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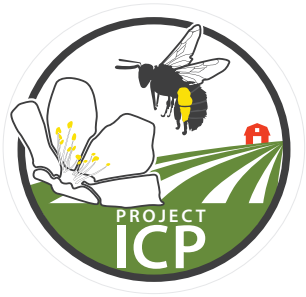
Establishing Wildflower Habitat to Support Pollinators of Michigan Fruit Crops

PROJECT ICP

MICHIGAN POLLINATOR INITIATIVE

MICHIGAN STATE UNIVERSITY | Extension

XERCES SOCIETY for Invertebrate Conservation



Integrated Crop Pollination (ICP) is the combined use of multiple pollinator species, habitat enhancements like wildflower plantings, and crop management practices that support bees, to provide reliable and economical pollination of crops. These pollination strategies are the focus of the Integrated Crop Pollination Project – a multi-year Coordinated Agricultural Project funded by the USDA-NIFA Specialty Crop Research Initiative. Members of the project team are investigating the performance, economics, and farmer perceptions of different pollination strategies in various fruit, nut, and vegetable crops.

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ESTABLISHING WILDFLOWER HABITAT TO SUPPORT POLLINATORS OF MICHIGAN FRUIT CROPS

Guidelines for Establishing Pollinator Habitat on Michigan Farms

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A long-horned bee (*Melissodes* sp.) foraging on cup plant (*Silphium perfoliatum*) in a western Michigan wildflower planting. *Photograph: Emily May, The Xerces Society.*

Acknowledgments

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Cover Photograph

Front: A common Eastern bumble bee (*Bombus impatiens*) visiting New England aster (*Symphyotrichum novae-angliae*) in a Michigan pollinator habitat planting. (Photograph: Emily May, The Xerces Society for Invertebrate Conservation)

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TIMELINE FOR ESTABLISHING WILDFLOWERS

Year 1

CHOOSE A SITE

Select a sunny site with manageable weeds that is protected from pesticide drift.

pg. 4

ERADICATE WEEDS

Prepare the site for seeding by killing existing weeds. This step takes time and is essential for success.

pg. 5

SELECT PLANT MIX

Choose a plant mix suitable for the site conditions and your goals for the planting.

pg. 7

SEED THE SITE

There are many different ways to efficiently and effectively seed a planting.

pg. 9

Year 2

MANAGE WEEDS

Mow or spot spray to control remaining weeds and create space for wildflowers to grow.

pg. 11

Year 3+

MAINTAIN OVER THE LONG TERM

Continue to monitor and manage problem weeds and woody plants as needed.

pg. 11

PLANTING WILDFLOWERS TO SUPPORT POLLINATORS OF MICHIGAN FRUIT CROPS

INTRODUCTION

A brown-belted bumble bee (*Bombus griseocollis*) visits blueberry flowers to collect pollen. *Photograph: Jason Gibbs, Michigan State University.*

Michigan is home to a wide variety of spring-blooming fruit crops. Nearly all of these crops require insect pollination in order to produce large, high-yielding fruit. Most Michigan fruit crops are pollinated by a combination of managed and wild bees. Honey bees (*Apis mellifera*) are often managed or rented from commercial beekeepers to provide on-demand crop pollination. Some growers purchase colonies of commercial bumblebees (*Bombus impatiens*) for pollinating early spring crops. In addition to these managed bees, there are dozens of species of wild bees that visit spring-flowering fruit crops like apples, cherries, and blueberries. Wild bee pollinators of Michigan fruit crops include several species of mining bees, bumblebees, and sweat bees.

Fruit crops benefit from having a diverse set of pollinators. Some wild bees, particularly large-bodied bees like bumblebees, are able to fly in cooler, cloudier conditions than honey bees, which can provide better pollination in variable spring weather conditions. In addition, unlike honey bees, many species of wild bees are able to "buzz pollinate" flowers. Once they land on a flower, these bees vibrate their wing muscles at a high frequency to release the pollen. Buzz pollination is particularly important for crops like blueberry, where the pollen is contained inside the anthers and not easily accessible like on apple or cherry flowers. Buzz-pollinating bees are highly efficient blueberry pollinators that can do the work of multiple honey bees in a day, buzzing pollen from flowers like salt from a salt shaker. Increasing the abundance and diversity of bees pollinating fruit fields and orchards can help to provide consistent pollination throughout bloom.

Wild bees are not directly managed in the same way that honey bees are, because they live freely in and around farms rather than in hives. However, their populations can be indirectly managed by maintaining natural areas that provide wild bees with food and shelter. Researchers at Michigan State University found that perennial wildflower plantings ranging from 0.2 to 2 acres in size increased

A mature perennial wildflower planting established on a Michigan blueberry farm. *Photograph: Emily May, The Xerces Society.*

wild bee abundance and diversity over time, and also increased wild bee visits to blueberry flowers in adjacent fields. This translated into yield benefits (10-20% greater weight of berries) that offset the costs of the wildflower plantings within four years. These plantings also provide pollen and nectar resources for honey bees present on the farm after crop bloom, making them a win-win strategy for managed and wild pollinators.

Perennial wildflower plantings have other economic, ecological, and aesthetic benefits besides providing resources for pollinators. These natural areas provide food and shelter for other beneficial insects, such as predatory insects that provide valuable pest control services. Perennial plantings can also help stabilize soil and reduce erosion, and can improve local surface water quality through better infiltration and reduced runoff. Plant mixes can be tailored to meet the needs and goals of the individual farm and planting site.

This guide provides step-by-step instructions for establishing a perennial wildflower planting to support pollinators of Michigan perennial fruit crops. There are many other ways to support these pollinators, including maintaining existing natural areas, minimizing bee exposure to toxic pesticides, and installing hedgerows with flowering trees and shrubs such as willow, redbud, and maple. The seed mix suggested in this guide (see *Appendix 2: Recommended Plant List*) is designed to support key pollinators for improved pollination. If other goals are identified (e.g. to support a diversity of rare pollinators) then additional strategies may be needed. For more information on ways to support pollinators on Michigan farms, see our list of resources at the end of this guide.

HOW DO WILDFLOWER PLANTINGS SUPPORT POLLINATORS?

Food

Female bees collect pollen and nectar from flowers to feed their offspring and to maintain their own energy levels when flying around. Although some bees are specialists, meaning they only collect the pollen from a specific type or group of flowers, most bees are generalists that collect pollen from many different types of flowers. Many generalist wild bees and a few specialist bees visit Michigan spring-flowering fruit crops for pollen and/or nectar. These wild bees need abundant, diverse flower communities close to their nests to provide food for their offspring. More abundant food locally means more offspring and more robust populations of wild crop pollinating bees.

Shelter

About 70% of wild bees nest in the soil, including most of the bees that pollinate spring fruit crops in Michigan. Soil-nesting bees tend to prefer nesting in undisturbed, well-drained areas with some bare soil surfaces. Wildflower plantings can provide ideal undisturbed nesting areas for bees that are close to the pollen and nectar resources they collect through the summer. Research on western Michigan blueberry farms found that more bees nest in the ground in wildflower plantings than other areas around the farm. Some bees were also found nesting in crop fields underneath blueberry bushes. Certain wildflowers and grasses also provide nesting materials for stem-nesting bees, which build nests in hollow or pithy plant stems.

Protection from pesticides

Many insecticides used to control pests in fruit crops are toxic to bees. Wildflower meadows planted away from crop fields can attract bees away from treated fields during the summer months and act as a refuge from pest management activity. Use drift mitigation methods to prevent harmful pesticides from drifting onto the wildflower plantings to protect bees living and foraging in those areas. Consider planting vegetative drift barriers between pollinator habitat and treated crop fields.

SITE SELECTION

WHAT TO CONSIDER WHEN CHOOSING A SITE

Selecting an appropriate site for establishing flowering pollinator habitat is critical for long-term success. Factors to consider when selecting a site to plant are listed below. When space is limited and the planting location is sub-optimal, extra site preparation and management may be needed to ensure a successful planting.

- **Evaluate existing weed pressure and identify problem weeds**. Some species of native wildflowers are weak competitors against weeds during the first year of growth, so pre- and post-planting weed management is an important step for reducing weed competition and allowing native wildflowers to germinate and establish. However, there are certain weeds that are very difficult to manage, which will undermine the success of a planting. A site dominated by one or more of these weeds will require very thorough pre-seeding weed eradication; consider alternative sites when possible *(see Appendix 1: Common Problem Weeds)*.

- **Look for sunny, well-drained areas.** Most native wildflower species require at least partial to full sun exposure during the day. The ideal areas for establishing habitat have well-drained soils with full sun exposure for at least half the day. If using solarization for site preparation, the area should have full sun exposure the entire day. Regardless of preparation method, avoid steep areas that are prone to erosion.

- **Optimal distance to field: not too close, not too far.** Avoid planting wildflower strips or meadows within 30 feet of a crop field in order to minimize pesticide drift onto the flowering area. Most bee pollinators, such as honey bees and bumblebees, can fly more than 150-300 feet from their nest or hive to forage on crop flowers, so the plantings do not need to be immediately adjacent to crop fields to realize pollination benefits.

- **Optimal size/shape of planting: large and square is best.** The larger the planting, the greater the benefits for pollinators. Ideally, the planting should be at least a half-acre in size and shaped more like a large square than a thin strip to minimize weed pressure.

Katharina Ullmann (The Xerces Society for Invertebrate Conservation), left, and Rufus Isaacs (Michigan State University), discuss site selection at a Michigan blueberry farm. *Photograph: Emily May, The Xerces Society.*

SITE PREPARATION

THE KEY TO A SUCCESSFUL PLANTING

Effective season-long weed management before seeding is essential for achieving good germination and wildflower establishment. It helps ensure long-term planting success and will reduce costly and labor intensive weed management after wildflowers are sown. If weeds are not managed before seeding, wildflowers will have a difficult time getting established and the planting will never reach its full potential.

At least one full season of weed control is needed for the common weeds that can undermine planting success. Do not rush weed management before seeding. Different weeds emerge and grow – and therefore must be controlled – at different times throughout the season. Depending on the weed growth habit (e.g. annual, biennial, or perennial seeds and rhizomes) and level of pre-existing weed pressure, particular management strategies may be necessary. Consult the MSU weed management website at www.msuweeds.com for more information on controlling difficult weed species.

There are many different options for site preparation. Use the one that is best suited to your farm and the weeds you are managing.

Removing solarization plastic used for weed control at the end of the season, just before seeding. *Photograph: Kerry Lynch.*

SITE PREPARATION METHODS

Herbicides

Herbicides are the most common weed control tool used to prepare a site for wildflower establishment. For effective weed control, first mow and rake off existing vegetation in early spring. Once new weed seedlings reach ankle height, apply a nonpersistent postemergent herbicide such as glyphosate per label instructions. As with any herbicide or other agricultural practice, runoff to waterways should minimized or avoided whenever possible. Starting management at the beginning of weed growth in the spring is key to controlling the cool season grasses that are dormant in mid-summer and will not be killed off by glyphosate at that time. Apply herbicide again every six weeks through the growing season, or whenever a new flush of weeds reaches ankle height. Avoid preemergent herbicides, as these will limit the germination of wildflowers in your seed mix. Be sure to wait long enough after the final herbicide application before seeding to avoid damage to wildflower seeds; this wait time is generally a few weeks, depending on the herbicide. Do not plant wildflowers in fields treated with atrazine or similarly persistent herbicides in the past two years.

Solarization

Solarization is a non-chemical weed control method that uses a layer of UV stabilized plastic (such as high tunnel greenhouse plastic) to 'cook' vegetation as well as most weed seeds in the topsoil with the

high temperatures generated underneath the plastic. This labor-intensive technique may be best for smaller plots. For effective solarization, clear existing vegetation off the site in early spring by mowing and raking, disk the site, then lay down the plastic. In the Great Lakes region, the plastic should be in place by the end of May. Bury the edges to prevent airflow underneath the plastic. Check for rips and tears throughout the growing season, and repair any rips using greenhouse plastic repair tape to prevent losses of temperature underneath the plastic. Remove the plastic in early to mid-October before temperatures cool down under the plastic. Before removing plastic be sure to remove any dead or living plants along the border that could drop seed into your treated plot. Take care not to spread untreated dirt used to bury the edges of the plastic over your treated plot. Solarization is not recommended for areas with Canada thistle. For sites with quackgrass or other rhizomatous grasses, make sure to remove plastic promptly in early fall, as these grasses can flourish under the plastic in late fall. Once the plastic is removed, seeds can be sown after the first killing frost. See *http://bit.do/solarizationvideo* for a video explaining the steps of the solarization process.

Smother crops

Smother crops can also be used to outcompete and suppress existing weeds. Year-round smother cropping is required to control weeds; for example, by planting buckwheat during the summer months followed by winter wheat. Glyphosate-resistant soybeans could also be used before seeding to allow herbicide application during the pre-seeding period. Two seasons of smother cropping are recommended for better control of biennial and perennial weeds, followed by minimal soil disturbance during seeding. If you do not have previous experience with these crops, consult with your local Extension office to determine the best strategy for your farm.

Raking vegetative debris off of a planting site using a harrow. *Photograph: Logan Rowe, Michigan State University.*

Do not till the soil after using any of the above weed control strategies. Tillage will bring dormant weed seeds in the soil up to the surface, where they will germinate and compete with wildflower seeds for soil, water, and light.

Repeated tillage

For some farms, repeated cultivation may be the only weed control method available. In early spring, mow or rake to clear off existing vegetation. Cultivate every two to three weeks as new flushes of weed seedlings emerge. Keep intervals between tillage short enough to prevent weeds from going to seed. Repeated tillage can lead to the formation of a compacted ('hardpan') layer of soil beneath the surface, so do not till when soils are overly moist to minimize compaction. This method may require two or more full seasons of weed management to be effective. Consult with your local Extension office to determine the optimal depth and frequency of tillage.

Each of these preparation techniques has pros and cons. For example, while solarization avoids the use of chemicals and can be used in an organic-certified setting, it is labor-intensive and creates plastic waste. Consider one's own farming ethics, ability to manage weeds before and after planting, and preferred installation method and timing when selecting your site preparation method. Also consider using multiple techniques together; for example, one round of tillage, followed by an herbicide application, followed by a full season of smother cropping prior to seeding. Consult with experts at your local native plant nursery, conservation district, Extension office, or NRCS office to determine the best strategy for your farm.

A sweat bee foraging on golden alexander (*Zizia aurea*). *Photograph: Sarah Foltz Jordan, The Xerces Society.*

Diverse flowering mixes that bloom through the season help support diverse and abundant wild bee populations. *Photograph: Kelly Gill, The Xerces Society.*

PLANT SELECTION

WHAT TO CONSIDER WHEN CHOOSING A SEED MIX

Wildflower mixes can be designed to meet many different goals and site needs. It can be helpful to consult with plant experts when designing a site-specific mix (*see Appendix 3: Additional Resources*). Some of the main considerations for creating a mix for crop pollinator habitat are below.

- **Provide season-long bloom to supply diverse pollen and nectar sources throughout the growing season.** Some bees have short life cycles that mostly overlap with spring crop bloom. These bees can be best supported by spring blooming shrubs and trees around the field. Many other bee species, including bumblebees and sweat bees, have longer life cycles or multiple generations in a single year. These bees stay active from early spring through early fall and need diverse and abundant flowering plant resources throughout the growing season in order to produce the offspring that will be present during crop bloom the next year. To ensure that they never experience a gap in food during the season, plant a seed mix that will provide flowers – and preferably more than one species –from just after crop bloom through fall.

- **Choose plants based on site conditions.** Plants have variable requirements for soil type and moisture, so tailor your seed mix to include plants that are well-adapted for the soil, moisture, and sun exposure conditions of the site. Native perennial wildflowers are typically the best long-term sources of nectar and pollen for wild native pollinators. Look for local seed sources that can supply local "ecotypes" of native wildflowers adapted to local soils and climate. These may also be better synchronized to bloom when their pollinators are active.

- **Choose a diverse mix of plants preferred by major crop pollinators.** See *Appendix 2: Recommended Plant List* (pages 16-17). These plants have been evaluated for their attractiveness to key spring pollinators and their ability to establish well in competitive mixes by Michigan State University researchers.

- **Grasses should not comprise more than 25% of the mix.** Native grasses and sedges can play an important role in perennial pollinator habitat. Native bunch grasses, such as big bluestem, Canada wild rye, and prairie dropseed, are used for nesting and overwintering habitat by bumblebees. They are also important to include in prairie plantings that will be burned for maintenance, as they provide fuel for the fire. However, grasses do not provide food for bees, and therefore they should only make up a minority of a pollinator habitat seed mix. Avoid sod-forming or creeping grasses, as these can suppress sown wildflowers.

- **Use optimal seeding rate.** The recommended seeding rate for a 75% wildflower/25% grass seed mix in Michigan is around 60 seeds or more per square foot, which translates into around 5 pounds or more of wildflower seed per acre. In Appendix 2 (pages 16-17), we provide a recommended plant mix for Michigan fruit crop pollinators including seeding rates. If you would like to develop your own mix, consult a local plant expert or seed vendor to help determine the best seeding rate for each species.

Plugs, Bare Roots, and Transplants

If time is limited but funds are not, already-germinated small plants, or "plugs," can be used to transplant seedlings into the site, helping to jump-start the bloom of a perennial planting. Plugs can be planted into a matrix of mulch or landscape fabric to control weeds.

Transplanting species that can be difficult to establish from seed, such as lupines and some bunchgrasses, can also be a useful addition to a sown wildflower meadow after the first year of mowing for weed management. This approach also works well for adding spring-blooming trees and shrubs along the edges of farm fields.

Drilling holes for transplants at Purple Sage Farm. *Photograph: Jennifer Miller.*

- **Include annuals to provide bloom in the first year, if desired.** Most perennial species will spend the first year after seeding building root systems, and will not produce flowers until the second year after seeding. If some bloom is desired in the first year, consider adding some annual flowers, such as partridge pea (*Chamaecrista fasciculata*), or fast-establishing perennials such as *Coreopsis* or *Rudbeckia* in the mix.

Grasses should comprise a low percentage of the seed mix to allow for a diversity of flowering forbs. *Photograph: Rufus Isaacs, Michigan State University.*

SEEDING

CHOOSING WHEN AND HOW TO GET SEEDS IN THE GROUND

There are many ways to effectively and efficiently seed a wildflower planting. Here are some of the options and additional considerations to ensure successful germination.

- **Dormant (frost) seeding.** For perennial wildflower plantings in Michigan, late fall planting (November-December) is typically the best time to seed. Most native wildflowers require several months of cold temperatures before they will germinate. By planting in the fall, the seeds will be worked into the soil by the freeze-thaw cycle and ready to emerge in the spring. Plant in late fall after frost kill to avoid the risk of seeds germinating in warm early fall weather and soils.

Hand broadcast seeding in late fall. *Photograph: Emily May, The Xerces Society.*

- **Spring seeding.** Seeds can also be successfully planted in early spring, but this will require some additional planning and preparation. Spring planting tends to favor quick-growing warm-season grasses over wildflowers, so you may want to reduce the proportion of grasses in the mix to account for this. In addition, wildflower species that require a cold, moist period before germination may need to be artificially cold stratified – for example, by placing the seeds in resealable plastic bags or other containers lined with moist paper towels in a refrigerator – for one to two months before seeding to prepare them for spring germination. Do not freeze. Grass seeds generally do not benefit from moist cold stratification. Sow seeds after the danger of frost has passed. Use care to avoid damaging tender cold-stratified seed cases during seeding. If the planting does not receive rain in the first week after spring sowing, irrigate to help with germination and early growth. If irrigation is not available for the planting, consider seeding the mix without artificial cold stratification; this will delay germination of some species until the following season, but will avoid issues with cold-stratified seeds that germinate quickly and then dry out without adequate rainfall.

- **Prepare seed bed for planting: minimize soil disturbance.** Do not till prior to seeding, as this will bring up weed seeds that will compete with the wildflowers for soil, light, and water. To prepare the soil, lightly remove debris using a rake or harrow to open up areas where seeds can make contact with the soil surface. The seedbed should have at least 50% bare ground for best results. Seeding is best done when the ground is not too moist or muddy.

Cultipacking to ensure seed-soil contact after seeding. *Photograph: Emily May, The Xerces Society.*

Loading a wildflower seed mix into a mechanical seeder. *Photograph: Katharina Ullmann, The Xerces Society.*

Seeding a wildflower planting with a mechanical drop seeder and cultipacker. *Photograph: Katharina Ullmann, The Xerces Society.*

SEEDING METHODS

Hand broadcast seeding

Seeds can be sown by hand or by using a hand-operated crank seeder or ATV-mounted seed spreader to scatter seeds across the planting area. This low-cost, easy method works best when seeds are mixed with an equal or greater volume of a bulking agent with similar grain size and density, such as cracked corn, polenta, sawdust, vermiculite, coarse sand, clay-based cat litter, or seed oats, to help distribute the small volume of seed mix evenly across a large area. Mix seed and bulking agent well. Consider seeding large and small seeds in separate batches. To avoid running out, divide the planting and seed mix into equal sections. Broadcast half of each batch back and forth horizontally in its section, then seed the remaining half vertically to ensure even spread. It's better to have some seed left over at the end and to reseed than to run out partway through the planting.

Mechanical seeding

No-till drills or large drop seeders can also be used to seed a planting. These are best used by someone with experience calibrating and operating them. With proper calibration, you may not need to add a bulking agent to wildflower seeds for mechanical seeding. Check seed distribution from the drill or drop seeder at regular intervals to ensure that seeds are sown evenly across the planting area. Make sure that you are also able to calibrate the depth at which seeds are sown. Seeds should be sown at very shallow depth to provide seed to soil contact, but without burying them too deep to germinate (no deeper than ¼ inch). It is better to sow seeds too shallow than too deep. Most conservation district offices have no-till drills available to loan or rent and can connect you with local expertise. Other mechanical options are available for seeding in addition to no-till drills. Consult local resources and professionals for advice.

After seeding

- **Ensure good seed-to-soil contact after planting.** If broadcasting seed by hand or with a drop seeder, use a cultipacker or lawn roller to tamp seeds into the top layer of soil after seeding. This will ensure that seeds receive the soil contact needed for germination. Do not disk, harrow, or cover sown seeds with additional soil or mulch; they will germinate best on the soil surface. This step is not necessary if using a no-till drill.

- **Post-seeding irrigation is usually not necessary.** Unless the area is experiencing drought conditions, most Michigan-native wildflowers will not need additional watering to germinate. Irrigation may be necessary if artificial cold stratification is used for spring-seeded mixes.

POST-SEEDING MAINTENANCE

MANAGING WEEDS AS WILDFLOWERS BEGIN TO GROW

Wildflower plantings often look very weedy in the first few years, but will gradually transition to more wildflowers and fewer weeds. While pre-seeding weed control is the major factor in successful wildflower establishment, post-planting maintenance is also critical. Regular high mowing in the first season after planting will help prevent weeds from going to seed and will allow sunlight to penetrate down to where the low-growing wildflowers are establishing root systems. In the second year, mow only when necessary (e.g., when weeds are about to flower). After the third year, only periodic maintenance in the form of high mowing or burning to eliminate trees and shrubs should be necessary to maintain the wildflower planting.

MAINTENANCE STRATEGIES: FIRST YEAR AFTER SEEDING

Mowing

In the first year after seeding, high mow the site to 6-8 inches every time the planting reaches knee height to prevent most annual weeds from going to seed. This also opens the planting to light to support germination and growth of the wildflowers. Mowing any lower than 6-8 inches will slow down wildflower growth. For long-term planting health, it is worth sacrificing some bloom in the first year to keep weeds from going to seed. In the second year, periodic high mowing just before weeds start flowering will help keep those weeds at bay.

Spot spraying and hand pulling

After the first season, if problem weeds are found in the planting, hand weed or use a backpack sprayer with glyphosate to prevent them from spreading. This can be especially useful for low-growing weeds, like plantain or dandelion, which would be missed with the mowing regime. Pull or treat weeds before they go to seed. Use care to avoid disturbing soil and small wildflower seedlings If spot spraying or hand pulling leads to patches of bare areas in the planting, consider seeding these areas with wildflowers or adding plugs to help prevent colonization by more weeds.

LONG-TERM MAINTENANCE

Prescribed burning

Every 4-5 years, prescribed burning of the planting or a combination of mowing plus light harrowing can be used to eliminate woody plants and reduce dense thatch cover to rejuvenate the site. Before burning, check local ordinances for needed permissions and alert the local fire department.

A controlled burn can reduce dense thatch in a mature wildflower planting and help ensure long-term planting vitality. *Photograph: Emily May, The Xerces Society.*

Reseeding/overseeding

If weeds begin to outcompete the wildflower mix (i.e., more than 75% of the plant cover is weeds by the end of

Year 2) or other factors led to poor establishment, reseeding or overseeding may be necessary. Unless you want to restart site preparation and reseed at the original rate, use overseeding to fill in gaps in the planting. Use a rake or light harrow to open up some areas of bare soil, then seed the wildflower mix in those areas in late fall. Do not till, as this will disturb wildflower seedlings and bring additional weed seeds to the surface. Resist the temptation to take drastic action in Year 1; these plantings look very weedy in their first year but fill in with sown wildflowers over time. Consult with a local restoration or plant expert in the first two years to determine how the planting is progressing and whether any additional action is needed.

Avoid insecticides

Avoid spraying insecticides toxic to bees on or near plantings to ensure that pollinators supported by the plantings are not killed by exposure to these chemicals. To learn more, see the MSU Extension guide, "Minimizing Pesticide Risk to Bees in Fruit Crops" (E-3245).

Manage planting borders to prevent weed encroachment

If weeds are allowed to flower and go to seed around the edges of plantings, they will compete with the native wildflowers. Mow, apply herbicide, or regularly disc around the edge of the planting to keep these edge weeds under control, and to provide a burn break if needed.

Some weeds are beneficial!

Many flowering weeds also provide pollen and nectar resources to pollinators, and can coexist with wildflowers in the planting to provide these resources. Consult with local plant experts and check the list of Common Problem Weeds (*Appendix 1*) to help determine whether the weeds present in your planting present a long-term threat to successful pollinator habitat.

WHAT SHOULD I EXPECT MY PLANTING TO LOOK LIKE OVER TIME?

Establishing pollinator habitat from seed requires time and patience. Perennial plants tend not to flower in the first year after planting, as they build their root base for the following year.

In the first and second years, plantings often look messy and weedy, with relatively little flowering. Take heart, it will look better over time!

By the third year, most of the sown species should begin to bloom and will start to form clusters or patches of flowers. Some species may not flower until the fourth or fifth years.

Some plants, like cup plant, may not flower until the fourth or fifth year after seeding. *Photograph: Emily May, The Xerces Society.*

Wildflower plantings placed near blueberry fields can boost crop yields by enhancing wild pollinators of blueberries. *Photograph: Emily May, The Xerces Society.*

COSTS AND BENEFITS

Wildflower plantings can seem expensive if you consider only the costs of establishment, including the cost of wildflower seed and labor to prepare and manage plantings. Depending on the seed mix and the need for weed control, establishment can cost $400-800 per acre. However, these plantings provide benefits over decades, and there are cost-share programs available from the US Department of Agriculture (USDA) as well as non-federal agencies. Tracking yields for four years in blueberry fields with or without adjacent pollinator plantings revealed that the initial cost of the plantings was recouped by the higher yields of blueberries in those fields. The return on investment has not been tracked for other Michigan fruit crops, and may vary depending on how well the planting establishes, as well as how dependent the crop is on insect pollinators for better yields and larger fruit.

SUMMARY

Many pollinators of spring-blooming fruit crops require flowers for food through the growing season. Wildflower plantings are one strategy to provide these resources on your farm and build populations of wild bees. Wild bees can complement honey bees, help ensure high yields, and reduce the risk of poor pollination. Additional strategies include planting shrubs, maintaining woodlots, and growing flowering cover crops. Wildflower plantings will take time to establish and may have a “messy” stage prior to maturing, but the expected yield benefits can make up for these initial costs.

APPENDIX 1: COMMON PROBLEM WEEDS

These weed species require aggressive management for control. If your selected site has any of the listed species present in abundance, consider selecting a different site. Weed issues can vary based on species abundance, soil conditions, competition, and management. Consult with local Extension or weed experts to create a plan for effective pre-seeding management; these species may require two seasons of weed control prior to seeding with wildflowers.

	DESCRIPTION	HOW TO CONTROL	FOLIAGE
Broadleaf & narrowleaf plantain *Plantago* spp. 	Plantains are highly adaptable invasive weed species that form large clumps or mats in disturbed areas. They can grow in very dry to very moist conditions and will suppress germination of natives with the shade from their dense, low-growing leaves.	Plantains are low-growing and cannot be controlled with mowing. Narrowleaf plantain has an extensive root crown system, which means that it must be hand-pulled from existing plantings for best control.	
Spotted knapweed *Centaurea maculosa* 	Spotted knapweed, or "star thistle," is an invasive weed species that quickly colonizes disturbed areas with low-nutrient soils. This species outcompetes native wildflowers with high seed production and allelopathy (its roots release a chemical that inhibits germination of other seeds).	Mechanical control and hand-pulling can be effective if repeated frequently. Infrequent tillage or mowing can worsen infestation. Seeds can easily be spread by vehicles and other equipment; avoid driving through knapweed patches. Glyphosate is not the most effective herbicide option.	
Non-Native Clovers *Trifolium & Melilotus* spp. 	Although these species provide floral resources for bees, they are highly competitive and can suppress germination and establishment of sown native wildflowers.	Apply postemergent herbicides before seedlings reach 3-4 inches; seedlings are not effectively controlled by herbicides after this point. Mechanical control can be effective. Multiple years of control can be necessary to control clovers in the seedbank, as seeds often have long viability.	
Non-Native Thistles *e.g. Cirsium arvense* 	Perennial invasive species that spread by seeds and creeping roots.	Not effectively controlled by tillage, mowing and other forms of mechanical control (this will often spread thistles). Apply herbicides between the bud and flower stages for best control. Smother cropping may be the best approach for organic management.	
Quackgrass *Elytrigia repens* 	Extremely aggressive cool season grass that spreads by seed and creeping rhizomes.	Poorly controlled by tillage unless diligently repeated each time grass begins to regrow. Infrequent tillage can worsen infestations by spreading fragments of rhizomes that then regrow. Clean tillage equipment before/after use to avoid spreading rhizomes. Several herbicides are labeled for control of quackgrass. Postemergent and systemic herbicides provide more effective control.	
Smartweeds/Knotweeds *Polygonum & Persicaria* spp. 	Low-growing perennial plants with high seed production. Prefer wet, poorly drained soils.	Several herbicides are effective for smartweed control. If using mechanical weed control, till at night to reduce additional germination and emergence.	

	DESCRIPTION	HOW TO CONTROL	FOLIAGE
Hoary alyssum *Berteroa incana* 	Hoary alyssym rapidly colonizes disturbed soil, particularly in dry, low-nutrient soils, and produces copious seeds.	Hand pulling or repeated shallow tilling can be effective, but these need to be repeated until the seedbank is exhausted. Mowing is generally not effective (and can be counterproductive). Repeated herbicide applications through the season can be effective; higher rates are needed for bolted plants than for basal rosettes.	
Garlic mustard *Alliaria petiolata* 	Aggressive biennial that produces copious seeds and spreads into meadows from wooded edges. First year plants develop a deep taproot, and plants do not bloom until the second year.	Postemergent herbicides applied in early spring or late fall can be effective. Garlic mustard generally greens up earlier and stays green later than other woodland plants. Hand pulling can be effective for small patches. Mowing plants to very low height at flowering can reduce infestation, but this is not universally effective.	
Burdocks *Arctium* spp. 	Biennial with deep taproot. Tends to be more common in areas that were previously grazed than in areas of previous cultivation.	Repeated tillage is an effective control for burdock. Mowing plants just before flowering can also be effective. Apply postemergent herbicides in early spring or late fall to first-year rosettes.	
Field bindweed *Convolvulus arvensis* 	Hardy perennial with extensive root and rhizome system that allows plant to regrow from root fragments as short as 2 inches long. Drought tolerant.	Tillage of young seedlings can be effective, but after 3-4 weeks of growth cultivation is no longer effective. Till every 2-3 weeks for best results. Herbicides can suppress but generally will not eliminate bindweed; repeat applications during the growing season for control .	
Tree-of-heaven *Ailanthus altissima* 	Fast-growing trees with pinnate leaves similar to sumac (*Rhus* spp.). Allelopathic; forms dense thickets.	Hand pull seedlings. Cut trees at ground level when the tree has begun to flower, followed by repeated chemical control to prevent resprouting (glyphosate or triclopyr ester). Wear protective clothing to avoid exposure to sap, which can cause dermatitis.	
Autumn & Russian olives *Elaeagnus* spp. 	Small trees/large shrubs that grow to 20-30' and can quickly invade open areas.	Pull seedlings. Cutting or mowing will cause resprouting unless followed up with chemical control (imazapyr, glyphosate, or triclopyr).	

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APPENDIX 2: RECOMMENDED PLANT LIST

	Common Name	Scientific Name	Soil Moisture	Seeding Rate	Percent of Mix	BLOOM PERIOD
FORBS			Wet, Mesic, Dry	Pounds per acre	% bulk seed per sq ft.	April May June July August Sept October
1	Golden Alexanders	*Zizia aurea*	M-DM	0.62	5%	
2	Hairy beardtongue	*Penstemon hirsutus*	DM-D	0.09	9%	
3	Lanceleaf coreopsis	*Coreopsis lanceolata*	DM-D	0.27	4%	
4	Wild bergamot	*Monarda fistulosa*	WM-D	0.14	7%	
5	Black-eyed Susan	*Rudbeckia hirta*	M-D	0.07	4%	
6	Leadplant	*Amorpha canescens*	M-D	0.24	3%	
7	Oxeye sunflower	*Heliopsis helianthoides*	WM-DM	0.73	3.5%	
8	Mountain mint	*Pycnanthemum tenuifolium*	M-D	0.03	8%	
9	Partridge pea	*Chamaecrista fasciculata*	M-D	1.01	2%	
10	Spotted bee balm	*Monarda punctata*	D	0.11	7%	
11	Yellow coneflower	*Ratibida pinnata*	WM-D	0.27	6%	
12	Showy goldenrod	*Solidago speciosa*	M-D	0.52	2.5%	
13	New England aster	*Symphyotrichum novae-angliae*	W-DM	0.14	7%	
14	Stiff goldenrod	*Solidago rigida*	M-D	0.23	7%	
GRASSES						
15	Big bluestem	*Andropogon gerardii*	WM-D	0.03	0.25%	
16	Canada wild rye	*Elymus canadensis*	M-D	0.39	1.5%	
17	Little bluestem	*Schizachrium scoparium*	M-D	0.91	10%	
18	Prairie Junegrass	*Koeleria macrantha*	DM-D	0.08	8%	
19	Tall dropseed	*Sporobolus compositus*	M-D	0.15	5.25%	

All of the species in this mix are native to the upper Midwest/ Great Lakes region. Bloom times will vary by year and location. Suggested seeding rate is based on 50 seeds/sq ft.

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APPENDIX 3: ADDITIONAL RESOURCES

Plant experts:

For more information on and assistance with designing a mix specific to your local area and soil conditions, consult native plant and habitat restoration experts in your area. Check with native plant producers in your area (www.MNPPA.org), your local USDA Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA) office (https://offices.sc.egov.usda.gov/locator/app), and non-profits like the Xerces Society for Invertebrate Conservation (http://www.xerces.org).

Bee conservation & habitat:

Isaacs, R., & J.K. Wilson. 2007. *Conserving Native Bees on Farmland*. Michigan State University Extension, E-2985. Available: http://bit.do/wildbeesMI

Gibbs, J., A. Bennett, R. Isaacs, & J. Landis. 2015. *Bees of the Great Lakes and Wildflowers to Support Them*. Michigan State University Extension, E-3282. http://bit.do/greatlakesbees

Fiedler, A., J.K. Wilson, R. Isaacs, & D. Landis. 2007. *Attracting Beneficial Insects with Native Flowering Plants*. Michigan State University Extension, E-2973. http://bit.do/E2973

Park, M., B. Danforth, J. Losey, D. Biddinger, M. Vaughan, J. Dollar, E. Rajotte, & A. Agnello. 2012. *Wild Pollinators of Eastern Apple Orchards and How to Conserve Them*. Cornell University, Penn State University, and The Xerces Society. Available: http://www.northeastipm.org/park2012

Pollinator Conservation Resource Center (The Xerces Society for Invertebrate Conservation): http://www.xerces.org/pollinator-resource-center/

Site preparation and weed management:

Michigan State University Weed Science: www.msuweeds.com

Foltz Jordan, S., J. Kay Cruz, K. Gill, J. Hopwood, J. Fowler, E. Lee-Mäder, & M. Vaughan. 2017. *Organic Site Preparation for Wildflower Establishment*. 42pp. Portland, OR: The Xerces Society for Invertebrate Conservation. Available: http://xerces.org/guidelines-organic-site-preparation/

Pesticide safety

May, E., J.K. Wilson, & R. Isaacs. 2015. *Minimizing Pesticide Risk to Bees in Fruit Crops*. Michigan State University Extension, E-3245. Available: http://bit.do/E3245

Bee Precaution Pesticide Ratings, University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program (UC IPM). Available: http://www2.ipm.ucanr.edu/beeprecaution/

Johansen, E., L. A. Hooven, and R. R. Sagili. 2013. *How to Reduce Bee Poisoning from Pesticides*. Oregon State University. Available: http://bit.do/reduce-bee-risk

Integrated Crop Pollination

Crop-specific resources can be found at http://projecticp.org/tools-for-growers/. Visit the Project ICP Youtube channel at http://bit.do/ICP-youtube for videos on pollination and habitat restoration.

Opposite: A mining bee (*Andrena* sp.) visiting golden Alexanders (*Zizia aurea*) in early spring. (Photograph: Sarah Foltz Jordan, The Xerces Society for Invertebrate Conservation)

A green sweat bee visiting goldenrod flowers. Many bees that pollinate fruit crops benefit from nearby wildflowers later in the season. Photo: Sarah Foltz Jordan (The Xerces Society for Invertebrate Conservation)

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