Kaleigh Mooney

Sudbury Shared Harvest – Pollinator Study 2022-2023

In the summer of 2022, Sudbury Shared Harvest (SSH) and Trent University collaborated to study the pollinator assemblages in community gardens around the Greater Sudbury Area. Volunteers and summer students from SSH collected insect samples from garden sites over the summer months, and a student from Trent analyzed them in an attempt to determine the landscape features that play an influential roll in the pollinator assemblages found at various sites. The two main questions of interest were, does proximity to current or previous mining operations have an influence on which pollinators are present, and/or do current land-uses have an influence on which pollinators are present?

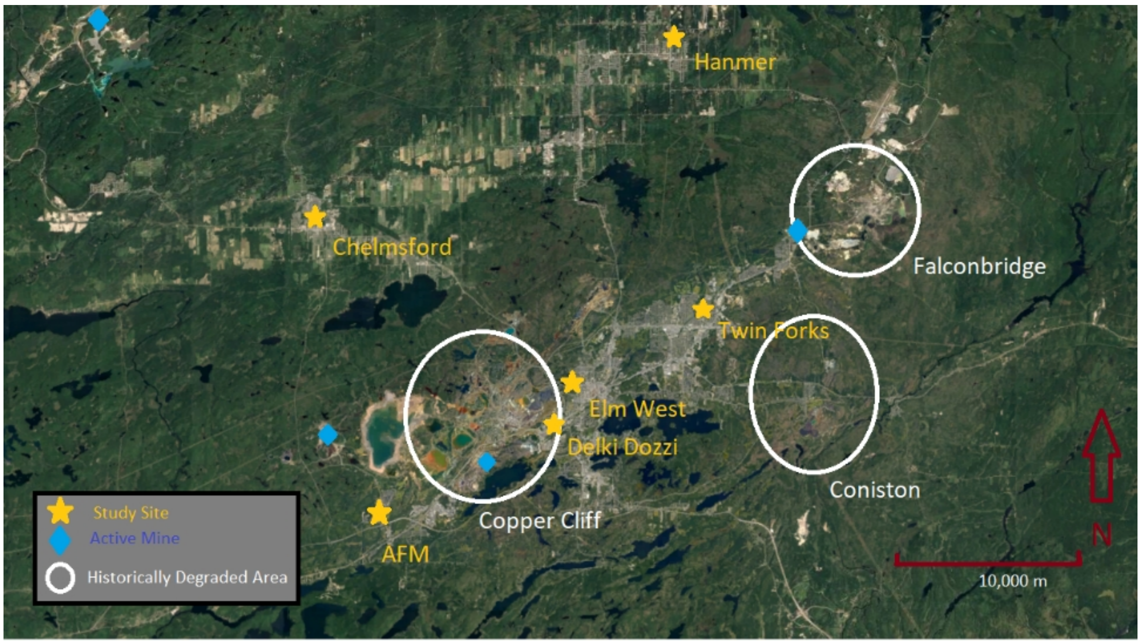


Figure 1. Map of the Greater Sudbury Region with starred markers where each sampling site is, diamond markers where there are active mines, and circles around approximate areas of severe degradation from historic mining (G. Spiers, *personal communication*, 2022-10-5).

Background

Pollinators provide an essential service to ecosystems. Pollination through insects or other fauna is the primary reproductive method for most plant species and helps to promote plant biodiversity (Ollerton, 2017). This in turn helps to foster a healthy, robust ecosystem. Of particular interest to this study, pollination also plays a critical role in the production of food products in urban gardening (Ollerton, 2017). Studies have demonstrated that pollinators, and the services they provide, are in global decline. The reasons for this are complicated and confounding, but some of the main drivers of this loss are land-use change, habitat loss, and fragmentation (Steffan-Dewenter and Westphal, 2008; Ollerton, 2017).

There is a well-established link between natural areas and pollinator diversity. Studies have shown that that an increase in natural or semi-natural correlates to an increase in pollinator richness and diversity (Holzschuh et al, 2012; Sritongchuay et al, 2022). The thought is that these areas provide habitat that supports pollinator communities with breeding and nesting sites and supplementary food resources

(Roulston and Goodell, 2011; Ollerton, 2017). Pollinating species vary in their foraging range – that is the distance they will travel from their nesting location to floral resources (Redhead et al, 2016). Habitat fragmentation and land use change can influence the pollinator community at the SSH gardens by selecting for groups that are able to travel greater distances to the garden sites (Bennet and Lovell, 2019).

Land use intensification is another well cited disturbance that can reduce pollinator abundance and diversity through the loss of complex vegetative communities that could serve as habitat (Holzschuh et al, 2012; Steffan-Dewenter and Westphal, 2008; Lybbert et al, 2022). Land use intensification is most often discussed in the context of agriculture and urban development (Holzschuh et al, 2012; Steffan-Dewenter and Westphal, 2008; Ollerton, 2017; Bennet and Lovell, 2019; Lybbert et al, 2022; Sritongchuay et al, 2022), but rarely are the effects of industrial mining on pollinator communities studied. In addition to the physical destruction of nesting habitat, these industries generate toxic by-products that have long lasting effects on the landscape (Winterhalder, 1995; Sivakoff et al, 2020).

Given Sudbury's long history of intensive industrial activity, it may be beneficial to understand the current pollinator community present and how it relates to the surrounding landscape. This may inform locations for future community gardens, pollinator conservation programs, and urban planning efforts.

Methods

In this study, six garden sites were chosen around the Greater Sudbury Area (figure 1). Sites that are less than 10 km away from past or present mining operations were considered the impacted sites and included Anderson Museum Farm, Delkie Dozzie, Twin Forks, and Elm West. The two non-impacted sites – Hanmer and Chelmsford – are located more than 10 km from mining activity. To determine which pollinators were visiting the SSH urban gardens, a pan-trap method was used. This method uses coloured bowls (in this case blue, white, and yellow) filled with non-toxic antifreeze which are placed in a given location for a predetermined amount of time during the months of flowering (figure 2). These sites were sampled with the pan-traps on a weekly basis over the course of six weeks (July-August). The idea is that the pollinators see these coloured bowls as flowers, and when they go to visit it, they become stuck in the liquid. Each sampling event lasted approximately seven hours, which sufficiently captures the daily activity of the pollinator community. When this period had lapsed, the sampler would filter the contents of each bowl into a coffee filter, which was labeled and placed into 80% ethanol for preservation.).

Figure 2. Pan traps at the Hanmer garden site.

Figure 3. Syrphid sampled by pan trap method.

The contents of these samples were then sorted into seven categories: large flies (bodies larger than 0.5 cm), small flies (bodies smaller than 0.5 cm), syrphids (figure 3), honeybees, bumble bees, other wild bees, and wasps. There was a focus on bees and flies because their bodies tend to be larger and hairier than most other insect groups, which makes them the ideal candidates for pollinators and so more likely to represent the fraction of insects responsible for production in the urban gardens (Ollerton, 2017).

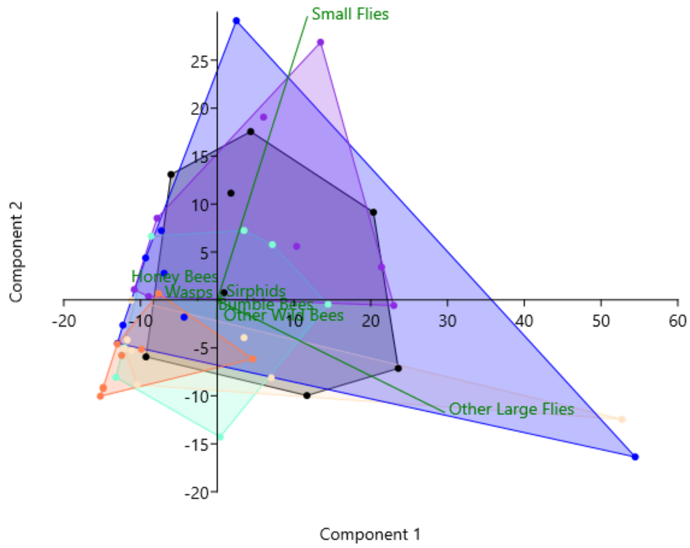
An analysis of land-use type was done on each of the garden sites using the Ontario Land Cover Compilation (version 2) data and ArcGIS. The Ontario Land Cover Compilation assigns a classification to areas of land based on the dominant land cover. To simplify the analysis, the land cover surrounding the garden sites were organized into broad categories: mature forest, sparse forest, community infrastructure, barren, agricultural, and water.

Pollinator assemblages were compared to the distance to the nearest mining operation (both past and present), the distance to the nearest habitat – considered here as either mature or sparse forest, and the total amount of habitat within 500 m, 1000 m, 1500 m, and 2000 m buffers. The statistical tests performed were a principal component analysis, regression analyses, and multiple regression analyses in order to find the factor with the greatest explanatory power for the sampled assemblages.

Results

There were some interesting findings that came out of these analyses. In general, the impacted sites showed similar assemblages. These were generally found to have less groups present, with wild bees having a slightly greater influence in these gardens (Figure 4). The exception to this is AMF, which had an assemblage that more closely resembled the non-impacted sites (Figure 4). The non-impacted sites seemed to have more pollinating groups present with a greater presence of flies (Figure 4). AMF is in close proximity to both historic and current mining operations but has a large percentage of forested area in the surrounding 500m radius that may serve as adequate habitat to support a stronger community of pollinators.

Because of this, it was thought that current land-uses may have a greater influence on pollinating communities than their proximity to disturbance. Simply put, it does not seem to matter if there is mining disturbance nearby, as long as there is enough forested area to supply the pollinator population with supplementary food resources and nesting habitat. In light of this trend, further analysis was done focusing on the distance and amount of forest area found in various buffer sizes. The results of the regression tests were fairly weak and difficult to draw a conclusion from. There did seem to be a positive relationship between bees and forest cover when both distance and total area covered in a 500 m buffer were considered. A new study with more sample sites would be beneficial to draw stronger conclusions about the relationship between pollinator groups and surrounding green space. The selected sample sites for this new study should be selected to represent a gradient of green space in various buffer areas. Studies have shown that there does seem to be a relationship between pollinators and the surrounding available habitat (Holzschuh et al, 2012; Sritongchuay et al, 2022) , so there is justification for future studies to gain a better understanding on the factors influencing the pollinators responsible for food production in the SSH gardens.



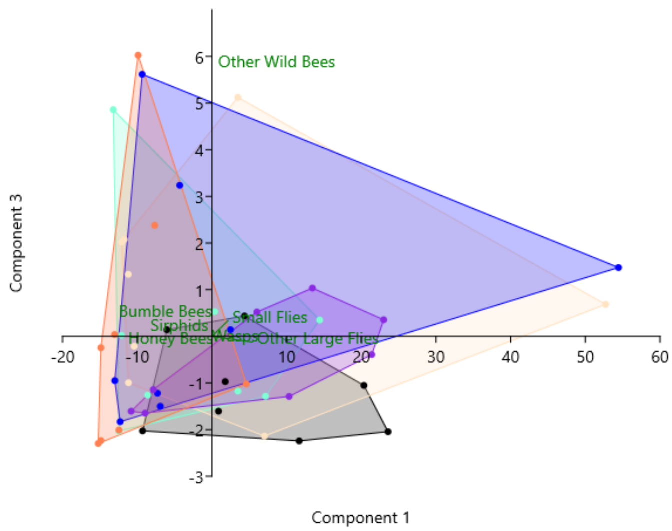


Figure 4: Principal Component Analysis of the variance in the proportion of pollinator groups between all garden sites. The coloured areas represent different sites (Hanmer by the purple shape, Chelmsford by black, AMF by pink, Delkie by teal, Twin Forks by orange, and Elm West by yellow). A comparison can be made between shapes that occupy a similar region, whereas a strong difference indicates that one or more of the principal components is has a greater influence on that site. Component 1 represents large flies that are not syrphids, Component 2 represents small flies, and Component 3 represents wild bees that are not honeybees or bumblebees.

References

Bennett, A.B., and Lovell, S. (2019). *Landscape and local site variables differentially influence pollinators and pollination services in urban agricultural sites.* PLoS ONE, 14(2): e0212034.

Holzschuh, A., Dudenhoffer, J-H., and Tscharntke, T. (2012). *Landscapes with wild bee habitats enhance pollination, fruit set and yield of sweet cherry.* Biological Consercation, 153: 101-107.

Lybbert, A.H., Cusser, S.J., Hung, K-L.J., and Goodell, K. (2022). *Ten-year trends reveal declining quality of seeded pollinator habitat on reclaimed mines regardless of seed mix diversity.* Ecological Application, 32(1): e02467.

Ollerton, J. (2017). *Pollinator Diversity: Distribution, Ecological Function, and Conservation.* Annual Review of Ecology, Evolution, and Systematics, 48: 353-76.

Redhead, J.W., Dreier, S., Bourke, A.F.G., Heard, M.S., Jordan, W.C., Sumner, S., Wang, J., and Carvevll, C. (2015). *Effect of habitat composition and landscape structure on worker foraging distances of five bumble bee species.* Ecological Applications, 26(3): 726-739.

Roulston, T.H., and Goodell, K. (2011). *The role of resources and risks in regulating wild bee populations.* Annual Review in Entomology, 56: 293-312.

Sivakoff, F.S., Prajner, S.P., and Gardiner, M.M. (2020). *Urban heavy metal contamination limits bumblebee colony growth.* Journal of Applied Ecology, 57(8): 1561-1569.

Sritongchuay, T., Dalsgaard, B., Wayo, K., Zou, Y., Simla, P., Tanalgo, K.C., Orr, M.C., and Hughes, A.C. (2022). *Landscape-level effects on pollination networks and fruit-set or crops in tropical small-holder agroecosystems.* Agriculture, Ecosystems, and Environment, 339: 108112.

Steffan-Dewenter, I., and Westphal, C. (2008). *The interplay of pollinator diversity, pollination services and landscape change.* Journal of Applied Ecology, 45:37-741.

Winterhalder, K. (1995). *Early History of Human Activities in the Sudbury Area and Ecological Damage to the Landscape*. In J.M. Gunn, Restoration and Recovery of an Industrial Region: Progress in Restoring the Smelter-Damaged Landscape near Sudbury, Canada.