University of Toronto

Final Report

Creating More Pollinator Habitats on UTSC Campus

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Sustainability in Practice EESC34

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Due Wednesday April 8th

Abstract

The decline in pollinator habitats due to urbanization, deforestation and climate change has led to negative ecological effects both locally and globally. This decline has led to negative ecological effects, impacting the surrounding environment. This report suggests improving pollinator habitats on a local scale, at the UTSC campus, by enhancing already in place green spaces with appropriate angiosperms and creating more areas with flowering beds on campus. This will attract and grow a greater pollinator population. Currently, our project is highly theoretical due to a lack of response from stakeholders like the UTSC Sustainability Office, Office of Business Development and the manager of the campus apiaries. However, we have cultivated a list of appropriate plants via their value to pollinators and secondarily their value to the campus. There was preliminary data gathered by researching costs of seeds, plantings, soils etc. We completed a cross-analysis to locate any other green space initiatives that incorporate pollinator habitat activities in several other universities across Canada including Queen's, York, Ryerson, the University of British Columbia (UBC), McGill and the University of Calgary. We also identified key hypothetical data sets that must be taken into account prior, in order for the project to be properly executed. This included the species of plants and their spacing, sunlight, water and shading needs, bloom colours, bloom periods, mature heights, as well as pesticide data to analyze the pesticides active ingredients, risk category, and residual time of mortality according to provincial standards. We are confident that we have a viable framework for the project to proceed in the future.

Keywords:

Angiosperms, Ecosystems, Habitat, Pollinators, Sustainability

Introduction

The University of Toronto Scarborough has made tremendous efforts to incorporate sustainability initiatives in its expansion. Anyone visiting the campus will view the multiple green infrastructures in place such as bioswales, green roofs and hiking trails. UTSC implemented apiaries on the Social Science (MW) rooftop (IC Rooftop Garden, 2020) and added a garden space called the Fred Urqhart Memorial Garden, which provides butterfly habitat (Fred Urqhart Memorial Garden, n.d.). Yet, our group noticed that most of the plants in campus green spaces are non-flowering. This is problematic for a variety of reasons, but mainly because it does nothing to support pollinators. To begin, pollinators are animals that move pollen from male structures (anthers) of flowers to the female structure (stigma) of the species ‘'forming a symbiotic relationship between the plant and animal” (Center for Pollinator Research, n.d.). This symbiosis helps the plants reproduce and provides food and shelter for the pollinator, and by helping sustain populations of plants, this biological interaction thus forms the basis of food chains which are among the most fundamental aspects of healthy ecosystems (Center for Pollinator Research, n.d.). Available pollen and nectar are reduced when habitat is lost, and because the constant availability of these two thing**s** is necessary for bees and butterflies to survive, their survival is placed at risk when they are lost (City of Toronto, 2018). Also, urbanization, climate change and general human activity, have led to a reduction in overwintering habitat, nesting habitat and caused invasive species to be introduced, all of which

threaten pollinator survival (City of Toronto, 2018). Therefore our proposal is to enrich the campuses currently existing green spaces, by planting angiosperms or flowering plants. This will have multiple ecological benefits from helping to fortify food webs to aiding in water filtration and soil health (Meeuse, 2006; University of Minnesota, 2000). Furthermore, as urbanization persists, habitat becomes increasingly fragmented, and by implementing green spaces with angiosperms, a continuous corridor can be created that makes moving through urban areas and onward easier and safer for pollinators (City of Toronto, 2018).

Methods and Data

Though sadly, we have had little success in contacting members of the Sustainability Office, the Office of Business Development, and the apiary manager, we have created a theoretical plan for the project. We have researched different species of plants and created a list of ones that would be best suitable for pollinator attraction via the Native Plant Encyclopedia from the Canadian Wildlife Federation; these included species such as asters, bee balm, bellflower, Black-Eyed Susan, Joe Pye weed, Lupine, Milkweed, and Thin-Leaved Sunflowers (2020). We have also collected data on the costs associated with planting (see Figure 1 in the appendix), such as that of soils and plants, and what the range of costs would be across wholesale or retail outlets for the needed supplies (Amazon, 2020; The Home Depot, 2020). Soil, for example, can be sourced in large quantities, and estimates from vendors like Amazon.ca and The Home Depot range from $149.95-199.00 per cubic yard (2020). We did not include the associated costs of labour or tools, however, for the reasons that we do not know the available workforce and also expect the institution already has access to machinery of the relevant kind.

If this plan is to be implemented on campus, it would be in line with Toronto's Green Standard, a sustainable design standard for buildings in the city, with goals to improve air quality and reduce the urban heat island effect, reduce energy use and greenhouse emissions from new buildings while making existing buildings more resilient to power disruption, encourage the use of renewable and district energy, reduce stormwater runoff, and protect and enhance ecological functions while integrating landscapes and habitats (City of Toronto, 2020).

We would require a list from the Apiary Manager and the UTSC Sustainability Office of the types of pollinators that visit the apiary, and what types of shelters they require, hypothetically similar to the list in Figure 2 of the Appendix for Southern Ontario pollinator species and habitat preferences. This would help inform how to properly design and enhance the campus green spaces to best provide for this subset of pollinators (Natural Resource Conservation Service, 2013).

Additional information needed would include details on the existing pollinator plants being grown or those eligible for procurement at UTSC. Data should include the name of the plants, bloom colour, bloom period, mature height and light needs, like from the University of Michigan (see Figure 3 of Appendix section). Furthermore, we would require a map of the campus that features the locations for all UTSC beehives, apiaries, and pollinator habitats, as the St. George campus has created, as well as a list of pesticides used on campus, in order to generate a table that analyzes their potential impacts on pollination (see Figure 5 of Appendix section). Data should be provided as such and include active ingredients, risk category and residual time of mortality according to provincial standards like in figure 4 (see Figure 4 of Appendix section).

Results and Discussion

At this time, our project remains highly theoretical, due to the lack of response we have received from various contacts on campus in order to obtain data and project support. There are also considerations that must be taken into account, in order for the project to be properly executed, such as the species of plants needed, as well as their needs for spacing, sunlight, water, and shading.

We have gathered information on similar pollination projects undertaken in campuses across the country and compared them with what UTSC is, and could be doing. First, Queen**'**s University implemented bee houses on campus surrounded by a garden of native plants such as Dutchman's Breeches, Violet and Goldenrod, which were strategically chosen to bloom throughout the growing season. Since its creation, that project has successfully attracted pollinators such as solitary bees (Queen**'**s Gazette, 2017). Additionally, other Universities such as York, Ryerson, University of British Columbia (UBC) and McGill all have initiatives to help integrate green spaces and eco-friendly practices into this infrastructure, such as apiaries and bike lanes, yet there is little direct data on helping increase pollinator populations by adding angiosperms, and some of the proposed initiatives to create beehives are more to do with the honey produced than the animals that need protection (Smyth, 2019; York University Sustainability Strategy, n.d.; McGill, 2017; *Ten Goals*, University of British Columbia, 2020; *Food*, University of British Columbia, 2019). The University of Calgary has undertaken several efforts to enhance their green spaces with native angiosperms, and Wilfred Laurier has created a five-year goal to make their campus more sustainable, which includes planting native angiosperms to provide for pollinators like bees and butterflies, and also involves raising

awareness around the plight of pollinators in nature (Current Bee Campuses, n.d.; Campus Initiatives, n.d.). It is our belief that despite the lack of solid information from the Sustainability Office and other relevant parties, this project would not be difficult to undertake. Our concept and rationale are realistic and sound, and we believe that this project could be implemented smoothly and would bring a plethora of benefits, and further integrate the UTSC campus with the City of Toronto's many green initiatives. We are also aware that our recommendations may be subject to change, depending on which sites are chosen and based on input from the aforementioned departments at the time the project is being considered.

Recommendations

Our group suggests planting angiosperms at several main sites on campus, such as the grassy space between the Arts & Administration building, the bioswales near both the student centre and Highland Hall, the lawn adjacent to the Academic Resource Center, and within the multiple garden beds around the campus such as those found along the Humanities Wing (see Figure 6 of Appendix section). We also have four specific recommendations for selecting appropriate plantings. First, we recommend that native plants be solely planted in order to appropriately support bees native to the region of Southern Ontario, such as solitary bees. We also recommend strategically selecting flowing species that remain in bloom long enough to ensure an optimal window of time for pollinators to visit. Additionally, we recommend that the plants selected should be perennial. By planting perennials that grow back every year, funds to buy supplies and needs for extra labour will be reduced. Our final recommendation is to do with the colour of plants selected. Bees are drawn to vibrantly coloured flowers such as sunflowers or

lavender (see Figure 7 in the appendix sections), and planting angiosperms such as these will increase the likelihood of successfully attracting pollinators (How to Create a Pollinator-Friendly Garden, n.d.)

Conclusion

To maintain a connection between the campus grounds and the ecological environment, UTSC must enhance their pollinator habitats as they expand as a school. Pollinators perform necessary and fundamental roles in the ecosystems, by helping improve the genetic diversity of plants, and thus improving soil health, water purity and sustaining healthy food webs (Center for Pollinator Research, n.d.). Other universities across the country have undertaken initiatives to further their green spaces and maintain colourful angiosperms that attract a variety of pollinator populations (these universities have noted and addressed the importance of pollinator survival). While conducting research, our group observed a lack of transparency between the public and what UTSC is doing to maintain an acceptable sustainability standard, and this is something that we hope will be remedied in the future. With the addition and enhancement of pollinator habitats on campus, UTSC will not only be advancing biological services needed to maintain a healthy ecological atmosphere, but aligning with the GTA's initiative while providing positive feedback for students and staff.

Appendix

Planting	**Anticipated Costs by Quantity (Includes shipping; pre-tax)** (Figures established via current pricing available from The Home Depot and Amazon.ca as of March 15th, 2020.)
Asters (Big-leaved)	$18.00 per 75 seeds
Bee Balm (mixed colour)	$5.00-13.78 for between 50-300 seeds
Bellflower (Harebell)	$5.00 for ~200 seeds
Black-Eyed Susan	$4.60-18.24 for between 100-5000 seeds
Joe Pye Weed	$4.60-13.78 for 100-200 seeds
Lupine (mixed colour)	$5.00-5.99 for 100-200 seeds
Milkweed	$14.00-20.35 for 50-100 seeds
Sunflower (Thin-leaved)	$10.88 for 30 seeds
Eight specimen types	**$106.02, if taken at the highest end within each listed range.***

Figure 1. A qualitative analysis of the associated costs with our proposal

Table 1. General native pollinator habitat requirements.		
Pollinator	**Food**	**Shelter**
Solitary bees	Nectar and pollen	Most nest in bare or partially vegetated, well-drained soil; many others nest in narrow tunnels in dead standing trees, or excavate nests within the pith of stems and twigs; some construct domed nests of mud, plant resins, saps, or gums on the surface of rocks or trees
Bumble bees	Nectar and pollen	Most nest in small cavities (approx. softball size), often underground in abandoned rodent nests or under clumps of grass, but can be in hollow trees, bird nests, or walls
Butterflies and Moths – Egg	Non-feeding stage	Usually on or near larval host plant
Butterflies and Moths – Caterpillar	Leaves of larval host plants	Larval host plants
Butterflies and Moths – Pupa	Non-feeding stage	Protected site such as a bush, tall grass, a pile of leaves or sticks or, in the case of some moths, underground
Butterflies and Moths – Adult	Nectar; some males obtain nutrients, minerals, and salt from rotting fruit, tree sap, animal dung and urine, carrion, clay deposits, and mud puddles	Protected site such as a tree, bush, tall grass, or a pile of leaves, sticks or rocks
Hummingbirds	Nectar, insects, tree sap, spiders, caterpillars, aphids, insect eggs, and willow catkins	Trees, shrubs, and vines. Typically need red, deep-throated flowers, such as twin berry or penstemons

Figure 2. A display of the food and shelter requirements for species of pollinators native to Southern Ontario

Table 4. Plants for pollinators in Michigan gardens.										
Common Name	***Scientific Name***	**Bloom Color**	**Bloom Period**	**Mature Height (feet)**	**Light Needs**	**Drought Tolerance‡**	**pH Minimum**	**pH Maximum**	**Salinity Tolerance†**	**Annual or Perennial**
Yarrow	*Achillea millefolium*	white	mid to late	3	sun	H	5	6.5	H	P
Korean Hummingbird Mint*	*Agastache rugosa*	purple	mid	4	sun to part shade	L	6	8	L	P
Anise Hyssop*	*Agastache rupestris*	purple	mid	4	sun to part shade	L	6	8	M	P
Borage*	*Borago officinalis*	blue	early	2	sun	L	6	7.5	M	A
Calliopsis	*Coreopsis tinctoria*	yellow	mid to late	3	sun	H	6	7.5	L	A
Cosmos	*Cosmos bipinnatus*	variable	late	5	sun	H	6.5	8.5	M	A
Purple Coneflower*	*Echinacea purpurea*	purple	mid	4	sun	M	6	8	M	p
Globe Thistle*	*Echinops ritro*	blue	mid to late	5	sun	H	5	6		P
Sea Holly*	*Eryngium spp.*	blue	mid	2	sun	M	6.5	8	L	P
Fennel	*Foeniculum vulgare*	yellow	mid	2	sun	L	7	8	L	P
Sunflower*	*Helianthus annuus*	yellow	late	3	sun	M	5.5	8	M	A
Lavender*	*Lavandula spp.*	purple	early to late	3	sun	M	6.5	7.5	M	P
Horehound	*Marrubium vulgare*	white	early to mid	3	sun	L	6	8	L	P

Figure 3- Information from the University of Michigan on the physical needs of various pollinator species

ACTIVE INGREDIENT	Most Restrictive Pollinator Precaution	Moderately Restrictive Pollinator Precaution	Least Restrictive Pollinator Precaution	RT_{25} (< 24 hours – hours; > 24 hours – days)	Additional Information (where available)
Piperonyl butoxide *Synergist for insecticides*			X	< 3 hours [2]	Low toxicity alone, increases the toxicity of insecticides by blocking cytochrome P450 activity.
Potassium salts of fatty acids *aka insecticidal soap*			X	–	
Pymetrozine *Pyridine azomethine derivative insecticide*		X		< 24 hours [28]	
Pyridaben *METI miticide/insecticide*	X			< 2 hours [1] < 24 hours [28] 0.5 lb ai/acre (227 g ai/acre) 20 hours [2]	> 8 hours ERT for alfalfa leafcutting bees [1]. 1 day ERT for bumble bees [3].
Pyriproxyfen *Pyriproxyfen insecticide; insect growth regulator*			X?	< 24 hours [28]	< 2 hours RT for alfalfa leafcutting bees [1]. May be toxic to bumble bee brood [18].

Figure 4- Active ingredients commonly found in pesticides and their level of risk associated to pollinators

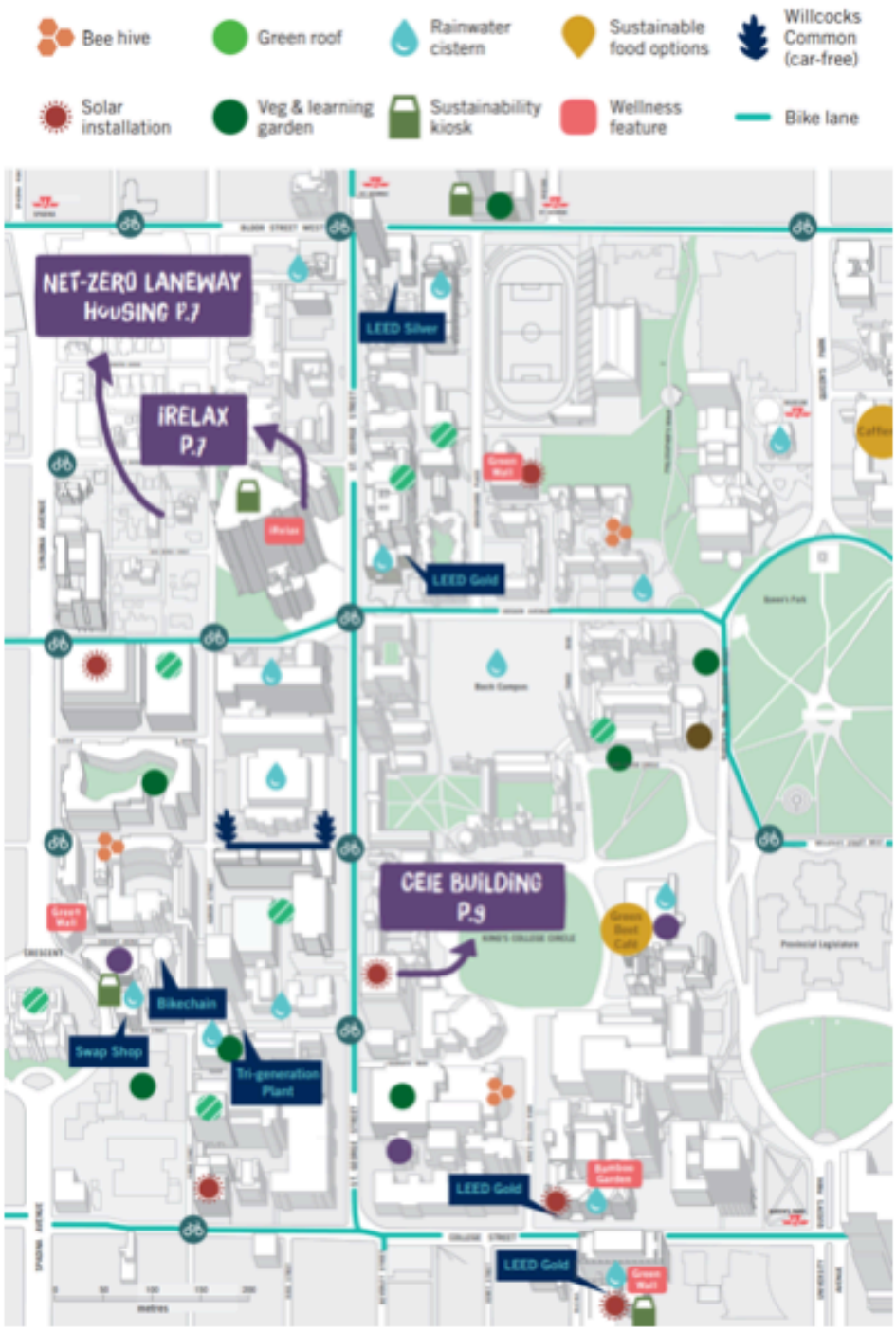

Figure 5- The St. George campus map of sustainability- related sites

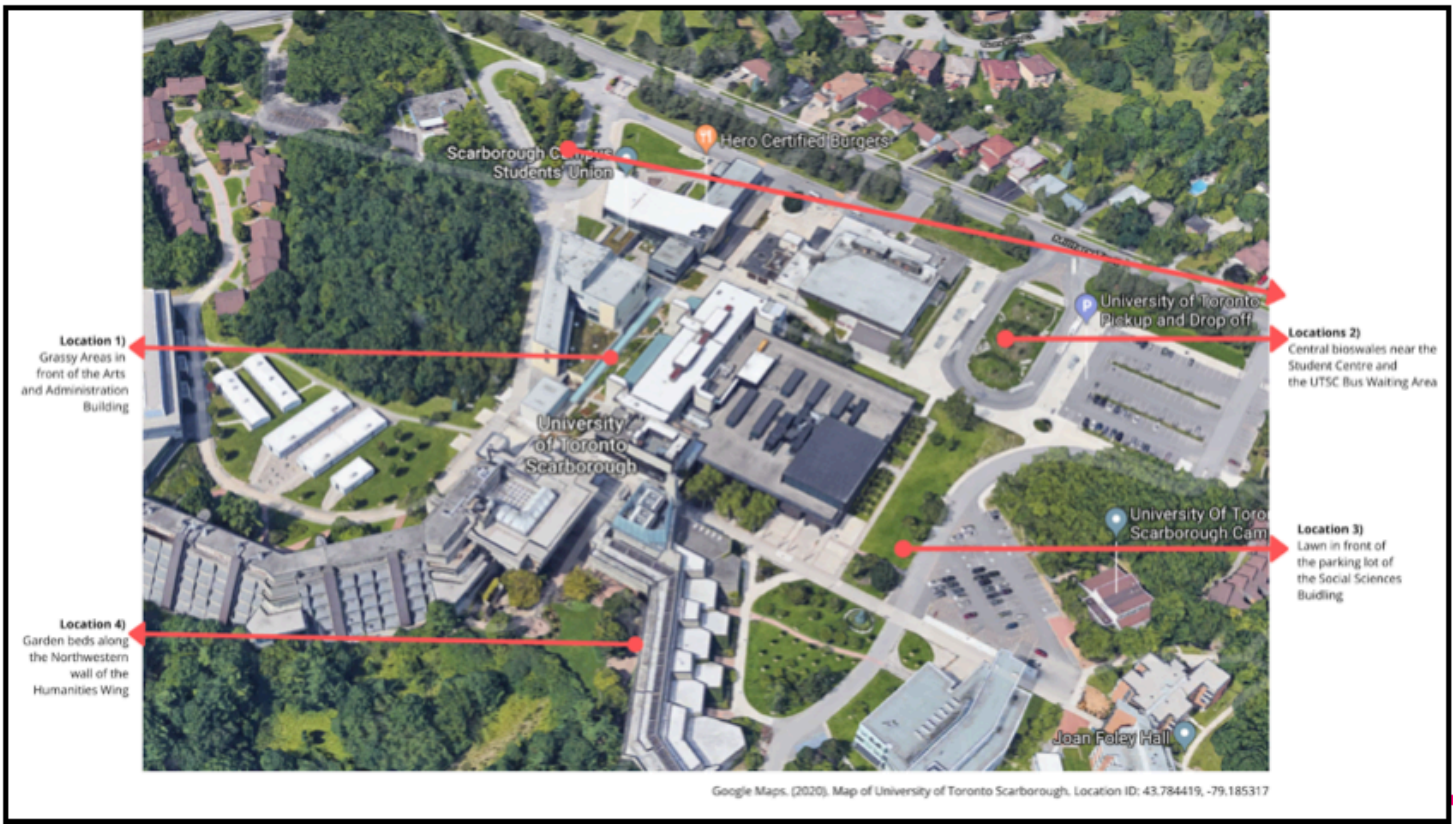

Figure 6- Locations at UTSC proposed for pollinator habitats

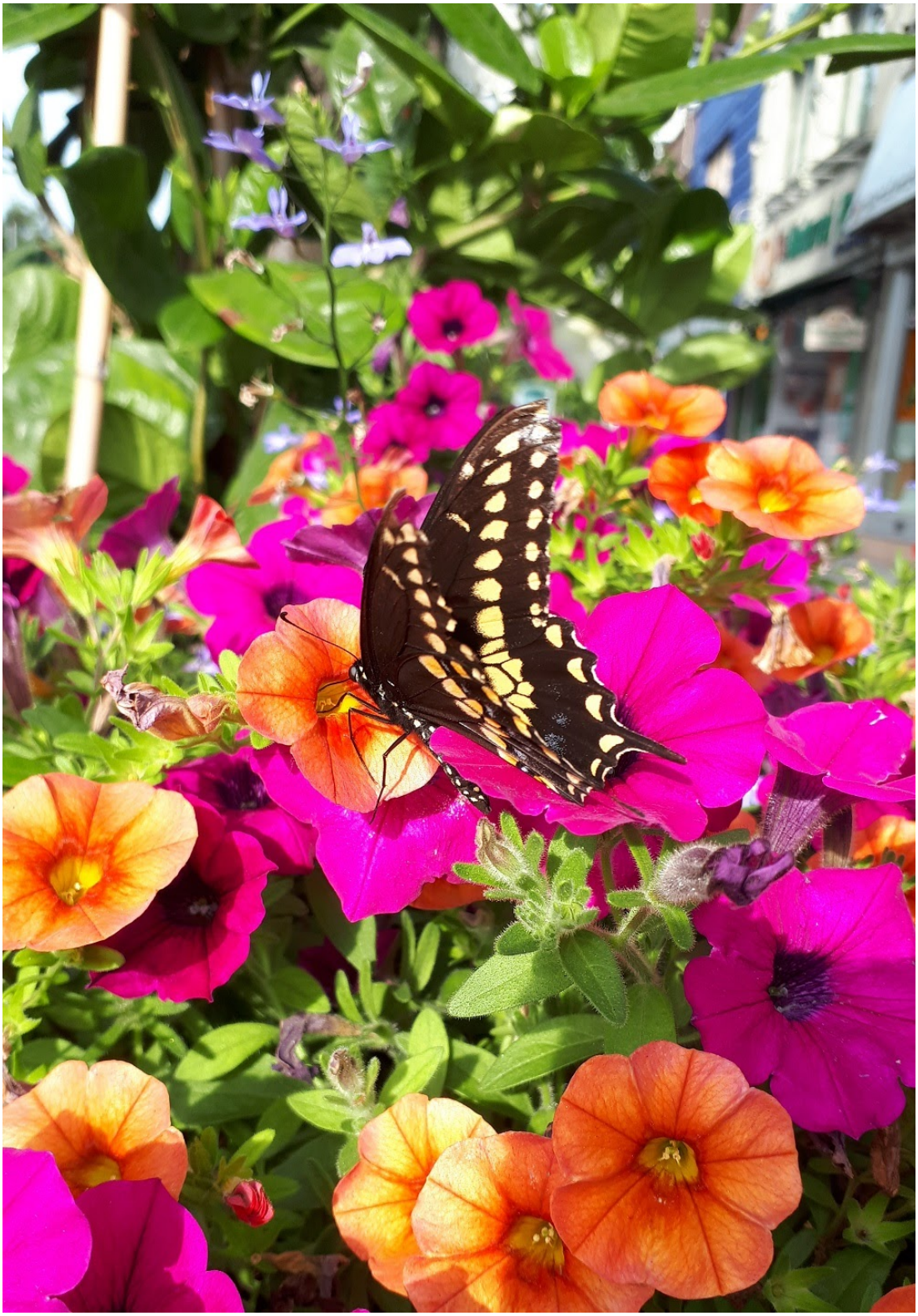

Figure 7- Vibrant angiosperms attracting a native butterfly species (Photo by Lindsay Gregory)

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