Habitat Restoration Planning for the "Vancouver Island" Ringlet (*Coenonympha tullia insulana*) at Rithet's Bog, Saanich B.C.

Photo credit: R.Boxem, 2018

Report prepared by Sonia Voicescu
(V#00023617)
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1. EXECUTIVE SUMMARY

Rithet's Bog is an area rich in ecological diversity. It is the last remaining peat bog within the Saanich Peninsula, and as such hosts an array of rare species, of wildlife and plants alike (Golinski 1995, 1997, Green 2006). The region has undergone tremendous change within the last century, and pressures from intensive agricultural use followed by rapid urbanization have impacted the health and structure of the bog ecosystem. From the moment it became a park in 1994, restoration efforts have been directed at preserving the sensitive wetland habitat required by many different species.

One of these species is the "Vancouver Island" Ringlet (*Coenonympha tullia insulana*), a butterfly that is considered as critically imperiled (red listed) across British Columbia (B.C. Conservation Data Centre, 2013). Although the Rithet population numbers have been stable over the last few years compared to others in the Victoria area (Miskelly, 2007, Hartwell, 2010), their main habitat patch is currently being threatened by Reed Canary Grass (*Phalaris arundinacea)* and other invasive species. As such, there is a need for a habitat restoration plan to be implemented, followed by a monitoring regime in order to assess the effectiveness of the restoration activities.

The following report describes the different steps and methods taken in order to plan for habitat restoration for this species. Methods included a systematic butterfly survey conducted every two weeks from April to September 2018, Terrestrial Ecosystem Mapping (TEM) of the main habitat area along with the proposed restoration site, and photo-point monitoring in order to assess seasonal changes in vegetation and water levels. Over the course of the survey period, 43km of trail were surveyed, spanning over 1000 minutes of observation time. A total of 249 butterflies were observed, from nine different species. Out of those, 83 were "Vancouver Island" Ringlets. Photo-point monitoring emphasized the dry conditions over the summer period, and the need to have a more permanent water source, while TEM highlighted some of main herbaceous plants and grasses which currently thrive within the butterfly habitat area. Proposed restoration activities for this site include the construction of a butterfly nectar garden, composed of mix of larval host plants and adult nectar species, as well as educational activities and interpretive signage in order to inform the public about this unique habitat.

2. HISTORICAL AND ECOLOGICAL OVERVIEW OF RITHET'S BOG

Rithet's Bog is a public conservation area, owned and managed by the District of Saanich, B.C.(Fig.1). It is the last remaining peat bog within the Saanich Peninsula, and has officially been classified as a coniferous treed basin bog (Golinski 1995, 1997). Bogs are known for their nutrient poor *Sphagnum* dominated ecosystems and their acidic soils, and they tend to thrive in regions with cool summers and low elevation terrain (MacKenzie and Moran, 2004). Basin bogs in coastal regions tend to be smaller than in continental areas, with peat accumulating above the water table (Golinski 1995, MacKenzie and Moran, 2004). As the historical land use and human legacy at Rithet's Bog have deeply modified nutrient regimes and succession patterns, the bog ecosystem has undergone many changes which have impacted how vegetation communities and wildlife interact with their environment today.

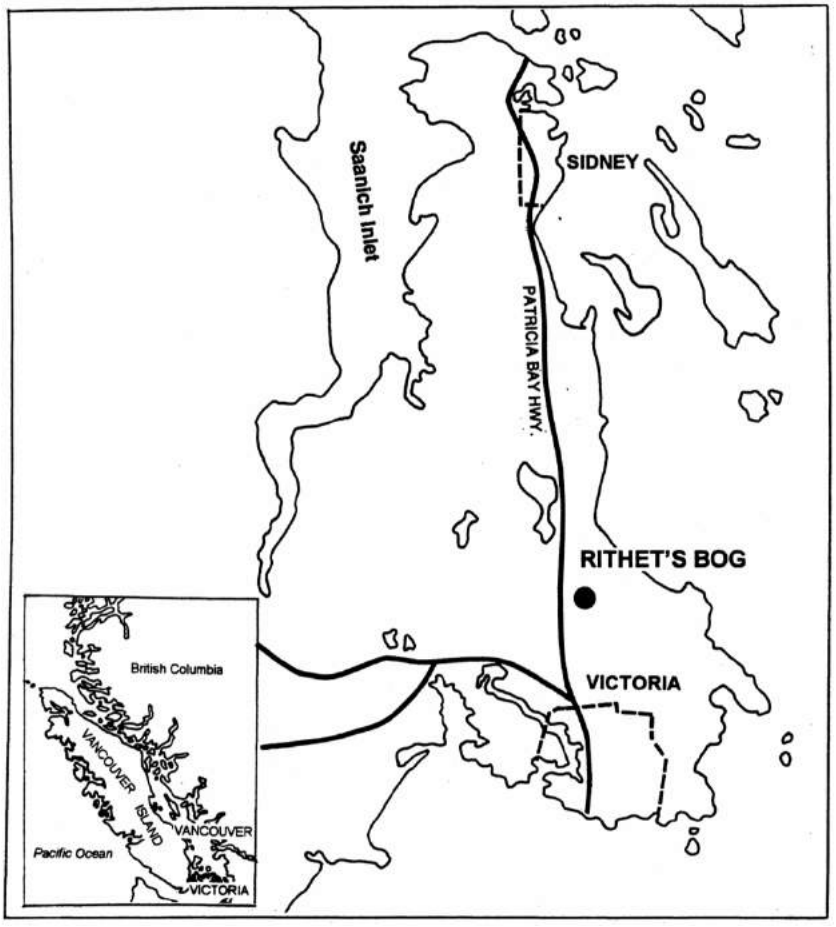

Fig.1 Rithet's bog location within the Saanich Peninsula, on Southern Vancouver Island. Source: Golinski, 1997.

Back in the late 1800's, when Victoria had just begun to develop as a city, the land which today forms the conservation area was still very much forested and was an extension of Mount Douglas forest to the east (Green, 2006). By the turn of the 19th century, a Victoria businessman known as Robert Patterson Rithet, for whom the bog is named after, purchased the land and converted it into a farm. The production at the farm was focused on grain and poultry, as well as horse-rearing, which was Rithet's true passion (Green, 2006). The site was used as farming grounds for many years, and evidence of the intensive agricultural use of the area can be still be seen in early to mid 20th century aerial photographs (Appendix

A). Eventually, the land was purchased by the Guinness family from Ireland, who continued to oversee its farming operations until 1994, when 42 hectares were donated to Saanich in order to create a park and protect sensitive wetland habitat (Golinski, 1995, HAT, 2007). The park was zoned as a nature sanctuary and the Rithet's Bog Conservation Society (RBCS) was established, in order to provide advice to the municipality on the ecology and ecosystem functions of the protected area, especially with regards to the well-being of the bog habitat. RBCS's mission is also to develop educational material and coordinate community volunteering efforts to restore some of the park's native vegetation and help to maintain its rich ecosystem and rare species (RBCS, 2014).

Due to its strong agricultural heritage and rapidly expanding urbanization of the area, the RBCS and Saanich Parks were faced with numerous challenges following the creation of the park. Water levels throughout the bog were fluctuating, with an overall decreasing trend, which favored the expansion of shore pines (*Pinus contorta*) in the central forest, to the detriment of the remaining *Sphagnum* moss patch (Hartwell, 2006). Other shrubs and water loving trees such as willows (*Salix spp.)* also began to gradually take over and further impact declining water levels (Hartwell, 2001). The increasing presence of weeds and invasive species also became a concern, as well as increasing levels of contaminants flowing into the park due to storm water inflow from nearby residential areas. To address these issues, Saanich Parks and RBCS partnered with Ducks Unlimited, the Department of Fisheries and Ocean and the Habitat Trust Fund in 2002, and the results of this partnership allowed for a weir to be put in place to control fluctuating water levels and for areas dominated by willows to be cleared (Faulkner, 2002, Miskelly, 2007). Although the initial goals of the restoration work were achieved by creating areas of open water, controlling water flows and allowing the vegetated riparian areas around the perimeter ditch to filter incoming storm water, other issues soon began to gather momentum (Hartwell, 2006). Namely, the presence and expansion of large areas of hybrid Cattail species (*Typha x glauca*) in the recently cleared open areas, and the expansion of Reed Canary Grass (*Phalaris arundinacea*) around the perimeter trail area (R.Pym, pers.comm, 2017). These new problems highlight the importance of adaptive management strategies and ongoing monitoring at the bog in order to continue supporting sensitive ecological communities. Some examples of these rare communities for which there is ongoing monitoring include the Purple Sanicle (*Sanicula bipinatafida*), "Vancouver Island" Beggarticks (*Bidens amplissima*), Foothill Sedge (*Carex tumulicola*) and the "Vancouver Island" Ringlet (*Coenonympha tullia insulana*), which is the focus of this report.

3. "VANCOUVER ISLAND" RINGLET SPECIES DESCRIPTION

At the end of the 19th century, Victoria-based naturalist George Taylor remarked on the abundance of butterfly species in the area: "*The extreme abundance of butterflies cannot fail to strike an observer. Nearly 40 species may be marked abundant. A patch of blossom in May, covered in blues and fritillaries with an occasional sulphur and two or three magnificent species of swallowtail, is a sight such as the British naturalist, at least, never sees at home. Later in the year, the hundreds of skippers, coppers, admirals, and ladies make a different, but no less beautiful, picture*." (Page et al., 2010, Nightingale and Copley, 2012). The mild climate and diversity of host and nectar plants on Southern Vancouver Island did indeed support up to 61 different butterfly species at one point in time (Nightingale and Copley, 2012). Unfortunately, pressures from urban development, increasing temperatures and invasive species have led to a decrease in suitable habitat for many of these species, which are becoming increasingly harder to find on the Island nowadays (Judith, 1999). The same trend unfortunately applies to our local Ringlet, which was known as the most abundant butterfly species in the Greater Victoria area in the 1950s, but which faced a 30% drop in its population by early 2000 (Judith, 1999, Guppy and Shepard, 2001). Now it is considered critically imperilled with known populations in less than 10 locations throughout southern Vancouver Island (B.C. Conservation Data Centre, 2013). The species was also observed to have a very narrow environmental specificity, due to its strong association and food preferences within rare Garry Oak ecosystems (B.C. Conservation Data Centre, 2013). This specificity further restricts the availability of suitable habitat and increases the vulnerability of the species to external factors such as the ones mentioned above.

3.1. DISTRIBUTION AND HABITAT REQUIREMENTS

The "Vancouver Island" Ringlet is part of the subfamily *Satyrinae* and the genus *Coenonympha,* for which it is estimated that there are around 22 species worldwide (Guppy and Shepard, 2001). The etymology of both subfamily and genus names have a Greek origin, with the former being attributed to the playful Greek god "Satyr", part man part goat, in reference to the bounciness of the butterfly's flight pattern, and the latter is associated with the gracefulness and fluidity of nymphs, those mythical maidens patrons of dance and music (Guppy and Shepard, 2001). The common name "Ringlet" associated with the *Coenonympha* genus refers to the eye-like spots or little rings on the wings of most species. Our *insulana* Ringlet is one of five subspecies of the *tullia/california* species (taxonomists are still in

disagreement over this and therefore these two species names are used interchangeably) which can be found in southwestern California, all the way to northern B.C. and Alberta (Guppy and Shepard, 2017, Fig.2A). In Canada, subspecies *insulana* is restricted to Vancouver Island (Miskelly, 2003, Fig. 2B). Originally, the "Vancouver Island" Ringlet was mostly found within the Saanich Peninsula, however its range has moved northward on the Island as field and meadows opened up and habitat and climate became more suitable to its needs (Baron et al., 1999).

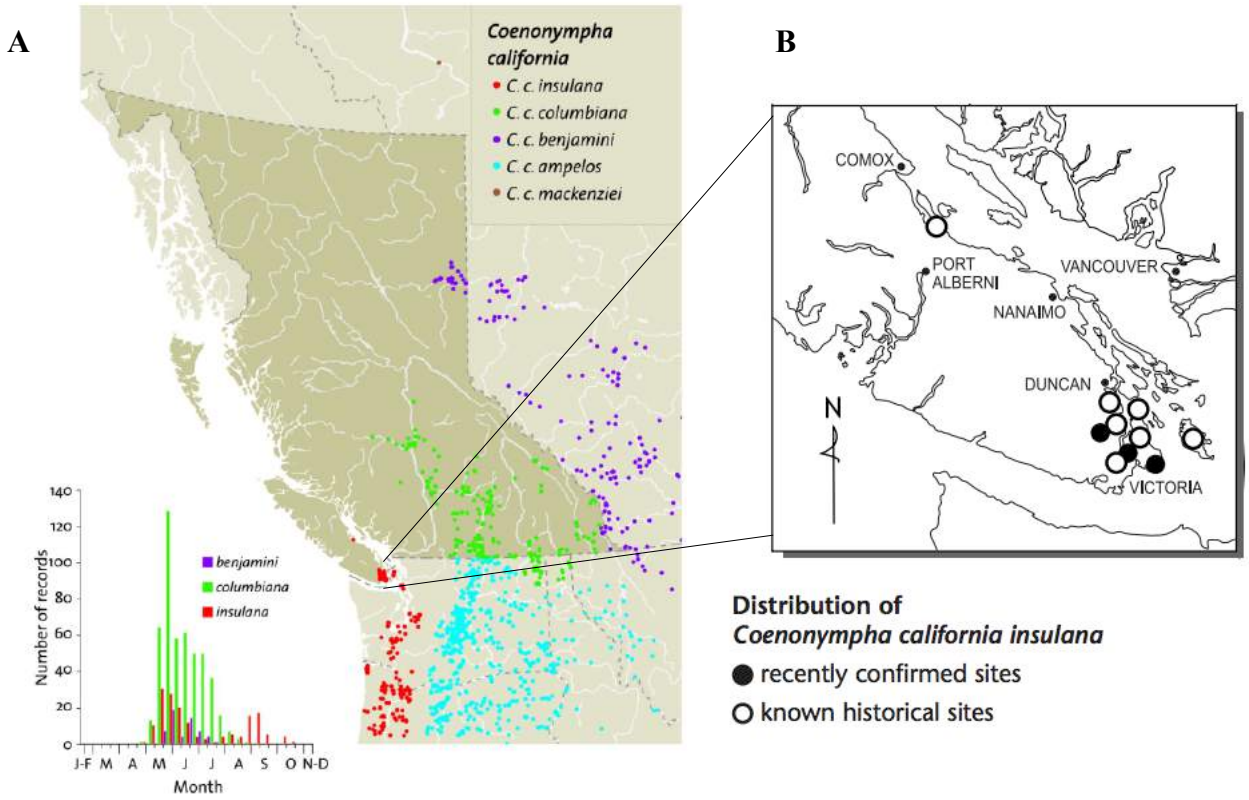

Fig.2 A) Distribution of the five subspecies of *Coenonympha tullia/california* in western North America. Red dots represent i*nsulana* subspecies. **B)** Distribution of *Coenonympha tullia/california insulana* on Vancouver Island. Black dots represent confirmed populations sites and white dots are historical populations sites. Sources: Guppy and Shepard, 2017, Miskelly, 2003.

With regards to habitat requirements, the *insulana* subspecies, as well as most of the species in its genus, requires open grassy fields and damp meadows in order to survive (Tilden and Smith, 1986, Guppy and Shepard, 2001, Lilley et al. 2009). Ringlet larvae need short native grasses which stay green throughout the summer in order to develop, while adults require a variety of meadow flowers that are in bloom most of the summer or have complementing blooming periods, in order to support both broods of the subspecies (Miskelly, 2003). There are still many

unknowns and areas of research left to be explored for this particular species, especially regarding confirmed plant hosts and nectar food plants for adults, which can be challenging for the establishment of habitat restoration activities.

3.2 BIOLOGY

The "Vancouver Island" Ringlet is an orange-brown to tan coloured butterfly, with females generally being a lighter shade than males (Fig. 3). Subspecies *insulana* is one of the rare subspecies that does not exhibit the characteristic ring for which its name is derived (Guppy and Shepard, 2001).

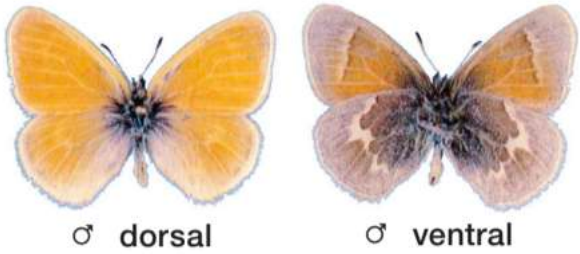

Fig.3. Dorsal and ventral views of a male Ringlet, *insulana* subspecies. Source: GOERT, 2018.

Although most Ringlets of the *tullia* species have only one brood throughout the summer, the Vancouver Island subspecies has two broods: one which emerges in May and dies-off in early July, and the second one which flies from August until early October (Guppy and Shepard, 2001). Adults from the first brood will lay their eggs in May, with some eggs maturing rapidly into larvae which form the second brood of adults in August. Other eggs from that first brood will mature more slowly, hibernate over the winter as larvae and emerge as first brood adults the next spring (Miskelly, 2003). The eggs from the second brood all develop into larvae which hibernate over the winter and become second brood butterflies the next fall.

"Vancouver Island" Ringlet eggs are barrel-shaped, white to green yellow in colour with 34 vertical line markings (Guppy and Shepard, 2017, Fig.4A). Caterpillar larvae are pale yellow to grass green (which adds complexity to spotting them in their natural environments), with two conical tails and a mid-dorsal reddish line, along with three more similar lines on the sides of its body (Miskelly, 2003, Guppy and Shepard, 2017, Fig. 4B). Ringlet pupae are grass green, broad, short and smooth in texture, with dark lines appearing on the wing cases and the underside of the last abdominal segment (Guppy and Shepard, 2017, Fig. 4C).

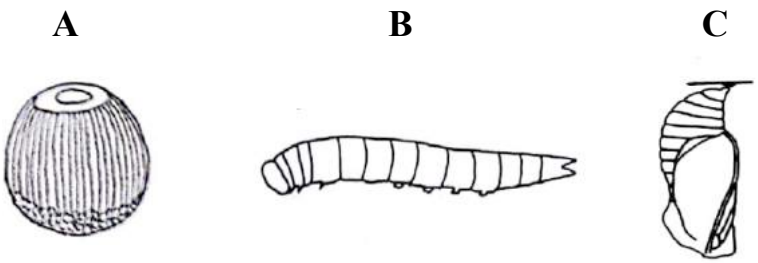

Fig. 4. Immature stages of *Coenonympha tullia insulana*: **A)** Egg. B) Larvae. C) Pupae. Source: Scott, 1986

Until 2009, actual identification of Ringlet (*insulana* subspecies) eggs and larvae had not been documented anywhere on Vancouver Island. However that summer, biologists Darren Copley and James Miskelly were observing female Ringlets at Rithet's Bog when they spotted a female laying eggs on Red Fescue (*Festuca rubra*) grass (Hartwell, 2010). Eggs were given to local entomologist Jeremy Tatum, who subsequently raised the larvae and documented the metamorphosis process. His pictures can be seen in Fig. 5 below.

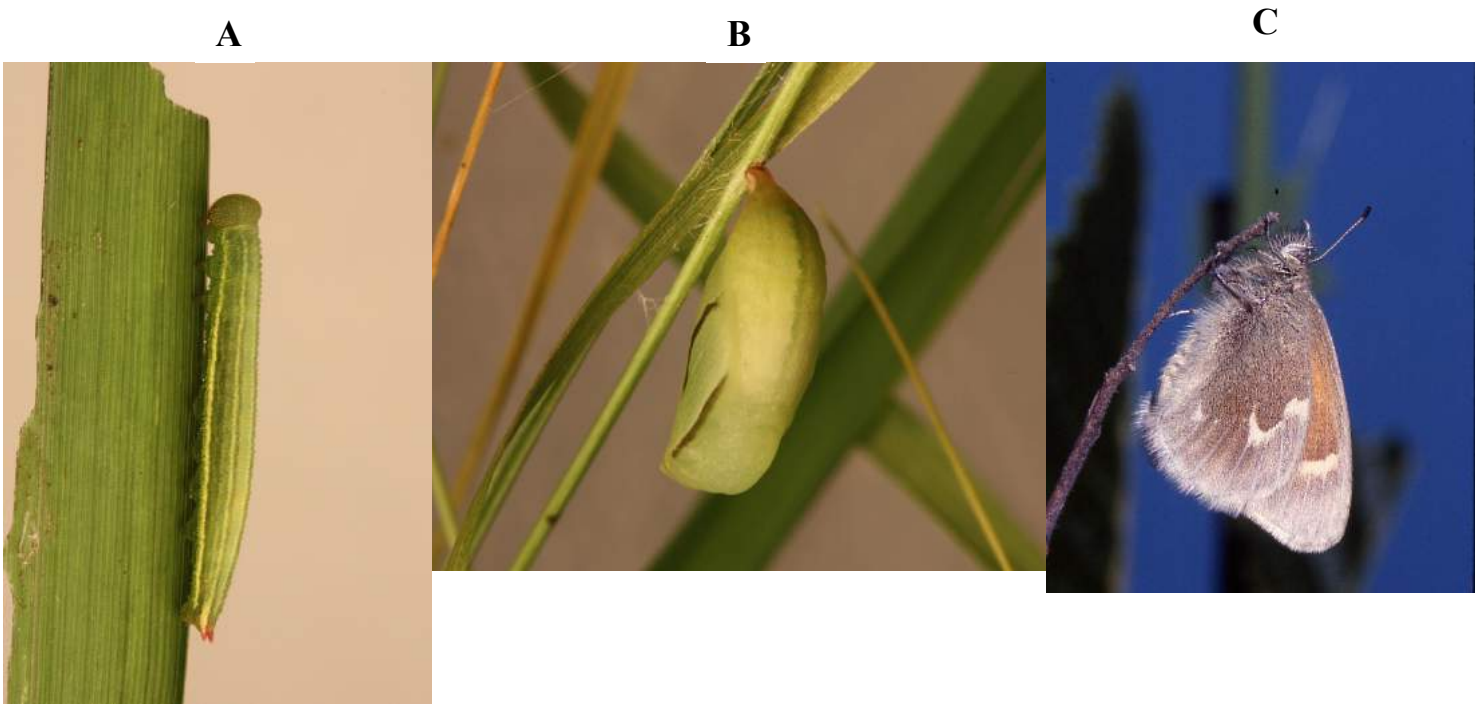

Fig.5. Metamorphosis process of "Vancouver Island" Ringlet, from Rithet Bog egg specimen**. A)** Larvae hatched on June 7th 2009**. B)** Pupae pupated on July 15th 2009. **C)** Adult butterfly emerged on July 25th 2009. Pictures and information from J. Tatum, pers. comm, 2018.

3.3 STATUS AT RITHET'S BOG

Systematic butterfly surveying at Rithet's Bog has been ongoing every summer month since 2001, until most recently 2013 (Miskelly, 2007, J.Miskelly, pers.comm., 2017). Although butterfly counts of the area continue to be added to the Victoria Natural History Society's monthly butterfly counts, numbers from the bog are added to those of other areas such as Elk/Beaver Lake and other parks in Cordova Bay (G.Hart, pers.comm, 2017), which makes it

harder to monitor ongoing population trends specific to Rithet's Bog. Prior to 2001, several research projects and monitoring reports have investigated butterfly diversity at the bog. Specifically, Karen Golinski's 1995 and 1997 reports highlighted the presence of 19 different species of butterflies, while the RBCS's website mentions that 25 different species were observed between 1992 and 2005 (Golinski, 1995, 1997, RBCS, 2014).

With regards to Ringlets (*insulana* subspecies), records show that the population was more or less stable at the bog, based on 2007 and 2010 monitoring reports (Miskelly 2007, Hartwell, 2010). Although there is a marked decline in numbers over the last two decades, this coincides with declines all over the Greater Victoria region and is not specific to Rithet's Bog (Miskelly, 2007). Fig. 6 below presents the overall trend of this population at the bog, obtained from records of the B.C. Conservation Data Centre and Miskelly and Hartwell's reports. Fig. 7 shows population numbers for the entire Victoria Area, as reported by the Victoria Natural History Society.

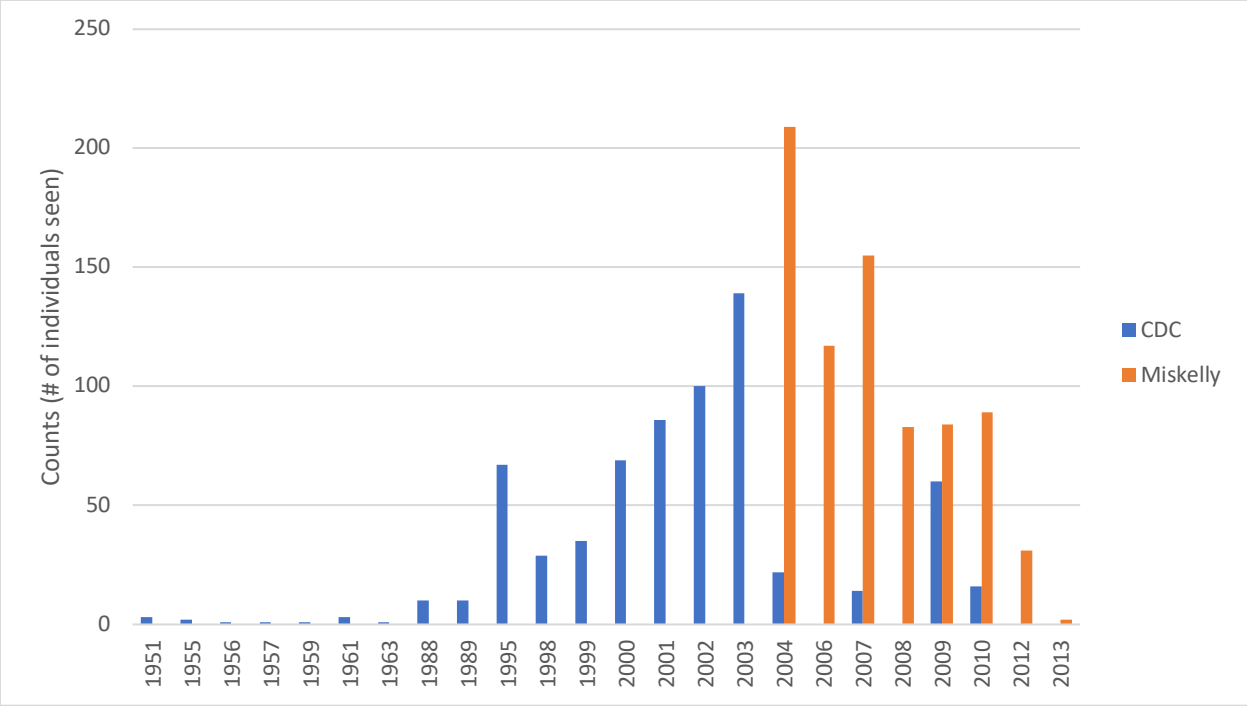

Fig.6. Recorded observations of "Vancouver Island" Ringlets at Rithet's Bog, 1951 to 2013. Source: CDC, 2018 and Miskelly, 2017, pers. comm.

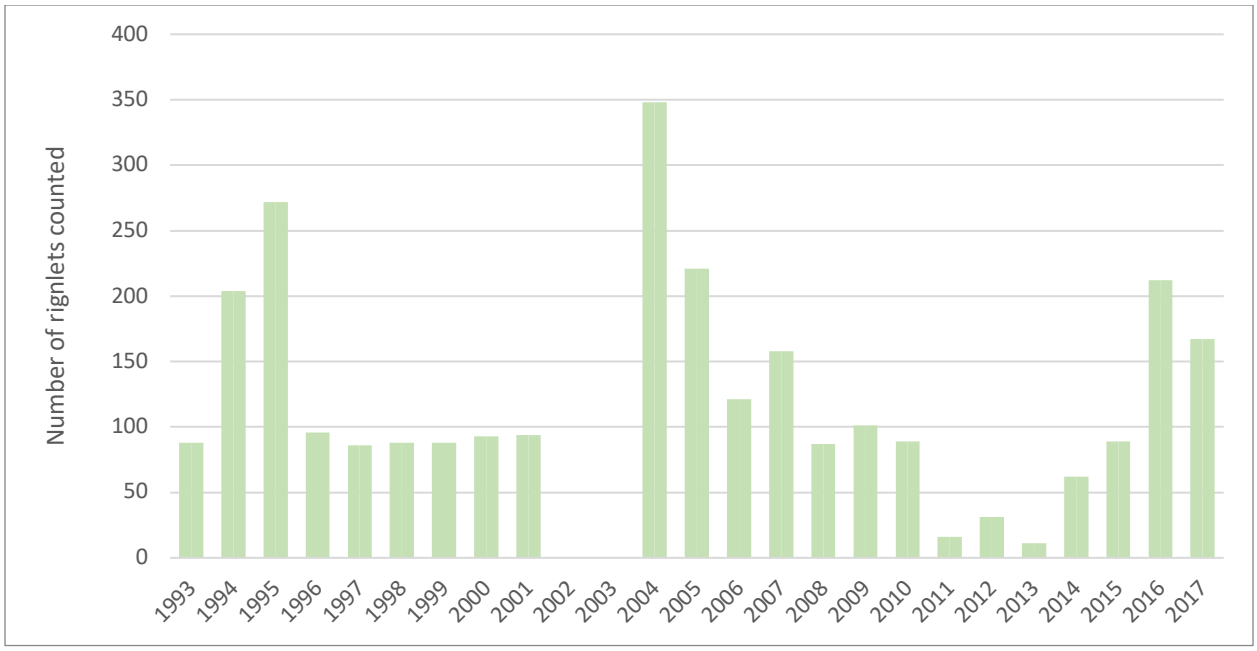

Fig.7. "Vancouver Island" Ringlets observations, Victoria & Greater Victoria, April to September 1993-2017. Source: Victoria Natural History Society, 1993 to 2017 archives.

According to past surveys, Ringlets can be found at the bog in all grassy open areas and meadows which are not dominated by Reed Canary Grass (Miskelly, 2007). Their highest density however is in the wet meadow area at the south end of bog, with some individuals observed in Garry Oak outcrops and open areas adjacent to the wet meadow or near the entrance kiosk at the intersection of Dalewood and Chatterton (Miskelly, 2007, Hartwell, 2010, R.Pym, pers.comm

Fig.8. The different wetland zones at Rithet's Bog. Highest Ringlet abundance is in the wet meadow (zone 6) with some individuals observed zones 11, 7 and 8. Source: Golinski, 1995

Currently the wet meadow site is slowly being encroached by Reed Canary Grass, and there have been discussions between RBCS and Saanich Parks in order to manage the invasive. However, as Reed Canary Grass remains green throughout the summer and there is no known confirmed host plant for the *insulana* subspecies of Ringlets, Saanich has decided to adopt the precautionary principle for now and not remove the Reed Canary Grass from the periphery of the meadow (R.Pym, pers.comm, 2017). This may change of course if the growth of the plant suddenly becomes more aggressive, or if there are major declines to the population of Ringlets. As this type of butterfly is non-migratory and its life cycle spans over the entire summer period, which is quite long for a butterfly, it becomes very vulnerable to any type of environmental stress which could disrupt its habitat (Baron et al., 1999, Miskelly, 2007, B.C. Conservation Data Centre, 2013). These factors yet again highlight the importance of habitat management and conservation for this species.

4. PROJECT SCOPE AND OBJECTIVES

The scope of this project is twofold: firstly, to assess the current population of "Vancouver Island" Ringlets at Rithet's Bog and secondly, to plan the habitat restoration for this species, with effective recommendations and monitoring activities in order to encourage long-term population growth and stability at the bog. Specifically, I aim to:

1- Survey the site with the highest density of individuals (wet meadow) and identify ideal habitat features for the Ringlet (*insulana* subspecies)
2- Survey Ringlet specimens throughout the summer (April-September 2018) and identify any emerging issues and potential visible threats to the population
3- Establish a long-term data record for the species at Rithet's Bog, based on local and provincially collected data
4- Propose habitat restoration activities which would include a transition from current invasive species such as Reed Canary Grass to native grasses and vegetation
5-Design a butterfly nectar garden containing a diversity of native host and nectar plants
6- Raise awareness of issues surrounding threats to Ringlet habitat by promoting public participation and community involvement with the RBCS

5. METHODS

5.1. BUTTERFLY SURVEYING

Assessing the abundance and distribution of a species is an essential step towards its management and conservation. Butterflies in particular, due to their sensitivity towards environmental and landscape change, can act as good indictors of the biodiversity of a region (van Swaay et al., 2008, Pellet et al., 2012). Throughout the years, many different countries have adopted butterfly monitoring as part of annual conservation efforts (van Swaay et al., 2008). Although monitoring techniques may vary between different countries, most have adopted the fixed width transect-count survey methods of the United Kingdom Butterfly Monitoring Scheme (UKBMS) (UKBMS, 2006, Nowicki et al., 2008, van Swaay et al., 2008, Pellet et al., 2012). This method, also known as a "Pollard Walk", was developed in the 1970s by Ernie Pollard and his colleagues at the Institute of Terrestrial Ecology in Monks Wood National Nature Reserve (Pollard, 1977, Botham, 2016). It was devised as a simple, quick and easy to use method that would provide reliable estimates of population size for all butterfly species within an area (Pollard and Yates, 1993). The scheme mostly involves doing transect counts, however it standardizes transect sections according to habitat type and the weather conditions under which surveying occurs. The main requirements for this methodology are as follows (from Pollard, 1977, Pollard and Yates, 1993, UKBMS, 2006):

1-Counts should be recorded during prime butterfly flight season, which is from April to September

2-There should be at least one count per week

3- Best times to count is during the middle of the day, from 10h45 to 15h45

4- As butterfly flight is dependent on temperature, best results are achieved when temperature is above 17°C. Counts can be recorded between 13°C. and 17°C, as long as there is at least 60% sun coverage

5- High winds will also affect butterfly flight, so it is recommended not to record if wind speed is over force 5 on the Beaufort scale (i.e. 29-38km/h)

6- The optimal length of a transect route is 3km. Routes should be divided according to a variety of habitat types, but should not exceed a maximum of 15 sections

7- Maximum width of a transection section should be 5m (2.5m on each side of the recorder)
8- All butterflies seen within the bounds of the route within an estimated maximum distance of 5m ahead of the recorder are counted
9- Butterflies flying high above the recorder are not recorded
10- All walking should be done at a constant, steady pace

By following this methodology, one can obtain an index of relative butterfly population size, which can be used to measure changes in abundance over time. This method is popular with many field naturalists due the easiness of its replicability and was found to be a good way to encourage citizen participation in nationwide biomonitoring projects (Pollard and Yates, 1993, Botham, 2016).

However, there have been some studies which have critiqued its reliability in providing an accurate representation of butterfly population trends over time of adequate quality for conservation decision-making (Nowicki et al., 2008, van Swaay et al., 2008, Isaac et al., 2011, Pellet et al., 2012). An important issue regarding the Pollard Walks is the fact that they only account for relative population size and not absolute values, which some have found not be reliable when modeling population trends for conservation-based decisions (Pellet et al., 2012). The UKBMS also does not take into account individual detectability (i.e. situations where only a fraction of individuals from a population is present at a specific site at a specific time, which would underestimate actual population numbers) and can also be affected by factors such as observer experience and the specific ecology and behavior of a targeted species, therefore not allowing for comparisons between different species of butterflies (Nowicki et al., 2008, Isaac et al., 2011, Pellet et al., 2012). To counter these issues and obtain true population values, researchers have proposed to use either capture-mark-recapture methods, or other methods of sampling such as distance sampling, where one applies a detection function to counts from a known distance (Isaac et al., 2011) or replicated counts (Pellet et al., 2012).

While these methods would indeed account for absolute population size values, they are not very practical for sampling in this specific study. First of all, this research is focused on a critically imperilled species, and capture-recapture methods may negatively affect its mortality rate, while

also being more demanding in terms of the time and labour costs associated with this technique. Distance sampling methods require a minimum of 60 observations in order to be able to apply the detection function (Isaac et al., 2011), which again is not practical in this case, as Ringlet counts at Rithet's Bog will most likely have values below this threshold, based on survey data from previous years. Finally, replicated counts requires that repeated butterfly counts be performed within a single day, which is not practical or efficient in the context of this study.

A final factor to consider is how surveys have historically been conducted at the bog. Miskelly (2007) and Hartwell (2010) have both used a monthly systematic transect method since 2001. Their methodology involves monthly surveying of the entire perimeter trail, as well as systematic transects of known pockets of Ringlet habitat, such as the wet meadow and grassy knolls in open areas (Fig.8). The transects were a series of parallel lines set every 10 meters, in order to maximize the number of butterflies observed (S.Hartwell, pers.comm., 2018). The specific 10m distance was chosen in order to avoid double counting, as it was observed that when butterflies were flushed due to recorder activity, they would land less than 10m away from their original flight spot (S.Hartwell, pers.comm., 2018). The latest butterfly counts at Rithet's Bog were usually performed every 3rd week of the month, in order to coincide with the Victoria Natural History Society (VHNS) counts (Hartwell, 2010). However, it was recommended to also perform counts on alternate days in case the weather wasn't appropriate for butterfly monitoring during the week selected by the VHNS for counts.

For this specific project, I decided to use a combination of the Pollard Walks methodology as described in Pollard (1977) and Pollard and Yates (1993), as well as the methodology employed by Miskelly (2007) and Hartwell (2010) during their systematic survey of the bog. Specifically, I used the following criteria:

1-Perform surveys, twice a month, during known flight period and life history of the Ringlet (i.e. April to September)
2- Perform surveys when temperatures were above 17°C or above 13°C as long as there was 60% sun exposure (exception was the month of April, in order to respect criteria 1 above) and when winds were less than 29km/h

3- Survey the entire perimeter trail, as well as the wet meadow area and adjacent grassy patches

4- Surveys were 5m wide transects, set 10m apart, recorded between 10h45 and 15h45, at a steady, constant walking speed

For an overview of the transect route taken, please see Fig. 9 below. Additionally, in order to map the distribution of species at the bog, GPS coordinates and abundance were recorded for each sighting. Both survey track and GPS coordinates were collected with a Garmin 62S GPS unit. Butterflies were identified according to National Audubon Society, 1981, Tilden and Smith, 1986, Woodward 2005, GOERT, 2018.

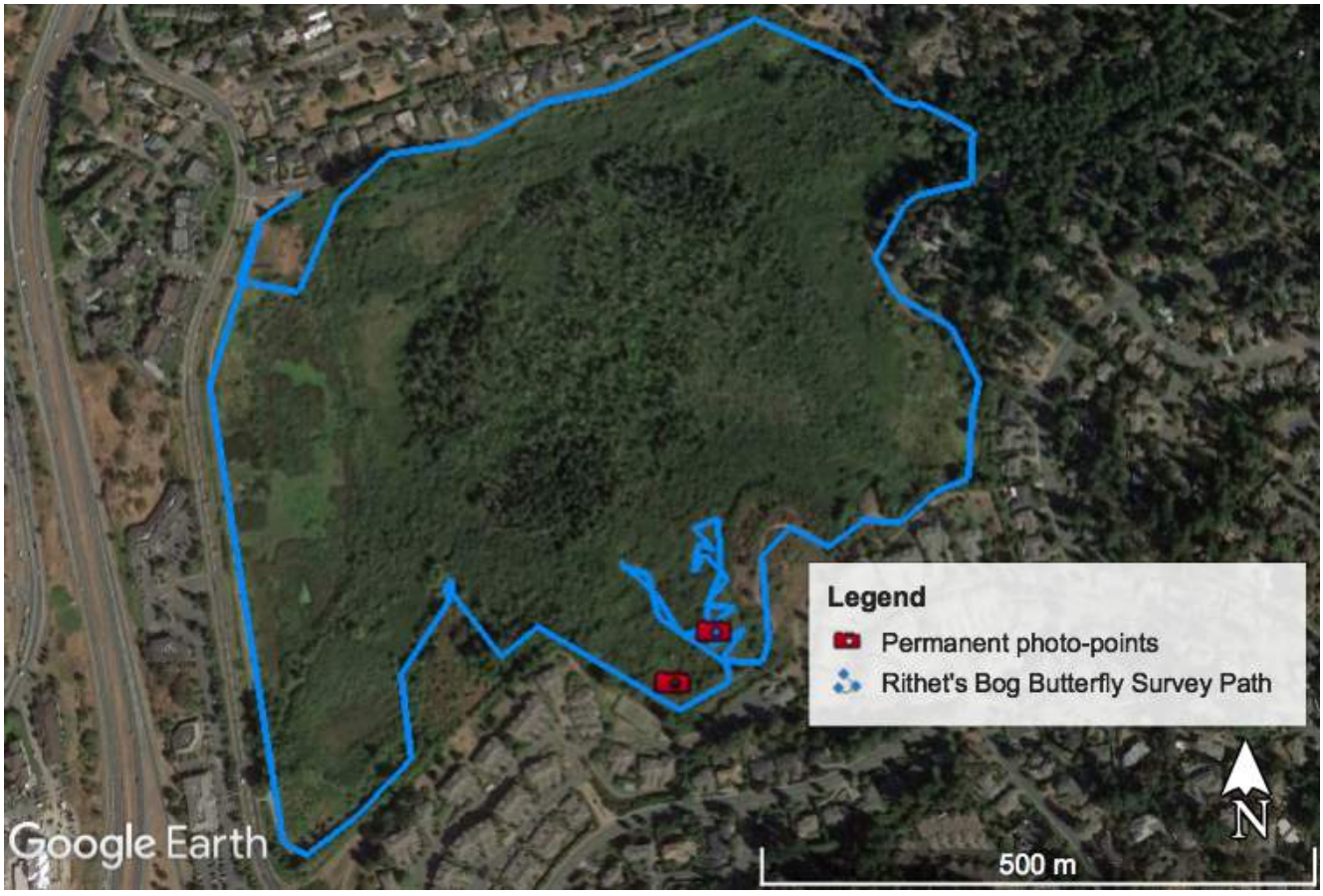

Fig.9. Survey path (in blue) of the butterfly recording which took place from April to September 2018 at Rithet's Bog, Saanich, BC. Permanent photo-monitoring points are also identified (in red). Source: Garmin 62S GPS and Google Earth, 2018.

5.2 TERRESTRIAL ECOSYSTEM MAPPING

Terrestrial Ecosystem Mapping (TEM) was performed in order to gather information on the structure and development patterns of vegetation inside the wet meadow area, and an area adjacent to the meadow, a proposed site for a future butterfly nectar garden. TEM at Rithet's Bog was completed on June 17th 2018 and followed procedures as outlined in the Standard for Terrestrial Ecosystem Mapping in British Columbia (Resources Inventory Commission, Government of B.C., 1998). For both plots, dimensions were 20m by 20m. For the first plot inside the wet meadow area, it was decided not to dig a soil pit, in order not to disturb sensitive habitat for a critically imperilled species. The site series for that area was therefore strictly based on observed vegetation and site characteristics and determined according to criteria outlined in Resources Inventory Commission (1998). For the second plot inside the future butterfly nectar garden, an 80cm by 80cm soil pit was dug out. Soil texture was determined with the Key to hand-texturing soil (Section 9, Field Manual for Describing Terrestrial Ecosystems, 2nd Edition, BC Ministry of Environment, 2010). Soil moisture and nutrient regimes (SMR and SNR) were derived following keys outlined on p.279-283 of the ER 312B course readings manual (Hebda, 2016). Aspect, site coordinates and elevation at both sites were recorded with a Garmin 62S GPS unit and slope gradient was measured with a Suunto clinometer. Finally, vegetation was surveyed inside each plot, and plant species identification was performed with the help of the Pojar and MacKinnon (1994) guidebook. Completed Ground Inspections Forms (GIFs) for both plots as per B.C. Ministry of the Environment (2010) requirements can be found in Appendix B at the end of this report.

5.3. PHOTO-POINT MONITORING

Performing a site inventory and planning for post-restoration monitoring of site conditions are key elements for ecological restoration, as they allow to evaluate the effectiveness of restoration actions and to plan for future interventions (Eastman et al., 2011). Using photo-point monitoring or repeat photography of a site is a great and simple way to achieve both of those requirements, as they can allow for benchmarks to be set against which restoration targets can be implemented and measured (Douglas, 2002). The principles regarding photo-point monitoring are simple: one must choose permanent photo-points, from which photos are to be taken at the exact same spot, at the same time of the year (Eastman et al., 2011). The camera must also be framed in such a

way that the field of view is replicable and identical between repeat sessions (Lucey and Barraclough, 2001, Hall, 2002). In order to assist with framing it is recommended to record the camera azimuth, as well as bring a pole/tall object of known length, as that will not only help to center the camera but can also help to document changes in vegetation height over time (Hall, 2002, Eastman et al., 2011). When done properly, photo-point monitoring is an excellent tool that allows for qualitative and quantitative comparisons to be made across different temporal scales (Lucey and Barraclough, 2001, Hall, 2002).

For the purpose of this report, two permanent photo-points were established at Rithet's Bog: one capturing the wet meadow Ringlet habitat and the other one set to document the pond adjacent to the meadow (see Fig. 9 above for locations of permanent photo-points). As butterflies require a permanent water source for drinking and puddling (Woodward, 2005), I wanted to see how much of the pond water would remain available at the height of the dry summer season. The camera used for this process was a Nikon D7200 (35mm focal length, 23.5mm x 15.6mm image sensor). Tripod height was set to 1.5m for both photo-points, and recorded azimuths were 30° for the wet meadow location and of 354° for the pond. ISO values, aperture and shutter speed settings were all set in the field in order to maximize photo quality according to weather conditions. After taking the first (benchmark) photography on November 6th, 2017, images for both points were gridded with Adobe Photoshop CC © in order to obtain a center point from which subsequent photos could be oriented. Repeat photographs of both areas were taken approximately every two months, from November 2017 to September 2018.

6. RESULTS

6.1. BUTTERFLY SURVEY RESULTS

Butterfly surveying at Rithet's Bog began on April 14th 2018 and ended on September 29th 2018. Over this time period, eleven different site visits occurred, totalling over 1000 minutes in survey time and over 40km in survey distance. A total of 249 butterflies were observed, from nine different species. With regards to Ringlets (*insulana* subspecies), there were 83 observations of the species. It was possible to notice the presence of both broods of adults, as highlighted by the absence of Ringlets in July and their re-emergence in August. The recorded numbers of

"Vancouver Island" Ringlets for this year seems to be much higher than the last available recording from Rithet's Bog in 2013 (Fig. 6, 2 individuals), however that number originates from a single survey date in June and therefore comparisons cannot be made with this study, which evaluated the population at multiple times during the summer. The last known date with available data in which a complete survey over the entire summer was performed was 2010, and for that period 103 Ringlets were observed (Hartwell, 2010). Thus, analyzing the numbers from this study and those of eight years ago is a more suitable comparison, however one must be cautious when interpreting these types of results. Indeed, there are many factors unrelated to true populations counts which might explain these differences and therefore simply looking at numbers without accounting for other variables can cause bias and misrepresentation. Another important point to consider is how counts are reported. Generally, butterfly counts are either reported monthly, or aggregated over the entire flight time period (i.e. April to September). The VNHS, for example, does both and reports counts in monthly format as well as with a grand total for the year. However, some non-migratory butterfly species such as the Ringlet have long life cycles, spanning over the entire summer. This means that often, for the same area, the same individuals which were counted during one month will be counted again the following month, as they really represent one population. Therefore, by adding up the counts one can over-represent certain species. This is why for this report, it is more appropriate to say that there were 83 observations of Ringlets, and for actual population counts one must look at monthly values (see Table 1). In this case, the recorded data shows that the first brood of Ringlets had approximately 23 individuals, while the second brood had about 9 individuals, which puts the estimate of the population at Rithet's Bog at 32 for the 2018 flight period. Other parameters recorded during the surveys were weather conditions, which followed the requirements as set by Pollard (1977), Pollard and Yates (1993) and UKBMSA (2016), except for the month of April, where temperatures and sun exposure values were below the required criteria. It was decided to survey in April even though conditions for surveying were not ideal, as that month was identified as part of the life cycle of the Ringlet and other species of butterflies. However, a direct result of this was that no butterflies were seen at all for that entire month. A more detailed view of the recorded species and weather conditions during each visit can be seen in Table 1 below, while a graphic representation of all butterfly individuals observed per site visit and grouped according to species is given in Fig.10. Photographs of each species seen are also available in Appendix C.

Table 1. Butterfly survey results from Rithet's Bog, Saanich BC, April-September 2018

	Species	Count	Average wind speed (km/h)	Average sun exposure (%)	Average temp (C)	Total survey time (mins)
Date						
April 14	N/A	0	4	20	11	111
April 29	N/A	0	8.5	10	12	124
May 16	Ringlet	23	7.5	100	17	150
	Western Spring Azure	7				
	Cabbage White	5				
May 30	Ringlet	19	12.5	100	17.5	105
	W.Tiger Swallowtail	4				
	Cabbage White	1				
	Western Spring Azure	1				
June 11	Ringlet	19	12.5	90	16.5	140
	Lorquin's Admiral	12				
	Mourning Cloak	1				
	W.Tiger Swallowtail	7				
	Cabbage White	4				
June 22	Lorquin's Admiral	15	11	40	19.5	128
	Ringlet	8				
	European Skipper	8				
	W.Tiger Swallowtail	4				
July 20	Lorquin's Admiral	9	9	100	18.5	114
	Pine White	1				
	Cabbage White	4				
	W.Tiger Swallowtail	1				
August 15	Ringlet	9	6.5	80	23	100
	Lorquin's Admiral	1				
	Pine White	2				
	Woodland Skipper	24				
	Cabbage White	3				
August 27	Ringlet	4	8	100	19.5	115
	Woodland Skipper	44				
	Cabbage White	3				
Sept 17	Ringlet	1	7.5	85	14.5	95
	Cabbage White	1				
	Woodland Skipper	3				
	Lorquin's Admiral	1				
Sept 29	N/A	0	22	30	18	75
TOTAL	**9**	**249**	**N/A**			**1257**

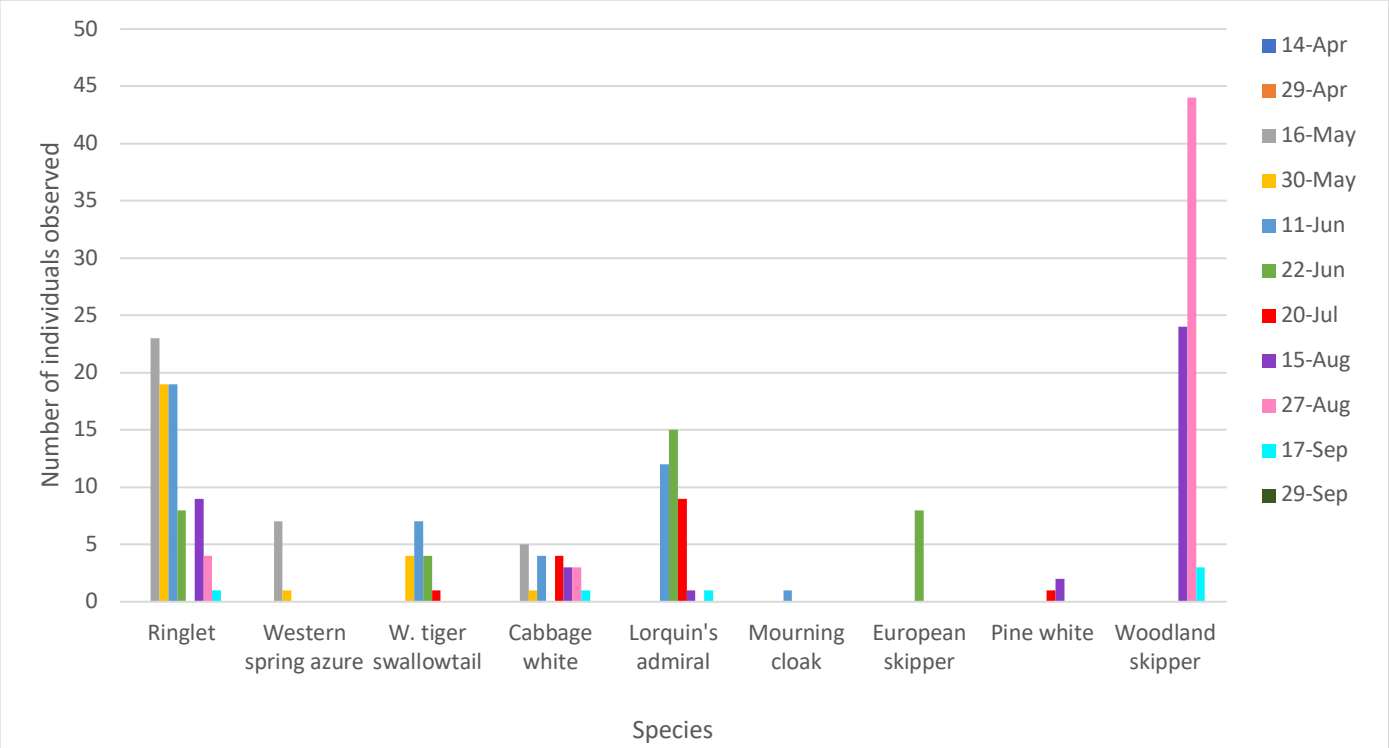

Fig.10. Butterfly species observations per site visit, April-September 2018, Rithet's Bog, Saanich BC.

Another factor which is important to consider in the context of habitat planning is the density and distribution of species. At Rithet's Bog, prior research and communication with RBCS members identified that the wet meadow area was most likely the one which would show the highest abundance of butterflies (Miskelly, 2007, Hartwell, 2010, R.Pym., pers.comm., 2017). In order to verify this, GPS points were taken for each individual seen during the recording season. When there was a high concentration of individuals at a same spot, abundance was recorded along with the coordinates. The results of this mapping can be seen in Fig.11 below and does highlight that indeed, the wet meadow site seems to be one with the highest concentration of "Vancouver Island" Ringlets, as well as other species. Other areas of notable density are, as previously reported, Garry Oak outcrops and grassy knolls.

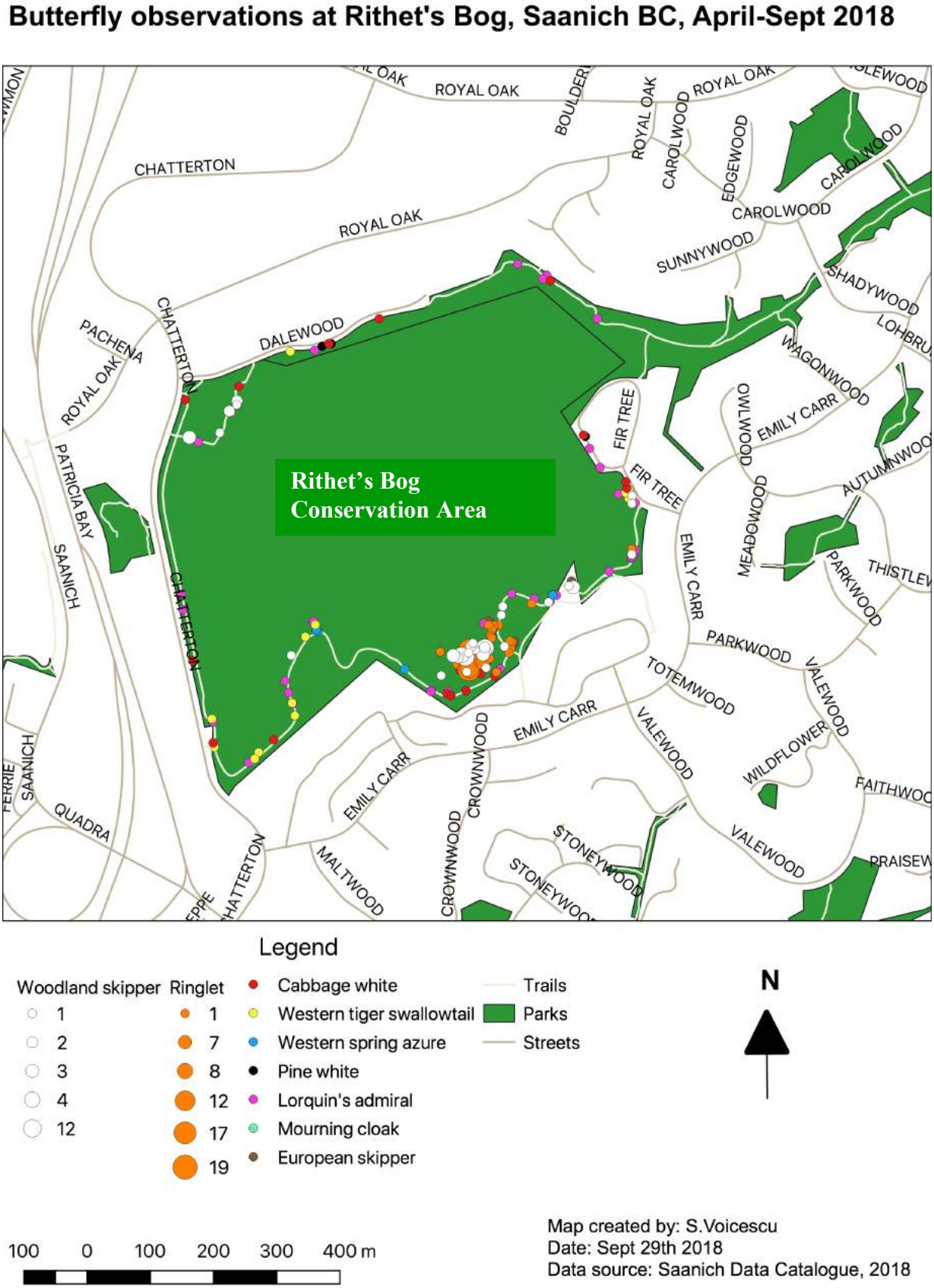

Fig. 11. Map of the distribution of butterfly species recorded at Rithet's Bog, from April-Sept 2018. "Vancouver Island" Ringlets are represented by orange circles, and their highest density is in the wet meadow area at the south end of the bog.

6.2. TERRESTRIAL ECOSYSTEM MAPPING RESULTS

Both plots chosen for TEM analysis are part of the Nanaimo Lowland Ecosection and the Coastal Douglas Fir moist maritime Biogeoclimatic zone, as part of the Biogeoclimatic classification in B.C. (Demarchi, 1996). These regions are associated with a mild Mediterranean climate, with wet winters and dry summers, and are dominated by Douglas Fir (*Pseudotsuga menziesii*) forests, with Salal (*Gaultheria shallon*) and Oregon Grape (*Mahonia aquifolium* and *Mahonia nervosa*) understory plants (Demarchi, 1996). For the first plot in the wet meadow, no soil pit was dug in order to avoid disturbing the sensitive habitat of the Ringlet (*insula* subspecies) and therefore identification of site series was mostly based on vegetation. The position of the plot was on a relatively level slope, and was dominated by herbaceous vegetation, hence it received the 2b "Herb Graminoid-dominated" structural stage classification (Resources Inventory Committee, 1998). Crown closure was 0%, as the area was completely opened. Herbs were by far the most dominant group (80%) of plant species on the plot, and grasses such as Red Fescue (*Festuca rubra*), Tufted Hairgrass (*Deschampsia cespitosa*), Common Velvet Grass (*Holcus lanatus*) and sedges such as the Beaked Sedge (*Carex rostrata*) were noted. Discussions with RBCS members also highlighted that non-native agricultural grasses (i.e. *Bromus* spp.) were the most common type of grass found in this area, due to its past land use as a farm (R.Pym., pers.comm., 2018). Many other types of grasses were also present, however as the author of this report is not very familiar with grasses, it was not possible to identify them at the time. It is important to note here that the patch of Reed Canary Grass (*Phalaris arundinacea)* was measured and found to occupy approximately 160m^2. This area will have to be monitored in order to see if it further encroaches on the wet meadow habitat. With regards to flowering plants, the Creeping Buttercup (*Ranunculus repens)* was quite widespread and seemed to be a favorite nectar plant of the Ringlet, and other plants such as the Canada Thistle (*Cirsium arvense*) and Fireweed (*Chamaenerion angustifolium*) were also present. For shrubs, Nootka Rose (*Rosa nutkana*) and English Hawthorn (*Crataegus laevigata*) were the most widespread on the plot. From these visual observations and the conditions at the site, it was decided that the site series for the plot is "Sough sedge graminoid dominated (CS2b). For a visual overview of the wet meadow area, please see Fig.12 below, and for a complete list of the vegetation observed, please see Plot 1 GIF in Appendix B.

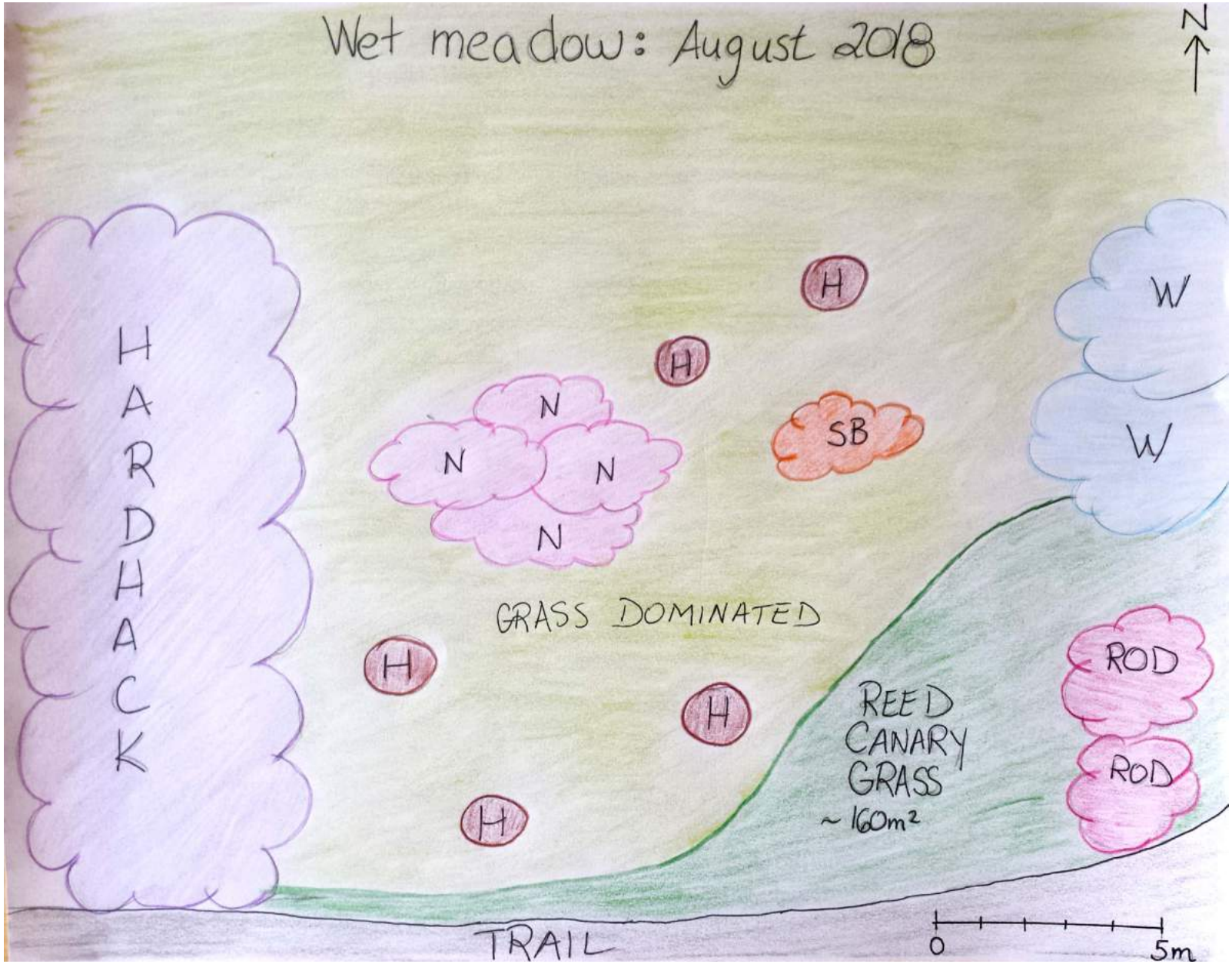

Fig.12. Current conditions and vegetation of the wet meadow area, as seen in August 2018. Legend: H= English Hawthorn, N= Nootka Rose, SB= Sweet Briar Rose, ROD= Red-osier Dogwood and W= Willows

For the second plot, which was identified as the site for a potential nectar garden in collaboration with the RBCS (R.Pym, pers.comm., 2018), an 80cm by 80cm soil pit was dug in order to evaluate soil quality for adequate plant growth. Soil texture was determined to be silty clay, due to its grittiness and the length and easy handling of the soil worm formed from the pit (BC Ministry of Environment, 2010). This type of soil generally has poor drainage, due to higher clay content (Jackson et al., 2014), however the water table was not reached at any point during the digging process. This may be possible due to the overall dry conditions in the summer when the site was sampled, when the water table would be lower. The soil moisture regime was determined to be 5, or subhygric, and the soil nutrient regime was found to be very rich. Both of these conditions are good for plant growth, as water will tend to be removed slowly from the soil, thus allowing it to remain wet for a good part of the growing season (Hebda, 2016). The soil humus form was defined as a mull for this pit, as the top horizons were hard to differentiate and earthworms were visible. The site was at a relatively level position and its structural stage is 3, or "Shrub/Herb" dominated, as the shrub and herb class respectively occupy 50% of the total surface area for the plot. Examples of vegetation present at the site included: Pacific and Scouler's Willows (*Salix lucida* and *Salix scouleriana*), English Hawthorn (*Crataegus laevigata*), Hardhack (*Spiraea douglasii*) and Nootka Rose (*Rosa nutkana*) for the shrubs, and many water loving grasses near the water/drain area, such as Horsetails (*Equisetum spp*.), Cattails (*Typha spp.*) and Reed Canary Grass (*Phalaris arundinacea*). From the observed vegetation, site physical conditions as well as information gathered from the soil pit, the site series for the plot was determined to be "RFf3", or Foamflower fine-textured soils shrub/herb dominated. As with the previous site, below (Fig.13) is a visual representation of site conditions as of August 2018 and in Appendix B it is possible to find the Ground Inspection Form for this site (Plot 2). Finally, for a complete overview of polygons with associated site series names, please see Fig.14.

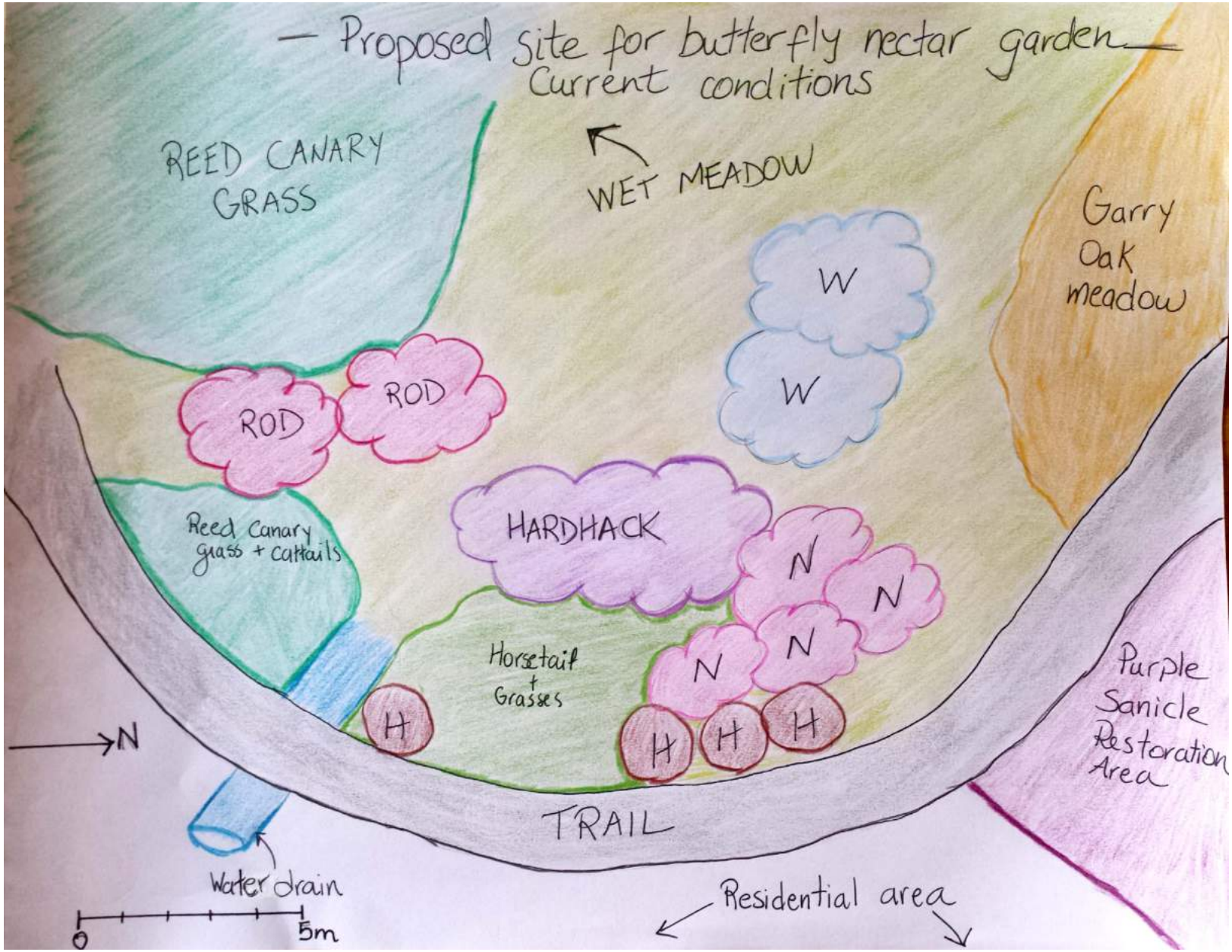

Fig. 13. Current conditions and vegetation for the butterfly garden nectar proposed site, August 2018. Legend: H= English Hawthorn, N= Nootka Rose, ROD= Red-osier Dogwood, W= Willows.

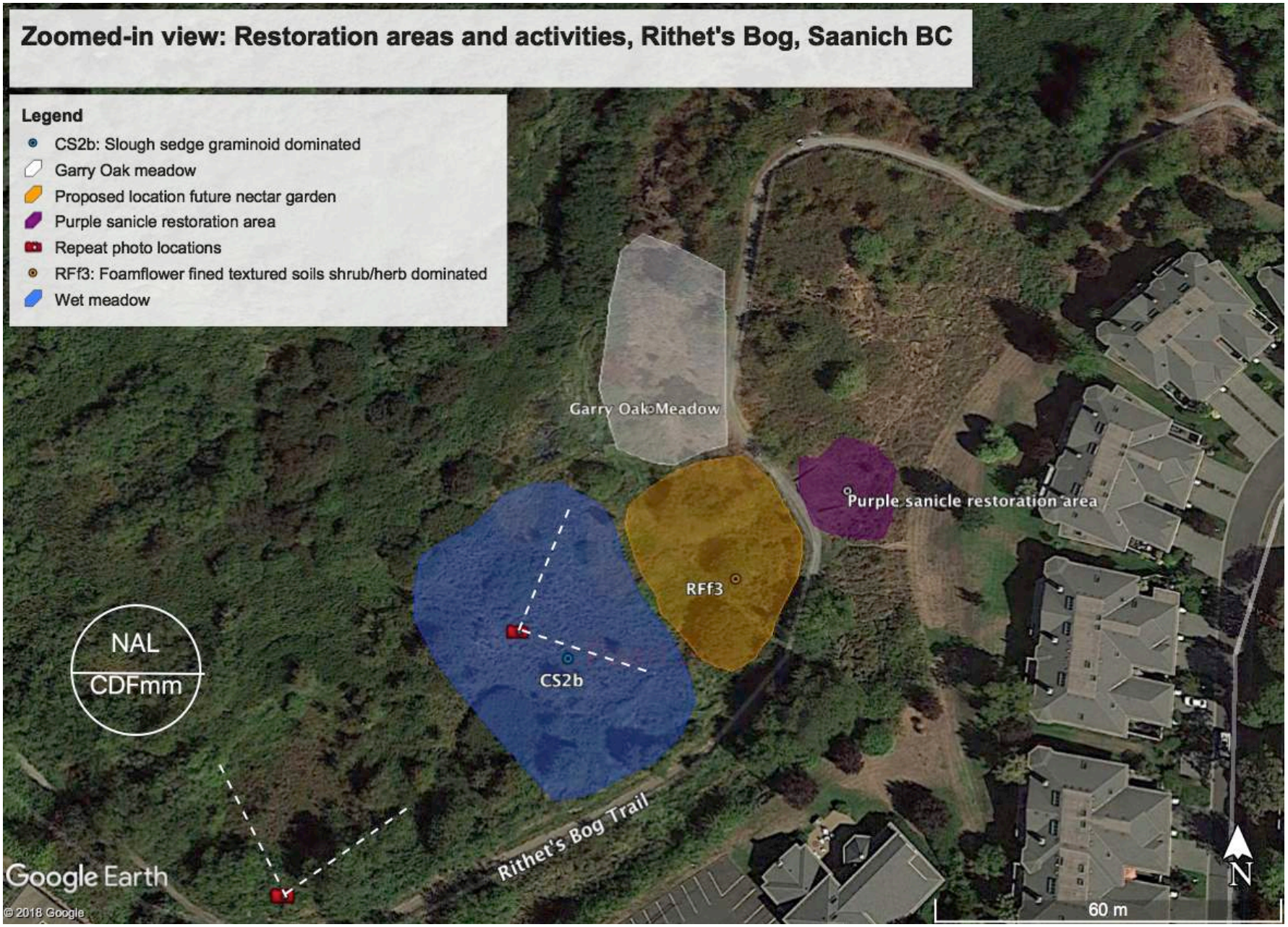

Fig.14. Results from TEM. Blue polygon represents the wet meadow site, a CS2b (Slough sedge graminoid dominated) and yellow polygon is the proposed site for the future nectar garden (RFf3-Foamflower fine-textured soils shrubs/herbs dominated). Both of those sites are near a Garry Oak meadow (in white) and a Purple sanicle (*Sanicula bipinnatifida*) restoration area (in purple). Red cameras represent permanent photo-points locations for photo-monitoring.

6.3 PHOTO-POINT MONITORING RESULTS

Photo-point monitoring was performed at the bog at six occasions: November 6th 2017, January 6th 2018, March 4th 2018, May 20th 2018, July 20th 2018, and September 17th 2018. Two permanent photo-points were established (see Fig.9 for location), one at the wet meadow and the other at an adjacent pond to the meadow. The locations were chosen in order to be able to observe changes to the main "Vancouver Island" Ringlet habitat and monitor potential encroachment by invasive species such as Reed Canary Grass. Additionally, another goal of this photo-monitoring was to be able to observe seasonal vegetation patterns and availability of plants and nutrients. Table 2. on the next page presents the results of this photo-point monitoring.

As can be seen, significant seasonal changes can be observed even for such a relatively short time frame. The most noticeable change is the water level at the pond site, which goes from very wet/water-logged conditions in the winter, to a completely dried out and overgrown area in the summer. As butterflies need wet areas to drink and for "puddling", a process whereby they gather on wet sand or mud to absorb minerals and nutrients (Woodward, 2005, National Gardens Club, 2015), having a consistent water source for the entire duration of their life cycles is an important feature of their habitat. Considering the climate change context and trends of hotter and drier summers in the area (CRD, 2017), it is most likely that the pond water source will dry up sooner in upcoming years. This may be an issue for the Ringlets occupying the nearby wet meadow habitat and highlights the need to have an alternative, and perhaps artificially maintained, water source. Another observation resulting from photo-monitoring is how quickly the vegetation dried up in the wet meadow. Green grasses and Buttercups were abundant in May, however in July much of the grasses had dried up, and the situation had not improved by September, when the last survey date took place. As Ringlets need an abundance of green grasses to act as host plants during their larval caterpillar stage, increased dryness and hotness could translate to a decrease in the availability of suitable host plants and therefore a decrease in overall population numbers. This again highlights the need for habitat composed of a diversity of flowering plants and grasses which can support butterfly development throughout their entire life cycles.

Table 2. Results of the photo-point monitoring, for the wet meadow area and the pond area

DATE	WET MEADOW	POND
November 6		
January 6		
March 4		

DATE	WET MEADOW	POND
May 20		
July 20		
Sept 17		

7. DISCUSSION

As Klonda et al. (1999) highlight in their review of butterfly conservation in Western Canada: "Butterflies are the charismatic megafauna of the insect world". Indeed, out of all the insect taxa monitored, butterflies are by far the most popular group, with citizens and scientists alike (New et al., 1995, Schmeller et al., 2009). Be it their attractive colours or their propensity to solicit awe and admiration which inspire many to devote time to their study and conservation, there is no doubt that this group constitutes a flagship taxon for invertebrate conservation (New et al., 1995, Klonda et al., 1999). The use of butterflies as conservation targets could therefore also encourage the protection and conservation of many other related species and ecosystems. However, in order to properly formulate and apply conservation-based decisions, there are a number of factors which need to be properly studied and analyzed. These factors, which will be discussed below, all apply to the context of this research project and to future conservation efforts of the "Vancouver Island" Ringlet.

Habitat loss

Unequivocally, the number one cause of the observed decline in butterfly populations is the loss of suitable habitat (New et al., 1995, Klonda et al., 1999, Severns et al., 2006, Öckinger et al., 2009, Schultz et al., 2011). Either due to increased urbanization, encroachment by invasive plants, use of harmful pesticides/herbicides or the loss of natural disturbance processes, the reality is that many of the once open meadows habitats where butterflies thrived have either disappeared or became fragmented, with smaller patches spread-out through the landscape (Schultz et al., 2011). As dispersal is critical to the long-term survival of populations, a fragmented and unconnected landscape can increase the mortality rates of species travelling through the landscape in order to find suitable habitat patches, either by being more vulnerable to predation and climate events or simply by not finding suitable healthy mates once they reach the new habitat (Polic et al., 2014). This is particularly true in urban contexts, where once diverse grasslands areas were converted into more traditional parks, with low cut managed grass turfs lacking in structural diversity (Öckinger et al., 2009). Research has shown that butterfly species richness and density are positively related to habitat connectivity (Öckinger et al., 2009, Pocewicz et al., 2009). Therefore conservation strategies, especially in urban environments,

should aim to spatially provide for suitable habitats across the landscape and allow for a more "wildland" type management of natural areas, whereby parks are sown with native grasses and left to grow undisturbed instead of manicured and ornamented according to anthropocentric principles.

Although research so far has shown other species of Ringlets to be more sedentary, and thus potentially less affected by habitat dispersal issues (Pocewicz et al., 2009, Polic et al., 2014), this does not mean that they are not susceptible to habitat loss and fragmentation. Indeed, habitat loss also translates to a loss of host and nectar plants species, which will negatively influence the larval and adult development of butterflies, thus affecting the overall fitness of their populations (Pocewicz et al., 2009, Celik et al., 2015). At Rithet's Bog, most butterfly species are concentrated around the wet meadow area and open grassy patches of habitat (Fig. 11). This is particularly true for the "Vancouver Island" Ringlet, who seems to be especially fond of the mix of native/non-native grasses and flowering plants found in that area. As the conservation area was established in an urban area and inherited decades of land management geared towards farming and agriculture, habitat loss will most likely be a challenge for many years to come. Pressures from nearby residences, in the form of runoff into the bog or increased pedestrian activity will have to be managed in a balanced way, that allows for recreational activity while also maintaining the park's ecological integrity.

Biology of the species

Another critical element that needs to be adequately researched in order to make successful conservation decisions is the biology of butterflies and their association with host and nectar plants (Severns et al., 2006, Pocewicz et al., 2009, Schultz et al., 2011, Celik et al., 2015). Studies have shown that the presence of host plants that remain green throughout the winter have an important role in the survival of hibernating butterfly larvae (Örvössy et al., 2013, Celik et al., 2015). Indeed, as the caterpillar emerges from hibernation, it requires host plants in close proximity in order to re-supply itself in nutrients and energy it lost during the winter. Having an established list of species-specific host-plants can therefore help with the management of endangered butterfly species (Schultz et al., 2011, Celik et al., 2015). This has proven rather difficult to establish for *Coenonympha tullia insulana*, as most records show an association with

different grassland and meadow associated plants, but very little specific species-level information is available for this butterfly (Ackery, 1988, Scott, 1992, Pocewicz et al., 2009, Schultz et al., 2011). It may also be possible that this Ringlet is more of a generalist in its choice of a host plant and its caterpillar feeds on multiple grass host plants, which would be beneficial in terms of management as it would reduce limitations associated with planting single species. From information gathered from past surveys and observations (Hartwell, 2010, J. Miskelly, pers.comm., 2017, J.Tatum, pers.comm., 2018) this seems to be the case with the Ringlets at Rithet's Bog. Indeed, oviposition at the bog was recorded on a Red Fescue blade and larvae from the site seemed to accept a variety of native and non-native grasses when reared from collected eggs. This does not mean however that the Ringlet caterpillar will accept all types of green grasses. Schultz et al. (2011) have shown in their review of conservation strategies for prairie butterflies that tall invasive grasses can reduce population fitness and deter oviposition, and this may be also be applicable at Rithet's Bog. In this case, the invasive Reed Canary Grass is one of the most visible threats to the wet meadow habitat (Fig. 12). However, it is a plant that remains green throughout the summer and is green as well in April when caterpillars emerge from hibernation, which is why it may be advisable to adopt a more cautionary approach to its management at that location. Indeed, not all invasive or non-native species are problematic for butterflies, with some species such as English Plantain (*Plantago lanceolata*) and Canada Thistle (*Cirsium arvense*) providing essential nutrients for many butterfly species (Klonda et al., 1999, Schultz et al., 2011). Managing competing priorities and incorporating multiple habitat requirements from different species can become a challenge in the context of ecological restoration. Nonetheless, it is an important priority to consider and plan for, in order to maintain the ecological integrity and structural complexity of a resilient landscape. For this purpose, it is recommended that cut-back of Reed Canary Grass at the site be done progressively, and that monitoring be in place in order to measure the effects of the removal, on the Ringlets as well as on the landscape.

Climate change

An undeniable factor which has to be accounted for in restoration planning is the effect climate change will have on an already changing landscape. Predictions for the region mention warmer winter temperatures, associated with more precipitation in the winter and spring, but also an

increase in extreme hot days in the summer and prolonged dry periods (CRD, 2017). For Rithet's Bog, an ecosystem heavily dependent on water levels, these projected changes could translate to an overall decrease in water availability and a progressive vegetation transformation with more woody communities taking over from water-loving ones. This summer alone, it was possible to see certain waterlogged areas such as the pond next to the wet meadow (Table 2) completely dry up by mid-July, thus limiting water availability for species that require it to survive. These changes will no doubt have a major effect on current flora and wildlife inhabiting the bog, and the "Vancouver Island" Ringlet is no exception. As butterflies are dependent on the availability of host and nectar plants, the timing of flowering must coincide with larval emergence and adult flight (Kharouba and Velland, 2015). However, as species respond differently to changing temperatures and precipitation, phenological mismatches can occur between different species, further impacting the fitness of populations (Schultz et al., 2011). For both butterflies and flowering plants, research by Kharouba and Velland (2015) has shown that the timing of critical life stages had advanced in response to temperature increases. The timing of this advance was not necessarily overlapping however, as flowering plants were more sensitive to a warming climate than butterfly flight time (Kharouba and Velland, 2015). This could translate to a poleward shift of many butterfly species, who are expanding their range in order to be able to find adequate host plants whose phenology coincidences with their nutritional requirements (Schultz et al., 2011). For the "Vancouver Island" Ringlet, this poleward expansion has already been observed, as populations from the Greater Victoria area moved North towards Chemainus and Nanaimo (Guppy and Shepard, 2001, B.C. Conservation Data Centre, 2013). Whether this shift is due to a lack of suitable habitat from urbanization, warming temperature and phenological mismatches or a combination of both remains to be investigated. What is important however is to account for these changes in ecological management, as successful restoration needs to be able to adapt to shifting climates and changing landscapes. For the population of Ringlets at Rithet's Bog, this could mean planning for plant species with staggered growth and complementing flowering times, as this would allow the butterfly to have a constant food source supply.

Monitoring efforts

According to Miller and Hammond (2007): "A suitable approach to quantitative assessment of [butterfly] population numbers is to establish a spatially replicated, and temporally repeatable, sampling protocol that provides a chance for observation of all individuals in the sample zone and avoids the removal of individuals from the habitat." Indeed, as was explained previously in Section 5.1, there are still many existing issues regarding the different techniques employed for butterfly surveying. Although the goal of monitoring in this context is to provide the best information possible regarding individual or multiple species, this does not mean that it should not be undertaken unless perfectly standardized and statistically sound methods are employed. As butterflies are one of the taxa with the most observations recorded for long periods of time, the potential of citizen science and volunteers to contribute meaningful data for conservation is not negligible (Matteson et al., 2012). This is particularly true in cities and densely populated urban areas, where by definition there is a higher availability of potential volunteer observers. In their study, Matteson et al. (2012) highlighted the value of ad hoc butterfly surveys versus standardized surveys methods and found that although standardized methods are more appropriate to detect population trends, unstandardized methods can be more effective at identifying a higher number of individuals and rare species. Others have found similar results, with research from Soroye et al. (2018) showing that citizen science methods combined with professionally recorded datasets can provide significant estimates of regional species richness.

In order to be meaningful however, data collection from either standardized or unstandardized methods needs to be consistent over time (Matteson et al., 2012). This criterion is also very much applicable to Rithet's Bog, whereby monitoring efforts of different components of the bog have either been conducted as research projects (Golinski, 1995, 1997, Smith et al., 2000), by members of the RBCS (Miskelly, 2007, Hartwell, 2010) or by the VNHS. Information regarding butterfly counts at the bog has mainly been collected by the B.C. Conservation Data Centre, Miskelly (2007), Hartwell (2010) and the VHNS (Fig. 6 and 7). With regards to the latter however, counts for the bog were aggregated with those from other areas, which makes area specific comparisons over different time periods impractical. It was also observed that some data, especially older records, only originate from one observation at a specific time, and that there are often gaps of decades in between records. These inconsistencies make it harder to

establish population trends and highlight the need for at least a semi-structed methodology to be in place, and of course for volunteers or scientists who are willing to dedicate time to surveying. In this modern and time-demanding world this may be somewhat difficult to achieve, however there are nowadays many different technological advancements which can facilitate monitoring. Some examples include the Insight app (https://insightcitizenscience.com/), which is a phone application that encourages citizen science by allowing individuals to record pollinator observations in their area. The application comes with a guide which facilitates the identification of different species as well as a data visualization option which allows users to map their observations as well as those of other volunteers. There is also E-butterfly: http://www.e-butterfly.org/, an online platform similar to the more well-known iNaturalist, where citizens from all over North America can submit photos and observations of butterfly species. Information from submissions are vetted by regional experts before they become part of a regional database. Finally, recent research by Ivosevic et al. (2017) has highlighted the potential of unmanned aerial vehicles (i.e. drones) for butterfly monitoring, as they could provide reliable information on population numbers without disturbing sensitive habitat as can sometimes occur with walking transects. All of these developments could aid towards achieving consistent monitoring of plant and animal species at the bog and could help to establish, for imperilled species such as *Coenonympha tullia insulana*, long term population perspectives.

7.1. RECOMMENDATIONS

Based on the Results section and the factors discussed in the above section, this report proposes the following recommendations in order to improve ecological management at Rithet's Bog, specifically regarding efforts to sustain a long-term population of the "Vancouver Island" Ringlet:

Habitat loss

1-Preserve the current wet meadow habitat at the south end of the bog through a series of non-invasive restoration efforts. This could include manual and progressive removal of Reed Canary Grass and other species seen encroaching the habitat. Restoration efforts should be systematic, and monitoring should be in place in order to assess the progress of activities. The restoration efforts can either be organized in conjunction with already ongoing volunteer activities organized

by RBCS or through other organizations such as HAT, Greater Victoria Green Team, UVIC Ecological Restoration Network, etc.

2- Design and implement a butterfly nectar garden in order to encourage the development of the "Vancouver Island" Ringlet and other butterfly species at the bog. The garden should be composed of a mix between host and nectar plants and be designed in such a way to include already existing plants and features of the landscape.

3-Educational activities and interpretive signage should be posted at the garden site, in order to raise awareness of issues and threats and to inform the public about actions which can be done in order to prevent butterfly habitat loss.

Biology of the species

4-Support ongoing research regarding the life cycle of the "Vancouver Island" Ringlet and its associated host and nectar plants. This can be done either in conjunction with research projects from neighbouring Colleges and University (i.e. Camosun, UVIC, Royal Roads) or though municipal and provincial governments efforts. Research could include the placement of wildlife cameras in order to monitor oviposition and nectaring, as well as collection of eggs and ex-situ rearing with specific grass host plants.

5- Support potential COSEWIC assessment of the "Vancouver Island" Ringlet. Even though the species is not currently on the COSEWIC candidate wildlife list, it is classified as critically imperilled and red listed across the province. It is the belief of the author of this report that preventive measures should be taken sooner rather than later and having an assessment of this species could prove instrumental in its survival. There have been cases when reports are produced once a species is very close to extinction and remedial actions may be too late or too difficult to implement at that stage. Much of the research examined in this report pointed at the lack of specific information regarding the association between the Ringlet (*insulana* subspecies) and potential host plants. A rigorous assessment of the species and associated Garry Oak ecosystems could fill these information gaps and contribute to its long-term persistence.

Climate change

6- Include plants with staggered flowering times in the nectar garden, in order to provide a constant food source throughout the entire summer for species with long life cycles such as the Ringlet. When possible, also include plants which perform well under drought conditions.

7-Manage water levels at the bog. This requires future consultation with the municipality and other organizations such as Ducks Unlimited, who have contributed in the past. The goal here would be to come up with a long-term solution in order to maintain water levels such that they are able to support the current bog ecosystem, considering pressures from urbanization and climate change.

Monitoring efforts

8-Encourage monitoring efforts from local citizens. A great opportunity would be to coordinate monitoring efforts to ongoing restoration work parties with the RBCS. As the RBCS tends to host bog restoration events approximately every two weeks over the summer, this would be a great opportunity for volunteers to diversify and get additional experience in field biology.

9-Monitoring efforts can also be supported through the VHNS, either by encouraging community members to submit observations during their walks to local platforms such as "Invert Alert" (https://www.vicnhs.bc.ca/?cat=8) or more widespread platforms such as e-butterfly and iNaturalist. The monthly butterfly walk, organized every 3rd Sunday at Mt. Tolmie in the summer by the VHNS, could also be held at Rithet's Bog on periodical occasions.

10-Promote the use of technology such as the Insight application at local community events in order to facilitate monitoring efforts and identification of local species by citizens.

Following these recommendations, a calendar of activities is proposed on the following page (Table 3) which outlines potential target periods and restoration activities for Rithet's Bog. The next section (Section 8) will provide more details on two specific recommendations, namely the design of the butterfly nectar garden and educational activities.

Table 3. Tentative schedule of proposed restoration activities and monitoring at Rithet's Bog: 4 years overview

	DATE			
ACTIVITY	**YEAR 1**	**YEAR 2**	**YEAR 3**	**YEAR 4**
Progressive removal of Reed Canary Grass patch	✓ (Remove ~80m^2)	✓ (Remove ~80m^2)	✓ (Remove ~80m^2)	✓ (Remove ~80m^2)
Management of aggressive native and non-native species at the wet meadow (i.e. Hardhack, Nootka Rose)	✓	✓	✓	✓
Removal of Hawthorn at proposed nectar garden site	✓ (Spring, Saanich Parks)			
Removal of Cattails, Horsetails, invasive grasses and aggressive native/non-native species at proposed nectar garden site	✓ (Fall)			
Planting/seeding butterfly nectar garden	✓ (Fall and spring)	✓ (Fall and spring)		
Pond construction at nectar garden site	✓ (Fall)			
Design and installation of interpretive signage		✓		
Monitoring: butterfly surveys	✓	✓	✓	✓
Monitoring: vegetation growth/decline	✓	✓	✓	✓
Monitoring: photo-point monitoring	✓	✓	✓	✓
Educational/community events (Restoration/monitoring work parties & educational programs)	✓	✓	✓	✓

8. PROPOSED RESTORATION ACTIVITIES

8.1. BUTTERFLY NECTAR GARDEN

Butterfly nectar gardens are a great way to provide patches of suitable habitat for species who have faced habitat destruction and loss of host and nectar plants. By providing plants suited to butterfly needs, one can help to increase diversity of both plants and species within a specific area, for the benefits of wildlife and humans alike (Woodward, 2005). Designing and creating such a space is not a difficult process and requires only a few, logical steps, to be adopted. The following requirements highlight some of the basic rules which apply to the construction of butterfly gardens (from Tilka, 2005, Woodward, 2005, National Garden Clubs, 2015):

1-Before designing the garden, plan a butterfly survey of the area.
This step was already performed in this report (see Table 1, Fig. 10 and 11) but is nonetheless essential to follow, as information on the species present at the site will allow for more accurate planning of which plant species to use. In this case, although the main goal is to grow plants and grasses for the "Vancouver Island" Ringlet, there were eight other species of butterflies recorded during the survey period. A goal of the garden is therefore to plant species which will also encourage the development of those butterflies as well.

2-Plan for the garden to be in a sunny location, sheltered from the wind.
As butterflies are diurnal animals who require sun in order to regulate their body temperatures, it is important to design the garden in an open location with full sun exposure. Also, butterflies don't tend to fly in high winds so planting hedges or low shrubs at the edges of the garden to shelter from the wind should be an important element to consider. The area chosen for the nectar garden at the bog follows those criteria, by being in an open area with sheltering shrubs. It is also located right next to the wet meadow habitat, thus allowing species to easily travel from that area without having their main habitat disturbed.

3- Include rocks and a water source.
Butterflies will often bask on dark rocks in order to increase their body temperatures and they require water and mud for the "puddling" process by which they absorb minerals and nutrients

from the ground. A permanent water source and rocks will therefore need to be included in the nectar garden design for Rithet's Bog.

4-Include as many native plants as possible in the planting design, and have a mix of both hosts and nectar plants.

It is important to have a diversity of host and nectar plants at the site, so that all stages of the butterfly life cycles have sufficient nutrients to grow and develop. As stated in Section 7, it is also important to consider the flowering time of plants and use a combination of plants which either have long flowering periods or complementing ones. The focus of the planting will be on native species, however as some non-natives species have been shown to be important nectaring plants for the Ringlet and other species, some of their cover will be maintained and monitored.

The following pages present a proposed plants list for the garden (Table 4) as well as a tentative design plan (Fig.15).

8.2. BUTTERFLY GARDEN: PLANTS LIST & DESIGN

This list of plants was compiled from the following resources, which offer information on butterfly loving plants of the Pacific Northwest, British Columbia and Southern Vancouver Island: Ackery, 1988, Scott, 1992, Guppy & Shepard, 2001, Woodward, 2005, Lilley et al., 2009, GOERT, 2011, National Garden Clubs, 2015, J. Miskelly, pers. comm., 2017, GardenHabitat, 2018, HAT, 2018 and Premier Pacific Seeds, 2018.

Specific attention was paid to plants favoured by the Ringlet (*insulana* subspecies) and plants native to BC. However, in order to provide a diverse habitat for a variety of different butterfly species, plants which are known to be good food sources for other butterflies recorded at the bog, as well as known to support both larval and adult life stages were also included. Some of these plants are not native to area and can also be aggressive in their growth, nonetheless as they do support the life of many different butterfly species at the bog, it was decided they be kept near the nectar garden under an active management regime. Where possible and beneficial, the

existing features of the chosen habitat for the nectar garden were preserved. The total area of the proposed site for the future nectar garden is ~ 1000m^2.

Table 4. List of proposed plant species for Rithet's Bog butterfly nectar garden

TREES			
Species	**Type of food source**	**Target butterfly species**	**Approximate quantity**
Pacific Willow (*Salix lucida*)	Larval host plant and nectar plant for adults	Lorquin's Admiral, Mourning Cloak, Western Tiger Swallowtail	1 (already at site)
Scouler's Willow (*Salix scouleriana*)	Larval host plant and nectar plant for adults	Lorquin's Admiral, Mourning Cloak, Western Tiger Swallowtail	1 (already at site)
Pacific Crabapple (*Malus fusca)*	Larval host plant and nectar plant for adults	Western Tiger Swallowtail	1
Red-osier Dogwood (*Cornus stolonifera*)	Larval host plant	Western Spring Azure	2 (already at site)
SHRUBS			
Species	**Type of food source**	**Target butterfly species**	**Approximate quantity**
Hardhack (*Spiraea douglasii)*	Larval host plant	Western Spring Azure	Maintain existing patch to ~10 individuals
Mock-orange (*Philadelphus lewisii*)	Adult nectar plant	Variety of different butterfly species and other pollinators	2
Hairy Honeysuckle (*Lonicera hispidula*)	Adult nectar plant	Variety of different butterfly species and other pollinators	6
Salmonberry (*Rubus spectabilis*)	Adult nectar plant	Variety of different butterfly species and other pollinators	3
HERBACEOUS PLANTS			
Species	**Type of food source**	**Target butterfly species**	**Approximate quantity**
White Yarrow (*Achillea millefolium*)	Adult nectar plant	Ringlet, Painted Lady, Purplish Copper, Anise Swallowtail, Grey Hairstreak, Cabbage White	12
Western Columbine (*Aquilegia formosa*)	Adult nectar plant	Anise Swallowtail, Ringlet	20

Ookow (*Dichelostemma congestum*)	Adult nectar plant	Ringlet, Western Tiger Swallowtail, Anise Swallowtail	12
California Poppy (*Eschscholzia californica*)	Adult nectar plant	Ringlet, Woodland Skipper, European Skipper	20
White Plectritis (*Plectritis macrocera)*	Adult nectar plant	Ringlet	12
Western Buttercup (*Ranunculus occidentalis)*	Adult nectar plant	Ringlet, Sara Orange-tip, Mylitta Crescent	Seeds for ~60m^2
Canada Goldenrod (*Solidago canadensis)*	Adult nectar plant	Ringlet, Painted Lady, Purplish Copper, Gray Hairstreak, Lorquin's Admiral, Mylitta Crescent, Pine White	40
Spring-gold (*Lomatium utriculatum*)	Adult nectar plant	Ringlet	20
Douglas Aster (*Aster subspicatus*)	Adult nectar plant	Ringlet, Painted Lady, Grey Hairstreak, Cabbage White, Anise Swallowtail, Purplish Copper, Lorquin's Admiral	40
Pearly Everlasting (*Anaphalis margaritacea*)	Adult nectar plant	Anise Swallowtail, Painted Lady, Myllita Crescent, Woodland Skipper	20
Yellow Monkeyflower (*Mimulus guttatus)*	Adult nectar plant	Cabbage White, Painted Lady, Ringlet	15
Thistles spp. (*Cirsium spp.)*	Adult nectar plant	Western Tiger Swallowtail, Pale Swallowtail, Woodland Skipper, Field Crescent, Lorquin's Admiral	Already at site
Woolly Sunflower (*Eriophyllum lanatum*)	Adult nectar plant	Grey Hairstreak	10
GRASSES & SEDGES			
Species	**Type of food source**	**Target butterfly species**	**Approximate quantity**
Red Fescue (*Festuca rubra)*	Potential larval host plant	Ringlet	Seeds/plugs for ~100m^2

California Oatgrass (*Danthonia californica)*	Potential larval host plant	Ringlet	Seeds/plugs for ~80m^2
Tufted Hairgrass (*Deschampsia cespitosa)*	Potential larval host plant	Ringlet	Seeds/plugs for ~40m^2
Hare Sedge (*Carex leporine)*	Potential larval host plant	Ringlet	10
Thick-headed Sedge (*Carex pachystachya)*	Potential larval host plant	Ringlet	12
Roemer's Fescue (*Festuca roemeri)*	Potential larval host plant	Variety of different butterfly species	Seeds/plugs for ~40m^2
Blue Wildrye (*Elymus glaucus*)	Potential larval host plant	Variety of different butterfly species	Seeds/plugs for ~40m^2
Pacific Bentgrass (*Agrostis exarata)*	Potential larval host plant	Ringlet	Seeds/plugs for ~40m^2

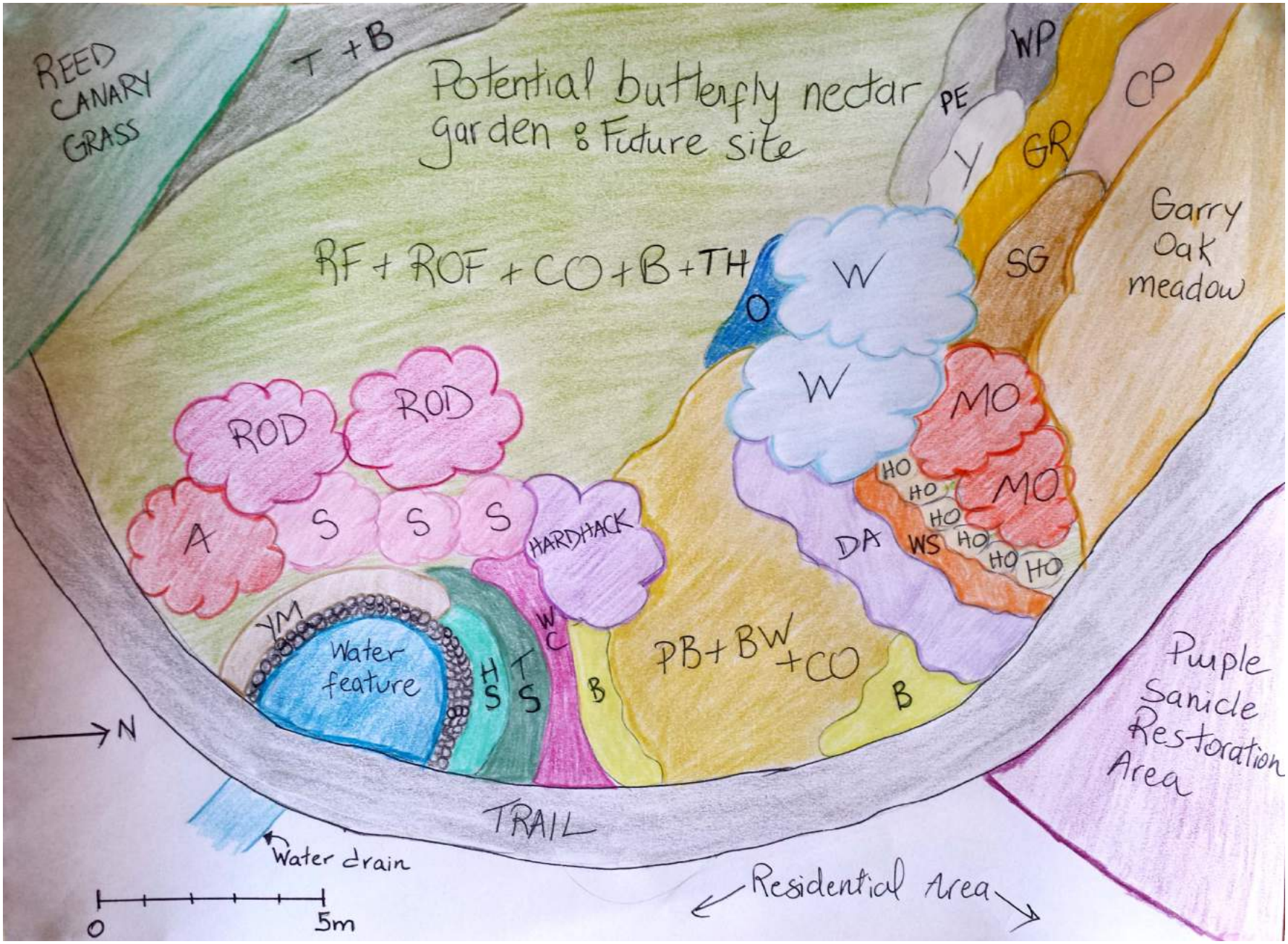

Fig.15. Proposed design of Rithet's Bog butterfly nectar garden. Legend describing plant species is on the following page.

PLANT LIST LEGEND

Trees

A Pacific crabapple (*Malus fusca*)
W Willows (*1 S.lucida + 1 S. scouleriana)*
ROD Red-osier dogwood (*Cornus stolonifera)*

Shrubs

Hardhack *(Spiraea douglasii)*
S Salmonberry (*Rubus respectabilis*)
MO Mock-orange (*Philadelphus lewisii*)
HO Hairy honeysuckle (*Lonicera hispidula*)

Grasses &Sedges

RF Red fescue (*Festuca rubra*)
BW Blue wildrye (*Elymus glaucus*)
CO California oatgrass (*Danthonia californica*)
TH Tufted hairgrass (*Deschampsia cespitosa)*
ROE Roemer's fescue (*Festuca roemeri*)
PB Pacific bentgrass (*Agrostis exarate)*
HS Hare sedge (*Carex leporine)*
TS Thick-headed sedge (*Carex pachystachya)*

Herbaceous

WC Western columbine (*Aquilegia formosa*)
YM Yellow monkeyflower (*Mimulus guttatus)*
DA Douglas aster (*Aster subspicatus*)
CP California poppy (*Eschscholzia californica*)
WS Woolly sunflower (*Eriophyllum lanatum*)
WP White plectritis (*Plectritis macrocera)*
PE Pearly everlasting (*Anaphalis margaritacea*)
O Ookow (*Dichelostemma congestum*)
B Western buttercup (*Ranunculus occidentalis)*
GR Canada goldenrod (*Solidago canadensis)*
SG Spring gold (*Lomatium urticulatum*
T Thistles spp. (*Cirsium spp.)*
Y Yarrow (*Achillea millefolium*)

8.3. EDUCATIONAL ACTIVITIES AND INTERPRETIVE SIGNAGE

In order to further conservation efforts at the bog and encourage public participation and learning, a number of activities are suggested in this report. First and foremost, it is proposed that an interpretive sign be posted on the perimeter trail by the future nectar garden, in order to inform the public of the project and raise awareness of the issues regarding butterfly habitat loss and what can be done to encourage recovery. The interpretive sign could follow the model presented adjacently in Fig. 16, with a more general focus on the habitat and plants as well as the threats faced by the "Vancouver Island" Ringlet. Discussions on the exact design and information presented on the sign will occur between the author of this report, RBCS and Saanich Parks before a finalized version is completed.

Fig.16. Proposed model for interpretive signage at the butterfly nectar garden. Display should be on the trail facing the garden. Source: Pulse Design, 2017.

Other types of activities to engage the public could include public displays and animations, focused on different aspects of the ecology of Rithet's Bog and the Ringlet. Examples could include: a miniature "bog" display where wetland ecology is presented, animation with puppets explaining Ringlet biology (see Fig.17) or introducing butterfly monitoring as a scavenger hunt in neighbouring schools, with collectible butterfly information cards as prizes.

Fig.17. Example of public engagement activity. The author of this report is seen here with "Ringo", a butterfly puppet which could help to deliver information on Ringlet biology.

Another way to support butterfly conservation would be to partner up with such projects as the Victoria Butterflyway (https://davidsuzuki.org/take-action/act-locally/butterflyway/victoria/). This project, organized by the David Suzuki Foundation, encourages citizens to build butterfly habitat in urban areas, either as gardens at private residences, or as patches of habitat near hospitals, schools, public buildings, etc. They also have built a mobile-garden: a "bicycle-propelled flower buggy" which can be transported to many areas around the city, especially to sites where there might not be much green space, thus providing a connecting habitat patch for dispersing pollinators. This type of project could be adapted to Rithet's Bog context and be used as a mobile display at different community events in order to inspire, inform and encourage people to build their own little patches of butterfly habitat.

9. BUDGET

The following table presents an estimation of costs associated with the restoration of the wet meadow/butterfly nectar garden area, the construction of the garden and costs involved with preparing and distributing educational material.

Table 5. Estimated budget for the habitat restoration project at Rtihet's Bog and associated educational activities

SITE AMELIORATION AND EDUCATIONAL MATERIAL COSTS					
Description	**Quantity**	**Unit**	**Unit price ($)**	**Total ($)**	**Notes**
Removal of Hawthorn	Saanich Parks				
Removal of patches of Hardhack, Reed Canary Grass and Nootka Rose	Tools and volunteers as part of a joint collaboration effort with RBCS (Pulling Together Program) & other restoration organizations such as the GVGT and HAT			100	For snacks/lunches during volunteer days
Water feature (pond) construction					Home Depot Victoria (Shelburne St) Quote
Pond liner	1	5'x5' PVC liner	24.99	24.99	
Pump	1	pump	66.13	66.13	
Tubing	2	½" black vinyl tubing 10ft	9.98	19.96	
Ruled level	1	level	19.98	19.98	
Levelling Sand	1	36kg bag	12.20	12.20	
Rocks for pond edge	3	18kg bag	8.98	26.94	
Shovels/volunteers	Tools and volunteers as part of a joint collaboration effort with RBCS (Pulling Together Program)				
Interpretive sign printing	1	24"x36" sign, metal frame	225	225	Alley Cat Signs Victoria
Printed educational material					ZAP copy UVIC
Pamphlets	100	Pamphlet	0.79	79	
Picture Cards	50	Card	0.55	27.50	
Information sheets	50	Sheet	0.5	25	

PLANTING COSTS					
Description	**Quantity**	**Unit**	**Unit price ($)**	**Total ($)**	**Notes**
Pacific Crabapple	1	1 gal pot	15.00	15.00	Saanich Native Plants
Mock-orange	2	1 gal pot	10.00	20.00	Saanich Native Plants
Hairy Honeysuckle	2	10cm flat	5.00	10.00	Saanich Native Plants
Salmonberry	3	1 gal pot	10.00	30.00	Saanich Native Plants
White Yarrow	1	1g seed bag	4.99	4.99	West Coast Seeds
Western Columbine	1	0.5g seed bag	5.99	5.99	West Coast Seeds
Ookow	1	1g seed bag	15.65	15.65	Sierra Seed Supply
California Poppy	1	0.5g seed bag	3.19	3.19	West Coast Seeds
White Plectritis	1	1g seed bag	3.19	3.19	West Coast Seeds

Western Buttercup	16	5g seed bag	3.25	52	Silver Falls Seed Company
Canada Goldenrod	10	10cm flat	3.50	35	Saanich Native Plants
Spring-gold	5	10cm flat	5.00	25	Saanich Native Plants
Douglas Aster	1	0.5g seed bag	4.49	4.49	West Coast Seeds
Pearly Everlasting	5	10cm flat	4.00	20	Saanich Native Plants
Yellow Monkeyflower	4	10cm flat	3.50	14	Saanich Native Plants
Woolly Sunflower	1	1g seed bag	4.99	4.99	West Coast Seeds
Red Fescue	15	10g seed bag	3.25	48.75	Silver Falls Seed Company
California Oatgrass	20	10g seed bag	3.25	65	Silver Falls Seed Company
Tufted Hairgrass	3	10g seed bag	3.25	9.75	Silver Falls Seed Company
Hare Sedge	3	10cm flat	4.00	12	Saanich Native Plants
Thick-headed Sedge	3	10cm flat	4.00	12	Saanich Native Plants
Roemer's Fescue	6	10g seed bag	3.25	19.50	Silver Falls Seed Company
Blue Wildrye	6	10g seed bag	3.25	19.50	Silver Falls Seed Company
Pacific Bentgrass	3	10g seed bag	3.25	9.75	Silver Falls Seed Company
Planting of new nectar garden plants	Tools and volunteers as part of a joint collaboration effort with RBCS (Pulling Together Program) & other restoration organizations such as the GVGT and HAT			100	For snacks/lunches during volunteer days
GRAND TOTAL	**$1186.44**				

10. CONCLUSION

Managing for sensitive habitat in urban areas can be a challenging and complex problem. Not only must one take into account the specific needs of the ecosystem and species inhabiting it, but at the same time balance often competing priorities between human growth and ecological diversity. It is also important to identify influences from past histories of the landscape, as different uses of the land can act as stacked up layers which can be difficult to separate. The situation at Rithet's Bog is a perfect example of these complex issues. Heavily influenced by its agricultural past, the wetland communities at the bog have undergone many changes in the last century. Now that it has become a conservation area, municipalities, conservation groups and researchers are working together in order to maintain its ecological integrity in increasingly changing climatic conditions. This report, which examined but one of many sensitive species who have made the bog their home, investigated the population of the "Vancouver Island"

Ringlet in this area, and proposed a series of solutions in order to restore and maintain a rich and diverse butterfly habitat. By providing for different host and nectar plants, with complementing flowering times, managing encroachment of invasive species and encouraging community participation, it is hoped that the area will be able to adapt to future challenges and thrive in balance with the urban neighbourhoods surrounding it. In order to ensure the long-term success of this project and other research initiatives at the bog, monitoring will be a critical and essential step, allowing to maintain a restored and resilient ecosystem.

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