

ESTABLISHING POLLINATOR MEADOWS FROM SEED



To boost healthy populations of both wild resident bees and managed pollinators, the single most effective action you can take is to plant native wildflower habitat. This tangible course of action can be accomplished by anyone at any scale. The process behind establishing a wildflower-rich pollinator planting from seed consists of five basic steps:

- Site selection
- Site preparation
- Plant selection
- Planting techniques
- Ongoing management

The steps outlined in this document are applicable to plantings that range in size from a small backyard garden up to areas around an acre.

1 Site Selection

Most native wildflowers and flowering shrubs need full sunlight to thrive. Choose open sites that receive full sun throughout most of the day. Level ground is best, however gentle slopes are suitable as long as erosion is controlled during the establishment process.

Consider using otherwise marginal land, such as septic fields, parking strips, or roadsides to establish your pollinator meadow. While trees can be problematic on these sites, herbaceous plants will not penetrate pipes, threaten overhead power lines, or create traffic hazards. As an additional benefit, the deep-rooted native plants used in habitat restoration can support other wildlife, improve water infiltration, withstand drought, filter runoff, and store carbon.

Soil is also an important consideration when selecting a site. Some wildflowers prefer rich, clay soils, while others prefer dry, sandy, and rocky soils. Know your soil type before you start. If there is a history of pre-emergent herbicide use, you may wish to have the soil tested by a local University soil lab for chemicals like atrazine and trifluralin, which will inhibit seed germination.

Finally, keep neighboring weeds in mind when selecting a planting location. If aggressive weed species are present on adjacent lands, they may colonize the site through either seed dispersal or the spread of underground rhizomes. Colonizing weeds can present a persistent problem if they are not actively controlled.



This established wildflower meadow will provide habitat for pollinators and other wildlife. (Photograph courtesy of Don Keirstead, New Hampshire–NRCS.)

2 Site Preparation

Before planting you will need to eliminate existing vegetation, reduce the amount of weed seed in the soil, remove plant debris, and create a smooth surface to ensure good seed-to-soil contact. The importance of proper site preparation cannot be overemphasized. More prep time at this stage will result in greater success.



This site was selected because it is open and sunny with limited weed pressure. (Photograph by Eric Lee-Mäder, The Xerces Society.)



After site selection, the homeowner chose to kill turf grass by using herbicide treatments over a full growing season. The seed bed is now ready for planting. (Photograph by Mace Vaughan, The Xerces Society.)

Weed Control

Competition from weeds for sunlight, water, and nutrients is the biggest challenge to successful wildflower establishment. Depending on the abundance of weeds or weed seed at your site, one to two years of site preparation may be needed.

Seeds and rhizomes of perennial weeds in particular need to be eliminated. Annual and biennial weed seed may still be present after one year of site preparation. However, with several years of proper management, your pollinator meadow will be largely free of annual weeds.

Weed control during site preparation will require the use of broad-spectrum herbicides, solarization, sod removal, or a combination of these methods. When deciding which weed control method to use, consider project time and budget constraints. In general, herbicide-free methods are usually more expensive and labor-intensive and may be better suited for smaller sites, unless you have access to a hardworking and enthusiastic group of volunteers.

Herbicide-free Methods

Sod removal is relatively easy if the existing vegetation is predominantly low-growing turf grasses. Specialized walk-behind gas-powered sod cutters are available for rent from many hardware stores and tool rental companies. Keep in mind, however, that sod strips are heavy and will require off-site removal.

Solarizing the existing vegetation with clear UV-stabilized plastic is very effective on small patches of land. The plastic usually needs to be left in place for several months during the hottest time of the year before all the vegetation underneath is dead. The goal of solarization is to raise the temperature of the soil high enough to kill any weed seed present.

Follow these steps for solarizing:

- Remove all vegetation by mowing and clearing the site in the spring, raking off debris, if necessary.
- After smoothing the site, irrigate thoroughly and lay down UV-stabilized plastic (such as high tunnel greenhouse plastic).
- Bury the edges to prevent airflow between the plastic and the ground. Any airflow between the plastic and the ground will lower soil temperatures, allowing more weed seed to survive. Weigh down the center of the plastic, if necessary, to prevent the wind from lifting it. Use greenhouse repair tape for any rips that occur during the season.
- Remove the plastic in early fall before the weather cools and the area beneath the plastic is recolonized by nearby rhizomatous weeds.
- Immediately plant your seed mix.



Adequate site prep requires the removal of existing vegetation, like this turf grass; without which, wildflower seedlings would have to compete with the existing vegetation for sunlight, water, and nutrients. (Photograph courtesy of Don Keirstead, New Hampshire NRCS)



This site was solarized during the summer months with greenhouse plastic to kill off existing vegetation and weed seed in the soil. (Photograph by Nancy Lee Adamson, The Xerces Society.)

Post-emergent Herbicide Application

The application of non-persistent glyphosate herbicides is a low-cost and less labor-intensive approach to weed control. For maximum efficiency, herbicide treatments should be applied when weeds are actively growing. It is important that any cool season weedy grasses are actively growing when using this treatment. If you apply herbicide when cool season plants are dormant in the summer heat, the product will not be transported to their roots.

Follow these steps for non-selective, non-persistent herbicide treatments:

- To ensure good contact of the product with weed foliage, mow the area as low as possible in the early spring, and then rake off the debris.
- Following this, make the first herbicide application as per label instructions as soon as weeds begin actively re-growing.
- Repeat additional treatments every six weeks, or whenever emerging weed seedlings reach 4–6" throughout the growing season.
- Plant pollinator seed mix, waiting at least 72 hours after the last herbicide treatment.

For your own safety and the safety of the environment, always follow the instructions on the herbicide label when determining how much to apply.

After using sod removal, solarization, or herbicide treatments, avoid any tillage as any cultivation will likely bring weed seed to the soil surface. Consider placing a thin layer of weed-free compost on the soil surface before seeding. For every weed you plow under, you are likely to bring several dormant weed seeds to the surface where they will germinate. Similarly, note that we do not recommend rototilling an area for primary site preparation.



Herbicides can be low-cost and low-labor method for preparing a site for planting. (Photograph by Mace Vaughan, The Xerces Society.)

Seedbed Preparation

After the existing vegetation has been removed, the soil surface must be prepared prior to planting. Ideally, you want a smooth, lightly packed surface, free of clumped sod and tall crop stubble. For small sites, a rake or turf roller can be used to remove or break up large dirt clods. For large areas, a lightweight harrow or roller can be used to prepare the soil surface.

The planting area can then be finished with an additional glyphosate treatment or hand-weeding, if necessary, and a shallow raking (less than an inch). These final steps are best performed on a warm day so that any uprooted seedlings are killed. Following any glyphosate treatment, allow at least 72 hours to pass prior to planting.

3 Plant Selection

In preparing your seed mix, take several points into consideration:

Floral Diversity

Select a diversity of plants with different flower sizes, shapes, and colors, as well as varying plant heights and growth habitats, to support the greatest numbers and diversity of pollinators.

Different bee species are active at different times of the year. Therefore, it is important to provide a continuous source of pollen and nectar throughout the growing season. At minimum, strive for three species to be blooming at any one time; the greater diversity the better. It is useful to include flowers that bloom early in the spring to provide food for emerging bumble bee queens. It is also important to provide flowers that bloom in late summer and fall that support new bumble bee queens before overwintering. The exact mixture of wildflowers, however, is a matter of personal preference and individual goals. For example, if you would like to attract butterflies, consider including the larval host plants for local native species. Alternatively, if you'd like the meadow to function as a rain garden, choose plants that are tolerant of wet soils.

Importance of Grasses

Though grasses do not offer nectar or high-quality pollen, it is often useful to include at least one native bunch grass or sedge in your seed mix. Short, clump-forming grasses are preferable to large, spreading, or sod-forming grasses. Native bunch grasses should not comprise more than 25% of the mix by seed per square foot. Grasses and sedges are larval host plants for some butterflies, and also provide nesting and overwintering sites for some bumble bees and other insects.

We recommend the establishment of bunch grasses and difficult-to-establish perennials by plug propagate, bulbs, corms, or rhizomes, and then sowing annual and easily established perennials in the gaps. The grasses and wildflowers together form tight living mats that resist the encroachment of weeds. Grasses are also essential to produce conditions suitable for burning, if that is part of your long-term management plan.



Late blooming goldenrod species can provide valuable floral resources for migrating monarchs or overwintering bumble bee queens. (Photograph by Jolie Goldenetz-Dollar, The Xerces Society.)

Bunch grasses can provide valuable nesting areas for bumble bees, predacious beetles, and other beneficial insects. (Photograph by Jessa Kay Cruz, The Xerces Society.)





Providing a diversity of bloom shapes and colors will attract a diversity of pollinators and other beneficial insects. (Photograph by Eric Lee-Mäder, The Xerces Society.)

Seeding Rate

The recommended seeding rate for wildflowers and other herbaceous plants ranges from 40–60 seeds per square foot. The exact seeding rate can be established through your seed vendor, who will be able to tell you how much of each species (by weight) you will need for planting a certain number of square feet or acres. To develop your own pollinator conservation seed mix, use the downloadable Xerces Society seed rate calculator, found in the references section of this document.

Seed Sourcing

Native wildflowers are usually the best sources of nectar and pollen for native pollinators. Compared to non-native plants, native plants are more likely to attract native bees and support a high diversity of butterflies and moths.

Whenever possible, you should try to purchase seed from local growers who specialize in “local eco-type” seed. Local eco-type means the seed was harvested or produced from a local source. Locally sourced plants generally establish and grow well because they are adapted to the local soils, climate, insects, and plant diseases.

If possible, try to order seed in individual lots and not as a mix. Individual lots help ensure that all species are accounted for and spreading the small and large seeded species separately will ensure a more even distribution of species across the site.

Once your pollinator meadow is established, you might consider collecting your own seed to plant in other areas or to participate in seed swaps with your friends and neighbors.



Native wildflower seed comes in a diversity of shapes and sizes. Planting large-seeded species separately from small-seeded species will allow a more even distribution of species across the site. (Photograph by Brianna Borders, The Xerces Society.)

4 Planting Techniques

Timing

For wildflowers, particularly perennial species in cold climates, early fall planting is often best. Many perennial plant seeds require exposure to cold temperatures and damp conditions before germination can occur. Additionally, winter precipitation helps the seeds settle into the soil and will stimulate germination. Fall planting is also suitable for annual wildflowers in warm climates.

Spring planting is also possible, but typically favors grasses rather than the wildflowers that you want to dominate your pollinator habitat. Spring planting is favorable for annual species in cold climates, but it is especially important that the site be properly prepped before planting to reduce weed pressure. For spring planting, indoor cold moist stratification of the seed is recommended, to enhance germination. This seed treatment is easy to perform and instructions are available from plant propagation guides and on the internet.

For wildflower mixes that include both perennial and annual species, aim for planting after any danger from frost. For specific regional planting times, see Table 1.

Table 1. Regionally Recommended Planting Times

New England Perennial Wildflowers	Oct–Dec
Mid-Atlantic Perennial Wildflowers	Oct–Jan
Southeast Annual and Perennial Wildflowers	Nov–Feb
Upper Midwest Perennial Wildflowers	Oct–Dec
Northern Plains Perennial Wildflowers	Oct–Dec
Southern Plains Perennial and Annual Wildflowers	Oct–Jan
Mountain and Great Basin Perennial Wildflowers	Oct–Dec
Southwest Annual and Perennial Wildflowers	Feb–May
California Annual Wildflowers	Oct–Jan
Pacific Northwest Annual and Perennial Wildflowers	Sept–mid. Oct

Seeding Methods

Broadcast seeding, which consists of scattering seed onto the soil surface, is a low-tech, low-cost method that can be very effective on bare soil. This technique can be performed by hand, or with hand-operated crank seeders. For large areas, seed can also be broadcast with ATV-mounted seed spreaders.

Regardless of the broadcasting method used, you will have the best seeding success by mixing the seed with an equal or greater volume of slightly damp inert materials such as coarse-textured sand, vermiculite, rice hulls, or sawdust. The inert material helps provide proper species distribution within the seed mix, and gives a visual representation of how evenly the seed mix is being spread across the planting area. When broadcast seeding, divide the mixture into two equal quantities, applying half of it to the planting area in one direction. Then, spread the second half of the mixture onto the planting area in a direction perpendicular to the initial sowing. This will result in fairly equal seed distribution throughout the site.

When broadcasting seed of separate species, mix seeds of similar size together with the inert material and broadcast across the site using the methods outlined above. For example, you may want to broadcast all small seeds at once, then all large seeds at once.

To achieve good seed-to-soil contact, the seed can be compacted into the ground with a standard lawn roller (available for rental at many hardware stores), or the wheels of an ATV or tractor on larger areas. If erosion is a concern, the planting site can be protected with a thin layer of weed-free straw.



For broadcast seeding, seed of similar size is mixed together. (Photograph by Brianna Borders, The Xerces Society.)



Sand or another inert carrier is added and then mixed with the seed. (Photograph by Brianna Borders, The Xerces Society.)



Divide the mix into separate batches for broadcasting in perpendicular passes over the planting site. (Photograph by Brianna Borders, The Xerces Society.)



For small sites, seed can also be broadcast by hand, similar to scattering chicken feed. (Photograph by Mace Vaughan, The Xerces Society.)



After broadcasting, roll the site with a turf roller. (Photograph by Mace Vaughan, The Xerces Society.)

For Larger Sites



For larger areas, seed can be broadcast using a belly grinder. (Photograph courtesy of the New Hampshire NRCS.)

6 Ongoing Management

Watering

Unless you are experiencing drought conditions, it is usually not necessary to water your seedbed. If inadequate rainfall is received following seed germination, irrigation may be needed to ensure seedling survival. Once established, native plants typically do not need supplemental irrigation and irrigation may favor the growth of weed species. With or without supplemental water, many perennial wildflower seeds germinate slowly, and may even take several seasons to germinate. Although this seems like a drawback, it actually works in your favor because any fast growing plants in your perennial seed mix during the first year are likely weeds that can be more easily identified and removed before they crowd out natives.

Management for Perennial Wildflower Mixes

If the majority of your seed mix is perennial wildflowers, the best way to control annual weeds during the first growing season is by regular mowing or string trimming of the seedbed. The exact number of times you have to mow will depend on your particular weed species, and how much rainfall is received. Plan on mowing every time the vegetation reaches a height of 12 inches, or when a large number of weeds begin to flower. This will prevent most annual weeds from re-seeding, while leaving your natives untouched.

For small areas, a walk-behind lawn mower is acceptable, although it may need to be operated slowly in thick vegetation. Sickle-bar mowers are also an acceptable option for large sites.

Weeds can also be spot-sprayed with glyphosate using a backpack sprayer. This is particularly useful against low-growing perennials like dandelion that might be missed by the mower. However, care should be taken so that herbicides do not drift or drip onto desirable plant species. Weeds should not be pulled during the first year, when the surrounding seedlings are still developing their root systems.

In the early spring of the second year, before plant emergence, the previous season's debris should be mowed and raked away. If you prepared your area properly before planting, and mowed aggressively during your first year of establishment, your pollinator meadow should now be more visible.

During the second growing season, most remaining weeds will be biennial species. These plants develop a thick taproot during their first year, and then flower during the second year before dying. Your main control tactic should again be mowing. However, rather than mowing at regular intervals, wait until most biennial weeds are about to flower, and then mow only as necessary. On small areas, you can also combat these plants with a string trimmer, hand-weeding, or again with glyphosate. It is important to remove them before they produce seed.



In the first spring after seeding the previous fall, this planting site is dominated by annual and biennial weeds like wild radish (left). Mowing the site periodically during the first year will prevent these short-lived weeds from producing more seed, and allow sunlight to reach the slower-growing natives (middle), which are generally unharmed by occasional mowing. The photo on the right shows flourishing wildflowers and pollinator habitat in the second year of establishment. (Photographs by Eric Lee-Mäder, Xerces Society (left and middle), and courtesy of Don Keirstead, New Hampshire NRCS.)

Beginning in your third season, you should start seeing regular flowering among most of your native plants. Bees, butterflies, and other pollinators like hummingbirds will become increasingly common.

At this point, your primary maintenance task will be periodic mowing (or burning for large sites) to eliminate small trees and shrubs, as well as cool season weedy grasses. These activities should take place in the early spring before most of your desirable plants have emerged.

Management for Annual Wildflower Mixes

If your seed mix consists of mostly annual wildflowers (common to seed mixes for the West Coast and warm climates like Texas), then you will need to ensure adequate site preparation to remove weeds before planting and spot-treat or hand-pull any weeds as necessary during the growing season. Late in the season, after the wildflowers are done blooming, you can mow the area to reduce woody plant encroachment and to help scatter the dry wildflower seed heads.

Fertilizers

It is not necessary to fertilize your pollinator meadow under normal conditions. Native plants do not require fertilizer, and the application of fertilizer with high nitrogen content will tend to encourage weed growth.

Long Term Management

After the meadow is mature, you should only mow or burn part of the planting in a single season—ideally only $\frac{1}{3}$ or $\frac{1}{4}$ of the overall area. No single area should be burned or mowed more frequently than every two years, to protect dormant insects such as butterfly pupae or stem-nesting bee larvae. Leaving patches untreated will ensure a population of insects to recolonize treated areas of the site.

After several years, re-seeding your pollinator meadow may be necessary to support long-term plant diversity. Similarly, for aggressive species, you may wish to remove seed heads to slow their expansion.

It is critical to protect your new pollinator meadow from pesticides, herbicides (except when necessary to control noxious or invasive plants), and other disturbance. We recommend using signage to designate your pollinator meadow.

Transforming turf grass to pollinator meadows can provide much needed habitat for wildlife and take less time to manage. (Photograph by Eric Lee-Mäder, The Xerces Society)



Many other publications exist on the subject of native plant restoration, often tailored specifically to certain regions (such as Midwest tallgrass prairies), or to other purposes (such as establishing game bird habitat). The formula presented here consistently produces high-quality pollinator habitat in most regions by strongly favoring wildflowers over grasses. Individual locations and equipment availability might require some adaptation of this approach.

When your pollinator meadow is established, consider adding it to the Bring Back the Pollinators Pledge map or submitting bumble bee observations from your meadow through the Bumble Bee Watch website (www.bumblebeewatch.org). We also encourage you to talk to your friends, family, and neighbors about what they can do to support pollinators! Enjoy watching your pollinator meadow attract a diversity of wildlife!

Additional Resources

Attracting Native Pollinators: Protecting North America's Bees and Butterflies

Our best-selling book highlights the role of native pollinators in natural ecosystems, gardens, and farms. Introductory sections explore the natural history and habitat needs of bees, butterflies, pollinating beetles, and much more. Advanced sections provide guidance on conserving pollinators in multiple landscapes. The book also includes a first-of-its-kind guide to all common native bee genera of North America. Available in bookstores everywhere, and through www.xerces.org/books.

Xerces Society Pollinator Conservation Resource Center

Our Pollinator Conservation Resource Center is an online database of pollinator plant recommendations, guidelines on establishing and protecting pollinator habitat, and a directory of native plant nurseries for every region of the United States and Canada.

www.xerces.org/pollinator-resource-center

Ladybird Johnson Wildflower Center

The Ladybird Johnson Wildflower Center has developed a collection of pollinator-friendly native plants as part of their extensive native plant database. Along with this special pollinator plant collection, the Center's website features image galleries, how-to articles on native plant gardening, and more.

www.wildflower.org/collections

Pollinator Habitat Installation Guides

These how-to guides, developed in collaboration with the USDA's Natural Resources Conservation Service, provide in-depth, step-by-step instructions for developing a large-scale wildflower meadow for bees and includes a list of regional native seed vendors and native plant nurseries.

www.xerces.org/pollinator-habitat-installation-guides

Xerces Society Seed Mix Calculator

Develop your own pollinator conservation seed mix using this seed rate calculator.

www.xerces.org/xerces-seed-mix-calculator

Bumble Bee Watch

A citizen science initiative to track all species of North American bumble bees. The website allows users to upload photos, use an interactive identification tool, and submit geo-referenced records of all North American bumble bees. These records will allow scientists to follow the status of these essential pollinators and inform effective conservation actions.

www.bumblebeewatch.org

USDA Natural Resources Conservation Service

The USDA's Natural Resource Conservation Service (NRCS) and Farm Service Agency (FSA) provide financial and technical assistance to support conservation efforts for pollinators and other wildlife on farms. Conservation programs such as the Environmental Quality Incentives Program, Agricultural Conservation Easement Program, Conservation Stewardship Program, and Conservation Reserve Program all provide support for farmers.

<http://offices.sc.egov.usda.gov/locator/app>

Bring Back the Pollinators

Our Bring Back the Pollinators campaign is based on four principles: grow pollinator-friendly flowers, protect bee nests and butterfly host plants, avoid pesticides, and spread the word. You can participate by taking the Pollinator Protection Pledge and registering your habitat on our nationwide map of pollinator corridors.

www.bringbackthepollinators.org



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Replacing traditional turf grass lawns with diverse native wildflower plantings can support wildlife while at the same time improving water infiltration, filtering runoff, and storing carbon. As an additional benefit, these plantings help beautify communities. (Photograph by Eric Lee-Mäder, The Xerces Society.)

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