POLLINATOR BIOLOGY AND HABITAT

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Introduction

This technical note provides information on how to plan for, protect, and create habitat for pollinators in agricultural settings. Pollinators are an integral part of our environment and our agricultural systems; they are important in 35% of global crop production. Animal pollinators include bees, butterflies, moths, wasps, flies, beetles, ants, bats, and hummingbirds. This technical note 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, other beneficial insects.

Common Eastern bumble bee (*Bombus impatiens*) on giant yellow hyssop (*Agatache nepetoides*).

Worldwide, there are an estimated 20,000 species of bees, with approximately 4,000 species native to the United States. The non-native European honey bee (*Apis mellifera*) is the most important managed crop pollinator in the United States. However, the number of honey bee colonies is in decline because of disease and other factors, making native pollinators even more important to the future of agriculture. Native bees provide free pollination services, and 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 at least $3 billion worth of crop pollination annually to the U.S. economy, which is likely a conservative estimate. A 2012 study in California, for example, found that native bees there are likely responsible for between $900 million and $2.4 billion in crop production. This suggests that the role of wild native bees may be much greater than earlier estimates.

Undeveloped areas on and close to farms can serve as long-term refugia for native wild pollinators. Protecting, enhancing or providing habitat is the best way to conserve native pollinators and, at the same time, provide pollen and nectar resources that support local honey bees; on farms with sufficient natural habitat, native pollinators can provide all of the pollination for some crops.

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 are predators or parasitoids of crop pests and lessen the need for pesticides on your farm. Pollinator habitat can also provide habitat for other wildlife, such as birds, serve as windbreaks, help stabilize the soil, and improve water quality.

Pollinators have two basic habitat needs: a diversity of flowering native or naturalized plants, and egg-laying or nesting sites. The NRCS can assist landowners with providing adequate pollinator habitat by, for example, suggesting locally appropriate plants and offering advice on how to provide nesting or egg-laying habitat.

This document provides a three step approach to pollinator conservation: (1) advice on recognizing existing pollinator habitat, (2) steps to protect pollinators and existing habitat, and (3) methods to further enhance or restore habitat for pollinators.

Part I
Recognizing Existing Pollinator Habitat

Many growers may 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. Marginal lands such as field edges, hedgerows, roadsides, sub-irrigated areas, and drainage ditches offer both nesting and foraging sites. Woodlots, conservation areas, utility easements, farm roads, and other untilled areas may also contain good habitat. Often, poor quality soils, unfit for crops, may be useful instead as pollinator habitat. Here we provide advice on recognizing specific habitat resources so they can be factored into farm systems planning.

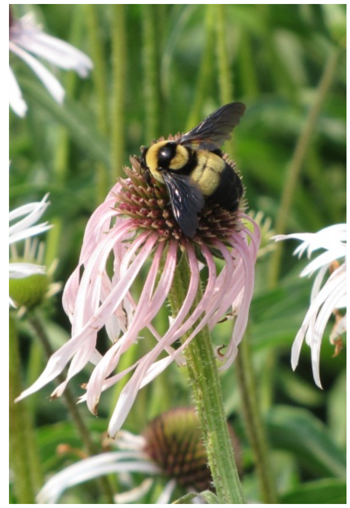
Existing Plant Composition

When assessing pollen and nectar resources, it is important to look at all of the potential plant resources on and around a landowner or farmer's property, and which plants are heavily visited by bees and other pollinators. These plants include insect-pollinated crops, as well as the flowers – even "weeds" – in buffer areas, forest edges, hedgerows, roadsides, natural areas, fallowed 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 grower 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 weed species that should be removed or controlled, producers might consider allowing some of the native or non-native forbs to bloom prior to their crop bloom, mow them during crop bloom, then let them bloom again afterward. For example, dandelions, clover, and other non-native plants are often good pollinator plants. Growers may also allow some salad and cabbage crops to bolt. In addition to pollinators, the predators and parasitoids of pests are attracted to the flowers of arugula, chervil, chicory, mustards, and other greens, supporting 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.

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.



Bumble bee (*Bombus fraternus*) on pale purple coneflower (*Echinacea pallida*). Courtesy Jennifer Hopwood/Xerces Society

Nesting and Overwintering Sites

Bees need nest sites. Indeed, for supporting populations of native bees, protecting or providing nest sites is as important, if not more important, as providing flowers. Similarly, caterpillar hostplants are necessary for strong butterfly populations, if that is a management goal.

The ideal is 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 too far apart.

Native bees often nest in inconspicuous locations. For example, many excavate tunnels in bare soil, others occupy tree cavities, and a few even chew out the soft pith of the stems of plants like elderberry or blackberry to make nests. It is important to retain as many naturally occurring sites as possible and to create new ones where appropriate.

Most of North America's native bee species (about 70 percent or very roughly 2,800 species) are ground nesters. 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 poor quality sandy or loamy soils may provide fine sites. The great majority of ground-nesting bees are solitary, though some will share the nest entrance or cooperate to excavate and supply the nest. Still other species will nest independently, but in large aggregations with as many as 100s or 1000s of bees excavating nests in the same area.

Approximately 30 percent (around 1,200 species) of bees in North America are wood nesters. These are almost exclusively solitary. Generally, these 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 elderberry, raspberry, or sumac. 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 considered to be social bees. Each spring a queen founds an annual colony, which may grow to have between 25 and 400 bees by late summer. There are about 45 species in North America. Bumble bees nest in small insulated 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.

A secondary benefit of flower-rich foraging habitats is the provision of egg-laying sites for butterflies and moths. They lay their eggs on the plant on which their larvae will feed once it hatches. Some butterflies may rely on plants of a single species or genus for host-plants (e.g. monarch butterflies feed only on species of milkweed, *Asclepias* spp.), whereas others may exploit a wide range of plants, such as some swallowtails (*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, growers should first provide plants that can be used by a number of species. Later those plants can be supplemented with host-plants for more specialized species. Consult a book on your region's butterfly fauna to find out about species' specific needs.

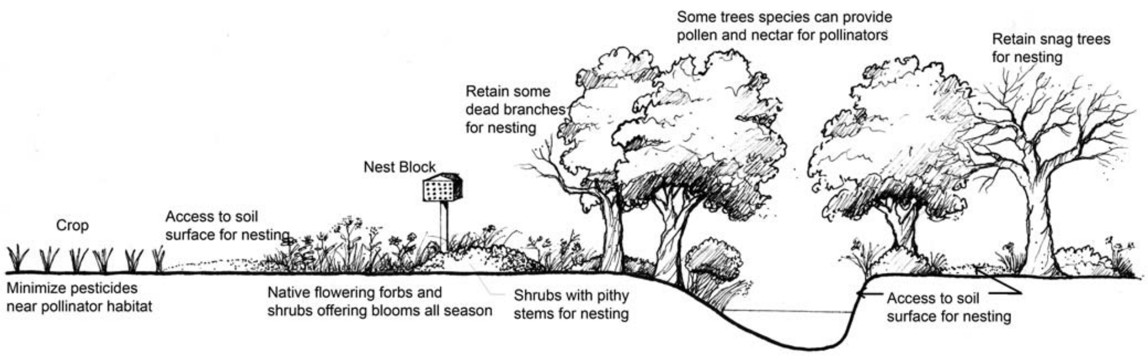


Figure 1. From: Agroforestry Note – 34: "Enhancing Nest Sites for Native Bee Crop Pollinators"

Table 1. General native pollinator habitat requirements.		
Pollinator	**Food**	**Shelter**
Solitary bees	Nectar and pollen	Most nest in bare or partially vegetated, well-drained soil; 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	Nectar and pollen	Most nest in small cavities (approx. softball size), often underground in abandoned rodent nests or under clumps of grass, but can be in hollow trees, bird nests, or walls
Butterflies and Moths – Egg	Non-feeding stage	Usually on or near larval host plant
Butterflies and Moths – Caterpillar	Leaves of larval host plants	Larval host plants
Butterflies and Moths – Pupa	Non-feeding stage	Protected site such as a bush, tall grass, a pile of leaves or sticks or, in the case of some moths, underground
Butterflies and Moths – 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, bush, tall grass, or a pile of leaves, sticks or rocks
Hummingbirds	Nectar, insects, tree sap, spiders, caterpillars, aphids, insect eggs, and willow catkins	Trees, shrubs, and vines. Typically need red, deep-throated flowers, such as twin berry or penstemons

[Adapted from: Native Pollinators. Feb. 2006. Fish and Wildlife Habitat Management Leaflet. No. 34.]

Part 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, farmers can take an active role in reducing mortality of the pollinators themselves. While insecticides are an obvious threat to beneficial insects like bees, other farm operations or disturbance, such as burning and tilling, can also be lethal to pollinators.

Minimizing Pesticide Use

Pesticides are detrimental to a healthy community of native pollinators. Insecticides not only kill pollinators, but sub-lethal doses can affect their foraging and nesting behaviors, often preventing pollination. 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.

If pesticides cannot be avoided, they should be applied directly on target plants to prevent drift, and broad-spectrum chemicals should be avoided if at all possible. Similarly, crops should not be sprayed while in bloom and fields should be kept weed free (or mowed just prior to insecticide applications) to discourage pollinators from venturing into the crop if it needs to be sprayed outside of the bloom period. Nighttime spraying, when bees are not foraging, is one way to reduce bee mortality. Periods of low temperatures may also be good for spraying since many bees are less active. However the residual toxicity of many pesticides tends to last longer in cool temperatures. For example, dewy nights may cause an insecticide to remain wet on the foliage and be more toxic to bees the following morning, so exercise caution.

In general, while pesticide labels may list hazards to honey bees, potential dangers to native bees are often not listed. For example, many native bees are much smaller in size than honey bees and affected by lower doses. Also, honey bee colonies may be covered or moved from a field, whereas wild natives will continue to forage and nest in spray areas.

The use of selective insecticides 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 that may become trapped in the pollen-collecting hairs of bees and consequently fed to developing larvae are more dangerous than liquid formulations. Alternatives to insecticides are also available for some pests, such as pheromones for mating disruption, and kaolin clay barriers for fruit crops.

Landowners who encourage native plants for pollinator habitat will inevitably be providing habitat that also will host many beneficial insects that help control pests naturally, and may come to depend less on pesticides.

In addition to providing pollinator habitat, windbreaks, hedgerows, and conservation headlands can be effective barriers to reduce pesticide drift from adjacent fields. Spray drift can occur either as spray droplets or vapors—as happens when a volatile liquid changes to a gas. Factors affecting drift include weather, application method, 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.

Midday 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. Similarly, during temperature inversions spray droplets become trapped in a cool lower air mass and move laterally above the ground. Inversions often occur when cool night temperatures follow high day temperatures, and are usually worst in 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. Optimal spray conditions for reducing drift occur when the air is slightly unstable with a very mild steady wind.

Spray application methods and equipment settings also strongly influence the potential for drift. Since small droplets are most likely to drift long distances, aerial applications and mist blowers should be avoided whenever possible. Standard boom sprayers should be operated at the lowest effective pressure and with the nozzles set as low as possible. For example, drop nozzles can 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. Select 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 your pesticide.

Minimizing the Impact of Mowing, Haying, Burning, or Grazing

Only a portion of pollinator habitat should be burned, mowed, grazed, or hayed at any one time in order to protect overwintering pollinators and foraging larvae and adults. This will allow for recolonization 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 or haying should be done only in the fall or winter.

Protecting Ground Nesting Bees

In order to protect nest sites of ground-nesting bees, tilling and flood-irrigating areas of bare or partially bare ground that may be occupied by nesting bees should be avoided. Grazing such areas can 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.

Entrances to these ground nesting bee nests resemble ant hills but have larger entrances.

Weed control alternatives to tillage include the use of selective crop herbicides, flame weeders, 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, raspberry, blackberry, box elder, and wild roses will go a long way towards supporting these solitary bees.

Part III
Enhancing and Developing New Pollinator Habitat

American bumble bee *(Bombus pensylvanicus)* on rattlesnake master (*Eryngium yuccifolium*). Courtesy Jennifer Hopwood/Xerces Society.

Landowners who want to take a more active role in increasing their 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 ("bee pastures"), demonstration gardens, orchard understory plantings, hedgerows and windbreaks with flowering trees and shrubs, riparian and rangeland re-vegetation efforts, flowering cover crops and green manures, and countless other similar efforts.

Where possible, locally native plants are often preferred for their ease of establishment, greater wildlife value, and their evolutionary mutualism with native pollinators. Recent research indicates that although bees will use some non-native species, they appear to prefer to forage on native plants. Non-native plants may be suitable, however, on disturbed sites, for specialty uses such as cover cropping, and where native plants are not available. Mixtures of native and non-native plants are also possible, so long as non-native species are naturalized and not invasive.

Site Selection

Site selection for installing new pollinator-enhancement habitat should begin with a thorough assessment of exposure 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 tend to be naturally dominated by grasses, which are of little food value to pollinators. North-facing slopes are often cooler and tend to be dominated by trees.

SUN EXPOSURE: Since some plants require full sun or shaded conditions to thrive, the planting design should allow for plants to remain in their preferred condition (sun-loving plants remain in full sun) as the habitat matures. Plantings can also be installed in several phases, for example allowing trees and shrubs to develop an over-story prior to planting shade-loving herbaceous plants below. Generally, plants will flower more, and thus provide greater amounts of nectar and pollen, when they receive more sunlight than when they are fully shaded.

SOIL CHARACTERISTICS: Soil type is also an important consideration when selecting a site, with some plants favoring particular soil textures such as sand, silt, clay, or loam. Drainage, salinity, pH, organic content, bulk density, and compaction are some of the other factors that will influence plant establishment. Many of these factors can be determined from local soil surveys, and the NRCS Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/). Planning should emphasize those plants that will be adapted for the particular soil conditions faced.

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 land. As the habitat matures, few if any inputs should be required, especially if native plants are selected. Similarly, previously cropped land may harbor soil borne pathogens that may inhibit plant development. Where such conditions exist, pathogen-resistant plant species should be considered. Conversely some soil microorganisms, such as rhizobium bacteria, are essential for the successful establishment of certain types of plants, legumes for example. If rhizobium bacteria are absent in the soil, specially inoculated seed is often available. Finally, many herbicides with soil activity can inhibit seed germination. These chemicals, soil pathogens, beneficial microorganisms, and soil fertility can all be tested for by state and extension soil laboratories.

ADJACENT LAND USE: Along with exposure and soil conditions, adjacent plant communities and existing land use activities should be considered. For example even if weeds are eliminated prior to planting, the presence of invasive plants adjacent to the restored habitat may result in a persistent problem that requires ongoing management. Adjacent cropland can also present a challenge unless the enhancement site is protected from herbicide drift.

USING MARGINAL LAND: Some otherwise marginal land, such as septic fields and mound systems, can be sites for pollinator plantings. While trees may be problematic on such sites, forbs will generally not penetrate pipes or clog systems. As an added benefit, plants on these sites may help absorb excess nutrients from wastewater. Ditches, field buffer strips, and waterways can also be planted with pollinator-friendly plants rather than turf grass.

SIZE AND SHAPE: The larger the planting area, the greater the potential benefit to pollinator species. An area considered for enhancement should be at least at least one half acre area in size, with a size of two acres 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.

Habitat Design

When designing a pollinator planting, first consider the overall landscape and how the new habitat will function with adjacent crops. 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.

Sunflowers are a prolific summer bee plant for Michigan.

LANDSCAPE CONSIDERATIONS: The first step in habitat design should be a consideration of how the area can work with adjacent landscape features.

For example, is the new habitat area located close enough to crops requiring pollination to be of significant value? Remember that 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. Thus, crops that depend heavily upon bumble bees for pollination, such as cranberries or blueberries, can have pollinator habitat located some distance from the field. This sort of arrangement would minimize the encroachment into the crop by unwanted pollinator plants while still supporting a strong local population of bees.

Similarly, is the new habitat located near existing pollinator populations that can "seed" the new area? For example, fallow areas, existing wildlands, 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 stable ground, but lack the floral resources to support a large pollinator population. Be aware of these existing habitats and consider improving them with additional pollinator plants or nesting sites.

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 as well as varying plant heights and growth habits to encourage the greatest numbers and diversity of pollinators. Most bee species are generalists, feeding on a range of plants throughout their life cycle. Many others, including some important crop pollinators, only forage on a single family or even genus or species of plant.

Butterflies have a long tongue that can probe tubular flowers. Therefore, choose plants with a variety flower shapes in order to attract a diversity of pollinators. Color is another 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 spring, summer, and fall, habitat enhancements can support a wide range of pollinator species that fly at different times of the season.

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 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 thrive together.

The level of plant community diversity can be measured in several ways. One system used in managed woody plant ecosystems is the *10-20-30 Rule*. This rule states that a stable managed plant community (i.e., one able to resist insect and disease epidemics) should contain no more than 10% of a single plant species, no more than 20% of a single genera, and no more than 30% of a single family.

PLANT DENSITY AND BLOOM TIME: Plant diversity should also be measured by the number of plants flowering at any given time. Researchers in California have 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. Therefore, at least three different pollinator plants within each of three blooming periods are recommended (i.e., early, mid or late season). Under this plan at least nine blooming plants should be established in pollinator enhancement sites, although studies have shown that the diversity of bee species continues to increase with increasing plant diversity. Tables 2-6 and “Example of Seeding for Pollinators on Moderate Moisture Sites in Michigan” provide more information and illustrate this concept.

It is especially important to include plants that flower early in the season. Many native bees, such as bumble bees and some sweat bees, produce multiple generations 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.

Plant clusters of a single species when possible. Research suggests that clump-plantings of at least three foot by three foot blocks of an individual species (that form a solid block of color when in flower) are more attractive to pollinators than when a species is widely and randomly dispersed in smaller clumps. Even larger single-species clumps (e.g., a single species cluster of perennials or shrubs more than 25 square feet in size) may be more even ideal for attracting pollinators and providing efficient foraging.

INCLUSION OF NON-FLOWERING PLANTS: Herbaceous plantings should include at least one native bunch grass or sedge adapted to the site in addition to the three or more forbs from each of the three bloom-periods. This scenario results in a minimum of 10 plant species per planting. Strive for an herbaceous plant community that mimics a local native ecosystem assemblage of plant density and diversity (generally with a greater diversity of forbs) to maximize pollinator habitat. Most native plant communities generally contain at least one dominant grass or sedge in their compositions. These grasses and sedges often provide forage resources for beneficial insects (including larval growth stages of native butterflies), potential nesting sites for colonies of bumble bees, and possible overwintering sites for beneficial insects, such as predaceous ground beetles. The combination of grasses and forbs also form a tight living mass that will resist weed colonization. Grasses are also essential to produce conditions suitable for burning, if that is part of the long-term management plan.

Care should be taken however that grasses do not take over pollinator sites. Anecdotal evidence suggests that tall dominant grasses (such as big bluestem or switch grass) crowd out forbs more easily than shorter grasses, and that cool season grasses are more competitive against many forbs than warm season grasses. Seeding rates for grasses should also not exceed seeding rates for forbs. Fall (rather than spring) planting of the forbs will also favor forb development over warm season grasses.

Plant Selection and Seed Sources

Choose plants with soil and sunlight requirements that are compatible with the site where they will be planted. Tables 2-6 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.

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. Conversely, some common horticultural plants do not provide sufficient pollen or nectar rewards to support large pollinator populations. Similarly, non-native plants may become invasive and colonize new regions at the expense of diverse native plant communities.

Native plants are advantageous because they generally: (1) do not require fertilizers and require fewer pesticides for maintenance; (2) 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 local native biological diversity.

Using native plants in NRCS conservation practices also will help provide connectivity for native plant populations, particularly in regions with fragmented habitats. By providing connectivity of plant species across the landscape, the potential is increased for these species to move in the landscape in relation to probable future climatic shifts.

SEED SOURCES: Where possible, native plants and seed should be procured from "local eco-type" providers. Local eco-type refers to seed and plant stock harvested from a local source (often within a few hundred miles). Plants selected from local sources will generally establish and grow well because they are adapted to the local climatic conditions. Depending on the location, state or local regulations may also govern the transfer of plant materials beyond a certain distance (sometimes called *Seed Transfer Zones*). Similarly, where possible, commercially procured seed should be certified by the state Crop Improvement Agency. Seed certification guarantees a number of quality standards, including proper species, germination rate, and a minimum of weed seed or inert material.

TRANSPLANTS: In addition to seed, enhancement sites can be planted with plugs, or in the case of woody plants, container grown, containerized, bare-root, or balled and burlaped materials.

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

Woody plants may also undergo a period of transplant shock and need similar care. In general, container grown and balled and burlaped woody plants have a higher survival rate and are available in larger sizes. They are also generally 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.

AVOID NUISANCE PLANTS: When selecting plants, avoid ones that act as alternate or intermediate hosts for crop pests and diseases. For example, many rust fungi require two unrelated plant species to complete their life cycle. 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.

APPLICATIONS FOR NON-NATIVE PLANT MATERIALS: While in most cases native plants are preferred, non-native ones may be suitable for some applications, such as annual cover crops, buffers between crop fields and adjacent native plantings, or short-term low cost insectary plantings that also attract beneficial insects which predate or parasitize crop pests . For more information on suitable non-native plants for pollinators, see Table 4.

A mason bee closing the entrance to her nest with mud after laying a series eggs in the tube.

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 *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, the precise conditions needed by most other ground-nesting bees are not well known. However, landowners can create conditions suitable to a variety of species by 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 or sandy loam soils.

In general these constructed ground nest sites should receive direct sunlight, and dense vegetation should be removed regularly, making sure that some patches of bare ground are accessible. Once constructed, these nest locations should be protected from digging and compaction.

Colonization of these nest sites will depend upon which bees are already present in the area, 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 ½ 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.

Such blocks should be constructed of preservative-free lumber, and the depth of the hole should be at least 4 inches (up to 6 inches is even better). Holes should not be drilled all the way through the block, and should also be spaced at least ¾ inch apart so that bees returning to the block from foraging can easily find their own nest tunnel.

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.

In addition to wooden blocks, artificial nests can 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.

Extensive information constructing these types of nests is widely available. In order to be sustainable, artificial nests will need routine management, and regular cleaning to prevent the build-up of bee parasites and diseases.

Management and Maintenance

Many native plants require several seasons before their initial flowering. As they mature, bees, butterflies, and other pollinators like hummingbirds will become increasingly common. Habitat plantings for pollinators should remain undisturbed to the greatest extent possible throughout the growing season so that insects can utilize flower pollen and nectar resources (for adult stages) and vegetative parts of plants for food and cover resources (for immature/larval stages).

After establishment the primary maintenance activity will be the periodic removal of undesirable woody plants and herbaceous weeds. This is often performed through mowing or burning in the early spring prior to the emergence of desirable pollinator plants.

To protect dormant insects such as butterfly pupae, you should only mow or burn part of the planting in a single season. This should ideally be only one-fourth to one third of the overall area, on a three to five year rotation. No single area should be burned or mowed more frequently than every two years. This will allow for re-colonization of disturbed habitat from the surrounding area. To facilitate these limited burns, temporary firebreaks can be created as needed, or they can be designed into the planting from the beginning by planning permanent firebreaks using the NRCS Conservation Practice Standard 394, Firebreak, that separate the habitat into multiple sections.

For detailed information on long-term site maintenance for pollinator habitat, that addresses techniques for minimizing the impact of herbicide, fire, grazing, mowing and other management activities, download a copy of *Pollinators in Natural Areas: A Primer on Habitat Management* from http://www.xerces.org/pollinators-in-natural-areas-a-primer-on-habitat-management/

Pollinator Habitat and NRCS Practices

The Natural Resources Conservation Service supports the use of native species in many conservation practices that involve seeding or transplanting.

Selecting pollinator-friendly native species for these practices can provide added conservation benefits. Many conservation practices also can support the inclusion or management of nest sites for native bees.

Many of these practices have a purpose or consideration for enhancing wildlife (that can include pollinators). However, the enhancement for wildlife should not compromise the intended function of the practice. For example, plants attractive to pollinators could be used in a grassed waterway practice, but the planting should not interfere with the hydraulic function of the practice and objective of stabilizing the waterway against erosion.

Some practices that could include pollinator friendly supplements include:

Conservation Practice Name (Units)	**Code**	**Pollinator Notes**
Alley Cropping (Ac.)	311	Can include native trees or shrubs or row covers (e.g., various legumes) that provide nectar or pollen (see Agroforestry Note 33).
Conservation Cover (Ac.)	327	Can include diverse forbs (e.g., various legumes) to increase plant diversity and ensure flowers are in bloom for as long as possible, providing nectar and pollen throughout the season.
Conservation Crop Rotation (Ac.)	328	Can include rotation plantings that provide abundant forage for pollinators forbs [e.g., various legumes, buckwheat (*Fagopyrum* spp.), phacelia (*Phacelia* spp.), etc.]. Moving insect-pollinated crops no more than 750 feet (250 meters) during the rotation may help maintain local populations of native bees that have grown because of a specific crop or conservation cover. Growers may want to 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 eliminating, minimizing insecticides and/or using bee-friendly insecticides in cover crop rotations.
Constructed Wetland (Ac.)	656	Constructed wetlands can include plants that provide pollen and nectar for native bees and other pollinators. Possible plant genera with obligate or facultative wetland species include: *Rosa* spp., *Ribes* spp., *Salix* spp., *Rubus* spp., *Crataegus* spp., *Spiraea* spp., *Solidago* spp., *Cornus* spp. Look for appropriate wetland plants from these genera for your region.
Contour Buffer Strips (Ac.)	332	Can include diverse legumes or other forbs that provide pollen and nectar for native bees. In addition, the recommendation to mow only every two or three years to benefit wildlife also will benefit nesting bumble bees. To protect bumble bee nests, mowing should occur in the late fall when colonies have died for the year and queens are overwintering.
Cover Crop (Ac.)	340	Can include diverse legumes or other forbs that provide pollen and nectar for native bees. Look for a diverse mix of plant species that overlap in bloom timing to support pollinators throughout the year. Some examples of cover crops that are utilized by bees include clover (*Trifolium* spp.), phacelia (*Phacelia* spp.), and buckwheat (*Fagopyrum* spp.). Many “beneficial insect” cover crop blends include plant species that will also provide forage for pollinators.

Conservation Practice Name (Units)	Code	Pollinator Notes
Critical Area Planting (Ac.)	342	Can include plant species that provide abundant pollen and nectar for native bees and other pollinators.
Early Successional Habitat Development/Management (Ac.)	647	This management practice is important for maintaining prime open and sunny habitat for pollinators. Note: To minimize damage to pollinator populations, disturbance practices should be implemented only every two to three years and, ideally, on only 30 percent or less of the overall site. This allows for recolonization from non-treated habitat. For example, mowing or burning one-third of the site every two or three years, on a three-year cycle. In addition, when possible, disturbance practices should be implemented when most pollinators are inactive, such as in late fall or winter.
Field Border (Ft.)	386	Can include diverse legumes or other forbs that provide pollen and nectar for native bees. Strive for a mix of forbs and shrubs that come into bloom at different times throughout the year. Site management (e.g., mowing) should occur in the fall to minimize impacts on pollen and nectar sources used by pollinators. If a goal is to create potential nesting habitat for bees, mowing, combined with no tillage, can maintain access to the soil surface that may provide nesting habitat for ground-nesting solitary bees. Alternatively, allowing field borders to become overgrown (e.g., with native bunch grasses) may provide nesting habitat for bumble bees.
Filter Strip (Ac.)	393	Can include legumes or other forbs that provide pollen and nectar for native bees. Look for a diverse mix of plant species that come into bloom at different times throughout the year. Site management (e.g., mowing or burning) should occur in the fall to minimize impacts on pollinators.
Forage and Biomass Planting (Ac.)	512	Can include diverse legumes (e.g., alfalfa, clovers) or other forbs that, when in bloom, provide pollen and nectar for native bees.
Forest Stand Improvement (Ac.)	666	Can help maintain open understory and forest gaps that support diverse forbs and shrubs that provide pollen and nectar for pollinators. Standing dead trees may be kept or drilled with smooth 4- to 6-inch deep holes to provide nesting sites for bees.
Grassed Waterway (Ac.)	412	Can include diverse legumes or other forbs that provide pollen and nectar for native bees. In dry regions, these sites may be able to support flowering forbs with higher water requirements and thus provide bloom later in the summer.
Hedgerow Planting (Ft.)	422	Can include forbs and shrubs that provide pollen and nectar for native bees. Look for a diverse mix of plant species that come into bloom at different times throughout the year. Bee nesting sites also may be incorporated, including semi-bare ground or wooden block nests. Including strips of unmowed grasses and forbs along the edge of the hedgerow may provide nesting opportunities for bumble bees. This practice

Conservation Practice Name (Units)	Code	Pollinator Notes
		also can help reduce drift of pesticides onto areas of pollinator habitat.
Herbaceous Wind Barriers (Ft.)	603	Can include diverse forbs and shrubs that provide pollen and nectar for native bees. Look for a diverse mix of plant species that come into bloom at different times throughout the year.
Integrated Pest Management (Ac.)	595	Biological pest management can include plantings that attract beneficial insects that predate or parasitize crop pests. These plantings can also benefit pollinator species. Plants commonly used for pest management that also benefit bees include: yarrow (*Achillea* spp.), phacelia (*Phacelia* spp.), and sunflowers (Helianthus spp.). Can include legumes or other forbs that provide pollen and nectar for native bees. Look for a diverse mix of plant species that come into bloom at different times throughout the year.
Prescribed Burning (Ac.)	338	Can greatly benefit pollinators by maintaining open, early successional habitat. Note: It is best if (a) only 30% or less of a site is burned at any one time to allow for recolonization by pollinators from adjacent habitat and (b) if burning occurs when pollinators are least active, such as when most plants have senesced or in the fall.
Prescribed Grazing (Ac.)	528	Can help maintain late successional habitat and its associated flowering plants. Can help provide for a stable base of pollinator plant species. Note: Properly managed grazing can sustain and improve all pollinator forage (pollen and nectar sources) and potential nesting sites for ground-nesting and cavity-nesting bees. Provide rest-rotation in pastures/fields during spring and summer when pollinators are most active.
Residue and Tillage Management, No-Till/Strip Till/Direct Seed (Ac.)	329	Leaving standing crop residue can protect bees that are nesting in the ground at the base of the plants they pollinate. Tillage digs up these nests (located 0.5 to 3 feet underground) or blocks emergence of new adult bees the proceeding year.
Restoration and Management of Rare and Declining Habitats (Ac.)	643	Can be used to provide diverse locally grown native forage (forbs, shrubs, and trees) and nesting resources for pollinators. Many specialist pollinators that are closely tied to rare plants or habitats may significantly benefit from efforts to protect rare habitat. In addition, certain rare plants require pollinators to reproduce. Note: Pollinator plants should only be planted if they were part of the rare ecosystem you are trying to restore.
Riparian Forest Buffer (Ac.)	391	Can include trees, shrubs, and forbs especially chosen to provide pollen and nectar for pollinators. This practice also can help reduce drift of pesticides onto areas of pollinator habitat.

Conservation Practice Name (Units)	Code	Pollinator Notes
Riparian Herbaceous Cover (Ac.)	390	Can include diverse forbs that provide pollen and nectar for native bees. In drier parts of the U.S., many of these forbs flower in the late summer and fall, when forage is needed most.
Stream Habitat Improvement and Management (Ac.)	395	Plants chosen for adjoining riparian areas can include trees, shrubs, and forbs that provide pollen and nectar for pollinators. Maximizing plant diversity along riparian corridors will result in more pollinators and other terrestrial insects to feed fish in the streams.
Streambank and Shoreline Protection (Ft.)	580	If vegetation is used for streambank protection, plants can include trees, shrubs, and forbs [e.g., willow (*Salix* spp.), dogwood, (*Cornus* spp.) and goldenrod (*Solidago* spp.)] especially chosen to provide pollen and nectar for pollinators.
Stripcropping (Ac.)	585	Can include diverse legumes or other forbs that provide pollen and nectar for native bees. Also, if insect pollinated crops are grown, plants used in adjacent strips of vegetative cover may be carefully chosen to provide a complementary bloom period to the crop, such that the flowers available in the field are extended over a longer period of time.
Tree/Shrub Establishment (Ac.)	612	Can include trees and shrubs especially chosen to provide pollen and nectar for pollinators, or host plants for butterflies.
Upland Wildlife Habitat Management (Ac.)	645	Can include managing for pollinator forage or pollinator nest sites, such as nest blocks or snags for cavity nesting bees, or overgrown grass cover for bumble bees.
Wetland Enhancement (Ac.)	659	Wetland and adjacent upland 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. Some forbs used for enhancement will require pollinators to reproduce.
Wetland Restoration (Ac.)	657	Wetland and adjacent upland 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. Some forbs used for restoration will require pollinators to reproduce.
Wetland Wildlife Habitat Management (Ac.)	644	Wetland and adjacent upland 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.
Windbreak/Shelterbelt Establishment (Ft.)	380	Can include trees, shrubs, and forbs especially chosen to provide pollen and nectar for pollinators. Can also be a site to place nesting structures for native bees. Windbreaks and shelter belts also will help reduce drift of insecticides on to a site.

Windbreak/Shelterbelt Renovation (Ft.)	650	Can include trees, shrubs, and forbs especially chosen to provide pollen and nectar for pollinators. If appropriate, dead trees and snags may be kept or drilled with holes to provide nesting sites for bees.

Conversely, various pollinator requirements are supported by the following conservation practices:

Pollinator Resource	**Code and Conservation Practice Name (Units)**
Forage (diverse sources of pollen and nectar that support pollinators from early in the spring to late in the fall)	311 - Alley Cropping (Acres) 322 - Channel Bank Vegetation (Acres) 327 - Conservation Cover (Acres) 328 - Conservation Crop Rotation (Acres) 656 - Constructed Wetland (Acres) 332 - Contour Buffer Strips (Acres) 340 - Cover Crop (Acres) 342 - Critical Area Planting (Acres) 386 - Field Border (Feet) 393 - Filter Strip (Acres) 512 – Forage and Biomass Planting (Acres) 412 - Grassed Waterway (Acres) 422 - Hedgerow Planting (Feet) 603 - Herbaceous Wind Barriers (Feet) 595 - Pest Management (Acres) 409 - Prescribed Forestry (Acres) 528 - Prescribed Grazing (Acres) 643 - Restoration and Management of Rare and Declining Habitats (Acres) 391 - Riparian Forest Buffer (Acres) 390 - Riparian Herbaceous Cover (Acres) 395 - Stream Habitat Improvement and Management (Acres) 580 - Streambank and Shoreline Protection (Feet) 585 - Stripcropping (Acres) 612 - Tree/Shrub Establishment (Acres) 645 - Upland Wildlife Habitat Management (Acres) 659 - Wetland Enhancement (Acres) 657 - Wetland Restoration (Acres) 644 - Wetland Wildlife Habitat Management (Acres) 380 - Windbreak/Shelterbelt Establishment (Feet) 650 - Windbreak/Shelterbelt Renovation (Feet)
Nest sites (stable ground, holes in wood, cavities for bumble bees, or overwintering sites for bumble bee queens)	656 - Constructed Wetland (Acres) 332 - Contour Buffer Strips (Acres) 342 - Critical Area Planting (Acres) 386 - Field Border (Feet) 422 - Hedgerow Planting (Feet) 409 - Prescribed Forestry (Acres) 329 - Residue & Tillage Management, No-Till/Strip Till/Direct Seed (Acres) 643 - Restoration and Management of Rare and Declining Habitats (Acres) 391 - Riparian Forest Buffer (Acres) 612 - Tree/Shrub Establishment (Acres)

	645 - Upland Wildlife Habitat Management (Acres) 659 - Wetland Enhancement (Acres) 657 - Wetland Restoration (Acres) 644 - Wetland Wildlife Habitat Management (Acres) 380 - Windbreak/Shelterbelt Establishment (Feet) 650 - Windbreak/Shelterbelt Renovation (Feet)
Pesticide protection (refuge from spray, buffers to drift, etc.)	656 - Constructed Wetland (Acres) 342 - Critical Area Planting (Acres) 422 - Hedgerow Planting (Feet) 391 - Riparian Forest Buffer (Acres) 657 - Wetland Restoration (Acres) 380 - Windbreak/Shelterbelt Establishment (Feet)
Site management for pollinators	647 - Early Successional Habitat Development or Management (Acres) 595 – Integrated Pest Management (Acres) 338 - Prescribed Burning (Acres) 409 - Prescribed Forestry (Acres) 528 - Prescribed Grazing (Acres) 643 - Restoration and Management of Rare and Declining Habitats (Acres) 645 - Upland Wildlife Habitat Management (Acres) 644 - Wetland Wildlife Habitat Management (Acres)

Table 2A. Native wildflowers of dry sites in Michigan.			
Common Name	***Scientific Name***	**Bloom Color**	**Bloom Period**
Yarrow	*Achillea millefolium*	white	June-Aug.
Yellow Giant Hyssop*	*Agastache nepetoides*	yellow	July-Sept.
Leadplant*	*Amorpha canescens*	violet	June-July
Prairie Pussytoes	*Antennaria neglecta*	white	April-May
Prairie Milkweed*	*Asclepias sullivantii*	rose-purple	June-July
Common Milkweed*	*Asclepias syriaca*	rose-purple	June-Aug.
Butterfly Milkweed*	*Asclepias tuberosa*	orange	July-Aug.
Whorled Milkweed*	*Asclepias verticillata*	white	June-Sept.
White Wild Indigo	*Baptisia alba*	white	May-Sept.
False Boneset	*Brickellia eupatorioides*	white	Aug.-Sept.
Tall Bellflower	*Campanulastrum americanum*	blue	June-Aug.
Indian Paintbrush	*Castilleja coccinea*	red	May-July
New Jersey Tea*	*Ceanothus americanus*	white	May-Nov.
Partridge Pea*	*Chamaecrista fasciculata*	yellow	July-Sept.
Fireweed*	*Chamerion angustifolium*	pink	July-Aug.
Lance-Leaf Coreopsis*	*Coreopsis lanceolata*	yellow	May-Aug.
Prairie Coreopsis	*Coreopsis palmata*	yellow	June-July
Purple Prairie Clover*	*Dalea purpurea*	purple	May-Sept.
Canada Tick Trefoil*	*Desmodium canadense*	pink	July-Aug.
Sessileleaf Ticktrefoil	*Desmodium sessilifolium*	pink	July-Aug.
Purple Coneflower*	*Echinacea purpurea*	purple	July-Aug.
Rattlesnake Master*	*Eryngium yuccifolium*	white	July-Sept.
Flowering Spurge	*Euphorbia corollata*	white	June-Oct.
Prairie Smoke	*Geum triflorum*	pink-red	April-June
Woodland Sunflower	*Helianthus divaricatus*	yellow	July-Sept.
Maximilian Sunflower*	*Helianthus maximiliani*	yellow	Aug.-Oct.
Western Sunflower*	*Helianthus occidentalis*	yellow	Aug.-Sept.
Ox-Eye Sunflower	*Heliopsis helianthoides*	yellow	July-Sept.
Round-Headed Bushclover	*Lespedeza capitata*	white	Aug.-Sept.
Violet Bush-Clover	*Lespedeza violacea*	purple	July-Sept.
Slender Bush-Clover	*Lespedeza virginica*	purple	July-Sept.
Tall Blazingstar*	*Liatris aspera*	pink-purple	July-Sept.
Dotted Blazingstar*	*Liatris punctata*	pink-purple	July-Sept.
Prairie Blazingstar	*Liatris pycnostachya*	purple	July-Oct.
Northern Blazing Star*	*Liatris scariosa*	pink	Aug.-Sept.

Table 2A. Native wildflowers of dry sites in Michigan cont'd			
Common Name	***Scientific Name***	**Bloom Color**	**Bloom Period**
Pale Spiked Lobelia	*Lobelia spicata*	white-pale blue	June-Aug.
Wild Lupine	*Lupinus perennis*	blue-lavender	June-July
Wild Bergamot	*Monarda fistulosa*	pink-lavender	June-July
Dotted Mint*	*Monarda punctata*	pink	July-Sept.
Evening Primrose	*Oenothera biennis*	yellow	June-Sept.
Stiff Goldenrod*	*Oligoneuron rigidum*	yellow	July-Sept.
Hairy Penstemon*	*Penstemon hirsutus*	white-lavender	May-July
Downy Phlox	*Phlox pilosa*	pink	May-June
Solomon's Seal	*Polygonatum biflorum*	yellow-green	May-June
Prairie Cinquefoil*	*Potentilla arguta*	creamy	June-Aug.
Sweet Everlasting	*Pseudognaphalium obtusifolium*	white	Aug.-Nov.
Pinnate Prairie Coneflower	*Ratibida pinnata*	yellow	June-Sept.
Black-Eyed Susan	*Rudbeckia hirta*	yellow	June-Oct.
Rosin Weed*	*Silphium integrifolium*	yellow	July-Sept.
Compass Plant*	*Silphium laciniatum*	yellow	July-Sept.
Common Blue-Eyed Grass	*Sisyrinchium albidum*	blue	May-July
Hairy Goldenrod*	*Solidago hispida*	yellow	July-Oct.
Old Field Goldenrod*	*Solidago nemoralis*	yellow	July-Nov.
Showy Goldenrod*	*Solidago speciosa*	yellow	Aug.-Oct.
Bushy Aster*	*Symphyotrichum dumosum*	pink-purple	Aug.-Oct.
Heath Aster*	*Symphyotrichum ericoides*	white	July-Oct.
Smooth Aster*	*Symphyotrichum laeve*	lavender	Aug.-Sept.
Sky Blue Aster*	*Symphyotrichum oolentangiense*	blue	Aug.-Oct.
Spiderwort*	*Tradescantia ohiensis*	blue	April-June
Hoary Vervain*	*Verbena stricta*	purple	June-Sept.
Culver's Root*	*Veronicastrum virginicum*	white	June-Sept.

(*) Honey bee preferred forage.
Plant characteristics may differ within a species. Developed from various sources including USDA-NRCS PLANTS Database.

Table 2B. Native wildflowers of moderate moisture sites in Michigan.			
Common Name	***Scientific Name***	**Bloom Color**	**Bloom Period**
Leadplant*	*Amorpha canescens*	violet	June-July
Columbine	*Aquilegia canadensis*	red	May-June
Butterfly Milkweed*	*Asclepias tuberosa*	orange	July-Aug.
White Wild Indigo	*Baptisia alba*	white	May-Sept.
Common Beggar-Ticks	*Bidens frondosa*	yellow	Aug.-Oct.
Indian Paintbrush	*Castilleja coccinea*	red	May-July
Lance-Leaf Coreopsis*	*Coreopsis lanceolata*	yellow	May-Aug.
Canada Tick Trefoil*	*Desmodium canadense*	pink	July-Aug.
Purple Coneflower*	*Echinacea purpurea*	purple	July-Aug.
Rattlesnake Master*	*Eryngium yuccifolium*	white	July-Sept.
Wild Strawberry	*Fragaria virginiana*	white	April-June
Sawtooth Sunflower*	*Helianthus grosseserratus*	yellow	July-Oct.
Ox-Eye Sunflower	*Heliopsis helianthoides*	yellow	July-Sept.
Prairie Alum Root	*Heuchera richardsonii*	green	May-July
Prairie Blazingstar	*Liatris pycnostachya*	purple	July-Oct.
Blazingstar	*Liatris spp.*	purple	July-Sept.
Wild Lupine	*Lupinus perennis*	blue-lavender	June-July
Wild Bergamot	*Monarda fistulosa*	pink-lavender	June-July
Stiff Goldenrod*	*Oligoneuron rigidum*	yellow	July-Sept.
Foxglove Beardtongue*	*Penstemon digitalis*	white	May-June
Hairy Penstemon*	*Penstemon hirsutus*	white-lavender	May-July
Downy Phlox	*Phlox pilosa*	pink	May-June
Slender Mountain Mint*	*Pycnanthemum tenuifolium*	white	July-Sept.
Pinnate Prairie Conflower	*Ratibida pinnata*	yellow	June-July
Black-Eyed Susan	*Rudbeckia hirta*	yellow-brown	June-Aug.
Bushy Aster*	*Symphyotrichum dumosum*	pink-purple	Aug.-Oct.
New England Aster*	*Symphyotrichum novae-angliae*	rose-purple	Sept.-Oct.
Spiderwort*	*Tradescantia ohiensis*	blue	April-June
Missouri Ironweed*	*Vernonia missurica*	purple	July-Sept.
Culver's Root*	*Veronicastrum virginicum*	white	June-Sept.
Golden Alexander	*Zizia aurea*	yellow	April-June

(*) Honey bee preferred forage.
Plant characteristics differ among species within a genus and may differ within a species.
Developed from various sources including USDA-NRCS PLANTS Database.

Table 2C. Native wildflowers of wet sites in Michigan.

Common Name	Scientific Name	Bloom Color	Bloom Period
Swamp Milkweed*	*Asclepias incarnata*	lavender	July-Aug.
Common Beggar-Ticks	*Bidens frondosa*	yellow	Aug.-Oct.
Marsh Marigold	*Caltha palustris*	yellow	April-June
Indian Paintbrush	*Castilleja coccinea*	red	May-July
Purple Prairie Clover*	*Dalea purpurea*	purple	May-Sept.
Canada Tick Trefoil*	*Desmodium canadense*	pink	July-Aug.
Boneset*	*Eupatorium perfoliatum*	white	July-Aug.
Joe Pye-Weed*	*Eutrochium maculatum*	rose	July-Sept.
Sneezeweed*	*Helenium autumnale*	yellow	Aug.-Oct.
Giant Sunflower*	*Helianthus giganteus*	yellow	Aug.-Oct.
Sawtooth Sunflower*	*Helianthus grosseserratus*	yellow	July-Oct.
Wild Iris	*Iris virginica*	purple	June
Tall Blazingstar*	*Liatris aspera*	purple	July-Sept.
Prairie Blazingstar	*Liatris pycnostachya*	purple	July-Oct.
March Blazingstar*	*Liatris spicata*	purple	July-Sept.
Michigan Lily	*Lilium michiganense*	orange	July-Aug.
Cardinal Flower	*Lobelia cardinalis*	red	July-Sept.
Great Blue Lobelia	*Lobelia siphilitica*	blue-violet	Aug.-Sept.
Evening Primrose	*Oenothera biennis*	yellow	June-Sept.
Riddell’s Goldenrod*	*Oligoneuron riddellii*	yellow	Aug.-Oct.
Foxglove Beardtongue*	*Penstemon digitalis*	white	May-June
Obedient Plant	*Physostegia virginiana*	pink	June-Sept.
Black-Eyed Susan	*Rudbeckia hirta*	yellow-brown	June-Aug.
Wild Senna	*Senna hebecarpa*	yellow	July-Aug.
Cup Plant*	*Silphium perfoliatum*	yellow	July-Sept.
Showy Goldenrod	*Solidago speciosa*	yellow	Aug.-Oct.
Bushy Aster*	*Symphyotrichum dumosum*	pink-purple	Aug.-Oct.
Panicled Aster*	*Symphyotrichum lanceolatum*	white-blue	Aug.-Oct.
New England Aster*	*Symphyotrichum novae-angliae*	rose-purple	Sept.-Oct.
Blue Vervain*	*Verbena hastata*	purple-blue	July-Sept.
Culver's Root*	*Veronicastrum virginicum*	white	June-Sept.
Golden Alexander	*Zizia aurea*	yellow	April-June

(*) Honey bee preferred forage.
Plant characteristics differ among species within a genus and may differ within a species.
Developed from various sources including USDA-NRCS PLANTS Database.

Table 2D. Native wildflowers of woodland and woodland edge sites in Michigan.

Common Name	***Scientific Name***	**Bloom Color**	**Bloom Period**
Columbine	*Aquilegia canadensis*	red	May-June
Jack in the Pulpit	*Arisaema triphyllum*	green-purple	April-June
Common Milkweed*	*Asclepias syriaca*	rose-purple	June-Aug.
Butterfly Milkweed*	*Asclepias tuberosa*	orange	July-Aug.
Fireweed*	*Chamerion angustifolium*	pink	July-Aug.
Big-Leaved Aster	*Eurybia macrophylla*	violet-blue	Aug.-Sept.
Wild Geranium	*Geranium maculatum*	lavender	April-May
Woodland Sunflower	*Helianthus divaricatus*	yellow	July-Sept.
Spotted Touch-Me-Not	*Impatiens capensis*	orange	July-Sept.
Turk's-Cap Lily	*Lilium michiganense*	orange	July-Aug.
Cardinal Flower	*Lobelia cardinalis*	red	July-Sept.
Wild Lupine	*Lupinus perennis*	blue-lavender	June-July
False Solomon's Seal	*Maianthemum racemosum*	white-pink	June-July
Solomon's Seal	*Polygonatum biflorum*	yellow	May-June
Large-Flowered Trillium	*Trillium grandiflorum*	white-pink	April-June

(*) Honey bee preferred forage.
Plant characteristics may differ within a species. Developed from various sources including USDA-NRCS PLANTS Database.

Table 3A. Native Michigan trees and shrubs for pollinators.

Common Name	*Scientific Name*	Wetland Indicator †	Bloom Color	Bloom Period	Mature Height (feet)	Shade Tolerance ‡	Drought Tolerance ‡	pH Minimum	pH Maximum	Salinity Tolerance ‡	Notes
Maple and Boxelder*	*Acer spp.*	FACW to UPL	range	spring	range to 100	M to T	range	3.7	7.9	N to M	10 species native to Michigan
Serviceberry*	*Amelanchier spp.*	FAC to FACU	white	spring	range to 36	T	L to M	4.5	7.5	N to L	10 species native to Michigan
Leadplant*	*Amorpha spp.*	OBL to FAC	purple	spring to summer	range to 15	range	M to H	5	8.5	L	False indigobush (*Amorpha fruticosa*) considered noxious
Sarsaparilla*	*Aralia spp.*	FAC to FACU	white	range	range to 50	range	M	5	7.2	N	small shrubs to trees
Birch	*Betula spp.*	OBL to FACU	yellow to brown	spring	range to 70	N to M	L to M	3	8.5	N to M	
New Jersey Tea*	*Ceanothus spp.*	?	range	spring	range to 100	M to T	M to H	4.3	8	N	
Buttonbush	*Cephalanthus occidentalis*	OBL	white	summer	15	T	M	4.7	8.6	L	
Redbud	*Cercis canadensis*	FACU to UPL	purple	spring	30	T	H	5	7.9	N	
Clematis	*Clematis spp.*	FAC to FACU	white	summer	range to 15	M	M	5	6.8	N	
Dogwood	*Cornus spp.*	FACW to FACU	white	spring	range to 40	M to T	range	4.8	7.8	N	10 species native to Michigan
Hazelnut	*Corylus spp.*	FACU to UPL	yellow to white	spring	15	M to T	M	4.8	7.5	N	
Hawthorn*	*Crataegus spp.*	OBL to FACU	pink to white	spring	range to 30	N	L	6.5	8	M	20+ species native to Michigan
Huckleberry	*Gaylussacia spp.*	FACU	white	spring	4	T	M	4.5	6.5	N	
Honeylocust*	*Gleditsia triacanthus*	FAC to FACU	yellow	spring	70	N	H	4.8	8	M	
Winterberry*	*Ilex verticillata*	OBL to FACW	white	spring	range to 15	I	L	4.5	7.5	N	
Juniper	*Juniperous spp.*	FAC to UPL	yellow to green	spring	range to 50	N to M	range	4.7	8	L to M	range from prostrate ground cover to tree

Table 3A. Native Michigan trees and shrubs for pollinators cont'd.

Common Name	Scientific Name	Wetland Indicator †	Bloom Color	Bloom Period	Mature Height (feet)	Shade Tolerance ‡	Drought Tolerance ‡	pH Minimum	pH Maximum	Salinity Tolerance ‡	Notes
Spicebush	*Lindera benzoin*	FACW	white	spring	12	I	L	4.5	6	N	plants dioecious (separate male and female plants) or polygamous
Tuliptree*	*Liriodendron tulipifera*	FAC to FACU	yellow	spring	120	I	L	4.5	6.5	L	
Hollyleaved Barberry	*Mahonia aquifolium*	UPL	yellow	spring	8	T	H	5	8	N	
Apple*	*Malus spp.*	?	range	spring	30	N	M to H	5	7.5	N	
Chokeberry*	*Photinia spp.*	FACW	white	spring	range to 15	T	M	4.4	6.5	Range	
Ninebark	*Physocarpus opulifolius*	FACW to UPL	purple	spring	10	I	H	4.5	6.5	N	
Cherry and Plum*	*Prunus spp.*	FAC to UPL	white to red	spring	range to 80	range	M to N	4	8.5	M to N	10+ species native to Michigan; wild plum (*P. americana* and *nigra*) can become invasive, spines may puncture tires
Oak	*Quercus spp.*	Range	yellow	spring	range to 100	I	range	4.3	7.5	M to N	20+ species native to Michigan
Sumac*	*Rhus spp.*	UPL	range	spring	range to 30	N to M	M to H	4.5	7.5	N to M	
Locust*	*Robinia spp.*	FAC to UPL	white	spring	range to 60	N	H	4.6	8.2	M	
Rose	*Rosa spp.*	Range	range	spring to summer	range to 16	range	range	4	7.5	N to M	10+ species native to Michigan
Bramble*	*Rubus spp.*	FACW to UPL	white	range	range to 6	range	range	4.5	7.5	N	20+ species native to Michigan
Willow*	*Salix spp.*	Range	yellow	spring	range to 100	range	L	4	8	Range	20+ species native to Michigan; dioecious (separate male and female plants); shrubs and trees

Table 3A. Native Michigan trees and shrubs for pollinators cont'd.

Common Name	Scientific Name	Wetland Indicator†	Bloom Color	Bloom Period	Mature Height (feet)	Shade Tolerance‡	Drought Tolerance‡	pH Minimum	pH Maximum	Salinity Tolerance‡	Notes
Elderberry	*Sambucus spp.*	FACW to FACU	white	spring to summer	15	I	M	5	8.9	N	
Sassafras	*Sassafras albidium*	FACU	yellow	spring	75	I	H	4.5	7.3	N	
Buffaloberry*	*Shepherdia spp.*	FACU to UPL	yellow	spring	range to 8	I	M to H	5.3	8	M to H	
Spirea	*Spiraea spp.*	FACW	range	spring to summer	4	I to M	L to M	4.3	7	N	
Basswood*	*Tilia americana*	FACU	yellow	spring	100	T	L	4.5	7.5	N	
Blueberry*	*Vaccinium spp.*	FACW to FACU	white	summer	range to 12	range	L to M	4.7	7.5	range	10+ species native to Michigan
Viburnum*	*Viburnum spp.*	FACW to UPL	white	range	range to 28	T	Range	4.5	7.5	N to L	10 species native to Michigan; Mapleleaf Viburnum (*Viburnum acerifolium*) flowering indeterminate

(*) Honey bee preferred forage.

†Wetland Indicators:

OBL	Obligate Wetland
FACW	Facultative Wetland
FAC	Facultative
FACU	Facultative Upland
UPL	Obligate Upland

‡Tolerance: N=none, L=low, M=medium, H=high, T=tolerant

Plant characteristics differ among species within a genus and may differ within a species. Developed from various sources including USDA-NRCS PLANTS Database.

Table 3B. Native Michigan bunchgrasses and grass-like plants for pollinator plantings.								
Common Name	***Scientific Name***	**Wetland Indicator**†	**Mature Height (feet)**	**Light Needs**	**Drought Tolerance**‡	**pH Minimum**	**pH Maximum**	**Salinity Tolerance**‡
Side-Oats Grama	*Bouteloua curtipendula*	UPL	3	sun to part shade	H	6	8	H
June Grass	*Koeleria macrantha*		2	sun to part shade	H	5.5	8	H
Little Bluestem	*Schizachyrium scoparium*	FACU-, FACU+	3	sun	H	5	7.5	H
Wool Grass	*Scirpus cyperinus*	FACW+, OBL	4	sun	L	5.5	7.5	H
Prairie Dropseed	*Sporobolus heterolepis*	UPL, FACU	3	sun	H	6	8	H

†Wetland Indicators:

OBL	Obligate Wetland	Almost always is a hydrophyte, rarely in uplands
FACW	Facultative Wetland	Usually is a hydrophyte but occasionally found in uplands
FAC	Facultative	Commonly occurs as either a hydrophyte or non-hydrophyte
FACU	Facultative Upland	Occasionally is a hydrophyte but usually occurs in uplands
UPL	Obligate Upland	Rarely is a hydrophyte, almost always in uplands

‡Tolerance: L=low, H=high

Plant characteristics may differ within a species.

Developed from various sources including USDA-NRCS PLANTS Database

Table 4. Plants for pollinators in Michigan gardens.										
Common Name	***Scientific Name***	**Bloom Color**	**Bloom Period**	**Mature Height (feet)**	**Light Needs**	**Drought Tolerance**†	**pH Minimum**	**pH Maximum**	**Salinity Tolerance**†	**Annual or Perennial**
Yarrow	*Achillea millefolium*	white	mid to late	3	sun	H	5	6.5	H	P
Korean Hummingbird Mint*	*Agastache rugosa*	purple	mid	4	sun to part shade	L	6	8	L	P
Anise Hyssop*	*Agastache rupestris*	purple	mid	4	sun to part shade	L	6	8	M	P
Borage*	*Borago officinalis*	blue	early	2	sun	L	6	7.5	M	A
Calliopsis	*Coreopsis tinctoria*	yellow	mid to late	3	sun	H	6	7.5	L	A
Cosmos	*Cosmos bipinnatus*	variable	late	5	sun	H	6.5	8.5	M	A
Purple Coneflower*	*Echinacea purpurea*	purple	mid	4	sun	M	6	8	M	p
Globe Thistle*	*Echinops ritro*	blue	mid to late	5	sun	H	5	6		P
Sea Holly*	*Eryngium spp.*	blue	mid	2	sun	M	6.5	8	L	P
Fennel	*Foeniculum vulgare*	yellow	mid	2	sun	L	7	8	L	P
Sunflower*	*Helianthus annuus*	yellow	late	3	sun	M	5.5	8	M	A
Lavender*	*Lavandula spp.*	purple	early to late	3	sun	M	6.5	7.5	M	P
Horehound	*Marrubium vulgare*	white	early to mid	3	sun	L	6	8	L	P

Table 4. Plants for pollinators in Michigan gardens cont'd.

Common Name	*Scientific Name*	Bloom Color	Bloom Period	Mature Height (feet)	Light Needs	Drought Tolerance‡	pH Minimum	pH Maximum	Salinity Tolerance‡	Annual or Perennial
Chamomile	*Matricaria recutita*	white	early	0.5	sun	M	5.5	7.5		A
Spearmint*	*Mentha spicata*	white or pink	mid	1	sun	L	6.5	7	L	P
Bergamot (Bee Balm)	*Monarda spp.*	blue	early to mid	4	sun to part shade	M	6	8	L	P
Catmint*	*Nepeta spp.*	white or blue	mid	1	sun to part shade	M	6	8	L	P
Basil	*Ocimum spp.*	white	mid	1	sun	M	4	8	L	A
Oregano*	*Origanum spp.*	pink	mid	1	sun	H	6.5	8	M	P
Penstemon*	*Penstemon spp.*	purple	early to mid	3	sun to shade	M	6	9	H	P
Russian Sage*	*Perovskia atriplicifolia*	blue	mid	5	sun	M	6	7.5	H	P
Tansy Phacelia*	*Phacelia tanacetifolia*	purple	early	1	sun	H	6	7.5	M	A
Japanese Pieris	*Pieris japonica*	white	early	8	part shade	L	5.5	7.5	L	P
Azalea	*Rhododendron* spp.	pink, purple, white	early	3	sun to part shade	L	5.5	7	L	P
Rosemary*	*Rosmarinus officinalis*	blue	late	3	sun	H	6.5	7.5	M	P

Table 4. Plants for pollinators in Michigan gardens cont'd.										
Common Name	***Scientific Name***	**Bloom Color**	**Bloom Period**	**Mature Height (feet)**	**Light Needs**	**Drought Tolerance†**	**pH Minimum**	**pH Maximum**	**Salinity Tolerance†**	**Annual or Perennial**
Siberian Squill*	*Scilla siberica*	blue	early	0.5	part sun to full shade	M	5.5	8	L	P
Thyme	*Thymus spp.*	pink	mid	1	sun	M	6.5	8	M	P
Mexican Sunflower*	*Tithonia rotundifolia*	orange	mid to late	6	sun	M	6	8	M	A

(*) Honey bee preferred forage.

†Tolerance: N=none, L=low, M=moderate, H=high

Plant characteristics differ among species within a genus and may differ within a species. Developed from various sources including USDA-NRCS PLANTS Database.

Table 5. Insectary and pollinator friendly cover crops for Michigan.								
Common Name	***Scientific Name***	**Flower Color**	**Life Cycle**	**Drought Tolerance**[‡]	**Shade Tolerance**[‡]	**Flood Tolerance**[‡]	**Preferred pH**	**Planting Season**
Oriental Mustard*	*Brassica juncea*	yellow	winter annual, cool season annual	Very good	Good	Fair	5.5-7.5	spring, late summer
Rapeseed, Rape, Canola*	*Brassica napus*	yellow	winter annual	Good	Good	Fair	5.5-8.0	fall, spring
Forage Turnip*	*Brassica rapa*	yellow	bienniel	Fair	Fair	Fair	6.0-7.0	summer
Buckwheat*	*Fagopyrum esculentum*	white	summer annual	Poor	Fair	Fair	5.0-7.0	spring to late summer
Alfalfa*	*Medicago sativa*	purple (ssp. *falcata* yellow)	perenniel	Excellent	Fair	Poor	6.8-7.5	spring, summer
Sweet Clover*	*Melilotus spp.*	yellow or white	bienniel, summer annual	Excellent	Fair	Fair	6.5-7.5	spring, summer
Field Pea	*Pisum sativum*	reddish purple or white	winter annual	Good	Fair	Fair	6.0-7.0	fall, early spring
Oilseed Radish*	*Raphanus sativus*	white	cool season annual	Fair	Good	Fair	6.0-7.5	spring, late summer, early fall
Crimson Clover*	*Trifolium incarnatum*	red	winter annual, summer annual	Fair	Very good	Fair	5.5-7.0	summer
Red Clover	*Trifolium pretense*	red	short-lived perennial, bienniel	Very good	Good	Good	6.2-7.0	early spring, late summer
Hairy Vetch*	*Vicia villosa*	purple to blue	winter annual, cool season annual	Good	Good	Fair	5.5-7.5	early fall, early spring

(*) Honey bee preferred forage.

[†]Drought, Shade, or Flood Tolerance:

Excellent	(darkest shading)
Very good	(dark grey shading)
Good	(medium grey shading)
Fair	(light grey shading)
Poor	(no shading)

Web-based sources for Table 5:

http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

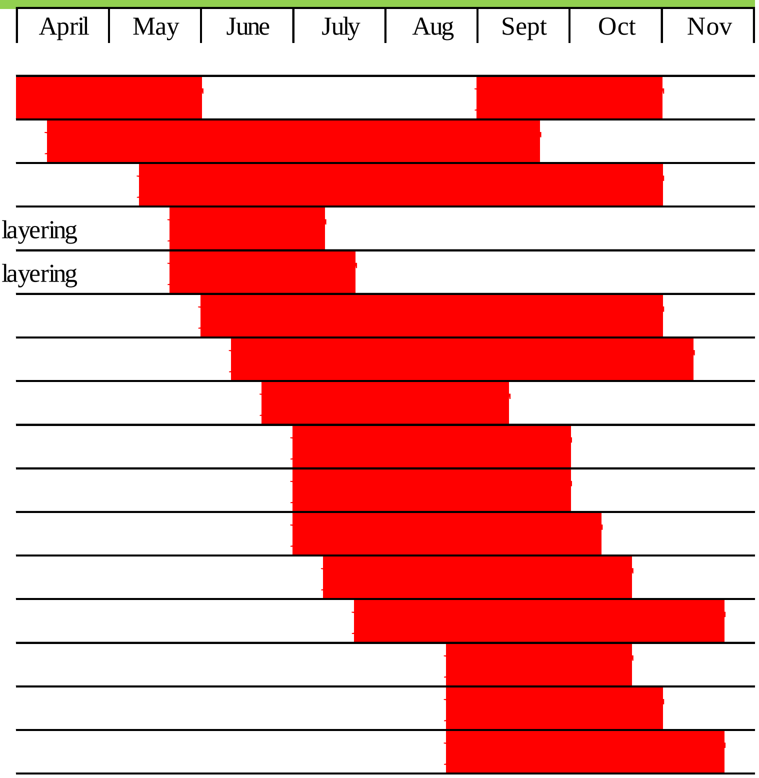
http://mcccdev.anr.msu.edu/VertIndex.php

http://plants.usda.gov/

Table 6A. Bloom period and spread of wildflowers at USDA-NRCS Rose Lake PMC, E. Lansing, MI.

Common Name	Scientific name	Spread?† Yes/No	Means of Propagation‡
Wild Strawberry	*Fragaria virginiana*	Y	seed, rhizomes, stolons
Golden Alexander	*Zizia aurea*	Y	seed, cutting, division
Spiderwort	*Tradescantia ohiensis*	N	seed, cutting, division
Hairy Penstemon	*Penstemon hirsutus*	N	seed, basal cutting, division, layering
Foxglove Beardtongue	*Penstemon digitalis*	N	seed, basal cutting, division, layering
Purple Coneflower	*Echinacea purpurea*	Y	seed, basal cutting
Black-Eyed Susan	*Rudbeckia hirta*	Y	seed, cutting
Butterfly Milkweed	*Asclepias tuberosa*	N	seed, root cutting, rhizomes
Wild Bergamot	*Monarda fistulosa*	Y	seed, cutting, division
Culver's Root	*Veronicastrum virginicu*	N	seed, cutting, division
Missouri Ironweed	*Vernonia missurica*	N	seed, sprig
Yellow Giant Hyssop	*Agastache nepetoides*	Y	seed, cutting
Showy Goldenrod	*Solidago speciosa*	N	seed, rhizomes
Riddell's Goldenrod	*Oligoneuron riddellii*	N	seed, rhizomes
New England Aster	*Symphyotrichum novae-*	N	seed, cutting
Hairy Goldenrod	*Solidago hispida*	N	seed, rhizomes

Bloom Period§



†Did plant spread beyond 2008 planting as evaluated during and after 2012 growing season?

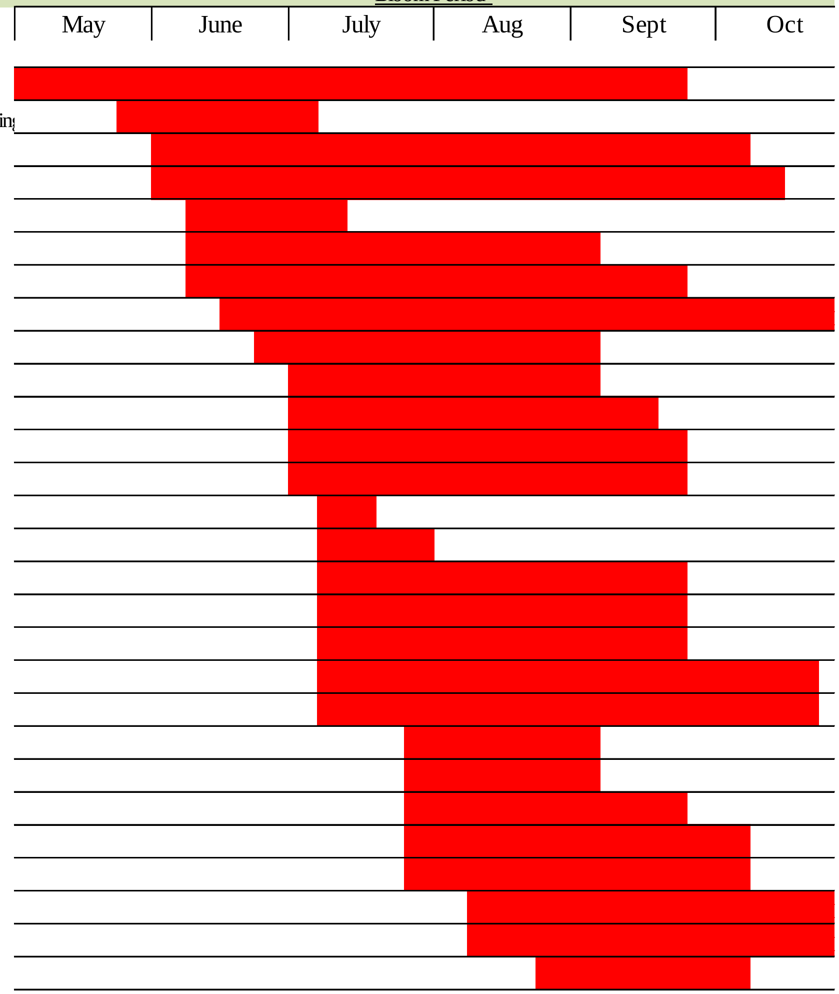
‡Means of propagation as indicated by various sources including USDA-NRCS PLANTS Database.

§Bloom periods evaluated in 2009-12. Aggregated bloom periods as shown here are longer than bloom periods in any single year.

Table 6B. Bloom period and spread of wildflowers at USDA-NRCS Rose Lake PMC, E. Lansing, MI.

Common Name†	*Scientific Name*	Means of Propagation‡
Golden Alexander	*Zizia aurea*	seed, cutting, division
Foxglove Beardtongue	*Penstemon digitalis*	seed, basal cutting, division, layerin
Spiderwort	*Tradescantia ohiensis*	seed, cutting, division
Lance-Leaf Coreopsis	*Coreopsis lanceolata*	seed, division
Poke Milkweed	*Asclepias exaltata*	seed
Narrowleaf Evening Primrose	*Oenothera fruticosa*	seed, cutting, division
Pale Spiked Lobelia	*Lobelia spicata*	seed, rosette division
Tall Thimbleweed	*Anemone virginiana*	seed
Butterfly Milkweed	*Asclepias tuberosa*	seed, root cutting, rhizomes
Hoary Vervain	*Verbena stricta*	seed
Flowering Spurge	*Euphorbia corollata*	seed, root cutting, clump division
Wild Bergamot	*Monarda fistulosa*	seed, cutting, division
Virginia Mountainmint	*Pycnanthemum virginianum*	seed
Pale Indian Plantain	*Arnoglossum atriplicifolium*	seed, division
Canada Germander	*Teucrium canadense*	seed, bulb
Illinois Ticktrefoil	*Desmodium illinoense*	seed
Stiff Ticktrefoil	*Desmodium obtusum*	seed
Sessileleaf Ticktrefoil	*Desmodium sessilifolium*	seed
Showy Goldenrod	*Solidago speciosa*	seed, rhizomes
Missouri Ironweed	*Vernonia missurica*	seed, sprig
Hairy Lespedeza	*Lespedeza hirta*	seed
Canada Tick Trefoil	*Desmodium canadense*	seed
Yellow Giant Hyssop	*Agastache nepetoides*	seed, cutting
Tall Tickseed	*Coreopsis tripteris*	seed, division
Hairy Goldenrod	*Solidago hispida*	seed, rhizomes
Common Blue Wood Aster	*Symphyotrichum cordifolium*	seed, bare root
Skyblue Aster	*Symphyotrichum olentangiense*	seed, root division
Bigleaf Aster	*Eurybia macrophylla*	seed, sprigs, bare root

Bloom Period§



†Collected at Ft. Custer Training Center in SW Lower Michigan.
‡Means of propagation as indicated by various sources including USDA-NRCS PLANTS Database.
§Bloom periods evaluated in 2009-10. Aggregated bloom periods as shown here may be longer than bloom period in any single year.

Example of Seeding for Pollinators on Moderate Moisture Sites in Michigan

The example seed mix below was developed with wildflower species listed in Table 2B. It has 25 Pure Live Seeds (PLS)/ft^2 of forbs and legumes and 19 PLS/ft^2 of grasses. Bloom is spread throughout the season with a variety of bloom colors. This is just one of thousands of possibilities.

FORBS

Common Name	Scientific Name	PLS (oz/a)	Bloom Color	Bloom Period
Butterfly Milkweed	*Asclepias tuberosa*	6	orange	July-Aug.
White Wild Indigo	*Baptisia alba*	8	white	May-Sept.
Canada Tick Trefoil	*Desmodium canadense*	6	Purple	July-Aug.
Purple Coneflower	*Echinacea purpurea*	5	purple	July-Aug.
Rattlesnake Master	*Eryngium yuccifolium*	5	white	July-Sept.
Sawtooth Sunflower	*Helianthus grosseserratus*	2	yellow	July-Oct.
Prairie Blazingstar	*Liatris pycnostachya*	3	purple	July-Oct.
Wild Lupine	*Lupinus perennis*	8	blue-lavender	June-July
Wild Bergamot	*Monarda fistulosa*	2	pink-lavender	June-July
Stiff Goldenrod	*Oligoneuron rigidum*	3	yellow	July-Sept.
Foxglove Beardtongue	*Penstemon digitalis*	3	white	May-June
New England Aster	*Symphyotrichum novae-angliae*	3	rose-purple	Sept.-Oct.
Spiderwort	*Tradescantia ohiensis*	6	blue	April-June
Culver's Root	*Veronicastrum virginicum*	0.2	white	June-Sept.
	Total	**60.2 oz or 3.8 lbs**		

GRASSES

Common Name	Scientific Name	PLS (lbs/a)
Little Bluestem	*Schizachyrium scoparium*	3.4
	Total	**3.4 lbs**

Additional Information

In addition to this document, information on pollinator habitat conservation is available through a number of other publications, websites, and organizations.

Publications

Black, S.H., N. Hodges, M. Vaughan and M. Shepherd. 2008. Pollinators in Natural Areas: A Primer on Habitat Management http://www.xerces.org/pollinator-conservation-managing-habitat/

Mader., E., M. Shepherd, M. Vaughan, S.H. Black, and G. LeBuhn. 2011. Attracting Native Pollinators. Protecting North America's Bees and Butterflies. Storey Publishing. 371 pp.

US EPA and USDA. 1991. *Applying Pesticides Correctly: A Guide for Private and Commercial Applicators*.

USDA Agriculture Extension Service. USDA, NRCS and FS, Agroforestry Note – 32: "Agroforestry: Sustaining Native Bee Habitat for Crop Pollination," Vaughan, Mace and Black, Scott Hoffman. 2006. USDA National Agroforestry Center. http://www.unl.edu/nac/agroforestrynotes/an32g06.pdf

USDA, NRCS and FS, Agroforestry Note – 33: "Agroforestry: Improving Forage for Native Bee Crop Pollinators," Vaughan, Mace and Black, Scott Hoffman. 2006. USDA National Agroforestry Center. http://www.unl.edu/nac/agroforestrynotes/an33g07.pdf

USDA, NRCS and FS, Agroforestry Note – 34: "Enhancing Nest Sites for Native Bee Crop Pollinators," Vaughan, Mace and Black, Scott Hoffman. 2006. USDA National Agroforestry Center. http://www.unl.edu/nac/agroforestrynotes/an34g08.pdf

USDA, NRCS and FS, Agroforestry Note – 35: "Pesticide Considerations for Native Bees in Agroforestry," Vaughan, Mace and Black, Scott Hoffman. 2007. USDA National Agroforestry Center. http://www.unl.edu/nac/agroforestrynotes/an35g09.pdf

USDA, NRCS. Idaho Plant Material Technical Note #2, "Plants for Pollinators in the Intermountain West" ftp://ftp-fc.sc.egov.usda.gov/ID/programs/technotes/pollinators07.pdf

USDA-BLM. 2003. Technical Reference 1730-3. "Landscaping with Native Plants of the Intermountain Region." 47pp.

USDA-NRCS. 2001. "Creating Native Landscapes in the Northern Great Plains and Rocky Mountains." 16p. http://www.mt.nrcs.usda.gov/technical/ecs/plants/xeriscp/

USDA-NRCS. Fish and Wildlife Insights. See "Native Pollinators", "Butterflies", "Bats", and "Ruby-throated Hummingbird" Fish and Wildlife Habitat Management Leaflet Numbers 34, 15, 5, and 14 respectively. http://www.whmi.nrcs.usda.gov/wps/portal/nrcs/detail/national/plantsanimals/fishwildlife/pub/?cid=stelprdb1043427

USDA-NRCS. Conservation Security Program Job Sheet: "Nectar Corridors," Plant Management EPL 41. www.wv.nrcs.usda.gov/programs/csp/06csp/JobSheets/nectarCorridorsEL41.pdf

Vaughan, M., M. Shepherd, C. Kremen, and S. Black. 2007. *Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms. 2nd Ed.* Portland, OR: Xerces Society for Invertebrate Conservation. 44 pp. http://www.xerces.org/guidelines-farming-for-bees/

Web Sites & Information

1. POLLINATOR INFORMATION

- The Xerces Society Pollinator Conservation Program http://www.xerces.org/pollinator-conservation/
- Logan Bee Lab – list of plants attractive to native bees http://www.ars.usda.gov/Main/docs.htm?docid=12052
- Michigan State University Native Plants and Ecosystem Services http://nativeplants.msu.edu/
- Lady Bird Johnson Wildflower Center's Native Plant Information Network, Database of plants for pollinators: http://www.wildflower.org/collections/
- Pollinator friendly practices http://pollinator.org/nappc/PDFs/PollinatorFriendlyPractices.pdf
- The Pollinator Partnership http://www.pollinator.org/
- USDA-ARS Logan Bee Lab www.loganbeelab.usu.edu
- USDA-NRCS Plant Materials Program http://plant-materials.nrcs.usda.gov/
- U.S. Fish & Wildlife Service Information http://www.fws.gov/pollinators/Index.html
- U.S. Forest Service Pollinator Information http://www.fs.fed.us/wildflowers/pollinators/index.shtml
- Urban bee gardens http://nature.berkeley.edu/urbanbeegardens/index.html

2. HABITAT RESTORATION WITH NATIVE PLANTS

- Considerations in choosing native plant materials http://www.fs.fed.us/wildflowers/nativeplantmaterials/index.shtml
- Selecting Native Plant Materials for Restoration http://extension.oregonstate.edu/catalog/pdf/em/em8885-e.pdf
- Native Seed Network http://www.nativeseednetwork.org/ has good species lists by ecological region and plant communities
- Prairie Plains Resource Institute has extensive guidelines for native plant establishment using agricultural field implements and methods http://www.prairieplains.org/restoration_.htm

Acknowledgements

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