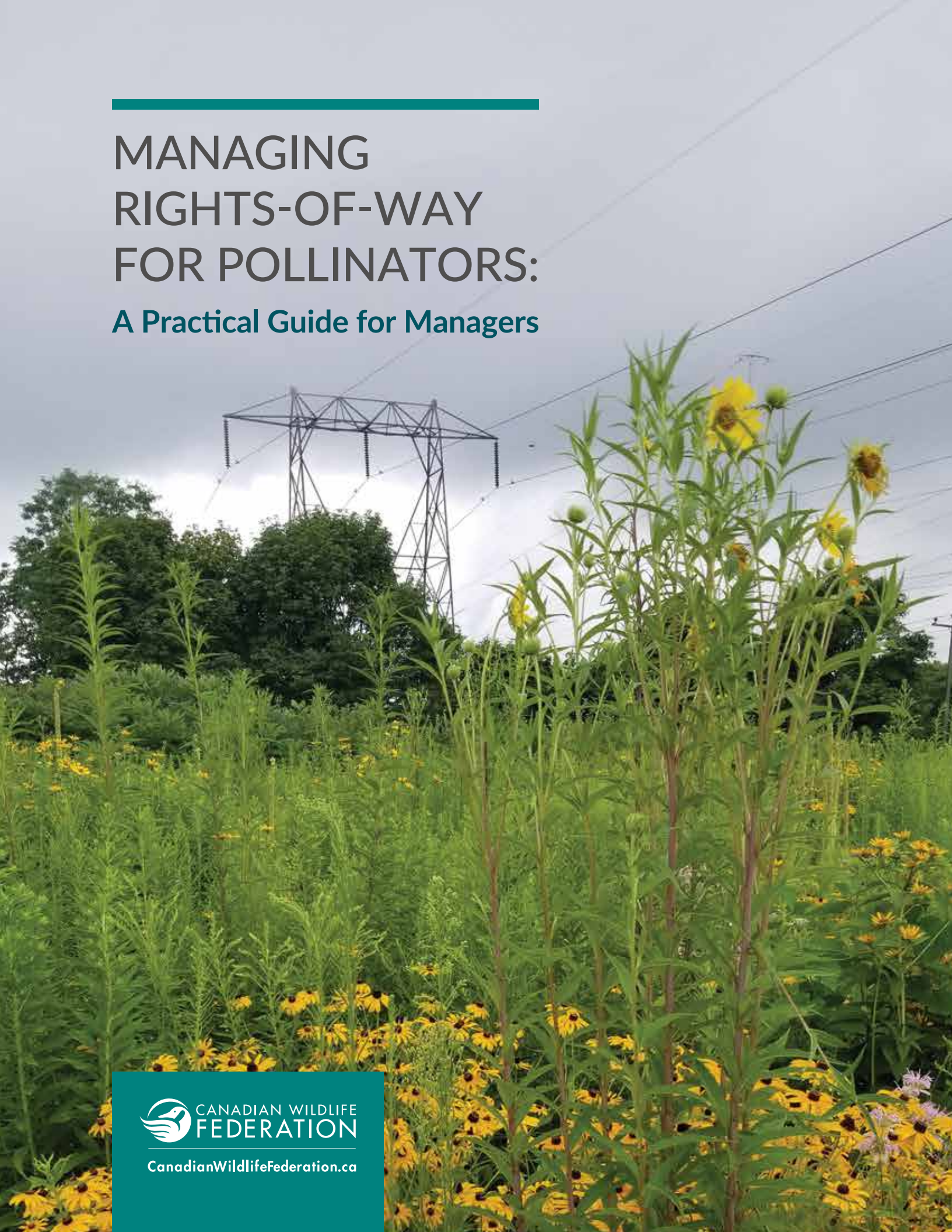
MANAGING RIGHTS-OF-WAY FOR POLLINATORS:

A Practical Guide for Managers



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Cover Photo: TRCA and The Meadoway

PURPOSE OF THIS GUIDE

This guide is designed to help managers of rights-of-way (ROW) in southeastern Canada begin taking a different approach to managing and restoring habitat. Roadsides, utility corridors, industrial lands, solar installations, wind farms and pipelines could all be managed to create and maintain a network of thousands of hectares of pollinator habitat. This guide aims to outline best practices for improved management of ROW to benefit pollinators, as well as practical methods of habitat restoration suitable for road and ROW use. By changing our management and increasing habitat restoration on ROW, the survival and recovery of pollinators and other wildlife can be supported at a broad scale.

INTRODUCTION

POLLINATORS: CRITICAL FOR OUR ECONOMY AND OUR ENVIRONMENT

Pollinators are a diverse group of animals that support our economy and our environment. Bees, flies, butterflies, moths, beetles, hummingbirds and some small mammals are pollinators. They carry pollen on their bodies and move it between flowers, a process necessary for reproduction and fruit development in most flowering plants. This almost invisible act occurs countless times each day and creates an estimated one third of the food we eat. It also sustains the native plants and habitats on which humans and wildlife depend.

And yet, these unsung heroes of the natural world are declining. Bumble bees, among the most efficient of pollinators, have declined in abundance across North America, and some species have been extirpated. Eight species of native bees are now considered to be at risk in Canada.[1] The much-loved Monarch butterfly, whose annual migration is well-known to schoolchildren, has declined by about 80 per cent in the last 20 years. Several studies in Europe and North America point to reductions in insect abundance of 50 to 90 per cent in the last 30 to 40 years.[2]

Multiple threats appear to be causing these declines, including habitat loss, pesticide use, climate change and disease. To reverse current trends, immediate changes to land use are necessary at a large scale.

OPPORTUNITY IS ALL AROUND US

Potential pollinator habitat is all around us. By naturalizing and restoring our working landscapes, we can create sizeable networks of pollinator habitat. What do we mean by 'working landscapes'? This refers to areas of land that are used for agriculture, forestry, transportation, energy production and distribution, and that also support tourism and outdoor recreation. These areas include networks of ROW: roadsides, power corridors, transmission lines and pipelines. Other working landscapes include urban parklands and farmland. With some habitat restoration occurring throughout the working landscape, including on marginal farmland, it is possible to create sizeable networks of pollinator habitat.

By design, ROW are open, sunny areas and often require low-growing vegetation for safety, access and visibility. Over the past several decades, the trend in North America has been to remove native vegetation and replace it with grasses native to Europe and Asia. Typically, these areas are mown and even sprayed throughout the growing season. While our eyes have become accustomed to the uniformity of these lawn features, they provide very little habitat for pollinating insects and wildlife. And yet, with a few cost-effective changes, ROW could deliver ideal spaces for restored native meadow habitat. In some cases these changes could yield cost savings for ROW managers.

While these individual corridors may not seem significant in size, collective changes across the landscape could create millions of hectares of habitat for pollinators and other wildlife. In Ontario alone, there are over 270,000 kilometres of roadways traversing the province. Over the last few decades, significant changes have occurred in the way roadsides are managed. Frequent mowing and herbicide spraying have resulted in the establishment of invasive grasses and alien invasive plants that outcompete native wildflowers. In some cases, the control of invasive alien plants has dominated the management regime of roadsides. Mowing and boom spraying selective herbicides to control invasive species removes the nectar-bearing flowers that are essential to the survival of pollinators.

Revised management practices on working landscapes could play a helpful role in pollinator recovery. For example, the Monarch butterfly migrates across most of North America each spring and fall. Flowers provide food nectar for this journey, much like gas stations along a road network.

Many land managers across North America and beyond are responding to a call for action to restore pollinator habitat. In the United States, Europe and Canada, land managers at all levels of government and in private corporations are undertaking changes to regular activities to benefit pollinators and other wildlife. Thousands of kilometres of roadsides and other ROW have already been restored to native meadow habitat across the U.S. and in parts of Canada.

This guide is designed to help managers in southern Canada begin taking a different approach to managing roadsides and other ROW within working landscapes. Industry leaders from the U.S. and Canada have shown that changes to management to benefit pollinators are compatible with priorities of safety and access. This guide aims to outline best practices for improved management of ROW to benefit pollinators, as well as practical methods of habitat restoration suitable for road and ROW use. By changing our management and increasing restoration on ROW, the survival and recovery of pollinators and other wildlife can be supported at a broad scale.

Holly Bickerton

HABITAT RESTORATION: THE MANY BENEFITS OF NATURAL MEADOWS

There is a host of other ecological and economic benefits that result from creating and enhancing pollinator habitat.

Pollination services: Native pollinators make a difference in agricultural landscapes. Wild pollinators, especially native bees, have been found to increase yields in many different cropping systems worldwide, especially fruits and many vegetables.[3] Urban and community gardens may similarly benefit.

Lower long-term maintenance costs: Many ROW organizations have realized significant long-term cost savings from reducing mowing and allowing native wildflowers to grow. Native meadows are stable, low-growth plant communities that require mowing or spot spraying every two to three years to control woody plant growth. Less frequent mowing also reduces opportunity for the spread of invasive species and can reduce the cost of controlling these species.

Climate change mitigation: As many municipalities and organizations strive to reach net-zero carbon targets in the next decade, meadow naturalization would offer carbon sequestration over thousands of hectares. The above-ground vegetation and deep root systems of native plants sequester carbon; soils may additionally build carbon stores. Reduced mowing means decreased fossil fuel use and lower greenhouse gas emissions.

Water and snow capture: Deep-rooted native perennials also offer additional benefits. They capture and slow the release of seasonal precipitation into stormwater systems and local waterways. They stabilize the soil and prevent soil erosion. They act as natural filters and improve water quality. Tall meadow vegetation reduces snow drift across roadways, improving winter road safety, especially near open fields and agricultural areas.

Aesthetics: Besides increasing habitat value for pollinators and other wildlife, native wildflowers, once established, can beautify roadsides and recreational spaces, even leading to increased tourism in some areas. These beautiful roadways could provide an important exposure to nature for thousands of commuters each day.

Krista Melville

The Monarch: An Iconic Species

As Canada's most recognized butterfly, the Monarch makes an excellent focal species for pollinator habitat restoration projects. Monarchs occur in the southern portion of every Canadian province and are generally most common east of the Rockies. The continent-scale migration of the adult butterflies is an amazing natural phenomenon. Because of steep population declines in the last 20 years, the Monarch has now been assessed as an endangered species in Canada.[4]

Within Canada, the most significant breeding areas for Monarchs are found in southern Ontario and Quebec. ROW such as road and utility corridors have the potential to add thousands of hectares of breeding habitat in working landscapes within the Monarch's critical Canadian range. In addition, ROW could help to provide a migration corridor that supports Monarchs heading to Mexico each fall and returning to the breeding grounds in the spring.

The Buzz About Honeybees

There has been a lot in the news about the declines in honey bees. Colony losses have significantly affected business for commercial beekeepers across North America and beyond. With good intention, pollinator restoration projects sometimes include the installation of commercial honey bee hives, thinking this provides a benefit to all pollinators generally. Many people are not aware, however, that honey bees are in fact a European species brought to North America for their ability to pollinate agricultural crops and provide honey. Honey bees are aggressive competitors with native bees and many other pollinating insects. While this guide recommends creating or naturalizing vegetation to support native wild pollinators, installing beehives in your restored habitat is not recommended.

WHAT IS POLLINATOR HABITAT?

There are millions of different types of pollinating insects, each with general or specific habitat needs. Overall, the habitat requirements of most pollinators are quite simple: they need regular access to nectar-bearing flowers that bloom through the entire growing season, and they need nesting areas that are usually found in soils and woody vegetation.

Food resources: Most pollinating insects are in search of the sugary nectar held deep within a flowering plant, either to feed themselves or their offspring; a few eat some of the protein-rich pollen. By entering numerous flowers, their often hairy bodies or sticky tongues transfer pollen between plants, fertilizing the plants and ensuring the development of seeds and fruits for the next generation. A continuous supply of nectar and pollen through the entire growing season is important.

Nesting areas: The hollow stems and root bases of grasses and woody plants provide nesting sites and shelter for many insects. Bare ground is also used by many insects; for example, many native bee species dig nests in the bare soil between native plants or nest in rodent or beetle tunnels. Some solitary bees nest in soft-pithed twigs or tunnels in old wood. Excavated sand or soil can be added to restored areas to provide a loose substrate for ground-nesting insects. Keeping or adding these features after planting will create different habitat types. Alternatively, you may choose to make artificial nest structures to enhance habitat.[5]

Host plants: Some pollinating insects, especially butterflies and moths, lay their eggs on specific host plant species. Monarch caterpillars, for example, emerge on milkweed plants, where they feed exclusively until developing into butterflies. Relationships between caterpillars and host plants are often highly specific. Having a large variety of native species ensures maximum pollinator diversity.

David Neads; Glenn Dunn

PASSIVE VS. ACTIVE RESTORATION

ROW managers have a choice between passive and active restoration methods. By **passive restoration**, we refer to reducing mowing, applying Integrated Vegetation Management, and allowing ROW to restore naturally, or "naturalize." This approach is less costly, and many ROW managers have found it reduces management costs overall. It can be widely and quickly implemented. Typically, a mix of native and non-native vegetation remains on the ROW.

Active restoration refers to replacing the existing vegetation with native plant species, resulting in high quality meadow habitat for pollinators and other wildlife. This is done most cost-effectively on clean, bare soil following construction or agricultural cropping. Removing the existing non-native vegetation before seeding is possible, typically requiring approximately three seasons of site preparation before seeding.

PASSIVE RESTORATION

ACTIVE RESTORATION

Jake Lozon; Holly Bickerton

RESTORATION THROUGH MOWING PRACTICES

The simplest and most cost-effective way to preserve pollinator habitat on ROW is to reduce mowing frequency. Mowing removes nectar, pollen and shelter for most pollinators and kills eggs, caterpillars and adults on mown vegetation. Fortunately, adjusting the amount, timing and frequency of mowing can make an important change for many pollinators, including Monarchs. Mowing less often also reduces maintenance costs without impacting safety.

Here are some ways to rethink current mowing practices on ROW:

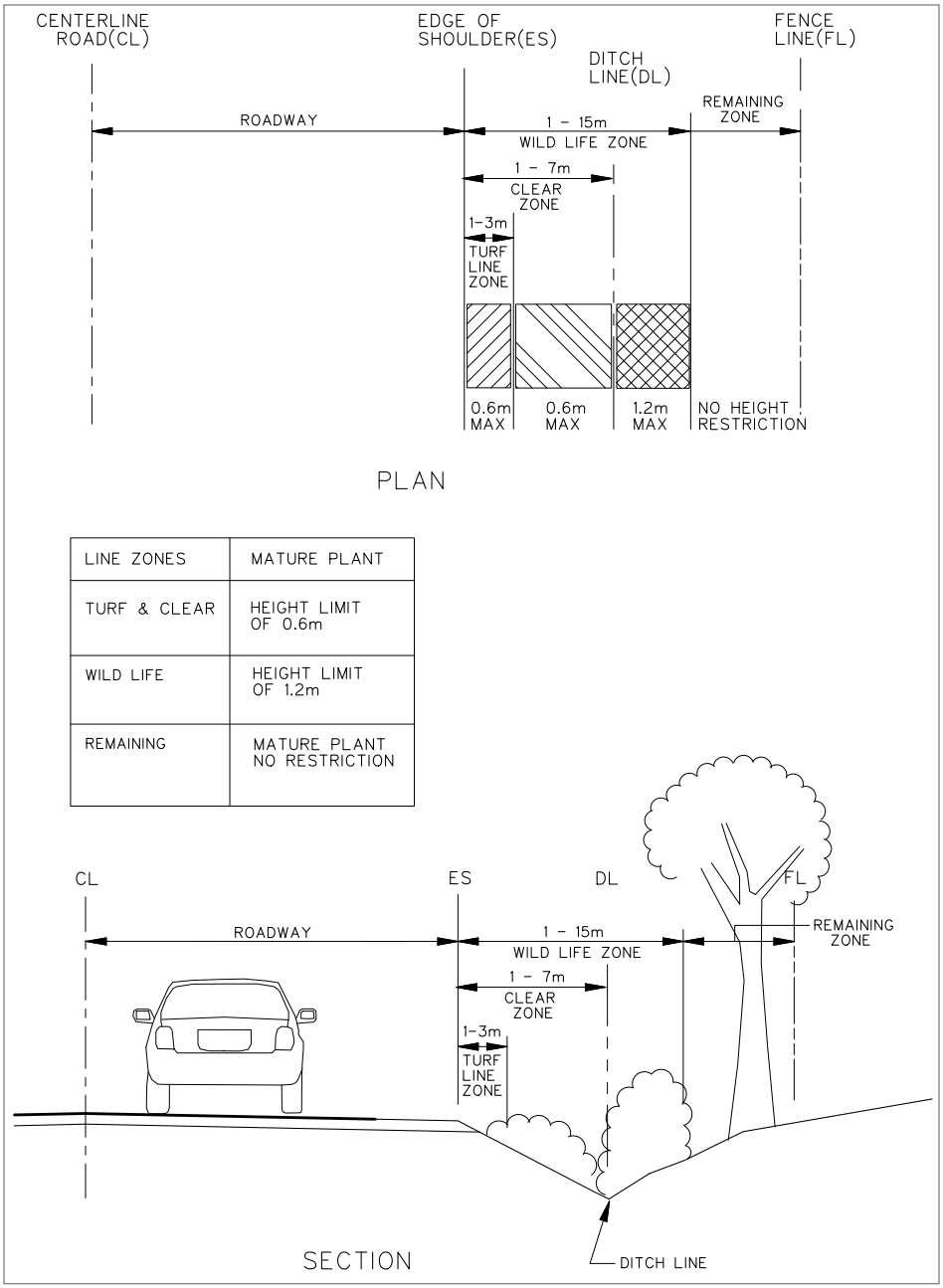
- **Reduce mown areas.** On roadsides, mow only to maintain a clear zone (usually up to three metres). Reduce mowing beyond the clear zone. In other ROW areas and parks, reduce mowing in areas that are not actively used all season, perhaps creating simple mown pathways through taller vegetation.
- **Reduce frequency of mowing.** Mow only once a year, and then only if necessary. In some areas, mowing every one to three years is enough to control woody growth and maintain access. To control unwanted woody vegetation and invasive species, Integrated Vegetation Management techniques can be used, such as spot spraying or hand pulling weeds.
- **Change timing of mowing.** Mowing once a year in late autumn has the least impact on pollinators, especially on Monarch butterflies. At this time, flowers have finished blooming and most pollinators are no longer active. Alternatively, mowing in spring to about mid-June allows optimal vegetation control but avoids peak bloom times. If mowing must occur between late June and October, it is best to mow during hot, sunny days when flying adult insects are active and better able to escape.
- **Mow higher and slow down.** Mowing to a height of 30 centimetres or more helps plants recover more quickly and keeps some shelter and cover for wildlife. Slowing down mowing speeds can give flying pollinators time to escape.
- **Keep some patches.** Leaving unmown patches can provide refuges for pollinators until other habitat areas grow back.

For information on mowing to protect Monarchs, also consult Monarch Joint Venture's handout, *Mowing and Management: Best Practices for Monarchs*.[6]

Additionally, reducing mowing frequency usually reduces costs for ROW organizations, sometimes significantly. It can result in the naturalization of large areas in just one season. The quality of the resulting pollinator habitat depends on the plant species that are present in the existing vegetation. In some areas, this may include unwanted species, including invasive species. Many ROW managers therefore direct savings from mowing toward some form of Integrated Vegetation Management (IVM), such as spot spraying with herbicide to reduce alien invasive or woody plants.

INTEGRATED VEGETATION MANAGEMENT

Many ROW organizations are increasingly looking to IVM plans for managing vegetation on their lands. As an alternative to mowing and other broadscale techniques, such as broadcast herbicide use, IVM offers a range of targeted mechanical and chemical techniques employed on an as-needed basis to control undesirable vegetation. These techniques may include mowing, brushing, girdling or targeted herbicide use. IVM techniques usually result in reduced mowing and herbicide application and are more beneficial to insect pollinators and the broader environment than traditional vegetation management approaches. The development of an IVM plan is a good first step for any ROW organization.



▲ Integrated Vegetation Management Planning

▲ IVM: Manual control of Wild Parsnip

Lanark County; Michelle Vala

STEPS TO TAKE IN RESTORING POLLINATOR HABITAT ON ROW

Habitat restoration to create wildflower-rich native meadows or prairies is an important option available to ROW managers. Although pollinator habitat restoration requires a higher investment of time and resources, very high quality habitat for pollinators can be created, which may offer multiple benefits to your ROW organization over the long term.

1. CHOOSING A SITE

Some sites are easier to restore than others. Conduct a site inspection of any candidate sites. The factors below are worth considering.

Quality of existing vegetation: If the site is already vegetated, evaluate the quality of the vegetation at the site, including the cover of native wildflowers, the presence of milkweed and the presence of a variety of pollinator types (bumble bees, flower flies, honey bees, butterflies and others). Some ROW already have good cover of native wildflowers and are probably best maintained as meadows rather than with replanting. The ROW as Habitat Working Group has created the Pollinator Scorecard[7] to help evaluate habitat quality for pollinators.

Weeds: In general, bare ground and recently cropped land are the easiest sites to restore because weed control is not required. The presence of aggressive invasive plants will lengthen site preparation time and cost.

Site conditions and soils: Full to partial sun is ideal for pollinator meadows, making ROW ideal candidates. Restoration sites can range from moist to dry, although wet sites are harder to access with heavy equipment. Most soil types are suitable (clay, sand or loams), but highly compacted soils are hard to restore.

Visibility: Active restoration is often selected for highly visible sites, such as roadsides, head offices and demonstration sites. These sites can allow your organization's broader commitment to pollinators to be more widely demonstrated.

Long-term goals: In most areas of Canada, meadows will naturally change to shrubland and forest over the long term unless they are maintained as meadows. Ideal sites are those that need to be maintained in low-growing, non-woody vegetation over the long term due to infrequent use, safety, maintenance needs, access or viewscapes.

Logistics: Depending on the size of the area to be restored and methods chosen, consider access for the equipment required. Steep slopes can present a challenge; proximity to a water source may be helpful if restoration will involve young transplants.

Size: Sites of any size can be restored or enhanced to provide pollinator habitat. However, this guide addresses management and restoration of larger sites, such as those occurring along roadsides and utility corridors.

Holly Bickerton

Is Road Mortality a Cause for Concern for Pollinators?

There has been concern that creating roadside pollinator habitat might result in increased insect road mortality, especially of highly mobile species, such as bees and butterflies. However, research indicates the net result of restoration is still positive.[8] While some pollinators are killed by traffic, studies have estimated that road mortality for certain groups is in the order of 10 per cent, which is much less than mortality due to natural causes. In other words, pollinator experts consider the positive benefits of roadside plantings to outweigh the losses.

2. PROJECT PLANNING

Forward planning is critical to the success of any project. Depending on the site, preparation for active restoration may take up to three growing seasons.

For large sites requiring large quantities of native seed, contact your grower as far in advance of seeding as possible, even at the initiation of your project. Currently there is a shortage of locally sourced native seed in many areas of Canada. Two or more years can be required to scale-up production to allow for sufficient supply.

3. SITE PREPARATION

To create a self-sustaining pollinator meadow of native species, it is critical to have a **weed-free site with a firm soil surface** that allows good seed-to-soil contact. Introduced lawn and pasture grasses are very aggressive and will quickly outcompete native species. It cannot be emphasized enough: it is worth spending time to prepare a site well!

For small or linear sites that will be actively restored, also consider establishing barriers to prevent the spread of weeds into your site. This can be done with regularly mown strips, pathways, asphalt, landscape fabric, or barriers of planted conifers, which can control the advance of introduced species into your site.

Preparing Sites with Bare Soil (Post-Construction)

Areas of bare soil following construction can be excellent opportunities to restore with native plants. Similarly, any site that has been intensively cropped (e.g., corn, soy, oats) will be relatively weed-free. These sites readily allow the seed-to-soil contact required for native plant establishment, and there is little need for site preparation. To increase success:

- Avoid bringing in soil. Soil brings the possibility of weeds or soil fungi not native to the site, which can limit success.
- If adding soil cannot be avoided, the best approach is to use washed and excavated pure sand mixed with peat moss to avoid importing weed seeds.
- Continually monitor sites for appearance of non-native vegetation, and control weeds as necessary.
- Prior to seeding, create a firm seed bed using a clean cultivator, tractor or ATV.[9]

TRCA and The Meadoway

The Importance of Clean Equipment

Using clean equipment is vital to the preparation and maintenance of pollinator restoration sites along ROW. Frequent mowing by contaminated equipment in the wrong season can unintentionally spread the seeds of invasive species over hundreds of kilometres. In the last decade, mowing has been responsible for the spread of Wild Parsnip along thousands of kilometres of Ontario roadsides, leading to costly control measures. Preventing the spread of invasive species to any ROW site is considerably more cost effective than trying to control the spread. Similarly, once a site has been prepared to be free of weed seeds, it is critical to prevent the arrival of invasive species on seeding or mowing equipment.

Fortunately, an excellent guide has been prepared for use in Ontario. A *Clean Equipment Protocol for Industry*[10] was developed by the Ontario Invasive Plant Council and partners, inspired by similar documents produced in Australia. The guide was developed for the construction, agriculture and forestry industries, and it outlines methods of inspecting and cleaning industrial equipment to prevent the unintentional spread of invasive plants. It gives operators practical tools and techniques to inspect and clean the inside and outside of a variety of conventional and heavy equipment vehicles.

Preparing Sites with Existing Vegetation

The goal of site preparation is to create a high quality, weed-free soil surface. To prepare a site for restoration, the competing non-native species must be removed from the site. Unless an area has been recently cropped, this may take several seasons.

Preparing large sites typically involves herbicide use. The application of a non-persistent, non-selective herbicide (e.g., glyphosate) is usually recommended. It must be applied while weeds are actively growing, in the early spring and fall. Permits are usually required to obtain and apply herbicide; check local regulations.

Mow and Spray Method

This is the most widely used type of site preparation. It requires the use of a non-selective herbicide, usually over at least two or three seasons. In this approach, a site is mown in fall or spring to remove thatch, but is not cultivated to avoid bringing weed seeds to the soil surface where they may germinate. Herbicide is then applied to European cool-season grasses at a time when growth rates are highest. This is repeated for one or two more seasons (fall/spring), until competing vegetation is eliminated. Seeds are broadcast directly onto the dead vegetation and may be pressed into the soil using a lawn roller, clean cultipacker or ATV.

Getty Images; Holly Bickerton

Repeated Cropping Method

The above method may be modified by working the soil to remove weeds. Following mowing and herbicide treatment, the soil is cultivated to prepare a seed bed to planting condition. A crop (e.g., oats or soy) is planted to suppress weed growth, allowed to germinate, and then the site is again sprayed with glyphosate. The process can be repeated multiple times in one growing season until a clean, weed-free seed bed is obtained.

The use of herbicide is the most common and cost-effective approach to site preparation and is recommended by many conservation organizations, including the Xerces Society. However, the use of herbicides is being increasingly limited in many provinces. Two approaches that use no herbicide are described below.

Stripdozing Method

This technique has been successfully used in southwestern Ontario, where pasture grasses have formed thick sods with dense roots, or in areas that have received high nutrient inputs (fertilization) over decades. Nutrients allow exotic weeds to outcompete native plants. Because native plants are more competitive where nutrients are low, they may do better in exposed subsoil. Removing soil to a depth of about 18 inches (50 cm) will expose the subsoil and will also remove the bulk of the viable weed seeds. Soil may be removed, or buried on site, depending on space. This method has been successfully used to remove sod on clay soils where the soil texture resulted in thick hummock formation.

This technique may be most effective in agricultural areas of southern Canada where native prairie previously dominated the landscape. However, as an organic method of site preparation, further experimentation is warranted in other areas.

Other Organic Methods of Site Preparation

There are additional site preparation methods that do not use herbicide, although these are usually more costly and require more time. They are worth consideration for smaller sites (e.g., less than one hectare) with access to volunteers to hand pull weeds. If using organic methods, start with a small area.

Some organic methods of site preparation include:

- **Solarizing** — covering the site in UV stable plastic for at least one growing season
- **Mulching** — covering the site with a thick organic layer, such as newspaper, leaves or wood chips, to suppress seeds
- **Sod removal** — cutting shallow roots with a commercial sod cutter and removing sod sheets

All of these methods will require follow-up manual weeding. For more detailed information on organic site preparation, consult the Xerces' Society's *Organic Site Preparation for Wildflower Establishment*.[11]

Katie Turnbul; Stefan Weber

4. CHOOSING AND PURCHASING NATIVE SEED OR PLANTS

Why Native?

Native plants that are found locally will provide the best resources for native pollinators, including bees and many other species. Some native insects specialize on native plants, which also offer the best sources of nectar and pollen for adults and larvae alike. Compared to non-native plants, native plants are more likely to attract native bees and support a higher diversity of moths and butterflies.

Using native species that are found in the local area helps ensure success; those not found locally may not germinate or persist through a winter. Seeds or plants that originate nearest to the local region will be the best adapted to local conditions and will likely be more successful over the long term.

However, we recognize that in some areas of southeastern Canada, there is a limited supply (or no supply) of locally sourced native seed. Policies that encourage the use of locally sourced native seed will help to grow this market. While challenging in the short term, sourcing seed from within your region or seed zone will pay off in the long run.

Seed Zones

Many Canadian provinces have identified Seed Zones[12] or ecozones by which seed sources are identified. Each zone has been created based on climate and/or ecological conditions, including temperature, precipitation and even soils; plants within these zones are assumed to be similarly adapted.

Identify your seed zone and ask suppliers from which area or seed zone their seed originates. Choose seed from as close to your zone as possible. To address the long-term warming effects of climate change, some restoration specialists now use mixes containing genetic sources from warmer zones. For example, some may choose a mix that originates 50 per cent from within their own zone and 50 per cent from a warmer zone(s).

Stefan Weber; Ministry of Natural Resources

Finding a Native Plant Supplier

Suppliers of native plants and seeds are found mainly in southern Ontario, Quebec, British Columbia and Alberta. The Canadian Wildlife Federation maintains a database of native seed suppliers and nurseries from across Canada,[13] and local lists can also be obtained from some chapters of the Society for Ecological Restoration (SER). In some areas, such as Atlantic Canada, availability of both native seeds and plants is very limited. Start planning your purchase early. Supporting local native seed and garden suppliers creates demand for their products and ensures that native seed of local origin is available for other conservation projects.

Note that many large-scale Canadian suppliers do not grow native seed but rather obtain stock from American suppliers across the continent. When ordering from a supplier, ask them which area or seed zone each species in a mix originated from. Good suppliers will know the source of each species and understand the importance of this information. Try to choose seed from a nearby zone (see "Seed Zones" sidebar).

Plant Selection

It is best to consider plant selection early in the planning process. Several decisions will guide which plants you select. Especially important factors are soil moisture conditions (dry/wet) and soil type (clay/sand/loam). ROW projects may also wish to consider unique factors, such as salt and disturbance tolerance and height of plantings. Safety is a clear priority along many ROW, and maintaining sight lines is critical for motorist safety. Most native plantings will be a minimum of three to four feet high, although shorter mixes can be created.

Early in your planning, consider whether you will use seeds or plants (that is, greenhouse grown container stock or plugs) at your restoration site, because it will affect the timing of your activities. In general, seeds are much cheaper per hectare and are most suitable for landscape-scale sites. Locally grown nursery stock is most suited to small-scale pollinator plantings, but may be more readily available and will establish and bloom more quickly. Some large-scale projects use a mix of seeds and plants. In this case, the container stock or plugs are usually clustered in high visibility areas and in places where they can more easily be watered and cared for through their first season.

Standard Seed Mixes

Some native plant suppliers sell standard native seed mixes for a variety of conditions (for example, "Dry Southern Ontario Prairie Mix" or "Native Pollinator Mix"). These mixes, used with caution, may be appropriate in some cases. They typically contain 10 or fewer species, which is less than half of what most specialists recommend, and may contain species that are not native to your local area. Many "native pollinator mixes" even contain European annual species. Use standard mixes with caution, confirming that the species list contains **only** species that are native to your area.

Custom Seed Mixes

For many restoration projects, custom mixes offer the best value and certainty. Good suppliers are knowledgeable and can offer guidance. Begin this process over a year before planting, in order to confirm the species and ensure availability. There are many resources available as a guide.

Conduct a site inspection. The plants you select will be determined by the moisture content and composition of the soils at the site, as well as other site-specific factors, such as height and disturbance.

Consult a list of native plants found in your area. Pollinator Partnership Canada has created online eco-regional planting guides for many areas of southern Canada. In other areas, consult local experts, native plant nurseries, reference sites or regional floras to develop a species shortlist. These sources provide plant species to use as a starting point, including site requirements, blooming time and pollinators of each species. It is recommended that you consult a local botanist or Society for Ecological Restoration member (see Additional Resources – Organizations) to develop or review your draft species list.

Involve partners. Selecting species can be an opportunity to involve partners, which may include local conservation groups and/or Indigenous communities. This will enhance your stewardship efforts.

Confirm availability. Contact native seed suppliers early in the process to ensure the species you need will be available in sufficient volume. If a species that is commercially unavailable grows locally, you may be able to contract a native grower to collect seed, or even use community partners to collect seed locally.

Here are some tips in preparing a species list:

- Choose a range of flowering species to provide continuous pollen and nectar sources from late May to September. Many meadow species bloom in August and September in Canada; choose carefully to ensure your mix includes both early and late flowers to sustain pollinators.
- Choose as many species as possible. Aim to include 20 to 40 species for most ROW sites. Extensive areas (e.g., utility corridors) in southern Ontario and Quebec will benefit from as many as 50 to 60 species if possible. Adding more species is more effective than adding more seed.
- Select about 60 per cent wildflowers to about 40 per cent native grasses. Select by species rather than weight, as grass seeds are naturally larger and heavier than most native wildflowers and will dominate by weight.
- Include at least one species of milkweed, ideally the one most common in your area (see "Milkweed: A Pollinator Superstar" sidebar).
- Include a diversity of plants with different flower shapes, colours and plant heights.

To help choose a species list, Pollinator Partnership Canada has produced Ecoregional Planting Guides containing plant lists for most regions of southern Canada.[14]

Stefan Weber

Native Plants and Road Salt

Road managers are understandably concerned about the effect of road salt on native plantings. However, many of our native plants are relatively tolerant of elevated salinity. Good all-round salt tolerant species for many areas of southern Canada that are widely available include Black-eyed Susan (*Rudbeckia hirta*), Little Bluestem (*Schizachyrium scoparium*), Indian Grass (*Sorghastrum nutans*), Virginia Wild Rye (*Elymus virginicus*), Blue Vervain (*Verbena hastata*), St. John's-wort (*Hypericum* sp.), Woolgrass (*Scirpus cyperinus*), Boneset (*Eupatorium perfoliatum*), Common Sneezeweed (*Helenium autumnale*) and Switch Grass (*Panicum virgatum*). Consult local resources or a local botanist to choose species appropriate for your area. Of course, reducing the quantity and impacts of road salt also benefits the broader environment.

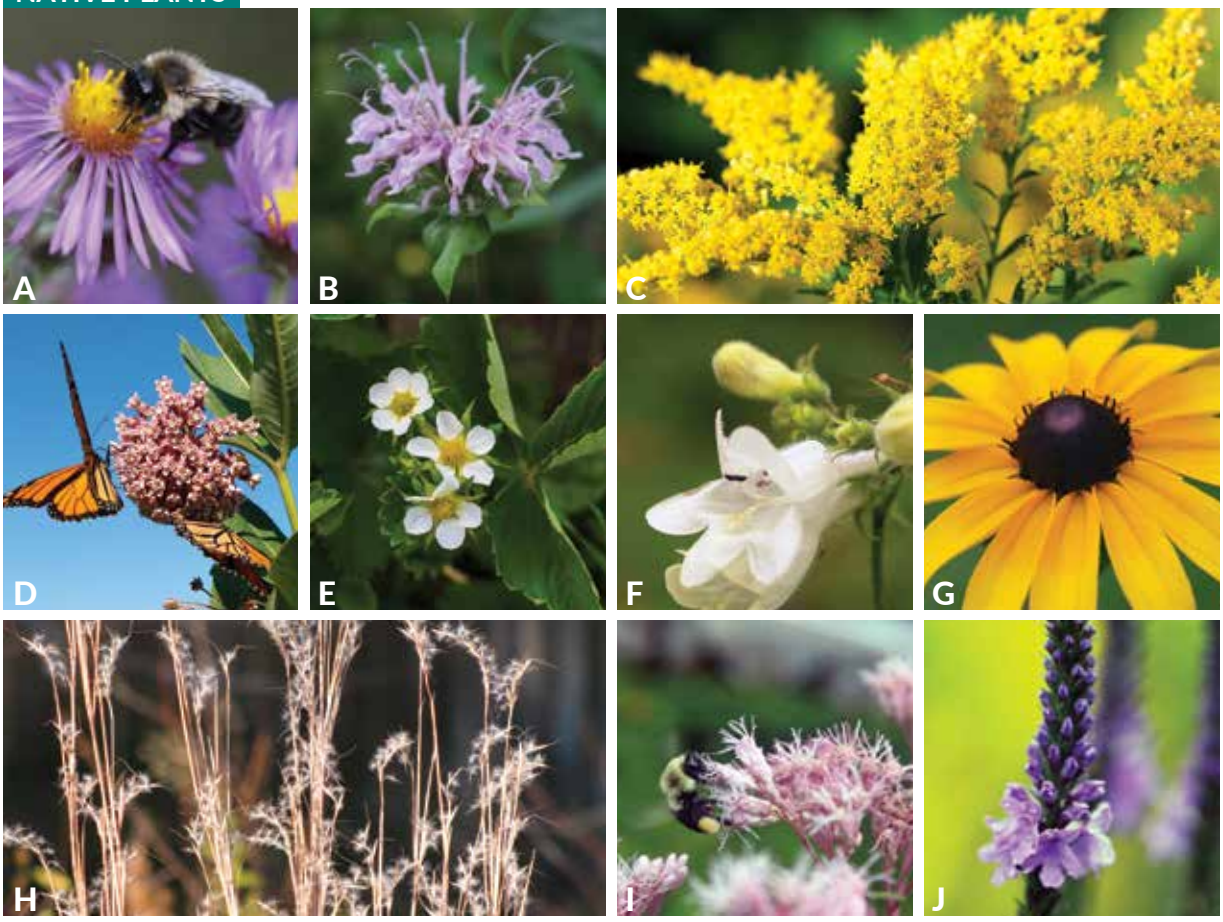
Great Wildflowers for Pollinators

While many flowering plants contain nectar, some are better sources than others. Native species of the following nectar-bearing genera are found in many parts of southern Canada and are great sources of nectar for pollinators, including bees and butterflies. Consult a local plant list to choose the species that are native to your area.

- Asters (*Aster* spp., *Doelleringia* spp., *Eupatorium* spp., *Eutrochium* spp., *Symphyotrichum* spp.)
- Bergamot (*Monarda* spp.)
- Beardtongues (*Penstemon* spp.)
- Black-eyed Susans/Coneflowers (*Rudbeckia* spp.)
- Fireweed (*Chamerion angustifolium*)
- Goldenrods (*Euthamia* spp., *Oligoneuron* spp., *Solidago* spp.)
- Milkweeds (*Asclepias* spp.)
- Strawberries (*Fragaria* spp.)
- Sunflowers (*Helianthus* spp.)
- Tick-trefoils (*Desmodium* spp.)
- Vervain (*Verbena* spp.)

For more information, see the Pollinator Partnership's ecoregional planting guide for your region of Canada.[14]

NATIVE PLANTS



| A New England Aster **| B** Wild Bergamot **| C** Goldenrod **| D** Common Milkweed **| E** Wild Strawberry **| F** Foxglove Beardtongue **| G** Black-eyed Susan **| H** Little Bluestem **| I** JoePyeweed **| J** Blue Vervain

Sarah Coulber; Sarah Coulber; Brenda Doherty; Getty Images; Getty Images; Getty Images; Sarah Coulber; Getty Images; Sarah Coulber; Sarah Coulber;

Great Shelter Plants for Pollinators

Grasses, sedges and shrubs provide shelter for insect pollinators. Typically, warm-season grasses (e.g., Big Bluestem, Little Bluestem, etc.) are recommended for meadow and especially prairie restorations, as these are dominant and rapidly growing species in North American prairies. The seeds are also widely cultivated and available through native plant suppliers. However, these species are often rare or absent in many more temperate areas of southcentral and southeastern Ontario, Quebec and eastern Canada. In their place, smaller, local species of native cool-season grasses (e.g., Rye grasses, *Elymus* spp., *Bromus* spp., *Danthonia* spp.) can be substituted in a pollinator seed mix. Some restoration specialists have also successfully used native sedges (*Carex* spp., e.g., Fox Sedge, *C. vulpinoidea*) and rushes (*Juncus* spp., e.g., *J. effusus*, *J. tenuis*) in restoration plantings.

Requesting a Purchasing Quote

Using the resources above, create a "wish list" of species and provide a list to potential suppliers to obtain a quote. Sources of certain species can be prohibitively expensive due to low supply in some years, and suppliers may recommend substituting similar species, or simply omitting a species, to keep costs down.

If a desired species is unavailable, some suppliers offer native seed collection on contract. Contract collecting services usually require a long lead time because seed needs to be collected at the right time, usually in late summer or fall.

Cindy Conlin

Milkweed: A Pollinator Superstar

Most people know that Monarch caterpillars feed only on the leaves of milkweed (genus *Asclepias*). But did you know that the showy flowers also provide an abundant source of nectar for many species of butterflies, moths, native bees and other native insects? Common Milkweed also blooms in June before many other nectar-bearing species are in flower. For all these reasons, milkweeds are an extremely valuable addition to pollinator restoration sites.

Planting at least one species of locally native milkweed is recommended. In eastern Canada, the most common species is Common Milkweed (*A. syriaca*), which favours dry to medium sites. It can be difficult to establish, but plants are long-lasting. The flowers of Swamp Milkweed (*A. incarnata*) are brighter pink and the seed pods are narrower than Common Milkweed. It occurs naturally in moist areas, including shorelines. It is easier to grow from seed, but seeds are more difficult to obtain. In the prairies and western Canada, the most common species is Showy Milkweed (*A. speciosa*), which prefers well-drained soils and grows in pastures, meadows, clearings and roadsides.

Many other milkweed species occur in Canada, but most are found in quite specific habitats in southern Canada, and their seeds are not widely available. Use other milkweed species only on the advice of a specialist.

How Much Seed Do I Need?

The amount of seed you need depends on the size of your area, the habitat type and your method of planting. Suppliers often recommend heavy seeding rates for native meadow and prairie plantings, often as much as 25 to 30 kilograms per hectare (kg/ha). However, well-prepared sites with low weed competition have been successfully seeded using seeding rates as low as three kg/ha. The plants that germinate in the first season naturally seed the area until it fills in.

A typical seeding rate recommended for a hand-broadcast meadow or prairie site in southeastern Canada is in the range of 6 to 10 kg/ha. A lower rate can often be used if drill-seeding, because the seed will be more evenly and effectively sown, and little is lost to seed-eating animals or to runoff. Typical costs of native seed mix range from $150/kg to $250/kg, depending on the species in the mix. Be aware that cheaper mixes may already contain a proportion of cover crop seeds (see "Using a Cover Crop or Thinner" sidebar).

Some nurseries in southwestern Ontario and parts of the prairies offer full-service installation of native meadows and prairie. This full-service approach includes custom advice, native seed and seed drill planting, and it costs around $2,000/acre.

Planting the right amount of seed is critical to success. A common mistake in native plant restoration is to sow sites too thickly, increasing competition among young plants. **Adding more species to your mix is usually better than adding more seed.**[15] Similarly, resist the temptation to add too much of the cover crop seed, as this can inhibit germination and smother young native plants.

Sandy Garland

Using a Cover Crop or Thinner

Some seed mixes are advertised with a "cover crop" or "nurse crop" included in the mix. This means that an agricultural crop grass, such as rye or oats, is added to the native seed mix.

Cover crop seeds can be useful in two ways. First, if your site is planted in spring, these annual plants will help protect young native plants and will compete with aggressive alien species through the first season. They are then killed by frost at the end of the first season, and native plants can fill their gaps in the second spring. If you are designing your own seed mix, you can mix it with a crop such as proso (white) millet or oats seed at 10 kg/ha. Note that clover as a cover crop is not recommended because it is perennial and adds nitrogen to the soil, which gives an advantage to European weed species.

A cover crop such as oats or millet is also an inexpensive thinner if you are broadcasting seed. For example, proso (or white) millet and oats ($2 to $5 per kilogram) are both effectively used in Ontario. By mixing native seed mix with an equal or greater volume of a "thinner" crop seed, your native seeds will be better distributed on the site and will give a visual representation of how evenly the seed is being spread. Resist advice to sow cover crops too thickly or they can shade and crowd out native seeds in the first year. If spread in fall, the crop seed will not survive to germinate the following spring. Other inert materials, such as coarse sand or vermiculite, can be used for this purpose, but crop seed is an available and inexpensive choice.

Tractor-mounted broadcast seeder

Native seed drill

Hydroseeding

Broadcasting seed by hand

5. FINAL SITE PREPARATION AND SEEDING

Before planting, the soil bed should be weed-free, smooth and firmly packed to ensure the best seed-to-soil contact. Do not till the soil since this may uncover weed seeds. Prior to planting, loose soil can be hard packed with a cultivator, tractor or ATV, but make sure all equipment is clean and free of weeds before use.

Timing: Either fall or spring seeding is possible. Many growers recommend fall seeding for native seeds, because exposure to the freezing winter temperatures helps to break down their seed coats and promotes higher germination in the first spring. Fall plantings are done after frost and before substantial snow cover, which is typically **mid-October to late November** in southern Canada.

Seeds can also be planted in spring, and some suppliers prefer this. Seeds sown in spring take a bit longer to establish. Some species may not appear in plantings until the following spring. Spring plantings are best done during the **month of May**.

Whether you seed in spring or fall, patience is a key ingredient! Most native plants spend their first one or two seasons developing strong root systems, and few species will produce flowers before their second or even third full season.

Final Site Preparation

When your seeds are ready and your site is weed-free, hard-packing the soil with a cultipacker, tractor or ATV is recommended. Hard-packing gives native prairie plants an advantage over introduced grasses, which exploit soft soils.

Jake Lozon; Jake Lozon; Stefan Weber; Holly Bickerton

Broadcasting by Hand

For smaller sites (up to 10 hectares), wet or steep areas, or irregularly shaped sites, seeds are best planted by hand broadcasting. This is a low-cost activity and can be done by volunteers with some training, as long as the site is safe to access.

Weigh and mix the seed on a tarp with a cover crop thinner, such as millet or oats, at a rate of approximately 10 kg/ha. Split the mixed seed into two halves. Mark lines approximately 10 metres apart across your site at right angles. Using half the seed distributed in buckets, volunteers walk along the lines, flinging seed every five steps or so. Repeat with the remaining half of the seed in the other direction. This approach helps get even coverage and prevents running out of seed. After broadcasting, pull a cultipacker or light roller over the area to get good seed-to-soil contact. If a roller is not available, a clean tractor or ATV can be used. The aim is not to cover the seed but to press it into the soil.

The widely available hand-cranked spreaders used to spread grass seed are not recommended. They spread seed much too thickly, and it's likely that seed will run out before the site is covered.

Broadcasting by Machine

At larger sites (e.g., 10 hectares or larger), a mechanical seeder can be pulled behind or mounted onto a tractor. Broadcast Seeders are automated tractor-mounted seeders for medium-scale sites.[16] A Wildflower Seeder is a larger drop seeder that is pulled behind a tractor.[17] The brand most commonly available in Canada is made by Truax. Seeders must first be calibrated to control the seeding rate. The native seed mix is fed into a hopper and is dropped on the ground and packed down. Native seed drills can also be rented or purchased at a higher cost. These drills plant seeds in rows by opening slits in the soil, and do not require the soil to be tilled before planting. For most sites, very good results are achieved with less expensive drop seeders.

Hydroseeding with Native Seeds

Hydroseeding involves mixing seed in slurry with mulch and dye and spraying it onto bare soil. It is often used in areas that are prone to erosion, especially on roadsides where soils require rapid stabilization following construction. Typically, hydroseeding has been done with rapidly germinating non-native species, such as non-native lawn grasses, clover and vetch.

Although hydroseeding provides an opportunity to establish native plants, there are challenges and considerations when using this method. Hydroseeding with tiny native seeds can require larger amounts of seed (up to 10 times more than other methods), and without careful attention the thick slurry may prevent the seed-to-soil contact needed for the successful establishment of native seeds.

An alternate method of hydroseeding native plants holds promise. Studies on Ontario roadsides showed improved germination by sowing seed first on bare soil, and then overspraying with a seed-free mulch.[18] This permits the seed to contact the soil before being covered with mulch, and it prevents loss of the tiny wildflower seeds within the hydroseeding equipment.

As an alternative to hydroseeding, consider sowing a rapidly establishing cover crop together with the native seed instead of applying mulch. The following tips may also help control erosion on steeper slopes:

- Use a higher seeding rate (around 50 to 100 per cent more seed) than on flat sites to account for loss due to erosion
- Inter-plant seedlings of rapidly growing native plants or small shrubs to bind soil
- Embed natural features, such as logs and/or rocks, in the slope to slow water flow
- Create channels or trails for drainage
- Spread leaves and/or clean mulch
- Use plain coir woven erosion control blankets on steep slopes

Using Plugs and Container Stock

Although more costly, using plugs or container stock may be ideal for smaller demonstration sites or in areas of high visibility. Seedlings are already further along in their development, and these sites will show early results, often flowering in their first year. Native shrubs can provide excellent early nectar sources but are very slow to grow from seed. Strategically placing container stock within larger plantings may be an option at some ROW sites. Planting plugs or nursery container stock can also be excellent ways to involve community members in a project. Some municipalities are involving community groups to participate in native meadow restoration projects.

To maximize success of using plugs or container stock:

- Mid-May to mid-June is the ideal window for planting transplants in most parts of southern Canada.
- Ensure transplants are acclimatized to open, sunny conditions ("hardened off") before planting.
- At planting time, water them well with 10-52-10 transplant solution to encourage root growth.

Transplants will need care for the first few months following planting (see below).

Preparing to transplant Prairie Smoke and some other native plants

Holly Bickerton; TRCA and The Meadoway; Jake Lozon

6. MAINTAINING A NATIVE MEADOW RESTORATION SITE

Short-term Maintenance

Fall-seeded meadows will begin growing early the following spring. Spring-seeded sites will develop slightly later, and germination may be somewhat lower in the first year. Native seed does not require mulch, fertilizer or water, unless you are experiencing prolonged drought conditions. Use of fertilizer is discouraged because it favours growth of non-native plants. Maintenance is minimal while you wait for plants to develop.

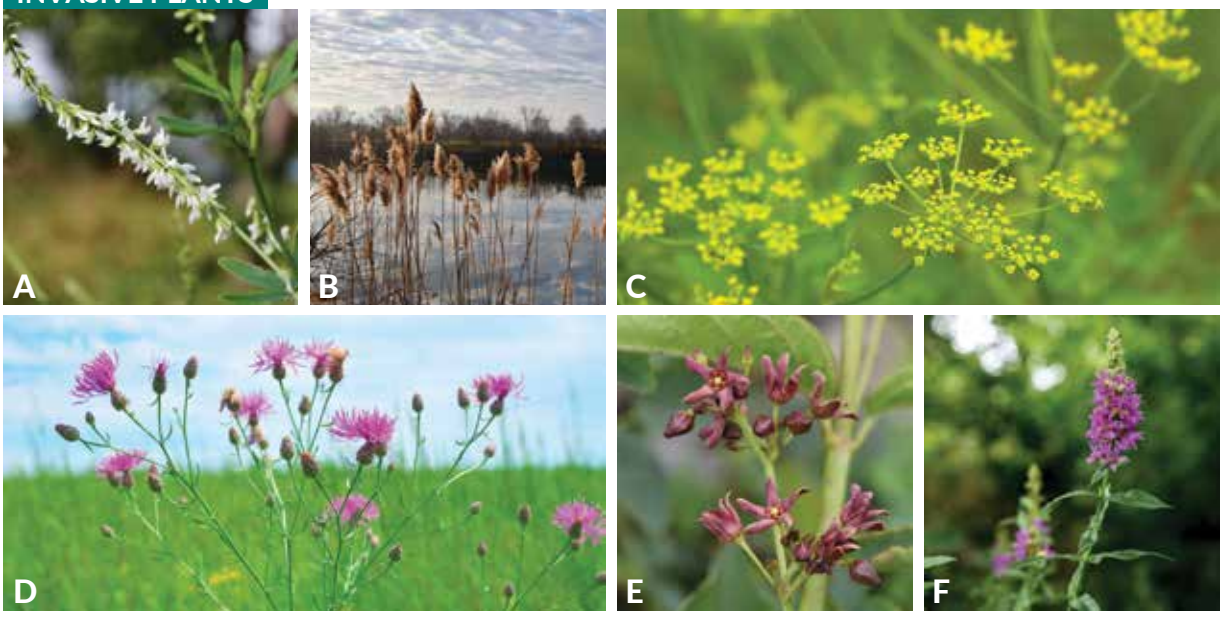
Transplants require more care. If there is insufficient rain, water them every two weeks with plain water. Shrubs and trees need watering every two weeks for at least two years when there is insufficient rain.

Fencing and Signage: Temporary fencing or barriers will protect your site from foot traffic and, if necessary, deer grazing of tender young plants and seedlings. Clear signage combined with fencing, barriers or stakes will protect the area from unintended mowing and from pesticide or herbicide use and other disturbances.

Mowing: Many experts now recommend mowing sites planted in native perennials in late June or early July of the first year, to reduce competition by annual weeds and promote the growth and flowering of native wildflowers. When the competing vegetation reaches 30 centimetres, or if weeds begin to flower, mow at a height that leaves the native seedlings untouched, usually about 12 to 15 centimetres. This will prevent the annual weeds from re-seeding. Remember that equipment must be clean.

Weed control: Monitoring and weeding may be required for two or three years depending on the success of site preparation and the rate at which new seeds establish. Options include hand pulling or spot spraying weeds with herbicide, ideally in early spring or late fall when native species are dormant and exotics are active. It can be difficult to distinguish weed species from native plants. The involvement of a local botanist would help in this regard. Aggressive and/or invasive species that may establish in pollinator meadows include Dog-strangling Vine, Wild Parsnip, Spotted Knapweed and White Sweet Clover.[19] Once a species-rich native meadow is established, it should minimize the need for regular weed control.

INVASIVE PLANTS



| A White Sweet Clover **| B** Phragmites **| C** Wild Parsnip **| D** Spotted Knapweed **| E** Dog Strangling Vine **| F** Purple Loosetrife

Getty Images; Getty Images; Getty Images; Getty Images; Tyler Smith; Nathaniel Cadiente

Long-term Maintenance

One of the advantages of native meadows is that long-term maintenance costs are greatly reduced when compared to manicured lawns or even areas dominated by introduced grasses.

However, in many areas, grasslands will eventually change into shrub thickets and young forests. Woody shrubs and trees will begin to establish after two or three years, and by five to eight years they can grow above the meadow. If natural succession is the long-term goal for the site, no management is required. However, if open habitat is desired, woody growth must be controlled. There are three main options for doing this: mowing, hand pulling or spot spraying, and burning.

Mowing: Mowing should be carefully considered. Done at the wrong time of year, it can be destructive to plants, insects, soils and wildlife. Equipment must be clean or restoration plantings can be quickly invaded by weed seeds. Mow sites to 18 inches every two to three years, ideally in early spring or late fall. (However, in areas where invasive species are present, fall mowing may spread weed seeds.) If possible, remove cuttings, which will otherwise build nutrients in the soil that favour introduced species. Mow different areas each year, so that a matrix of young and mature plants will always be available to pollinators.

Hand Pulling or Spot Spraying: Aggressive invasive plants should be hand pulled or spot sprayed to prevent re-growth. Areas of bare soil where plants have been controlled can be over-seeded with native seed. Remove stems from the site to prevent nutrient build-up, which favours invasive plants. This is more labour-intensive than mowing, but because heavy equipment is not needed, there is reduced risk of transporting invasive species.

Prescribed Burning: For most areas of southeastern Canada, prescribed burning is the most ecologically effective way to maintain a site as a meadow or a prairie. However, burning is often impossible in ROW sites for safety and logistical reasons. If possible, consider burning small patches of a pollinator meadow in early spring every three to five years, on a rotational basis.

Training Staff and Contractors

Getting staff at all levels on board with changes in management practices is crucial to success. When there is a lack of communication or support, areas of pollinator habitat are sometimes mistakenly sprayed or mown, leading to setbacks and sometimes poor community relations.

Engaging all staff within your organization, including planners, operations staff, engineers, public relations staff and communications staff will help make sure that their investment in pollinator habitat is fully realized. If contractors are frequently used, include them in training and communications to ensure their support. Training may include information on changes to practices, but also on the importance of pollinators, IVM techniques, native and invasive plant identification, and communication with the public. Changes to contract specifications to include native seed planting and altered mowing schedules will be key to achieving success.

Engaging and investing in staff training from all levels and departments is the best way to ensure that your organization's pollinator habitat management and restoration work is integrated into regular operations for the long term.

Jake Lozon; TRCA and The Meadoway

Partnership and Community Engagement

We are currently in a time of great environmental change, and pollinator conservation is one of many environmental concerns of the broader community. There are opportunities for partnerships with corporations, local governments, non-profit groups, community organizations, small businesses, agricultural communities, schools and many others. Partnership across communities ensures the long-term sustainability of your work.

To promote community engagement, many ROW organizations have undertaken significant communications work to their benefit. These might include community consultation events, signage, demonstration gardens, seeding or seed collection events, bee hotel building, community plantings, or promotions though seed availability. There is a huge scope for partnership and community relations through positive environmental action.

GROWING FORWARD

We hope this guide has provided both the inspiration and the information needed for you and your local ROW organizations to begin improving and restoring networks of habitat throughout southern Canada. Remember: this is a continent-wide movement, and your work will help to build a continuous network of natural habitat, not only for insect pollinators but also for other wildlife. For more resources, visit HelpThePollinators.ca.

Holly Bickerton; TRCA and The Meadoway; TRCA and The Meadoway; Jake Lozon

ADDITIONAL RESOURCES

1. **Technical Guide for Enhancing, Managing and Restoring Pollinator Habitat along Ontario's Roadsides**
   www.pollinatorpartnership.ca
   This guide offers additional technical detail for road managers, including detailed information on pollinators, and species lists for five Ontario ecoregions.
2. **Technical Guide for Enhancing, Managing and Restoring Pollinator Habitat on Ontario's Utility Lands**
   www.pollinatorpartnership.ca
   This guide offers additional technical detail for utility managers, including detailed information on pollinators, and species lists for five Ontario ecoregions.
3. **Selecting Plants for Pollinators: Guides for Gardeners, Farmers and Land Managers**
   https://pollinatorpartnership.ca/en/ecoregional-planting-guides
   A series of guides listing pollinator plant species, including wildflowers, grasses, trees and shrubs, found in 28 ecoregions in most Canadian provinces.
4. **Rights-of-Way as Habitat Working Group website**
   www.erc.uic.edu/biofuels-bioenergy/pollinator-habitat/rights-of-way-as-habitat/
   This North American network of ROW organizations holds regular conferences and has an informative website with Best Management Practices, webinars and archived recordings, case studies, pollinator scorecard, and many other resources designed for ROW managers.
5. **ODOT Guide to Establishing and Maintaining Roadside Pollinator Habitats, Ohio Department of Transportation**
   www.transportation.ohio.gov
   ODOT is a leader in ROW management and restoration for pollinators; their guide contains additional information on site criteria, equipment, seeding and maintenance at scale.
6. **Guide to Monarch Habitat on Rights-of-Way, Monarch Wings Across Ohio**
   www.pollinator.org
   This work contains great information on Monarchs along ROW, with Ohio-based examples of restoration.
7. **Establishing Pollinator Meadows from Seed, Xerces Society**
   www.xerces.org
   This US document describes in detail methods to create native wildflower meadows in areas up to one acre.
8. **Organic Site Preparation Methods for Wildflower Establishment, Xerces Society**
   www.xerces.org
   Evidence-based guidelines for a number of herbicide-free site preparation methods.

Organizations

- Rights-of-Way as Habitat Working Group
  http://rightofway.erc.uic.edu
- Society for Ecological Restoration – Chapters in Ontario and Western Canada,
  www.ser.org
- Field Botanists of Ontario
  www.fieldbotanistsofontario.com
- Wild Pollinator Partners -Ontario East-Outaouais
  https://wildpollinators-pollinisateurssauvages.ca/

Suppliers of Locally-sourced Native Seed

- St. Williams Nursery and Ecology Centre, St. Williams, Ontario; southwestern Ontario sourced
- Ontario Native Scape, Wallaceburg, Ontario; southwestern Ontario sourced

Native Plant Nurseries and Suppliers

- CWF Native Plant Supplier Profiles
  http://cwf-fcf.org/en/explore/gardening-for-wildlife/plants/buy/native-plant-suppliers/native-plant-supplier-profiles/
- Native Plant Resource Guide Ontario, 6th edition
  http://chapter.ser.org/ontario/files/2012/08/SERO-6th-Ed.-Growers-List-Only.pdf
- Ferguson Tree Nursery
  www.fergusontreenursery.ca

ENDNOTES

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[6] Monarch Joint Venture, Mowing and Management: Best Practices for Monarchs. https://monarchjointventure.org/images/uploads/documents/MowingForMonarchs.pdf

[7] Rights-of-Way as Habitat Working Group, Pollinator Scorecard User's Guide, v.2.0, 2019, http://rightofway.erc.uic.edu/resources/tools/

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[9] Halloran, J., H. Anderson, and D. Tassie. 2013. Clean Equipment Protocol for Industry, Peterborough Stewardship Council and Ontario Invasive Plant Council, https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/Clean-Equipment-Protocol_June2016_D3_WEB-1.pdf

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[11] Jordan, S., J. Cruz, K. Gill, J. Hopwood, J. Fowler, E. Lee-Mader, M. Vaughan. Organic Site Preparation for Wildflower Establishment. https://xerces.org/publications/

[12] OMNR 2011. Southern Ontario Tree Seed Zone Atlas. https://collections.ola.org/mon/25007/311423.pdf

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[15] M. Gartshore, pers. comm. 2018.

[16] Truax Seed Slinger, see Prairie Habitats Inc. http://www.prairiehabitats.com/Equipment_Seeders.html

[17] Truax Wildflower Seeder, see Prairie Habitat Inc., http://www.prairiehabitats.com/Equipment_Seeders.htmlhttp://www.prairiehabitats.com/Equipment_Seeders.html.

[18] Roadside prairie re-assembly in southern Ontario: does method matter?, Stefan Weber, PhD dissertation, Chapter 2, McMaster University, Department of Biology, 2020, in press

[19] See the Ontario Invasive Plant Council's *Best Management Practices* series: https://www.ontarioinvasiveplants.ca/resources/best-management-practices/

MANAGING RIGHTS-OF-WAY FOR POLLINATORS:

A Practical Guide for Managers

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