

Mary Lake Nature Sanctuary — Lake Stewardship Project



Royal Roads University B.Sc. Environmental Science

ENSC 420 — Major Project

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RRU
Environmental
Consulting

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Executive Summary

Mary Lake Nature Sanctuary is a 42-acre protected property, located about 25 kilometers northeast of Victoria, British Columbia. The sanctuary, which protects a variety of natural ecosystems, including wetlands, stream sides, forests, and outcrops, lies within the traditional territory of the WSÁNEC (Saanich) Coast Salish First Nations, as well as the Highlands District of the Capital Region District (CRD) of Vancouver Island (GVGS, n.d.a,b).

Currently, Mary Lake Nature Sanctuary is governed by the Greater Victoria Greenbelt Society (GVGS), a registered non-profit society that emphasises environmental conservation, as well as the purchase of greenbelt land for the purpose of preserving natural and cultural heritage. Since the GVGS first purchased the land of Mary Lake Nature Sanctuary, they have partnered with several groups and organizations, including the CRD, District of Highlands, MJ Architecture, and the Tsartlip First Nation. The GVGS has also worked closely with local supporters and businesses, as well as environmental clubs and organizations (GVGS, n.d.c).

In 2019, on behalf of Royal Roads University, Van Isle Eco Consulting were recruited to prepare a baseline report outlining the health and current state of Mary Lake and the surrounding area. Over a six-month period, Van Isle Eco Consulting conducted a series of sampling and monitoring plans to obtain baseline data on the water and sediment quality of the lake and surrounding streams, as well as the biodiversity of the lake and surrounding area. Following analysis of the data obtained by Van Isle Eco Consulting, it was concluded that the ecosystems in the sanctuary were relatively healthy; however, it was recommended that both water quality and ecological monitoring continue following completion of the project (Jones, Le, May & Ross, 2019).

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RRU Environmental Consulting was recruited the following year, 2020, on behalf of Royal Roads University to initiate the second phase of the project. Following the recommendations proposed by Van Isle Eco Consulting, as well as the interests mentioned by members of the GVGS, RRU Environmental Consulting had prepared a series of sampling and monitoring plans. The results obtained from analysis of the sampling and monitoring data would assist in answering a series of questions that the project was based on, including if there were any significant differences between the data obtained in 2019 and 2020. Additionally, the gathered data would have also been used to assess whether construction of a public use trail would adversely impact the area, what shoreline species are present, and if there is suitable habitat available for salmonids.

RRU Environmental Consulting began sampling and monitoring in February 2020, but shortly after, the COVID-19 pandemic was declared and all field work ceased until further notice. A few weeks following the declaration of the pandemic, RRU Environmental Consulting was notified that the project was to come to an end, and were given until the end of June of the same year to prepare a formal report using the limited data that had been collected as well as data from phase one. Online literature was also heavily utilized for the development of this report and the development of recommendations regarding work that could be carried out in future.

Acknowledgements

We would like to acknowledge that we live and learn on the unceded territories of the Coast Salish Peoples. We are extremely grateful to have the opportunity to experience these lands and hope that our work will help protect the Mary Lake Nature Sanctuary and its deep ties to First Nations culture.

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We would also like to thank our sponsor at the Greater Victoria Greenbelt Society (GVGS), Eric Bonham, as well as Bob McMinn, Koi Neah and Tim Boesenkool.

Thank you to Jonathan Moran, our advisor, for guiding us throughout the project, accompanying us to tour Mary Lake and offering invaluable ecological insights and suggestions for project implementation. Thank you to Sharon McMillan for assisting us at the Royal Roads laboratory with our water quality analysis. And lastly, thank you to Mickie Noble and the all of the Royal Roads staff that make the major projects possible.

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Acronyms and Abbreviations

AAS: Atomic Absorption Spectrophotometry

CCME: Canadian Council of Ministers of the Environment

CRD: Capital Region District

DO: Dissolved Oxygen

GVGS: Greater Victoria Greenbelt Society

N&P: Nitrates and Phosphates

RRU: Royal Roads University

TDS: Total Dissolved Solids

XRF: X-ray Fluorescence

Glossary of Terms

Conductivity: A measure of a water sample's ability to conduct electricity which is related to the ion concentration.

Dissolved Oxygen: A measurement of the oxygen concentration dissolved in a volume of water.

Flora: Vegetation found in a particular region.

Fauna: Animals found in a particular region.

Gee Trap: A fish trap that allows fish species and density to be monitored without harming the specimen.

Spectrophotometry: An analysis method used to measure the light absorbance of a sample; this is used to calculate the concentration of a contaminant.

Total Nitrate: A measure of total nitrate concentration found in a water sample.

Total Phosphate: A measure of total phosphate concentration in a water sample.

X-ray Fluorescence: Analytical technique used to determine the elemental composition of materials.

1.0 Introduction

1.1 Background and History

The Mary Lake Nature Sanctuary is owned and operated by the GVGS, which intends to ensure the property stays a protected area with minimal human interference in natural processes. This property is a traditional territory of the WSÁNEC (Saanich) Coast Salish Peoples, with several other groups being known to have used this site for spiritual ceremonies, hunting and gathering of food and medicines. It was not until 1887 that the land was privately owned, being purchased by settlers of Vancouver Island. The site was later purchased by a logger, Albert Reginald Manzer, who had the earth dam installed, producing the lake which was named after his daughter, Mary. In 1947, a local artist, Gertrude Mabel Snider, purchased the property with the intent of protecting the property's beauty. The property was sold again in 1963 to Peter & Hazel Brotherston, avid conservationists who added some features to the property such as a fish ladder and concrete dam, which improved the lake's potential as habitat. Finally, the GVGS purchased the property in 2016 with the intent of ensuring that the site stays protected for the foreseeable future (GVGS, n.d.d).

The GVGS acknowledges the importance of this site for traditional uses and continues to work with First Nations groups to that ensure stewardship of the land is done in a meaningful way. This has allowed the GVGS to build a strong relationship with these First Nation groups and has opened the property to traditional events to respect the site's history and encourage indigenous education. (GVGS, n.d.e). To help aid the preservation and conservation efforts of the GVGS, a partnership has been made with RRU for the purpose of continued monitoring.

1.2 Scope

This project was designed to answer four main questions:

1. Do the water quality parameters fall within government guidelines and does a significant difference exist between the previous year's sampling data and the current year's data?
2. Would the construction of a public use trail adversely impact the surrounding area?
 - a. Would there be an impact on wildlife trees?
 - b. Would there be an impact on red or blue listed species (plant and animal)?
3. What shoreline plant species are present and is there risk to the shoreline habitat?
4. Does suitable habitat exist for aquatic invertebrates and salmonids?

1.3 Lake Monitoring Plan

Phase one of RRU's partnership with the GVGS was focused on collecting bathymetric data of Mary Lake along with beginning to develop a baseline dataset for water quality parameters. Multiple years of monitoring is required to develop a representative baseline dataset and thus, phase two had a significant water quality monitoring plan. The baseline data would give insight into the condition of Mary Lake and allows future monitoring to identify a significant change in the water chemistry from ongoing land development in the region. Given the size and depth of the lake, some potential parameters of concern are dissolved oxygen (DO), temperature, and total coliforms, as well as nitrates and phosphates (N&P). Since the lake is shallow it was expected to be quite warm by mid to late summer, acting as a potential stressor on flora & fauna and drastically reducing DO. This increase in temperature is also likely to increase the total coliform count as coliforms typically thrive in warm waters; this is also true for algae, making additional nutrients from

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runoff or upstream pollution of concern. These contaminants, along with several other potentially damaging parameters were to be monitored to expand the baseline dataset and give a better understanding of the health of Mary Lake.

1.4 Shoreline Plant Survey

To determine the shoreline plant species present at Mary Lake Nature Sanctuary, as well as to determine if there was any risk to the shoreline habitat, shoreline plant surveys were planned to be conducted on a monthly basis, starting in March 2020. Although no ecological data regarding the shoreline habitat was obtained, RRU Environmental Consulting consulted available resources to propose a recommendation for the shoreline habitat of Mary Lake. It is thought that there is a potential risk of natural and anthropogenic erosion of the shoreline, as well as risk of harm to presumably present native shoreline plant species.

1.5 Proposed CRD Trail

The CRD has proposed that a walking trail be constructed that will run along the southern end of the property. While a biological survey had been completed on behalf of the CRD, the GVGS was not pleased with the results or the timing of the survey. The survey had been completed in the fall/winter season and therefore, missed many important seasonal species and changes on the property. As a result, this was not accepted as representative of the actual species found within the sanctuary and hence, does not include all potential impacts the constructed trail would incur.

This area was to be continuously monitored for red and blue listed flora and fauna as well as wildlife trees. This would have allowed us to understand potential ecological impacts that the proposed trail may cause and allow us to give more informed recommendations for reducing this impact.

1.6 Salmonid Habitat and Gee Trapping

Currently, it is unclear what fish species inhabit Mary Lake seasonally or permanently and due to the high protection status of salmonids through the Department of Fisheries and Ocean Canada (DFO), the presence of salmonids would be extremely valuable for conservation purposes. As many landlocked fish migrate throughout water systems seeking optimal conditions, it is possible for species such as cutthroat trout to inhabit Mary Lake or Earsman Creek during certain seasons. To better understand the fish species in Mary Lake and Earsman Creek, gee trapping was to be used to begin the process of species monitoring. To further support the idea of this site being salmonid habitat, surveys were to be completed following outlines found in *The Streamkeepers Handbook* (Fisheries and Oceans Canada, 2000). Since some conditions of the stream may be improved by altering land management practices, recommendations have been given on how to improve habitat for salmonids. Due to no data being available for the presence of salmonids in Mary Lake, this section will not be discussed.

2.0 Materials and Methods

2.1 Water Quality

Water quality parameters to be monitored on a regular basis (bi-weekly) included pH, temperature, DO, conductivity and salinity. Parameters that were to be monitored quarterly are nitrate, phosphate and heavy metals. Bi-weekly sampling frequencies were selected for parameters that were expected to have high fluctuation in values, such as pH and DO. Nitrates, phosphates and heavy metals show patterns of seasonal changes or human interference but rarely suddenly change from natural processes, and thus can be sampled less

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frequently. Consistent data collection is crucial as this will allow future sampling results to be more accurately compared to past values.

Each parameter was to be sampled for at five locations: Lake 1, 2 and 3, as well as North Earsman and South Earsman. A map labelling these locations and a table of coordinates can be found in Appendix A. These sites were selected based on locations used in phase one to keep data collection as consistent as possible, although it should be noted the location labelled “Dead Deer Creek” was retired. During the times when the team was able to collect water quality data, Thermo Scientific Eutech Elite PCTS and Digi-Sense Dissolved Oxygen probes were used to measure pH, temperature, DO, and conductivity. Additionally, water samples were collected in HDPE bottles 30cm below the water surface and analyzed in the RRU laboratory using potentiometric titration and spectrophotometry, to determine concentrations of nitrates and phosphates. While no heavy metal samples were collected, a wide array of metals were to be tested for using AAS to quickly develop a complete workup of the metal content of the water column.

Given that a lack of data was collected, 2020 data was reviewed and compared with 2019 water quality data to produce recommendations and identify potential parameters of concern for the continuation of monitoring.

2.2 Sediment Survey

In order to gain a better understanding of potential impacts created by the addition of a walking trail, this project was designed to assess the area throughout the spring and summer to survey and record species that may be affected. Given that the field surveys were unable to occur, a variety of online resources in combination with the confirmed and suspected species lists available on the Mary Lake website and the report from the preceding RRU team project were used.

2.3 Shoreline Plant Species

Shoreline plant surveys were to be conducted on an observational basis, once a month, starting in March 2020 and to continue for the duration of the project. The surveys would have involved performing transects and recording the plant species present. To ensure that the plant species were properly identified, field guides, as well as assistance from our academic advisor, Jon Moran, were to be utilized. Populations of the identified plant species, as well as GPS coordinates and field observations, were to be recorded and transcribed to an Excel document. Photos of the plant species and habitat were also to be included. Since no surveys were conducted, both online literature and data collected from phase 1 were used to predict the shoreline plant species present at Mary Lake, and to determine whether there was a risk to the shoreline habitat.

2.4 Proposed CRD Trail Impact Assessment

In order to gain a better understanding of potential impacts created by the addition of a walking trail, this project intended to assess the area throughout the spring and summer to survey and record species that may be affected. In place of field surveys, online resources including confirmed and suspected species recorded in the area as well as the report from the preceding RRU team were used.

2.5 Salmonid Habitat and Gee Trapping

Gee traps were to be used to better understand and record the aquatic life found in Mary Lake and Earsman Creek with the intent to potentially identify the area as cutthroat trout (or other salmonids) habitat. Gee traps were to be placed in locations where there is a

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light current, woody debris acting as cover and mostly shaded and cool enough to provide suitable habitat. In order to prevent damaging the specimen a soak time of no longer than 2 hours was to be used. It should also be noted that proper permitting is required to trap salmonids and to ensure compliance with said permit, sites and sampling plans should be approved by the academic advisor holding the permit. To objectively rate Mary Lake and Earsman Creek for potential salmonid habitat, The Streamkeepers Handbook was to be used to assess parameters such as overhead canopy coverage, woody debris cover and off-channel habitat (Fisheries and Oceans Canada, 2000). While no data was collected that gave insight to the presence of salmonids in Mary Lake, water monitoring data was used from the phase one report to discuss the potential of their presence and produce recommendations for future monitoring.

3.0 Results

3.1 Water Quality

Due to the halt of the project, general water quality parameters could only be sampled for twice, including one N&P sample that was analyzed in the lab, the results of which can be seen in Tables 1 to 4. Table 1 shows nitrate concentrations for water samples collected from Mary Lake and Earsman Creek to be low. Table 2 shows phosphate concentrations for the same locations which again, resulted in low values. Tables 3 and 4 show conductivity, total dissolved solids, pH, dissolved oxygen and temperature values, all of which were within acceptable ranges.

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Table 1. Absorbance readings of blank, prepared nitrate standards of 0.5ppm, 1ppm, 2ppm and 3ppm and water grab samples collected and prepared with calculated ppms for each water sample on March 3, 2020 using a Genesysis 10VIS Thermo Scientific spectrophotometer at a wavelength of 520nm.

Samples and Standards	Absorption (520nm)	Calculated Concentration (ppm)
Blank	0.000	-
Standard 1 (0.5 ppm)	0.061	-
Standard 2 (1.0 ppm)	0.097	-
Standard 3 (2.0 ppm)	0.243	-
Standard 4 (3.0 ppm)	0.342	-
Lake 1	0.000	0.000
Lake 2	0.000	0.000
Lake 3	0.007	0.063
Earsman Creek (North)	0.011	0.097
Earsman Creek (South)	0.010	0.089

Table 2: Absorbance readings of blank, prepared phosphate standards of 0.25ppm, 0.5ppm, 1ppm, 2ppm, 3ppm and water grab samples collected and prepared with calculated ppms for each water sample on March 3, 2020 using a Genesysis 10VIS Thermo Scientific spectrophotometer at a wavelength of 650nm.

Samples and Standards	Absorption (520nm)	Calculated Concentration (ppm)
Blank	0.000	-
Standard 1 (0.25 ppm)	0.029	-
Standard 2 (0.50 ppm)	0.069	-
Standard 3 (1.00 ppm)	0.167	-
Standard 4 (2.00 ppm)	0.349	-
Standard 5 (3.00 ppm)	0.533	-
Lake 1	0.011	0.073
Lake 2	0.008	0.060
Lake 3	0.008	0.060
Earsman Creek (North)	0.004	0.030
Earsman Creek (South)	0.011	0.073

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Table 3: Water quality measurements including conductivity, TDS, pH and dissolved oxygen recorded onsite on February 29th, 2020 by Hailey Morrell and Laura Stewart using Thermo Scientific Eutech Elite PCTS and Digi-Sense Dissolved Oxygen probes.

Location	Conductivity (μS/cm)	Total Dissolved Solids (ppm)	pH	Dissolved Oxygen (%)	Temperature (°C)
Lake 1	126.9	90.1	8.26	21.1	4.93
Lake 2	125.9	89.5	7.68	19.4	5.65
Lake 3	126.2	91.0	7.80	21.5	5.25
Dock	127.5	90.8	8.04	19.9	5.33
Earsman Creek (North)	129.6	92.3	7.99	21.5	5.28
Earsman Creek (South)	120.2	85.6	7.00	21.3	5.33

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Table 4: Water Quality measurements including conductivity, TDS, pH and dissolved oxygen recorded onsite on March 3, 2020 by Hailey Morrell and Laura Stewart using thermo Scientific Eutech Elite PCTS and Digi-Sense Dissolved Oxygen probes.

Location	Conductivity (µS/cm)	Total Dissolved Solids (ppm)	pH	Dissolved Oxygen (%)	Temperature (°C)
Lake 1	141.6	101	8.25	20.7	6.13
Lake 2	127.8	91.8	8.10	20.8	6.95
Lake 3	125.9	90.0	7.98	21.2	6.60
Dock	128.6	91.4	7.94	-	6.28
Earsman Creek (North)	131.6	93.6	8.24	-	5.70
Earsman Creek (South)	125.2	88.3	8.06	-	6.00

3.2 Shoreline Plant Species

Although the shoreline surveys were not conducted, it was expected that native shoreline plant species would be present in the shoreline habitat of Mary Lake. Using the report prepared by Van Isle Eco Consulting, Mary Lake contains at least four shoreline plant species, including Water Smartweed (*Polygonum amphibium*), common bur-reed (*Sparganium eurycarpum*), diverse-leaved star-wort (*Callitriche heterophylla*), and water mint (*Mentha aquatica*) (Jones, Le, May & Ross, 2019). All of the shoreline plant species identified by Van Isle Eco Consulting are considered to be perennial, and most are classified as native to British Columbia (Klinkenberg, 2020).

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Common Bur-reed (*Sparganium eurycarpum*)

Common bur-reed, also known as broadfruit bur-reed, is an aquatic plant species classified as native to British Columbia. The plant grows to be about 60 to 120 cm tall, contains alternating 20 to 80 cm long and 8 to 20 cm wide leaves, and bears branched flowers. Currently, common bur-reed is yellow-listed, with a provincial conservation status of S5, meaning that the population of the species is abundant and secure (Klinkenberg, 2020a).

Water Smartweed (*Polygonum amphibium*)

Water smartweed grows to be about 30 to 80 cm tall, and bears spike-like pink flowers, as well as 1 to 2 cm long egg-shaped leaves. Just like common bur-reed, water smartweed is classified as native to British Columbia, and is currently yellow-listed with a provincial conservation status of S5 (Klinkenberg, 2020b).

Diverse-leaved Star-wort (*Callitriche heterophylla*)

Diverse-leaved star-wort, also known as large water-star-wort, contains opposite veined leaves about 5 to 25 mm long, and bears small ascending flowers. Diverse-leaved star-wort is a yellow-listed species, with a provincial conservation status of S4S5, meaning that the species is either apparently or demonstrably secure (Klinkenberg, 2020c).

Water Mint (*Mentha aquatica*)

Water mint is a small plant, about 15 to 90 cm tall, that produces clusters of lemon-scented flowers, and contains 2 to 6 cm long lobed leaves that are oppositely arranged. Water mint is classified as exotic to British Columbia (Klinkenberg, 2020d).

3.3 Proposed CRD Trail Impact Assessment

Our team had originally planned to survey the proposed trail area to determine if sensitive plants and animals were within a boundary that would cause a negative impact to their wellbeing. We have used available information regarding current wildlife and vegetation species that are present as well as other online information to support our recommendation that a trail not be constructed.

During our limited visits to the sanctuary in early spring, it was evident that the forest area where the trail is proposed contains an extremely high density of various lichen and moss species. Observational surveys conducted by the previous RRU team resulted in 21 species being identified (Jones, Le, May & Ross, 2019).

One species, the Seaside Bone Lichen (*Hypogymnia heterophylla*), is federally threatened and red-listed in BC (B.C. Conservation Data Center, 2020a). Within Canada, all of the seven known locations for this species are on the southern coast of Vancouver Island with a total of 2000 to 3000 individuals (Environment and Climate Change Canada, 2017). The Mary Lake location of this lichen does not appear to be included in the 2017 report, making it all the more important to protect and document. Its primary habitat is on live branches of Shore Pine growing on rocky, wind affected ledges (Goward, 1996). However, Douglas-fir (*Pseudotsuga menziesii*) (Marsh, 2012), Sitka Spruce (*Picea sitchensis*) (Noble, 1975), and Oceanspray (*Holodiscus discolor*) (Goward & Knight, 1991) are also known substrates.

The Phantom Orchid (*Cephalanthera austiniiae*) is also provincially red-listed and federally threatened (B.C. Conservation Data Center, 2020d) and has been recorded on the land (Greater Victoria Greenbelt Society, n.d.). This species is of particular concern due to its precise habitat and relationship requirements; the phantom orchid requires a three-way mutualistic relationship with a fungus and tree partner to grow, and all three must be in

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good health to increase the viability of the orchid's reproduction. According to the BC Conservation Data Centre: Species Summary (n.d.), the Phantom Orchid grows in areas where little to no ground disturbance has occurred to the surface and with open canopy cover. Additionally, this species is only known to occur in two small regions of BC; the southern tip of Vancouver Island and the Fraser Valley Regional District (B.C. Conservation Data Center, n.d.).

There are also a number of reptiles and amphibians residing on the Mary Lake land, two of which are listed species. The Sharp-tailed Snake (*Contia tenuis*) is red-listed in BC and federally endangered (B.C. Conservation Data Center, 2020b) and the Northern Red-legged Frog (*Rana aurora*) is blue-listed in BC and of special concern federally (B.C. Conservation Data Center, 2020c).

The available information indicates that, within the Mary Lake sanctuary, two threatened bird species have been seen and recorded: the Great Blue Heron (*fannini* subspecies), and the Olive-sided Flycatcher (*Contopus cooperi*). The Western Screech Owl (*kennicotti* subspecies) is also suspected to reside in the area (Greater Victoria Greenbelt Society, n.d.).

In addition to plants and animals, the sanctuary also contains a variety of provincially red-listed ecological communities such as: Garry Oak / Arbutus, Red Alder / Skunk Cabbage, Trembling Aspen / Pacific Crab Apple / Slough Sedge, Douglas-fir / Dull Oregon-grape, Garry Oak / Ocean Spray, and Western Redcedar-Douglas-fir / Oregon Beaked-moss (Greater Victoria Greenbelt Society, n.d.). The ecosystems that the proposed trail would transect however are unknown due to interrupted survey plans and the absence of relevant online resources.

In addition to listed species and ecosystems, the sanctuary is home to other rare and interesting species such as those identified by the previous year's study by Royal Roads

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Students (Jones, Le, May & Ross, 2019). Over the course of their project, they identified Candystick (*Allotropia virgata*), Ground Cones (*Boschniakia hookeri*), and Bladderwort (*Utricularia sp.*), all uncommon species. Though not endangered, the protection and preservation of these species is important for maintaining the biodiversity found on the land.

4.0 Discussion

A full understanding of the health of the Mary Lake Nature Sanctuary was not able to be assessed. However, through research using various resources, an assessment based on literature review as well as our brief time visiting the sanctuary was conducted.

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4.1 Lake and Stream Water Quality

Due to lack of data, no trends could be observed for the water quality of Mary Lake and Earsman Creek for 2020. For the data that was collected, no value recorded exceeds the Government of BC's Approved Water Quality Guidelines. Background parameters indicate the lake may have low conductivity levels, which indicate high water quality, along with pH and DO readings that are all well within guidelines; there is no indication of contaminated water (Government of Northwest Territories. N.D; Government of BC, 2019). Nitrogen and phosphate levels follow trends seen in phase one data and are well below the allowable levels outlined in the Approved Water Quality Guidelines, further suggesting that Mary Lake is not threatened by algal blooms (Government of BC, 2019). While the water quality of Mary Lake appears to be quite good, the water temperatures recorded in phase one water sampling may show an issue for aquatic life. With values surpassing 20°C on several monitoring days, it seems that the lake regularly reaches high temperatures (Jones, Le, May & Ross, 2019). With these high temperatures, come low DO values, which when paired acts as a major stressor on aquatic life. Phase one data shows DO values in ranges of 4.3% to 10.9%, depending on location, during sampling in June, which is out of range for the Approved Water Quality Guidelines (Jones, Le, May & Ross, 2019). This confirms that the largest threat to aquatic life in Mary Lake is likely high temperatures and low DO values, which may remove the lake as potential habitat for some species of aquatic life.

4.2 Shoreline Plant Species

A shoreline is a region of land that is located adjacent to a body of water. Shorelines provide visitors with beautiful views, but more importantly, they provide habitat for flora and fauna. The plant species found thriving in shorelines are of great importance, as they provide several benefits to the ecosystems they reside in. One such benefit is that plants

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support the structural integrity of shorelines by preventing erosion from water, waves, and intense stream flows. Another benefit is that plants provide smaller organisms with food and shelter. Although there are many native shoreline plant species that provide benefits to their surrounding ecosystem, there are also many invasive plant species that can cause harm to the shoreline. For this reason, the identification of plants inhabiting a shoreline is important in determining the health and current state of the ecosystem.

Shorelines are extremely vulnerable to erosion, and although they often erode from natural causes, such as water breaching, they may also erode from anthropogenic causes as well. An example of a shoreline eroding due to an anthropogenic cause, is recreational overuse. If a shoreline is frequently visited, not only will the underlying soil become compacted and damaged, but the native plant species that aid in the structural integrity of the shoreline will become compacted and damaged as well.

For the reasons mentioned above, conducting shoreline surveys at Mary Lake Nature Sanctuary would have been extremely useful for determining the degree of conservation that needs to be subsequently enforced. The purpose of conducting shoreline surveys was to determine the shoreline plant species present, as well as to determine whether or not there is any risk to shoreline habitat. In the project plan, it was outlined that shoreline plant identification would be conducted on an observational basis once a month, beginning near the end of February 2020. However, due to COVID-19, the shoreline surveys were never conducted.

Using the plants that were identified by Van Isle Eco Consulting in 2019, there are at least four shoreline plant species present at Mary Lake, three of which are classified as native to British Columbia, including water smartweed, common bur-reed, and diverse-leaved starwort. Although all three of the native species identified by Van Isle Eco Consulting are

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yellow-listed and have a provincial conservation status of S5, meaning they are in abundant and secure populations, they should still be conserved and protected.

4.3 CRD Trail

Though walking trails bring many benefits to those who use them, their presence in a forest ecosystem can be of great disturbance to wildlife (Botsch et al., 2018). Specifically, Botsch et al. (2018) found that the presence of humans in a forest habitat negatively impacted the density and species richness of birds. A number of endangered species including birds have been found on the property. Legislation regarding species at risk has not yet been developed in BC; however, it is in the early stages of doing so. According to a publication regarding protecting species at risk in BC, the province has more endangered species than any other province in Canada and regards preventing additional species from becoming at risk of high importance. The goal of the developing legislation is “to manage human-related activities so that: species are recovered and are no longer considered at risk; species at risk are safeguarded from further threats; and native species are not lost from B.C. (Ministry of Environment and Climate Change Strategy, 2018, p.10).

Though Mary Lake is not located near the heart of Langford, it could be considered urban due its close proximity to the downtown area. There is new construction adjacent to the land parcel and with Langford growing in popularity, sprawl is inevitable. With time, housing and commercial development may occur on all sides of Mary Lake, making it ever more accessible to those living around it. This will most likely increase the popularity of Mary Lake and the use of its walking trails and may, therefore, increase the level of disturbance felt by the local wildlife.

The construction of an additional walking trail on the south side of Mary Lake will require soil disturbance and vegetation removal. This may include habitat used by the many

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plants and animals that inhabit the area which may contribute to population decline. For example, the specific habitat requirements of the Seaside Bone Lichen are a limiting factor for this species; therefore, if vegetation must be removed during trail construction, this species may be negatively impacted by the trail. Environment and Climate Change Canada (2017) has listed recreational activities as a threat to the species. Impacts will also be felt by the phantom orchid if the specific habitat requirements are compromised.

Altering the various habitats that the trail will intersect may have similar impacts on other species that are present which could reverse progress of the recovery of a species at risk. Further, a decrease in species richness will impact the overall health of this forest (National Science Foundation, 2019).

4.4 Gee Trapping and Potential Salmonid Habitat

With the high temperatures seen in Mary Lake during summer months, it is unlikely any salmonid use this habitat year-round but there is a possibility that landlocked species may move through the area during migrations. After inspecting the site with the teams academic advisor, Jon Moran, it is believed that Earsman Creek and Mary Lake may be habitat used by species such as cutthroat trout during cooler seasons. While no sighting of the species has been made, Earsman Creek and sections of Mary Lake have good shaded sites with lots of woody debris and mild currents that may act as good sites for breeding, hunting or development for some salmonids (Fisheries and Oceans Canada, 2000). As many landlocked species face issues of high temperature and low water levels in summer months, they tend to migrate throughout the water system and thus this site may act a habitat during certain periods of the year.

5.0 Recommendations

As mentioned previously, the COVID-19 pandemic caused the scope of the project to change drastically and as a result, our recommendations for future work are largely based on online research instead of on the ground field work, as was previously planned.

5.1 Continued Lake and Stream Monitoring

Phase one of the Mary Lake project was focused on completing a bathymetric survey so the lakes depths and contours could be mapped for the first time. Phase one also included some water quality monitoring although more data was required to understand the seasonal patterns of the lake. Phase two was intended to regularly collect the additional data to better understand the lake and help produce a complete set of background data for future monitoring. This data would allow the GVGS to monitor potential changes in water quality due to on-going development in their area with the intent of protecting the valuable habitat. It is recommended that the next group of RRU students follow a similar sampling plan as outlined in this report. The outlined parameters were selected with the assistance of a phase one team representative and academic advisor, Jon Moran, to deliver an in-depth understanding of the water quality. While locations may be changed it is suggested that sampling locations stay on all incoming and outgoing streams as well as multiple locations on the lake to understand the whole water system on the site.

5.2 Shoreline Plant Species

After conducting research on shoreline habitats, and using the shoreline plant species that had been identified by Van Isle Eco Consulting in 2019 as reference, it is recommended that the shoreline habitat of Mary Lake be conserved and protected in order to preserve the

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present native shoreline plant species that are presumably present. It is also recommended that shoreline surveys be conducted in the future when COVID-19 restrictions have been lifted, and field work is both safe and permitted, in order to identify any unidentified shoreline plant species present, as well as to determine and update the risk posed to the shoreline habitat of Mary Lake.

5.3 Proposed CRD Trail

From analyzing available data regarding what flora and fauna may be present at Mary Lake at this time, we recommend that a new walking trail not be constructed. The addition of a walking trail in an area that is currently untouched by visitors has the potential to negatively impact populations of flora and fauna which in turn, will reduce the overall health of the land.

If there is opposition from interested parties, we recommend having a second impact assessment performed during the spring and/or summer months so that a more accurate survey of potentially impacted organisms can be acquired.

If, however, the trail is approved, we recommend that guidelines for construction set by the Ministry of Forests (British Columbia Ministry of Forests, 2000) should be used and great care should be taken to avoid sensitive and/or endangered species. Additionally, we think it would be best to use a raised boardwalk, especially in areas containing highly sensitive plant species. The use of a boardwalk rather than a traditional walking trail can reduce the impact on vegetation as well as the soil. Trampling and erosion can occur if users walk off trail; a boardwalk with handrails can reduce this chance. If a boardwalk is not feasible for the entire length of the trail, features that deter off trail meandering such as logs or rocks should be used. Additionally, signage that requests that users stay on trail can be used to promote the preservation of sensitive species. Areas that are prone to flooding or are regularly saturated must have a raised boardwalk or the trail should be designed to avoid such areas. Areas identified as critical habitat for threatened species should be avoided altogether.

5.4 Identification of Salmonid Species and Potential Improvements of Salmonid Habitat

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Salmonids have not been seen within the Mary Lake Sanctuary but due to their high protection status through the DFO, the identification of Mary Lake and Earsman Creek as a potential habitat would be extremely beneficial for conservation purposes. It was noted by academic advisor, Jon Moran, that while Mary Lake is likely too warm during summer months cutthroat trout may use the lake during periods of lower temperatures and Earsman creek during warm months. The finding of this species along with other salmonids could greatly increase the ecological value of the site and thus this was to be investigated by Gee trapping. Locations were identified within Mary Lake and south Earsman Creek that could potentially act as good sites for Gee trapping, selected as they had a light current, shade or woody-material cover and would stay cool throughout sampling. Due to these conditions potentially changing season to season it is suggested that a walk through is completed with the academic advisor to select appropriate sites. It would also be suggested that habitat surveys are completed, such as surveys found in *The Streamkeepers Handbook*, to test whether or not habitat might be suitable for salmonids.

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Appendix A

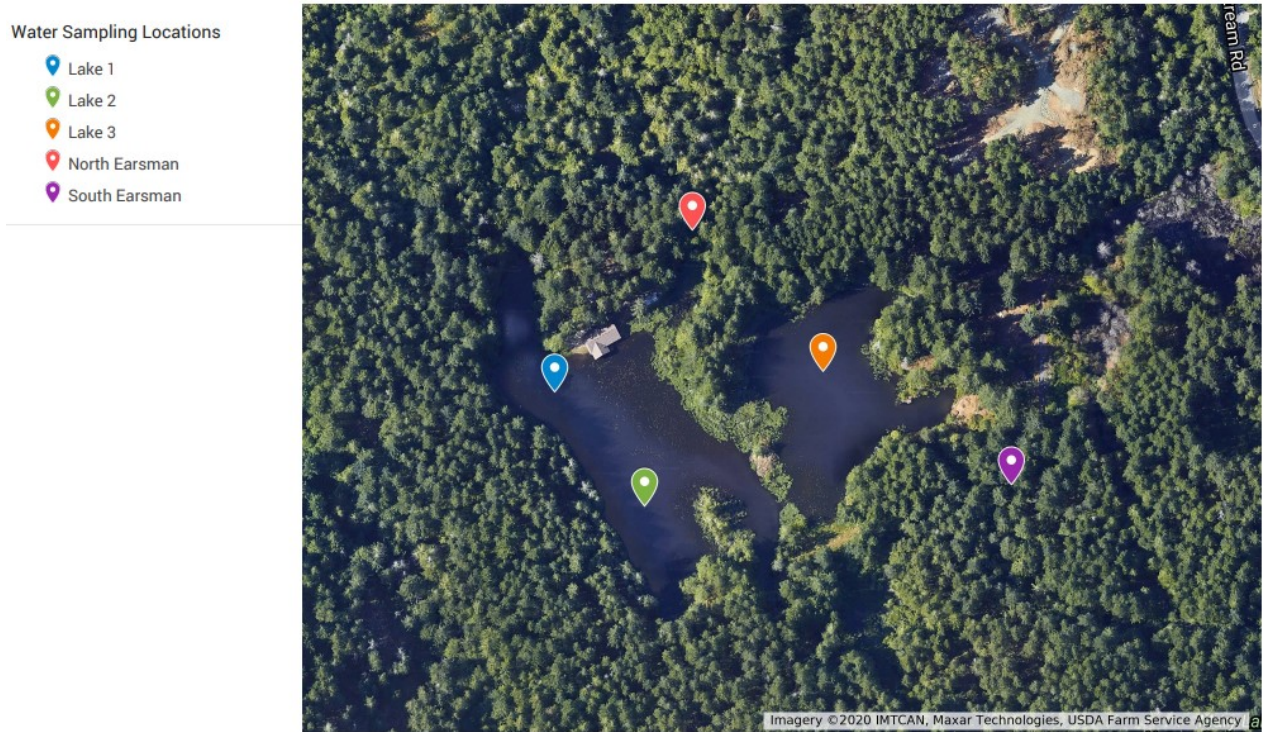


Figure 1: Overhead view of Mary Lake showing sampling locations Lake 1 - 3, North Earsman and South Earsman for Water Quality Monitoring.

Coordinate	Lake 1	Lake 2	Lake 3	Dock	Dead Deer Creek	North Earsman	South Earsman
Lat (N)	48°29.972	48°29.939	48°29.972	48°29.994	48°29.991	48°30.036	48°29.916
Long (W)	123°31.143	123°31.126	123°31.019	123°31.130	123°31.132	123°31.084	123°30.947

Figure 2: Image of Table 2 from the Mary Lake Stewardship Project Report showing coordinates used to reproduce sampling sites seen in Figure 1 (Jones, Le, May, & Ross, 2019).

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