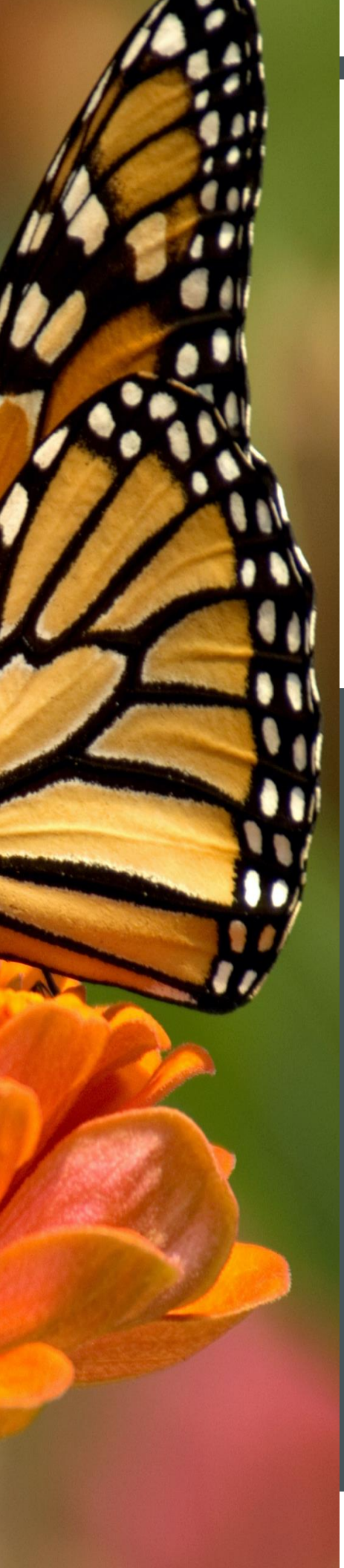

ENV332
March 2022

Creative Hub1352
Experimental Pollinator Plot

University of Toronto Mississauga

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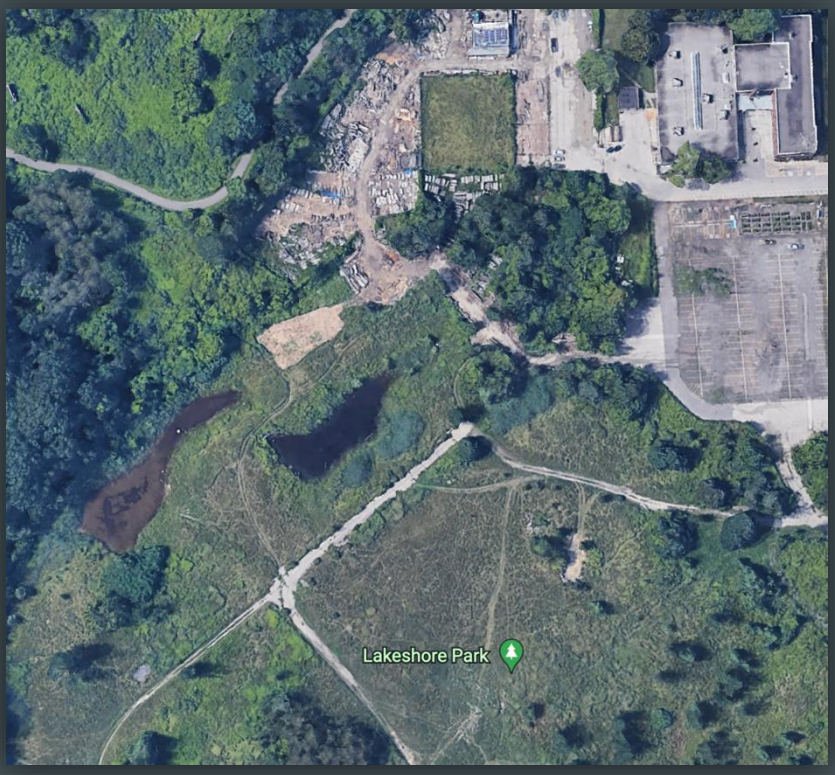

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Abstract

The purpose of this report is to provide Creative Hub 1352 and the TRCA with a short and long-term plan to inform best practices to implement a pollinator plot on a parcel of the Mississauga Arsenal Lands. This project is comprised of 5 main goals. The goals include (1) a rationale for the layout of the plot (this includes suggestions for optimal placement of new species, (2) a removal strategy for the invasive species present (namely phragmites), (3) suggestions for introducing new species, (4) a long-term maintenance plan, and finally (5) a public engagement section whereby we recommend methods to engage communities with the project. This research report was completed by meeting with stakeholders to survey the land and determine the goals and deliverables that would be further researched. The results of this report suggest planting medium size plots, removal of invasive species via manual removal, tarping, herbicide application, and underwater cutting. We also recommend planting Swamp Milkweed, Common Milkweed and Butterfly Weed, and we recommend community engagement through UTM environmental clubs. The suggestions covered in this report will be necessary to maintain the longevity of the pollinator plots—this way communities can participate in planting that will facilitate land stewardship and help maintain monarch, honeybee, and wildlife populations.

Introduction

The Toronto Region Conservation Authority (TRCA) owns a significant portion of Arsenal Land (approx. 16 hectares) located east of Dixie Road and Lakeshore Rd. E in Mississauga. Most of this land is currently vacant and degraded (see Fig. 1). We propose the implementation of an experimental pollinator plot within this parcel of land. This initiative is driven by the environmental non-profit CreativeHub135 to perform land rehabilitation to transform the land into a wildlife hub to provide communal benefits that will transcend generations. Implementing a pollinator plot will flower and other plants will provide nectar for pollinators (DeKalb County Farm Bureau Connections, 2020). Pollinators like butterflies use the nectar from these plants for food (Creative Hub, n.d.). They tend to prefer host plants over nectar flowers, as host plants send an invitation to pollinators to stay for a longer time and often lay their eggs within host plants (Credit Valley Conservation, n.d). Considering the current decline of the monarch butterfly population within Ontario, butterfly populations must be supported (Crewe et al. 2019). The Arsenal Lands presents an ideal location for the pollinator plot as it is near the Jim Tovey Lakeview Conservation land. This conservation land will be used to connect people with nature, provide a safe space for wildlife to inhabit, and is close to a large body of water. In turn, our pollinator plot will provide a corridor allowing the species to have better access to this conservation land. Implementing pollinator plots will sustain bee and monarch populations while engaging families in the land by this summer, with the intention to have planting continue annually for 3-5 years. This project will facilitate land stewardship and help families and children learn about the importance of protecting and rehabilitating areas of the neglected Arsenal land.

Fig. 1. Overview of the arsenal land on which the pollinator plots will be implemented. (*Arsenal lands/Marie Curtis park west master ... - trca.on.ca*, n.d.)

Methods

Our methods include both primary and secondary research. Our main role for the project was to provide suggestions based on our research for best practices for removal of invasive species, suggestions for best practices regarding plot implementation and which plants to plot, and suggestions for community engagement. This required an on-site meeting with our client from which we took active notes to guide our research for our goals and deliverables as well as information regarding the invasive species present and suggested plants for the plot. The subsequent secondary research required us to review the relevant literature pertaining to cultivating our plan for the pollinator plots—we specifically focused our literature on peer-reviewed articles, and case studies in Southern Ontario so that they were contextually relevant to our project.

To access resources to inform our suggestions for the best plants to use, we used the University of Toronto Libraries website. We first completed general Google searches such as "best plants for butterflies in Ontario" and "best pollinator plants in Ontario." This was done to gain background information about pollinator plants, so we knew which plants to search for on the University of Toronto Libraries Website. When researching, we used key searches such as "Asclepias AND Ontario", "Asclepias syriaca AND Ontario", "Asclepias tuberosa AND Ontario" and "Asclepias incarnata AND Ontario" among other milkweed variants to find peer-reviewed sources. As there were limited peer-reviewed sources within Ontario on species other than Asclepias syriaca, we looked to peer-reviewed academic sources outside of Ontario and non-peer review recommendations based in Ontario (full details on this in the discussion portion). These non-peer review recommendations were accessed using Google and only credible institutions such as the Toronto Zoo and the Credit Valley Conservation were included.

The long-term maintenance plan was developed by searching over ten case studies using the University of Toronto Library and Google search engines and focusing our searches on peer-reviewed research conducted in Mississauga and Ontario. We then compared data across multiple sources to produce a long-term governance plan. This was done by extrapolating the research found regarding the long-term maintenance of similar projects to apply to the long-term governance plan to ensure that the plan can still operate when despite climate changes. We then

searched data from the Toronto City Planning website for opinions on long-term governance and compared them with government policies. Furthermore, additional contracts and documents were assessed regarding the long-term planning of pollinators plots in different countries and regions and some information from these resources was used to inform our management plan.

Results

Establishing Pollinator Plots

We recommend establishing pollinator plots and planting seeds in June, to allow for the pollinator plots to be ready in time for the oviposition season which occurs in July and August in southern Ontario (Knight et al., 2019). The medium-sized pollinator plots should consist of similar milkweed species, allowing for easier detection of the plots (Pitman et al., 2018). Each plot should contain approximately 11 milkweeds per m^2 to maximize oviposition (Knight et al., 2019, p.7).

Best Practices for the Removal of the Invasive Species Present

Secondary research was done to establish the best strategy for the removal of invasive species present and yielded the following results. First and foremost, the most appropriate method of removal for the site in question is initially, tarping. Research suggests that for large plots of land, tarping provides the best results over a longer period, and different methods of tarping can be used to accommodate different spatial and temporal needs Hoidal (2021). The two methods of tarping best applied to the Arsenal Lands are Solarization and Occultation. Furthermore, manual removal using cultivation or hand-weeding, was determined to be a crucial step in the removal process, as both methods are more selective and can be done without harming neighbouring flora and fauna. In addition, research suggests that the use of herbicides is an effective method of preventing the expansion of invasive species early. There are two main types of herbicides, pre-and post-emergent. Each type is used at different stages of the removal process. However, using herbicides comes with risks that are discussed further later in the paper. The final method deemed necessary for the removal strategy is underwater cutting, which is used circumstantially for flowering plants, to maintain a steady stream of water for roots to survive when cutting the stems.

Recommendations for Planting Appropriate Species

The genus Asclepias commonly known as Milkweed is favoured by many pollinators (Credit Valley Conservation, n.d.; Lalonde et al. 2022; Pitman et al. 2018; Szigeti et al. 2020; Toronto Zoo n.d.). Based on the literature gathered from peer-reviewed academic sources within

Southern Ontario, we recommend using the Asclepias syriaca also known as the common milkweed (Credit Valley Conservation, n.d.; Howard and Barrows 2014; Lalonde et al. 2022; Maclvor et al. 2017; Szigeti et al. 2020, n.d. Toronto Zoo, n.d.). Additionally, based on peer-reviewed studies outside of Ontario and recommendations from institutions within Ontario, we also suggest the use of Asclepias incarnata and Asclepias tuberosa (Baker et al., 2020; Credit Valley Krochmal, 2016; Conservation, n.d; Toronto Zoo, n.d)

Governance Strategy for Long-Term Maintenance

The ten-year long-term maintenance strategy will begin with the first mowing in July 2022, followed by mowing and selective weeding the following year. Subsequent plans will include large-scale plot regeneration activation every four to five years (Heck, A Michigan State University Extension, 2022). To avoid excessive reclamation grass must be mowed diligently (Gathmann A, Tscharntke T. 2002). We further advise minimizing the use of pesticides and avoiding excessive use of herbicides (Benedek P. 1972).

Community Engagement

Our action plan to increase community engagement involves contacting elementary schools and community centers in the neighbourhood through email and providing them with posters and infographics that would be distributed to the students and families involved at the community center. This plan would be an effective approach to involve local families and children in the pollinator plot project. Adhering to COVID-19 public health measures, we planned on hosting workshops for children at the local libraries and community centers, involving activities about the importance of pollinator plots. We also recommend getting students and faculty at the University of Toronto Mississauga to be involved in this project by reaching out to student groups such as Zero Waste and the Student Association of Geography and Environment (SAGE) (The University of Toronto, n.d.).

Discussion and Recommendations

Establishing Pollinator Plots

We recommend designing pollinator plots that include similar species of host plants, as it is easier for butterflies to locate chemical signals from plots that have similar species (Pitman et al., 2018). According to a study conducted in southern Ontario, it was found that medium-sized patches and low-density patches result in the highest rate of oviposition. Medium-sized patches less than 28 m^2 in size and low-density patches would be the ideal dimensions for pollinator plots to maximize oviposition (Pitman et al., 2018, p. 57). Low-density patches resulting in the highest rate of oviposition during summer should consist of a maximum of 11 milkweeds per m^2 (Knight et al., 2019, p.7). According to a recent study conducted in southern Ontario, the peak egg-laying season is mid-July to August, so we recommend establishing pollinator plots as early as June (Knight et. al., 2019).

Best Practices for the Removal of Invasive Species Present

The research process mentioned above was crucial in determining the best methods and practices to achieve the aforementioned goals. Although manual removal can seem as simple and straightforward, best removal practices are precise and calculated to avoid damage done to the site. The manual removal of invasive species like weeds can be done using two methods: cultivation, or hand-weeding. Cultivation is the manual removal of weeds using a garden hoe. This method is not preferred if there are other plants in the area that are not to be damaged or have shallow roots that are vulnerable to removal (Wilen, 2018). Furthermore, hand-weeding much like the name suggests; involves manual hand removal to selectively remove weeds and prevent them from seeding (Wilen, 2018). This process is time-consuming but is strongly recommended to be used in conjunction with other methods (Wilen, 2018).

A recent article written for the University of Minnesota, Hoidal (2021) describes the best solarization and occultation practices for removing weeds from large areas. Both processes are similar in their use of tarps however, solarization involves the use of a clear tarp and occultation involves the use of a dark opaque tarp. Solarization is described by Hoidal (2021) as the use of clear plastic covering, to heat the soil underneath, and block access to water which will kill any

vegetation beneath it. Furthermore, since occultation uses opaque coverings, the process can take longer and is usually advantageous because these coverings are less prone to tears (Hoidal, 2021). In a study conducted for the University of Maine comparing the effectiveness of solarization and occultation, Smith et al. (2017) determined that in shorter time periods, solarization is preferred as the process is shorter than occultation.

Furthermore, the use of herbicides is recommended to chemically kill invasive species and prevent seed germination. This method, however, comes with risks and considerations that must be accounted for. In addition, there are a plethora of herbicide types on the market, and it is essential that the right one be used on the site. Two types of herbicides that differ in application are pre and post-emergence herbicides. Preemergence simply refers to the application of the product before the germinated seed can sprout (Altland, 2019). Post-emergence is herbicide applied after seeds have germinated and established sprout. Both products have separate uses and are valuable to the removal of the invasive species on site. With respect to the Arsenal Lands site, two (significant) existing risks must be considered with respect to the use of herbicides; the effects the application may have on neighbouring native species and the runoff that may reach the existing bodies of water and its impact on neighbouring flora and fauna. Therefore, before application, it is imperative that the risk and symptoms of herbicide injury are recognized. Wilen (2018) describes the symptoms visually as yellowing, whitening, root stunning, distorted growth, and/or death of leaves.

Underwater cutting is an aspect of our removal strategy that is circumstantial to the existence of flowering plants that are to be reused or relocated. The process is generally recommended for flowers because when the stems are cut to cuff off root access to water. Therefore, cutting these plants underwater will ensure that the roots receive a steady supply of water through the process.

Recommendations for Planting Appropriate Species

Monarch butterflies migrate twice a year (Baker et al., 2020; Lemoine, 2015). In the first few months of the year, they inhabit central Mexico before moving into northern Mexico and the south of the United States of America (Baker et al., 2020; Lemoine, 2015). Throughout the rest

of the year, the butterflies continue to move north into Canada and in the fall, they begin to return to central Mexico (Baker et al., 2020; Lemoine, 2015). Monarch butterflies continue to migrate north into Canada to avoid extreme heat and to access milkweed. Therefore, planting is essential for the pollinator plots as milkweed is has been proven to be favoured by monarch butterflies (Credit Valley Conservation, n.d.; Lalonde et al. 2022; Pitman et al. 2018; Szigeti et al. 2020; Toronto Zoo n.d.). Increasing milkweed populations in Ontario can assist in reducing the decline of the monarch butterfly populations (Lalonde et al. 2022; Pitman et al. 2018). Milkweed is also popular among the attraction of honeybees (Connie, 2016). Milkweed is versatile and considered a host plant for monarch butterflies (Kaul & Wilsey, 2019). Host plants are ones that different types of insects tend to inhabit, live on, and often lay their eggs in (Credit Valley Conservation, n.d.). Therefore, we recommend planting milkweeds as they are a main source of nectar for pollinators and provide other insects with food and shelter (Credit Valley Conservation, n.d.).

Furthermore, we investigated the different types of milkweeds that would be best suited for this plot. Our goal was to understand which plants were preferred by the butterflies and bees to increase their population within the plot. Plan type and its ability to attract butterflies and outcompete invasive species are critical to long-term plot success. The common milkweed is an ideal pollinator plant because it is a diverse plant that can inhabit many different locations such as gardens, roadsides or even landfills (Lalonde et al. 2022). Known as Asclepias syriaca as its scientific term, it is one of the most recommended milkweeds for its ability to attract monarch butterflies (Maclvor et al. 2017) Within a study in Southwestern Ontario, it was preferred by honeybees over an invasive species known as the dog-strangling vine (Howard and Barrows 2014; Maclvor et al. 2017; Szigeti et al. 2020.). Asclepias syriaca provides suitable habitats for the monarch butterflies who use the plant for oviposition which is when monarch butterflies lay their eggs (Credit Valley Conservation, n.d.; Lalonde et al. 2022; Toronto Zoo, n.d.). This is why we recommend the common milkweed to be used in this pollinator plot.

While the common milkweed is very popular, there are other types of milkweeds that can be used as well. There were very few peer-review studies on other milkweed populations within Ontario. As a result, we looked to peer review studies outside of Ontario when these species were also recommended by institutions within Ontario. This Asclepias incarnata which has the common name of swamp milkweed and Asclepias tuberosa known as the butterfly weed, are also

popular milkweeds (Baker et al., 2020; Credit Valley Conservation, n.d.; Toronto Zoo, n.d.) These milkweeds specialize in attracting monarch butterflies as they provide an abundant amount of nectar (Baker et al., 2020; Credit Valley Conservation, n.d.; Toronto Zoo, n.d.). In Kentucky, honeybees and wasps have been found to be some of the most effective pollinators of the swamp milkweed and the butterfly milkweed (Baker et al., 2020). The butterfly weed tends to reach three feet in height which helps in increasing the attraction of butterflies and honeybees (Krochmal, 2016). The swamp milkweed blossoms from midsummer till the fall (Krochmal, 2016). As this is when monarch butterflies migrate to Canada, their inclusion in the pollinator plot would be beneficial (Baker et al., 2020; Lemoine, 2015). Additionally, swamp milkweed is known for encouraging an abundance of honey crops (Krochmal, 2016). Both milkweeds are also recommended by the Toronto Zoo (n.d.) and the Credit Valley Conservation, (n.d.) to the public who want to create pollinator gardens and help pollinators. The common milkweed, butterfly weed and swamp milkweed all prefer full sunshine, and are easy to grow (Krochmal, 2016). They thrive in different types of soil and are known to spread at fast rates (Krochmal, 2016). Therefore, we recommend the implementation of the butterfly weed and the swamp milkweed to be used along with the common milkweed in the pollinator plot.

Fig. 2. Images of recommended milkweed plants in order of appearance; (1) Common milkweed (Taylor, n.d), (2) Butterfly Stritch, n.d.), (3) Weed Swamp Milkweed (Holmes, n.d.)

Governance Strategy for Long-Term Maintenance

Mowing strategies and the use of herbicides and pesticides are some of the vital management practices for the long-term maintenance of pollinator plots. Mowing at the right time is not only important for the maintenance of pollinator plots but also important to maximize oviposition during egg-laying season (Knight et al., 2019). We recommend that patches should not be mowed from late July to mid-August, to decrease larvae mortality rate, as this is peak egg laying season in southern Ontario (Knight et al., 2019). According to Knight et al. (2019) oviposition increased drastically in mid-July when the patches were only mowed once in early July. Mowing less frequently allows the milkweed plants to mature in time for the female butterflies to oviposit, resulting inadequate time for the larvae to develop into adults (Knight et al, 2019). Therefore, we suggest the patches should be mowed less frequently.

Although female butterflies prefer agricultural land over natural areas to oviposit, the use of effective insecticides decreases predators from the host plants, which likely attracts more female butterflies (Pitman et al., 2018). The use of insecticides on pollinator plots could be helpful to decrease predators present at the site (Pitman et al., 2018). Insecticides containing neonicotinoids should not be used, as the long-term impact on plants, the surrounding habitats and most importantly the monarch larvae is still unknown (Pitman et al., 2018). Furthermore, according to a study, it was found that the use of highly toxic pesticides in orchards resulted in a reduction in pollinating insects and a reduction in fruit germination and setting rates (Free & Ferguson, 1980). Pesticide application should be planned out appropriately, typically pesticides can be applied before or after the flowering of plants to reduce the impact on pollinators or pesticides can also be used at night when pollinators do not interact with plants (Free & Ferguson, 1980). Although pesticide use is more harmful than herbicides, herbicide use should be limited (Benedek, 1972). Kevan (2001) states that herbicides reduce the number of flowering plants, which attracts less pollinators, therefore, reducing host plant species in the area.

The use of fertilizers to increase nitrogen content in host plants is also recommended, as some studies found that oviposition increased drastically in patches where host plants were composed of a higher nitrogen content (Pitman et al., 2018).

Community Engagement

One of our goals was to engage the community. One aspect of community engagement is to connect with students and faculty at the University of Toronto Mississauga. To increase public awareness about the importance of the pollinator plot, we recommend hosting workshops in local libraries and nearby community centers. These workshops can have pictures of the pollinator plot, and fun activities for the younger generation to learn about different types of milkweed flowers and butterflies. These activities meant for the ages 9-15 can include teaching them how to make a small garden, or how to identify different types of flower seeds. At the end of these workshops, an invitation to come and visit the pollinator plot can be handed out to the participants, to increase their enthusiasm for coming to the creative hub and seeing the pollinator plot firsthand.

We also recommend connecting with students through environmental-focused student groups and other continued partnerships within ENV332. At the University of Toronto Mississauga, there is a wide range of environmental focused groups such as the Student Association of Geography and Environment (SAGE), the Zero Waste University of Toronto Mississauga and Generation Climate (The University of Toronto, n.d.).. Reaching out to these groups and inviting these clubs to help with the planting of the milkweed and or after the plants are planned, creating events where students come and visit the pollinator plot would engage the UTM community. Additionally, continuing to work with UTM on projects within this class in future years would also connect students. Prior to this project, we had not heard about these lands, but our group is now excited to see the pollinator plot and continue to be a part of the journey. Future projects could perhaps have students focus on engaging UTM students and creating events where students visit the pollinator plot.

One way to increase community engagement and involvement with the pollinator plot project is to contact schools. Our main goal was to email elementary schools within the neighbourhood near Marie Curtis Park, informing them about the pollinator plot project and how students and their families can get involved. The email would also include posters such as infographics with the details about the timeline and how students can sign up. We also planned

on increasing our outreach to the community centers within the neighbourhood through email, so they could share our infographic with their mailing list. Email marketing and creating online marketing content such as infographics and posters were originally planned to be our main form of promoting the pollinator plots. However, we were informed that another team was already involved with community outreach and that we should prioritize other goals over community outreach.

Conclusion

To revive the pollinator plot, increasing the usage of different types of native milkweed flowers, can contribute immensely towards saving the monarch butterflies as well as native honeybees conservation. Promoting community engagement and public support to help in gardening will increase awareness about pollinators. The community will be able to understand the importance of maintaining this pollinator plot and help protect it. In terms of long-term maintenance management strategies, we made a 10-year plan and provided advice on maintaining local or restoring the diversity of pollinators in habitats, and maintenance and artificial construction of suitable habitat environments.

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Appendices

Appendix A

Image of Arsenal Land and Surrounding Area
Figure 1

(Toronto and Region Conservation, n.d.)

Appendix B

Images of milkweed plants
Figure 2

(1) Common milkweed (Taylor, n.d), (2) Butterfly Stritch, n.d.), (3) Weed Swamp Milkweed (Holmes, n.d.)