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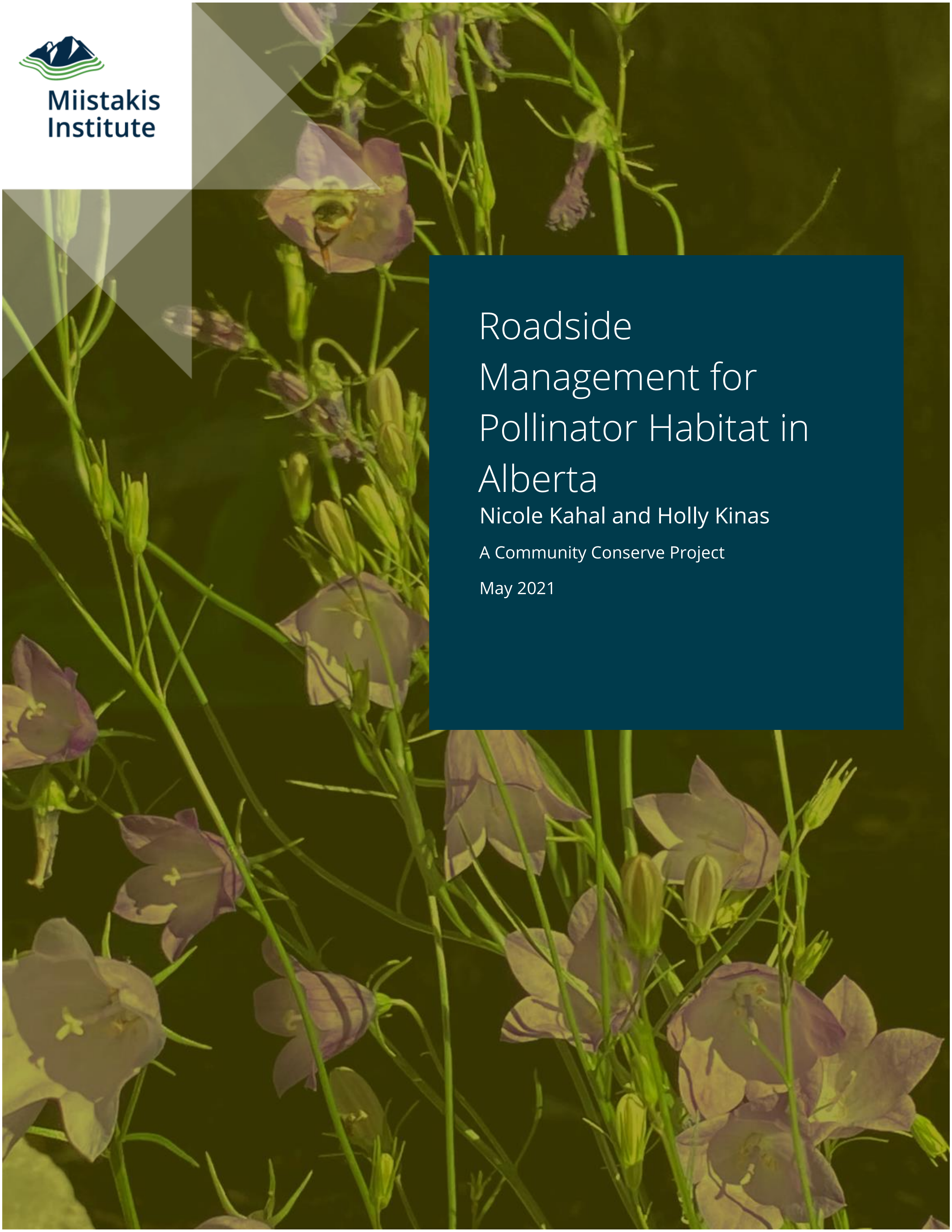

Roadside Management for Pollinator Habitat in Alberta

Nicole Kahal and Holly Kinas

A Community Conserve Project

May 2021

Innovative research. Engaged communities. Healthy landscapes.

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This resource was created as part of **Community Conserve.**

Community Conserve

Building environment and conservation capacity for municipalities

For more information about Community Conserve, please visit the website (www.communityconserve.ca) or contact one of the partner organizations:

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Executive Summary

Pollinators contribute to food security, biodiversity maintenance and ecosystem resiliency in addition to their social and cultural value. However, pollinators, particularly native populations, are declining around the world due to threats from habitat loss and land use practices. Roadsides, and other marginal lands, are not traditionally managed to support biodiversity or pollinators. However, these lands provide a unique conservation opportunity to continue serving their traditional purposes, while also supporting native pollinator populations.

Roadside restoration for pollinators was identified as a topic of interest to municipalities in Alberta through the Community Conserve program. We initiated a survey to determine what type of projects municipalities in Alberta are currently undertaking to support pollinator populations and conducted a literature review to summarize beneficial management practices in roadside maintenance and restoration for pollinator habitat. As well, relevant case studies and resources were gathered to guide municipalities interested in pursuing roadside pollinator projects.

Key findings:

- There is a plethora of information on beneficial management practices for incorporating pollinator habitat along roadsides. However, these practices have not been incorporated widely throughout Alberta or Canada.
- Alberta's municipalities that responded to our survey are supporting a wide diversity of pollinator topics by implementing projects. The most common topics are pollinator habitat on private property, herbicide use information, and marginal land reclamation (Figure 2). Alberta's municipalities are mainly using outreach and education and best management practices to promote pollinator conservation — policies and bylaws are less common. It is important to note that our survey reached only a small portion of Alberta's municipalities.
- There are few case studies in Alberta that provide information on the beneficial management practices, successes, cost and benefits of managing roadsides for pollinator habitat. However, interest is growing, and current pilot projects will provide much-needed information.
- Maintaining roadsides to support pollinator habitat, in addition to traditional uses, is possible.
    - Cost savings may arise from reduced mowing practices and reduced or altered application of herbicide.

    - Habitat restoration projects along roadsides may establish pollinator habitat more effectively, however, will require higher initial investment than traditional practices.
    - Native seed mixes are still a constraint, due to availability and cost.
- The development of an integrated vegetation management plan that incorporates practices supportive of pollinator habitat is integral to managing roadsides for biodiversity.
- We recommend that municipalities in Alberta pursue small pilot projects to continue to gather information on the successes and cost-benefit information that can be used to champion additional projects or changes in roadside management policy and practices.
- Council, Agricultural Service Board, and community support are important to ensure sustainability of roadside pollinator projects.
- We also recommend the creation of an Alberta community of practice to leverage successes, share resources, and ultimately make progress towards making roadsides a source of biodiversity, including pollinator habitat.

Introduction

Roadside restoration for pollinators was proposed by a municipal participant to the Community Conserve (www.communityconserve.ca) program as an idea of interest to other municipalities in Alberta. The Miistakis Institute developed this resource to assist municipalities interested in the restoration and management of 'marginal' lands such as roadsides to create low maintenance pollinator habitat. While we use the term roadsides, we recognize that municipalities may refer to the portion of managed land directly adjacent to a road as ditches and/or transportation rights-of-way.

Municipalities manage a significant portion of roads in Alberta. Rural municipalities alone manage 77% or 173,226 km of roads in the province (Button, 2006). Roadsides are conventionally managed to provide visibility, safety, and access, and are not traditionally designed to provide habitat. Management of roadsides includes vegetation maintenance to ensure these purposes are not impeded and invasive weeds are controlled. Due to the large cumulative area of roadsides, there is a lot of pressure to limit maintenance costs per kilometer. Because the intended purpose of roadsides lends itself to low, non-woody vegetation such as grasslands, roadsides also provide an opportunity to support pollinator habitat.
This document is intended to serve as a starting point for municipalities exploring projects that can reduce maintenance costs by repurposing roadsides as pollinator habitat. Our approach is to consider creating roadside pollinator habitat both through roadside maintenance and restoration. We provide a brief overview of the beneficial management practices for roadside maintenance and restoration, relevant case studies, and additional resources.

Based on our research, information related to roadside pollinator habitat in Alberta is growing but still limited. Therefore, many of the resources and case studies we present are from outside of Alberta.

Review process

A diverse approach was taken to review what information is available on the topic of using roadsides as pollinator habitat. We conducted a broad literature search, interviews with local municipal contacts and a survey of Alberta municipalities.

We began with a peer-reviewed literature search for studies in Alberta, Canada, and globally. We also conducted a search for unpublished (grey) studies based in Alberta, Canada, and globally. We began with the Google search engine and Google

Scholar search engine using keywords: ‘right of way’, ‘roadside’, ‘ditch’, ‘road’, ‘highway’, ‘pollinator’, ‘restoration’, and ‘management’. Additionally, references in identified sources were reviewed.

Local municipal contact interviews were conducted either by phone or video conference and focused on pollinator projects being undertaken. Many of these conversations and the subsequent resources formed the case studies in this report. At the end of the interview, we asked each contact if there was anyone within their network that they suggest we contact, or other written resources to review.

An Alberta-wide online survey was conducted to understand which municipalities have pollinator projects, what topics they address, and how their project is supported (e.g., policy, bylaw, educational materials, etc.). The survey was open from March 18–April 9, 2021, and was opportunistic — we did not reach out to each individual municipality but instead promoted the survey over social media and the Miistakis Institute newsletter. We also requested that the following groups considering promoting the survey through their channels:

- Alberta Urban Municipalities Association
- Rural Municipalities Association
- Association of Alberta Agriculture Fieldmen
- Alberta Recreation & Parks Association

Background

What are Pollinators?

The term pollinator probably congers images of furry bumble bees or hovering hummingbirds. But pollinators in Canada are very diverse, including bees, wasps, flies, moths, butterflies, ants, beetles, and birds (Agriculture and Agri-Food Canada, 2014). Because bees are responsible for the majority of global and Canadian pollination (Agriculture and Agri-Food Canada, 2014; Kearns et al., 1998; Klein et al., 2007; Nabhan & Buchmann, 1997; K. W. Richards & Kevan, 2002) many pollinator projects justifiably focus on bees. Due to their importance and abundance, we include here a review of bee life history characteristics (for details please refer to Alberta Native Bee Council (2018)):

- There are over 300 bee species native to Alberta. However honey bees are not native to Alberta, or North America. (Alberta Native Bee Council, 2018; Farmer & Pisicoli, 2020)
- Nesting habitat varies but the majority of native bee species nest in the ground or decaying wood (Alberta Native Bee Council, 2018; Farmer & Pisicoli, 2020) (Figure 1). Hollow plant stems are also important habitat for some bees (Alberta Native Bee Council, 2018).

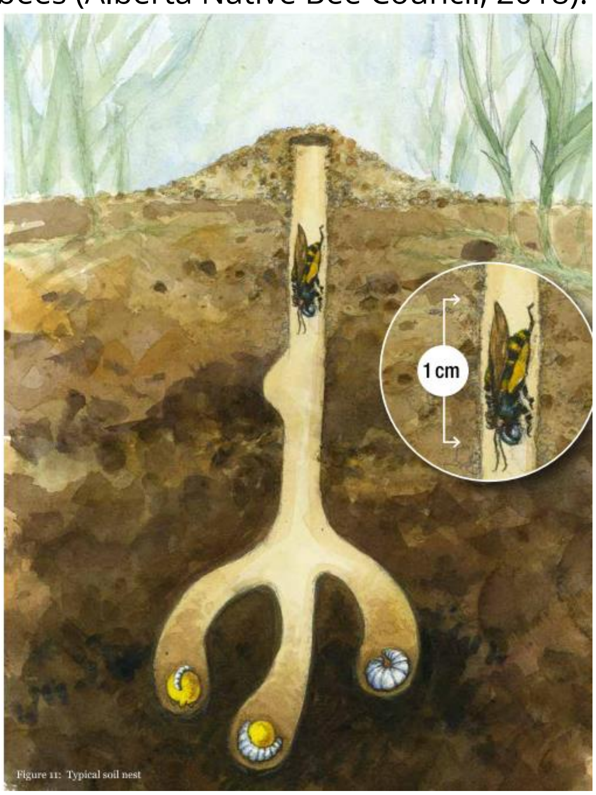


Figure 1: Typical soil/ground nest (Agriculture and Agri-Food Canada, 2014)

- Most native bee species are solitary and do not live in colonies or hives (with some exceptions like bumble bees) (Alberta Native Bee Council, 2018).
- Solitary bees overwinter in their nest during the egg, larva, and pupa stages (typically in a ground or wood nest), emerging as adults in the spring (Agriculture and Agri-Food Canada, 2014).
- Because bees need flowers throughout the spring, summer and fall, they use a variety of flowering plants for food.
- "Just like flowers, bees come in different shapes and sizes and not all bees are good at pollinating all flowers." This is why flower diversity is so important for pollinators. Although not common, there are bee species that will only forage on one species of flower. So having a diversity of plants helps ensure a diversity of pollinators are supported. (Alberta Native Bee Council, 2018)
- Although native plant species are the best for Alberta's bees, they will also visit flowers of non-native plants (Alberta Native Bee Council, 2018).

Why are We Concerned about Pollinators?

Pollinators are an important group of animals for both their ecological and agricultural roles. About 70% of all fruit, vegetable, and seed crops in the world rely on pollinators (Klein, 2007 as cited in Agriculture and Agri-Food Canada, 2014). The pollination services they provide for wild and agricultural plants is unintentional and is the result of foraging for nectar and pollen (Agriculture and Agri-Food Canada, 2014).

Native pollinators in Canada play an important ecological and agricultural role. However, due to the intensification of crops reliant on pollination, honey bee keeping has become a popular way to increase pollination services and produce honey (native pollinators do not generally produce honey in excess). Because honey bees are not native to North America and honey bee colonies have been shown to displace native bees and other native pollinators that share flowers and food (Lindström et al., 2016; Mallinger et al., 2017), native pollinators are under threat. Nearly 40% of all honey bee colonies in Canada are in Alberta (Crops and Horticulture Division - Agriculture and Agri-Food Canada, 2020) and beekeeping is regulated by the Alberta Bee Act with the requirement that each colony must be registered with the province annually (Government of Alberta, 2021). Honey bees' value as crop pollinators has been estimated to be more than $17 billion in produce yields in North America alone (Agriculture and Agri-Food Canada, 2014). However, when it comes to native pollinators, honey bees are not as efficient *per bee* as native pollinators (Agriculture and Agri-Food Canada, 2014). In the United States, native bees contribute to the production of an estimated $3 billion worth of crops annually (Calderone, 2012; Hopwood, Black, Lee-Mäder, et al., 2015; Losey & Vaughan, 2006).

In Canada, honey bee colonies are increasing due to bee imports in response to increase in demand from farmers for pollinator services, honey and challenges with winter kill and colony collapse disorder. Yet, there are indications that native pollinator abundance and diversity are declining and that some species are already at risk (COSEWIC 2010; CSPNA 2007 as cited in Agriculture and Agri-Food Canada, 2014). Agriculture and Agri-Food Canada (2014) lists a variety of causes contributing to the decline of native pollinators, including:

- declining diversity of flowering plants (Di Pasquale et al., 2013),
- loss, fragmentation and degradation of habitat due largely to agriculture and urban development (Grixti et al., 2009; Kremen et al., 2002; Larsen et al., 2005; A. J. Richards, 2001),
- the introduction of invasive, non-native plant species (Potts et al., 2010),
- the toxicity and widespread use of pesticides (Desneux et al., 2007; Kevan, 1975; Pettis et al., 2013),
- air pollution (Girling et al., 2013),
- climate change (Potts et al., 2010),
- diseases and parasites (Potts et al., 2010), including those from managed honey bees (Mallinger et al., 2017), and
- competition with honey bees for resources (Lindström et al., 2016; Mallinger et al., 2017).

This project seeks to profile a partial solution to some of the challenges native pollinators are facing by providing good quality pollinator habitat in space that, from a pollinator’s perspective, is currently empty.

Roadsides as a Solution

Roadsides and other rights of way (e.g., utility corridors, railways) offer a unique conservation opportunity to address declining pollinator populations. Roadsides provide a managed buffer between roads and adjacent land, secure road user visibility, accommodate road infrastructure, and provide a pedestrian refuge. These purposes are often compatible with low-growing native grassland habitat that can provide pollinators with forage (nectar and pollen), and sites to breed, nest and overwinter. While roads may fragment habitats for many species, road networks can aid pollinator dispersal by linking fragmented grassland habitats (Hopwood, Black, Lee-Mäder, et al., 2015; O'Sullivan et al., 2017b). Further, many roads are already a source of flowering vegetation and pollinator populations and can be further enhanced with intentional management (Phillips et al., 2020).

Given the large area that roadsides cover and their rapid growth as road networks expand, roadsides are increasingly being explored as a potential conservation resource (Gardiner et al., 2018; O'Sullivan et al., 2017b). Managing for pollinator habitat along roadsides can provide a substantial contribution to biodiversity and provision of ecosystem services, particularly in areas with limited options to do so. This includes those dominated by urbanization or agriculture. In addition to supporting pollinator species, roadsides provide an opportunity for municipalities to support biodiversity, address climate mitigation (carbon storage) and climate resiliency, as well as enhance the aesthetics of roads (Fernandes et al., 2018; O'Sullivan et al., 2017a; Spooner, 2015). Additionally, altered management regimes to support pollinators can result in long-term fiscal benefits from reduced maintenance costs (Lanark County, 2020; O'Sullivan et al., 2017a).

Currently, the most common practice for roadside maintenance is mowing, usually one to four times per year from spring to fall depending on the jurisdiction (Rural Municipalities of Alberta, 2016). Frequent mowing can benefit driver sightlines, but prevents vegetation from completing life cycles and providing pollinators with nectar, pollen and suitable habitat for breeding and nesting. Some municipalities, and Alberta Transportation, allow private hay production of the roadsides with permission, which encourages pre-flower mowing. Herbicide application is another common approach used to manage roadside vegetation and control invasive, noxious weeds. But widespread herbicide application indiscriminately reduces all vegetation and can harm pollinators.

There is some concern that roadside habitat may cause ecological traps. These occur when a species is drawn to a low-quality or dangerous habitat. Keilsohn et al. (2018) found that roads with heavy traffic volume and vegetated medians had high insect mortality. However, other studies have found that the benefits of pollinator habitat along roadsides outweigh the potential risks of vehicle collision and pollution (Hopwood, Black, Lee-Mäder, et al., 2015; Phillips et al., 2020).

When roadsides are managed for pollinator habitat, tradeoffs are inevitable. Simultaneous consideration must be given to maintaining the type and amount of vegetation to support pollinators, and maintaining motorist sightlines, ensuring invasive and noxious weeds are controlled, and mitigating any potential wildlife hazards. Pollinator habitat along roadsides may have the potential to attract larger wildlife, which could pose a safety risk to motorists. As well, there may be a public preference for manicured roadsides, and changes in roadside appearances may be seen as a lack of investment in maintenance.

Beneficial Management Practices

Traditional roadside management can harm pollinators and their habitat, particularly in urbanized areas. However, research has shown that roadside maintenance strategies, such as mowing and herbicide use, can be accomplished in a way that promotes pollinators (Hopwood, Black, Lee-Mäder, et al., 2015).

Roadside Management

Mowing

Mowing is the primary strategy for vegetation control along roadsides to maintain sightlines for human safety (e.g., visibility of intersections and wildlife crossing) and control invasive species. However, frequent mowing regimes reduce bloom times and stunt plant growth, leading to a reduction in available habitat and nectar sources for pollinators, as well as causes direct mortality of pollinator species (Phillips et al., 2020). Altering the frequency and seasonal / daily timing of mowing individual roadsides can promote pollinator-friendly plants, increasing pollinator abundance while satisfying the need to maintain road safety (Halbritter et al., 2015; Norcini, 2014; Phillips et al., 2019, 2020). The following mowing beneficial management practices can be applied to support pollinators.

Reduce mowing

To provide optimal pollinator habitat it is recommended to reduce mowing to 0–2 times per year (Entsminger et al., 2017; Halbritter et al., 2015; Phillips et al., 2019, 2020). This is relatively easy to implement, and reduced mowing has been reported to lower maintenance costs (Entsminger, 2014; O'Sullivan et al., 2017b). Reduced mowing may also result in increased native plant species richness (Entsminger et al., 2017).

Schedule mowing around pollinator activity

Avoid mowing during peak bloom times to allow for vegetation to provide pollinator habitat (Canadian Wildlife Federation, 2020; Galea et al., 2016). This could include considerations for mowing of dandelions, which provide pollinator forage year-round but elicit strong opposition in some communities. Because peak bloom times will vary by the native vegetation species present, some knowledge of the local native species mix will be helpful. Avoiding peak blooming will also avoid peak pollinator activity, allowing pollinators to benefit from the blooming vegetation and reduce direct mortality from mowing. Mow as late as possible, once vegetation is past the blooming stage, as pollinator activity will rapidly decline after this point.

Rotational mowing

Stagger mowing schedules along portions of the length or width of a roadside. For example, split the roadside into three sections, from nearest to the road to farthest. Mow the nearest section twice a year (spring and fall), the middle section once per year (fall), and the farthest unmown or every second year. This mowing regime can maintain sightlines and safety of roadsides, while allowing sections of vegetation to mature to support pollinators. Alternatively, regular mowing of a safety strip, together with less frequent mowing of entire roadside, can promote pollinator-friendly plant production (Norcini, 2014).

Considerations

It is important to note the need to maintain minimum safety standards, as altered mowing regimes may not always control vegetation sufficiently to maintain sightlines. This can be addressed by mowing a buffer strip directly adjacent to roadsides more frequently. Not mowing at all may also not be good for pollinators. Undisturbed grasslands can result in roadsides dominated by only a few plant species, leaving little room for a diversity of plants that support pollinators.

While allowing vegetation to grow and provide pollinator habitat may result in a showy wildflower display, there are those in the community who view tall grass as unkempt. While there may be a cost reduction in less mowing, there may be increased cost to control invasive species by other means (e.g., hand-pulling, herbicide application). This may be particularly true during the first few years after changing roadside management.

Cost-benefit

Investments to maintain roadsides as pollinator habitat will vary by project, as will potential costs savings. However, municipalities may experience costs savings from reduced mowing. Madison County, Florida reduced the amount of area they had previously mowed six times per year to mowing just a safety strip directly adjacent to the road, and one fence-to fence mowing in the fall (Norcini, 2014). This reduced the amount of mowing from previous practices, reducing maintenance costs by over US$ 625 / km (US$ 1,000 / mile) in 2010 and 2011 (Norcini, 2014). While it can be assumed that reducing mowing alone will also save maintenance costs in Alberta, a City of Calgary pilot project is underway, including a cost-benefit analysis, that will provide additional information specific to our province. The pilot study is outlined in the case study section of this report.

Herbicide Use

Mindful use of pesticides (herbicides and insecticide) is an essential component of roadside restoration. Improperly applied, pesticides can drift into unintended areas, putting pollinators and the plants that sustain them at risk (Agriculture and Agri-Food Canada, 2014). Herbicide use is often an effective *and* cost-effective management tool to control invasive or noxious weeds along roadsides. However, boom spraying, or the application of herbicides indiscriminately to large areas, can indirectly harm pollinators and reduce their populations. Indiscriminate application of herbicides over a large area can alter the life cycle of plants, including those that support pollinators (Hopwood, Black, Lee-Mäder, et al., 2015; Kearns et al., 1998). The following herbicide beneficial management practices can be applied to support pollinators:

Spot Spraying

Spot spraying is targeted herbicide application to remove an individual invasive or noxious weed. Spot spraying will reduce application of herbicides to non-targeted vegetation, protecting plants that support pollinators. Applying herbicides when the target weed is most vulnerable will be the most effective.

Avoiding Drift

If the roadside is near an agricultural crop that is being treated with pesticides, steps can be taken to avoid damage caused by drift. Depending on the site orientation, consider “planting coniferous trees on the field-side edge of the habitat — coniferous trees are less susceptible to damage by herbicides specifically designed to control broadleaf weeds,” as a partial barrier to pesticide drift (Agriculture and Agri-Food Canada, 2014).

Timing

If pesticides must be used, limit their application to early morning or after sunset to avoid direct contact with foraging bees. Additionally, do not use pesticides when plants are flowering.

Hand Removal

Hand removal of individual invasive or noxious weeds is a labor-intensive process. However, it can be effective for removal of light infestations or a small, affected area. Hand removal provides no risk of non-target plant application.

Considerations

Spot spraying and hand removal of invasive and noxious weeds requires plant identification skills, knowledge on best time to apply herbicide, and the ability to recognize native plant species. Training in plant identification and growth cycles may be necessary. Hand removal is labor intensive. Community members may be opposed to herbicide use, however, a reduction in use through spot spraying and hand removal may garner support. Additionally, community buy-in can be achieved by including community members in hand removal initiatives to support pollinator and biodiversity conservation.

Cost-benefit

Adaptive herbicide use may result in lower long-term maintenance costs, depending on how management practices are changed. For example, in Northern Sunrise County, Alberta the first three years of their Integrated Vegetation Management Plan (IVMP) (which also included mowing), herbicide costs exceeded the original annual cost of $75,000. But they rapidly declined when the benefits of the IVMP kicked in such that costs were reduced to $35,000 annually, a 53% savings. Another example is Lanark County, Ontario where spot spraying was found to be about ⅔ the cost of boom spraying (Lanark County, 2020). A study by Indiana State Department of Transportation and Purdue University found that a 40% reduction in maintenance cost was incurred by replacing one round of mowing with one herbicide application (Herold et al., 2013). Properly applied, herbicide use can result in considerable savings and pollinator species protection.

Tillage and Burning

The majority of native bee species nest in the ground or in decaying wood making it important to keep these “habitats” available and accessible (Farmer & Pisicoli, 2020). Soil tillage can kill ground-nesting bees, their offspring, and the nest, so it is best to leave areas where bees nest untilled if possible. Examples of marginal lands that could be left untilled include roadsides but also hedgerows or shelterbelts, field margins, field corners, and river or stream banks (Province of Manitoba, 2017).

Burning can also kill pollinators or damage nests, however most can survive infrequent, low intensity burns. Indeed, frequent, low-intensity burns can improve pollinator habitat over the long term (U.S. Department of Agriculture and U.S. Department of Interior as cited in Province of Manitoba, 2017). To support pollinator habitat, it is recommended to avoid tilling and burning, or reduce burning to infrequent, small events.

Considerations

In general terms, mowing has less of an impact on wild ground-nesting bees than burning, and burning less of an impact than tilling (Province of Manitoba, 2017). Mowing is certainly most commonly used for roadside vegetation management and, for pollinators, tillage and burning more often refers to agricultural land uses. They do not frequently apply to roadsides. Additional research is needed to determine if burning may be an appropriate roadside vegetation management practice and what size and frequency would be acceptable or improve pollinator habitat.

Cost-benefit

The cost saving of reducing tillage and burning will vary by municipality and whether another management strategy will be required as a replacement.

Restoration

Restoration) can enhance roadsides' ability to support pollinator habitat through native planting and seeding. Directly following construction or other disturbance, it is a conventional practice to treat roadsides with a mix of non-native grass seeds. By switching to a native plant seed mix, or a combination of non-native grass and native plant seed mix, plants that support pollinators can be incorporated into the area. Additionally, if the site has existing healthy native vegetation, restoration should be considered pre-disturbance as this allows for an opportunity to collect seeds, plugs, or sod to restore the site after disturbance.

For areas that currently have existing vegetation that is non-native, or not pollinator-friendly (e.g., a grass-only mat), a more thorough restoration effort may be needed to remove or transition vegetation to a more appropriate, pollinator-friendly planting.

Considerations

Site selection and preparation need to be carefully considered prior to beginning roadside restoration. Bare ground can be the easiest to restore if native seed is available and quickly applied. Otherwise, weeds and the quality of existing vegetation will need to be evaluated and potentially controlled prior to planting or seeding.

Transportation projects that prioritize biodiversity can align with other municipal priorities and policies, such as those focused on sustainability. This can help leverage support for roadside restoration projects from council, municipal staff, and community members. Often, such support is necessary to justify or secure the funds necessary to purchase native seed mixes to revegetate a disturbed area — native seeds are more expensive than non-native, commercially available seed mixes. Partnerships with other municipal sectors (e.g., Transportation and Parks) and outside organizations can also leverage funds and capacity.

Consultation with native plant experts or suppliers will be necessary to either gather existing seeds, plugs, and sod from site or choose the right plants and seed mixes for the selected site. Plant species selection should begin with the needs of the roadside. For example, woody or tall plants may not be desirable along roadsides where sightlines and regular maintenance are objectives. Ongoing maintenance to control weeds will be necessary to ensure the native plants can properly establish, especially in the first three years of restoration (Dunk et al., 2010). Young plants or seeds may require watering support until they are established, which can take up to three years depending on the species (Dunk et al., 2010).

See the resources section and Appendix 2 for information on Alberta specific native seed mixes that support pollinators.

Cost-benefit

Altering mowing regimes and herbicide use can be used to passively naturalize roadsides and can be widely applied to reduce overall maintenance costs. Active roadside restoration will require additional investment of time and resources, although it is more likely to result in high quality, resilient pollinator habitat. Availability of native seed mixes is currently a significant barrier for widespread use on roadsides as it is more expensive than non-native seed mixes. As demand for native seed mix grows, cost should decline, approaching non-native cultivars.

Monitoring and Evaluation

Monitoring and evaluation are important parts of projects that enhance roadside pollinator habitat. Identifying and tracking measures of success prior to the project will help repeat achievements, avoid repeated failures and allow activities to be scaled up. Taking an inventory of existing plants and pollinators before a project takes place and during subsequent growing seasons will give insight into what management practices or native plant/seed applications are working and can help identify where areas should be improved on. Monitoring also provides an opportunity to achieve community engagement goals if a citizen science program aiding monitoring efforts. This also encourages greater buy-in from the community and from municipal Council. Indeed, expenses and cost savings associated with roadside pollinator habitat enhancement projects are not well documented and can help make the case for additional projects elsewhere.

Municipal Pollinator Projects in Alberta

We conducted an Alberta-wide online survey to understand which municipalities have undertaken pollinator projects, what topics they cover, and how their project is supported (e.g., policy, management plan, outreach programs, etc.). The survey was open from March 18–April 9, 2021, and was opportunistic — we did not reach out to each individual municipality but instead promoted the survey over social media and the Miistakis Institute newsletter. We also requested that the following groups considering promoting the survey through their channels:

- Alberta Urban Municipalities Association
- Rural Municipalities Association
- Association of Alberta Agriculture Fieldmen
- Alberta Recreation & Parks Association

The survey had six questions and a typical completion time of 3 minutes. There were 27 respondents representing 21 different municipalities (Table 1), out of a maximum of 356 municipalities in Alberta (Government of Canada, 2017) . Some municipalities had multiple respondents participate in the survey. One respondent indicated they do not represent a municipality, and one respondent did not answer the questions. 63% of respondents (17 respondents) indicated that their municipality has pollinator projects/programs, 37% (10 respondents) do not.

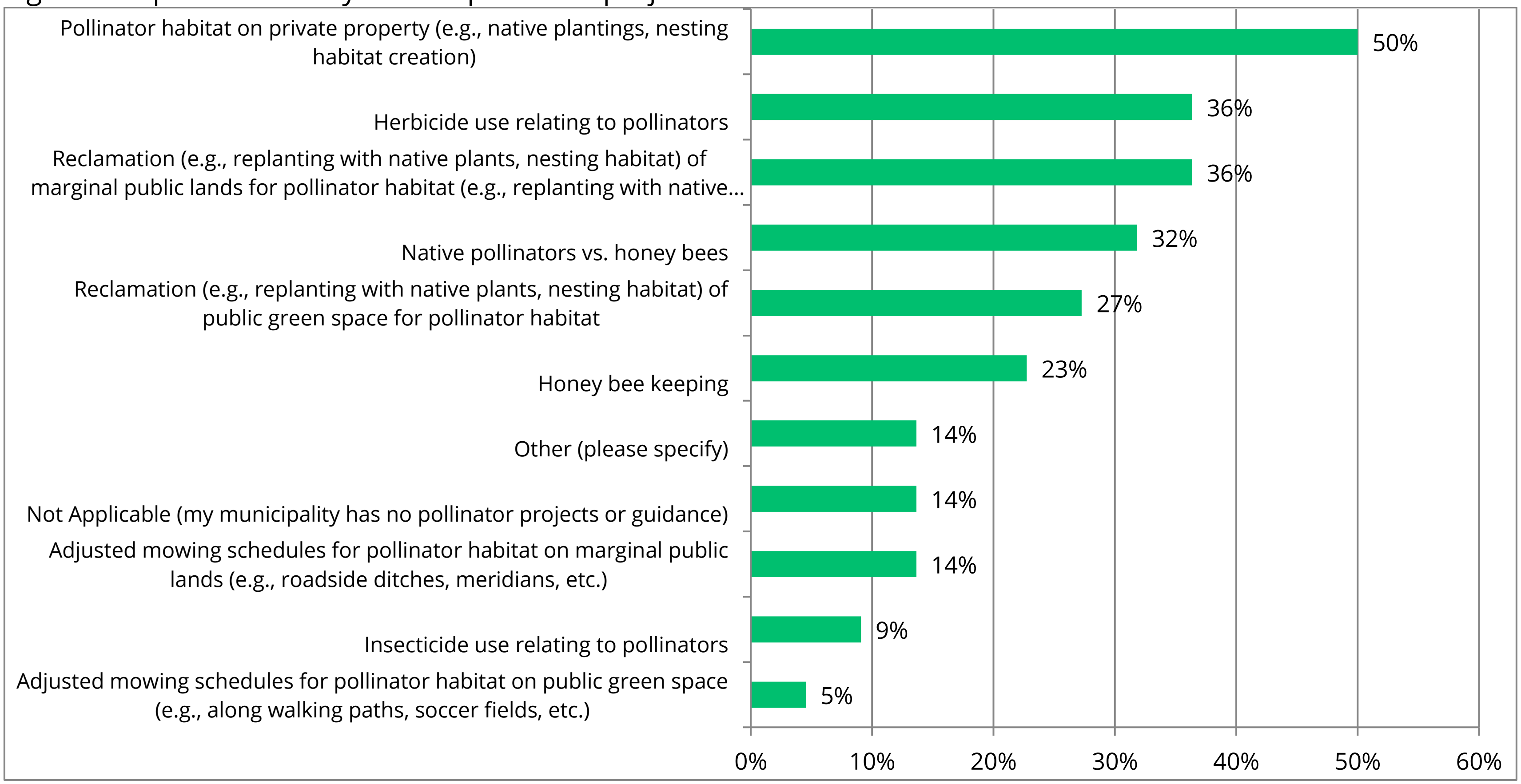
Table 1: Municipalities represented in the survey.

Municipality
Town of Okotoks
Mountain View County
Strathcona County
Yellowhead County
St. Albert
Saddle Hills County
Clear Hills County
Cypress County
Red Deer County
Wainwright
M.D. of Pincher Creek
Clearwater County
Northern Sunrise County
Woodlands County

County of Wetaskiwin
M.D. of Fairview
Birch Hills County
Kneehill County
County of Vermilion River
Municipal District of Spirit River No. 133
City of Calgary

Alberta's Municipalities support a wide diversity of pollinator issues with their projects. The most common are pollinator habitat on private property, information on herbicide use, and reclamation of marginal lands (Figure 2). Alberta's municipalities are mainly using outreach and education as well as best management practices to promote pollinator conservation; policies and bylaws are less common.

Figure 2: topics covered by Alberta pollinator projects.



The responses given for "other (please specify)" include not fully mowing county ditches, rules regarding honey bee keeping, requirements for new municipal developments to incorporate native plants for pollinator habitat, and information on ALUS (Alternative Land Use Services) community pollinator programs.

Case Studies

Our research identified seven case studies specific to roadside management or restoration for pollinator habitat in Canada. Four of the studies were from Alberta and three from Ontario; their scale varied as did their purpose and approach. Nevertheless, these case studies were a valuable source of roadside pollinator information. Common themes included pollinator habitat management, the design of restoration projects to ensure long-term cost savings and local support, collaboration as a way to achieve goals, and the role of small, inexpensive pilot projects to provide information necessary to move forward with larger projects or management changes.

Alberta

Canyon Meadows Bee Boulevard — Calgary, Alberta

Purpose:

Established in 2017, Canyon Meadows Bee Boulevard provides urban pollinator habitat along Canyon Meadows Drive from Macleod Trail to Bow Bottom Trail S.E. in Calgary, Alberta. The pollinator corridor also provides an opportunity for community members to enjoy a path network and learn about pollinators and the benefits of naturalization projects.

Partners:

The Canyon Meadows Bee Boulevard is a partnership of the City of Calgary Roads and Parks departments, Mount Royal University, the University of Calgary, and the David Suzuki Foundation.

Results:

The pollinator corridor was restored with native shrubs, grasses and flowers, as well as pollinator habitat features such as sand beds and bee houses (City of Calgary, 2021). The Bee Boulevard improves the aesthetics of the area and reduces costs of maintaining its green space. Since its creation, the endangered western bumble bee (*Bombus occidentalis*) and a variety of other threatened species have been found in Bee Boulevard among over 100 additional native bee species, indicating the success of attracting pollinators to a restored area. Additionally, the site is included in a University of Calgary and City of Calgary study exploring native plant and pollinator relationships to better understand which native plants provide forage for pollinators in Calgary (Mindi M. Summers, personal communication).

The Canyon Meadows Bee Boulevard is an example of a successful roadside naturalization project that benefits the community by increasing biodiversity, aesthetics, and providing engagement opportunities for community members.

Roadside Naturalization Pilot Project — Calgary, Alberta

Purpose:

The Roadside Naturalization Pilot Project, initiated by the City of Calgary Transportation Department, is a 3-year project intended to inform maintenance practices, engage stakeholders and expand naturalized open spaces (City of Calgary, 2020).

The City of Calgary manages about 1000 hectares of roadside land, maintained as turf grass, and that is regularly mowed at a cost of $1.5 million per year (City of Calgary, 2020). This pilot project includes a primary treatment area along 16th Avenue N.E. (Trans-Canada Highway), on which 5 hectares will be actively and 5 hectares passively naturalized. The active naturalization area will be converted to an urban meadow of native grasses and wildflowers mixed with cover crops. The passive naturalization area will focus on reduced mowing. Canada thistle, a noxious weed, will be managed by selective herbicide application. As part of the monitoring program, this project includes a citywide assessment of roadsides that receive reduced maintenance (mowing) as a way to assess weed establishment and biodiversity.

Partners:

The City of Calgary has partnered with University of Calgary researchers to determine which pollinator-friendly plants to include and monitor.

Results:

The pilot project is expected to end in 2023. It will provide data to inform potential changes to roadside policy and practices that can reduce maintenance costs while enhancing biodiversity priorities and investments. For example, the project is designed to determine if reduced mowing can be implemented more broadly in Calgary's roadside management. While reduced mowing may not be suitable on all managed roadsides in Calgary, it has the potential to save $8 million in costs over 10 years (Askey, 2021).

Roadside Management and Biodiversity — Northern Sunrise County, Alberta

Purpose:

Over the preceding decade, Northern Sunrise County has been working to enhance the environmental integrity of its lands. Part of this initiative was the adoption of an Integrated Vegetation Management Plan in 2012 as well as Policy 2.14, Maintaining Biodiversity (Northern Sunrise County, 2020). The purpose of Policy 2.14, is "to support the enhancement of the environmental integrity on all lands in Northern Sunrise County by developing and implementing programs that are flexible and promote environmental conservation, enhancement and restoration" (Northern Sunrise County, 2020). As part of this work, the Agricultural Services Department has been adjusting their mowing and herbicide application along roadsides and fence lines in the County to enhance biodiversity (including pollinator biodiversity). In Northern Sunrise County, like in many municipalities, the battle with invasive plant species is one reason for mowing and herbicide application. Other reasons include maintenance of sightlines for human safety and managing drifting snow.

Partners:

Northern Sunrise County, ALUS Canada

Results:

Since the implementation of their Integrated Vegetation Management Plan (IVMP), Northern Sunrise County has been making great progress towards successfully controlling invasive plant species. As a result, they were able to reduce their roadside mowing and herbicide application by more than 50%. Their monitoring program has noted that in areas no longer affected by invasive plants nor requiring mowing/herbicide application, native plant species are beginning to return naturally.

As an alternative to herbicide application and mowing for invasive weed management in roadsides, Northern Sunrise County also relies on targeting spraying, biological control (e.g., released insect species) focused on specific weed species, and hand removal.

When the IVMP was first implemented in 2012, there were start-up costs — retrofitting equipment (mowers with herbicide application sprayers) — and staff training for different application techniques. During the first three years of the IVMP, herbicide costs rose above the predicted annual cost of $75,000 but then rapidly decreased as the benefits of the IVMP began to be realized. Annual costs settled at about to $35,000. These cost savings are directly related to correctly timing applications with the right application equipment and the right product at the right rate. Combined, this increased control effectiveness by creating a healthier environment for native vegetation to compete against invasive species. The outcome was improved roadside biodiversity.

Landowner participation is an important aspect of the biodiversity policy. Northern Sunrise County uses three strategies to encourage participation: education and awareness, incentives and voluntary programs (such as the ALUS (Alternative Land Use Services) program, fence line agreement or small area request agreement) and voluntary agreements (such as conservation easements) (Northern Sunrise County, 2020).

In addition to roadside management, the County is a member of the ALUS Canada program. Through ALUS Northern Sunrise, the County can encourage producers to transition their marginal lands to habitats that contribute to ecological goods and services, including for pollinators. Recently, they have worked with a landowner to reclaim nearly an acre of their land for pollinator habitat by seeding pollinator-friendly native plant species. With grants to ALUS Northern Sunrise, this was accomplished at a reduced cost to the landowner.

Mount Royal University — Calgary, Alberta

Purpose:
On Mount Royal University's campus, the grounds team and a science instructor have initiated *Plan Bee,* a pollinator pathway project. The project seeks to enhance native bee diversity and abundance by providing crucial nesting habitat and forage throughout the campus.

Partners:
Mount Royal University

Results:
There are 15 locations on campus that have been designed or redesigned to support the needs of bees and other pollinators by incorporating "bee-friendly plants and desirable habitat" with more locations planned (Farmer & Pisicoli, 2020). Desirable habitat is being created by adding nesting boxes and sandpits at on-campus locations (Rolfe, 2018). Mount Royal also has an inventory of flowering trees, important forage for pollinators, that provide early spring nectar when it is scarce from other plants. There are currently 581 flowering trees and there will be

more added in coming years. *Plan Bee* also includes annual flowering plants to provide forage through the summer and into the fall. The planters are important from an aesthetic perspective but also create food sources in an otherwise barren landscape of concrete sidewalks or roadways. The team will sample the bee population as project proceeds to measure success and adapt to a changing environment (Farmer & Pisicoli, 2020; Rolfe, 2018).

Outside of Alberta

Lanark County — Lanark, Ontario

Purpose:

Lanark County, a rural municipality in eastern Ontario, has committed to establishing diverse roadsides that support biodiversity. As such, the county invests approximately $25,000 in pollinator projects each year (Lanark County, 2020). The county adopted an integrated vegetation management (IVM) plan in December 2016 to control invasive plants that encroach on pollinator habitat (Cain & Brown, 2017). Of particular concern to the county is wild parsnip, which was designated as a noxious plant in 2015, which helped secure support for creating the IVM plan. It includes mowing practices that reduced frequency to allow for pollinator-plant survival and considers timing to avoid peak bloom times of pollinator plants. Width of mowed areas are considered to ensure that additional pollinator habitat is left while satisfying roadside sightlines.

Partners:

Lanark County recommends partnering with restoration groups and organizations to provide technical expertise and guidance on roadside projects to enhance biodiversity.

Results:

Lanark County invests approximately $25,000 in pollinator projects each year (Lanark County, 2020). Their work to manage roadsides for pollinator habitat offers learning opportunities for other municipalities.

Lanark County has successfully reduced mowing on 1,122 lane kilometers, resulting in 450 hectares of un-mowed or naturalized area with improved pollinator habitat. This change has resulted in $11,500 of cost savings from 2016 to 2019, or an average of $7.50 savings per swath kilometer (Lanark County, 2020). However, they recognize that mowing alone is not effective to control noxious and invasive species, and there are many roadsides are not accessible for mowing (e.g., rocky or uneven terrain). To address this, the IVM plan includes guidelines for herbicide use.

The guidelines have reduced Lanark County's herbicide use by 82% while still controlling wild parsnip infestations by phasing out boom spraying and increasing spot or targeted spraying and hand removal. Lanark County reported a cost saving in spot spraying over boom spraying (they note that spot spraying is ⅔ the cost of boom spraying); however, hand removal remains expensive and is only used for light infestations of noxious or invasive species (Lanark County, 2020).

The IVM plan includes alternative hydroseeding practices for restoration. The county now uses a custom seed mix that includes pollinator supportive plants. This mix is about 20% more expensive than the traditional grass mix, requiring an investment to increase pollinator-friendly plants (Lanark County, 2020). Surveys have found roadsides in 2019 had nearly double the flowering nectar plant species since the IVM plan implementation in 2017.

Following Lanark's IVM plan was integral to their success. The county estimates that developing a similar IVM plan may cost a municipality about $5,000–10,000 (Lanark County, 2020). Leveraging the need to control invasive or noxious plants can provide opportunities to also restore habitat for pollinators. Starting with small projects with clear goals and performance measures is a good starting point as they are inexpensive and lead to reporting on preliminary successes that make the case for project growth.

Engaging the community to foster positive relationships is necessary to success. Lanark County initially faced pushback from community members unhappy with the use of herbicide on roadsides adjacent to their property. They addressed this by enhancing Lanark's "adopt-a-road" program (its previous goal was litter control) to include volunteers to hand-remove wild parsnip and assist with planting and seeding. In 2019, the program controlled wild parsnip on 60 kilometers of roadway. Further engagement included workshops with municipal staff and council, and public information sessions with the local stewardship council.

Roadsides — Various locations, Ontario

Purpose:

Roadsides is a planting project that aims to create pollinator habitat patches in unused public spaces such as roadsides and cloverleafs, public spaces, and home gardens (Dunk et al., 2010).

Partners:

Ontario Horticultural Association

Results:
Along with transforming roadsides throughout Ontario, they have created a how-to guide or ‘planting plan’ to help others who want to create pollinator habitat in their community (Dunk et al., 2010).

Monarch butterfly recovery project — Southern Ontario

Purpose:
In 2017, the Canadian Wildlife Federation launched a project to restore Monarch butterfly habitat on rights-of-way. The project explores the use of public land such as parks, rights-of-way and roadsides as potential pollinator habitat, and experiments with diverse restoration methods. The goal is to create and restore breeding and feeding habitat for the declining Monarch butterfly and other pollinators.

Partners:
The Monarch butterfly recovery project is a partnership with Canadian Wildlife Federation, National Capital Commission, HydroOne, and Lanark County and is supported by the Ontario Trillium Foundation.

Results:
The three-year project spans six counties (Prince Edward, Hastings, Lennox Addington, Frontenac, Lanark, and Leeds and Grenville), and aims to provide a model from which other municipalities in Canada can learn. To date, the project has prepared and seeded native wildflowers on five hectares of habitat across four sites. The Canadian Wildlife Federation provides information, technical guides, webinars, and facilitates a rights-of-way working group on creating pollinator habitat. For project updates, visit CanadianWildlifeFederation.ca.

Recommendations for Alberta Municipalities

Management Recommendations

- Reduce mowing to 0–2 times a year. Mowing in May and September will avoid peak bloom times and pollinator activity.
- Experiment with rotational mowing.
- Spot-spray herbicides to target invasive or noxious weeds. Avoid boom spraying and be mindful of herbicide drift.
- Avoid using insecticides.
- Avoid tillage and burning as this may destroy nesting habitat.
- Use native plants relevant to your site when possible (see Appendix 2 for suppliers in Alberta).
- Incorporate monitoring into project planning to measure the success of pollinator habitat establishment and document and cost savings from maintenance schedule changes.

Restoration Recommendations

- When new construction takes place, seed with pollinator-friendly mixes, preferably native species.
- If site has existing healthy native vegetation gather seeds, plugs or sod for use to restore the site after disturbance.
- Incorporate monitoring into project planning to determine the success of pollinator habitat establishment and potential cost savings.
- Pursue habitat restoration on roadsides for newly constructed roads, and for existing roads when possible.
- Use native plants relevant to your site when possible (see Appendix 2 for suppliers in Alberta).

Policy Recommendations

- Develop an Integrated Vegetation Management Plan to guide management and maintenance of roadsides that encourage pollinator habitat.
- Include "supporting biodiversity" as an explicit purpose for roadsides in municipal transportation plans and other high-level policy documents. Link the transportation plan to biodiversity goals in municipal development plans and policies/strategies for sustainability and biodiversity.
- Gain the support of municipal Council and Agricultural Service Board to support policy creation.

Engagement Recommendations

- Engage adjacent landowners and community members to educate on the change in maintenance practices and gain support.
- Involve community members through educational programs, volunteer plantings, and citizen science programs to increase awareness and community buy-in.

Additional recommendations

- Pursue project partnerships, such as with university researchers, pollinator and native plant experts and organizations, landowners, etc.
- Join the Canadian Chapter of the Rights-of-Way Habitat Working Group (ROWHWG) facilitated by the Canadian Wildlife Federation.
- Create an Alberta community of practice to facilitate knowledge transfer.

Resources

The resources below can help guide municipalities in projects to reclaim and manage roadsides for pollinator habitat. This table includes references to detailed beneficial management practices and guides and organizations that offer expertise on pollinators, native plants, and more.

Resource Type	Name	Description
Native Bee Resource (Alberta)	Alberta Native Bee Council (Alberta Native Bee Council, 2019)	The Alberta Native Bee Council is a non-profit with a mission "to promote conservation of native pollinator communities through research and monitoring, advocacy, education, and collaboration with others." (Alberta Native Bee Council, 2019).
Beneficial Management Practices (U.S.A.)	Pollinators and Roadsides: Best Management Practices for Managers and Decision Makers (Federal Highway Administration, 2016)	Provides best management practices intended as a starting point for State Departments of Transportation (DOTs) wanting to make roadsides more pollinator-friendly. Based on findings by the Xerces Society for Invertebrate Conservation and ICF International staff literature review interviews with State DOTs and roadside restoration experts. Includes case studies that demonstrate cost savings.
Beneficial Management Practices (U.S.A.)	Roadside Best Management Practices that Benefit Pollinators (Hopwood, Black, & Fleury, 2015)	These BMPs identify key steps that State DOTs can take to improve the quality of roadside habitat for pollinators including 1) adjusting roadside vegetation management techniques to accommodate pollinator resource needs,2) enhancing and restoring native roadside vegetation to include plant materials that improve pollinator habitat, and 3) incorporating native plants and pollinator habitat needs into roadside landscape design.
Beneficial Management Practices (southeastern Canada)	Managing Rights of Ways for Pollinators: A Practical Guide for Managers (Canadian Wildlife Federation, 2020)	Provides a guide for Rights-of-Way (ROW) managers in southeastern Canada to create and maintain pollinator habitat. The guide outlines best practices for improved management of ROW to benefit pollinators, as well as practical habitat restoration methods suitable for road and ROW use.

Resource Type	Name	Description
Beneficial Management Practices (Ohio)	ODOT Guide to Establishing and Maintaining Roadside Pollinator Habitats (Cardno, 2017)	Provides a brief overview of implementing pollinator habitat along roadsides from Ohio Department of Transportation. Includes information on implementation, site selection, equipment/tools needed, and seed installation and maintenance.
Beneficial Management Practices (U.S.A.)	Technical Manual for Pollinators Establishment, Restoration, Management and Maintenance. A Guide for State DOT Managers and Staff (Galea et al., 2016)	Provides information on roadside enhancements that allow the maintenance of safe and accessible roadsides while supporting pollinators. Outlines science and research used to develop State DOT technical guidelines, case studies and background on pollinator biology.
Beneficial Management Practices (Ontario)	Technical Guide for Enhancing, Managing and Restoring Pollinator Habitat Along Ontario's Roadsides (Gilbertson et al., 2016)	This habitat restoration, management, and enhancement guide has been developed to provide those responsible for maintaining roads in Ontario with the most current science, tools, and resources they need to support pollinators.
Information and Guidance	Native Pollinators and Agriculture in Canada (Agriculture and Agri-Food Canada, 2014)	This booklet, created by Agriculture and Agri-Food Canada, outlines the relationship between pollinators and agriculture in Canada, including detailed information on pollinator ecology and habitat management. The intent of the booklet is to provide guidance for actions that conserve and protect native pollinators.
Integrated Vegetation Management Plan (Ontario)	County of Lanark IPM Vegetation Management Plan 2016 (Cain & Brown, 2017)	Lanark County follows an Integrated Vegetation Management (IVM) Plan to use cultural, mechanical, and chemical methods to control weeds and brush. The IVM Plan integrates two or more control methods to best target weeds while minimizing herbicide use and its impacts.
Information and Guidance (International)	Xerces Society for Invertebrate Conservation (Xerces Society for Invertebrate Conservation, 2014)	The Xerces Society for Invertebrate Conservation is an international nonprofit organization that protects the natural world through the conservation of invertebrates and their habitats. Xerces is a source of the latest research and provides pollinator conservation

Resource Type	Name	Description
		resources specific to the north-central region that includes Alberta.
Information and Guidance (Canada)	Pollinator Partnership Canada (Pollinator Partnership Canada, 2021)	Pollinator Partnership Canada (P2C) is a charity dedicated to the protection and promotion of pollinators and their ecosystems through conservation, education, and research. It provides resources such as native plant guides specific to ecoregions. Bee City Canada is a P2C program.
Information and Guidance (Canada)	Bee City Canada (Bee City Canada, 2021a)	"Bee City Canada's mission is to inspire cities, towns, First Nations, schools, businesses and other organizations to take action to protect pollinators." Communities and organizations can attain the Bee City, Bee School, Bee City Campus or Bee City Partner designation by committing to the following: "Creating, maintaining and/or improving pollinator habitat; educating their community, employees and/or customers about the importance of pollinators; [and] celebrating pollinators during National Pollinator Week or at other times." (Bee City Canada, 2021b) In Canada, there are currently 50 Bee Cities, 43 Bee Schools, 14 Bee Campuses, and 29 Bee Partners. In Alberta there are 5 Bee Cities (Okotoks, Grade Prairie, City of Calgary, Airdrie, Chestermere), 1 Bee School (Belvedere Parkway Eco Leaders), and 2 Bee Campuses and several Bee Partners (Bee City Canada, 2021a). Bee City Canada is now a Pollinator Partnership Canada Initiative.
Project Management, Information (Alberta)	Agroforestry & Woodlot Extension Society (AWES) (Agroforestry & Woodlot Extension Society, 2018)	The Agroforestry & Woodlot Extension Society (AWES) is a non-profit organization based in Alberta with the mission of increasing awareness of the environmental, social and economic values of agroforestry and woodlots throughout the province. Their website provides resources such as a Recommended Native Pollinator Friendly Plants for the

Resource Type	Name	Description
		Aspen Parkland Region of Alberta, and a Planting Assessment Worksheet.
Information (Alberta)	Innotech Alberta: Inventory of native species seed mixes in Alberta: December 2018 update (Powter et al., 2018)	This report inventories “native species seed mixes required or recommended for use in Alberta and those that are commercially available.” “The report focuses on native grass seed mixes for use in revegetation projects (reclamation, restoration, naturalization and remediation) undertaken for or by government or industry.” Several of the seed mixes are developed specifically for pollinators.
Information (Alberta)	Alberta Native Plant Council (Alberta Native Plant Council, 2019)	The Council’s objectives are to educate on and encourage the appropriate use of native plants in Alberta.
Guidance and Financial Support (Canada)	ALUS (Alternative Land Use Services) Canada (ALUS Canada, 2021)	ALUS Canada is a national charitable organization with the mission to enable Canadians to provide direct support to a national network of farmers and ranchers delivering ecosystem services in their communities, including cleaner air, cleaner water, carbon sequestration, erosion control, flood mitigation, pollinator support and wildlife habitat.
Publications (Canada)	NSERC- Canadian Pollination Initiative (NSERC Canadian Pollination Initiative, 2021)	NSERC-CANPOLIN is a five-year Natural Science and Engineering Research Council (NSERC) Strategic Network that is addressing the growing problem of pollinator decline in agricultural and natural ecosystems in Canada. Their website, while no longer being updated, hosts a large number of publications and resources related to pollinators.
Training and Networking (Canada)	The Canadian Chapter of the Rights-of-Way Habitat Working Group (ROWHWG) (Canadian Wildlife Federation, 2021b)	The ROWHWG offers training, discussion boards and various online resources including the pollinator score card. The Canadian chapter will not only connect you to American ROW Managers and vegetation management practitioners who have a variety of experience in the field but also to other Canadian practitioners. Joining is free and also includes access to the U.S. ROWHWG network.

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Appendix 1: Survey Questions

1. What Municipality do you represent?
2. Does your municipality have any projects/programs related to pollinators?
3. If yes, what topics do your program/projects cover? (Please select all that apply).
4. If yes, what type of supports do you have for your pollinator programs/projects? (Please select all that apply).
5. Are there any pollinator resources, or other municipalities we should follow up with? Feel free to provide links below.
6. Can we contact you if we need more information on your pollinator projects?

Appendix 2: Alberta Native Plant Suppliers

Native plants, selected for specific site requirements and zones should be used whenever possible. The following is a list of suppliers in Alberta (Canadian Wildlife Federation, 2021a):

- Wild About Flowers (Okotoks): http://www.wildaboutflowers.ca/
- Bow Point Nursery (Calgary): https://www.bowpointnursery.com/
- ALCLA Native Plant Nursery (Calgary): https://alclanativeplants.com/
- Tannas Conservation Services Ltd. (Cremona): https://www.tannasenvironmental.com/
- Oxbow Native Plants (Lethbridge): email: oxbownativeplants@gmail.com
- Bearberry Creek Greenhouses, Nursery & Water Garden (Sundre): https://www.bbcreek.ca/
- Parkland Nursery and Landscape Services Ltd. (Red Deer): https://pnls.ca/
- Medieval Manor Gardens (Parkland County): https://www.mmgardens.ca/
- Blazing Star Wildflower Seed Company (Edmonton): https://www.growwildflowers.ca/
- Arch Greenhouses (Edmonton): https://archgreenhouses.com/
- TreeTime.ca (Edmonton): https://treetime.ca/
- Devonian Botanic Garden (Devon): https://botanicgarden.ualberta.ca/

This list may be incomplete, please let us know if we have missed a supplier (institute@rockies.ca).