March 8, 2022

Living Lab Program for Climate Change and Conservation - Final Report

Project Title: Building Climate Resilient Butterfly Habitat, Yr.1

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Research Findings

Butterflies

Fifteen formal transects were established at Beaver Creek Provincial Park, 16 transects at Charbonneau Creek Conservation Area, and 5 transects at Syringa Provincial Park, reflecting the different sizes of the three research sites. A modified survey was conducted at the Syringa Interpretive Site (explained in Methods, below).

Forty-nine butterfly species were identified, including two listed species: Silver-spotted Skipper (*Epargyreus clarus* - S3) and Variegated Fritillary (*Euptoieta laudia* - S3N) (Appendix A). A total of 141 nectaring observations were recorded; namely butterflies used asters (*Symphyotrichum* spp. - 45%), spreading dogbane (*Apocynum androsaemifolium* - 16%), and brown-eyed Susan (*Gaillardia aristata* – 11%) (Appendix B). Eleven observations of oviposition behaviour were recorded, including two at Syringa, four at Beaver Creek, and three at Charbonneau Creek. Butterflies oviposit on both native (*Pinus* sp., *Ceanothus velutinus, Lupinus sericeus)* and non-native species (*Vicia* sp., *Rumex acetosella*) (Appendix B).

In terms of community similarity for butterflies among the three research sites, Beaver Creek and Syringa were most similar, showing high species overlap (n = 20). Beaver Creek and Charbonneau Creek recorded the least overlap in butterfly species (n = 16). Twenty-five percent (n = 13) of the species were observed at all sites.

An estimation of butterfly species richness showed that observed species were underrepresented at all sites. At Beaver Creek, 49 species are estimated (actual = 32) and 62 species are estimated to be detected at both Syringa (actual = 30) and Charbonneau Creek (actual = 31). Although this is a normal result in ecological studies, the lower-than-expected species richness could also have been caused by an unusually hot and smoky summer season, and the reduced number of field days as a result.

Botany

One hundred and sixty plant species were identified in the three research sites and, of these, 68% (n = 109) are native plants (Appendices C, D). The listed Pursh's wallflower (*Erysimum capitatum* - S3), recorded at the Charbonneau Creek site in the Pend d'Oreille Valley, is only known from this part of British Columbia.

Community similarity for plants showed that Syringa and Charbonneau Creek share the greatest overlap in species (n = 38); whereas, as with the butterfly community similarity analysis, the least

number of species in common occurred between Beaver Creek and Charbonneau Creek (n = 27). A total of 72 plant species were surveyed at Syringa, 74 at Beaver Creek, and 91 at Charbonneau Creek.

Regarding flowering phenology - the timing of sexual reproduction and corresponding availability of nectar resources - most plant species at all sites experienced peak flowering during the months of June and July. Flowering, in general, appears to readily diminish after August, however, our surveys did not continue after this time (Appendices C, D).

When plant community similarity results are integrated with phenology data from each site, some interesting information appears. At Charbonneau Creek, there are 49 plant species that are common to this site and at least one other site. There are an additional 49 species that were only recorded and tracked at Charbonneau Creek, demonstrating the high species diversity known to the site specifically, and the Pend d'Oreille Valley, in general. Some notable plants that occur at this site are the species that favour hot and dry environmental conditions, such as lemonweed (*Lithospermum ruderale*), silverleaf phacelia (*Phacelia hastata*), showy milkweed (*Asclepias speciosa*), and parsnip-flowered buckwheat (*Eriogonum heracleoides*). All these species are summer bloomers that are key nectar and host plants for butterflies, and important floral resources for native pollinators generally (Appendix D).

In comparison to our reference site, Charbonneau Creek, different trends are apparent at Syringa and Beaver Creek. Syringa has the most in-common plant species (n = 54) and the least number of species (n = 18) that are unique to the site. Of note, the species that stand out at Syringa are the native bloomers of early emerging meadows (April-May); for example, few-flowered shootingstar (*Dodecatheon pulchellum*), upland larkspur (*Delphinium nuttallianum*), and meadow death-camas (*Toxicoscordium venenosum*) (Appendix D). Beaver Creek has 41 plant species in common with one or both of the other sites and 33 species only recorded at that site. Because this site is closest to a river and includes riparian and nearshore plant communities, the notable species at this site include plants that prefer moister soil conditions. These species are late summer bloomers that are vital nectar resources for late season butterflies and include golden tickseed (*Coreopsis tinctoria*) and two asters, boreal (*Symphyotrichum boreale)* and Douglas' (*Symphyotrichum subspicatum*). Finally, because this site is also a popular hiking and dog walking locale, Beaver Creek is also host to several non-native species, such as hoary alyssum (*Berteroa incana*), spotted knapweed (*Centaurea sto*ebe), common St. John's wort, (*Hypericum perforatum*), and oxeye daisy (*Leucanthemum vulgare*) (Appendix D).

Syringa Interpretive Site

A concept design was created, and initial site preparation occurred at the Syringa Interpretive Site in the fall 2021. A portion of the site was planted with rhizomes of showy milkweed (*Asclepias speciosa*) and this area, as well as an adjacent space, were sowed with locally collected native plant seed (*Clarkia pulchella, C. rhomboidea, Collomia grandiflora, Phacelia hastata*). The reminder of the site was covered with black plastic to prevent the regrowth of weedy plants (Appendix E).

Methods Summary

All research sites were previously selected as part of an umbrella project called the Pollination Pathway Climate Adaptation Initiative, a program of the Kootenay Native Plant Society as part of the Columbia Basin Trust Ecosystems Enhancement Program. The sites are known to support herbaceous plant (non-forested) communities and native pollinators including butterflies, moths, and skippers. The main research sites for the *Building Butterfly Habitat* project are located at

Syringa and Beaver Creek provincial parks, with an additional reference site at the Charbonneau Creek Conservation Area in the Pend d'Oreille Valley. An interpretive site was selected at Syringa Park, at which only site preparation occurred in 2021.

Due to hazardous air quality (i.e. wildfire smoke) over several weeks in the summer, only seven of the proposed eight survey days were completed for each site, occurring from April 14 to September 2. The sites were visited every two weeks, as weather and schedules allowed, in the spring, and approximately every three weeks after June.

For the butterfly surveys, observations of butterflies were recorded in timed transects (Pollard Walk). Special attention was made to species-at-risk. A Pollard Walk is a standard butterfly survey method during which a surveyor records butterfly species and individuals observed within a 5 x 5 x 5 m cube, or 2.5 m on the left, 2.5 m on the right, 5 m ahead, and 5 m above along a transect. The total transect length is 100 m and it is walked over 10 minutes. The transects are permanent; GPS coordinates were taken for each Pollard Walk so the transects could be repeated on subsequent survey days. Butterfly surveys occurred only on relatively calm days that were mostly sunny and warm, starting usually at 10:00 am. In addition to the formal surveys, butterflies were also recorded outside the transects (incidental observations) and before/after each survey (checklist surveys) to capture additional information about butterfly presence and nectaring behaviour.

A modified transect at the Syringa Interpretive Site involved walking around the roundabout for 10 minutes, counting all butterflies observed within the circle, up to 5 m (maintaining a cube of the same size). This approach was standardized for each visit; therefore, results are comparable over time within the interpretive site itself.

Phenology observations of insect-pollinated flowering plants occurred over similar transects. Extended General BBCH-scale phenology codes (Hack et al. 1992) were used to track plant development by species throughout the summer. Because different individuals of a species can appear at different phenological stages within the same ecosystem, often an averaged code was recorded for each transect to best represent the developmental status of the population at the time of the survey. Only plants with known floral resources for butterflies were included in the survey.

A Pale Tiger Swallowtail survey was completed by Mitacs student summer intern, Josh Fogal, using the same and similar butterfly surveys (Appendix F).

Key Outcomes for BC Parks

There is high plant, butterfly, and non-forest ecosystem diversity in the West Kootenay, including within both Syringa and Beaver Creek parks. Based on observations this year, plants responded to severe heat and drought, and possibly weeks of wildfire smoke, by shortening maturation periods: aborting growth, including flowering; producing low to no seed set; and undergoing rapid senescence. These are all important considerations as we begin to look more closely at the role of climate change within these ecosystems.

For nectaring, butterflies rely on:

- non-native weeds in the spring, especially annual mustards; for example, pale alyssum (*Alyssum alyssoides*), mouse-ear [*Arabidopsis thaliana*], and common draba (*Draba verna*);
- spreading dogbane (*Apocynum androsaemifolium*) and plants in the Sunflower Family (Asteraceae), specifically fleabanes (*Erigeron* spp.) and asters (*Symphyotrichum* spp. and other aster genera); and

- shrubs, for example saskatoon (*Amelanchier alnifolia*), kinnikinnick (*Arctostaphylos uva*-ursi), oceanspray (*Holodiscus discolor*), and black raspberry (*Rubus leucodermis*).

Thirty-two percent of all the species recorded on all research sites were non-native and many of these play a key role in providing food for native butterflies presently. The removal of non-native species within parks should only proceed with a clear plan for replanting immediately with complementary native species to continue to attract and support butterflies and other native pollinators. Some of the weedy annuals that support butterflies in the spring should not be considered for removal as they quickly die off as the season becomes warmer and drier and provide valuable food resources for early emerging butterflies. These species are not a management concern and there are no known native alternatives that can readily replace them.

Relevance to BC Parks Management

As there is currently no active management that occurs on our research sites, the best approach, currently, is to continue as is. This was the first year of our study and we have baseline information that we can build upon. As we move forward in 2022, we will be creating restoration plots within the research sites that will be seeded to meet plant-butterfly association targets. Climate research and seed sourcing analysis, as part of "Pollination Pathway," will help inform seeding/planting prescriptions within both the research and interpretive sites.

We will be able to provide BC Parks with a planting plan, a list of target plant species, and recommendations for supporting plant-butterfly interactions in subsequent years.

Project's Challenges/Opportunities

The main challenge in 2021 was poor air quality. As wildfires, and resulting smoke, will likely continue to be an issue in the summer in British Columbia, getting into the field to conduct surveys could be limited. As previously mentioned, it is likely the intense heat and drought conditions over the summer likely led to changes in plant growth and development and may have affected butterflies as well.

Butterfly surveys need to occur during calm days that are sunny and warm, so we often didn't know if we were in the field until the day before. Fortunately, we were able to remain flexible and coordinate our calendars, so the surveys occurred on schedule, as much as possible.

It is difficult to determine if our strategy of sampling every 2-3 weeks was sufficient to capture the diversity and variability within and among our research sites. We lost some information with the poor air quality and cancelled field days. Although we managed to complete seven of the proposed eight field days, it would have been beneficial to start surveys earlier in the spring and continue into the fall. For example, we observed the importance of willow (*Salix* spp.) at Beaver Creek during our first survey at the site. Willows bloom in the late winter/early spring and are likely critical food resources for butterflies when herbaceous species have yet to emerge from the ground. Similarly, during our last field visit at Beaver Creek, we noticed the high popularity of late-season asters with butterflies. These are some of the only plant species flowering at this time.

There were also some challenges associated with the phenology surveys. The codes denote one stage of sexual development with the assumption that the entire individual, as well as the population, fit well with the stage. For example, the code 59 represents the stage "first flower petals visible (in petaled form) and code 71 represents "fruits begin to develop." We found that it is difficult to pin a single code on many plants, especially longer-lived species such as some perennials

and shrubs. A species may have 10% of the flowers open (code 61) and have flower buds visible (code 51). Similarly, a species may have open flowers (code 65) and have fruits developing (code 71). In these cases, it was important to calibrate oneself and to use the same logic for code naming throughout the survey. Although, we had others (student interns) help with the phenology surveys, only the Botany Lead contributed to the official record to maintain consistency.

Studying the phenology of plant species, especially those that have long seasonal maturation rates, revealed some interesting phenomena. For example, at Syringa, smooth aster (*Symphyotrichum laeve*) remained in a vegetative growth form without obvious development of a flowering stalk (code 49) from May to July. A code of 51 ("inflorescence or flower buds visible") was recorded for this species on July 10 and a 61 ("10% of the flowers open") was finally recorded on August 31. Moreover, the seemingly large phenological gaps between some of the codes required a slight modification of the coding convention for some of the shrub species. At Beaver Creek, for instance, choke cherry (*Prunus virginiana*) remained at code 71 ("fruits begin to develop") for several weeks before the next code, 79 ("nearly all fruits have reached final size normal for the species and location"), was recorded. In this case, the second time the code of 71 was recorded it was modified as "71+" to indicate that it was still best choice as fruit development was still occurring.

The main lessons learned, or insights, that resulted from our first year of the *Building Butterfly Habitat* project all are related to the environmental conditions over the summer 2021. Although the summer heat was, at times, sweltering, and the wildfire smoke limited our field days, these conditions also provided some insights into how extreme climate could affect both the behaviour of butterflies and the phenology of plant species. We learned that spreading dogbane, a species that was not on our radar previously, is a butterfly magnet and a very important nectar source for a wide range of insect species. Even though this species showed reduced flowering in droughty upslope locations, it continued to flower and provide food resources for butterflies for over a month lower on slopes during a very hot summer. Finally, despite the extreme weather conditions, both butterflies and plants demonstrated remarkable resilience and tenacity.

Conclusions/Next Steps

We were pleased with the results of the first year of our study and now have a good foundation of baseline data. The recording of 49 butterfly species and 160 plant species in our three research sites supports the West Kootenay as a region of high plant, butterfly, and non-forest ecosystem diversity. The three sites, Syringa, Beaver Creek, and Charbonneau Creek, show overlap in both butterfly and plant species and clear differences that allude to their ecological uniqueness and high connectivity value when taking a landscape approach to this research.

As we begin to consider enhancement efforts in the second year of the study, there are three main considerations for target plant species. First, at present, some weedy species are important nectar and ovipositing plants for native butterflies and additional research will help determine appropriate native equivalents. Second, plant species appeared to respond to the adverse summer environmental conditions by altering development; changes that could negatively affect butterfly populations by limiting important nectar sources. These results from our study to date, along with climate forecasting research, will help us determine if there are either hardier species or species from drier locales that should be considered for planting. Finally, target species will be informed by a comprehensive review of butterfly host plants based on 2021 findings to ensure that appropriate species are present on the sites to support butterfly reproduction.

In the next two years of the research study, we'll maintain butterfly and phenology surveys every 2-3 weeks. Plant communities will be surveyed for plant abundance (cover) and floral density as well.

Data from these surveys, as well as climate research, will inform the prescriptions within restoration plots within the Syringa and Beaver Creek research sites. These plots will be seeded to meet plant-butterfly association targets. Host and nectar plants that were established by seeding/planting will be monitored for use by target butterflies. Site management activities may occur, based on monitoring results and in accordance with provincial park objectives.

For the Syringa Interpretive Site, site prep will continue in spring/summer 2022. Future meadow community areas will be solarized, and sheet mulch will be applied to the flowering shrub areas. These areas will be seeded and planted in the fall 2022. If funding is available, a pathway with a bench and permanent interpretive signs will be installed. Plants will be monitored for germination success and plant establishment. Site interpretation, in the forms of written outreach materials and/or in-person tours, could occur during the summer camping season, dependent on provincial standards for Covid-19 and air quality (summer wildfire smoke). Site maintenance will be on-going.

Appendix A. Butterfly Species (J. Arndt data); listed species in bold.

BEA = Beaver Creek; CHA = Charbonneau Creek; SYR = Syringa

No.	Scientific Name	Common Name	BEA (n=31)	CHA (n=31)	SYR (n=29)
1	*Amblyscirtes vialis*	Common Roadside Skipper	✓	✓	✓
2	*Anthocharis julia*	Julia Orangetip	✓	✓	✓
3	*Argynnis cybele*	Great-spangled Fritillary	✓	✓	
4	*Callophrys augustinus*	Brown Elfin	✓	✓	
5	*Callophrys eryphon*	Western Pine Elfin	✓		✓
6	*Callophrys polia*	Hoary Elfin	✓		
7	*Celastrina echo*	Echo Azure	✓	✓	✓
8	*Cercyonis pegala*	Common Wood Nymph	✓	✓	✓
9	*Chlosyne palla*	Northern Checkerspot		✓	
10	*Coenonympha california*	Ochre (Common) Ringlet	✓	✓	
11	*Colias eurytheme*	Orange Sulphur			✓
12	*Colias philodice*	Clouded Sulphur	✓		
13	*Colias* sp.	Unidentified Sulphur		✓	
14	***Epargyreus clarus***	**Silver-spotted Skipper**	✓		✓
15	*Erebia epipsodea*	Butler's (Common) Alpine			✓
16	*Erynnis icelus*	Dreamy Duskywing		✓	✓
17	*Erynnis persius*	Persius Duskywing		✓	
18	*Euphilotes glaucon*	Cascadia Blue		✓	
19	*Euphydryas anicia*	Anicia Checkerspot		✓	
20	***Euptoieta claudia***	**Variegated Fritillary**		✓	
21	*Glaucopsyche lygdamus*	Silvery Blue	✓	✓	✓
22	*Hesperia* sp.	Branded Skipper	✓	✓	
23	*Icaricia acmon/lupini*	Acmon/Lupine Blue	✓		
24	*Icaricia icarioides*	Boisduval's Blue		✓	
25	*Limenitis lorquini*	Lorquin's Admiral	✓	✓	✓
26	*Nymphalis antiopa*	Mourning Cloak	✓	✓	✓
27	*Nymphalis californica*	California Tortoiseshell	✓		✓
28	*Oarisma garita*	Garita Skipperling	✓	✓	
29	*Ochlodes sylvanoides*	Woodland Skipper	✓	✓	✓
30	*Papilio zelicaon*	Anise Swallowtail		✓	
31	*Parnassius* sp.	Unidentified Parnassian		✓	
32	*Phyciodes cocyta*	Northern Crescent	✓	✓	✓
33	*Phyciodes mylitta*	Mylitta Crescent	✓	✓	✓
34	*Pieris marginalis*	Margined White	✓		✓
35	*Pieris rapae*	Cabbage White	✓		✓
36	*Polygonia faunus*	Green Comma		✓	✓
37	*Polygonia gracilis*	Hoary Comma	✓		✓
38	*Polygonia satyrus*	Satyr Anglewing			✓
39	*Pterourus eurymedon*	Pale Tiger Swallowtail	✓	✓	✓
40	*Pterourus multicaudata*	Two-tailed Tiger Swallowtail			✓
41	*Pterourus rutulus*	Western Tiger Swallowtail	✓	✓	✓
42	*Pyrgus ruralis*	Two-banded Checkered Skipper		✓	✓
43	*Satyrium saepium*	Hedgerow Hairstreak	✓		
44	*Satyrium sylvinus*	Sylvan Hairstreak			✓
45	*Satyrium titus*	Coral Hairstreak	✓	✓	
46	*Strymon melinus*	Grey Hairstreak	✓	✓	✓
47	*Tharsalea helloides*	Purplish Copper	✓		✓
48	*Thorybes pylades*	Northern Cloudywing			✓
49	*Thymelicus lineola*	European Skipperling	✓		

Appendix B. Nectar and Host Plants (J. Arndt data).

BEA = Beaver Creek; CHA = Charbonneau Creek; SYR = Syringa

Nectar plants – number of records from formal surveys.

Scientific name	Common Name	Number	Percent
Symphyotrichum spp.	aster species	63	44.68%
Apocynum androsaemifolium	spreading dogbane	22	15.60%
Gaillardia aristata	brown-eyed Susan	15	10.64%
Ceanothus velutinus	snowbrush	7	4.96%
Physocarpus malvaceus	mallow ninebark	7	4.96%
Mahonia aquifolium	tall Oregon-grape	6	4.26%
Allium schoenoprasum	wild chive	6	4.26%
Centaurea stoebe	spotted knapweed	4	2.84%
Leucanthemum vulgare	oxeye daisy	3	2.13%
Rubus leucodermis	black raspberry	3	2.13%
Achillea millefolium	common yarrow	3	2.13%
Lithophragma parviflorum	small-flowered woodland-star	2	1.42%

Oviposition behaviour – records from all surveys.

Date	Host Plant Scientific Name	Common Name	Butterfly Species	No.	Site
April 16	*Pinus* sp.	pine species	Western Pine Elfin	1	SYR
April 26	*Arctostaphylos uva-ursi*	kinnikinnick	Hoary Elfin	1	BEA
April 27	*Lupinus sericeus*	silky lupine	Silvery Blue	1	CHA
May 10	*Vicia* sp.	vetch species	Silvery Blue	1	SYR
May 13	*Lupinus sericeus*	silky lupine	Boisduval's Blue	3	CHA
June 18	*Populus trichocarpa*	black cottonwood	Western Tiger Swallowtail	1	BEA
June 18	*Ceanothus velutinus*	snowbrush	Pale Tiger Swallowtail	1	BEA
June 21	*Lupinus sericeus*	silky lupine	Boisduval's Blue	3	CHA
August 30	*Rumex acetosella*	sheep sorrel	Purplish Copper	2	BEA

Appendix C. Phenology, reported as peak bloom time (orange), for flowering plants common to two or more sites. Survey months range from April -Sept., however, specific days vary depending on site. Peak flowering defined as a phenology code between 60-69 ("Principal growth stage 6: Flowering").

Charbonneau Creek Conservation Area

Scientific Name	4.15	4.27	5.13	6.01	6.21	7.12	9.02
Arabidopsis thaliana							
Draba verna							
Collinsia parviflora							
Lithophragma parviflorum							
Balsamorhiza sagittata							
Taraxacum officinale							
Amelanchier alnifolia							
Boechera retrofracta							
Linaria genistifolia							
Lomatium dissectum							
Mahonia aquifolium							
Myosotis laxa							
Veronica arvensis							
Ceanothus sanguineus							
Crataegus douglasii							
Prunus pensylvanica							
Triteleia grandiflora							
Medicago lupulina							
Collomia linearis							
Eurybia conspicua							
Lonicera ciliata							
Maianthemum racemosum							
Prunus virginiana							
Rosa nutkana (hybrid)							
Sedum sp.							
Achillea millefolium							
Gaillardia aristata							
Rosa woodsii							
Apocynum androsaemifolium							
Hieracium scouleri							
Leucanthemum vulgare							
Rosa sp.							
Silene menziesii							
Symphoricarpos albus							
Tragopogon dubius							
Hypericum perforatum							
Medicago sativa							
Philadelphus lewisii							
Centaurea stoebe							
Holodiscus discolor							
Potentilla recta							
Toxicodendron rydbergii							
Polygonum douglasii							
Symphyotrichum laeve							
No. Plants Flowering		18			29		2

Syringa Provincial Park

Scientific Name	4.16	5.01	5.14	5.31	6.17	7.10	8.31
Collomia linearis							
Draba verna							
Taraxacum officinale							
Collinsia parviflora							
Erythronium grandiflorum							
Arabidopsis thaliana							
Amelanchier alnifolia							
Arctostaphylos uva-ursi							
Balsamorhiza sagittata							
Lithophragma parviflorum							
Prunus pensylvanica							
Triteleia grandiflora							
Mahonia aquifolium							
Myosotis laxa							
Campanula rotundiflora							
Ceanothus sanguineus							
Erodium cicutarium							
Asparagus officinalis							
Boechera retrofracta							
Erigeron sp.							
Medicago lupulina							
Prunus virginiana							
Rosa nutkana (hybrid)							
Achillea millefolium							
Rumex acetosella							
Silene menziesii							
Vicia villosa							
Apocynum androsaemifolium							
Gaillardia aristata							
Paxistima myrsinites							
Philadephus lewisii							
Potentilla recta							
Rosa woodsii							
Sedum sp.							
Symphoricarpos albus							
Trifolium arvense							
Allium cernuum							
Eurybia conspicua							
Holodiscus discolor							
Hypericum perforatum							
Rosa. sp. (intro.)							
Tragopogon dubius							
Plantago lanceolata							
Centaurea stoebe							
Hieracium scouleri							
Lomatium dissectum							
Polygonum douglasii							
Symphyotrichum laeve							
No. Plants Flowering		17			31		6

Beaver Creek Provincial Park

Scientific Name	4.14	4.28	5.13	6.02	6.20	7.06	8.30
Draba verna							
Erythronium grandiflorum							
Arctostaphylos uva-ursi							
Arabidopsis thaliana							
Taraxacum officinale							
Amelanchier alnifolia							
Mahonia aquifolium							
Erodium cicutarium							
Crataegus douglasii							
Myosotis laxa							
Prunus virginiana							
Maianthemum racemosum							
Rumex acetosella							
Asparagus officinalis							
Paxistima myrsinites							
Rosa nutkana (hybrid)							
Rosa woodsii							
Toxicodendron rydbergii							
Tragopogon dubius							
Triteleia grandiflora							
Achillea millefolium							
Apocynum androsaemifolium							
Leucanthemum vulgare							
Erigeron sp.							
Trifolium arvense							
Veronica arvensis							
Campanula rotundiflora							
Gaillardia aristata							
Philadelphus lewisii							
Symphoricarpos albus							
Vicia villosa							
Plantago lanceolata							
Allium cernuum							
Centaurea stoebe							
Medicago sativa							
Potentilla recta							
Hypericum perforatum							
Linaria genistifolia							
Symphyotrichum laeve							
No. Plants Flowering		13			25		3

Appendix D. Phenology, reported as peak bloom times (yellow), for flowering plants only found at indicated site. Survey months range from April -Sept., however, specific days vary depending on site. Peak flowering defined as a phenology code between 60-69 ("Principal growth stage 6: Flowering").

Charbonneau Creek Conservation Area

Scientific Name	4.15	4.27	5.13	6.01	6.21	7.12	9.02
Fragaria vesca							
Lithospermum arvense							
Lomatium ambiguum							
Hydrophyllum capitatum							
Lomatium triternatum							
Alyssum desertorum							
Acer glabrum							
Arenaria serpyllifolia							
Delphinium sp.							
Galium triflorum							
Neslia paniculata							
Prosartes hookeri							
Senecio sp.							
Lithospermum ruderale							
Scutellaria angustifolia							
Erysimum capitatum							
Lupinus sericeus							
Phacelia hastata							
Alyssum alyssoides							
Boechera stricta							
Linum lewisii							
Triflolium sp.							
Phacelia linearis							
Physocarpus malvaceus							
Ipomopsis aggregata							
Clematis sp.							
Epilobium minutum							
Erigeron speciosus							
Eriogonum heracleoides							
Rhus glabra							
Sambucus nigra							
Sisymbrium altissimum							
Melilotis alba							
Erigeron divergens							
Asclepias speciosa							
Calochortus macrocarpus							
Circium undulatum							
Collomia grandiflora							
Lactuca serriola							
Madia exigua							
Epilobium foliosum							
Melilotus officinalis							
Solidago sp.							
Verbascum thapsus							
No. Plants Flowering		**18**			**27**		**4**

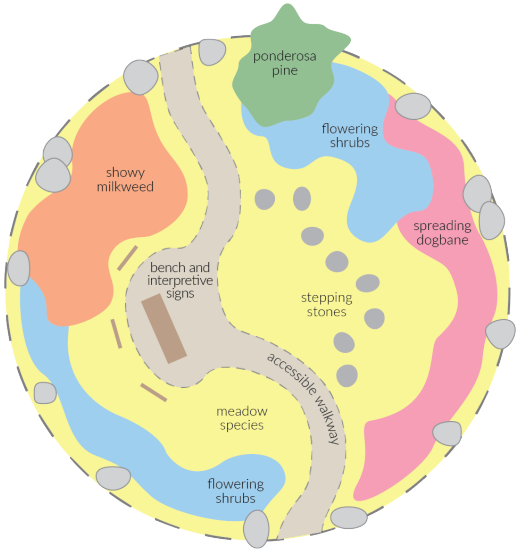
Syringa Provincial Park

Scientific Name	4.16	5.01	5.14	5.31	6.17	7.10	8.31
Claytonia rubra							
Dodecatheon pulchellum							
Delphinium nuttallianum							
Toxicoscordium venenosum							
Antennaria rosea							
Logfia arvensis							
Veronica sp.							
Epilobium sp.							
Erigeron linearis							
Lonicera ciliosa							
Plantanthera sp.							
Rubus leucodermis							
Plantago patagonica							
Castilleja hispida							
Crepis sp.							
Spiraea lucida							
Hieracium albiflorum							
Heuchera cylindrica							
Solidago simplex							
No. Plants Flowering		**7**			**10**		**2**

Beaver Creek Provincial Park

Scientific Name	4.14	4.28	5.13	6.02	6.20	7.06	8.30
Corylus cornuta							
Salix scouleriana							
Camassia quamash							
Arenaria sp.							
Malus pumila							
Sorbus sp.							
Allium schoenoprasum							
Ceanothus velutinus							
Hieracium gracile							
Plantago major							
Prunus avium							
Trifolium pratense							
Lilium columbianum							
Berteroa incana							
Lysimachia ciliata							
Myosotis sp.							
Prunella vulgaris							
Rhamnus purshiana							
Lotus unifoliolatus							
Rumex acetosa							
Arnica chamissonis							
Conyza canadensis							
Coreopsis tinctoria							
Hieracium umbellatum							
Symphyotrichum boreale							
Symphyotrichum subspicatum							
Artemisia lindleyana							
Mentha arvensis							
Gratiola neglecta							
Lycopus europaeus							
Lythrum salicaria							
Oenothera sp.							
Solidago lepida							
Tanacetum vulgare							
No. Plants Flowering		**7**			**22**		**8**

Appendix E. Syringa Provincial Park Interpretive Site for Climate Resilient Butterfly Habitat, including site concept diagram, posted sign, and select photos, October 2021.



Proposed Concept Design for Syringa Park Native Plant - Butterfly Interpretive Site. Diagram not to scale (B. Beckwith, Sept. 16, 2021).

Installed information sign (Oct. 18, 2021).

Before and after work photos (Sept. 27, 2021).

Photos of completed 2021 site prep (Oct. 18, 2021).

Appendix F. Pale Swallowtail Abundance and Plant Interaction Study - 2021 Highlights

Pale Swallowtail (Papilio eurymedon) on spreading dogbane (Apocynum androsaemifolium) (J. Arndt photo).

Study by Joshua Fogal

Summer Student Intern, "Building Climate Resilient Butterfly Habitat" Project

Funding for the summer student intern position, and this study, provided by Kootenay Native Plant Society and Mitacs and was supported by Selkirk Innovates and Co-op Education and Employment Services at Selkirk College, Castlegar, British Columbia.

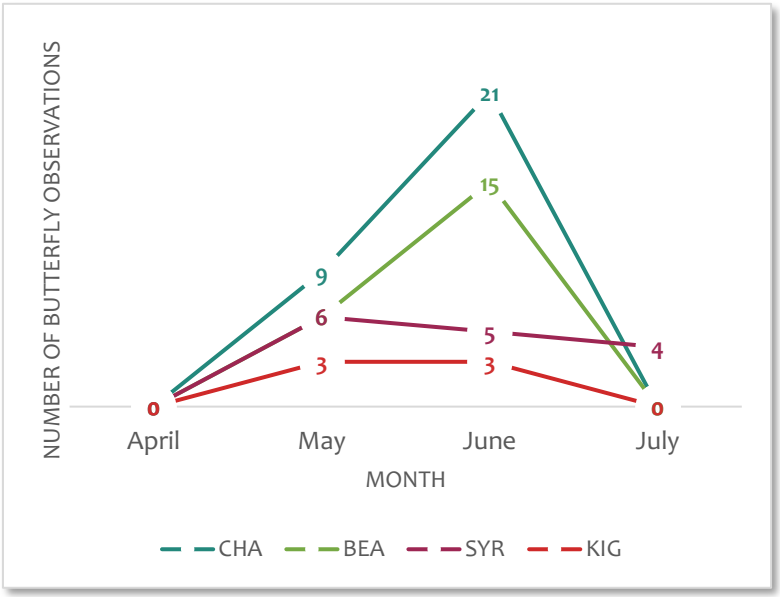
Plant-butterfly networks are affected by environmental changes globally and in the West Kootenay region of British Columbia. "Building Climate Resilient Butterfly Habitat" is a BC Parks Living Lab for Climate Change and Conservation funded project that will help identify and determine the best habitat enhancement methods for butterflies, especially at-risk and climate-vulnerable butterflies. Although currently listed as provincially secure, the Pale Swallowtail (*Papilio eurymedon*) may be vulnerable to the effects of climate change due to life history characteristics including range contraction and shifts in the timing of, and increased vulnerability at certain, life stages.

"Butterfly Habitat" is a sub-project of the Pollination Pathway Climate Adaptation Initiative ("Pollination Pathway"), an ongoing program managed by the Kootenay Native Plant Society. This Pale Swallowtail study was conducted to gain a better understanding of this species' occurrence and plant-butterfly interactions in our region and to contribute additional information about an important and charismatic pollinator in the West Kootenay.

All the Pale Swallowtail study sites occur within the Pollinator Pathway program area, the Lower Columbia Subregion. There are four main research locales at the Syringa Provincial Park, Beaver Creek Provincial Park, Charbonneau Conservation Area, and King George IV Provincial Park. All the Pale Swallowtail surveys at these sites occurred while assisting supervising Lepidopterist Janice Arndt with her "Butterfly Habitat" surveys (Pollard Walks). Single surveys were also conducted at Goose Creek Forest Service Road (Pass Creek Valley), Worksite F (Waneta), Old Orchard Trail (Montrose), Millennium Park (Castlegar), and Lower Brilliant Terrace (*kp'itl'els*), as well as two surveys on the Castlegar campus of Selkirk College. These supplemental surveys were completed either as additional field sites or as part of other Pollination Pathway field work.

Janice Arndt and Joshua Fogal conducting a butterfly survey at Charbonneau Creek Conversation Area (B. Beckwith photo).

In total, 72 observations of Pale Swallowtail were recorded in the study area from May 1 to July 29, 2021. Charbonneau Creek Conservation Area and Beaver Creek Provincial Park appeared to offer the most floral resources for the species as 30 individuals were documented at Charbonneau Creek and 21 at Beaver Creek during this time. Fewer Pale Swallowtail individuals were recorded at Syringa (n = 15) and King George (n = 6) provincial parks. Of the supplemental surveys, one Pale Swallowtail was observed at Millennium Park and six individuals were seen on the Old Orchard Trail.



Pale Swallowtail observations over the summer field season 2021 (CHA = Charbonneau Creek Conservation Area; BEA= Beaver Creek Provincial Park; SYR - Syringa Provincial Park; KIG = King George Provincial Park).

It should be noted that not all sites were the same size and, hence, the sampling effort across the sites varied. Charbonneau Creek had the greatest detection rate (# pale swallowtails/hour spent on site = 1.69); the other three sites were comparable (range = 0.90-1.10).

Most Pale Swallowtail observations occurred in June (61% of total). The butterflies were most often demonstrating flying behaviour; however, they were also observed flushed, perching, twirling, nectaring, and ovipositing on snowbrush (*Ceanothus velutinus*), a known host plant. Spreading dogbane (*Apocynum androsaemifolium*) accounted for one quarter of all observations, suggesting that this plant species is an important nectar resource for Pale Swallowtail in our region. It is still unclear, though, if spreading dogbane is favoured over other plant species or if it is more common, and hence more available, in the study sites. Currently, it appears that the Pale Swallowtail is secure and supported in the West Kootenay.