dense sod cover or there is a potential for weed competition. Consult the University of Kentucky Cooperative Extension Service to determine the best herbicide combination and apply it at the appropriate time either in the in the spring or fall. Consider using a cover crop if conventional tillage is used in the fall to prepare the site.

Since these types of plantings are often slower to establish, competition control is critical to success. Conventional seedbed preparation, herbicide application or both may be needed to control competition prior to planting. It is important to allow adequate time to complete this process.

HERBICIDE USE (to establish habitat)

Many landowners that are interested in pollinator habitat and bees are somewhat reluctant to use herbicides. Unfortunately herbicide use is normally required to successfully establish and maintain pollinator habitat. The application of the proper herbicide using the safest most targeted application method is what landowners should strive to perform. There are many safe herbicides that landowners can purchase and apply that have very low risks associated with them. NRCS employees can run a pesticide screening tool known as WinPST to determine the risks associated with offsite sediment attached drift or water quality and the risks associated to humans and fish. These toxicity ratings can be combined with the off-site movement potential ratings to provide an overall rating of the pesticide movement below the root zone and past the edge of the field. That information can be provided to landowners as a report.

Often times areas selected for pollinator enhancements are already in sod bound conditions requiring removal of an existing stand prior to establishing more beneficial vegetation. This table contains suggestions for controlling competing, non-desirable vegetation prior to native forb establishment. In most instances this requires application of some form of herbicide. Sometimes more than one application is necessary.

Herbicides can be applied prior to planting (pre-emergent) and after the stand has begun to grow to control competition (post-emergent). Some forbs and wildflowers may not be compatible with post-emergent herbicide products (check the label for compatibility). All herbicides should be applied and used according to their label recommendations and may slightly differ from that listed below.

METHOD	SETTING	TIMING	PROCEDURE
Single Application This option should not be used when tall fescue or orchardgrass is the predominant cover. Two herbicide burndowns are recommended when fescue is the predominant cover.	Grassland adjacent to cropland or other area needed for pollinators.	Spring	1. Remove excess vegetation in fall or winter via mowing or close grazing. 2. Apply herbicide after vegetation has grown 4 to 6 inches in April – May. 3. Apply broad spectrum herbicide product. Follow all label instructions.
Double Application This option should be used when tall fescue or orchardgrass is the predominant cover.	Grassland adjacent to cropland or other area needed for pollinators.	Fall & Spring	1. Remove excess vegetation in late summer (Aug-Sept.) by mowing or grazing. 2. Apply broad spectrum herbicide after vegetation has actively grown to 4 to 6 inches in Sept/Oct. Follow all label instructions. 3. Apply broad spectrum herbicide just prior to planting and after remaining vegetation grows 4 to 6 inches in April-May. Follow all label instructions.

Note that some pesticides can leave residues within the soil that are harmful to pollinators and native forbs. Utilize all pesticides according to the label directions and utilize only to establish habitat.

HERBACEOUS PLANTING

The species discussed in this document will grow throughout the entire growing season in Kentucky. 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 of the species within this document require a cool, moist period prior to germination. This process is known as a stratification period. Most seed may be purchased already stratified. Stratified seed should be planted between April 1 and May 15. Un-stratified seed may be planted in the fall (November 15 – March 1). Check with the supplier to determine if any seed will require stratification or specific storage methods prior to planting.

Most of the species listed within this document are measured (and usually sold) in lbs. per acre of Pure Live Seed (PLS). They usually have a lower germination rate than many other common species. Therefore, it is essential when purchasing and planting native forbs that the quantities of seeds are based on PLS.

Commercial seed mixes are typically sold based on planting area size. Depending on the region, and the species included in each mix, 1/4 to 1/3 lb. is required for each 1,000 sq. ft. As a general rule, for areas of one acre in size, 5 to 10 lb. of seed is required. This results in approximately 20 to 40 seeds per square foot of planting area.

When actually planting seeds, it is imperative to establish good seed-to-soil contact. However, planting most native species too deep within the soil will result in failed plantings. Generally speaking, regardless of the planting method used the seeding depth should never exceed ¼ inch. Plantings deeper than ¼ inch will almost always fail.

Seeds of native plants are very different from most seeds to which landowners are accustomed. They are generally very small in size, often times in the 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 fluff 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.

CONVENTIONAL SEEDING

Old fields and weedy areas can provide abundant natural habitat for pollinators and beneficial habitat like this area in Russel County, KY
Photo: *N. Adamson*

Many times small areas may be established using hand or cyclone seeders; or similar equipment that is adapted to all-terrain vehicles or small tractors. If using these methods, the seedbed must be prepared by tillage (disking and/or plowing) to a depth of three inches. After tillage, make at least one trip over the field using a cultipacker to firm the seedbed. 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. On poorly or somewhat poorly drained soils cultipacking

may not be a feasible option. Utilize equipment suitable to maneuver in wetter environments or use hand equipment and ensure good seed coverage as best as possible by hand methods.

Another effective method for competition control is to establish native plantings immediately following an annual row crop such as corn. However, it is imperative to know the pesticides utilized and allow ample time for residual chemicals to be removed from the soil prior to establishment. Some chemical pesticides are not only harmful to pollinators but also will be harmful to the native plants to which they depend. Some chemicals are active within the soil long after they have been applied. Refer to the section of this document dealing with pesticide use.

Seed may be broadcast if accomplished in a uniform manner and should always be cultipacked after seeding. Pre-mixing the seed with 200 lbs./acre of pelletized lime and utilizing an airflow applicator is an effective method. Strive for 35-40 seeds per square foot. Wind speed should be minimal when using this method.

Broadcast fluffy seed with a drop or cyclone type spreader. A carrier may be used to help distribute the seed. The following carriers could be used: lime at 200 lbs/acre; wheat at 40 lbs/acre; or oats at 32 lbs/acre. Since fluffy seed will only broadcast as far as the carrier, make sure your passes overlap to ensure even coverage. If wheat or oats are used as a carrier, mow them prior to seed head formation.

After the seedbed is prepped by removing as much of the thatch as possible and creating a smooth seedbed. Do not cultivate the area because this will allow weed seed in the soil to germinate and compete with the planting. Seed may be bulked up using kitty litter, sand, vermiculite, cornmeal or other suitable medium to aid in dispersal.

Four Key Steps to Using a Drop or Broadcast Spreader:

1. Set the flow control to the lowest setting possible. Group seed according to size. Similar sized seed should be planted simultaneously.
2. Plant very large seed separately with a larger opening.
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.
4. Consider the use of row cover fabric to protect against bird predation.

Planner Note

Smaller sized plantings and potential nesting sites should be scattered throughout the farm, ideally separated by no more than 500 feet (150 m). This can encourage bees to travel farther into agricultural lands.

No-Till Using a Truax or Other Seed Drill

Most pollinator plantings are established using specialized drills and equipment. These plantings almost always require herbicide applications.

Photo: *M. Hensley, KY TNC*

Weed suppression and competition control is vital to establishing successful stands of pollinator habitat. There are several steps required to achieve competition control. The first step is to mow (or graze) the area to a very low height in late summer followed immediately by a herbicide application. If possible, after mowing and prior to herbicide application, remove any plant matter on the surface. This provides a better seedbed and allows for more herbicide contact with the vegetation and may allow reduced herbicide use in necessary subsequent applications.

Usually, a second herbicide application should be planned; this should always occur where dense fescue or orchardgrass stands exist. This application should occur just prior to planting and after any surviving vegetation has regrown to a height of 4 to 6 inches. All herbicide applications should be performed when vegetation is actively growing.

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

Four Key Steps to Using a No-Till Drill:

1. Calibrate the drill. Consult the owner's manual for the drill manufacturer.
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 ¼ inch (6mm) deep. 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. As a general rule, the depth of planting should be equal to the 1.5 times the diameter of the seed.
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.

HERBACEOUS STAND MAINTENANCE

Always allow enough time for establishment prior to disturbance of the stand, which may take as long as three years. During this period exclude livestock, maintain weed suppression measures and monitor the stand density for the intended purpose for the life of the stand.

Habitat plantings specifically for pollinators should remain undisturbed to the greatest extent possible throughout the growing season so that insects are able to utilize flower pollen and nectar resources (for adult stages) and vegetative parts of plants for food and cover resources (for immature/larval stages).

If site maintenance must occur during the growing season in order to maintain the open, species rich habitat preferred by pollinators, establish a system for managing a percentage (50% or less) of the site each year on a three to five year rotation. (See the diagram on the following page.) This will allow for re-colonization of disturbed habitat from the surrounding area. Ideally, disturbance should not occur every year, but be sure to prioritize a management scenario that will maintain the desired habitat components and a diversity of habitats.

Weed Suppression During the Establishment Period & Year One

Competition control remains the most important part of pollinator establishment for up to three years after planting. Weed control during the establishment period is usually achieved by mechanical (mowing or disking) or (if absolutely necessary) by chemical methods. Native pollinator stands can generally be top clipped to control competition during the establishment period without harm to the forbs since most of the growth occurs below ground during the establishment year.

Use caution when determining what species of vegetation are considered as “weeds”. Some native species of forbs (intended or unintended) may provide pollinator resources and serve as supplemental resources. Where possible, reserve the application of pesticides for situations when the stand is being invaded by noxious alien species that threaten to choke out more beneficial species.

Never apply nitrogen during the planting year. This encourages cool season grasses and other competition. Lime may be applied if desired but is usually not necessary. Consider the need and use of fertilizers carefully since these are generally also not required and tend to encourage undesirable competition.

Mow the planting as needed to control weeds. Mow at a height of 4 to 6 inches or just above seedling height. As a general rule, never allow undesirable vegetation to exceed 18 inches or form seed heads. In the event of a noxious or alien invasive species is threatening the existence of the stand, a “wickbar” or similar device may be used to selectively apply pollinator-friendly herbicides. However, many warm season grasses and some wildflowers are not post-emergent herbicide tolerant nor are many of them pollinator-friendly. Check with the UK County Extension Agent and labeling of the product.

Second and Third Year after Planting

Plantings should be inspected in the early spring. If undesirable or noxious, alien or invasive species comprise more than thirty percent of the stand mow the area very short until the forbs start to green up.

Small low impact herbicide rope wick applicators direct herbicide applications to target weeds without drift or overspray. These can be purchased or constructed for small ATV's or for commercial farm equipment.

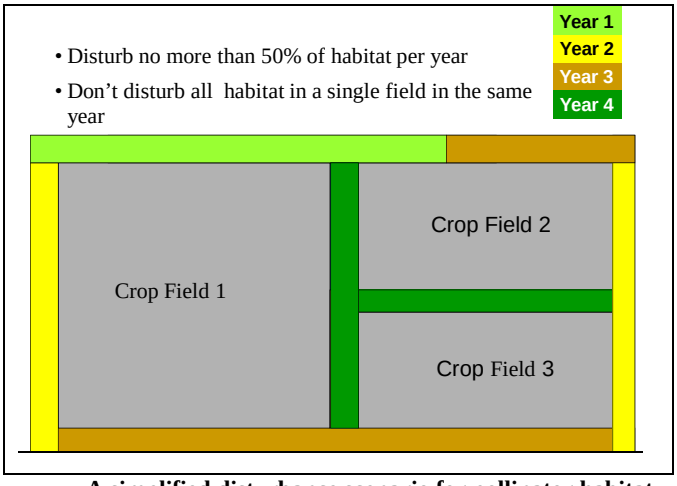
Photo: workhorseprayers.com

Throughout the growing season mow as needed above the seedling height to prevent weeds from overtaking the stand. However never mow more than 30-50 percent of the stand at one time to prevent removing sources of nectar and pollen.

If it is necessary apply lime, phosphorus, and potassium only if soil tests indicate that they are needed. Nitrogen should not be applied.

Fourth Year after Planting

By the fourth year, the stand should be well established. Established stands do not require frequent attention, but periodic disturbance is necessary to stimulate growth of desirable vegetation and to eliminate encroachment of undesirable or rank vegetation. The type and frequency of management will depend on the size and composition of the planting. For optimum pollinator habitat, all management practices should be conducted on a schedule where only thirty to fifty percent of the stand is disturbed annually. Management and maintenance activities may include, mowing or haying, weed control, grazing and light disking to rejuvenate the stand. Phosphorus and/or potassium may be applied moderately where desired or needed. Careful consideration should be given to the application of nitrogen. If nitrogen is required, apply 40 to 80 pounds of nitrogen per acre split in two applications: one as growth of the stand begins and the second in mid-summer.



A simplified disturbance scenario for pollinator habitat.
H. Henry, NRCS

In subsequent years continue to manage for maintenance of open sunny areas and remove or girdle large undesirable trees that begin to shade out the more desirable forbs and shrubs. Control invasive plants to lessen any negative impacts to the habitat.

Prescribed Fire

Fire has played an important role in natural ecosystems and controlled 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. Other studies have found a negative or mixed response of invertebrates to fire. In Midwestern prairie systems, fire as a management tool is based on the supposition that many species are adapted to wildfires, and thus can cope with regular burns.

This is dependent, however, on there being adequate unburned areas that can provide sources of colonizers into the burned habitat. In habitat fragments where populations are more isolated, prescribed burning can have much more deleterious effects on the population due to a lack of colonizing capacity. Some research suggests that burning a small habitat fragment in its entirety could risk extirpating some insect species because of limited recolonization from adjacent habitat. Fire can have serious impacts on population levels and unless there are adequate refuges from the fire or adjacent habitat, recolonization of a burned site may not be feasible. Some key points are:

- Always have a prescribed burning plan by certified planners and trained personnel. Contact the KY Department of Fish and Wildlife Resources, The Nature Conservancy or private contractors. Follow all state and local laws regarding prescribed burning.
- Timing of burns is critical and should not be carried out when pollinators are in a critical foraging stage (growing season burns).
- Habitat patches should not be burned completely, but rather a mosaic of burned and unburned areas is ideal but often not practical or feasible.
- Fires should not burn more than one-third of the entire habitat in any given year.
- A program of rotational burning where small sections are burnt every few years will ensure adequate colonization potential for pollinators.
- As a fire moves through an area it may leave small patches unburned. These areas should be left intact as potential micro-refuges.

Mowing and Haying

Mowing is a common method used to control rank growth and rejuvenate pollinator stands. However, simply mowing the stand and leaving the residue on the surface is not effective. If left on the surface, it will eventually smother and inhibit new growth. Usually mowing in combination with a light disking regime, herbicide application and or fire is the best method of disturbance to pollinator habitat. At a minimum, practice rotational mowing which entails mowing different parts of a field or stand each year and schedule management for late fall after resident bees have become inactive.

On sites where soils are too wet in the spring (or other times) to mow, disturbance may be performed in 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 fifty percent of the pollinator resources in one disturbance period. Also remember to 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. To maximize benefits, mow any given area on a 2 to 3 year rotation to control unwanted, rank and woody growth. Where feasible, mow only one-third to one-half of the stand each year. The remaining areas will provide year-round pollinator food and cover.

Remember that frequent mowing can be detrimental to pollinators. Balance any needed mowing schedule to allow plants such as dandelion and clover to periodically bloom. Raise the height of mowers to allow these common annuals to bloom and re-bloom where it is feasible.

Light Disking

Light disking may temporarily reduce the density of the stand, provide openings in the planting, facilitates the maximum amount of bloom, prevents the stand from becoming rank and allows movement of other wildlife. It should occur on a managed scheduled rotation. Rotation length depends on a number of factors including composition, stand size and density. Most typical stands should be disked on rotations of 2-3 or 3-4 years. It is important to remember to disk only 30 to 50 % 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 fifty percent of the pollinator resources in one disturbance period. Light disking in conjunction with herbicide application to reduce residue and rejuvenate stands is often the most practical and effective way to manage stands.

Prescribed Flash Grazing

Livestock could sometimes be utilized to manipulate stand density and remove residue. Flash grazing is controlled, rotational grazing and is a good tool to influence or maintain a plant community. Grazing should generally occur at only light intensities with a long rest-rotation schedule of grazing. In some instances this method may provide the most benefits with the least amount of impacts on wildlife. However, this technique should only be performed in accordance with a grazing plan with pollinator habitat as the primary objective. Some native forbs can be toxic to livestock. Always check to ensure the stand will not harm livestock prior to implementing this method. Livestock can quickly eliminate the floral resources from an area, so it is important that grazing be monitored closely.

The amount of grazing is determined by how many head of livestock are placed on the stand and how long they are allowed to graze the stand. As a management tool, rotational grazing should always be used. Native grasses should only be grazed to a minimum height of 12 inches and livestock should not graze more than one-half of the above ground height of other plants in the

stand before removal. Most plants need to have some growth 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 to 49 days. As a general rule never utilize this method 30 days prior to the first killing frost to provide this reserve. Flash grazing an established stand of forbs and grasses for pollinators should occur no more frequently than every two to three years. This residual growth is excellent overwinter cover and may provide nesting areas for bumble bees the following spring.

Planner Note

Note that some native forbs may exhibit livestock toxicity. Always check with grazing lands experts or the UK Cooperative Extension Agents to ensure that livestock poisoning does not occur if grazing as a maintenance strategy is considered.

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

In reality, a combination of the methods described above will need to be performed. Pollinator plantings in general are very diverse by design. Because the plants bloom throughout the year and differ in height, density and structure, several different methods might be required to completely remove the thatch or disturb the soil to stimulate regrowth. A combination of mowing, burning and disking areas is required to set back succession. The size and location of the area will dictate the type of management and planting required. Discuss the best management for a particular stand with wildlife managers.

V. Pollinator Habitat and NRCS Practices

The Natural Resources Conservation Service supports the use of native species in many of their conservation practices. In fact, most any 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 tree species to plant for a forested riparian buffer. Select species that have multiple consecutive flowering times, yet still provide the water quality and other benefits for which the buffer is primarily intended. Selecting pollinator-friendly native species for these practices can provide many additional conservation benefits. However, an enhancement for pollinators should not compromise other intended functions of a practice. For example, plants attractive to pollinators could be used in a grassed waterway, but the planting should not interfere with the hydraulic function of the practice and the primary objective of stabilizing erosion.

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 table on the following pages is a quick reference to NRCS practice standards, their criteria, considerations and jobsheets to aid in planning the appropriate practices for pollinators. This table only includes those practices that have been revised with current criteria and/or considerations. Some practices have specific pollinator jobsheets while others have had existing jobsheets modified to include pollinators. Some jobsheets may be utilized without any further modification. As practice standards are periodically revised this list will likely change.

Key	
X	Pollinator information has been provided in the conservation practice standard or standalone pollinator jobsheet
E	Planners may utilize the existing jobsheet to establish/maintain pollinator habitat

NRCS Practices that could be utilized as pollinator enhancements in Kentucky include:

Conservation Practice Name (Units)	Code	RELEVANCE TO POLLINATOR HABITAT	Consideration	Criteria	Pollinator Job Sheet Available
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 principle source of pollinator habitat in a given area.		**X**	**E**
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. Inter-seeding 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.	**X**	**X**	**X**
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 feet 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 season to support pollinator populations. Growers might also consider using *Integrated Pest Management* (595) to minimize insecticides and/or using bee-friendly insecticides in cover crop rotations.	**X**	**X**	
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 principle 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.	**X**		

Conservation Practice Name (Units)	Code	RELEVANCE TO POLLINATOR HABITAT	Consideration	Criteria	Pollinator Job Sheet Available
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 principle 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.	**X**		**X**
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.	**X**		**E**
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.	**X**	**X**	**E**
Field Border (Ac.)	**386**	This practice may provide nesting, foraging and various other forms of habitat along edges of fields. It provides early successional habitat by planting pollinator species a minimum of 20 feet wide to plants that provide resources throughout the year.	**X**	**X**	**X**
Filter Strip (Ac.)	**393**	Filter strips can be used to provide supplemental pollinator resources within crop fields especially in areas where there the landscape is somewhat homogenous. The primary purpose of the filter strip should not be compromised. Increasing the flow length (10 feet) on the downstream side of the filter strip and including legumes or other forbs that provide pollen and nectar is a good secondary resource for pollinators.	**X**		

Conservation Practice Name (Units)	Code	RELEVANCE TO POLLINATOR HABITAT	Consideration	Criteria	Pollinator Job Sheet Available
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 times 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.*	**X**		
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 2-3 years may provide areas for bumble bee nesting.		**X**	
Forest Stand Improvement (Ac.)	**666**	This practice includes criteria for wildlife and pollinators that can help maintain open understory and forest gaps that support diverse forbs and shrubs that provide pollen and nectar for pollinators. In addition, the retention of very early and early blooming species flowering species during harvest activities, especially near edges of fields and openings is highly encouraged.	**X**	**X**	
Grassed Waterway (Ac.)	**412**	Medium or tall bunch grasses 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 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/or nectar resources. Flow length should be increased a minimum of 10 feet.	**X**	**X**	

Conservation Practice Name (Units)	Code	RELEVANCE TO POLLINATOR HABITAT	Consideration	Criteria	Pollinator Job Sheet Available
Hedgerow Planting (Ft.)	**422**	The minimum width for hedgerows where the principle purpose is to provide pollinator habitat is **25 feet**. 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 that provides semi-bare ground and un-mowed herbaceous strips for bumble bees. This practice also can help reduce drift of pesticides onto areas of pollinator habitat as well.	**X**	**X**	**X**
Herbaceous Weed Control (Ac.)	**315**	This practice is to be utilized to reduce or eliminate noxious herbaceous plants in order to maintain or restore a native plant community or maintain an established plant community that supports native pollinators (O&M). Where possible or feasible, establish replacement species prior to removal to provide pollinator resources when noxious species are suspected of providing the principle source of pollinator habitat. In addition, apply herbicides in wildlife friendly methods to prevent harm to native pollinators and their food sources.	**X**		
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 5 - *Pest Management in the Conservation Planning Process*. 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 beneficial to bees include: yarrow (*Achillea* spp.), phacelia (*Phacelia* spp.), and sunflowers (*Helianthus* spp.)		**X**	**X**
Prescribed Burning	**338**	Considerations are in this standard for burning intensities, patch burning and maintenance of habitat to not impact pollinators during the peak activity times.	**X**	**X**	
Prescribed Grazing (Ac.)	**528**	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.	**X**		**E**

Conservation Practice Name (Units)	Code	RELEVANCE TO POLLINATOR HABITAT	Consideration	Criteria	Pollinator Job Sheet Available
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 to 3 feet 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.		**X**	**E**
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 to 3 feet 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.	**X**		**E**
Restoration and Management of Rare and Declining Habitats (Ac.)	**643**	A consideration was added to this practice. It could 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 and these plants and rare plants may significantly benefit from efforts to restore and\or manage rare habitat. However, pollinator plants should only be planted if they were part of the rare ecosystem you are trying to restore. *(e.g. rattlesnake-master borer moth and the rattlesnake master plant)*	**X**		
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 and/or shrubs consisting of very early, early or mid-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.		**X**	**X**
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 three forbs in each of the bloom periods.		**X**	**E**

Conservation Practice Name (Units)	Code	RELEVANCE TO POLLINATOR HABITAT	Consideration	Criteria	Pollinator Job Sheet Available
Stream Habitat Improvement and Management (Ac.)	**395**	A consideration in this standard 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 in the streams.	**X**		**E**
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, dogwood and goldenrod. The addition of native forbs and legumes to grass mixes will increase the value of plantings for both wildlife and pollinators.	**X**		
Stripcropping (Ac.)	**585**	There is criteria to include diverse legumes or other forbs that provide pollen and nectar for native pollinators. 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.	**X**	**X**	
Structures for Wildlife	**649**	This practice may describe the design construction and placement of artificial nesting structures such as nesting blocks or nesting bundles for bees. In addition, structures such brush piles may provide shelter for predatory insects such as lacewings and predatory wasps.		**X**	**E**
Tree/Shrub Establishment (Ac.)	**612**	Include trees and shrubs especially chosen to provide pollen and nectar for pollinators, or host plants for butterflies, and nesting habitat for tunnel nesting bees. Trees are vitally important for native bees in the early growing season.	**X**		**E**
Upland Wildlife Habitat Management (Ac.)	**645**	This practice has been revised to include the Kentucky Pollinator Handbook and habitat appraisal methodology and the requirements to report this practice. It should be the governing practice utilized to provide and establish pollinator habitat in Kentucky.		**X**	
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. Refer to the Kentucky Pollinator Handbook or contact the State Biologist for recommendations of specific plants.	**X**		

Conservation Practice Name (Units)	Code	RELEVANCE TO POLLINATOR HABITAT	Consideration	Criteria	Pollinator Job Sheet Available
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 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)*.	**X**		
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)*.	**X**		
Wetland Wildlife Habitat Management (Ac.)	**644**	A consideration was added to this standard. 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)*.	**X**		
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 nesting habitats or place nesting structures for native bees. Windbreaks and shelterbelts also will help reduce drift of insecticides to areas of pollinator habitat. Criteria includes, a woody pollinator mix containing a minimum of three species in each of the three blooming periods (very early, early and mid).	**X**	**X**	**E**

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 it is installed with pollinators in mind. Secondary practices have other principle 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.

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

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

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Conservation Reserve Program (CRP) - Potential Pollinator-Friendly Practices

Practices commonly used to improve pollinator habitat, either through establishing new habitat or improving existing sites by adding more pollinator plants. The column labeled "Notes" lists how these activities can support pollinators.

CODE	PRACTICE NAME	NOTES
PRACTICES TO CREATE POLLINATOR HABITAT		
CP2	Native grasses	Include pollinator forbs or legumes
CP4D	Permanent wildlife habitat	Include high percentage of forbs or legumes
CP42	Pollinator habitat	Used to contract permanent high-value pollinator wildflower plantings
PRACTICES THAT CAN INCLUDE POLLINATOR PLANTS		
CP3A	Hardwood trees	Include pollinator trees[1]
CP4B	Wildlife habitat corridor	Include high percentage of forbs or legumes
CP12	Wildlife food plot	Include pollinator forbs or legumes
CP22	Riparian buffer	Include high percentage of forbs or legumes
CP23	Wetland restoration	Include high percentage of forbs or legumes
CP25	Rare and declining habitat	Include high percentage of forbs or legumes
CP29	Wildlife habitat buffer (marg. pasture)	Include high percentage of forbs or legumes
CP30	Wetland buffer (marg. pasture)	Include high percentage of forbs or legumes
CP31	Bottomland hardwood trees	Include pollinator trees
CP32	Hardwood trees (previous expired)	Include pollinator trees
CP33	Upland bird habitat buffer	Include high percentage of forbs or legumes
CP41	Flooded prairie wetland (FWP)	Include high percentage of forbs or legumes

[1] *Pollinator trees produce high-quality pollen, nectar or both that support native bees and honey bees, or have pithy stems that provide nesting sites for cavity-nesting bees.*

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Appendices

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I. Financial Resources

The following table is an excerpt from Using Farm Bill Programs for Pollinator Conservation - Technical Note No. 78, 2nd Ed., May 2015
NOTE*: Programs and Program rule changes occur frequently. Always consult the local NRCS or FSA office for the most current program guidelines.*

The following are 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 or FSA Web sites for more information (http://www.nrcs.usda.gov/programs/) (http://www.fsa/usda.gov).

PROGRAM	PURPOSE	LAND ELIGIBILITY	TYPE OF ASSISTANCE
Conservation Reserve Program (CRP)	Land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat, and safeguard ground and surface water. An offshoot of CRP, 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. CREP contracts require a 10- to 15-year commitment to keep lands out of agricultural production. CREP is administered by FSA. NRCS provides technical assistance. Contact NRCS or FSA State or local office: http://www.fsa.usda.gov/programs-and-services/conservation-programs/index
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 resources concerns. Participants earn CSP payments for conservation performance - the higher the performance, the higher the payment. Awaiting Description	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.	The CSP program is being revised for 2017. Refer to the USDA NRCS Program homepage for the latest information regarding this program.

The following are 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 or FSA Web sites for more information (http://www.nrcs.usda.gov/programs/) (http://www.fsa/usda.gov).			
PROGRAM	**PURPOSE**	**LAND ELIGIBILITY**	**TYPE OF ASSISTANCE**
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 NRCS State or local office: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/.
Agricultural Conservation Easement Program (ACEP)	ACEP is a new easement program introduced in the 2014 Farm Bill. It replaces the Wetlands Reserve Program, Grassland Reserve Program, and Farm and Ranch Land Protection Program. ACEP helps prevent agriculture working land conversion to nonfarm activities. It also encompasses restoration, protection, and enhancement of wetlands on agricultural lands.	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 which 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 NRCS State or local office: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/

II. Plant Tables

A WORD CONCERNING POLLINATOR PLANTS

There is a vast array of native forbs to choose from when designing pollinator habitat. The following tables include native species to consider using when planning hedgerows, at the base of one or both sides of a hedgerow, riparian buffers, windbreaks, alley cropping, field borders, filter strips, waterways, bee pastures, nectar corridors or any planting to enhance conditions for pollinators. The following are just some of the plant options that you might want to consider. Pay close attention to overlapping bloom periods and the appropriate plant for the site conditions. Species should be selected according to light regimes, moisture requirements, height, pH concerns, color and blooming periods. They may require supplemental irrigation and fertilization. Establishment of perennial plants or a complete thriving population may take a few years, but will often last for an extended period of time.

In order to reduce the size and length of the lists, some species were not included due to their infrequency of occurrence or their commercial availability was questionable. Where there were many species of the same genus and those species were all suitable with very little difference among plants, the genera was listed as *spp.* An example is *Bidens* spp., which are also called Tickseeds. This would mean that there are numerous species of tickseeds that are useful to pollinators or other beneficial insects and there are multiple species within that genus considered beneficial. Consult nurseries or technical experts to determine if a particular species is suitable for use, propagation and the flowering characteristics.

For the most part, only perennial plants were identified for use in the pollinator plant tables (Tables A and B). This is not to imply that annual and biennial plants do not provide food or other resources for pollinators and cannot be utilized. The premise is that flowering annuals are usually present throughout the Kentucky landscape and in the settings where these practices are usually applied. The establishment of permanent habitat consisting of perennials would be more economical and provide greater benefit over a longer period of time.

It is not imperative to plant or establish only the native plants that are listed in this document. However, it is highly suggested to include the maximum amount of native species practical. Often times it is necessary to include non-native or introduced species to fill in gaps of bloom times, provide additional color or to provide pollinator resources during cropping sequences. Any non-native species utilized should not be invasive or established at the expense of native plant species. The list of non-natives that are non-invasive and could be used in conjunction with native species in mixes or established as individual stands is included. There are certainly other species that could be utilized. Consult with technical specialists to determine the suitability of those species.

There are numerous native vines that provide resources for pollinators in Kentucky. These species are not easily established or propagated, and/or most are not widely available commercially. This list is provided for information to clients that they may recognize existing value within the landscape. If these species are identified within the landscape they should be encouraged and retained.

Planner Note

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

PLANT TABLE NOTES AND DEFINITIONS:

The following information is provides information for the following plant tables:

1. **spp**. – These are taxons listed to indicate that there are multiple species within this genus that could be useful for pollinators and/or habitat enhancement purposes. Consult technical specialists to determine if a particular species is suitable for use, propagation, commercial availability and the flowering characteristics.

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2. **Bloom Periods** are defined as follows:
   March to April = **Very Early Season*** } **Counts as a single blooming period for herbaceous plantings.**
   March through May = **Early Season** }
   May through July = **Mid-Season**
   July through Sept **(**or later) = **Late Season**

   ** Note that **Very Early** and **Early** blooming plants may constitute one blooming period. "Very early" blooming plants are <u>not</u> critical or required for overlapping bloom times in herbaceous plantings.*

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3. **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.

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4. **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

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5. **pH Range** – This range indicates the minimum and maximum soil pH, of the top 12 inches of soil, within the plant's known geographical range.

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6. **Pollinator Preference** – The identified plant species produce resources that attract, support or are pollinated by native bees, butterflies, hummingbirds, various beneficial insects, beetles or flies. There are a few species that provide mostly nesting and overwintering protection; although these species do may also provide some secondary pollinator resources. Some plants provide resources for multiple insects; therefore they may have multiple codes. These codes are identified as follows:

NB	Native Bee Species
BU	Native Butterfly Species
H	Ruby-throated Hummingbirds
BI	Beneficial Insects
B	Beetles
F	Flies
N/O	Nesting and Overwintering

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7. **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 a slowly pervious 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 a slowly pervious 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. Free water is commonly at the surface. Poor drainage may result from high water tables, slowly draining pervious layers within the profile, seepage or any combination of these factors.

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8. **Form**: Describes the type of plant as:

   T – tree
   S – shrub
   T/S – tree/shrub
   V – vine *
   F – forb (wildflower)
   G – graminoid (grass or sedge)

** There are some native vines that provide resources for pollinators in Kentucky. These species are not widely commercially available. The few species included within this list are primarily listed for planning information and to inform clients that these species are valuable where they occur naturally. Therefore when pollinators are a concern they should be retained. Consult technical experts to determine if a species is suitable for use, propagation and the flowering characteristics.*

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9. **Wetland** – 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%).
   - For the purposes of this document, if the field is blank the wetland code is considered upland (**UPL**)

A. Native Plants Suitable for Pollinator Applications in Kentucky

Scientific Name	Common Name	Bloom Period [1]	Flower Color	Height at Maturity [2] (feet)	Shade Tolerance [3]	pH Range [4]	Pollinator Preference [5]	Drainage [6]	Form [7]	Wetland [8]
Acer rubrum	Red Maple	Very Early	Red	90	Tolerant	4.5 – 7.5	NB	Well – Somewhat Poorly	T	FAC
Agastache scrophulariifolia	Purple Giant Hyssop	Mid	Purple	4	Intermediate	5.9 – 8.0	NB, BU	Well – Somewhat Poorly	F	
Agastache spp	Hyssops	Mid	– –	– –	– –	– –	NB, BU	– –	F	– –
Amelanchier arborea	Common Serviceberry	Very Early	White	50	Tolerant	4.8 – 7.5	NB, BU	Moderately Well – Somewhat Poorly	T	FAC
Amelanchier spp.	Sarvice	– –	– –	– –	– –	– –	NB, BU	– –	T	– –
Amorpha fruticosa	false indigo bush	Mid	Purple	15	Intolerant	5.0 – 8.5	NB, BU, BI	Well – Somewhat Poorly	S	FACW
Andropogon gerardii	Big Bluestem	Mid	Yellow	6	Intolerant	6.0 – 7.5	N/O	Well – Moderately Well	G	FAC
Andropogon virginicus	Broomsedge	Late	Yellow	3	Intolerant	4.7 – 9.0	N/O	Well – Moderately Well	G	FACU
Angelica venenosa	Hairy Angelica	Mid	White	4	Intermediate	5.0 – 8.5	BU, BI	Somewhat Poorly – Poorly	F	OBL
Apocynum androsaemifolium	Spreading Dogbane	Mid	Pink	3	Intolerant	5.0 – 7.5	NB, BU, BI	Well – Moderately Well	F	FAC
Apocynum cannabinum	Indian – Hemp	Mid	White	3	Intermediate	4.5 – 7.0	NB, BU, BI	Well – Somewhat Poorly	F	FAC
Arnoglossum plantagineum	Groovestem Indian plantain	Late	White	5	Intolerant	6.8 – 7.2	BI	Well – Somewhat Poorly	F	
Asclepias amplexicaulis	Clasping Milkweed	Mid	Pink	3	Intermediate	5.0 – 8.5	NB, BU, BI	Well – Moderately Well	F	UPL
Asclepias incarnata	Swamp Milkweed	Mid	Pink	3	Intermediate	5.0 – 8.5	NB, BU, BI	Somewhat Poorly – Poorly	F	OBL

A. Native Plants Suitable for Pollinator Applications in Kentucky

Scientific Name	Common Name	Bloom Period [1]	Flower Color	Height at Maturity [2] (feet)	Shade Tolerance [3]	pH Range [4]	Pollinator Preference [5]	Drainage [6]	Form [7]	Wetland [8]
Asclepias purpurascens	Purple Milkweed	Mid	Purple	4	Intermediate	5.0 – 8.5	NB, BU	Well – Moderately Well	F	FACU
Asclepias syriaca	Common Milkweed	Mid	Pink	5	Intermediate	5.0 – 7.5	NB, BU, BI	Well – Somewhat Poorly	F	FACU
Asclepias tuberosa	Butterflyweed	Mid	Orange	3	Intermediate	5.0 – 7.0	NB, BU, BI, H	Well – Moderately Well	F	
Asclepias variegata	red ring milkweed	Mid	White	4	Intermediate	5.0 – 7.0	NB, BU, BI	Well – Moderately Well	F	FACU
Asclepias spp.	Milkweeds	Mid	– –	– –	– –	– –	NB, BU, BI	– –	F	– –
Asimina triloba	Common Pawpaw	Very Early	Purple	30	Tolerant	4.7 – 7.2	NB	Moderately Well – Poorly	T	FACU
Baptisia alba var. macrophylla	large leaf wild indigo	Early	White	4	Intolerant	5.9 – 7.8	NB, BU	Well – Somewhat Poorly	F	
Baptisia australis	Blue Wild Indigo	Early	Purple	3	Intolerant	5.9 – 7.8	NB	Well – Moderately Well	F	
Baptisia bracteata var. leucophaea	long–bract wild indigo	Early	Yellow	2	Intolerant	5.9 – 7.8	NB	Moderately Well – Somewhat Poorly	F	
Baptisia tinctoria	Yellow Wild Indigo	Early	Yellow	2	Intolerant	5.8 – 7.0	NB	Well – Moderately Well	F	
Bidens laevis	Smooth Tickseed	Late	Yellow	3	Intermediate	5.0 – 7.0	NB	Poorly	F	OBL
Bidens spp.	Tickseeds	Late	– –	– –	– –	– –	NB	– –	F	– –
Bignonia capreolata	Crossvine	Mid	Red	60	Intermediate	5.0 – 6.5	H	Moderately Well – Somewhat Poorly	V	FAC
Blephilia ciliata	Downy Woodmint	Late	Purple	3	Intermediate	5.1 – 7.9	NB, BU	Well – Moderately Well	F	

A. Native Plants Suitable for Pollinator Applications in Kentucky

Scientific Name	Common Name	Bloom Period [1]	Flower Color	Height at Maturity [2] (feet)	Shade Tolerance [3]	pH Range [4]	Pollinator Preference [5]	Drainage [6]	Form [7]	Wetland [8]
Bouteloua curtipendula	Side Oats Grama	Late	Yellow	3	Intolerant	5.5 – 8.5	N/O	Well – Somewhat Poorly	G	
Campsis radicans	Trumpet–Creeper	Late	Red	20	Intolerant	4.9 – 6.8	NB, H	Moderately Well – Somewhat Poorly	V	FAC
Carex lurida	Shallow Sedge	Late	Green	3	Intermediate	4.9 – 6.8	N/O	Poorly	G	OBL
Carex spp.	Sedges	Late	– –	– –	– –	– –	N/O	– –	G	– –
Castanea pumila	Allegheny Chinquapin	Mid	Yellow	20	Intermediate	4.5 – 6.6	NB, BU	Well – Moderately Well	T	
Ceanothus americanus	New Jersey – Tea	Mid	White	3	Tolerant	4.3 – 6.5	NB, BU, H	Well – Moderately Well	S	
Cephalanthus occidentalis	Common Buttonbush	Late	White	20	Tolerant	4.7 – 8.6	NB, BU	Poorly	S	OBL
Cercis canadensis	Eastern Redbud	Very Early	Purple	16	Tolerant	5.0 – 7.8	NB, BU	Well – Somewhat Poorly	T/S	FACU
Chamaecrista fasciculata	Partidge Pea	Mid	Yellow	3	Intolerant	4.3 – 6.5	NB, BU	Well – Moderately Well	F	FACU
Chelone glabra	White Turtlehead	Late	White	3	Intermediate	5.5 – 7.5	BU	Poorly	F	OBL
Chrysopsis mariana	Maryland goldenaster	Late	Yellow	1	Intolerant	5.0 – 7.0	NB	Well	F	UPL
Clethra acuminata	Mountain Sweet – Pepperbush	Late	White	15	Tolerant	5.5 – 7.5	NB	Well – Somewhat Poorly	S	
Clematis virginiana	Virgin's bower	Late	White	6	Intermediate	5.0 – 8.0	NB, BU, H	Moderately Well – Somewhat Poorly	V	FAC
Clematis spp.			– –	– –	– –	– –	NB, BU, H		V	– –

A. Native Plants Suitable for Pollinator Applications in Kentucky

Scientific Name	Common Name	Bloom Period [1]	Flower Color	Height at Maturity [2] (feet)	Shade Tolerance [3]	pH Range [4]	Pollinator Preference [5]	Drainage [6]	Form [7]	Wetland [8]
Clinopodium vulgare	Wild Basil	Late	Purple	4	Intermediate	5.0 – 7.5	NB	Well – Moderately Well	F	
Conoclinium coelestinum	Blue Mistflower	Late	Blue	2	Intermediate	5.5 – 7.5	BU	Moderately Well – Somewhat Poorly	F	
Coreopsis lanceolata	Long – Stalk Tickseed	Mid	Yellow	2	Intolerant	6.0 – 7.0	NB, BU, BI	Moderately Well – Somewhat Poorly	F	FACU
Crataegus phaenopyrum	Washington hawthorn	Mid	White	25	Intolerant	6.8 – 7.2	NB	Moderately Well – Somewhat Poorly	T/S	FAC
Crataegus spp.	Hawthorn	Mid	– –	– –	– –	– –	NB, BU, H	Well – Somewhat Poorly	S	– –
Dalea purpurea	Purple Prairie Clover	Late	Purple	3	Intolerant	5.0 – 7.9	NB, BU	Well – Moderately Well	F	
Delphinium tricorn	Dwarf Larkspur	Early	Purple	1	Tolerant	5.8 – 7.8	NB, BU	Well – Somewhat Poorly	F	
Desmanthus illinoensis	Illinois bundleflower	Mid	White	3	Intolerant	5.0 – 8.0	NB	Well – Moderately Well	F	
Diospyros virginiana	Persimmon	Early	Yellow	50	Tolerant	4.7 – 7.5	NB	Well – Somewhat Poorly	T	FAC
Dodecatheon meadia	Shooting Star	Early	White	2	Tolerant	4.5 – 7.5	NB	Well – Moderately Well	F	FACU
Doellingeria umbellata	Flat topped White Aster	Late	White	3	Intermediate	5.5 – 7.9	NB, BU	Somewhat Poorly – Poorly	F	FACW
Echinacea purpurea	eastern purple coneflower	Mid	Purple	1	Intolerant	6.5 – 7.2	NB, BU	Well – Moderately Well	F	
Elymus virginicus	Virginia wild rye	Early	Yellow	3	Tolerant	5.0 – 7.0	N/O	Somewhat Poorly – Poorly	G	FACW

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Eupatorium fistulosum	Common Joe Pye Weed	Late	Purple	11	Intermediate	5.0 – 7.5	NB, BU	Moderately Well – Somewhat Poorly	F	FAC
Eupatorium perfoliatum	Boneset	Late	White	4	Intermediate	5.0 – 7.5	NB, BU	Somewhat Poorly – Poorly	F	FACW
Eupatorium purpureum	Spotted Trumpetweed	Late	Purple	6	Intermediate	5.0 – 7.5	NB, BU	Somewhat Poorly – Poorly	F	FACW
Eupatorium rotundifolium var. ovatum	Roundleaf thoroughwort	Late	White	4	Intermediate	5.0 – 7.5	NB, BU	Well – Somewhat Poorly	F	
Eupatorium rugosum	white snakeroot	Late	White	2	Tolerant	5.0 – 7.0	N/O	Well – Moderately Well	F	
Eupatorium serotinum	Late Thoroughwort	Late	White	6	Intermediate	5.0 – 7.5	NB, BU	Moderately Well – Somewhat Poorly	F	FAC
Eupatorium spp.	Joe –Pye Weed	Late	– –	– –	– –	– –	NB, BU	– –	F	– –
Gaylussacia baccata	Black Huckleberry	Mid	White	2	Tolerant	4.5 – 6.5	NB	Well – Moderately Well	S	FACU
Gentiana andrewsii	Bottle Gentian	Late	Purple	1	Intermediate	5.8 – 7.2	NB	Somewhat Poorly – Poorly	F	FACW
Geranium maculatum	Spotted Geranium	Early	Purple	2	Intermediate	5.5 – 8.5	NB, BU	Well – Somewhat Poorly	F	FACU
Helenium autumnale	Yellow Sneezeweed	Late	Yellow	4	Intolerant	4.0 – 7.0	NB, BU	Somewhat Poorly – Poorly	F	FACW
Helianthus angustifolius	swamp sunflower	Late	Yellow	3	Intolerant	4.0 – 8.0	NB	Somewhat Poorly – Poorly	F	FACW
Helianthus maximiliani	Maximillian Sunfloweer	Late	Yellow	5	Intolerant	4.0 – 8.0	NB, BU	Well – Somewhat Poorly	F	UPL
Helianthus tuberosus	Jerusalem Artichoke	Late	Yellow	10	Intermediate	4.0 – 7.0	NB, BU	Well – Somewhat Poorly	F	FAC

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Helianthus spp.	*Sunflowers*	Late	Yellow	– –	– –	– –	– –	– –	F	– –
Hibiscus moscheutos	Eastern Rose-mallow	Late	White	6	Intolerant	4.0 – 7.5	NB, BU, H	Poorly	F	OBL
Hydrophyllum virginianum	Shawnee Salad	Early	Blue	2	Tolerant	5.7 – 7.5	NB	Moderately Well – Somewhat Poorly	F	FAC
Juncus spp.	Rushes	Late	– –	– –	– –	– –	N/O	– –	G	– –
Kalmia latifolia	Mountain Laurel	Mid	Purple	5	Tolerant	4.5 – 5.5	BU	Well – Moderately Well	S	FACU
Lamium amplexicaule	Henbit	Early	Purple	1	Intermediate	4.0 – 8.9	NB	Well – Somewhat Poorly	F	
Lespedeza capitata	round–headed bush clover	Late	Pink	4	Intolerant	5.5 – 6.9	NB	Well – Moderately Well	F	
Lespedeza hirta	hairy bush clover	Late	White	3	Intolerant	5.0 – 9.0	BU	Well – Moderately Well	F	
Lespedeza intermedia	Intermediate Lespedeza	Late	Purple	3	Intermediate	5.0 – 9.0	NB	Well – Somewhat Poorly	F	
Lespedeza virginica	Virginia Bush-clover	Late	Purple	3	Intermediate	5.7 – 9.0	NB	Well – Somewhat Poorly	F	
Liatris aspera	Rough Blazingstar	Late	Purple	3	Intolerant	5.6 – 7.5	BU, H	Well – Moderately Well	F	
Liatris spicata	Gay Feathers	Late	Purple	4	Intermediate	5.6 – 7.5	NB, BU, H	Moderately Well – Poorly	F	FAC
Liatris squarrulosa	Appalachian Blazing Star	Late	Purple	4	Intolerant	5.6 – 7.5	NB, BU	Well – Moderately Well	F	
Liatris spp.	Liatris	Late	– –	– –	– –	– –	NB, BU	– –	F	– –

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Lilium canadense	Canada Lilly	Mid	Pink	2	Intolerant	4.9 – 7.0	NB, BU	Moderately Well – Somewhat Poorly	F	FAC
Lilium superbum	Turk's Cap Lilly	Mid	Orange	4	Intolerant	5.8 – 7.8	NB, BU	Somewhat Poorly – Poorly	F	FACW
Lindera benzoin	Spice Bush	Early	Yellow	12	Tolerant	4.5 – 6.0	NB, BU, BI	Well – Somewhat Poorly	S	FAC
Liriodendron tulipifera	Tuliptree	Mid	Yellow	120	Intolerant	4.5 – 6.5	NB, H	Well – Moderately Well	T	FACU
Lobelia cardinalis	Cardinal – Flower	Late	Red	3	Intermediate	5.8 – 7.8	BU, H	Somewhat Poorly – Poorly	F	FACW
Lobelia siphilitica	Great Blue Lobelia	Late	Blue	3	Intermediate	5.6 – 7.8	BU	Moderately Well – Somewhat Poorly	F	FACW
Lupinus perennis	Wild Lupine	Early	Blue	2	Intermediate	5.8 – 7.8	NB, BU	Well – Moderately Well	F	
Malus angustifolia	Southern Crabapple	Early	Pink	30	Intermediate	5.7 – 8.2	NB	Well – Moderately Well	T	
Mentha arvensis	Wild Mint	Late	White	2	Intermediate	5.0 – 7.0	NB, BU	Somewhat Poorly – Poorly	F	FACW
Mertensia virginica	Virginia Bluebells	Very Early	Blue	2	Tolerant	4.5 – 8.0	NB, BU	Moderately Well – Poorly	F	FACW
Mimulus ringens	Square Stemmed Monkey Flower	Mid	Blue	2	Intermediate	5.8 – 8.9	NB	Somewhat Poorly – Poorly	F	OBL
Monarda clinopodia	Basil Balm	Mid	White	3	Intermediate	5.6 – 7.6	NB, BU	Well – Moderately Well	F	
Monarda didyma	Scarlet Beebalm	Late	Red	3	Intermediate	5.0 – 8.1	NB, BU, H	Moderately Well – Somewhat Poorly	F	FAC
Monarda fistulosa	Wild Bergamot	Late	Purple	3	Intermediate	5.6 – 7.5	NB, BU	Well – Moderately Well	F	

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Monarda media	Purple Bergamot	Late	Pink	3	Intermediate	4.9 – 7.0	NB	Moderately Well – Somewhat Poorly	F	
Morus rubra	Red Mulberry	Early	Green	70	Intermediate	5.0 – 7.0	NB	Well – Somewhat Poorly	T/S	FAC
Nyssa sylvatica	Blackgum	Early	White	95	Tolerant	4.5 – 6.0	NB	Well – Somewhat Poorly	T	FAC
Oenothera biennis	Common evening–primrose	Late	Yellow	6	Intermediate	4.5 – 6.0	NB, H	Well – Moderately Well	F	
Oenothera fruticosa	narrowleafed evening–primrose	Mid	Yellow	3	Intolerant	4.9 – 6.8	NB, H	Somewhat Poorly – Poorly	F	FAC
Oligoneuron rigidum var. *rigidum*	Rigid Goldenrod	Late	Yellow	4	Intermediate	5.0 – 7.5	NB, BU, BI	Well – Moderately Well	F	UPL
Oxydendrum arboreum	Sourwood	Late	White	35	Intermediate	5.0 – 7.5	NB, BU	Well – Somewhat Poorly	T	
Parthenium integrifolium	American Fever–few	Mid	White	3	Intermediate	5.0 – 7.5	BU, BI	Well – Moderately Well	F	
Penstemon calycosus	Long–sepal Beardtongue	Early	Pink	4	Intolerant	4.9 – 7.0	NB	Well – Moderately Well	F	UPL
Penstemon canescens	Eastern Gray Beard Tongue	Early	Purple	2	Intermediate	5.0 – 7.5	NB, BU, H	Well – Moderately Well	F	
Penstemon digitalis	Foxglove Beardtongue	Early	Purple	4	Intermediate	5.5 – 7.0	NB, BU, H	Moderately Well – Somewhat Poorly	F	FAC
Penstemon hirsutus	Hairy Beardtongue	Early	Purple	2	Intermediate	5.5 – 7.1	NB, H	Well – Somewhat Poorly	F	
Penstemon laevigatus	Smooth Beardtongue	Early	Purple	2	Intermediate	5.5 – 7.1	NB	Moderately Well – Somewhat Poorly	F	FACU

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Penstemon pallidus	pale beardtongue	Mid	Pink	3	Intermediate	5.6 – 7.6	NB	Well – Moderately Well	F	FACU
Penstemon spp.	Beardtongues	– –	– –	– –	– –	– –	NB	– –	F	– –
Phlox divaricata	Wild Blue Phlox	Early	Purple	3	Intermediate	5.5 – 7.2	NB, BU, H	Well – Moderately Well	F	FACU
Phlox glaberrima	Smooth phlox	Early	Pink	2	Intermediate	5.0 – 7.0	NB, BU, H	Well – Somewhat Poorly	F	FAC
Phlox maculata	Sweet William	Early	Pink	3	Intermediate	5.0 – 7.0	NB, BU, H	Moderately Well – Somewhat Poorly	F	FACW
Phlox spp.	Phlox	– –	– –	– –	– –	– –	NB, BU	– –	F	– –
Photinia melanocarpa	Black Chokeberry	Early	White	6	Tolerant	4.4 – 6.5	NB, BU	Moderately Well – Somewhat Poorly	S	FAC
Physocarpus opulifolius	Eastern Ninebark	Mid	Purple	10	Intolerant	4.5 – 6.5	NB, BU	Somewhat Poorly – Poorly	T/S	FACW
Physostegia virginiana	Obedient Plant	Late	Purple	3	Intolerant	4.9 – 7.8	NB, BU, H	Moderately Well – Somewhat Poorly	F	
Physostegia virginiana ssp. praemorsa	Fall obedient plant	Late	Purple	4	Intermediate	5.8 – 8.6	NB, BU, H	Moderately Well – Poorly	F	FACW
Prunus americana	American Plum	Early	White	25	Intermediate	5.0 – 7.0	NB, BU	Well – Moderately Well	T/S	FACU
Prunus angustifolia	Chickasaw Plum	Early	White	30	Intolerant	5.6 – 7.5	NB, BU, H	Well – Moderately Well	T/S	
Prunus serotina	Black Cherry	Early	White	100	Intolerant	4.0 – 7.5	NB, BU	Well – Somewhat Poorly	T	FAC
Pycnanthemum flexuosum	Narrowleaf Mountainmint	Late	Pink	5	Intolerant	4.6 – 7.0	NB, BU, BI	Well – Moderately Well	F	

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Pycnanthemum incanum	Hoary mountain mint	Late	White	4	Intermediate	6.8 – 8.4	NB, BU	Moderately Well – Somewhat Poorly	F	
Pycnanthemum tenuifolium	Narrowleaf Mountainmint	Mid	White	3	Intolerant	4.6 – 7.0	NB, BU	Well – Somewhat Poorly	F	
Pycnanthemum spp.	Mountainmints	– –	– –	– –	– –	– –	NB, BU, BI	– –	F	– –
Ratibida pinnata	Greyheaded Coneflower	Mid	Yellow	4	Intolerant	5.6 – 6.8	NB	Well – Somewhat Poorly	F	
Rhododendron arborescens	Smooth Azalea	Mid	White	18	Tolerant	4.2 – 5.7	BU, H	Moderately Well – Poorly	S	FAC
Rhododendron calendulaceum	Flame Azalea	Early	Orange	20	Tolerant	4.2 – 5.7	NB, BU, H	Well – Moderately Well	T/S	FACU
Rhododendron maximum	Great Laurel	Early	Pink	20	Tolerant	5.5 – 7.4	NB, BU	Moderately Well – Somewhat Poorly	S	FAC
Rhododendron periclymenoides	Pink Azalea	Mid	Pink	10	Tolerant	4.3 – 5.5	NB, BU	Moderately Well – Somewhat Poorly	S	FAC
Rhododendron spp.	Laurels, Rhododendrons	– –	– –	– –	– –	– –	NB, BU	– –	S	– –
Rhus aromatica	Fragrant sumac	Early	Yellow	10	Intermediate	6.8 – 7.2	NB	Well – Somewhat Poorly	S	UPL
Rhus copallinum	Winged sumac	Late	Yellow	20	Intolerant	4.5 – 6.0	NB	Moderately Well – Somewhat Poorly	S	FACU
Rhus typhina	Staghorn sumac	Mid	Yellow	25	Intermediate	6.8 – 7.2	NB	Well – Moderately Well	S	
Rhus spp.	Sumac	– –	– –	– –	– –	– –	NB	– –	S	– –

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Robinia pseudoacacia	Black Locust	Mid	White	70	Intermediate	4.6 – 8.2	NB, BU	Well – Somewhat Poorly	T	FACU
Rubus allegheniensis	Allegheny Blackberry	Mid	White	6	Intolerant	4.6 – 7.5	NB, BU	Well – Somewhat Poorly	S	
Rubus spp.	Blackberries, Raspberries	– –	– –	– –	– –	– –	NB, BU	– –	S	– –
Rudbeckia hirta	Blackeyed Susan	Late	Orange	1	Intolerant	6.0 – 7.0	NB, BU	Well – Moderately Well	F	FACU
Rudbeckia laciniata	Green – Head Coneflower	Late	Yellow	8	Tolerant	4.5 – 7.0	NB	Somewhat Poorly – Poorly	F	FACW
Rudbeckia triloba	Browneyed Susan	Late	Yellow	6	Intolerant	5.2 – 7.2	NB	Well – Moderately Well	F	FACU
Rudbeckia spp.	Black/Browneyed Susans	– –	– –	– –	– –	– –	NB, BU	– –	F	– –
Salix nigra	Black Willow	Very Early	Green	65	Intolerant	4.8 – 8.0	NB	Somewhat Poorly – Poorly	T/S	FACW
Salix spp.	Willows	– –	– –	– –	– –	– –	NB, BU	– –	– –	– –
Salvia lyrata	Lyreleaf Sage	Mid	Blue	4	Intermediate	5.5 – 7.5	NB, BU	Well – Somewhat Poorly	F	
Sambucus canadensis	common elderberry	Mid	White	6	Intermediate	6.8 – 7.2	NB, N/O	Moderately Well – Somewhat Poorly	S	
Sambucus nigra ssp. canadensis	Black Elderberry, Common Elder	Early	White	7	Intermediate	5.0 – 8.9	N/O	Well – Somewhat Poorly	S	FAC
Sambucus racemosa	Red Elder	Mid	White	10	Intermediate	5.2 – 7.2	N/O	Well – Somewhat Poorly	S	FAC
Sambucus spp.	Elderberries	– –	– –	– –	– –	– –	NB, N/O	– –	– –	– –

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Schizachyrium scoparium	Little Bluestem	Late	Yellow	3	Intolerant	5.0 – 8.4	N/O	Well – Moderately Well	G	
Scrophularia lanceolata	Early Figwort	Early	Purple	3	Intolerant	4.5 – 7.6	NB, BU, BI	Well – Moderately Well	F	FACU
Sedum ternatum	Wild Stonecrop	Early	White	1	Tolerant	3.9 – 7.1	NB, BU	Well – Moderately Well	F	
Senna hebecarpa	Wild Hairy – fruited Senna	Late	Yellow	6	Intolerant	5.0 – 7.0	NB	Well – Moderately Well	F	FAC
Senna marilandica	Maryland senna	Mid	Yellow	4	Intermediate	5.0 – 7.8	NB	Moderately Well – Somewhat Poorly	F	FAC
Sericocarpus linifolius	narrowleaf whitetop aster	Late	White	2	Intermediate	5.7 – 7.2	BI	Well – Moderately Well	F	
Silene virginica	Fire – Pink	Mid	Red	1	Intermediate	5.0 – 7.0	BU, H	Well – Moderately Well	F	
Silene spp.	Pinks	– –	– –	– –	– –	– –	BU, H	– –	F	– –
Silphium integrifolium	wholeleaf rosinweed	Late	Yellow	6	Intolerant	4.5 – 7.6	NB	Well – Moderately Well	F	
Silphium laciniatum	Compass plant	Late	Yellow	6	Intolerant	4.5 – 7.6	NB, BU	Well – Moderately Well	F	
Silphium perfoliatum	Cup plant	Late	Yellow	6	Intolerant	6.1– 7.6	NB	Moderately Well – Poorly	F	FAC
Silphium terebinthinaceum	Prairie rosinweed	Late	Yellow	6	Intolerant	5.1– 7.8	NB	Somewhat Poorly – Poorly	F	FACU
Silphium trifoliatum	Whorled Rosinweed	Late	Yellow	6	Intolerant	5.5 – 7.2	NB	Well – Moderately Well	F	
Silphium spp.	Rosinweeds	– –	– –	– –	– –	– –	NB	– –	F	– –

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Solidago altissima	Tall Goldenrod	Late	Yellow	4	Intermediate	5.2 – 7.3	NB, BU, BI	Well – Somewhat Poorly	F	
Solidago canadensis	Canada Goldenrod	Late	Yellow	3	Intolerant	4.8 – 7.5	NB, BU, BI	Moderately Well – Somewhat Poorly	F	FACU
Solidago gigantea	Giant Goldenrod	Late	Yellow	8	Intermediate	4.0 – 8.0	NB, BU, BI	Moderately Well – Somewhat Poorly	F	FACW
Solidago juncea	Early Goldenrod, Yellow – Top	Late	Yellow	4	Intolerant	5.0 – 7.5	NB, BU, BI	Well – Moderately Well	F	
Solidago nemoralis	Gray Goldenrod	Mid	Yellow	2	Intolerant	6.5 – 7.5	NB	Well – Somewhat Poorly	F	
Solidago odora	Anise–scented goldenrod	Late	Yellow	5	Intolerant	5.0 – 6.8	NB	Moderately Well – Somewhat Poorly	F	
Solidago speciosa	showy goldenrod	Late	Yellow	5	Intolerant	4.9 – 7.9	NB, BU	Moderately Well – Poorly	F	
Solidago spp.	Goldenrods	– –	– –	– –	– –	– –	NB, BU, BI	– –	F	– –
Spiraea alba	White Meadowsweet	Late	White	3	Intermediate	4.3 – 6.8	NB, BU	Moderately Well – Somewhat Poorly	S	
Spiraea tomentosa	Steeplebush	Late	Pink	6	Intolerant	4.5 – 7.0	NB, BU	Somewhat Poorly – Poorly	S	FACW
Symphyotrichum drummondii	Drummond's aster	Late	Purple	3	Tolerant	5.4 – 7.4	NB, BI	Well – Moderately Well	F	
Symphyotrichum laeve	Smooth Blue Aster	Late	White	3	Intolerant	5.9 – 7.0	NB, BU, BI	Well – Moderately Well	F	
Symphyotrichum lateriflorum	Calico Aster	Late	White	3	Intolerant	5.4 – 7.4	NB, BU, BI	Well – Moderately Well	F	FAC

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Symphyotrichum novae–angliae	New England Aster	Late	Purple	4	Intermediate	5.2 – 7.5	NB, BU	Somewhat Poorly – Poorly	F	FACW
Symphyotrichum patens	Late Purple American – Aster	Late	Purple	3	Intolerant	4.9 – 7.9	NB, BU	Well – Moderately Well	F	
Symphyotrichum pilosum	Heath Aster	Late	White	3	Intolerant	5.4 – 7.0	NB, BU, BI	Well – Moderately Well	F	UPL
Symphyotrichum praealtum	Willowleaf American – Aster	Late	White	3	Intolerant	5.5 – 7.5	NB, BU	Somewhat Poorly – Poorly	F	FACW
Tephrosia virginiana	Goat's rue	Mid	Pink	3	Intermediate	4.5 – 7.0	BI	Well – Moderately Well	F	
Teucrium canadense	Wood sage	Late	Pink	2	Intermediate	6.3 – 8.0	BU	Moderately Well – Poorly	F	FACW
Thaspium barbinode	Hairy–jointed Meadowparsnip	Early	Yellow	3	Intermediate	5.5 – 7.5	NB, BI	Well – Moderately Well	F	FACU
Tilia americana	American Basswood	Mid	Yellow	90	Intermediate	4.5 – 7.5	NB, BU, BI	Well – Moderately Well	T	
Tradescantia ohiensis	Ohio Spiderwort	Early	Blue	1	Intermediate	4.0 – 8.0	NB, BU, BI	Moderately Well – Somewhat Poorly	F	FAC
Tradescantia subaspera	Zig–Zag Spiderwort	Early	Purple	1	Intermediate	4.5 – 9.0	NB, BU, BI	Well – Moderately Well	F	
Tradescantia virginiana	Virginia Spiderwort	Early	Blue	1	Intermediate	4.0 – 8.0	NB, BU, BI	Well – Moderately Well	F	
Vaccinium corymbosum	Highbush Blueberry	Mid	White	10	Shade Intolerant	4.7 – 7.5	NB	Somewhat Poorly – Poorly	S	FACW
Vaccinium pallidum	Upland Low Blueberry	Mid	White	2	Intolerant	4.1 – 6.9	NB	Well – Moderately Well	S	
Vaccinium spp.	blueberries, huckleberries	– –	– –	– –	– –	– –	NB	– –	– –	– –

A. Native Plants Suitable for Pollinator Applications in Kentucky

Scientific Name	Common Name	Bloom Period [1]	Flower Color	Height at Maturity [2] (feet)	Shade Tolerance [3]	pH Range [4]	Pollinator Preference [5]	Drainage [6]	Form [7]	Wetland [8]
Vaccinium stamineum	Deerberry	Mid	White	6	Tolerant	4.0 – 7.0	NB	Well – Moderately Well	S	FACU
Verbena hastata	Blue Vervain	Late	Blue	5	Intolerant	5.1 – 7.1	NB	Somewhat Poorly – Poorly	F	FACW
Verbena stricta	Hoary Vervain	Late	Blue	4	Intolerant	4.0 – 8.0	BU	Well – Moderately Well	F	
Verbesina alternifolia	Wingstem	Late	Yellow	4	Intermediate	5.0 – 7.0	NB	Moderately Well – Poorly	F	FAC
Verbesina helianthoides	Gravelweed	Mid	Yellow	2	Intolerant	5.0 – 7.5	NB, BU	Well – Moderately Well	F	
Verbesina occidentalis	yellow crownbeard	Mid	Yellow	4	Intolerant	5.0 – 7.5	NB	Well – Moderately Well	F	FACU
Vernonia gigantea	giant ironweed	Mid	Purple	5	Intolerant	5.6 – 8.2	NB, BU	Moderately Well – Somewhat Poorly	F	FAC
Vernonia missurica	Missouri ironweed	Mid	Purple	4	Intolerant	5.6 – 8.2	NB, BU	Well – Moderately Well	F	FACU
Vernonia noveboracensis	New York Ironweed	Mid	Purple	4	Intolerant	5.2 – 8.8	NB, BU	Moderately Well – Somewhat Poorly	F	FAC
Veronicastrum virginiacum	Culver's Root	Mid	White	4	Intolerant	4.8 – 8.8	NB	Well – Moderately Well	F	FACU
Viburnum lentago	Nannyberry	Mid	White	25	Tolerant	5.0 – 7.0	NB, BU	Moderately Well – Somewhat Poorly	T/S	FAC
Viburnum opulus	American Cranberrybush	Mid	White	6	Intolerant	5.5 – 7.5	NB, BU, BI, F	Somewhat Poorly – Poorly	S	FACW
Vicia americana	American Vetch	Mid	Purple	1	Intolerant	5.9 – 7.2	NB, BU	Moderately Well – Somewhat Poorly	F	

A. Native Plants Suitable for Pollinator Applications in Kentucky

Scientific Name	Common Name	Bloom Period [1]	Flower Color	Height at Maturity [2] (feet)	Shade Tolerance [3]	pH Range [4]	Pollinator Preference [5]	Drainage [6]	Form [7]	Wetland [8]
Vicia caroliniana	Carolina Wood Vetch	Mid	White	1	Intermediate	4.9 – 7.9	BU	Well – Somewhat Poorly	F	FACU
Zizia aptera	Heartleaf Meadow Parsnip	Mid	Yellow	2	Tolerant	5.6 – 8.2	NB	Well – Moderately Well	F	FAC
Zizia aurea	Golden Alexanders	Mid	Yellow	3	Intermediate	5.6 – 8.2	NB, BU	Well – Moderately Well	F	FAC

NOTE: *Native taxons listed as* spp. *indicate that there are multiple species within this genus that could be useful for pollinators and habitat enhancement purposes. Consult technical experts to determine if a species is suitable for use, propagation and the flowering characteristics.*

B. Non-Native, Non- Invasive Plants Suitable for Pollinator Applications in Kentucky

Scientific Name	Common Name	Bloom Period	Flower Color	Height at Maturity (feet)	Shade Tolerance	pH Range	Annual Perennial Biennial	Pollinator Preference	Drainage	Form	Wetland
Calluna vulgaris	Heather, Ling	Late	Pink	3	Intermediate	4.5 – 6.5	P	BU	Well – Somewhat Poorly	S	FAC
Catalpa bignonioides	Southern Catalpa	Mid	White	65	Intermediate	5.5 – 7.5	P	NB, BU	Moderately Well – Somewhat Poorly	T	FAC
Catalpa speciosa	Northern Catalpa	Mid	White	60	Intolerant	5.5 – 7.0	P	NB	Well – Somewhat Poorly	T	FAC
Chamaecrista fasciculata	Partridge Pea	Late	Yellow	3	Tolerant	5.5 – 7.5	A	NB, BU	Well – Moderately Well	F	FACU
Centaurea cyanus	Bachelor's buttons	Late	Blue	3	Intolerant	5.5 – 7.9	A	NB, BU, BI	Moderately Well - Somewhat Poorly	F	FACU
Chelone lyonii	Pink Turtlehead	Late	Pink	3	Intermediate	5.5 – 7.5	P	BU	Somewhat Poorly – Poorly	F	FACW
Coreopsis grandiflora	Bigflower Coreopsis	Mid	Yellow	2	Intermediate	5.0 – 7.0	P	NB, BU	Well – Moderately Well	F	
Echinacea purpurea	Purple Coneflower	Mid	Purple	1	Intolerant	6.5 – 7.2	P	NB, BU	Well – Somewhat Poorly	F	
Erica tetralix	Crossleaf Heath	Late	Purple	2	Intermediate	5.3 – 7.0	P	NB	Well – Somewhat Poorly	S	FACU
Filipendula rubra	Queen – Of – The – Prairie	Mid	Pink	4	Intolerant	5.5 – 7.5	P	BU	Moderately Well – Somewhat Poorly	F	FACW
Gaillardia aristata	Common Gaillardia	Early	Yellow	2	Intolerant	5.5 – 7.9	P	NB, BU	Well – Moderately Well	F	
Helianthus maximiliani	Maximillian Sunflower	Late	Yellow	5	Intolerant	6.0 – 8.0	P	NB	Well – Somewhat Poorly	F	

B. Non-Native, Non-Invasive Plants Suitable for Pollinator Applications in Kentucky

Scientific Name	Common Name	Bloom Period	Flower Color	Height at Maturity (feet)	Shade Tolerance	pH Range	Annual Perennial Biennial	Pollinator Preference	Drainage	Form	Wetland
Liatris scariosa	Devil's – Bite	Late	Purple	2	Intolerant	5.8 – 7.5	P	NB, BU	Well – Moderately Well	F	FACU
Liatris squarrosa	Blazing Star	Late	Purple	2	Intolerant	5.8 – 7.5	P	NB, BU	Well – Moderately Well	F	
Lotus corniculatus	Birdsfoot Ttrefoil	Mid	Yellow	2	Intolerant	5.0 – 8.0	P	NB	Well – Moderately Well	F	FACU-
Medicago sativa	Alfalfa	Mid	Blue	2	Intolerant	6.0 – 8.5	P	NB	Well – Moderately Well	F	
Onobrychis viciifolia	Sainfoin	Mid	Red	2	Intolerant	6.0 – 8.5	P	NB	Well – Moderately Well	F	OBL
Pontederia cordata	Pickerelweed	Early	Blue	3	Intolerant	4.9 – 8.7	P	BU	Poorly	F	
Ratibida columnifera	Red Spike Mexican Hat	Late	Yellow	3	Intolerant	5.9 – 7.0	P	NB, BU	Well – Moderately Well	F	
Ratibida pinnata	Grey Headed Coneflower	Late	Yellow	4	Intolerant	5.0 – 7.5	P	NB, BU	Well – Moderately Well	F	
Scilla siberica	Siberian squill	Very Early	Purple	1	Intolerant	5.8 – 7.5	P	NB, BU	Moderately Well – Somewhat Poorly	F	
Thymus praecox	Wild Thyme	Late	Purple	1	Intermediate	5.5 – 7.5	P	NB, BU	Well – Somewhat Poorly	F	
Trifolium incarnatum	Crimson clover	Early	Red	2	Intolerant	5.5 – 7.5	A	NB	Well – Somewhat Poorly	F	
Trifolium pratense	Red clover	Mid	Red	1	Intolerant	6.0 – 7.5	P	NB	Well – Somewhat Poorly	F	
Trifolium repens	White clover	Early	White	1	Intolerant	6.0 – 7.5	P	NB	Well – Somewhat Poorly	F	

NOTE: *The list above provides non-native, non-invasive species that could be used in conjunction with native species in mixes, or established as individual stands. These species may be utilized in conjunction with grasses for erosion control or for permanent areas adjacent to cropland (alleys, etc.). An* ***** *indicates that this species could be utilized for erosion control and/or forage mixes. Monitor the establishment of these stands closely to determine the potential to invade or spread. There are certainly other species that could be utilized. Consult with technical specialists to determine the suitability of other species. Any non-native species utilized should not be invasive or established at the expense of native plant species.*

C. Common Crop Species Useful to Pollinators

Scientific Name	Common Name	Bloom Period	Flower Color	Height at Maturity (feet)	Shade Tolerance	pH Range	Annual Perennial Biennial	Pollinator Preference	Drainage	Form
Brassica napus	rape	Early	Yellow	4	Intolerant	6.0 – 7.2	B/A	NB	Well – Moderately Well	F
Brassica nigra	black mustard	Early	Yellow	3	Intolerant	5.6 – 7.6	A	NB	Well – Moderately Well	F
Cucumis melo	cantaloupe	Mid	Yellow	4	Intolerant	5.0 – 7.5	A	NB	Well – Moderately Well	V
Cucurbita pepo	pumpkin	Mid	Orange	5	Intolerant	5.6 – 7.6	A	NB	Well – Moderately Well	V
Raphanus sativus	radish	Mid	Purple	2	Intolerant	5.0 – 7.5	B/A	NB, BU	Well – Moderately Well	F

NOTE: *The list above identifies only a few beneficial pollinator crops. Due to the variability of crops produced and the varieties and horticultural crosses utilized throughout the region, bloom times, color variations and pH requirements will vary. Planners should always consult with experienced growers to determine the specifics of crops planted and the rotations used.*

Corn and soybeans are crops commonly grown in KY. Although they are not dependent upon insects for pollination they are certainly visited by pollinators.

D. Non-Native Plants Suitable for use in Crop Rotations, Cover Crops or Green Manures

Scientific Name	Common Name	Bloom Period	Flower Color	Height at Maturity (feet)	Shade Tol-erance	pH Range	Annual Perennial Biennial	Pollinator Preference	Drainage	Form
Borage officinalis	borage	Early	Blue	2	Intolerant	6.0 – 7.5	A	NB	Well – Moder-ately Well	F
Trifolium incarnatum	crimson clo-ver	Early	Red	2	Intolerant	5.5 – 7.5	A	NB	Well – Somewhat Poorly	F
Vicia villosa	hairy vetch	Early	Purple	2	Intolerant	6.0 – 7.5	A	NB	Well – Moder-ately Well	F
*Trifolium repens**	white clover	Early	White	1	Intolerant	6.0 – 7.5	P	NB	Well – Somewhat Poorly	F
Vicia atropurpurea *	purple vetch	Mid	Purple	1	Intolerant	5.5 – 6.5	A	NB	Well – Moder-ately Well	F
Brassica spp.	mustard	Mid	Yellow	4	Intolerant	6.0 – 7.2	A	NB	Well – Moder-ately Well	F
*Medicago sativa**	alfalfa	Mid	Blue	2	Intolerant	6.0 – 8.5	P	NB	Well – Moder-ately Well	F
Melilotus alba	sweet white clover	Mid	White	5	Intolerant	5.0 – 8.0	A	NB	Well – Moder-ately Well	F
Melilotus officinalis	yellow sweet clover	Mid	Yellow	5	Intolerant	6.5 – 8.0	A,B, P	NB	Well – Moder-ately Well	F
*Trifolium pretense**	red clover	Mid	Red	1	Intolerant	6.0 – 7.5	P	NB	Well – Somewhat Poorly	F
Fagopyrum esculentum	buckwheat	Late	White	2	Intolerant	6.0 – 8.5	A	NB	Well – Moder-ately Well	F
Phacelia tanacetifolia	phacelia	Early	Blue	1.5	Intolerant	5.8 – 7.5	A	NB	Well –Moder-ately Well	F

NOTE: *Taxons listed as* spp. *indicate that there are multiple species within this genus that could be useful for pollinators and habitat enhancement purposes. Consult technical experts to determine if a species is suitable for use, propagation and the flowering characteristics. An * indicates that this species could be incorporated into pollinator-friendly erosion control mixes. A number of non-native plants used for cover crops, green manures, or short-term plantings are productive forage sources for pollinators. These species may be suitable to augment existing habitats and/or to correspond with gaps in bloom times while providing supplemental resources for pollinators. Some of these species could become weedy or have the potential to spread to adjacent communities; so select appropriate species for your needs and monitor their development on the site.*

E. Plants Principally Pollinated by Flies or Beetles

Scientific Name	Common Name	Bloom Period	Flower Color	Height at Maturity	Shade Tolerance	pH Range	*Pollinator Preference	Drainage	Form	Wetland
Actaea racemosa	black cohosh	Late	White	3	Tolerant	5.0 – 7.9	NB, BU, F	Moderately Well – Somewhat Poorly	F	
Chamaelirium luteum	fairywand	Mid	White	3	Intermediate	5.5 – 7.5	NB, F	Somewhat Poorly	F	FAC
Claytonia virginica	Virginia springbeauty	Early	Pink	1	Tolerant	5.0 – 7.0	NB, F	Well – Somewhat Poorly	F	FACU
Erigeron philadelphicus	Philadelphia fleabane	Mid	Purple	2	Intermediate	4.8 – 7.8	F	Well – Somewhat Poorly	F	FACU
Erigeron spp.	fleabanes	– –	– –	– –	– –	– –	F	– –	F	– –
Fragaria virginiana	Virginia strawberry	Early	White	1	Intolerant	5.0 – 7.5	F	Well – Moderately Well	F	FACU
Hesperis matronalis	dame's rocket	Early	Purple	4	Intermediate	5.0 – 7.0	F	Well - Somewhat Poorly	F	
Symplocarpus foetidus	skunk – cabbage	Very Early	Red	1	Tolerant	4.0 – 7.1	B	Poorly	F	OBL
Sassafras albidum	sassafras	Very Early	Green	75	Intermediate	4.5 – 7.3	F	Well – Somewhat Poorly	T	FACU
Zizia aurea	golden alexanders	Mid	Yellow	2	Intermediate	5.5 – 6.9	F	Well – Somewhat Poorly	F	FAC

These species may be suitable to augment existing habitats or substitute within pollinator mixes. Many other species of plants are visited by flies and beetles. This list only identifies a few that are principally pollinated by those insects. **NOTE:** *Taxons listed as spp. indicate that there are multiple species within this genus that could be useful for pollinators and habitat enhancement purposes. Consult technical experts to determine if a species is suitable for use, propagation and the flowering characteristics.*

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III. Plant Mixes

WOODY MIXES

Woody plants may be established for pollinators in a variety of settings. Since hedgerows and 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 season as possible. Since trees and shrubs typically are available prior to the bloom period of most herbaceous plants, they are often the most visited of plants by bees early in the season. Conversely, woody species stop blooming earlier in the growing season and the floral resources are not available throughout the growing season. Therefore, it is not advisable to depend solely upon woody species to provide pollinator resources. **For this reason, it is acceptable when installing exclusively woody species enhancements to utilize bloom periods of very early, early and mid-season. Late season species are not required.**

Many species of woody plants are wind pollinated. It is important to utilize trees and shrubs that are known to be principally pollinated by insects. Examples of species that are wind pollinated are: hickories (*Carya* sp.), Ash (*Fraxinus* sp.) and Oaks (*Quercus* sp.). These species should not be utilized as pollinator species. Check with the state staff specialist if you are uncertain as to the methods of pollination for a particular species not listed in this document.

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 species pollinator friendly plantings to provide corridors or nectaring areas. Use caution when planting woody species around orchards and certain crops as these species may provide alternate hosts to some plant diseases (e.g. cedar apple rust).

Deer browse, labor and cost of materials, disease and maintenance are important considerations when choosing to establish woody plants. Consider these carefully prior to investment of large plantings.

Woody pollinator planting mixes that contain only woody species must be at least one-half acre (0.5 acres) in size. A woody pollinator mix must also contain at least three species in each of the three blooming periods (**very early, early** and **mid)**. Trees and shrubs should be planted in close proximity to aid in pollinator access but far enough apart to allow for maximum crown development and bloom. Planting materials may be seedlings, bare root, containerized or balled and burlapped.

Installation of trees and shrubs should follow the Kentucky conservation practice standards (612) Tree and Shrub Establishment and (490) Tree and Shrub Site Preparation. For pollinator mixes that incorporate herbaceous species to provide pollinator resources throughout the season refer to the Kentucky conservation practice (327) Conservation Cover or other appropriate practices.

Tree plantings for pollinators may be planted in several ways. They may be intermingled into existing stands of species (e.g. riparian areas); they may be planted in linear plantings (hedgerows and forest riparian buffers) or as blocks of stand-alone enhancements such as cover crops. Many species may be utilized that bloom throughout the required periods; however consider the arrangement, spacing and placement with regard to shade tolerance. Refer to the example mixes and drawing on the following pages. The mixes are examples which contain commercially available seedlings and meet the specified bloom periods.

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GENERAL WOODY SPECIES MIX FOR POLLINATORS

Scientific Name	Common Name	Bloom Period	Flower Color	Height at Maturity	Shade Tolerance	Form	*Pollinator Preference	Plants	Spacing
Acer rubrum	**Red Maple***	**Very Early**	Red	90	Tolerant	T	NB	25	10’ x 10’ to 15’ x 15’
Sambucus canadensis	**Elderberry**		White	7	Intermediate	T/S	NB	25	10’ x 10’ to 15’ x 15’
Cercis canadensis	**Eastern Redbud**		Purple	16	Tolerant	T/S	NB, BU	25	10’ x 10’ to 15’ x 15’
Prunus americana	**American Plum**	**Early**	White	30	Intolerant	T/S	NB, BU	25	10’ x 10’ to 15’ x 15’
Diospyros virginiana	**Persimmon**		Yellow	50	Tolerant	T	NB	25	10’ x 10’ to 15’ x 15’
Nyssa sylvatica	**Blackgum**		White	95	Tolerant	T	NB	25	10’ x 10’ to 15’ x 15’
Prunus serotina	**Black Cherry**		White	100	Intolerant	T/S	NB, BU	25	10’ x 10’ to 15’ x 15’
Robinia pseudoacacia	**Black Locust**	**Mid**	White	70	Intermediate	T	NB, BU	25	10’ x 10’ to 15’ x 15’
Liriodendron tulipifera	**Tuliptree**		Yellow	120	Intolerant	T	NB, H	25	10’ x 10’ to 15’ x 15’
Tilia Americana	**American Basswood**		Yellow	90	Intermediate	T	NB, BU	25	10’ x 10’ to 15’ x 15’

NOTES:

250 plants @ 10’ x 10’ spacing = ~ 0.57 acres

250 plants @ 12’ x 12’ spacing = ~ 0.83 acres

250 plants @ 12’ x 15’ spacing = ~ 1.03 acres

250 plants @ 15’ x 15’ spacing = ~ 1.29 acres

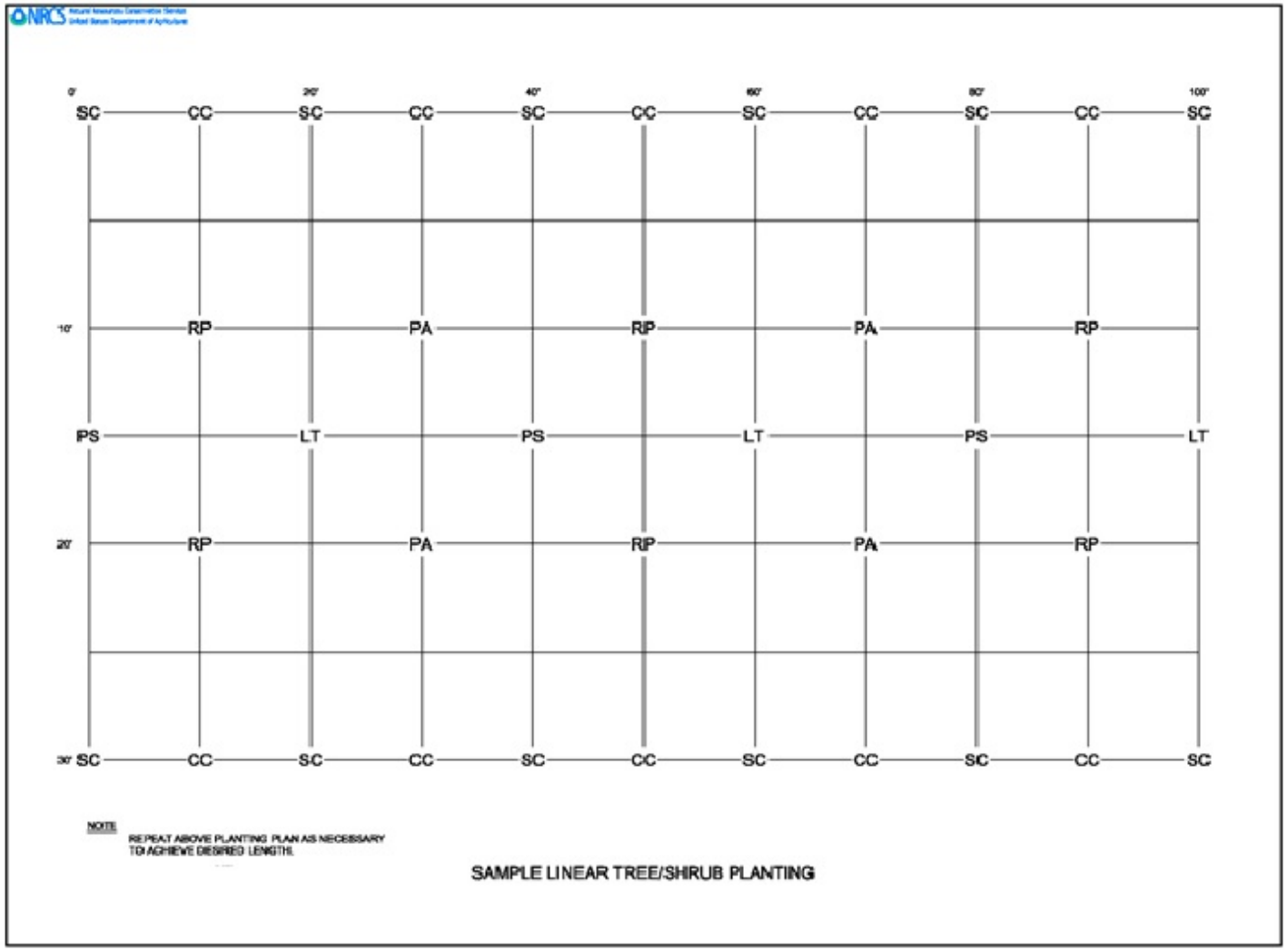
*Consider substituting serviceberry (*Amelanchier* spp.) for red maple on suitable sites. There are no late blooming species. Where possible utilize this type of mix in conjunction with herbaceous plantings or existing stands of flowering forbs.

LINEAR WOODY SPECIES MIX FOR POLLINATORS* *(For use in and around hedgerows, fence rows, ephemeral ditch lines, etc.)*

Scientific Name	Common Name	Bloom Period	Flower Color	Height at Maturity	Shade Tolerance	Form	*Pollinator Preference	Plants	In-Row Spacing	Shelters
Sambucus canadensis	**Elderberry**	**Very Early**	White	7	Intermediate	T/S	NB	25	10’ x 10’	Not Required
Cercis canadensis	**Eastern Redbud**		Purple	16	Tolerant	T/S	NB, BU	25	10’ x 10’	Not Required
Prunus americana	**American Plum**	**Early**	White	30	Intolerant	T/S	NB, BU	25	20’ x 20’	Not Required
Prunus serotina	**Black Cherry**		White	100	Intolerant	T/S	NB, BU	25	20’ x 20’	5’
Robinia pseudoacacia	**Black Locust**	**Mid**	White	70	Intermediate	T	NB, BU	25	20’ x 20’	Not Required
Liriodendron tulipifera	**Tuliptree**		Yellow	120	Intolerant	T	NB, H	25	20’ x 20’	5’

***Not recommended for riparian corridors**

Note: There are no late blooming species. Where possible utilize this type of mix in conjunction with herbaceous plantings or existing stands of flowering forbs.



SC– *Sambucus canadensis* (elderberry)
LT- *Liriodendron tulipfera* (tulip poplar)
PA-*Prunus americana* (American plum)

PS-*Prunus serotina* (wild cherry)
CC-*Cercis canadensis* (Eastern redbud)
RP-*Robinia pseudoacacia* (black locust)

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HERBACEOUS MIXES

There are many species of plants that provide resources for native pollinators. The lists provided in this document only identify some of the more common perennial and a few annual species. The mixes provided have been developed with consideration of availability, bloom period, benefit to pollinators, site adaption and several other factors. Every effort was made to recommend species that meet all criteria. However, due to market variability, seasonal availability and many other factors, each species may not be available or practical each year. Therefore it is up to the planners and clients to work together with the seed provider to substitute suitable species to fill in any gaps in recommended mixes. Utilize the native plant lists within this document to evaluate suitable substitutes.

Many nurseries and seed companies provide their own blends of pollinator mixes. Pollinator mixes are variable and may provide the same benefits as those listed in these documents. It is important to check the species included in the mix to ensure that the species included are native, they meet pollinator needs throughout the growing season and do not have the potential to become invasive. Check with NRCS state staff specialists, KDFWR or the seed provider if it is unclear.

- **General Purpose Mixes for Native Pollinators #1, #2 and #3 –** These forb/grass mixes are suitable for most soil conditions and shade requirements. It provides pollen and nectar resources for a wide variety of native bees and butterflies and other pollinators while adding a grass component. Maximum height is approximately 6 feet upon maturity. These mixes are designed to create, enhance and augment existing habitats. Minimum establishment should be 0.5 acres in most situations.
- **Wet Site Mix for Pollinator Habitat–** This mix is suitable for a variety of open meadow sites that contain moist to saturated conditions (moderately well to poorly drained soils) and receive at least partial sun during the day. It provides pollen and nectar resources for a wide variety of native bees and butterflies while adding a native sedge component. This mix is designed to create, enhance and augment existing habitat. Minimum establishment is 0.5 acres in most situations.
- **General Pollinator Site Mix Attractive To Hummingbirds –** This optional forb/grass mix is suitable for most site conditions and most shade requirements. It provides pollen and nectar resources for some native bees and native butterflies and is attractive to hummingbirds. It adds a short warm season bunch grass component for structure. Note that it does not contain Early or very early blooming species and should not be utilized for native bee habitat. Minimum establishment is 0.5 acres in most situations. It adds a warm season bunch grass component for structure. This mix is designed to enhance and augment existing native habitat. Minimum establishment is 0.25 acres in most situations.
- **General Mix for Monarchs and Other Butterflies -** This optional forb/grass mix is suitable for most site conditions and most shade requirements. It provides pollen and nectar resources for some native bees during a portion of the season but is tailored to native and monarch butterflies. It adds a short warm season bunch grass component for structure. *Note that it does not contain early or very early blooming species and should not be utilized for native bee habitat.* It should be established in stands that are ¼ acre or greater.
- **Linear Conservation Cover Plant Mix for Pollinators –** This mix could be utilized to establish along linear corridors (plantings where the shape is longer than wider) such as drainage ditches, riparian areas, hedgerows, field borders or other corridors where pollinator habitat is desired. It is also suitable to small block or patch style habitat. Consider utilizing this mix and general mixes to create narrow pollinator corridors in very sunny locations. It is primarily established in smaller amounts (0.5 acres or less).

- **Spot Area Mix For Pollinators –** This seed mix is a good compromise of native and non-native pollinator plants where cost is an issue and native plant restoration is not the primary objective (such as smaller urban gardens, vacant lots, orchard understory plantings, highly degraded sites, etc.). It is better suited for small, very sunny areas (less than 0.25 acres). The included species are adaptable and will naturalize in most soil condition but will not tolerate saturation. Management may include mowing closely every 2-4 yrs. in early spring or late fall and regular applications of lime.

GENERAL PURPOSE MIX FOR POLLINATOR HABITAT #1

Common Name	Scientific Name	Rate (PLS)	Bloom Period	Flower Color	Height at Maturity (ft.)	Shade Toler-ance	Preference
Ohio spiderwort	*Tradescantia ohiensis*	8 oz./ac	Early	Blue	1	Intermediate	NB, BU, BI
blue wild indigo	*Baptisia australis*	6 oz./ac		Purple	2	Intolerant	NB
smooth beardtongue	*Penstemon digitalis*	8 oz./ac		White	2	Intermediate	NB, H
Eastern purple coneflower	*Echinacea purpurea*	8 oz./ac	Mid	Purple	1	Intolerant	NB, BU
Illinois bundleflower	*Desmanthus illinoensis*	6 oz./ac		White	3	Intolerant	NB
long – stalk tickseed	*Coreopsis lanceolata*	6 oz./ac		Yellow	2	Intolerant	NB, BU, BI
spiked blazing star	*Liatris spicata*	12 oz./ac	Late	Purple	4	Intermediate	NB, BU, H
smooth aster	*Aster laevis*	5 oz./ac		White	3	Intolerant	NB, BU, BI
wild bergamot	*Monarda fistulosa*	5 oz./ac		Purple	3	Intermediate	NB, BU
side-oats grama	*Bouteloua curtipendula*	1 lbs./ac	N/A	N/A	3	Intolerant	N/O
little bluestem	*Schizachyrium sco-parium*	1 lbs./ac		N/A	3	Intolerant	N/O

This mix is suitable for a wide variety of soils and sunny conditions. It is suitable primarily for native bees and various butterfly species. It may be attractive to hummingbirds. It is relatively a short height mix which emphasizes late season species. This mix contains 6.0lbs of seed (4.0lbs forbs and 2.0 lbs. grass)

GENERAL PURPOSE MIX FOR POLLINATOR HABITAT #2

Common Name	Scientific Name	Rate (PLS)	Bloom Period	Flower Color	Height at Maturity (ft.)	Shade Tolerance	Preference
white beardtounge	*Penstemon digitalis*	8 oz./ac	Early	Purple	4	Intermediate	NB, BU, H
Ohio spiderwort	*Tradescantia ohiensis*	8 oz./ac		Blue	1	Intermediate	NB, BU, BI
White wild Indigo	*Baptisia alba*	5 oz./ac		White	2	Intolerant	NB
purple coneflower	*Echinacea purpurea*	10 oz./ac	Mid	Purple	1	Intolerant	NB, BU
common milkweed	*Asclepias syriaca*	3 oz./ac		Pink	5	Intermediate	NB, BU, BI
Illinois bundleflower	*Desmanthus illinoensis*	8 oz./ac		White	3	Intolerant	NB
wild bergamot	*Monarda fistulosa*	2 oz./ac	Late	Purple	3	Intermediate	NB, BU
rigid goldenrod	*Solidago ridida*	3 oz./ac		Yellow	4	Intermediate	NB, BU
smooth aster	*Symphyotrichum laeve*	2 oz./ac		White	3	Intolerant	NB, BU, BI
little bluestem	*Schizachyrium scoparium*	1 lbs./ac	N/A	N/A	3	Intolerant	N/O
side-oats grama	*Bouteloua curtipendula*	1 lbs./ac		N/A	3	Intolerant	N/O
Virginia wild rye	*Elymus virginicus*	1 lbs./ac		N/A	1	Intolerant	N/O

This mix is suitable for a wide variety of soils and in sunny to slightly shaded conditions (including edges). This is a shorter growing mix 1-5 feet high and grows on a variety of soils that are well to moderately well drained soils. It is suitable for native bees, butterflies and beneficial insects.

GENERAL PURPOSE MIX FOR POLLINATOR HABITAT #3

Common Name	Scientific Name	PLS Rate	Bloom Period	Flower Color	Height at Maturity (ft.)	Shade Toler-ance	Preference
smooth beardtongue	*Penstemon digitalis*	8 oz./ac	Early	Purple	2	Intermediate	NB, H
wild lupine	*Lupinus perennis*	2 oz.		Purple	2	Intermediate	NB
Ohio spiderwort	*Tradescantia ohiensis*	8 oz./ac		Blue	1	Intermediate	NB, BU, BI
Illinois bundleflower	*Desmanthus illinoensis*	10 oz./ac	Mid	White	3	Intolerant	NB
butterflyweed	*Asclepias tuberosa*	3 oz./ac		Orange	3	Intermediate	NB, BU, BI, H
long – stalk tickseed	*Coreopsis lanceolata*	10 oz./ac		Yellow	2	Intolerant	NB, BU, BI
New England aster	*Symphyotrichum novae-angliae*	3 oz./ac	Late	Purple	4	Intermediate	NB, BU
roundleaf thoroughwort	*Eupatorium rotundifo-lium*	5 oz./ac		White	6	Intermediate	NB, BU
wild bergamot	*Monarda fistulosa*	3 oz./ac		Purple	3	Intermediate	NB, BU
little bluestem	*Schizachyrium sco-parium*	1 lbs./ac	N/A	N/A	3	Intolerant	N/O
side-oats grama	*Bouteloua curtipendula*	1 lbs./ac		N/A	3	Intolerant	N/O

This mix is suitable for a wide variety of soils and sun conditions. It is suitable primarily for native bees and some butterfly and hummingbird habitat.

WET SITE MIX FOR POLLINATOR HABITAT

Common Name	Scientific Name	Rate PLS	Bloom Period	Flower Color	Height at Maturity (ft.)	Shade Tolerance	Preference
Ohio Spiderwort	*Tradescantia ohiensis*	8 oz./ac	Early	Blue	1	Intermediate	NB, BU, BI
foxglove beardtongue	*Penstemon digitalis*	5 oz./ac		Purple	4	Intermediate	NB, BU, BI
smooth beardtongue	*Penstemon laevigatus*	5 oz./ac		Purple	2	Intermediate	NB
New York ironweed	*Vernonia noveboracensis*	5 oz./ac	Mid	Purple	4	Intolerant	NB, BU
swamp milkweed	*Asclepias incarnata*	8 oz./ac		Pink	3	Intermediate	NB, BU
square stemmed monkey flower	*Mimulus ringens*	5 oz./ac		Blue	2	Intermediate	NB
common joe-pye weed	*Eupatorium fistulosum*	8 oz./ac	Late	Purple	11	Intermediate	NB, BU
boneset	*Eupatorium perfoliatum*	3 oz./ac		White	4	Intermediate	NB, BU
showy tickseed	*Bidens aristosa*	16 oz./ac		Yellow	3	Intermediate	NB
tussock sedge	*Carex stricta*	6 oz./ac	N/A	N/A	3	Intolerant	N/O

This mix is to be utilized in wet conditions only. This mix is suitable for a variety of open meadow sites that contain moist to saturated conditions (moderately well to poorly drained soils) and receive at least partial sun during the day. It provides pollen and nectar resources for a wide variety of native bees and butterflies while adding a native sedge component. This mix is designed to create, enhance and augment existing habitat. Minimum establishment is 0.5 acres in most situations.

GENERAL POLLINATOR SITE MIX ATTRACTIVE TO HUMMINGBIRDS

Common Name	Scientific Name	Rate PLS	Bloom Period	Flower Color	Height at Maturity (ft.)	Shade Toler-ance	Preference
Eastern gray beard tongue	*Penstemon canescens*	3 oz./ac	Early	Purple	2	Intermediate	NB, BU, H
foxglove beardtongue	*Penstemon digitalis*	3 oz./ac		Purple	4	Intermediate	NB, BU, H
Ohio spiderwort	*Tradescantia ohiensis*	3 oz./ac		Blue	1	Intermediate	NB, BU, BI
purple coneflower	*Echinacea purpurea*	8 oz./ac	Mid	Purple	1	Intolerant	NB, BU
common milkweed	*Asclepias syriaca*	6 oz./ac		Pink	5	Intermediate	NB, BU, BI
butterflyweed milkweed	*Asclepias tuberosa*	6 oz./ac		Orange	3	Intermediate	NB, BU, BI, H
common joe pye weed	*Eupatorium fistulosum*	2 oz./ac	Late	Pink	11	Intermediate	NB, BU
New England aster	*Aster novae-angliae*	2 oz./ac		Purple	4	Intermediate	NB, BU
slender mountain mint	*Pycnantheum tenuifo-lium*	1 oz./ac		White	3	Intolerant	NB, BU
little bluestem	*Schlzachyrium sco-parium*	0.5 lbs./ac	N/A	Yellow	3	Intolerant	N/O

This optional forb/grass mix is suitable for most site conditions and most shade requirements. It provides pollen and nectar resources for some native bees and native butterflies and is attractive to hummingbirds. It adds a short warm season bunch grass component for structure. Note that it does not contain Early or very early blooming species and should not be utilized for native bee habitat. Minimum establishment is 0.5 acres in most situations.

GENERAL MIX FOR MONARCHS & OTHER BUTTERFLIES

Common Name	Scientific Name	Rate (PLS)	Bloom Period	Flower Color	Height at Maturity (ft.)	Shade Tolerance	Preference
butterfly milkweed	*Asclepias tuberosa*	4 oz.	Mid	Orange	3	Intermediate	NB, BU, BI, H
purple coneflower	*Echinacea purpurea*	10 oz.		Purple	1	Intolerant	NB, BU
common milkweed	*Asclepias syriaca*	3 oz./ac		Pink	5	Intermediate	NB, BU, BI
slender mountain mint	*Pycnanthemum tenuifolium*	1 oz.		White	3	Intolerant	NB, BU, BI
New York ironweed	*Vernonia noveboracensis*	4 oz.		Purple	4	Intolerant	NB, BU
spiked blazing star	*Liatris spicata*	2 oz.	Late	Purple	4	Intermediate	NB, BU, H
wild bergamot	*Monarda fistulosa*	2 oz.		Purple	3	Intermediate	NB, BU
common joe-pye weed	*Eupatorium fistulosum*	2 oz.		Pink	11	Intermediate	NB, BU
New England aster	*Symphyotrichum lateriflo-rum*	2 oz.		Purple	4	Intermediate	NB, BU
rigid goldenrod	*Solidago rigidum*	2 oz.		Yellow	4	Intermediate	NB, BU
Little bluestem	*Schlzachyrium scoparium*	0.25 lbs./ac	N/A	N/A	3	Intolerant	N/O
side oats grama	*Bouteloua curtipendula*	0.125 lbs./ac		N/A	3	Intolerant	N/O
Virginia wild rye	*Elymus virginicus*	0.25 lbs./ac		N/A	3	Intolerant	N/O

This optional forb/grass mix is suitable for most site conditions and most shade requirements. It provides pollen and nectar resources for some native bees during only a portion of the season but is tailored to native butterflies. It adds a short warm season bunch grass component for structure. ***Note that it does not contain early or very early blooming species and should not be utilized for native bee habitat.*** *Consider establishing approximately 0.5 acres to see the most biodiversity benefits.*

LINEAR CONSERVATION COVER PLANT MIX FOR POLLINATORS

Common Name	Scientific Name	Rate (PLS)	Bloom Period	Flower Color	Height at Maturity (feet)	Shade Tolerance	Preference
Ohio spiderwort	*Tradescantia ohiensis*	3 oz./ac	Early	Blue	1	Intermediate	NB, BU, BI
blanketflower	*Gaillardia aristata*	2 oz./ac		Yellow	2	Intolerant	NB
White Wild Indigo	*Baptisia alba*	1 oz./ac		Yellow	2	Intolerant	NB
Common Milkweed	*Asclepias syriaca*	4 oz./ac	Mid	Pink	5	Intermediate	NB, BU, BI
New York Ironweed	*Vernonia noveboracensis*	9 oz./ac		Purple	4	Intolerant	NB, BU
Long – Stalk Tickseed	*Coreopsis lanceolata*	3 oz./ac		Yellow	2	Intolerant	NB, BU, BI
Calico Aster	*Symphyotrichum lateriflo-rum*	3 oz./ac	Late	White	3	Intolerant	NB, BU, BI
Grey Headed Coneflower	*Ratibida pinnata*	8 oz./ac		Yellow	3	Intolerant	NB, BU
Gay Feathers	*Liatris spicata*	2 oz./ac		Purple	4	Intermediate	NB, BU, H
Little bluestem	*Schlzachyrium scoparium*	8 oz./ac	N/A	Yellow	3	Intolerant	N/O

This mix could be utilized to establish along linear corridors such as drainage ditches, non-forested riparian areas, hedgerows, field borders or other corridors where pollinator habitat is required. In larger landscape contexts small linear areas form can be scattered to make up nectar corridors. It is also suitable to small block or patch style habitat. Consider utilizing this mix and general mixes to create pollinator corridors in sunny locations. It is primarily established in smaller amounts.

SPOT AREA MIX FOR POLLINATORS

Common Name	Scientific Name	Rate (PLS)	Bloom Period	Flower Color	Height at Maturity (feet)	Shade Tolerance	Preference
Crimson Clover *	*Trifolium incarnatum*	4 oz./ac	Early	Red	1	Intolerant	NB
Perennial Blanketflower	*Gaillardia aristata*	4 oz./ac		Yellow	2	Intolerant	NB, BU
Red Clover	*Trifolium pratense*	2 oz./ac	Mid	Red	1	Intolerant	NB
Largeflower Tickseed	*Coreopsis lanceolata*	10 oz./ac		Yellow	2	Intolerant	NB, BU, BI
Purple Coneflower	*Echinacea purpurea*	8 oz./ac		Purple	1	Intolerant	NB, BU
Alfalfa	*Medicago sativa*	8 oz./ac		Blue	1	Intolerant	NB
Bachelor Button *	*Centaurea cyanus*	6 oz./ac	Late	Blue	3	Intolerant	NB, BU, BI
Maximillian's Sunflower	*Helianthus maximiliani*	4 oz./ac		Yellow	5	Intolerant	NB, BU
Hoary Vervain	*Verbena stricta*	4 oz./ac		Blue	4	Intolerant	NB, BU
Rough Blazingstar	*Liatris aspera*	6 oz./ac		Purple	3	Intolerant	BU, H
Little bluestem	*Schlzachyrium scoparium*	8 oz./ac	N/A	Yellow	3	Intolerant	N/O

** Species listed with an asterisk are reseeding non-native annuals*

This seed mix is a good compromise of native and non-native pollinator plants where cost is an issue and native plant restoration is not the primary objective (such as smaller urban gardens, vacant lots, orchard understory plantings, highly degraded sites, etc.). It is better suited for small, very sunny areas (e.g. 0.25 acres). The included species are adaptable and will naturalize in most soil condition but will not tolerate saturation. Management may include mowing/disking every 2-4 yrs. in early spring or late fall and regular applications of lime.

IV. Sources of Plant Materials

The following list contains plant vendors that may provide native plant materials that would be suitable for pollinator enhancements. Carefully select production facilities that can provide sources of native plants that will tolerate local climate and environmental conditions. Consider the time factors for shipment, planting and storage and order appropriately. Some companies may charge additional fees for custom mixes and special orders for pollinators. This list is by no means all-inclusive and other suppliers are certainly able to provide quality native plants. This list is provided as a courtesy to clients and planners and does not constitute an endorsement or certify to the acceptable quality of any of the products sold by the supplier.

Note also that some nurseries specialize in shrubs, trees or herbaceous plants and some specialize in providing seed. Be sure and request specific information on the plants that you require prior to purchase. Always request certified seed when an option is available.

The Xerces Society

The Xerces Society also provides native mixes that are suitable for pollinator habitat. Mixes created and approved by the Xerces Society could also be utilized to establish pollinator habitat. Mixes selected must be approved for use in Kentucky. These seed mixes may or may not meet the requirements for NRCS-administered private landowner conservation programs, such as the Environmental Quality Incentives Program (EQIP), the Conservation Stewardship Program (CSP), the Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP). For cost-share approval, please consult the local NRCS Service Center prior to purchase. Always check with state technical specialists to determine if the mixes meet the bloom period or program requirements necessary for Kentucky. Mixes may be found online at: http://www.xerces.org/pollinator-seed/ .

Plant Materials Centers

Some Plant Materials Centers (PMC) are available to assist in establishing protocols for planting and maintaining pollinator habitats. Their mission is to evaluate plants for their use in treating soil and water conservation resource concerns. Some plant material centers actually work specifically with pollinator habitat establishment and have pollinator specialists to assist with establishment of habitat. Information may be found at: http://plant-materials.nrcs.usda.gov/ . Contact the PMC to determine how they may assist.

Commercial Nurseries

There are many great Kentucky and nationwide commercial nurseries that provide native plants. These species are frequently more expensive than common horticultural varieties. 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. It is important to compare stock types, sizes, prices, species and type of materials when deciding upon the plants to purchase. One of the most useful tools for locating and finding local nurseries is found here: http://www.findnurseries.com A simple internet search will yield hundreds of native seed and nursery sources.

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COMMERCIAL NATIVE SEED & TREE VENDORS

NOTE: *This information is provided as a service and constitutes no endorsement by the USDA or the NRCS of any service or supplier listed. Errors and omissions may occur; therefore other sources should be consulted. Plants utilized should be suited for your particular hardiness zone. It is recommended that plants be obtained from your hardiness zone or colder.*

Vendors	Address	City/State/Zip	Phone	Fax	Internet Site
KENTUCKY					
Dropseed Nursery	1205 S Buckeye Ln,	Goshen, KY 40026	502.439.9033		www.dropseednursery.com
Habitats Native Plant Nursery, **L**LC	P.O. Box 265	Silver Grove, KY 41085	859/442-9414		www.habitatsnursery.org
Kelly Nursery LLC	1158 Manchester St	Lexington, KY 40508	(859) 333-3794		
Roundstone Native Seed	9758 Raider Hollow Road	Upton, KY 42784	270-531-3034	270-531-3036	
Shooting Star Nursery	444 Bates Rd.	Frankfort, KY 40601	502-223-1679	502-875-2231	
INDIANA					
LaCrosee Seed	12071 N State Road 37	Elwood, IN. 46036	(800) 562-2459		www.lacrosseseed.com
Cardno	128 Sunset Drive	Walkerton, IN 46574	(574) 586-2412	(574) 586-2718	www.cardnonativeplant-nursery.com
MARYLAND					
Atlantic Star	620 Pyle Rd.	Forest Hill, MD 27050	470- 838-7950		atlantic@iximd.com
Benedict Nurseries	1054 S. Salisbury Blvd	Salisbury, MD 21801	410-742-2266		
Environmental Concern	PO Box P,	St. Michaels, MD 21663	410-745-9620	410-745-3517	www.wetland.org
Lower Marlboro Nursery	P.O. Box 1013	Dunkirk, MD 20754	301- 812-0808	301-812-0808	
Maryland Natives Nursery, Inc.	9120 Hines Road	Baltimore, MD 21234	410-529-0552	410-529-3883	www.marylandnativesnursery.com

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Vendors	**Address**	**City/State/Zip**	**Phone**	**Fax**	**Internet Site**
MISSOURI					
Hamilton Seed	16786 Brown Road	Elk Creek, MO 65464	(417) 967-2190		www.hamiltonseed.com
OHIO					
John Deere Landscapes	1385 East 36th Street	Cleveland, OH 44114	(216) 706-9250		www.johndeerelandscapes.com
Lake County Nursery	Box 122	Perry, OH 44081	216-259-5571		www.lakecountynursery.com
Mary's Plant Farm and Landscape	2410 Lanes Mill Road	Hamilton, OH 45013	513-894-0022	513-892-2053	
Mellinger's	2310 West South Range Rd.	North Lima, OH 44452	800-321-7444	330-549-3716	
Land Reforms Nursery & Landscape	35703 Loop Rd.	Rutland, OH 45775	740-742-3478		
PENNSYLVANIA					
Appalachian Nurseries Inc.	POB 87	Waynesboro, PA 17268	717-762-4733		
Bowman's Hill Wildflower Preserve	P.O. Box 685	New Hope, PA 18938	215-862-2924	215-862-1846	www.bhwp.org/native
Carino Nurseries	POB 538	Indiana, PA 15701	800-223-7075		www.carinonurseries.com
Doyle Farm Nursery	158 Norris Road	Delta, PA 17314	717-862-3134		
England's Herb Farm	33 Todd Rd.	Honey Brook, PA	610-273-2863	610-273-2556	
Ernst Conservation Seed Co.	9006 Mercer Pike	Meadville, PA 16335	800-873-3321	814-336-5191	www.ernstseed.com
Flickingers' Nursery (conifer specialist)	P.O. Box 245	Sagamore, PA 16250	800-368-7381	724-783-6528	www.flicknursery.com

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Vendors	Address	City/State/Zip	Phone	Fax	Internet Site
Gary's Perennials	1122 E. Welsh Road	Maple Glen, PA 19002	800-898-6653	215-628-0216	
Kneehigh Nursury Inc.	2 Deerfield Ln.	Indiana, PA 15701	724-349-4611	724-349-6650	
Munro Ecological Services Inc.	990 Old Sumneytown Pike	Harleysville, PA 19438	610-287-0671	610-287-0672	
Musser Forest, Inc.	Rt. 119N POB 340	Indiana, PA 15701	724-465-5685	412-465-9893	www.musserforests.com
Octoraro Native Plant Nursery	6126 Street Rd	Kirkwood, PA 17536	717-529-3160	717-529-4099	www.octoraro.com
Pine Grove Nursery, Inc.	RD #3 Box 146 Pine Grove Nursery Rd	Clearfield, PA 16830	800-647-1727	814-765-2363	
Sylva Native Nursery & Seed	1683 Sieling Farm Rd	New Freedom, PA 17349	717-227-0486	717-227-0484	www.sylvanative.com
Wetland Supply Co./Native Plant Nursery	1633 Gilmar Rd.	Apollo, PA 15613	724-327-18307	724- 733-3527	
SOUTH CAROLINA					
Arborgen	PO Box 840001	Summerville, SC 29484-8401	843-851-4129	843-832-2164	www.arborgen.com
TENNESSEE					
Tennessee Nursery Co	HCR 77 Box B-1	Altamont, TN 37301	931-692-4252	931-692-4266	www.tnnursery.net
The Hogan Company	3628 Kelton Jackson Rd. PO Box 400	Springfield, TN. 37172	(888) 224-6426		www.thehogancompany.us
TEXAS					
Turner Seed Company	211 County Road 151	Breckenridge, TX 76424	1 (800) 722-8616 (254) 55-2065	(254) 559-5024	www.turnerseed.com
Browning Seed Company	3101 South IH 27 Box 1	Plainview, TX 79073	(806) 293-5271 (800) 243-5271	(806) 293-9050	www.browningseed.com

NOTE: *This information is provided as a service and constitutes no endorsement by the USDA or the NRCS of any service or supplier listed. Errors and omissions may occur; therefore other sources should be consulted. Plants utilized should be suited for your particular hardiness zone. It is recommended that plants be obtained from your hardiness zone or colder.*					
Vendors	**Address**	**City/State/Zip**	**Phone**	**Fax**	**Internet Site**
Bamert Trustworthy Seed	1897 County Road 1018	Muleshoe, TX 79347	800) 262-9892	(888) 378-0419	www.bamertseed.com
VIRGINIA					
Bobtown Nursery	RR 1 Box 436-P	Melfa, VA 23410	800-201-4714	757-787-8611	
Conservation Services, Inc.	300 W. Beverly Street	Staunton, VA 24401	540-213-8733	540-213-2445	
Ingleside Plantation Nurse-ries	5870 Leedstown Road	Oak Grove, VA 22443	800-883-4637	804-224-2032	www.inglesidenurseries.com
Virginia Natives	PO Box D	Hume, VA 22639	540-364-1665	540-364-1665	
WEST VIRGINIA					
G & G Nursery	P.O. Box 420 7800 Ohio River Rd	Lesage, WV 25537	304-762-2100		www.gngnursery.com
Mountain Laurel Nursery	POB 339	Bud, WV 24716	304-294-7412	304-294-7158	
Native Garden Design	Rt. 2 Box 484	Salt Rock, WV 25559	304-541-0184		
Sunshine Farm & Gardens	HC 67 Box 539B	Renick, WV 24966	304-497-2208		www.gardenweb.com/sunshine

OTHER SOURCES (Always try to obtain seed form the most local source)					
Lawyer Nursery Inc.	950 Highway 200 W.	Plains, MT 59859-9706	800-551-9875	406-826-5700	www.lawyernursery.com
Great Lakes Nursery Co	1002 Hamilton St	Wausau, WI 54403	888-733-3564	715-848-9436	www.greatlakesnursery.com
Xerces Society, The	4828 SE Hawthorne Blvd.	Portland, OR 97215	(855) 232-6639	(503) 233-6794	www.xerces.org/pollinator-seed
Pawnee Buttes Seed, Inc.	PO Box 100, 605 25th St	Greeley, CO 80632	(970) 356-7002 (800) 782-5947	(970) 356-7263	www.pawneebuttesseed.com
Sharp Bros. Seed Company	1005 S. Sycamore	Healy, KS 67850	(620) 398-2231 (800) 462-8483		www.sharpbro.com

This list does not constitute an endorsement of any kind and does not imply that these are the only suitable sources.

V. Common Bees

The following table outlines bee genera that could be found in Kentucky. Individual life history details for certain species may vary from the general genus-level characteristics described here. The purpose of this listing is so that planners and clients can have a generalized place to start researching specific types of native bees.

Family	Genus	Nest Site	Sociality	Time of Year	Abundance	Common Name & Notes
Andrenidae	Andrena	Ground	Solitary & Communal	All season	Abundant	Commonly called mining bees. They are among the most common North American bees and are very common in the spring.
	Protandrena					
	Anthemurgus					
	Calliopsis					
	Macrotera					
	Panurginus					
	Perdita					
	Pseudopanurginus					
Apidae	Anthophora	Wood & Ground	Solitary	Spring & Summer	Local	Mining bees. Males sometimes form sleeping aggregations, clustering together on a plant stem.
	Apis	Hives	Social	All season	Abundant	Honey bees.
	Bombus	Rodent burrows, large cavities	Social	All season	Abundant	Bumble bees.
	Ceratina	Stems	Solitary	All season	Abundant	Small carpenter bees.
	Eucera	Ground	Solitary	Summer & Fall	Common	Long-horned bees: often associated with sunflowers and related species.
	Hapropoda	Muddy Streambanks	Solitary	Spring	Local	One species occurs and is locally common, especially near its preferred floral source blueberries.
	Melissodes	Ground	Solitary	Summer & Fall	Common	Long-horned bees: often associated with sunflowers and related species.
	Nomada	Parasite	N/A	All season	Abundant	All species cuckoo bees, laying their eggs in the nests of other species. Usually black and yellow, hairless and wasp-like in appearance.

Family	Genus	Nest Site	Sociality	Time of Year	Abundance	Common Name & Notes
Apidae (continued)	Peponapis	Ground	Solitary	Summer	Common	Called “squash bees” due their close association with squash, often nesting at the base of squash and pumpkin plants and pollinating the flowers early in the morning
	Svastra	Ground	Solitary	Summer	Common	Long-horned bees: often associated with sunflowers and related species.
	Xenoglossa	Ground	Solitary	Summer	Common	Called “squash bees” due their close association with squash, often nesting at the base of squash and pumpkin plants and pollinating the flowers early in the morning
	Xylocopa	Wood	Nest sharing	All season	Common	Large carpenter bees: often resemble bumble bees in size and color, but are typically shinier and have less hair.
Colletidae	Colletes	Ground	Solitary	All season	Common	Polyester bees: nests are lined with a waterproof cellophane-like glandular secretion.
	Hylaeus	Stems & Ground	Solitary	Summer	Common	Yellow-faced bees: typically very small, wasp-like in appearance.
Halictidae	Agapostemon	Ground	Communal & Solitary	All season	Common	Green sweat bees: usually metallic green in color.
	Augochlora	Wood	Solitary	Spring & Summer	Common	Sweat bees: so named for their occasional attraction to perspiration.
	Augochlorella	Ground	Social	All season	Common	Sweat bees.
	Augochloropsis	Ground	Nest sharing	Summer	Local	Sweat bees.

Family	Genus	Nest Site	Sociality	Time of Year	Abundance	Common Name & Notes
	Halictus	Ground	Social & Solitary	All summer	Abundant	Sweat bees. Unlike other bees, Halictus may be regularly found foraging at twilight. They may nest as solitary individuals or complex colonies with multiple queens and hundreds of workers.
	Lasioglossum (Dialictus)	Ground	Communal & Social	All season	Abundant	Sweat bees: One of the largest and most common genera often overlooked due to their small size.
	Sphecodes	Parasite	N/A	All season	Abundant	Cuckoo bee. Eggs lain in the nests of other bees.
Megachilidae	Chelostoma	Wood & Stone Cavities	Solitary	Summer	Common	Leafcutter, resin, and mason bees.
	Coelioxys	Parasite	N/A	Summer	Common	Cuckoo bee. Eggs lain in the nests of other bees.
	Heriades	Wood & Stone Cavities	Solitary	Summer	Uncommon	Leafcutter, resin, and mason bees.
	Hoplitis	Wood, Stone Cavities, Masonry	Solitary	Summer	Local	Mason bees.
	Megachile	Wood, Ground, & Stone Cavities	Solitary	Summer	Local	Leafcutter bees. Some species clip circular leaf sections to line their nests, and to seal off nest entrances.
	Osmia	Wood & Stone Cavities	Solitary	Spring & Summer	Abundant	Leafcutter and mason bees. Nest entrances closed with mud or masticated leaf pieces.
	Paranthidium	Ground	Solitary	Summer	Rare	Leafcutter, resin, and mason bees.
	Stelis	Parasite	N/A	Summer	Uncommon	Cuckoo bee. Eggs lain in the nests of other bees.

*(Adapted from *The Bee Genera of Eastern Canada* by Laurence Packer, Julio Genaro, and Cory Sheffield. Canadian Journal of Arthropod Identification. No. 3. 2007, and the Great Sunflower Project, Gretchen LaBuhn. 2008. (http://www.greatsunflower.org) Information revised by Harry W. Godwin, Biologist, AFSRC, ARS, USDA, Beaver, WV and Eric Mader, The Xerces Society Portland, OR.

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VI. Additional Information

In addition to this document, information on pollinator habitat conservation is widely available through a number of other publications, websites, and organizations. Kentucky NRCS staff is required to utilize only approved technical information provided state staff and located within the Field Office Technical Guide (FOTG). Contact the NRCS state staff if there are questions regarding the information's applicability to farm bill programs or conservation planning.

Agronomy Technical Note No. 5 – *Pest Management in the Conservation Planning Process* - February 2011

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

Technical Note Number 78 – *Using 2014 Farm Bill Programs for Pollinator Conservation,* May 2015

USDA NATIONAL AGROFORESTRY CENTER (http://www.unl.edu/nac)

Agroforestry Info - *How can agroforestry help pollinators?*
Agroforestry Note 32 - *Agroforestry: Sustaining Native Bee Habitat for Crop Pollination* – August 2006
Agroforestry Note 33 - *Improving Forage for Native Bee Crop Pollinators* - August 2006
Agroforestry Note 34- *Enhancing Nest Sites for Native Bee Crop Pollinators* - February 2007
Agroforestry Note 35- *Pesticide Considerations for Native Bees in Agroforestry* - June 2007

All the Agroforestry Notes may be accessed at: http://nac.unl.edu/publications/agroforestry-notes.htm

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THE XERCES SOCIETY FOR INVERTEBRATE CONSERVATION
(http://www.xerces.org)

Invertebrate Conservation Fact Sheet – *Nests for Native Bees*, The Xerces Society for Invertebrate Conservation

Invertebrate Conservation Fact Sheet – *Butterfly Gardening,* The Xerces Society for Invertebrate Conservation

Invertebrate Conservation Fact Sheet – *Plants for Native Bees in North America*, The Xerces Society for Invertebrate Conservation

Invertebrate Conservation Fact Sheet – *Pollinators in Natural Areas, A Primer on Habitat Management,* The Xerces Society for Invertebrate Conservation

Invertebrate Conservation Fact Sheet – *Nests for Native Bees*, The Xerces Society for Invertebrate Conservation

Invertebrate Conservation Fact Sheet – *Northeast Plants for Native Bees*, The Xerces Society for Invertebrate Conservation

Invertebrate Conservation Fact Sheet – *Tunnel Nests for Native Bees – Nest Construction and Management*, The Xerces Society for Invertebrate Conservation

The Xerces Society for Invertebrate Conservation *Farming for Bees – Guidelines for Providing Native Bee Habitat on Farms*

The Xerces Society for Invertebrate Conservation *Making Room for Native Pollinators – How to create Habitat for Pollinator Insects on Golf Courses*

The Xerces Society for Invertebrate Conservation *Are Neonicotinoids Killing Bees – A Review of Research into the Effects of Neonicotinoids Insecticides on Bees with Recommendations for Action*

The Xerces Society for Invertebrate Conservation *Making More Room – A Companion to Making Room for Native Pollinators: Oregon's Butterflies, Local Plants and Extra Resources*

The Xerces Society for Invertebrate Conservation *Pollinator Friendly Parks – How to Enhance Parks, Gardens, and Other Greenspaces for Native Pollinator Insects*

The Xerces Society for Invertebrate Conservation *Conserving Bumble Bees – Guidelines for Creating and Managing Habitat for Americas Declining Pollinators*

WILDLIFE HABITAT COUNCIL AND NRCS (http://www.wildlifehc.org)

Wildlife Habitat Council/NRCS -Fish and Wildlife Habitat Management Leaflet, Number 24 - *Integrated Pest Management (IPM) and Wildlife*, April 2004
Wildlife Habitat Council/NRCS -Fish and Wildlife Habitat Management Leaflet, Number 34 – *Native Pollinators*, February 2006

USDA NRCS Resources http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate

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INTERNET RESOURCES

General Pollinator Information

1. The Xerces Society Pollinator Conservation Program: http://www.xerces.org/pollinator-conservation/
2. U.S. Forest Service Pollinator Information http://www.fs.fed.us/wildflowers/pollinators/index.shtml
3. U.S. Fish & Wildlife Service Information http://www.fws.gov/pollinators/Index.html
4. Urban bee gardens http://nature.berkeley.edu/urbanbeegardens/index.html

5. North American Pollinator Protection Campaign (NAPPC) http://www.pollinator.org
6. The Economic Challenge Posed by Declining Pollinator Populations https://www.whitehouse.gov/the-press-office/2014/06/20/fact-sheet-economic-challenge-posed-declining-pollinator-populations

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Habitat Restoration with Native Plants

1. Selecting Native Plant Materials for Restoration http://extension.oregonstate.edu/catalog/pdf/em/em8885-e.pdf
2. Native Seed Network http://www.nativeseednetwork.org/ has good species lists by ecological region and plant communities
3. Prairie Plains Resource Institute has extensive guidelines for native plant establishment using agricultural field implements and methods http://www.prairieplains.org/restoration_.htm
4. The Illinois Wildflowers website has several databases that list plant-insect associations. You are able to search for insects by plant species or vice versa. There's also a list of plants used by orioles and the ruby throated hummingbird. http://www.illinoiswildflowers.info/flower_insects/index.htm

Pesticide Toxicity

1. Extension Toxicity Network: http://pmep.cce.cornell.edu/profiles/extoxnet/index.html

2. **PNW 591** *How to Reduce Bee Poisoning from Pesticides* http://extension.oregonstate.edu/catalog/pdf/pnw/pnw591.pdf

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Monarch Butterfly Information

1. Xerces Society – Monarch Butterflies: http://www.xerces.org/monarchs/#
2. Recovery Plan: http://monarchwatch.org/blog/2014/03/25/monarch-butterfly-recovery-plan/
3. Tracking Milkweed emergence: http://www.learner.org/jnorth/maps/milkweed_spring2015.html
4. Tracking Monarch Migration: http://www.learner.org/jnorth/monarch/index.html
5. Monarch Watch: http://monarchwatch.org/blog/

6. All About Monarchs – The Wild Center: http://wildcenter.org/tag
7. Monarch Foundation: http://www.saveourmonarchs.org/
8. National Geographic – All about Monarchs: http://animals.nationalgeographic.com/animals/bugs/monarch-butterfly/

Kentucky Natural History Survey (Discover Life.Org)

The survey's goals are to teach science and quantitative skills through inquiry-based learning; understand the impacts of weather, invasives, pollution, pests, diseases and other factors on species and their interactions; provide timely information to gardeners, farmers and natural resource managers, enabling them to respond rapidly to invasives, pests and other threats.

Kentucky Natural History Survey http://www.discoverlife.org/kentucky/

Nursery Information

There are many nurseries that supply native plants for pollinators and woody plantings. One of the most useful tools for locating and finding local nurseries is found here:

FindNurseries.com http://www.findnurseries.com

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.

Local and State Technical Support

CONTACT	TITLE	AGENCY	LOCATION	INFORMATION
Local NRCS Conservationist		NRCS	Local USDA Service Center	http://www.ky.nrcs.usda.gov Contact Us
Casey Shrader	NRCS State Biologist	NRCS	Lexington, KY	
Jason Scott	Area 1 Farm Bill Biologist Liaison	NRCS/KDFWR	Madisonville, KY	
Danny Hughes	Area 2 Farm Bill Biologist Liaison	NRCS/KDFWR	Monticello, KY	
Vacant	Area 3 Farm Bill Biologist Liaison	NRCS/KDFWR	Lexington, KY	

Kentucky Farm Bill Programmatic Support

Support for various farm bill questions may be addressed by:

AGENCY	PROGRAM	CONTACT	LOCATION	INFORMATION
NRCS	Environmental Quality Incentives Program (EQIP)	State Program Manager	Lexington, KY	http://www.ky.nrcs.usda.gov
	Conservation Security Program (CSP)			
FSA	Conservation Reserve Enhancement Program(CREP)	State Program Manager	Lexington, KY	http://www.fsa.usda.gov
	Conservation Reserve Program (CRP)			
KSNPC	Invertebrate Biodiversity Monitoring	Ellis Laudermilk	Frankfort, KY	http://naturepreserves.ky.gov

Regional Technical Support

AGENCY	CONTACT	LOCATION	CONTACT
The Xerces Society & USDA-NRCS East National Technology Support Center	Nancy Adamson	Pollinator Conservation Specialist 2901 East Lee St., Suite 2100, Greensboro, NC	http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/entsc/

Regional staff should only be contacted by state staff

VII. Glossary

The following is a list of terms that one may encounter either in this document or when working with pollinators and managing habitats.

Bee Pasture – 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.

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:

- March through April = **Very Early Season**
- April through May **= Early Season**
- May through July **= Mid-Season**
- July through Sept **= Late Season**

Bunch Grass – a species of grass, which possess a growth characteristic of forming a clump as it matures. These species do not typically form sods and are sporadically scattered throughout the landscape. While some cool season grasses are bunchgrasses, the majority are warm season grasses. As pollinator habitat they provide attachment points for beneficial insects and egg laying sites.

Burndown – herbicide application to eliminate a cool season species 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 in food habit, with some species being insectivorous. Caterpillars are voracious feeders and many of them are considered pests in agriculture. The common Woolly Bear Caterpillar is shown below which is not known to cause damage to agricultural crops.

The Banded Woolly Bear Caterpillar (*Pyrrharctia isabella***)**
Photo: *IronCh 2006*

Adult Isabella Tiger Moth (*Pyrrharctia isabella***)**
Photo: *Steve Jurvetson*

Conservation Practice – science-based, proven technical criteria for implementation of various techniques to establish, manage, construct or maintain vegetation, structures or systems of natural resources. NRCS plans and assists in installation of conservation practices.

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 (especially by adding nitrogen). Cover crops can be made pollinator friendly by adding appropriate flowering species.

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 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 Kentucky this area is limited in scope. This program is instrumental in establishing pollinator habitat throughout the state. (See also **Conservation Reserve Program**)

Conservation Stewardship Program (CSP) – The Conservation Stewardship Program (CSP) which is administered by the helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns.

Early Successional Habitat – early successional vegetation is considered collectively as grasses, forbs, shrubs and saplings. Usually areas that are idle, fallow, field borders, fencerows, pivot corners, ditch banks consist of early successional habitat.

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 the comprehensive Acts passed through congress. 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. Sometimes referred to as the **eFOTG**.

FSA-Farm Service Agency – Farm Service Agency is an agency within the USDA which serves farmers, ranchers, and agricultural partners through the delivery of agricultural programs.

Green Manure – a type of cover crop grown primarily to add nutrients and organic matter to the soil. They are typically grown for a specific period and then plowed under and incorporated into the soil. Green manures can be made pollinator friendly by adding appropriate flowering species

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 native elsewhere in North America north of Mexico which has been intentionally planted in KY 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.

Kentucky Department of Natural Resources (KDFWR) – the state wildlife agency responsible for fish, and wildlife (game and non-game) and other natural resources within the State of Kentucky.

Kentucky State Nature Preserves Commission (KSNPC) – The Kentucky State Nature Preserves Commission (KSNPC) participates in an international network of programs that monitor biodiversity. The 1976 Kentucky legislature created the commission to protect the best remaining natural areas in the state, not only to preserve our natural heritage, but also in recognition of the dependence of our well-being on healthy ecosystems.

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 KY prior to European settlement and that still occurs naturally within the state.

Nectar – a sweet liquid secreted by flowers of a plant, which attracts the 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 sources for migratory species such as Monarch butterflies and various hummingbirds scattered along great distances which sustains them over, and during migration. On a smaller (farm planning) scale, these areas are fashioned along ditches, hedgerows, riparian areas, etc. to facilitate movement throughout a pollination area and/or provide pollinator resources in the form of nectar and pollen. Cumulatively, small scale corridors may be beneficial to provide resources in a watershed scale and so on.

Non-native – a taxon considered not to have occurred in Kentucky prior to European settlement but still may occur within the state.

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 for a list of those species within Kentucky.

NRCS (Natural Resources Conservation Service) – a federal agency of the United States Department of Agriculture which assists with implementing strategies to solve soil, water, air, plant and animal resource concerns primarily on private lands.

Pesticide Drift - the physical movement of pesticide droplets or particles through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site.

Plant Materials Center (PMC) – an office of the USDA Plant Materials Program. The centers have responsibilities for assembling, testing, releasing, and providing for the commercial production and use of plant materials and plant materials technology for programs of soil, water, and related resource conservation and development. The PMC responsible for this area is located in Alderson, WV.

Pollinator – an organism that transfers pollen from one seed plant to another, unwittingly aiding the plant in its reproduction. Common pollinators include insects, especially bees, butterflies, and moths, some birds and bats.

Prescribed Burning – the process of planning and applying fire to a predetermined area, under specific environmental conditions, to achieve a desired outcome. One of several ways utilized to maintain early successional habitats for pollinators. Prescribed, controlled and planned burns are the same thing

Pupa – the non-feeding stage between the larva and adult in the metamorphosis of some insects (bees, moths, butterflies or some beetles) during which the larva typically undergoes complete transformation.

Shrub – perennial, multi-stemmed woody vascular plant that is usually less than 14 to 15 feet in height and usually less than 3.0 inches in diameter at breast height. Shrubs typically have several stems arising from or near the ground, but may be taller than 5 meters or single-stemmed under certain environmental conditions.

Social Bee – (eusocial) bees that live in colonies and work together to build nests, provide food and raise offspring. Only a few native bee species are social including bumble and sweat bees.

Solitary Bee – bees that after mating prepare and provision their own nests without cooperation with other bees. The great majority of bee species are solitary.

Tree – a woody vascular plant usually greater than 3.0 inches in diameter at breast height and usually greater than 15 feet in height (exclusive of woody vines).

Swarming – the process by which an overgrown bee colony divides with half the colony flying away to find a new nest.

Vine – twining/climbing plant with relatively long stems which can be woody or herbaceous.

Warm Season Grass – a species of grasses that grow best when the weather is hot and other species' growth are declining. They begin growing when the soil temperature is above 50^{o} F and continue to grow until the soil temperature reaches nearly 90^{o} F (usually May - September). They may form clumps or sods. Often referred to as native grasses.

Win-PST-Windows Pesticide Screening Tool – WIN-PST is an environmental risk screening tool for pesticides. 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.

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.

Xerces Society, The – a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. Established in 1971, the Society is involved in invertebrate protection worldwide through the implementation of various conservation programs. NRCS has an existing Memorandum of Understanding (MOU) at the national level with The Xerces Society.

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