Ecological Restoration: A Butterfly Garden at Mystic Vale, Victoria, B.C.

Abstract:

The sump house at Mystic Vale is a heavily eroded site that straddles a mature forest on one side with heavily used walking path on the other. The area is part of the University of Victoria's campus, but the sump-house belongs to the municipality of Oak Bay, B.C. It is a large cement structure with some planters on a veranda at the top, a middle section with a large circular green space, and a lower section that extends into Hobbs Creek. The banks and the grounds, including the riparian area of Hobbs Creek, are heavily compacted. Pedestrian and dog traffic has made it an inhospitable environment for fragile plant species which have left an open niche for invasive species. Sections of the area are thick with Himalayan Blackberry. This project builds on previous restoration and attempts to enhance native plants and pollinators in the semi-urban setting.

Restoration activities include: building a phenologically timed garden to support plant pollinators; soil conditioning including vermicomposting and utilization of bokashi fermentation methods; and construction of a fence to redirect foot traffic and installation of niche habitat for bees, birds, butterflies and bats. Native species plantings grew to unexpected proportions. Pollinator surveys need to be conducted in subsequent years to determine how utilizing native species impacted pollinator populations and a watering system needs to be installed to help support the plants through the summer drought.

Figure 1. Knox, Ein and Nayeli McIntosh

Figure 2. The sump-house garden

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Introduction:

The grounds of the sump-house at Mystic Vale are heavily degraded. Restoration activities have taken place but the mid-level garden remains devoid of plants and pollinators. The site itself has significant value being at the interface between the urban setting and a mature forest. Goals of the project include enriching the area with native species plantings; supporting pollinators by adding niche space; creation of a teaching garden to conduct ecology lessons with the local elementary school. Connections were also made with the Greater Victoria Natural History Society to include the site in their annual butterfly counts. Membership with the David Suzuki's ButterflyWay Ranger Program was initiated. The program required attendance of monthly zoom meetings and the creation of 12 mini butterfly gardens to create a series of microhabitats to make a ButterflyWay.

Initial actions taken at the site included restoration of soil porosity and removal of a large number of stones, invasive grasses, and unidentified roots. Soil characteristics were examined; See Appendix B: Soil Characterization. Soil amendments included addition of composted sheep manure, coco coir, black dirt and soil inoculated with mycorrhizae See Appendix B: Soil amendments. 65 plants were transplanted that comprised of 26 different species. 4 seed packs were also planted. See Table 1. Fertilization techniques included: compost tea, Pacific ocean by-catch fermented with traditional Korean techniques; vermicompost, and bokashi ferment. See Appendix B: Soil Treatments. Animal niche space was created by installing bat boxes, bee condos, bird houses, a bird bath and a butterfly puddle dish. A fence was erected for redirecting foot traffic out of the area See Figure 31. Plants were propagated from the original stock and prepared for the following season. The propagations are planned to be used to expand on the ButterflyWay making new microbutterfly gardens in the vicinity. Additional issues that were identified but were unable to be addressed include mitigation of drought caused by climate change.

Methods:

Initial characterization and restoration of soil porosity

Soil was dug and turned to a depth of 18 -24 inches. Rocks, sticks, twigs and invasive grasses

and plant roots removed. Assessments were done using guides from Brady (2008) and the Montreal Insectarium guide on jar testing. Soil was characterized as dry, sandy, devoid of nutrients, and pH of 5.5 See Appendix B: Figures 13 -15 Restoration of soil porosity and rock removal and Soil Characterization.

Soil Amendments

20 kilograms of dry coco coir was hydrated with 80L of water to increase soil water retention. 125 kg of black dirt was added, 180L of soil inoculated with mycorrhizae and 300L of sheep manure compost were added See Figures 16-18.

Native species transplants

Phenologic coupling between pollinators and native plants was assessed. INaturalist data was downloaded for the months of March to October from the years of 2018, 2019, 2020, 2021 and 2022. See Appendix C. The Greater Victoria Natural History Society provided butterfly counts of the Greater Victoria and UVic campus areas for the 3 years previous to construction of the garden See Appendix D. These resources were used to choose pollinators to support. The selected pollinators were chosen and their preferences identified utilizing information from Alaback *et. al.* (2014); Bradbury (2019); Evert (2013); Dorst (2018); Satinflower Nursery; Varner (2012); Yip and Miskelly (2014). See Appendix A for phenologic coupling information. Plants were selected to provide maximal food sources to provision the selected species throughout the growing season as well as being suitable to the site conditions. The Roumer's fescue and honeysuckle were given a liquid root treatment with a conventional root fertilizer once prior to planting See Appendix B: Soil Treatments. The University of Victoria's Society for Ecological Restoration assisted with the planting of the native species. See Figure 36.

Figure 3. Plan for the native species garden.

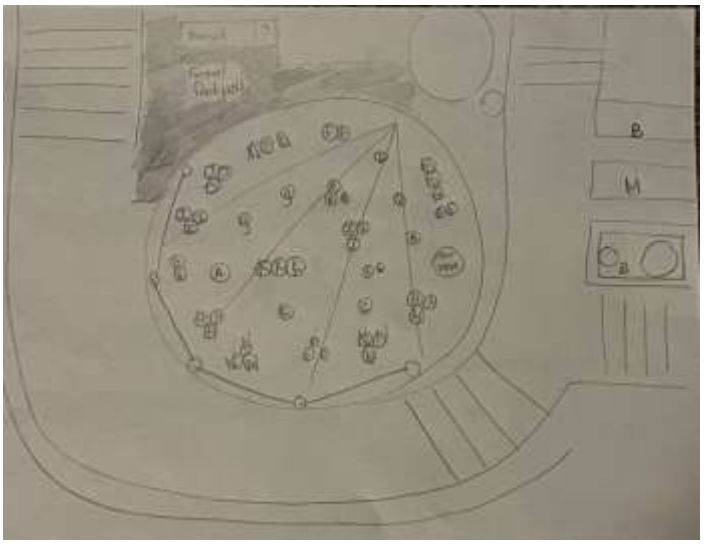

Table 1. Plant selection; 65 plants, 26 species

Letter designation	Plant species	Number of plants
A	Orange Honeysuckle (*Lonicera ciliosa)*	4 - 1 gal
B	Hairy Honeysuckle (*Lonicera hispidula)*	4 – 1 gal
C	Oceanspray (*Holodiscus discolor)*	2 – 2 gal
D	Yarrow (*Achillea millefolium)*	2 – 1 gal
E	Nootka Rose (*Rose nutkana)*	2 – 1 gal
F	Hooker's onion (*Allium acuminatum)*	6 – 10 cm
G	Great Camas (*Camassia leichtlinii)*	4 – 10 cm
	Common Camas (*Camassia quamash)*	3 – 10 cm
H	Western Buttercup (*Ranunculus occidentalis*)	6 – 10 cm
I	White Fawn Lily (*Erythronium oregonum)*	4 – 10 cm
J	Chocolate Lily (*Fritillaria affinis)*	4 – 10 cm
K	Pearly Everlasting (*Anaphalis margaritacea)*	2 – 9 cm
L	Miners Lettuce (*Claytonia perfoliate)*	10 - 4 cm
M	Red flowering currant (*Ribes sanguineum)*	2 – 1 gal
	Red Columbine (*Aquilegia Formosa)*	2 – 9 cm
	Roumer's fescue *(Festuca roumeri)*	10 – 10 cm
N	Coastal Strawberry (*Fragaria chiloensis)*	6 – 10 cm
O	Bicoloured lupine (*Lupinus bicolour)*	2 seed packs
	Native Pollinator seed mix	4 packs
	Nodding onion *(Allium cernuum)*	seed
	Field chickweed *(Cerastium arvense)*	seed
	Farewell-to-spring *(Clarkia amiena)*	seed
	Wooly sunflower *(Eriophyllum lanatum)*	seed
	Junegrass *(Koeleria macrantha)*	seed
	Seablush *(Plectritis congesta)*	seed
	Self-heal *(Prunella vulgaris ssp. Lanceolata)*	seed
	Canada Goldenrod *(Solidago lepida)*	seed

Soil Treatments:

Compost tea

The compost tea was made with a microtubulator aereation machine (www.gardener's pantry.ca). The effective microorganisms were derived from a composted algae and vermicompost, garden compost, humic acid powder and organic alfalfa meal. (www.compost.bc.ca) See Figure 21.

Pacific Ocean Marine Bycatch (Fish Amino Acids, FAA)

A collapsible rain barrel was used to transport water to the site. The water was supplemented

with compost tea and with L'Ocean Fish Amino Acid Fertilizer (Terra Flora Organics). The FAA fertilizer was made from by-catch waste from the Pacific Ocean fishing industry and fermented according to traditional Korean fermentation methods. Hocking and Reimchen. (2002); *Mathewson et. al.* (2003); Reimchen *et. al.* (2002); Reimchen and Arbellay (2019); Reimchen and Fox (2013), See Figure 22.

Vermicomposting

Seeds were allowed to hydrate in a mixture of worm tea mixed with worm casings prior to sowing (www.compost.bc.ca). Worm casings were generously donated by Cherry Fan with Tricity Worms (www.Tricityworms.com). Alam *et. al.* (2017); Aruna *et. al.* (2022); Tehada *et. al.* (2010), See Figure 19.

Traditional Japanese Bokashi Fermentation

Bokashi fermentation set up was supplied by Terra Flora Organics. (www.terrafloraorganics.com). The product was added to the upper layers of soil after the plants were transplanted Christel (2017); Lew (2021); Quiroz and Céspedes (2019); Xu (2001), See Figure 20.

Animal niche supports

8 bird houses, 2 bee condos, 2 hummingbird nests; 2 small bat boxes mounted on posts near the garden. See Figures 29 and 33. 2 large bat condos were installed by Ryann Rudderham and Evan Cline near the service road. See Figures 32-36. See Figure 34. The bee condos were placed on a ground level fence at approximately 4 foot above the soil. A shepherd's hook with the hummingbird nests was placed in the garden. A large concrete bird bath was placed in the garden alongside a small butterfly puddling dish. Roumer's fescue was planted to crowd out weeds and for provisioning butterflies a place to lay their eggs.

Construction of a garden fence

10 feet of fencing was installed around the garden to stop foot traffic from compacting the soil and crushing the plants. 3 sono tubes filled with concrete were buried to support the fence on the outer margin of the garden. A length of 24 feet of small decorative butterfly fencing was placed along the inner margin of the garden to direct foot traffic allowing access to the graffiti wall. See Figure 28 + 32.

Community networking

The Greater Victoria Natural History Society decided to incorporate the butterfly garden in their annual butterfly counts of the area.

Techniques from David Suzuki's Butterfly Ranger Program were included where possible. The main goal of the ButterflyWay program was to create 12 microgardens in a small geographic area thereby establishing a "ButterflyWay". A second, small butterfly garden was created nearby.

Connections were made with Campus View Elementary school and their Out-of-School Care Program to incorporate the garden in their regular ecology programming. An elementary school level power point was made for their use and arrangements for walking guided tours of the Butterfly Garden and Mystic Vale for their lessons was arranged for spring of 2024.

Propagations, plant hormones and the ButterflyWay

Cuttings from a variety of the plants both in the garden and from the surrounding area were taken and prepared for propagation with treatments based on methods described by Relf and Ball (2009). See Table 2 and Appendix E. Commercial rooting hormone was compared to organic rooting hormone Rajan and Singh (2021); www.gardeningknowhow.com. Three different hormone treatments were experimented with. In trial 1 organic methods were tested. Willow was cut into 2-inch sticks and placed in a 500mL glass jar. The glass jar was filled with boiling water and left to steep for 24 hours. After 24 hours the willow sticks were removed and the "willow water" was diluted with an equal volume of tap water. Plant cuttings were placed in test tubes in a sunny window. The water was topped up daily and replaced once a week until rootlets appeared. Once rootlets became well established the cuttings were planted in vermicompost. Trial 2 consisted of dipping freshly prepared stem cuttings into commercial rooting powder and planting them in vermicompost. Trial 3 consisted of diluting the commercial rooting powder with water and placing freshly prepared stem cuttings in it. The water was changed similarly to Trial 1 and when rootlets appeared they were planted in vermicompost soil. All of these plants prepared and will be held indoors under full spectrum light for the winter and planted in the additional microbutterfly gardens for the 2024 field season.

Table 2. Propagation techniques

Native species	**Stem Cutting Technique**	**Figure Reference**
Red flowering currant (*Ribes sanguineum)*	single eye and shield	36
Orange Honeysuckle (*Lonicera ciliosa)*	single eye	36
Hairy Honeysuckle (*Lonicera hispidula)*	single eye	36
Nootka Rose (*Rose nutkana)*	double eye	37
Dull Oregon Grape (*Berberis nervosa*)	double eye	
Oceanspray (*Holodiscus discolor)*	single eye and shield	36
Miners Lettuce (*Claytonia perfoliate)*	division	38
Roumer's fescue *(Festuca roumeri)*	division	38
Yarrow (*Achillea millefolium)*	division	38

Table 3. Plant hormone trials

Trial number	Plant species
Trial 1	Red flowering currant (*Ribes sanguineum)*, Nootka Rose (*Rose nutkana),* Dull Oregon Grape (*Berberis nervosa*)
Trial 2	Red flowering currant (*Ribes sanguineum)*, Nootka Rose (*Rose nutkana),* Dull Oregon Grape (*Berberis nervosa*)
Trial 3	Red flowering currant (*Ribes sanguineum)*, Nootka Rose (*Rose nutkana),* Dull Oregon Grape (*Berberis nervosa*)

Results

The plants grew extremely well. A control site was found nearby with Miner's lettuce. Two plants at the different sites were compared and the garden plants with treatments were found to be exponentially larger. See Figure 30. With this phenomenal growth invasive weeds also grew exceedingly well. At 10 weeks after planting, the average height of the invasive weeds was 3.5 feet tall. The University of Victoria's Society for Environmental Restoration assisted with weeding the garden and installing the infrastructure.

The garden was observed for pollinators throughout the summer season. See Table 4 for observations.

Table 4. Pollinator observations from spring 2023

Pollinator	Plant species pollinator was observed on	Figure number
Black tailed bumble bee (*Bombus melanopygus)*	Hooker's onion (*Allium acuminatum)*	39
Lorquin's Admiral (*Limenitis lorquini ilgae*)		
Western Tent Caterpillars (*Malacosoma californica)*		
Yellow faced bumble bee (*Bombus vosnesenskii*)		54

Discussion and Recommendations

Climate projections for this region include more precipitation, but also extended summer drought (Climate Atlas of Canada). Together, this means the rains will be heavier, but increasingly restricted to the winter months. Although there is more water, it is a harsher environment overall. Our efficient municipal storm drainage system reduces the contact time of the precipitation with the environment and so reduces the underground water storage. Infiltration is reduced and the local water table is not replenished. The summer drought is predicted to become hotter, and longer which lowers the water table to inaccessible levels for some vegetation. Creating a novel ecosystem using exotic C4 CAM plants, or desert adapted plants, that can survive drought may not be a practical solution because they will struggle with the cool temperate winters and heavy winter rainfall. A permanent gravity fed rainwater collection system is highly recommended to assist in alleviating water stress at this garden during the summer drought to support native species plants, however it was beyond the resources available for this stage of the project.

A large donation of Stargazer lillies were received. Some of the plants were planted in the garden at the sump-house, the rest were put in pots at the second butterfly garden. Although these plants were not native species, the guideline ratio of 70:30 native to exotic was maintained.

Vandalism continued to be a problem at the site. Most users of the area were grateful of the work that was being done, some were not. The temporary fence was removed as well as the plant stakes. Many of the plants were stepped on and crushed. The honeysuckles did not survive. Many dogs were seen running through the middle of the garden and lying on top of the plants. It is recommended that the fence is expanded for the 2024 field season.

A second butterfly garden was set up as a container garden nearby however it was not as exclusive to the use of native species. Acquiring the native species for the original garden was very time consuming and expensive. Plants were acquired months in advance, from 3 different nurseries up to 150 km away. The first garden at the sump-house was designed to be a native species garden. The second garden was designed to have as many plants as could be attained for free, or minimal cost. The plants in the native species garden were around $600 whereas the plants in the container garden cost around $50 and came from local stores. As the native propagations grow, the percentage of native species in the container garden will be increased. The exotic species will be dispersed throughout the additional gardens in the ButterflyWay. Future applications of vermicompost, bokashi fermentation products, compost tea, and FAA are planned to enrich the main site as well as the microgardens in subsequent field seasons.

Plant hormones were experimented with during the propagation stage. It was decided that the cuttings for this project would receive auxin after the initial cutting and when they were ready

for soil, they would be planted using vermicompost. Rajan and Singh 2021; Urry *et. al.* 2021.

Not all of the target animal species were supported for the full season of March to October each year. The larger animals that have a greater day to day home range, songbirds, hummingbirds, and bats are not restricted to living and foraging in the small 350 sq. ft garden space. It was not considered necessary to attempt to fully meet their needs with the garden. The pollinator animals that have restricted day to day ranges, such as the bees and butterflies, are fully supported with multiple plants in flower throughout the full season of March to October.

It was decided unnecessary to add a specific species of mycorrhizae to the soil amendments. Mycorrhizae was incorporated into the project by way of sheep manure compost and the commercial garden soil that was inoculated with mycorrhizae (Conversation with Paul de la Bastide, January 2023).

Some of the Roumer's fescue that was planted to the side of the garden was failing to thrive. It may have been too protected by the sump-house from precipitation. It was relocated back to the staging area to receive less sunlight and more water. It appears that some areas of the garden are too protected by the sump-house and do not receive sufficient precipitation. When the permanent water system is installed, the fescue will be replaced in hopes that the spot is more hospitable.

While constructing the garden there was great interest in the restoration activities by users of the natural area. Signage about the project needs to be drafted and installed but it is beyond the resources available for this field season. Permanent signage is recommended and planned for the 2024 field season.

Acknowledgements

I would like to take the time to thank a multitude of people who made this restoration possible. Nancy Shackleford for her ongoing support and caretaking of the honeysuckles. Jennifer Rodriguez and Andrea Kwok for organizing labour with the University of Victoria's Society for Environmental Restoration to see the project to completion. I wish to thank Ein McIntosh for all of their hard work carrying many buckets of heavy rocks from the site. Knox and Nayeli McIntosh for graciously managing the worm hotel (Le Ver de Terre Hotel). I would like to generously thank Cherry Fan with her company TriCity Worms for her vermicompost knowledge, support and donation of worm casings, worms, expertise in design and construction of Le Ver de Terre Hotel. I would like to thank Ryann Rudderham and Evan Cline for the construction and installation of the bat boxes; Gord Hart from the Greater Victoria Natural History Society for supplying historical butterfly counts of the surrounding area. I also wish to

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Appendix A

Table 5. Plant ecological information

Native species	**Plant characteristics**	**Associated ecological information** www.satinflower.ca
Chocolate Lily	*Fritillaria affinis*	
	Description	Perennial. Flowers are bell shaped and the petals are variable, from brownish-purple mottled with greenish-yellow, to yellowish-green mottled with purple.
	Companion plants	White Fawn Lily, Western Buttercup, Great Camas
	Flowering times	May to June
	Associated pollinator	Bees and Hummingbirds
	Environmental conditions	Dry to mesic meadows and woodlands; full sun to partial shade.
Great Camas	*Camassia leichtlinii*	
	Description	Perennial. Purplish-blue flowers, yellow stamens, colourful sepals and large, open flowers attract many pollinators.
	Companion plants	Western Buttercup, Chocolate Lily, White Fawn Lily
	Flowering times	April to June
	Associated pollinator	Bees
	Environmental conditions	Full sun to partial shade.
Hairy Honeysuckle	*Lonicera hispidula*	
	Description	Purple tubular flowers and red fruit
	Companion plants	Oceanspray, Western buttercup, Orange Honeysuckle
	Lupinus bicolour	
Bicoloured lupine	Flowering times	May to June
	Associated pollinator	Hummingbirds, songbirds, bats
	Environmental conditions	Dry to mesic
Himalayan Blackberry	*Rubus armeniacus*	This is not being planted in the garden however it is prominent at the site and does support wildlife

	Description	
	Companion plants	Irrelevant
	Flowering times	August - September
	Associated pollinator	Bats, Bees, Songbirds,
	Environmental conditions	Irrelevant
Hooker's Onion	*Allium acuminatum*	
	Description	Drought-tolerant. Globe-shaped inflorescent pink flowers in summer
	Companion plants	None in garden
	Flowering times	May to June
	Associated pollinator	Bees
	Environmental conditions	Full sun, full drainage
Miner's Lettuce	*Claytonia perfoliate*	
	Description	Annual with connate leaves and small white flowers
	Companion plants	None in garden
	Flowering times	April to June
	Associated pollinator	Bees and butterflies
	Environmental conditions	Full sun meadows to shady forest understorey
Nootka Rose	*Rose nutkana*	
	Description	Large pink flowers
	Companion plants	Oceanspray
	Flowering times	May to June
	Associated pollinator	Bees and butterflies
	Environmental conditions	Full sun to dappled light in dry to mesic soils
Oceanspray	*Holodiscus discolor*	
	Description	White flowers bloom from June through July. Bushtits nest in its branches, others eat the seed heads, butterflies lay eggs on the buds and leaves.
	Companion plants	Great Camas, Nootka Rose
	Flowering times	June and July
	Associated pollinator	Butterflies and hummingbirds
Orange Honeysuckle	*Lonicera ciliosa*	
	Description	One of the two native vines of Southern Vancouver Island. Orange tubular flowers. This deciduous vine will climb into shrubs and trees.

	Companion plants	Oceanspray
	Flowering times	April to May
	Associated pollinator	Hummingbirds, bats, and birds
	Environmental conditions	
Pearly Everlasting	*Anaphalis margaritacea*	
	Description	Perennial with green above, white-woolly below
	Companion plants	Yarrow
	Flowering times	June to August
	Associated pollinator	Butterflies
	Environmental conditions	Full sun to partial shade, well-drained soils
Red flowering currant	*Ribes sanguineum*	
	Description	Shrub with clusters of pink flowers. Flowers attract hummingbirds and berries attract birds. Requires considerable drainage and prefers part shade to full sun.
	Companion plants	Oceanspray
	Flowering times	March to May
	Associated pollinator	Birds and hummingbirds
	Environmental conditions	Dry to mesic
Snowberry	*Symphoricarpos albus*	
	Description	Deciduous shrub with pink flowers and white berries
	Companion plants	Nootka Rose, Oceanspray, Great Camas
	Flowering times	May to June
	Associated pollinator	Bees and Birds
	Environmental conditions	Full sun to partial shade
Western Buttercup	*Ranunculus occidentalis*	
	Description	Tufted buttercup with bright yellow flowers
	Companion plants	Great Camas, White Fawn Lily
	Flowering times	March to June
	Associated pollinator	Butterflies and bees
	Environmental conditions	Full sun to partial shade; dry to mesic moist soils

White Fawn Lily	*Erythronium oregonum*	
	Description	Petals curved backwards, forming bell-shaped flowers and large mottled leaves
	Companion plants	Western Buttercup, Great Camas
	Flowering times	March to April
	Associated pollinator	Bees and hummingbirds
	Environmental conditions	Dry open forest in partial shade to mesic meadows to full sun
Woodland Strawberry	*Fragaria vesca*	
	Description	Large white flowers and red berries
	Companion Plants	
	Flowering times	March to May
	Associated pollinator	Song birds, bees, bats, butterflies
	Environmental conditions	Mesic to moist
Yarrow	*Achillea millefolium*	
	Description	Perennial wildflower with small white flowers. Partially evergreen in winter.
	Companion plants	Great Camas, Common Camas
	Flowering times	May to Sept
	Associated pollinator	Bats and butterflies
	Environmental conditions	Sun loving

Table 6. Animal ecological information

Target animal	**Species**	**Attractant** Evert and Eichorn (2013)	**Plant in garden**	**Other food/niche requirements**
Hummingbirds		Deep throated flowers; Red	Hairy Honeysuckle, Orange Honeysuckle, White Fawn Lily, Chocolate Lily	Nectar
	Rufous *Selasphorus rufus*			Seasonal. It migrates and overwinters in Mexico.

	Anna's *Calypte anna*			Invasive from California. Arrived in 1940's Winters in area
Butterflies	60 species	Yellow, blue, violet, corollar tube, fragrant flowers	Pearly Everlasting, Western Buttercup, Miner's Lettuce, Nootka Rose, Ocean spray, Yarrow	Nectar
Nocturnal moths		White, or pale colour. Strong sweet scent that is released after sunset, corollar tube, fragrant flowers, many flower shapes	Yarrow	Nectar
Songbirds		Poor smell; Red and yellow flowers. UV florescence	Hairy Honeysuckle, Himalayan Blackberry, Oceanspray, Orange Honeysuckle, Hooker's Onion, woodland strawberry	Nectar, flower parts, insects
Bats		Dull colouration, flowers that open at night, strong fermenting or fruit-like odors, flowers that hang down below foliage	Hairy Honeysuckle, Himalayan Blackberry, Yarrow	Nectar and pollen
	Big Brown Bat			
	Hoary Bat			
	Keen's Long-eared Myotis			

	Little Brown Bat			
	Long-legged Myotis			
	Townsend's Big-eared Bat			
	Western Long-eared Myotis			
	Yuma Myotis			
Bees		UV florescence. They prefer blue and yellow. They can not see red; nectar guides; light scent; bowl shaped flowers	Nootka Rose, Miner's Lettuce, Chocolate Lily, Great Camas, Himalayan Blackberry, Hooker's Onion, Western Buttercup, White Fawn Lily, Woodland Strawberry	Nectar and pollen
	Mason Bee *Osmia spp.*			
	Leaf cutting Bee *Megachile spp*			

Table 7. Phenologic timing information

Month	**Plants in bloom**	**Animal supported**
March	Western buttercup, White Fawn Lily	Butterflies, Bees
April	Great Camas, Miner's Lettuce, Orange Honeysuckle, Western Buttercup, White Fawn Lily	Butterflies, Bees, Hummingbirds, songbirds
May	Chocolate lily, Great Camas, Hairy Honeysuckle, Hooker's Onion, Miner's lettuce, Nootka Rose, Orange Honeysuckle, Western buttercup, Yarrow	Bats, Butterflies, Bees, Hummingbirds, songbirds, Nocturnal moths
June	Chocolate lily, Great Camas, Hairy Honeysuckle, Hooker's	Bats, Butterflies, Bees, Nocturnal moths

	Onion, Miner's lettuce, Nootka Rose, Oceanspray, Pearly Everlasting, Western Buttercup, Yarrow	
July	Oceanspray, Pearly Everlasting, Yarrow	Bats, Butterflies, Nocturnal moths
August	Pearly Everlasting, Yarrow	Bats, Bees, Butterflies, Nocturnal moths, Songbirds
September	Yarrow	Bats, Bees, Butterflies, Nocturnal moths, Songbirds

Table 8. Animals supported through the season

Animal	**Time supported in the season**
Hummingbirds	April - May
Butterflies	March - September
Nocturnal Moths	May - September
Songbirds	April – May + August - September
Bats	May - September
Bees	March – June + August - September

Appendix B:

Pre restoration photos

Figure 4. Pre restoration

Figure 5. Pre restoration

Figure 6. Pre restoration

Figure 7. Pre restoration

Figure 8. Pre restoration

Figure 9. Pre restoration

Restoration of soil porosity and rock removal

Figure 10. Nayeli McIntosh

Figure 11. Knox McIntosh

Figure 12. Ein McIntosh

Soil Characterization

Figure 13. pH test approx. 5.5

Figure 14. Jar test

Figure 15. Jar test

Soil amendments

Figure 16. 20 Kg Coco coir

Figure 17. 125 kg black dirt

Figure 18. 180 L soil innoculated with mycorrhizae and Nayeli McIntosh

Soil Treatments

Figure 19. Flow through vermicompost system

Figure 20. Bran innoculated with EM

Figure 21. Microtubulator for compost tea

Figure 22. Fish Amino Acids

Plant hormone treatments

Figure 23. Root treatment

Figure 24. Rooting hormone power

Figure. 25 Willow water

Setting the fence posts

with Ryann Rudderham and Evan Cline

Figure 26. Evan Cline pouring concrete for the fence posts

Figure 27. Left to right: Knox McIntosh, Ryann Rudderham, Evan Cline and Nayeli McIntosh

Figure 28. Butterfly fence on the inner margin of the garden

Planting day

Figure 29. The University of Victoria's Society for Ecological Restoration

Weeding, fence construction, and animal niche supports

Figure 30. Giant Miner's lettuce (left) with control (right)

Figure 31. Fence building

Figure 32. Knox and Nayeli McIntosh with bird houses

Figure 33. Ryann Rudderham

Figure 34. Large Bat Condos

Figure 35. Evan Cline

Figure 36. Knox and Nayeli with small bat boxes

Stem cutting techniques

Figure 37. Propagations with root hormone

Figure 38. Single eye technique

Figure 39. Double eye technique

Figure 40. Division technique

Completion of 2023 field work

Figure 41. *B. melanopygus* pollinating *Hooker's Onion*

Figure 42. Western Buttercup

Figure 43. Red Columbine

Figure 44. Great Camas

Figure 45. Hairy Honeysuckle

Figure 46. Miner's lettuce and Nootka rose

Figure 47. Pearly Everlasting

Figure 48. Oceanspray

Figure 49. Roumer's Fescue

Figure 50. Coastal Strawberry

Figure 51. Stargazer Lillies

Figure 52. Black Eye Susan

Figure 53. Bleeding Hearts

Figure 54. Great Blanket flowers

Figure 55. Lady Bird beetle

Figure 56. Yellow faced bumble bee

Appendix C: INaturalist Data from Mystic Vale

Table 9: Birds

Species Common Name	Scientific Name	2022	2021	2020	2019	2018	Local species
Northern Flicker	*Colaptes auratus*	1	1	0	0	0	No
Golden Crowned Kinglet	*Regulus satrapa*	1	0	1	1	0	Yes
Red breasted Nuthatch	*Sitta canadiensis*	1	1	1	1	0	Yes
Anna's Hummingbird	*Calypte anna*	1	0	1	1	0	No
Bewick's Wren	*Thryomanes bewickii*	1	0	0	1	0	Yes
Dark eyed Junco	*Junco hyernalis*	1	0	1	1	0	Yes
American Robin	*Turdus migratorius*	1	0	1	1	1	Yes
Spotted Towhee	*Pipilo meculatus*	1	0	1	1	0	No
Chestnut Backed Chickadee	*Poecile rugescens*	1	1	1	1	0	Yes
Blackheaded Grosbeak	*Pheucticus melanocephalus*	1	0	0	0	0	Yes
Song Sparrow	*Melospizza melodia*	1	0	0	0	0	Yes
Bushtit	*Psaltriparus minimus*	1	0	1	0	0	Yes
Pileated Woodpecker	*Dryocopus pileatus*	1	1	1	0	0	Yes
Golden Crowned Sparrow	*Zonotrichia atricapilla*	0	1	0	0	0	Yes
Purple Finch	*Ixoreus naevius*	0	1	0	0	0	Yes
Downy Woodpecker	*Dryobates pubescens*	0	1	0	0	0	Yes
Hutton's Vireo	*Vireo huttoni*	0	1	0	0	0	Yes

Pacific slope Flycatcher	*Empidonax difficilis*	0	0	1	0	0	Yes
Brown Creeper	*Certhia americana*	0	0	1	1	0	Yes
House Finch	*Haemorhous mexicanus*	0	0	1	0	0	No
Red breasted Sapsucker	*Sphyrapicus ruber*	0	0	0	1	0	No
Greater Yellow Legs	*Rtringa melanoleuca*	0	0	0	1	0	No

Table 10: Butterflies

Species Common Name	**Scientific Name**	**2022**	**2021**	**2020**	**2019**	**2018**	**Local species**
Silver spotted Tiger Moth	*Lophocampa argentata*	1	0	0	1	1	No
Lorquin's Admiral	*Limenitis lorquini*	1	1	1	1	1	Yes
Virginian Tiger Moth	*Spilosoma virginica*	0	0	0	0	0	No
Woodland skipper	*Ocholdes sylcanoides*	1	0	0	1	0	Yes
Western Tiger Swallowtail	*Papilio rutulus*	1	1	1	1	0	Yes
Pine White	*Neophasia menapia*	0	0	0	1	0	Yes
Omnivorous Looper	*Sabulodes aegrotata*	0	0	0	1	0	No
Dimorphic Snout	*Hypena bijugalis*	0	0	0	1	0	No
Spotted Tussock Moth	*Lophocampa maculata*	0	0	0	1	0	No
Madrone Skin Miner	*Marmara arbutiella*	0	0	0	1	0	No
Western Tent Caterpillar	*Malacosoma californica*	1	1	1	1	0	No
	Epinotia emarginana	0	0	0	1	0	
Montana Six-plume Moth	*Alucita montana*	0	0	1	0	0	No

Maple Leaftier Moth	*Acleris forsskaleana*	0	0	1	0	0	No
Oblique Banded Leafroller	*Choristoneura rosaceana*	0	0	1	0	0	No
Four spotted Yellowneck Moth	*Oegoconia novimundi*	0	0	1	0	0	No
Cosmia	*Cosmia praeacuta*	0	0	1	0	0	No
	Epinotia johnsonana	0	0	1	0	0	
Common Emerald	*Hernithea aestivaria*	0	0	1	0	0	No
	Herpetpgramma aquilonalis	0	0	1	0	0	
Holly Tortrix	*Rhopobota naevana*	0	0	1	0	0	No
Rose Tortrix Moth	*Archips rosana*	0	0	1	0	0	No
Echo Azure	*Celastrina echo*	1	0	1	0	0	No
Western Brown Elfin	*Callophrys augustinus iroides*	0	0	1	0	0	Yes
Ceanothus Silk Moth	*Hyalophora euryalus*	0	1	0	0	0	No
Pale Swallowtail	*Papilio eurymedon*	1	1	0	0	0	Yes
Essex Skipper	*Thymelicus lineola*	0	1	0	0	0	No
Small White	*Pieris rapae*	1	1	0	0	0	No
Forest Tent Caterpillar Moth	*Malacosma disstria*	1	1	0	0	0	No
Western White Ribboned Moth	*Mesoleuca gratulata*	0	1	0	0	0	Yes
Satyl Comma	*Polygonia satyrus*	1	1	0	0	0	Yes
Small Magpie	*Anania hortulata*	1	0	0	0	0	No

Morning cloak	*Nymphalis antiopa*	1	0	0	0	0	Yes
Brown Mouse Moth	*Hofmannophila pseudospretella*	1	0	0	0	0	No
Common Whitetail	*Plathemis lydia*	1	0	0	0	0	No
Painted Lady	*Vanessa cardui*	1	0	0	0	0	Yes
Banded Pebble Moth	*Gluphisia severa*	1	0	0	0	0	No
White bowed Smoothwing	*Scaeva affinis*	1	0	0	0	0	No
	Egira simplex	1	0	0	0	0	

Table 11. Bees

Species Common Name	**Scientific Name**	**2022**	**2021**	**2020**	**2019**	**2018**	**Local species**
Yellow faced Bumble bee	*Bombus vosnesenskii*	1	1	0	1	1	Yes
Black tailed bumble bee	*Bimbus melanopygus*	0	1	0	0	1	Yes
Bald Faced Hornet	*Dolichovespula maculata*	1	0	1	1	0	No
Mossy Rose Gall Wasp	*Diplolepis rosae*	0	0	0	1	1	No
Yellow Fronted Bumblebee	*Bombus flavifrons*	0	0	0	1	0	Yes
Western Leafcutter	*Megachile perihirta*	0	0	1	1	0	No
Western Honey Bee	*Apis mellifera*	1	0	0	1	0	No
Fuzzy Horned Bumble Bee	*Bombus mixtus*	0	1	0	0	0	Yes
Texas Striped Sweat Bee	*Agapostemon texanus*	0	0	0	1	0	No
Orange Legged Furrow Bee	*Halictus rubicundus*	0	0	1	0	0	No
German Yellowjacket	*Vespula germanica*	0	0	0	0	0	No
	Philanthus crabroniformis	0	1	0	0	0	No

Jumping Gall Wasp	*Neuroterus saltatorius*	0	1	0	0	0	No
Small Long-horned Bee	*Elissodes microstictus*	0	1	0	0	0	No
Western Blue Orchard Bee	*Osfmia lignaria propinqua*	0	1	0	0	0	No
Total Species observed		3	7	3	7	3	

Table 12. Bats

Species Common Name	**Scientific Name**	**2022**	**2021**	**2020**	**2019**	**2018**	**Local species**
Silver haired bat	*Lasionycteris noctivagans*	1	0	0	1	0	Yes
North American Hoary Bat	*Lasiurus cinereus*	1	0	0	0	0	Yes
Big Brown Bat	*Eptesicus fuscus*	0	1	0	1	0	Yes
Townsend's Big-eared Bat	*Corynorhinus townsendii*	0	1	1	1	0	Yes

Appendix D: Butterfly counts with the Greater Victoria Natural History Society

BUTTERFLY COUNT RESULTS 2021	APRIL	MAY	JUNE	JULY	AUG	SEPT	2022 TOTAL	2021 TOTAL	2020 TOTAL
Anise Swallowtail		1	2	2			5	6	2
American Lady								3	
Brown Elfin		4					4	11	5
Cabbage White	53	149	230	525	346	438	1741	3788	2902
California Tortoiseshell	7	1		1			9	7	10
Cedar Hairstreak	1		3				4		3
Common (Van Isl) Ringlet."Large Heath"			20	1	16		37	65	114
Common Woodnymph									
European (Essex) Skipper			1	325	2		328	361	225
Field Crescent									
Great Arctic									
Green Comma	1	3	1	1			6	9	3
Grey Hairstreak					2		2	3	2
Lorquin's Admiral			42	350	26	5	423	395	417
Milbert's Tortoiseshell				1			1	2	1
Monarch									
Moss' Elfin								1	
Mourning Cloak	13	7	8	2		3	33	18	14
Mylitta Crescent									
Orange Sulphur					1	6	7	1	
Painted Lady	1		4	4		2	11	24	43
Pale Swallowtail			68	36			104	116	46
Pine White				2	6	5	13	109	153
Propertius Duskywing	2	1					3	11	5
Purplish Copper				1			1	5	1
Red Admiral			3	5	1	1	10	1	6
Sara's Orangetip	53	19					72	104	30
Satyr Comma	10	5		6	1		22	43	7
Silvery Blue									3
Sulphur species									
Two-banded Checkered Skipper								1	
Westcoast Lady									1
Western Pine Elfin	9	149	31				189		
Western Spring Azure								152	174
Orange Sulphur									1
Clouded Sulphur					1		1		
Sulphur sp.-probably Clouded		4	173	220	6		403		
Western Tiger Swallowtail				22	576	19	617	441	284
Woodland Skipper								352	485
Total	**150**	**343**	**586**	**1504**	**984**	**479**	**4046**	**6029**	**4937**
2021 Totals	**780**	**874**	**2025**	**1261**	**790**	**299**	**6029**		
Number of Observers per month	16	16	19	20	14	15			
Number of Reports	25	26	47	47	23	26			
Number of species	10	11	13	17	12	8	24	26	26

Appendix E: Propagation techniques

Single eye technique for plants with alternate leaf arrangements

A small glass tube was prepared with tap water and a small amount of rooting hormone powder. A small cane containing a terminal bud of approximately 10cm long was cut just below a node. The cane was placed vertically in the hormone solution and placed in an environment with bright light until rootlets began to form. When new rootlets were established, the cane was transferred to a pot with soil.

Double eye technique for plants with opposite leaf arrangements

A small glass dish was prepared with tap water and a small amount of rooting hormone powder. A small cane approximately 10cm long was cut just above and below a node. The cane was placed horizontally in the hormone solution and placed in an environment with bright light until rootlets began to form. When new rootlets were established, the cane was transferred to a pot with soil.

Shield technique

A small glass dish was prepared with tap water and a small amount of rooting hormone powder. A small segment of the stalk approximately 2 cm long was cut out of the main stem. Semi-circlular cut was made just above and below a node encompassing the axillery leaf node. The stem piece was placed horizontally in the hormone solution and placed in an environment with bright light until rootlets began to form. When new rootlets were established, the stem was transferred to a pot with soil.

Layering

Runners were buried and watered to promote root growth. After successful establishment, the stolon was cut, and the new plant was transplanted.

Division

The large root base was gently separated into two portions. The smaller portion was transplanted into a nursery pot for removal and replanting.