

BC PARKS LIVING LAB PROGRAM FOR CLIMATE CHANGE AND CONSERVATION

Building Climate Resilient Butterfly Habitat, Yr.2



Selkirk Innovates and the Kootenay Native Plant Society gratefully acknowledge the support of the BC Parks Living Lab Program and Mitacs.

Lead Researcher: Brenda Beckwith

Co-Lead Investigator: Terri MacDonald

Additional Research Team: Janice Arndt (Lepidoptera), Valerie Huff (Restoration Botany), Emma Lognon (student intern)

Cover Photo: Janice Arndt. Purplish Copper on choke cherry.



On behalf of Selkirk College, I (we) acknowledge that we operate and serve learners on the unceded traditional territories of the Sinixt (Lakes), the Syilx (Okanagan), the Ktunaxa, and the Secwépemc (Shuswap) peoples.

Living Lab Program for Climate Change and Conservation - Final Report



Building Climate Resilient Butterfly Habitat, Year 2

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Building Climate Resilient Butterfly Habitat, Year 2 is part of the Pollination Pathway Climate Adaptation Initiative, a signature program of the Kootenay Native Plant Society. This project receives core funding from the Columbia Basin Trust Ecosystem Enhancement Program, administrative support from Selkirk Innovates at Selkirk College, and summer student intern guidance and funding from Mitacs and Selkirk Innovates.

Research Findings

The aim of this project is to determine the current extent of plant-butterfly associations and establish butterfly meadow habitat in Beaver Creek and Syringa Provincial Parks, both located in the West Kootenay Region of the BC Interior (Appendix 1). Although all butterflies are included in the research, the restoration focus is on the enhancement of habitat with climate resilient native plants that have nectar and host plant value and butterflies at risk and those species predicted to be climate vulnerable.

In this report, the results from 2022 research are presented and compared with the results from the first year of the study in 2021. The main avenue of investigation is how the weather over the two years possibly affected our observations:

- 2021 - dry and hot, including a heat dome in late June/early July and drought conditions in the summer.
- 2022 - cooler and wetter, with prolonged flooding into the summer.

Although these comparisons are exploratory and largely speculative at this point in the project, they merit discussion as there could be insights that may shed light on future management practices.

Butterflies

For the butterflies, the main findings include:

- Butterflies delay adult flight time during a cool, wet spring.
- Many species are quite adaptable to climate variation, but not all.
- As the climate warms, some species may experience longer adult flight periods and have time for a second brood; others don't have that flexibility.

As in the first year of this project, surveys were completed at one large research site at Beaver Creek Provincial Park (15 transects total) and three smaller research sites at Syringa Provincial Park (5 transects total) (Appendix 2). A modified survey was conducted at the Syringa Interpretive Site as well. In 2022, 33 butterfly species were recorded Beaver Creek and 28 species at Syringa. The numbers of species remain similar over the two years, including the total number of species documented (Table 1). There were 48 total butterfly species recorded in both years. These numbers include all species seen during formal surveys, checklist observations, and incidental sightings within and outside of the research sites.

Table 1. Number of butterfly species observed in 2021 and 2022 in both parks.

Park	2021 # Species	2022 # Species	Total # Species
Beaver Creek	31	33	40
Syringa	29	28	38

Thirty percent of the total observed butterfly species were recorded in both parks in both years. Of the rare species, the blue-listed Silver-spotted Skipper (*Epargyreus clarus*) was recorded in both parks in both years and the red-listed Edith's Copper (*Tharsalea editha*) was recorded in Beaver Creek in 2022.

It is difficult to interpret the phenology of butterflies as all species are unique and respond to environmental cues differently. Some species are adaptable, and others are not. In general, adult butterflies tend to emerge and fly when the weather conditions are warm and dry. Hence, many species delayed flight times in the spring 2022. This pattern was noticeable with the swallowtails; the Western Tiger Swallowtail (*Pterourus rutulus*), for example, delayed emergence by a month in 2022. Additionally, some species flew for a longer period, such as the Western Pine Elfin (*Callophrys eryphon*) that was observed flying from mid-April to mid-May in 2021, and from late-April to late-July in 2022 (Appendix 3). Alternatively, there are some species that flew longer in 2021. For instance, the Common Roadside Skipper (*Amblyscirtes vialis*) was observed flying from late-May to late-July in 2022, but was observed, in 2021, flying from early-May to early-September. Janice Arndt, who documented this information from project surveys, as well as during other local

observations, suspects that the species could have experienced two broods in 2021, a phenomenon only recorded for Common Roadside Skipper in southern latitudes.

Plants

After two years of following the phenology of insect-pollinated angiosperms, the main takeaways are:

- Plants alter maturation periods in response to seasonal weather.
- Flowering shrubs are foundation butterfly plants in non-forested ecosystems.
- As the climate changes, introduced invasive species, in particular weedy forbs, will likely become an important management concern.

The number of plant species surveyed increased at both sites in 2022. At Beaver Creek, 79 species were observed at Beaver Creek, as compared to 68 species at Syringa. There were 116 total plant species recorded in the two years. Of all the plants monitored 31% are common in both parks, 64% are native species, and 17% are shrubs. Between the two parks the difference in number of species did not vary noticeable, nor did the total number of species; approximately 10 more species were tracked at Beaver Creek than at Syringa (Table 2).

Table 2. Number of plant species surveyed in 2021 and 2022 in both parks.

Park	2021 # Species	2022 # Species	Total # Species
Beaver Creek	67	79	81
Syringa	60	69	71

The difference in species number between the two parks can be attributed to the different plant communities. The research site at Beaver Creek is characterized as brushlands on broad benches spanning from the Columbia River to the Trail Regional Airport (Appendix 1). The upper portion of this area is the uncommon Gb06 Snowbrush, Poverty Oatgrass plant community (MacKillop and Ehman 2016), and the lower area is characterized as low bench flood (McKenzie and Machmer 2021). The Beaver Creek site is a popular dog walking spot along the Columbia River, hence includes species that are common weeds found on low shoreline benches. The research sites at Syringa are shallow-soiled and steep forest gaps characterized as a Gg11 Bluebunch Wheatgrass, Idaho Fescue plant community (MacKillop and Ehman 2016). The Syringa sites are more remote and protected and support a broad range of meadow and grassland species (Appendix 1).

Comparing plant phenology between the two years is best summarized by separating the plants into three groups: native forbs, introduced forbs, and shrubs (all native). Native forbs appear to be well adapted to hotter and drier conditions. In general, these species bloomed longer and earlier in 2021

than in 2022. This pattern was most noticeable for some of the late-spring bloomers such as spreading dogbane (*Apocynum androsaemifolium*), yarrow (*Achillea millefolium*), and common harebell (*Campanula rotundifolia*). On the other hand, it appears the introduced forbs took advantage of the cooler, wetter conditions in 2022 as seen from longer and, in some cases, earlier blooming times for these species. The favourable growing conditions in 2022 likely contributed to the high cover of some weedy species including woolly vetch (*Vicia villosa*), sheep sorrel (*Rumex acetosella*) and hare's-foot clover (*Trifolium arvense*). Shrub phenology did not vary widely though two early summer shrub species, mock-orange (*Philadelphus lewisii*) and snowberry (*Symphoricarpos albus*) seemed to delay flowering in 2022. Native shrubs are important for butterflies not only because these plants are long-lived, have abundant flowers for nectaring, and are often host plants, but they are hardy and resilient species.

Restoration Areas

In fall 2022, restoration areas were established in each park (Table 3). The Beaver Creek area is located on an upper bench and is partially protected by trees and shrubs (Appendix 4). On October 18, a group of eight people including members of the Rossland Society for Environmental Action (RSEA) Board, established three monitoring plots, and planted (50 plants of 5 species) and seeded (approx. 105,000 of 9 species) these plots, as well as within the general restoration area (Appendix 3).

At Syringa, the area is located on a steep, shallow-soil slope and is protected by trees and shrubs on all sides (Appendix 4). This is a second-choice location as the first-choice area became overrun with woolly vetch over the summer 2022. Taking advantage of the availability of the fantastic BC Invasive Species Summer Crew, seven people established and prepped 12 monitoring plots on August 23 (Appendix 3). Eight of these plots were then seeded with approximately 68,000 seeds of 18 species (see Methods Summary for treatment design). On October 20, five people completed the work, planting 240 plants of 12 species in the remaining four plots, as well as within the general restoration area.

Table 3. Number and examples of native plants and seeds included in restoration treatments in Fall 2022.

Site	Plants		Seeds		Target Spp. Added (examples)
	Spp.	No.	Spp.	No.	
Beaver Creek	5	50	9	105,000	<ul style="list-style-type: none"> • yarrow (<i>Achillea millefolium</i>) • common harebell (<i>Campanula rotundifolia</i>) • parsnip-flowered buckwheat (<i>Eriogonum heracleoides</i>) • golden-aster (<i>Heterotheca villosa</i>) • swale desert-parsley (<i>Lomatium ambiguum</i>) • yellow penstemon (<i>Penstemon confertus</i>)
Syringa	12	240	18	68,000	<ul style="list-style-type: none"> • showy milkweed (<i>Asclepias speciosa</i>)

					<ul style="list-style-type: none"> • dangling suncrest (<i>Boechera retrofracta</i>) • showy aster (<i>Eurybia conspicua</i>) • brown-eyed Susan (<i>Gaillardia aristata</i>) • silky lupine (<i>Lupinus sericeus</i>) • silverleaf phacelia (<i>Phacelia hastata</i>) • spikelike goldenrod (<i>Solidago simplex</i>)
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Butterfly Habitat Interpretive Garden (Interpretive Site)

The development of the interpretive site, called the Butterfly Habitat Interpretive Garden (BHIG), located within the Bighorn Campground & Day-Use Area at Syringa Park moved forward largely in fall 2022. On June 4, 10 people, including BC Parks staff and volunteers, helped prepare the site by installing layers of organic materials (sheet mulching) onto the areas to be planted with shrubs and spreading dogbane in the fall (Appendix 3). On October 22, 24 people, including BC Parks staff, KNPS directors, and youth, helped plant the site (Appendix 3). To date, the site has 500 plants of 50 species, including 28 forb species, 18 shrub species, and 4 grass species. Most importantly, the plants have been chosen, in part, because they are important potential host plants for many butterflies, including species that are at risk and thought to be climate vulnerable (Table 4).

Table 4. Notable examples of planted forbs, shrubs, and grasses that could possibly be used by butterflies as host plants. Note: butterflies in red and blue are provincially red-listed and blue-listed, respectively. The asterisk denotes species that were recorded in BC Parks as part of our surveys in 2021 and 2022.

Host Plant	Butterfly Spp. Possibly Supported (examples)
FORBS	
<ul style="list-style-type: none"> • Showy Milkweed (<i>Asclepias speciosa</i>) • Can. Milk-vetch (<i>Astragalus canadensis</i>) • Wild Licorice (<i>Glycyrrhiza lepidota</i>) • Silky Lupine (<i>Lupinus sericeus</i>) 	<ul style="list-style-type: none"> • Monarch (<i>Danaus plexippus</i>) • Orange Sulphur (<i>Colias eurytheme</i>)* Clouded Sulphur (<i>Colias philodice</i>)* • Silver-Spotted Skipper (<i>Epargyreus clarus</i>)* • Orange Sulphur (<i>Colias eurytheme</i>)* Boisduval's Blue (<i>Plebejus icarioides</i>)*
SHRUBS	
<ul style="list-style-type: none"> • Saskatoon (<i>Amelanchier alnifolia</i>) • Kinnikinnick (<i>Arctostaphylos uva-ursi</i>) • Parsnip-flowered Buckwheat (<i>Eriogonum heracleoides</i>) • Oceanspray (<i>Holodiscus discolor</i>) • Choke Cherry (<i>Prunus virginiana</i>) 	<ul style="list-style-type: none"> • Lorquin's Admiral (<i>Limenitis lorquini</i>)* • California Hairstreak (<i>Satyrium californicum</i>) • Brown Elfin (<i>Callophrys augustinus</i>)* • Hoary Elfin (<i>Callophrys polia</i>)* • Immaculate Green Hairstreak (<i>Callophrys affinis</i>) • Acmon Blue (<i>Icaricia lupini</i>)* • Edith's Copper (<i>Tharsalea editha</i>)* • Purplish Copper (<i>Tharsalea helloides</i>)* • Pale Tiger Swallowtail (<i>Pterourus eurymedon</i>)* • Western Tiger Swallowtail (<i>Pterourus rutulus</i>)* • Coral Hairsreak (<i>Satyrium titus</i>)*
GRASSES	
	<ul style="list-style-type: none"> • Common Roadside Skipper (<i>Amblyscirtes vialis</i>)* • Dark Wood Nymph (<i>Cercyonis oetus</i>)*

-
- Common Alpine (*Erebia epipsodea*)*
 - Woodland Skipper (*Ochlodes sylvanoides*)*
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Methods Summary

Surveys of plant and butterfly presence, abundance, and phenology, as in Year 1, were conducted along established transects in Beaver Creek and Syringa Provincial Parks from April to August 2022 (Appendix 2). As previously introduced, also this year a restoration area within each research site for each park was established. These areas have been seeded and planted with locally collected and grown native plants that meet the requirements of our target plant list. At both sites, monitoring plots were installed to track plant establishment over time, though more plants and seeds were added into the restoration areas at each location.

There was a different ecological restoration approach at each park (Appendix 4). A more conservative approach was adopted at Beaver Creek where fewer species were introduced and three 1 m² permanent plots were created to monitor plant establishment. As there were few weedy species occurring on this open, flat site, no pre-planting preparation was required. Because of the large cover of hare's-foot clover at the Syringa restoration site, a more intensive and broader approach was adopted. Twelve 3 m² x 2 m² permanent plots were installed at this site. Each monitoring subplot is 2 m² x 1 m² with a 0.5 m buffer around the perimeter. Preparation and planting treatments were randomly assigned to these plots as a pilot experiment to determine how best to establish native forbs in an area of high weedy plant cover and density (Table 5).

Table 5. Preparation and planting treatments for restoration plots at Syringa Provincial Park.

No. Plots	Preparation	Planting
4	all aboveground biomass cleared and plot scalped	seeded
4	all aboveground biomass cut and plot raked	seeded
4	all aboveground biomass cut and plot raked	planted

In addition to the research sites, the development of a unique interpretive space continues as well. The installation of the Butterfly Habitat Interpretive Garden (BHIG) began in Year 1 and is proposed to be completed in 2023, if funding is available.

Key Outcomes for BC Parks

After two years of this research, we are gaining a better understanding of plant and butterfly interactions and phenology. Weather information from the Warfield Weather Station (Govt. of Canada 2022) was used to provide annual temperature and precipitation data to compare with butterfly and plant species numbers. The butterfly data include formal transect data, as well as

species recorded as part of the checklist and incidental observations. Separate comparisons were made for each park (Appendix 5).

At both Beaver Creek and Syringa research sites, the changes in species numbers over the course of the field season showed similar trends regardless of year. In general, the number of species – for both plants and butterflies - rises in the spring (April-May) and declines in late spring/early summer (late June-early July). It is impossible to determine if the heat dome that occurred in late June 2021 affected the slope of the declines in butterfly or plant species diversity (Appendix 5).

From these analyses, three main points of discussion are presented.

1. In 2021 at Beaver Creek, we observed how important the lower bench along the Columbia River is for butterflies in the mid-summer. This riparian zone becomes a colourful and diverse flowering meadow after the flooding caused by freshet recedes. Because of the large snowpack from winter 2021-22 and the long cool, wet spring in 2022, flooding along the Columbia River was widespread and prolonged well into August affecting both the timing and abundance of flowering plants. The delay and subsequent reduction in the number of flowering plants no doubt impacted the ability of butterflies to access floral resources at Beaver Creek at a time when many other plants at the park are post-flowering (Appendix 5, #1).
2. A decrease in flowering plants in Syringa in 2022 was likely due to the dominance of invasive plants, namely woolly vetch. This species - doubling the duration of its blooming time in 2022 - grew broadly over two of the three research sites and smothered other flowering plants, thereby making them unavailable for monitoring and for adult butterfly use. This species, as well as other weedy plants, likely set down an extensive seedbank in this year as well, thus potentially increasing the persistence for these species in these sites (Appendix 5, #2).
3. A spike in butterfly numbers in Syringa in the summer 2022 was largely due to many observations of Woodland Skipper (*Ochlodes sylvanoides*). This little butterfly was recorded, as part of the nonformal surveys, near the research sites. Additionally, Woodland Skippers were taking advantage of the dense swath of flowering pink fairies (*Clarkia pulchella*) seeded in the interpretive site in fall 2021. These latter observations demonstrate how important native annual species can be in ecological restoration (Appendix 5, #3).

Relevance to BC Parks Management

The research sites at Beaver Creek and Syringa are important plant communities that hold vital resources for butterflies. At Beaver Creek, taking a slower approach in our restoration initiatives is warranted as the research site is within the uncommon and at-risk Snowbrush – Poverty oatgrass brushland (ICHxwa/Gb06) plant community (McKenzie and Machmer 2021), includes habitat for listed reptiles (Machmer and Dulisse 2021), and is a known archaeological site (A. Weber-Roy, pers. comm., Sept. 26, 2022). The research site receives groundwater from a large bedrock aquifer extending from Fruitvale to the Columbia River (BC Gov't 2022); the groundwater in the soil of the lower benches also gets recharged by annual flooding of the Columbia River. Hence, these largely open benchlands support high botanical and ecological diversity and could represent vital habitat for native shrubs and herbs, as well as at-risk and climate vulnerable butterflies, in the future.

At Syringa, the research sites are naturally occurring forest gap plant communities. Although shallow-soiled and often steep, these sites are partially shaded by trees at the margins and support a high diversity of native herbs and shrubs. This perimeter protection buffers the effects of summer heat and exposure at these sites. The rapid growth and coverage of weedy plants in these plant communities in the summer 2022 is worrying. Although the seeds of the annual woolly vetch may not be long-lived, periodic cool and wet springs could give this species punctuated leaps forward in terms of site dominance in the future. Efforts should be made to control woolly vetch, and other invasive species, and prevent them from flowering.

New information from Columbia Basin Climate Source shows an increase in mean annual temperature of + 2.73°C and in the length of the growing season of + 30.10 days for the region (CRCSC 2021). These climate changes could have neutral to positive effects on native plants and butterflies in the future. Native plants tended to fair better in 2021 than in 2022 and many species of butterfly prefer to emerge and fly when the weather is warm, dry, and sunny. This database also projects an increase in total annual precipitation of + 31.90 mm although a decrease in total summer precipitation of -14.13 mm (CRCSC 2021). Increases in precipitation especially in the spring may positively influence the growth of weedy plants and deter the emergence of some butterfly species. If increased precipitation results in longer than normal freshet flooding, the persistence of valuable floral resources for butterflies along riverways could be negatively affected. Finally, if the local climate becomes warmer and moister, annually, the plant communities in the lower elevations of both parks will likely change to grassland/steppe (CRCSC 2021; Appendix 6), emphasizing the urgent need to manage for and increase the diversity and abundance of native herbs and shrubs and control the spread of invasive and weedy plants.

Project's Challenges & Opportunities

The main challenge this year was an inability to fully track the phenology of the plants for the entire field season. Even though more species of plants were included in the surveys this year, these plants were largely identified in the spring and early summer when they were observable. At Beaver Creek, one of the four transects could not be accessed for plant phenology monitoring for most of the summer due to flooding. Butterfly surveys were conducted along the edge of the river for this transect. At Syringa, many of the plants in two of the three research sites were smothered by dense woolly vetch in the summer, rendering them unnoticeable. This species also made walking through the sites difficult as it was a tripping hazard. On the hand, it was discovered that the flowers of woolly vetch are a favourite of the blue-listed western bumble bee (*Bombus occidentalis*).

The very different weather patterns over the two years of the project have provided opportunities for insightful speculation and pondering, as discussed in this report. This work, to date, provides us with a solid baseline from which to guide restoration treatments and maintenance activities as well.

Finally, seeding of a small portion of the interpretive site, BHIG, in the fall of 2021 resulted in an explosion of fuchsia-coloured pink fairies flowers (see below). Only a few species were seeded at this time to give the site some growing plants in 2022, while most of the site was prepped, and funding was raised, to plant the garden more fully in the fall 2022. Woodland Skippers took full advantage of this pilot project, showing us the conservation value of seeding with annual species. The Butterfly Habitat Interpretive Garden is a tremendous opportunity to discover new plant-butterfly interactions and to create a space that can showcase the importance of native plant landscaping and the learning we're gaining from this project.

Conclusions & Next Steps

Now that the restoration and interpretive sites have been established, these areas will be monitored for plant establishment and butterfly-plant interactions in 2023 and 2024. In 2025, the aim is to repeat the initial surveys of plant and butterfly presence, abundance, and phenology, as conducted in 2021 and 2022. The research sites, especially at Syringa, will be maintained over these years to control the introduced invasive species. Restoration and interpretive sites will be augmented with additional plants and seed from our target plant list in the fall based on findings from these surveys.

The interpretive site, BHIG, will receive a universally accessible walkway and a bench in the spring 2023, thanks to additional BC Parks funding. Funding from Parks Enhancement Fund (PEF) and the License Plate Program will be sought to create and install permanent educational signs at the site and to provide interpretation and outreach for staff and park visitors. With 2022 PEF funding and continued support from Columbia Basin Trust, a rare and climate vulnerable butterfly brochure will

be produced and made available at a public open house event for BHIG scheduled for summer 2023, and for park visitors at Syringa, generally.



Flowering pink fairies (Clarkia pulchella) in the Butterfly Habitat Interpretive Garden.

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Appendix 1. Location of research and interpretive sites at Beaver Creek and Syringa Provincial Parks.

Appendix 2. Research sites showing locations of survey transects at Beaver Creek Provincial Park (top) and Syringa Provincial Park (bottom).

Appendix 3. Photo Plates.

Appendix 4. Restoration areas showing monitoring plots at Syringa and Beaver Creek Provincial Parks.

Appendix 5. Comparison between years of plant species number, butterfly species number, and weather for Beaver Creek and Syringa Provincial Parks. Bars show the timing and duration of the heat dome (red) in 2021 and prolonged flooding (blue) in 2022. The number correspond to discussion points in the text (see page 7).

Appendix 6. Screenshots from Columbia Basin Climate Source showing changes in bioclimates with a warm-moist increase in the future (CRCSC 2021).

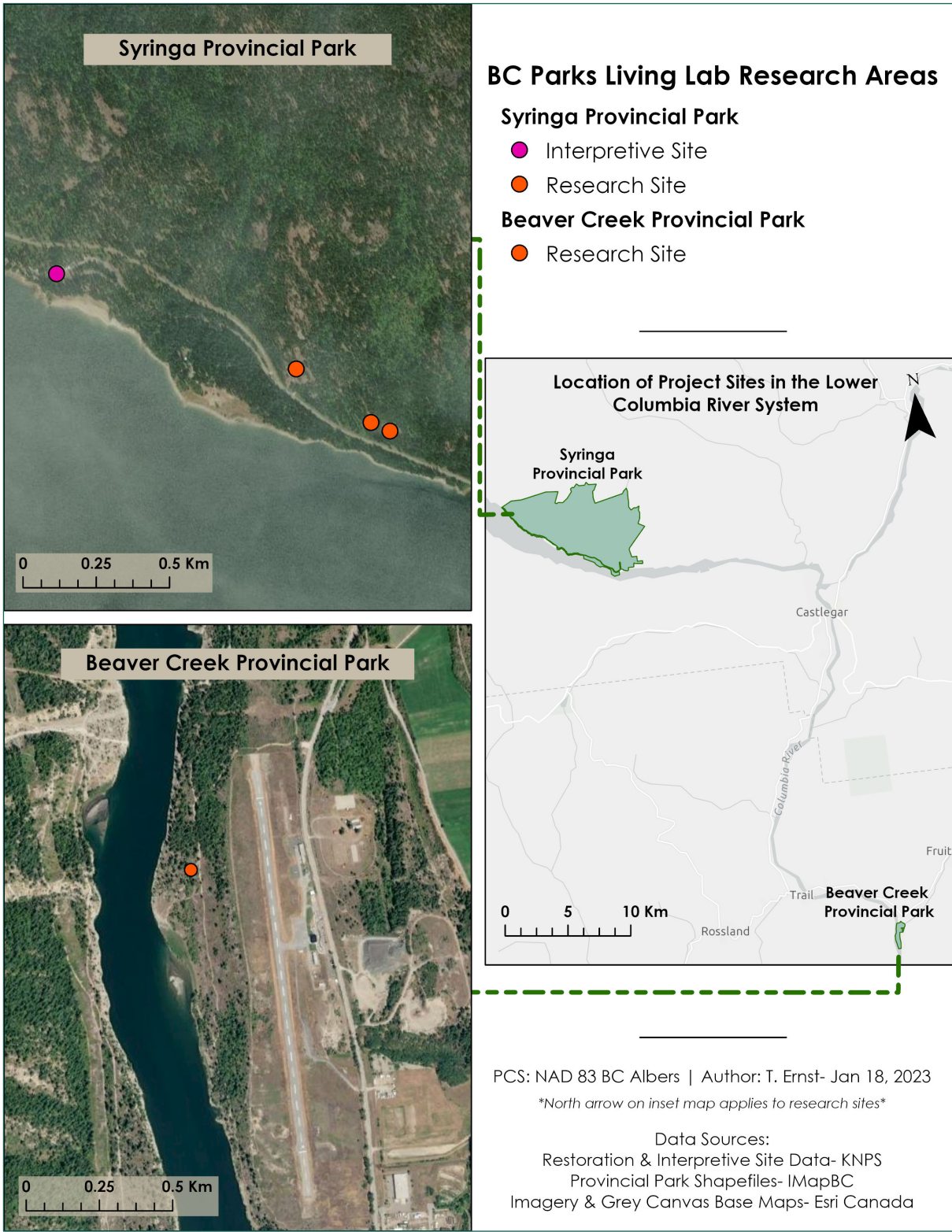
Appendix 7. Summary of butterfly species recorded during formal surveys, checklist observations, and incidental sightings within and outside of research and interpretive sites, 2021 and 2022 (J. Arndt Field Data). SAR in bold.

Appendix 8. Summary of butterfly nectaring observations recorded at research sites, 2021 and 2022 (J. Arndt Field Data). Plants with single nectar records have been omitted. Orange = estimates (tallies).

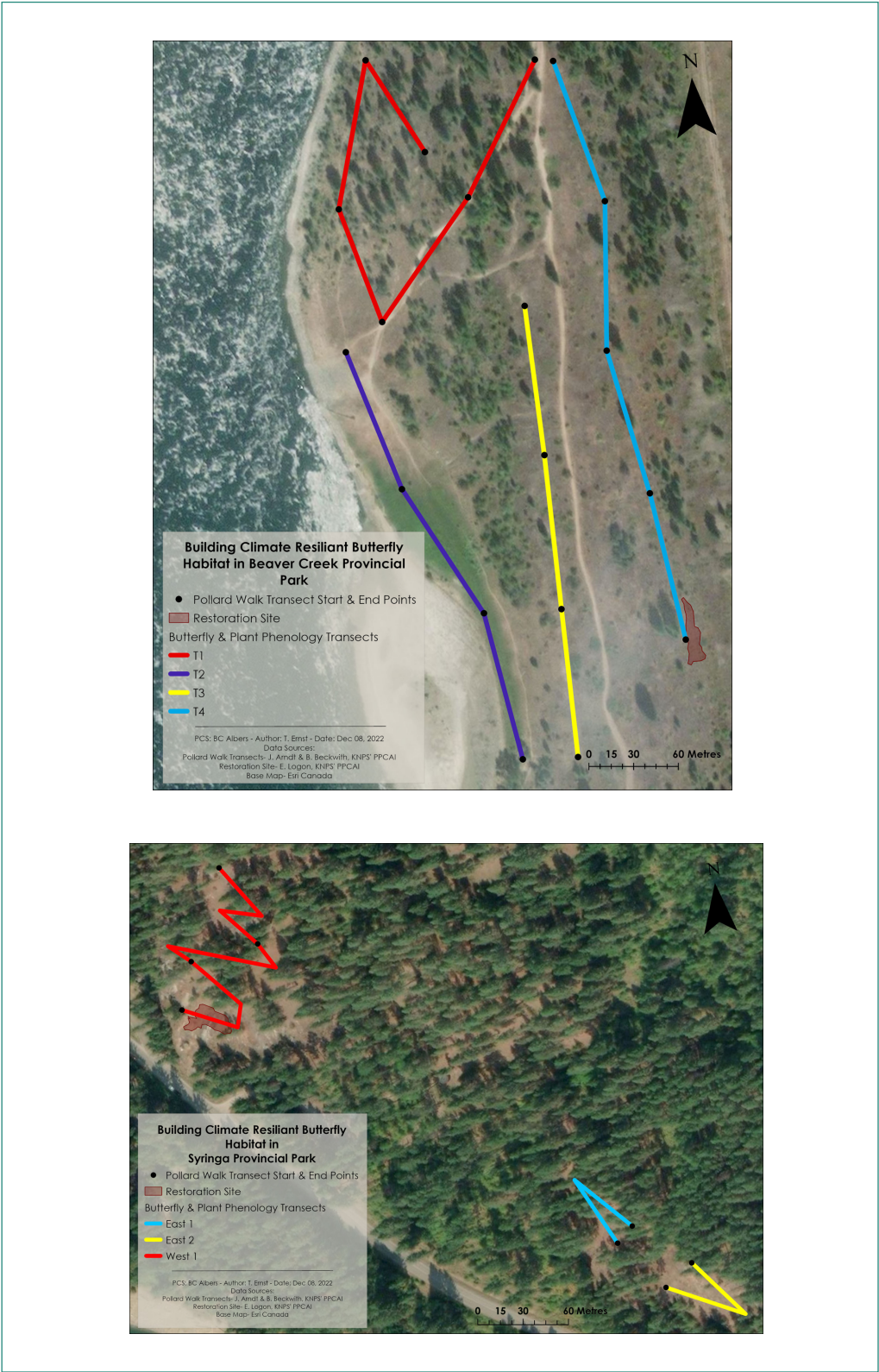
Appendix 9. Summary of host plant observations recorded at research sites, 2021 and 2022 (J. Arndt Field Data). 2021 data represent oviposition behaviour observed from all surveys. 2022 data represent host plant use by caterpillars.

Appendix 10. Summary of plant species recorded during phenology surveys at research sites, 2021 and 2022 (B. Beckwith Field Data).

Appendix 1. Location of research and interpretive sites at Beaver Creek and Syringa Provincial Parks.



Appendix 2. Research sites showing locations of survey transects at Beaver Creek Provincial Park (top) and Syringa Provincial Park (bottom).



Appendix 3. Photo Plates.



Western Tiger Swallowtail on choke cherry (J. Arndt photo).



Western Pine Elfin on yarrow (J. Arndt photo).



Prepping monitoring plots at Syringa restoration area, August 23 (B. Beckwith photo).



Planting crew at Beaver Creek restoration area, October 18 (B. Beckwith photo).

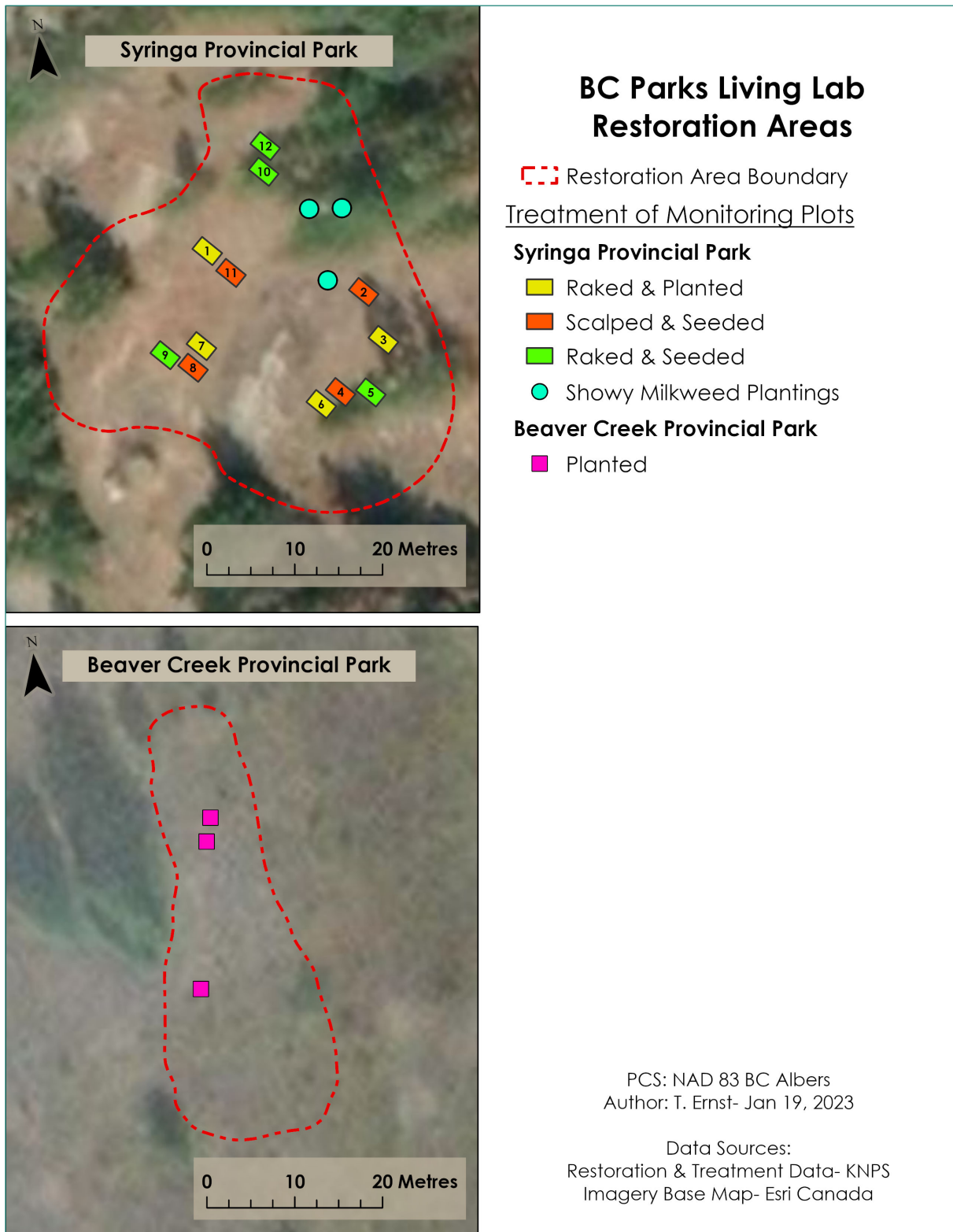


Volunteers and BC Parks staff preparing materials for sheet mulching the future planting areas at interpretive site, June 4 (B. Beckwith photo).

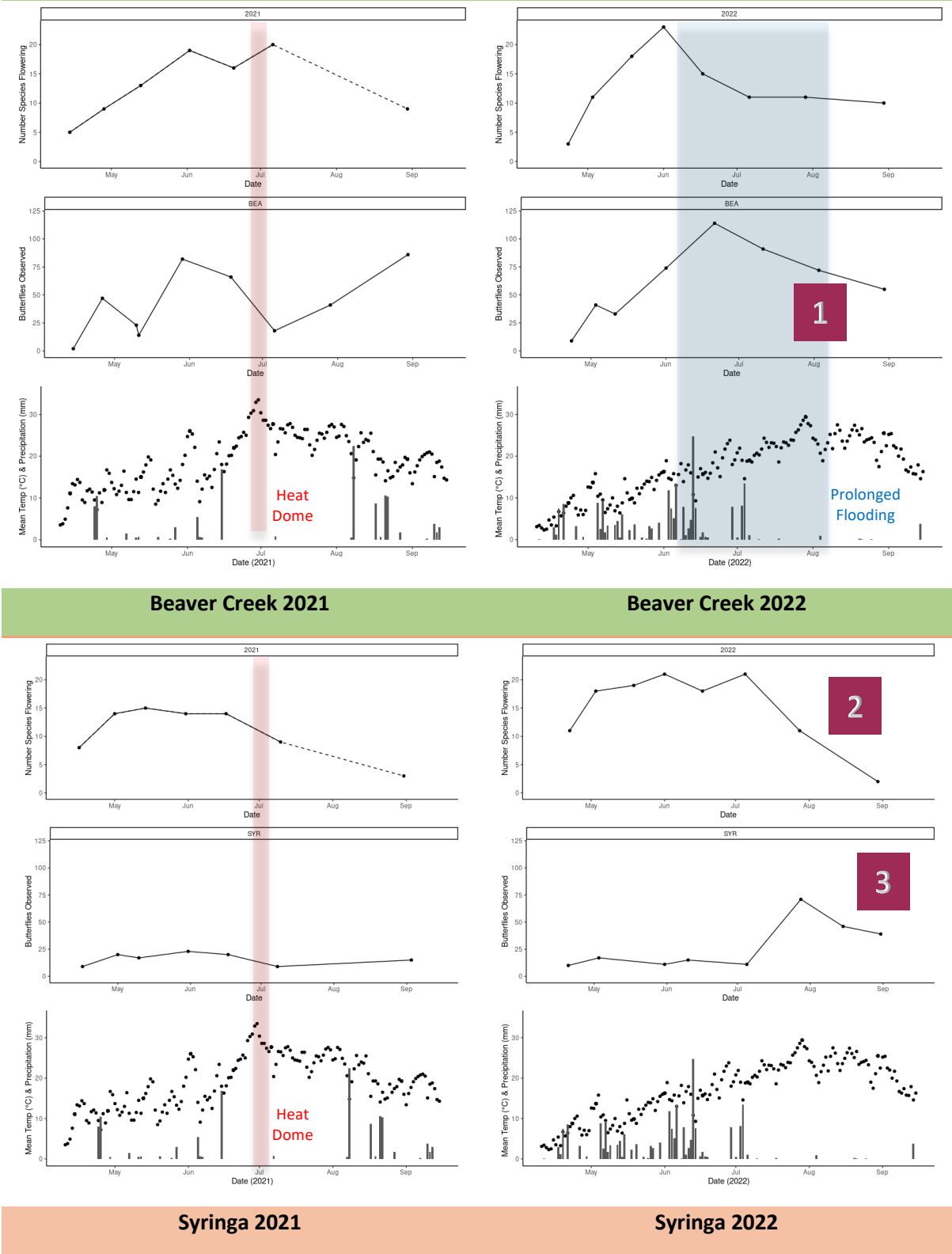


Volunteers and BC Parks staff planting interpretive site, October 22 (B. Beckwith photo).

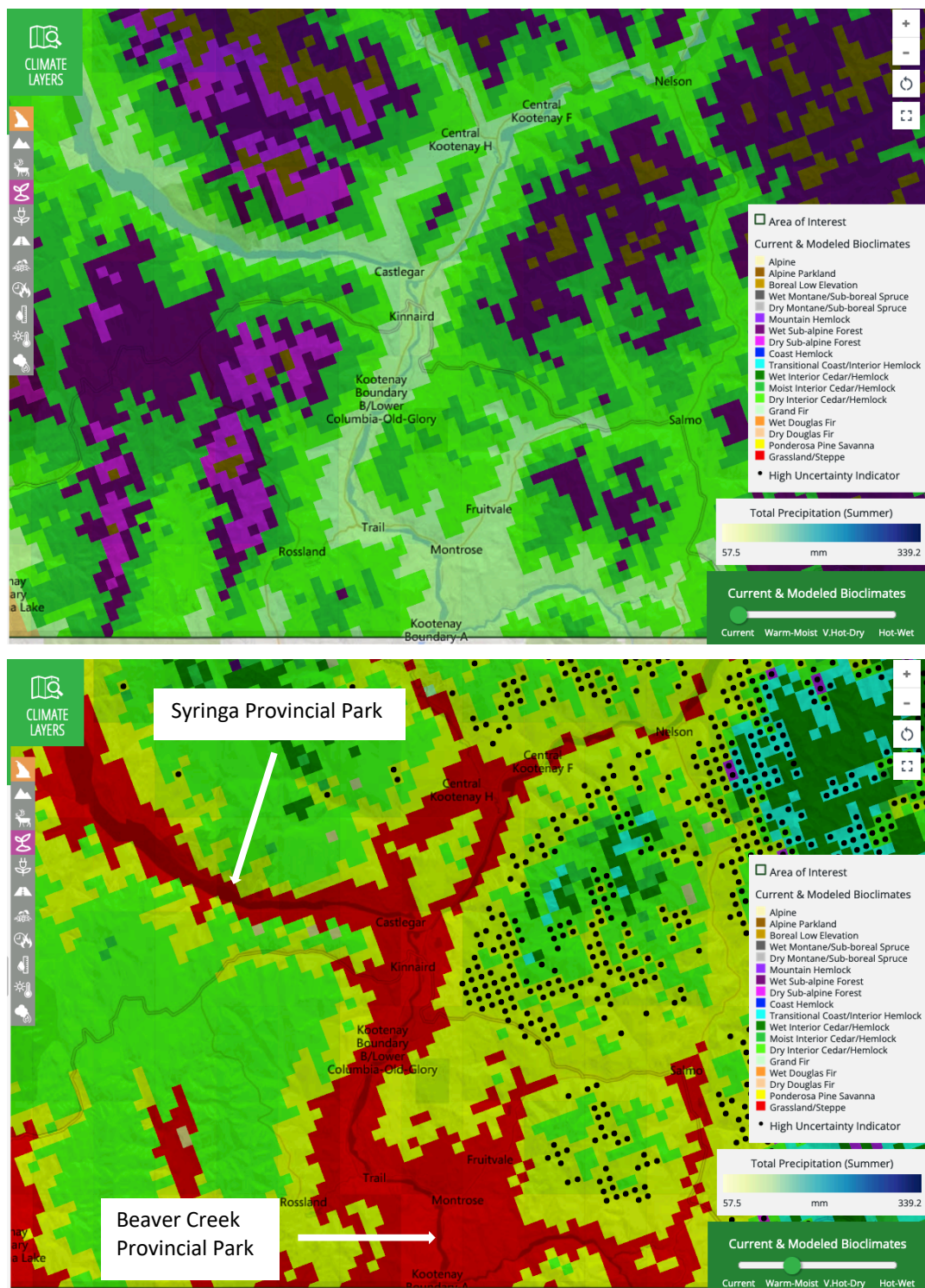
Appendix 4. Restoration areas showing monitoring plots at Syringa and Beaver Creek Provincial Parks.



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Appendix 6. Screenshots from Columbia Basin Climate Source showing changes in bioclimate with a warm-moist increase in the future (CRCSC 2021).



Appendix 7. Summary of butterfly species recorded during formal surveys, checklist observations, and incidental sightings within and outside of research and interpretive sites, 2021 and 2022 (J. Arndt Field Data). Bold = SAR.

PARK	BEAVER CREEK				SYRINGA	
No.	Common Name	2021	2022	2021	2022	Scientific Name
1	Milbert's Tortoiseshell		o			<i>Aglais milberti</i>
2	Common Roadside Skipper	o		o	o	<i>Amblyscirtes vialis</i>
3	Julia Orangetip	o	o	o		<i>Anthocharis julia</i>
4	Great-spangled Fritillary	o				<i>Argynnis cybele</i>
	Fritillary sp				o	<i>Argynnis sp</i>
5	Brown Elfin	o	o		o	<i>Callophrys augustinus</i>
6	Western Pine Elfin	o	o	o		<i>Callophrys eryphon</i>
7	Hoary Elfin	o	o			<i>Callophrys polia</i>
8	Thicket Hairstreak				o	<i>Callophrys spinetorum</i>
9	Asher Blue*		o		o	<i>Celastrina asheri</i>
10	Echo Azure	o	o	o	o	<i>Celastrina echo</i>
11	Dark Wood Nymph		o		o	<i>Cercyonis oetus</i>
12	Common Wood Nymph	o	o	o	o	<i>Cercyonis pegala</i>
13	Ochre (Common) Ringlet	o	o			<i>Coenonympha californica</i>
14	Orange Sulphur		o	o	o	<i>Colias eurytheme</i>
15	Clouded Sulphur	o	o		o	<i>Colias philodice</i>
16	Silver-spotted Skipper	o	o	o	o	<i>Epargyreus clarus</i>
17	Butler's (Common) Alpine			o		<i>Erebia epipsodea</i>
18	Dreamy Duskywing			o		<i>Erynnis icelus</i>
	Duskywing sp		o			<i>Erynnis sp</i>
19	Silvery Blue	o	o	o	o	<i>Glaucopsyche lygdamus</i>
20	Branded Skipper	o	o		o	<i>Hesperia sp</i>
21	Acmon/Lupine Blue	o				<i>Icaricia acmon/lupini</i>
22	Lorquin's Admiral	o	o	o	o	<i>Limenitis lorquini</i>
23	Pine White				o	<i>Neophasia menapia</i>
24	Mourning Cloak	o	o	o	o	<i>Nymphalis antiopa</i>
25	California Tortoiseshell	o	o	o	o	<i>Nymphalis californica</i>
26	Compton Tortoiseshell		o		o	<i>Nymphalis l-album</i>
27	Garita Skipperling	o				<i>Oarisma garita</i>
28	Woodland Skipper	o	o	o	o	<i>Ochlodes sylvanoides</i>
29	Northern Crescent	o	o	o	o	<i>Phyciodes cocyta</i>

30	Mylitta Crescent	o		o		<i>Phyciodes mylitta</i>
31	Margined White	o	o	o		<i>Pieris marginalis</i>
32	Cabbage White	o	o	o	o	<i>Pieris rapae</i>
33	Green Comma			o	o	<i>Polygonia faunus</i>
34	Hoary Comma	o	o	o	o	<i>Polygonia gracilis</i>
35	Satyr Anglewing			o		<i>Polygonia satyrus</i>
36	Western White		o			<i>Pontia occidentalis</i>
37	Pale Tiger Swallowtail	o	o	o	o	<i>Pterourus eurymedon</i>
38	Two-tailed Tiger Swallowtail		o	o	o	<i>Pterourus multicaudata</i>
39	Western Tiger Swallowtail	o	o	o	o	<i>Pterourus rutulus</i>
40	Two-banded Checkered Skipper			o		<i>Pyrgus ruralis</i>
41	Hedgerow Hairstreak	o				<i>Satyrium saepium</i>
42	Sylvan Hairstreak			o		<i>Satyrium sylvinus</i>
43	Coral Hairstreak	o				<i>Satyrium titus</i>
44	Grey Hairstreak	o	o	o	o	<i>Strymon melinus</i>
45	Edith's Copper		o			<i>Tharsalea editha</i>
46	Purplish Copper	o	o	o	o	<i>Tharsalea helloides</i>
47	Northern Cloudywing			o		<i>Thorybes pylades</i>
48	European Skipperling	o	o			<i>Thymelicus lineola</i>
Total Number of Species per Year		31	33	29	28	
Total Beaver Creek Species No.		40		38		Total Syringa Species No.

* Asher Blue was split from Echo Azure in 2022. It was likely present at both sites in 2021.

Appendix 8. Summary of butterfly nectaring observations recorded at research sites, 2021 and 2022 (J. Arndt Field Data). Plants with single nectar records have been omitted. Bold = estimates (tallies).

No.	Nectar plants - number of records from formal surveys only			Nectar plants - number of records from checklist surveys and incidental observations		
	Common Name	2021	2022	2021	2022	Scientific Name
1	spotted knapweed	31	4	8	0	<i>Centaurea stoebe</i>
2	aster	21	61	89	>50	<i>Symphotrichum</i> spp.
3	pink fairies	9	0	0	0	<i>Clarkia pilchella</i>
4	wild chives	9	6	25	0	<i>Allium schoenoprasum</i>
5	vetch	8	1	1	2	<i>Vicia</i> sp.
6	alfalfa	7	0	5	2	<i>Medicago sativa</i>
7	purple loosestrife	5	1	5	0	<i>Lythrum salicaria</i>
8	choke cherry	4	0	9	0	<i>Prunus virginiana</i>
9	fireweed	3	0	0	0	<i>Chamaenerion angustifolium</i>
10	spreading dogbane	3	11	1	30	<i>Apocynum androsaemifolium</i>
11	Scouler's woollyweed	2	0	0	0	<i>Hieracium scouleri</i>
12	dandelion	2	0	0	0	<i>Taraxacum officinale</i>
13	kinnikinnick	2	1	0	0	<i>Arctostaphylos uva-ursi</i>
14	oxeye daisy	2	3	0	0	<i>Leucanthemum vulgare</i>
15	storks-bill	1	1	1	1	<i>Erodium cicutarium</i>
16	tall Oregon grape	1	6	1	7	<i>Mahonia aquifolium</i>
17	Himalayan blackberry	0	0	0	2	<i>Rubus armeniacus</i>
18	perennial sow thistle?	0	0	0	3	<i>Sonchus arvensis</i>
19	mock-orange	0	0	1	1	<i>Philadelphus lewisii</i>
20	willowherb	0	0	2	0	<i>Epilobium</i> sp
21	sulphur cinquefoil	0	0	2	0	<i>Potentilla recta</i>
22	goldenrod	0	0	3	0	<i>Solidago</i> spp.
23	common tansy	0	0	5	0	<i>Tanacetum vulgare</i>
24	chicory	0	0	19	6	<i>Cichorium intybus</i>
25	common St John's wort	0	1	0	0	<i>Hypericum perforatum</i>
26	mustard family	0	1	1	0	Brassicaceae
27	small-flowered woodland-star	0	2	0	0	<i>Lithophragma parviflorum</i>
28	yarrow	0	2	0	1	<i>Achillea millefolium</i>
29	brown-eyed Susan	0	2	0	1	<i>Gaillardia triloba</i>
30	meadow arnica (poss.)	0	3	0	0	<i>Arnica chamissonis</i>

31	blackcap	0	3	0	0	<i>Rubus leucodermis</i>
32	snowbrush	0	7	3	8	<i>Ceanothus velutinus</i>

Appendix 9. Summary of host plant observations recorded at research sites, 2021 and 2022 (J. Arndt Field Data). 2021 data represent oviposition behaviour observed from all surveys. 2022 data represent host plant use by caterpillars. BEA = Beaver Creek; SYR = Syringa

Plant Species Common Name	Plant Species Scientific Name	2021		2022		Butterfly Species
		No.	Date/Park	No.	Date/Park	
pine	<i>Pinus</i> sp.	1	APR 16 - SYR			Western Pine Elfin
kinnikinnick	<i>Arctostaphylos uva-ursi</i>	1	APR 26 - BEA			Hoary Elfin
vetch	<i>Vicia</i> sp.	1	MAY 10 - SYR			Silvery Blue
black cottonwood	<i>Populus trichocarpa</i>	1	JUN 18 - BEA			Western Tiger Swallowtail
snowbrush	<i>Ceanothus velutinus</i>	1	JUN 18 - BEA			Pale Tiger Swallowtail
vetch	<i>Vicia</i> sp.			1	JUL 5 - SYR	Silvery Blue
willow	<i>Salix</i> sp.			35	AUG 3 - BEA	Mourning Cloak
sheep sorrel	<i>Rumex acetosella</i>	2	AUG 30 - BEA			Purplish Copper
dried vegetation				1	AUG 31 - SYR	Woodland Skipper

Appendix 10. Summary of plant species recorded during phenology surveys at research sites, 2021 and 2022 (B. Beckwith Field Data).

Park	BEAVER CREEK				SYRINGA	
No.	Common Name	2021	2022	2021	2022	Scientific Name
1	yarrow	o	o	o	o	<i>Achillea millefolium</i>
2	nodding onion	o	o	o	o	<i>Allium cernuum</i>
3	wild chives	o	o			<i>Allium schoenoprasum</i>
4	desert alyssum		o			<i>Alyssum desertorum</i>
5	saskatoon	o	o	o	o	<i>Amelanchier alnifolia</i>
6	Howell's pussytoes				o	<i>Antennaria howellii</i>
7	umber pussytoes			o	o	<i>Antennaria umbrinella</i>
8	spreading dogbane	o	o	o	o	<i>Apocynum androsaemifolium</i>
9	mouse-ear	o	o	o	o	<i>Arabidopsis thaliana</i>
10	kinnikinnick	o	o	o	o	<i>Arctostaphylos uva-ursi</i>
11	thyme-leaved sandwort	o	o		o	<i>Arenaria serpyllifolia</i>
12	meadow arnica	o				<i>Arnica chamissonis</i>
13	Columbia River mugwort	o	o			<i>Artemisia lindleyana</i>
14	asparagus	o	o	o	o	<i>Asparagus officinalis</i>
15	balsamroot			o	o	<i>Balsamorhiza sagittata</i>
16	hoary alyssum	o	o			<i>Berteroa incana</i>
17	dangling suncrest			o		<i>Boechera retrofracta</i>
18	common camas	o	o			<i>Camassia quamash</i>
19	common harebell	o	o	o	o	<i>Campanula rotundiflora</i>
20	harsh paintbrush			o	o	<i>Castilleja hispida</i>
21	red-stemmed ceanothus			o	o	<i>Ceanothus sanguineus</i>
22	snowbrush	o	o			<i>Ceanothus velutinus</i>
23	spotted knapweed	o	o	o	o	<i>Centaurea stoebe</i>
24	common chickweed		o			<i>Cerastium fontanum</i>
25	sticky chickweed		o			<i>Cerastium glomeratum</i>
26	redstem springbeauty			o	o	<i>Claytonia rubra</i>
27	small-flowered blue-eyed Mary			o	o	<i>Collinsia parviflora</i>
28	horseweed	o	o			<i>Conyza canadensis</i>
29	golden tickseed	o	o			<i>Coreopsis tinctoria</i>
30	black hawthorn	o	o			<i>Crataegus douglasii</i>
31	slender hawksbeard			o	o	<i>Crepis atriobarba</i>
32	upland larkspur			o	o	<i>Delphinium nuttallianum</i>
33	few-flowered shootingstar			o		<i>Dodecatheon pulchellum</i>
34	draba	o	o	o	o	<i>Draba verna</i>
35	foliose willowherb			o	o	<i>Epilobium foliosum</i>
36	stork's-bill	o	o	o	o	<i>Erodium cicutarium</i>

37	yellow glacier lily	o	o	o	o	<i>Erythronium grandiflorum</i>
38	showy aster			o	o	<i>Eurybia conspicua</i>
39	wild strawberry				o	<i>Fragaria virginiana</i>
40	brown-eyed Susan	o		o	o	<i>Gaillardia aristata</i>
41	small bedstraw		o			<i>Galium trifidum</i>
42	large-leaved avens		o			<i>Geum macrophyllum</i>
43	roundleaf alumroot			o	o	<i>Heuchera cylindrica</i>
44	Scouler's woollyweed			o	o	<i>Hieracium scouleri</i>
45	umbellate hawkweed	o	o			<i>Hieracium umbellatum</i>
46	oceanspray			o	o	<i>Holodiscus discolor</i>
47	common St. John's wort	o	o	o	o	<i>Hypericum perforatum</i>
48	yellow iris				o	<i>Iris pseudacorus</i>
49	field pepper-grass		o			<i>Lepidium campestre</i>
50	oxeye daisy	o	o			<i>Leucanthemum vulgare</i>
51	Columbia lily	o	o			<i>Lilium columbianum</i>
52	Dalmatian toadflax	o	o			<i>Linaria genistifolia</i>
53	small-flowered woodland star			o	o	<i>Lithophragma parviflorum</i>
54	field filago			o	o	<i>Logfia arvensis</i>
55	Geyer's desert-parsley				o	<i>Lomatium geyeri</i>
56	fern-leafed desert-parsley			o	o	<i>Lomatium multifidum</i>
57	Spanish clover/bird's-foot trefoil	o	o			<i>Lotus unifoliolatus</i>
58	European horehound	o	o			<i>Lycopus europaeus</i>
59	fringed loosestrife	o	o			<i>Lysimachia ciliata</i>
60	purple loosestrife	o	o			<i>Lythrum salicaria</i>
61	little tarweed				o	<i>Madia exigua</i>
62	tall Oregon-grape	o	o	o	o	<i>Mahonia aquifolium</i>
63	false Solomon's seal		o			<i>Maianthemum racemosum</i>
64	star-flowered Solomon's-seal	o	o			<i>Maianthemum stellatum</i>
65	cultivated apple	o	o			<i>Malus pumila</i>
66	black medic		o	o	o	<i>Medicago lupulina</i>
67	alfalfa	o				<i>Medicago sativa</i>
68	field mint	o	o			<i>Mentha arvensis</i>
69	meadow saxifrage				o	<i>Micranthes nidifica</i>
70	small-flowered forget-me-not	o	o	o	o	<i>Myosotis laxa</i>
71	evening primrose	o	o			<i>Oenothera sp.</i>
72	falsebox	o	o	o	o	<i>Paxistima myrsinites</i>
73	mock-orange	o	o	o	o	<i>Philadelphus lewisii</i>
74	ribwort plantain	o	o	o	o	<i>Plantago lanceolata</i>
75	English plantain	o	o			<i>Plantago major</i>
76	woolly plantain			o	o	<i>Plantago patagonica</i>
77	Douglas' knotweed			o	o	<i>Polygonum douglasii</i>
78	sulphur cinquefoil	o	o	o	o	<i>Potentilla recta</i>
79	self-heal	o	o			<i>Prunella vulgaris</i>

80	pin cherry		o	o	o	<i>Prunus pensylvanica</i>
81	choke cherry	o	o	o	o	<i>Prunus virginiana</i>
82	meadow buttercup		o			<i>Ranunculus acris</i>
83	creeping buttercup		o			<i>Ranunculus repens</i>
84	casara	o	o			<i>Rhamnus purshiana</i>
85	prickly rose			o	o	<i>Rosa acicularis</i>
86	Nootka rose	o	o			<i>Rosa nutkana (hybrid)</i>
87	Wood's rose	o	o			<i>Rosa woodsii</i>
88	blackcap			o	o	<i>Rubus leucodermis</i>
89	common sorrel	o	o			<i>Rumex acetosa</i>
90	sheep sorrel	o	o	o	o	<i>Rumex acetosella</i>
91	annual knawel		o		o	<i>Scleranthus annuus</i>
92	stonecrop			o	o	<i>Sedum sp.</i>
93	sleepy catchfly				o	<i>Silene antirrhina</i>
94	Menzie's campion	o	o	o	o	<i>Silene menziesii</i>
95	tall tumble-mustard				o	<i>Sisymbrium altissimum</i>
96	Western Canada goldenrod	o	o			<i>Solidago lepida</i>
97	spikeline goldenrod			o	o	<i>Solidago simplex</i>
98	mountain ash	o	o			<i>Sorbus sp.</i>
99	white meadowsweet			o	o	<i>Spiraea lucida</i>
100	snowberry	o	o	o	o	<i>Symphoricarpos albus</i>
101	rush aster	o	o			<i>Symphyotrichum boreale</i>
102	smooth aster	o	o	o	o	<i>Symphyotrichum laeve</i>
103	Douglas aster	o	o			<i>Symphyotrichum subspicatum</i>
104	common tansy	o	o			<i>Tanacetum vulgare</i>
105	dandelion	o	o	o	o	<i>Taraxacum officinale</i>
106	poison ivy	o	o	o	o	<i>Toxicodendron rydbergii</i>
107	yellow salsify	o	o	o	o	<i>Tragopogon dubius</i>
108	hare's-foot clover	o	o	o	o	<i>Trifolium arvense</i>
109	red clover	o	o			<i>Trifolium pratense</i>
110	white clover		o			<i>Trifolium repens</i>
111	large-flowered triteleia	o	o	o	o	<i>Triteleia grandiflora</i>
112	great mullein	o	o			<i>Verbascum thapsus</i>
113	wall speedwell	o	o	o	o	<i>Veronica arvensis</i>
114	American vetch		o			<i>Vicia americana</i>
115	woolly vetch	o	o	o	o	<i>Vicia villosa</i>
116	meadow death-camas			o	o	<i>Zygadenus venenosus</i>
Total Number of Species per Year		67	79	60	68	
Total Beaver Creek Species No.		81		71		Total Syringa Species No.

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