

Mosses and Lichens of 10 North Saanich Parks



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For: The Friends of North Saanich Parks (FNSP)

1. Introduction

The parks of North Saanich are areas of recreation and education for residents to enjoy and gather in. They foster community, are sites for interpersonal interactions, and play a crucial role in how residents interact with nature. These parks also play critical roles in ecosystem services and serve as habitat for countless plants and animals. Finally, the parks of North Saanich provide an opportunity to monitor ecosystem health and how the natural world is responding to climate change and pollution.

Through observations, testing, and data collection, these parks can be sites of ecological monitoring, acting as tools which governing bodies can use to create more robust and resilient legislation for the benefit of human and non-human park-goers alike. Mosses and lichens found within the parks of North Saanich are one such way to monitor the natural world.

Due to the small scale at which these life forms exist, it is easy to overlook mosses and lichens. Though they are both epiphytic autotrophs and are similar in appearance, mosses and lichens are two separate groups of organisms (Sales et al., 2016). Mosses are considered non-vascular plants, whereas lichens are not plants but rather the products of a symbiotic relationship between fungi and photosynthetic partners such as algae or cyanobacteria. Both mosses and lichens lack roots, meaning they must derive moisture and nutrients from their immediate surrounding (Forest Preserve District of Will County, 2020). As a result, using mosses and lichens serves as an ideal way to monitor pollutants in the air, as well as changes to hydrologic regimes as a result of climate change. Both unique organisms are abundant in the parks of North Saanich and can be key tools in understanding the changing environment.

2. Literature Review on the Significance of Mosses and Lichens in Parks

Mosses, like all plants, require water. However, unlike most plants, mosses lack roots and vascular tissues. This means that mosses need to derive water (and nutrients) directly from the air, as well as any pollutants also present in their surroundings. In a study conducted by Sarah Jovan and Geoffrey Donovan of the U.S. Forest Service's Pacific Northwest Research Station, they found that Lyell's Bristle Moss (*Pulvigerella lyellii*) (Figure 1) could be used as a bioindicator for heavy metal pollution in the air (2016). The research found heightened levels of cadmium in mosses collected near stained-glass manufacturing facilities in Portland – a common source of heavy metal

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air pollution. Following this discovery, mobile air-quality monitoring instruments were implemented in these locations, confirming that the concentration of cadmium in the air surrounding these facilities was 49 times higher than the benchmark set out by the state of Oregon (Donovan et al., 2016). These findings are significant to the parks of North Saanich because this study focussed on Lyell's Bristle Moss, a moss common to the Saanich Peninsula (Pojar & MacKinnon, 2016).



Figure 1: Lyell's Bristle Moss (*Pulvigerella lyellii*).

Lichens can survive in a wider array of habitats than mosses, however, since lichens, like mosses, gather nutrients from the air, they are still sensitive to pollutants. This makes lichens a valuable tool in determining how air pollutants affect and work within ecosystems. In particular, the presence or absence of certain lichens can be used as nitrogen dioxide and sulphur dioxide bioindicators (Askham, 2020). One study found that the greater concentration of sulphur dioxide

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exposure to lichens in the *Cladonia* and *Parmelia* genera resulted in a greater reduction of chlorophyll, affecting the ability of the lichen to produce sugars. It was also found that the lichens analyzed in this study were more sensitive to fluctuations in sulphur dioxide than vascular plants (Nash, 1973). These two pollutants are significant for the parks of North Saanich as nitrogen dioxide is produced from road traffic, and sulphur dioxide is a common pollutant of the burning of fossil fuels – both common in North Saanich.

Lichens and mosses are also ecologically significant and provide many ecosystem services. Lichens serve as important food sources for animals found in the parks of North Saanich, such as small mammals and deer. Additionally, they are used as nesting materials for a wide array of birds, as well as habitat for countless insects, spiders, and other small organisms (Noland & Noland, 2019). Mosses act as a barrier to heat transfer into the soil as well as provide shade. This decreases the evaporation of soil moisture as well as the amount of precipitation being lost to run-off (Dollery et al., 2022). Being photosynthetic, mosses and lichens are active agents in nutrient cycling and sequestration. One study suggests that photoautotrophic cryptogamic covers (such as mosses and lichens) account for 7% of net primary production and nearly half of the biological nitrogen fixation terrestrially (Elbert et al., 2012). Finally, mosses and lichens aid in the stabilization and creation of soils, reducing erosion and facilitating new habitats for vascular plants to colonize (Elbert et al., 2012).

Lichens have long been a source of dyes for Indigenous populations on Vancouver Island. Of particular significance is the use of *Usnea* (Figure 2) in the making of green dye – a common genus found in North Saanich (Turner & Bell, 1971). Some lichens have also been used as a form of birth control in the form of steeping into a tea to be consumed by the WSANEC. Additionally, mosses have served WSANEC peoples for many years as steam coverings for pit cooks, as well as household uses such as bedding, floor coverings, and diapers (Turner & Hebda, 2014).



Figure 2: Bristly Beard Lichen (*Usnea hirta*), a member of the *Usnea* genus.

Mosses and lichens serve many important purposes in the natural and human worlds. These tiny organisms are significant to the health and vibrancy of ecosystems, humans, and the cultures of North Saanich.

3. Methods

Ten parks of North Saanich in which the Friends of North Saanich Parks operate are analyzed within the scope of this report. Moss and lichen plot locations were chosen to be representational of the entirety of their respective parks. Two 10x10m plots were established for Denham Till, Green, Nymph Point, Lillian Hoffar, Gulf View, Sumac, Quarry, and Prentice Pond Parks. For the remaining R.O. Bull Park and H.M.S. Plumper Park, one 10x10m plot was established due to the smaller size of these parks. After the establishment of the plots, a general inventory of common moss and lichen species was conducted through systemic sweeps of the plots using a hand lens, identification keys, and internet identification assistance. The data collection process took place over the course of June 5th – 9th, 2023. Figure 3 shows the locations of the eighteen moss and lichen research plots located around North Saanich.

It is important to acknowledge that the lands of North Saanich are located on the traditional territory of the WSANEC peoples consisting of the BOKECEN (Pauqachin) and the WSIKEM (Tseycum) Nations, who have inhabited and stewarded the land since time immemorial. Many parks of North Saanich honour colonial and settler figures, however, many parks also serve as significant sites for burials and archaeological sites containing shell middens (Adams, 2021).

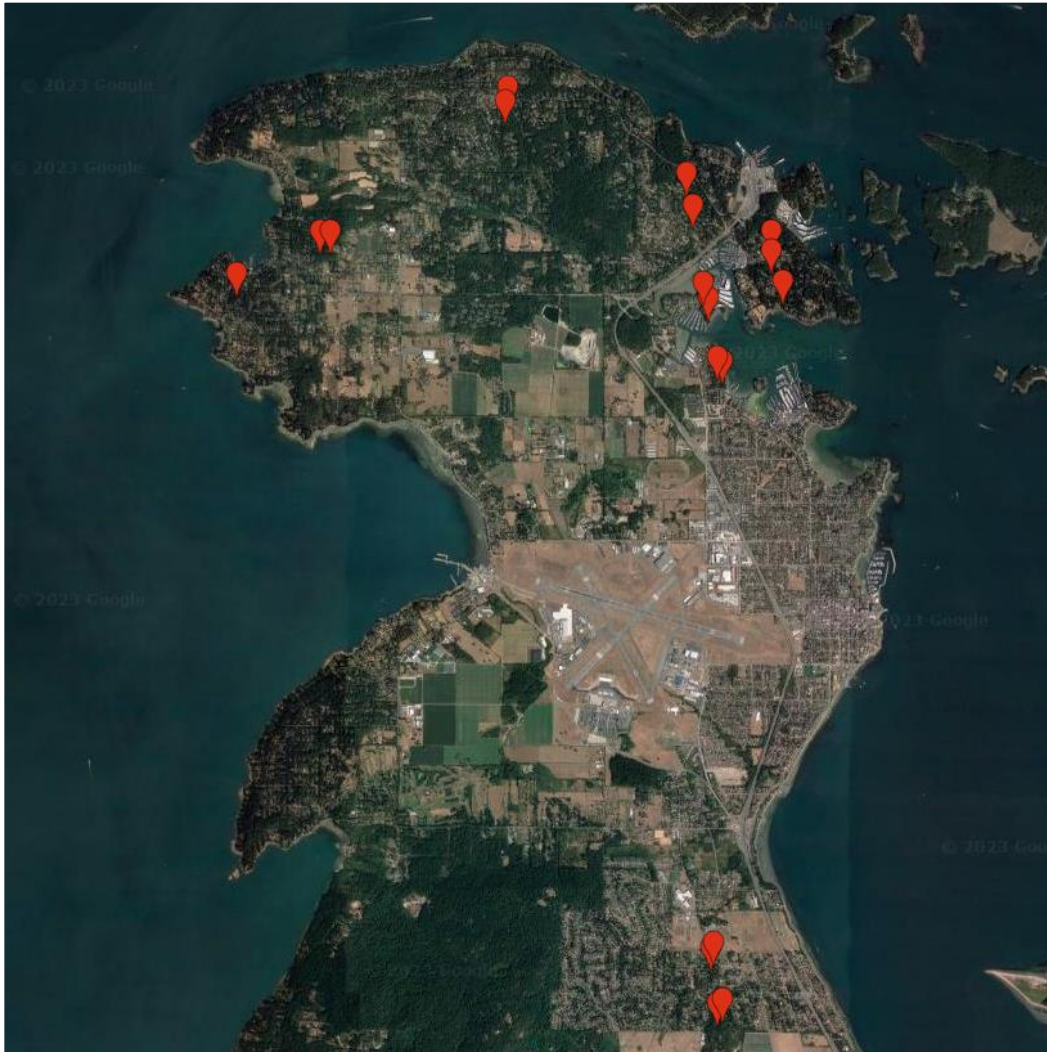


Figure 3: Location of the eighteen moss and lichen plots around the Municipality of North Saanich (Red).

4. Limitations

Though field tools such as hand lenses, identification keys, and modern internet capabilities were implemented, mistakes may stem from the equipment used as well as user error. Additionally, due to time and resource constraints, the findings of this report represent the single period of June 5th – 9th, 2023. This may be of concern as many mosses and lichens may appear different based on the time of year/abundance of water available to them at the time of sampling. Finally, this is not a complete inventory of every moss and lichen found within the ten parks falling under the scope of this study, but rather an inventory of common mosses and lichens to North Saanich which one can expect to encounter within the parks.

5. Findings

5.1. R.O. Bull Park

R.O. Bull Park is a small, yet diverse park located on the western side of the Saanich Peninsula. This ~2ha park contains some of the only remaining old-growth trees on the Saanich Peninsula (Adams, 2021). The park varies in elevation and moisture as one moves from northwest to southeast, resulting in three unique plant communities (Adams, 2021). The moss and lichen study was conducted in one plot for this relatively small park. This plot is situated at a meso-slope position, under a canopy of Douglas-fir (*Pseudotsuga menziesii*), and Western Redcedar (*Thuja plicata*) (Figure 4). The understory of the site is relatively open and is comprised of primarily Oregon grape (*Mahonia nervosa*).

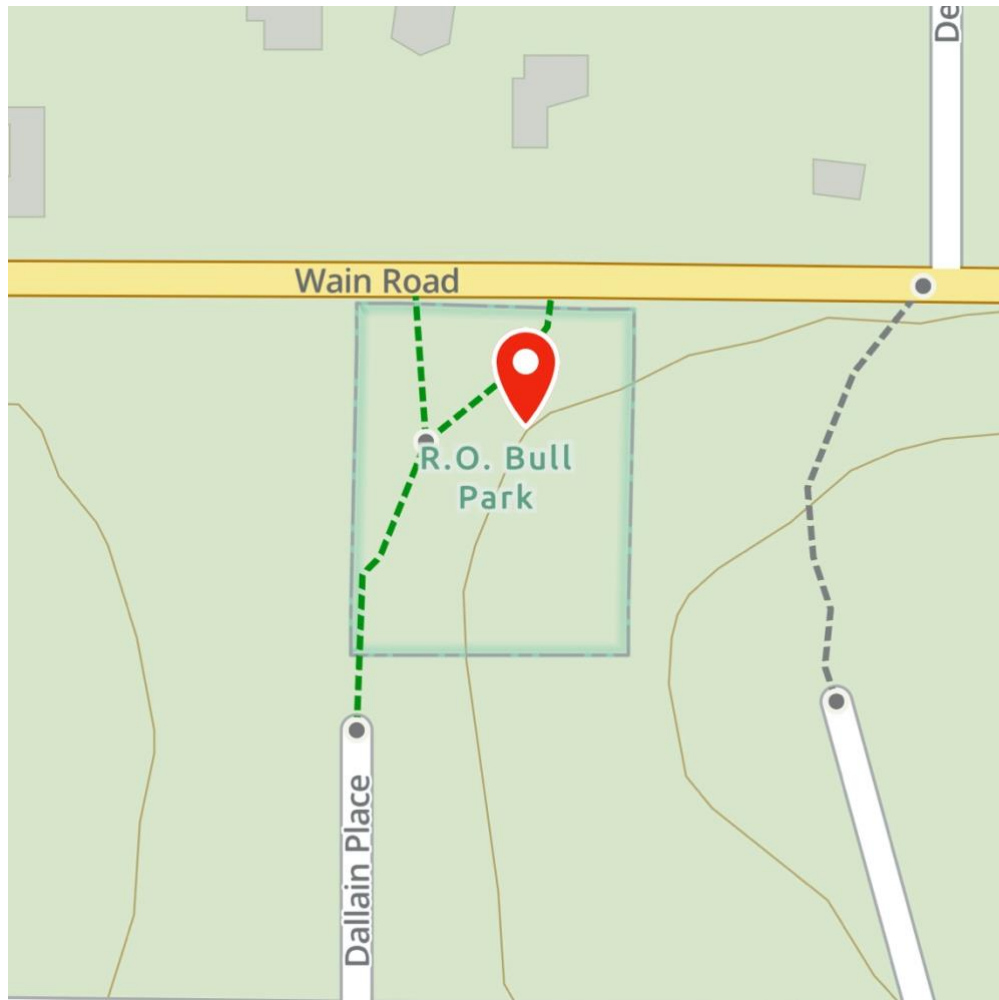


Figure 4: Location of the moss and lichen plot within R.O. Bull Park.

Table 1: Moss and Lichens present within the R.O. Bull Park plot.

Common Name	Scientific Name	Substrate	Percent Coverage
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Decaying wood (unidentified)	<1
Antlered Perfume	<i>Evernia prunastri</i>	Fallen tree (unidentified)	<1
Green Dust Lichen	<i>Lepraria spp.</i>	Fallen tree (unidentified)	<1
Rough Speckled Shield Lichen	<i>Punctelia redecta</i>	Fallen tree (unidentified)	<1
Note: This 10x10m plot is at a meso-slope position and north-facing aspect, with no direct sunlight and dense canopy cover.			

5.2. Denham Till Park

Denham Till Park is a highly disturbed park also located on the western side of the Saanich Peninsula, constituting an area of roughly 3.5ha (Adams, 2021). While much of the park is open grass fields, the northern portion consists of a relatively homogenous forest dominated by Douglas-fir, Western redcedar, salal (*Gaultheria shallon*), and Oregon grape. The moss and lichen study was conducted in two plots in this flat northern forested region (Figure 5).

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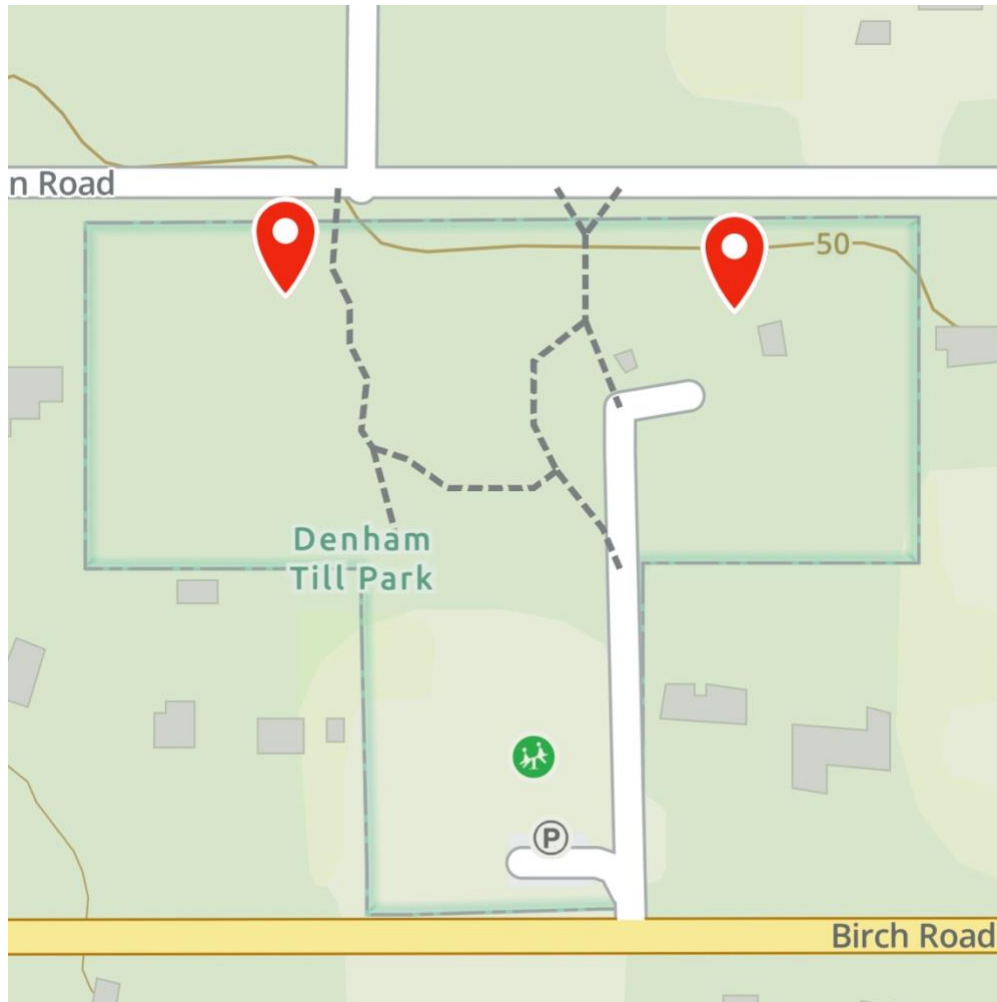


Figure 5: Location of the moss and lichen plots within Denham Till Park.

Table 2: Mosses and lichens present in Plot 1 (West) within Denham Till Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Conifer tree base, soil	5
Cat's Tail Moss	<i>Isoetecium stoloniferum</i>	Conifer tree	<1
Antlered Perfume	<i>Evernia prunastri</i>	Conifer tree	<1
Golden Short Capsuled Moss	<i>Brachythecium frigidum</i>	Conifer tree base	<1
Green Dust Lichen	<i>Lepraria spp.</i>	Conifer tree	<1
Nuttall's Yellow Moss	<i>Homalothecium nuttallii</i>	Downed branch (unidentified)	2
Rag Bag	<i>Platismatia glauca</i>	Downed branch (unidentified)	<1

Note: This 10x10m plot is on a flat area of conifer-dominated forest with no direct sunlight in a multi-storied stand.

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Table 3: Mosses and lichens present in Plot 2 (East) within Denham Till Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Conifer tree base, soil, rock	40
Cat's Tail Moss	<i>Isothecium stoloniferum</i>	Conifer tree	<1
Nuttall's Yellow Moss	<i>Homalothecium nuttallii</i>	Conifer tree base	3
Green Dust Lichen	<i>Lepraria spp.</i>	Conifer tree	<1
Note: This 10x10m plot is on a flat area of conifer-dominated forest with dappled light in a multi-storied stand.			

5.3. Green Park

Green Park is a park located on the eastern side of the Saanich Peninsula near Tsehum Harbour. This long and narrow park spans roughly 4ha and is divided into a north and south region, being separated by a road. The park contains two anthropogenic ponds and a stream which runs from north to south. Due to the variation of elevation and water availability at this site, this park contains four distinct plant communities (Adams, 2021). To be representative of this diverse park, one plot is situated in a relatively wet region of the park in the north, and the other is in a relatively dry region of the park in the south (Figure 6). The plant community surrounding the moist site consists primarily of Western redcedar and Western sword fern (*Polystichum munitum*), with an abundance of decaying wood, while the plant community surrounding the dry site consists of Oceanspray (*Holodiscus discolor*) and Nootka Rose (*Rosa nutkana*).

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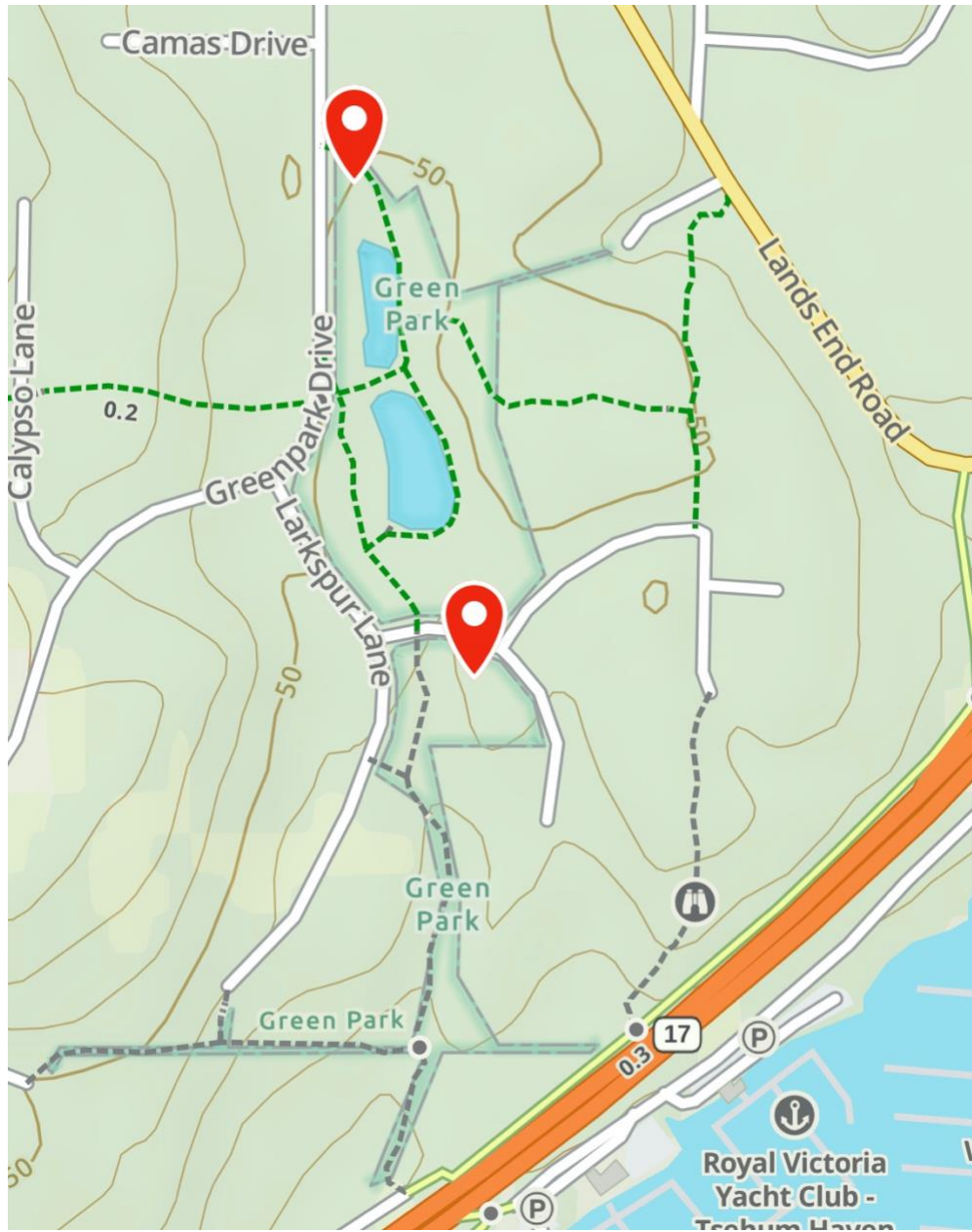


Figure 6: Location of the moss and lichen plots within Green Park.

Table 4: Mosses and lichens present in Plot 1 (North) within Green Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Decaying wood (unidentified), soil	20
Cats Tail Moss	<i>Isoetecium stoloniferum</i>	Conifer tree	2
Menzies Tree Moss	<i>Leucolepis acanthoneura</i>	Soil	<1
Crust Lichen		Deciduous tree	<1
Rag Bag	<i>Platismatia glauca</i>	Deciduous tree	<1

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Goose Neck Moss	<i>Hylocomiadelphus triquetrus</i>	Rock	<1
Lanky Moss	<i>Rhytidiadelphus loreus</i>	Rock	<1
Step Moss	<i>Hylocomium splendens</i>	Rock	<1
Bristly Beard Lichen	<i>Usnea hirta</i>	Deciduous tree	<1
Note: This 10x10m plot is in a basin with dappled sunlight, dominated by conifers. Abundant decaying wood is present.			

Table 5: Mosses and lichens present in Plot 2 (South) within Green Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Antlered Perfume	<i>Evernia prunastri</i>	Deciduous shrub	<1
Bristly Beard Lichen	<i>Usnea hirta</i>	Deciduous shrub	<1
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Deciduous tree base, rock, soil	15
Lyell's Bristle Moss	<i>Pulvigerella lyellii</i>	Deciduous tree	<1
Shield Lichen	<i>Parmelia sulcata</i>	Downed branch (unidentified)	<1
Note: This 10x10m plot is on a rocky upland site with dappled sunlight, with an overstory of small trees and shrubs.			

5.4. Nymph Point Park

Nymph point park is a small park located on a rocky outcrop which juts into Tsehum Harbour on the eastern side of the Saanich Peninsula. This highly disturbed site is surrounded by marine commercial developments and contains Indigenous shell middens and burial cairns (Adams, 2021). Though one of the moss and lichen plots falls outside of the park boundaries, it is included in the study as it is located along the only public path leading to Nymph Point, effectively making it part of the park for the average park-goer (Figure 7). The two plots vary significantly in moisture availability, as plot 1 (located on the rocky outcrop) is subject to high sun exposure and saltwater spray, whereas plot 2 (located outside the park boundary) receives more shade due to a more developed shrub layer. Plot 1 is surrounded by a plant community consisting of Garry Oak (*Quercus garryana*), Douglas-fir and Arbutus (*Arbutus menziesii*), and lacks a shrub layer. Plot 2 is located within a highly disturbed site containing Red Alder (*Alnus rubra*), willow (*Salix spp.*), and red-osier dogwood (*Cornus sericea*).

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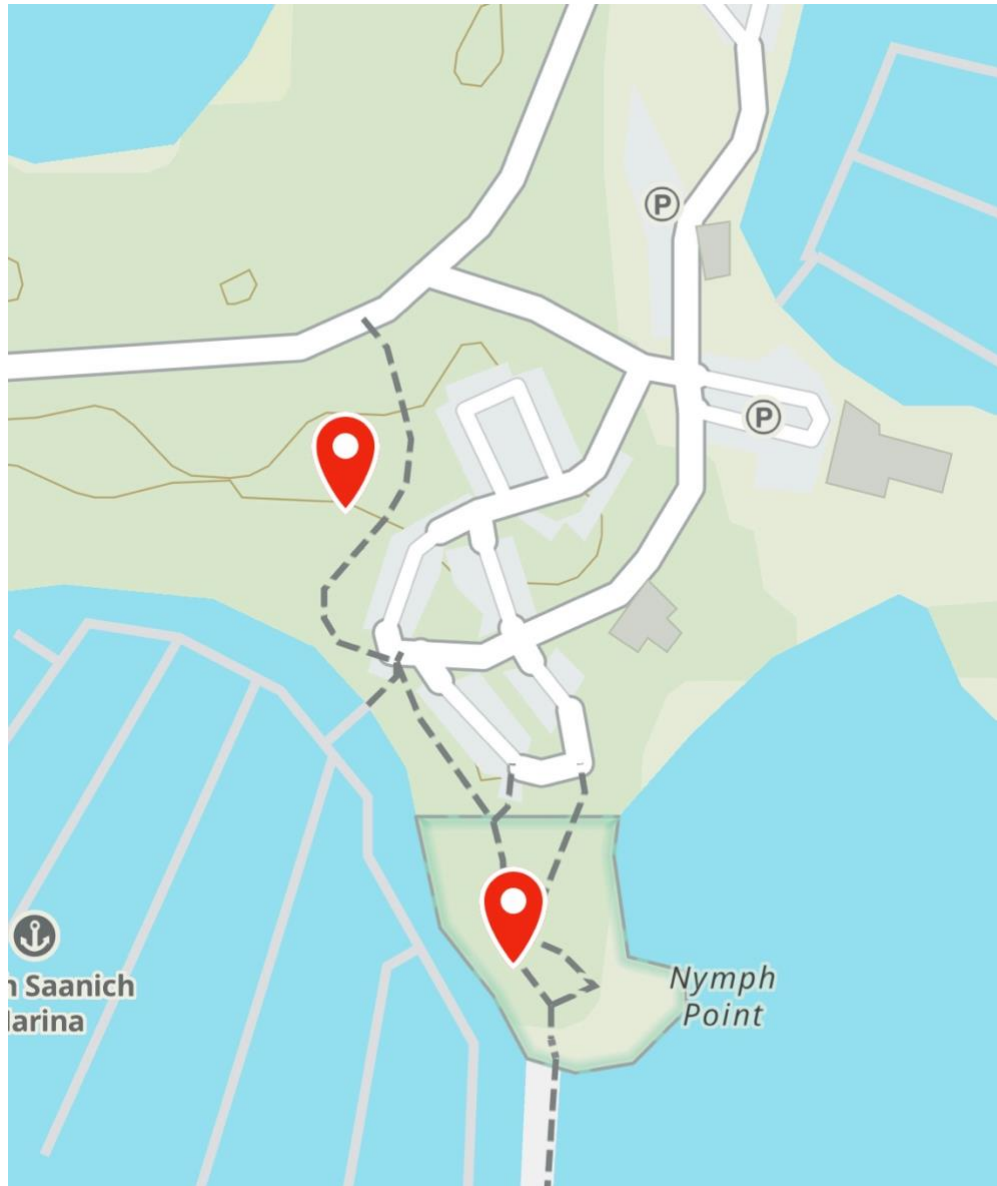


Figure 7: Location of the moss and lichen plots within Nymph Point Park.

Table 6: Mosses and lichens present in Plot 1 (South) at Nymph Point Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Antlered Perfume	<i>Evernia prunastri</i>	Deciduous tree	<1
Shield Lichen	<i>Parmelia sulcata</i>	Deciduous tree	<1
Rag Bag	<i>Platismatia glauca</i>	Deciduous tree	<1
Cumberland Rock Shield	<i>Xanthoparmelia cumberlandia</i>	Rock	<1
Black Rock Moss	<i>Andreaea rupestris</i>	Rock	<1
Green Dust Lichen	<i>Lepraria spp.</i>	Conifer tree	<1
Gold Dust Lichen	<i>Chrysothrix candelaris</i>	Conifer and deciduous trees, rock	<1

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Seaside Kidney Lichen	<i>Nephroma laevigatum</i>	Deciduous tree	<1
Note: This 10x10m plot is on a rocky peninsula with little tree cover and high sun exposure. Shallow soils and ample wind/salt spray are present, as well as exposed rock.			

Table 7: Mosses and lichens present in Plot 2 (North) within Nymph Point Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Antlered Perfume	<i>Evernia prunastri</i>	Deciduous tree	2
Shield Lichen	<i>Parmelia sulcata</i>	Deciduous tree	<1
Lyell's Bristle Moss	<i>Pulvigeria lyellii</i>	Deciduous tree	2
Slender Beaked Moss	<i>Kindbergia praelonga</i>	Snag (unidentified)	<1
Green Dust Lichen	<i>Lepraria spp.</i>	Deciduous tree	<1
Rag Bag	<i>Platismatia glauca</i>	Snag (unidentified)	<1
Note: This 10x10m plot is on a flat, moist site with recent disturbance. Dominated by deciduous shrubs, this area received abundant direct sunlight.			

5.5. Lillian Hoffer Park

Lillian Hoffer Park is a highly disturbed and previous residential site located on the eastern side of the Saanich Peninsula on the shore of Tsehum Harbour. Constituting 4ha of flat land, this park contains three distinct plant communities as well as colonial and Indigenous heritage sites – including heritage trees, shell middens and burial cairns (Adams, 2021). Plot 1 is placed along the border of two plant communities which are on a moister site (Figure 8). These plant communities consist of one dominated by Black Cottonwood (*Populus trichocarpa*), and one dominated by Western redcedar, both with dense shrub layers. Plot 2 is located on a drier site and is comprised of mainly Douglas-fir and Western redcedar trees, with a less substantial shrub and herb layer (Figure 8).

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Figure 8: Location of the moss and lichen plots within Lillian Hoffar Park.

Table 8: Mosses and lichens present in Plot 1 (Northwest) within Lillian Hoffar Park)

Common Name	Scientific Name	Substrate	Percent Coverage
Antlered Perfume	<i>Evernia prunastri</i>	Deciduous shrub	<1
Lyell's Bristle Moss	<i>Pulvigerella lyellii</i>	Decaying wood (unidentified)	<1
Wirth's Beard Lichen	<i>Usnea flavocardia</i>	Deciduous tree	<1
Rag Bag	<i>Platismatia glauca</i>	Deciduous tree	<1
Nuttall's Yellow Moss	<i>Homalothecium nuttallii</i>	Deciduous tree	<1
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil	<1
Menzies Tree Moss	<i>Leucolepis acanthoneura</i>	Soil	<1

Note: This 10x10m plot is in a moist site with dense canopy cover and abundant deciduous shrubs, allowing for very little light to penetrate.

Table 9: Mosses and lichens present in Plot 2 (Southeast) within Lillian Hoffar Park.

Common Name	Scientific Name	Substrate	Percent Coverage
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Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil	<1
Antlered Perfume	<i>Evernia prunastri</i>	Downed branch (unidentified)	<1
Hooded Bone Lichen	<i>Hypogymnia physodes</i>	Downed branch (unidentified)	<1
Menzies Tree Moss	<i>Leucolepis acanthoneura</i>	Soil	<1
Slender Beaked Moss	<i>Kindbergia praelonga</i>	Conifer tree base	<1
Rag Bag	<i>Platismatia glauca</i>	Downed branch (unidentified)	<1
Green Dust Lichen	<i>Lepraria spp.</i>	Downed branch (unidentified)	<1
Seaside Kidney Lichen	<i>Nephroma laevigatum</i>	Downed branch (unidentified)	<1
Note: This 10x10m plot is in a flat area with a relatively open understory and dense canopy cover.			

5.6. Gulf View Park

Gulf View Park is a small park located near the southern border of North Saanich on the eastern meso-slope of LAU, WELNEW (John Dean Provincial Park). The park contains two distinct plant communities within its roughly 1.5ha footprint, as well as an open grass field. The two moss and lichen plots are distributed in each of the plant communities found here – a drier site of Douglas-fir, oceanspray and camas (*Camassia quamash*), and a moister site of Douglas-fir, Western redcedar and oceanspray (Figure 9). It is important to note the previous disturbance of the site as farmland and later a recreational park owned by the Municipality of North Saanich in 1936 (Adams, 2021). This has resulted in a long legacy of disturbance which continues to this day.

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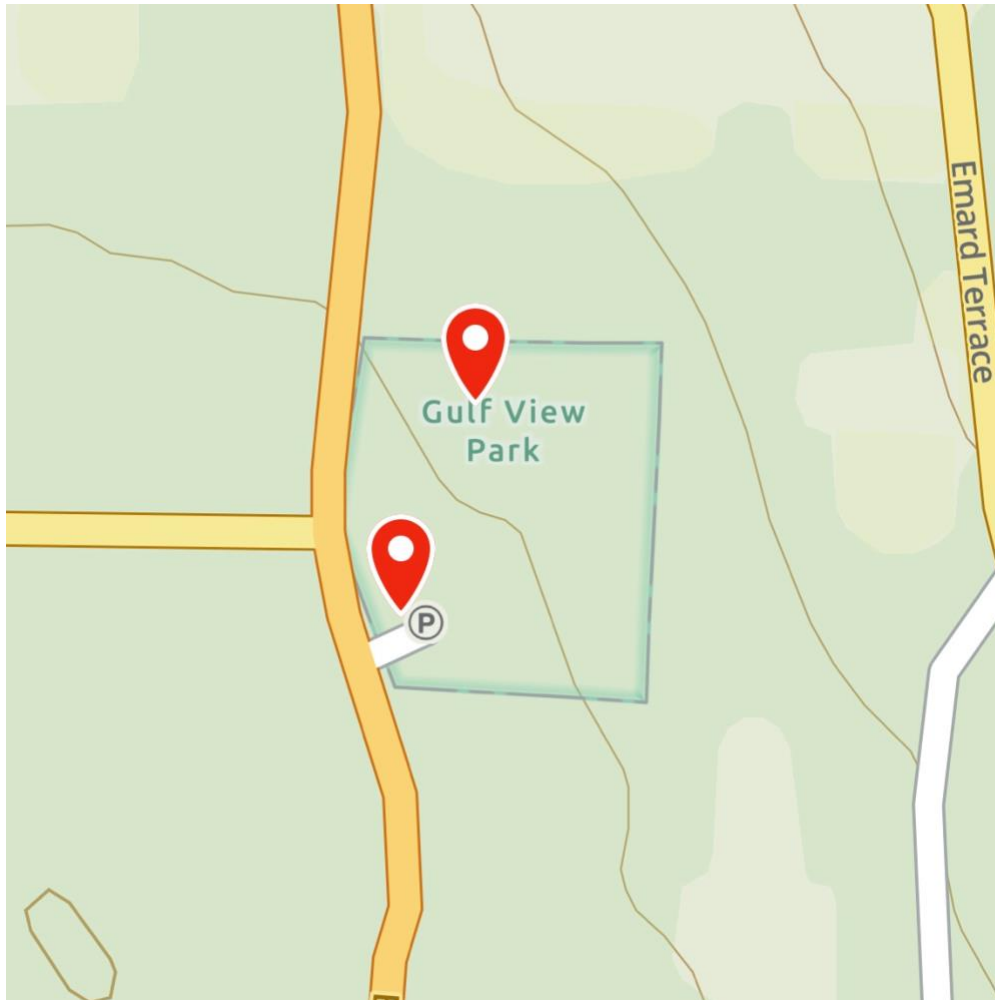


Figure 9: Location of the moss and lichen plots within Gulf View Park.

Table 10: Mosses and lichens present in Plot 1 (South) within Gulf View Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Antlered Perfume	<i>Evernia prunastri</i>	Conifer tree	<1
Laundered Rag	<i>Platismatia norvegica</i>	Conifer tree	<1
Goose Neck Moss	<i>Hylocomiadelphus triquetrus</i>	Soil	1
Note: This 10x10m plot is in an upland, rocky site which received ample direct sunlight.			

Table 11: Mosses and lichens present in Plot 2 (North) within Gulf View Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil	60
Shingle Moss	<i>Neckera pennata</i>	Deciduous shrub	<1
Forking Bone Lichen	<i>Hypogymnia inactiva</i>	Downed branch (unidentified)	<1
Antlered Perfume	<i>Evernia prunastri</i>	Downed branch (unidentified)	<1

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Rag Bag	<i>Platismatia glauca</i>	Downed branch (unidentified)	<1
Cat's Tail Moss	<i>Isothecium stoloniferum</i>	Deciduous tree	<1
Note: This 10x10m plot is on a flat site dominated by conifers and a well-developed shrub layer, allowing for some dappled light.			

5.7. Quarry Park

Quarry Park is located on the southern border of North Saanich, constituting roughly 2ha of a former quarry and the surrounding forest. There are three plant communities found within the park, one of which is in the basin of the quarry itself. This highly disturbed region of the park is relatively small, has minimal tree and shrub layers, and is covered mostly with invasive and native herbs. For these reasons, it is left out of this study. The two larger plant communities found within the park are represented in the plots selected. Plot 1 is located at an upland drier site which receives dappled sunlight (Figure 10). This plant community is comprised of Douglas-fir, Oregon grape, and a substantial herb layer. Plot 2 is located at a meso-slope position under a canopy of exclusively Western redcedars (Figure 10). Plot 2 lacks a shrub and herb layer and receives little to no sunlight.

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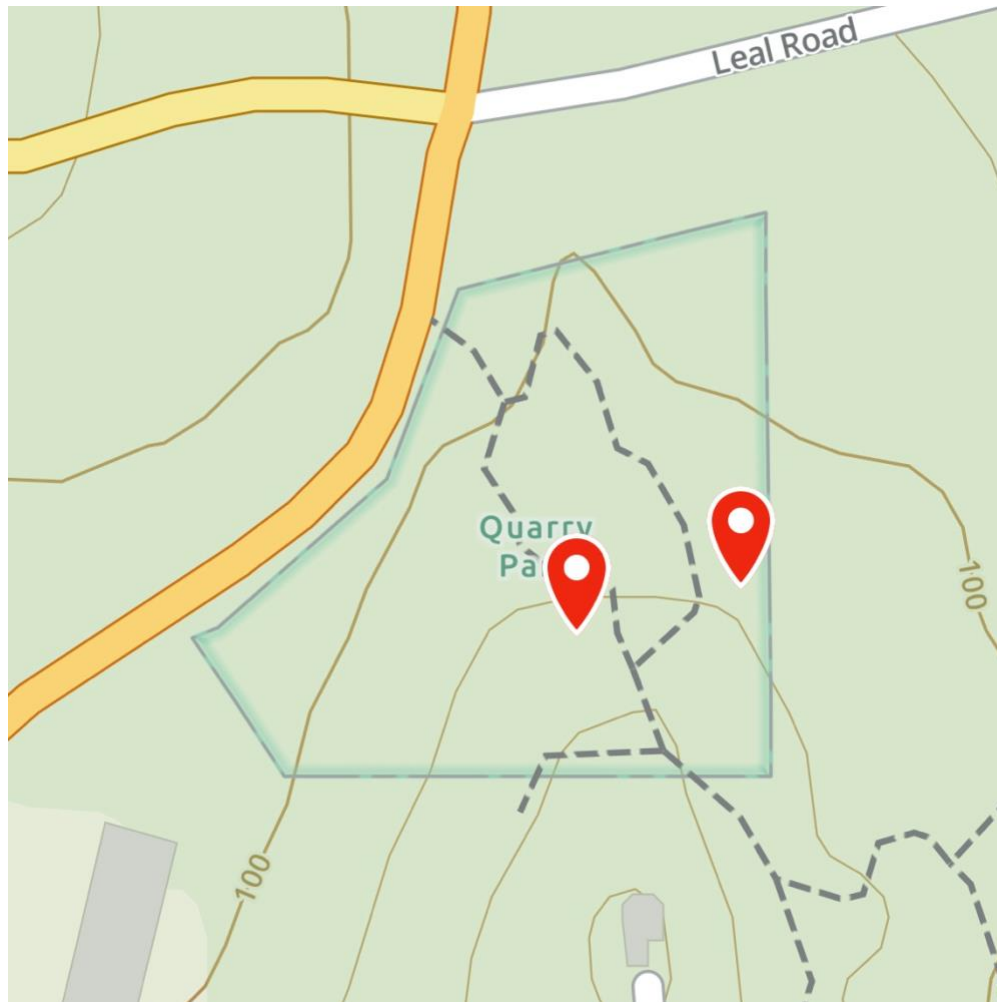


Figure 10: Location of the moss and lichen plots within Quarry Park.

Table 12: Mosses and lichens present in Plot 1 (West) within Quarry Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Cat's Tail Moss	<i>Isoetecium stoloniferum</i>	Conifer and deciduous trees	2
Golden Short Capsuled Moss	<i>Brachythecium frigidum</i>	Decaying wood (unidentified)	2
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil	10
Antlered Perfume	<i>Evernia prunastri</i>	Downed branch (unidentified)	<1
Rag Bag	<i>Platismatia glauca</i>	Downed branch (unidentified)	<1
Green Dust Lichen	<i>Lepraria spp.</i>	Deciduous tree	<1

Note: This 10x10m plot is on a relatively flat meadow with ample sunlight and an open canopy and a well-developed herb layer.

Table 13: Mosses and lichens present in Plot 2 (East) within Quarry Park.

Common Name	Scientific Name	Substrate	Percent Coverage
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Nuttall's Yellow Moss	<i>Homalothecium nuttallii</i>	Decaying wood (unidentified)	<1
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil	2
Cat's Tail Moss	<i>Isothecium stoloniferum</i>	Decaying wood (unidentified)	2
Green Dust Lichen	<i>Lepraria spp.</i>	Conifer tree	<1
Note: This 10x10m plot is at a meso-slope position with a northeastern aspect. Conifer dominated and lacking any shrub layer; this dense canopy allowed no sunlight through.			

5.8. Sumac Park

Sumac Park is a large park located in the Land's End neighbourhood of North Saanich on the northern tip of the Saanich Peninsula. The 4ha park shows signs of past disturbances such as fire and logging activity, however, remains relatively undisturbed, lacking infrastructure such as picnic tables, grass fields, and parking lots - unlike most other parks within this report. The park hosts three distinct plant communities located at different elevations within the ravine that runs through the park in a northwest-to-southeast direction (Christensen, 2023). The two plant communities selected for this report are located at an upland and a meso-slope position. The bottom of the ravine is left out of this study due to a lack of substrate for mosses and lichens to grow. The upland plant community (Plot 1) is comprised of Douglas-fir, oceanspray, and salal. It is at this upland site where the highest percentage of moss cover is found for this study (Table 14). Plot 2, located in a meso-slope position, has a plant community of Western redcedar, Grand Fir (*Abies Grandis*), Western sword fern, and Oregon grape, with a higher percentage of decaying wood (Figure 11).

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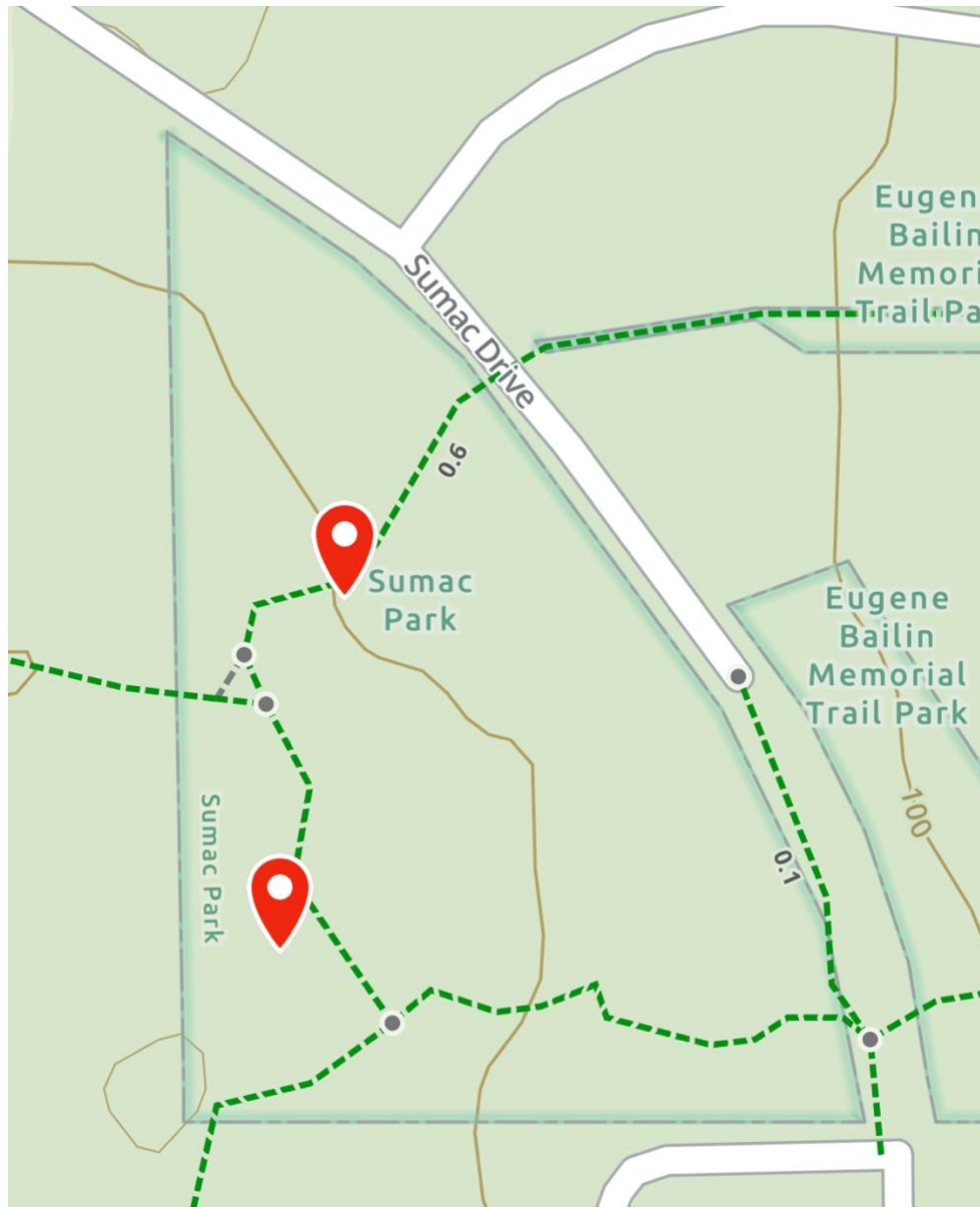


Figure 11: Location of the moss and lichen plots within Sumac Park.

Table 14: Mosses and lichens present in Plot 1 (South) within Sumac Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Methuselah’s Beard	<i>Usnea longissima</i>	Downed branch (unidentified)	<1
Bristly Beard Lichen	<i>Usnea hirta</i>	Downed branch (unidentified)	<1
Step Moss	<i>Hylocomium splendens</i>	Soil	65
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil/decaying wood/rock	15

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Menzies Tree Moss	<i>Leucolepis acanthoneura</i>	Soil and rock	1
Cat's Tail Moss	<i>Isothecium stoloniferum</i>	Deciduous shrub and conifer tree	8
Big Shaggy Moss	<i>Hylocomiadelphus triquetrus</i>	Soil and rock	<1
Shingle Moss	<i>Neckera pennata</i>	Deciduous shrub	<1
Rag Bag	<i>Platismatia glauca</i>	Downed branch (unidentified)	<1
Antlered Perfume	<i>Evernia prunastri</i>	Downed branch (unidentified)	<1
Note: This 10x10m plot is at an upland site with rocky terrain. The canopy is dominated by conifers and a well-developed shrub layer. This area received little direct sunlight.			

Table 15: Mosses and lichens present in Plot 2 (North) within Sumac Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Green Dust Lichen	<i>Lepraria spp.</i>	Conifer base	3
Cat's Tail Moss	<i>Isothecium stoloniferum</i>	Conifer and decaying wood	5
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil and decaying wood	25
Variable Wrinkle-Lichen	<i>Tuckermanopsis orbata</i>	Downed branch (unidentified)	<1
Antlered Perfume	<i>Evernia prunastri</i>	Downed branch (unidentified)	<1
Bristly Beard Lichen	<i>Usnea hirta</i>	Downed branch (unidentified)	<1
Note: This 10x10m plot is at a meso-slope position with an eastern aspect. Abundant decaying wood and dappled sunlight were present.			

5.9. H.M.S. Plumper Park

H.M.S. Plumper Park is the smallest of the parks within the scope of this study, occupying 0.2ha of land on Curteis Point overlooking Tsehum Harbour. Due to the small size of the park (Figure 12), one moss and lichen plot was determined to be sufficient being located along the border of the two plant communities present – one located on the generally flat, upper portion of the park, and the other located on the slope leading to the ocean. The upland plant community is comprised of Douglas-fir, salal, oceanspray, and Western redcedar. The lower plant community consists mainly of Grand Fir, Red Alder, and salal.

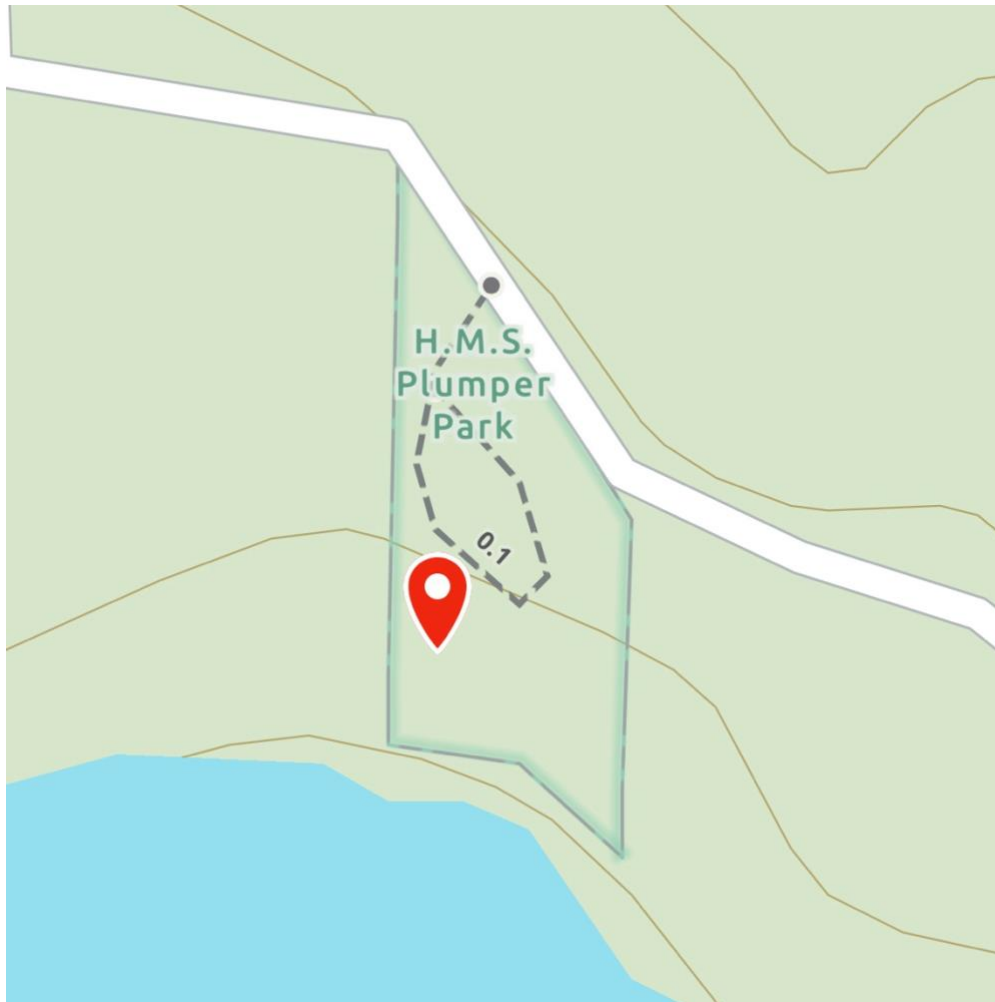


Figure 12: Location of the moss and lichen plots within H.M.S. Plumper Park.

Table 16: Mosses and lichens present within the H.M.S. Plumper Park plot.

Common Name	Scientific Name	Substrate	Percent Coverage
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil and decaying wood	15
Antlered Perfume	<i>Evernia prunastri</i>	Deciduous tree	<1
Pencil Script Lichen	<i>Graphis scripta</i>	Deciduous tree	<1
Rim Lichen	<i>Lecanora spp.</i>	Deciduous tree	<1
Note: This 10x10m plot is at a meso-slope position with a southern aspect. The area received dappled sunlight and had mixed stand composition.			

5.10. Prentice Pond Park

Prentice Pond Park, also located on Curteis Point, is on an upland position of this rocky peninsula, however, remains moist due to an anthropogenic pond and dense forest cover. Two plant communities within this park are represented within this moss and lichen study, excluding the wetland plant community found at this site. Plot 1 is located in the northern region of the park

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adjacent to the wetland habitat (Figure 13). The plant community found here is comprised of Western redcedar, Red Alder, and Douglas-fir, with minimal shrubs. Plot 2 is located in the southern region of the park and receives more light (Figure 13). The plant community here consists of Western redcedar, Red Alder, and Big Leaf Maple (*Acer macrophyllum*).

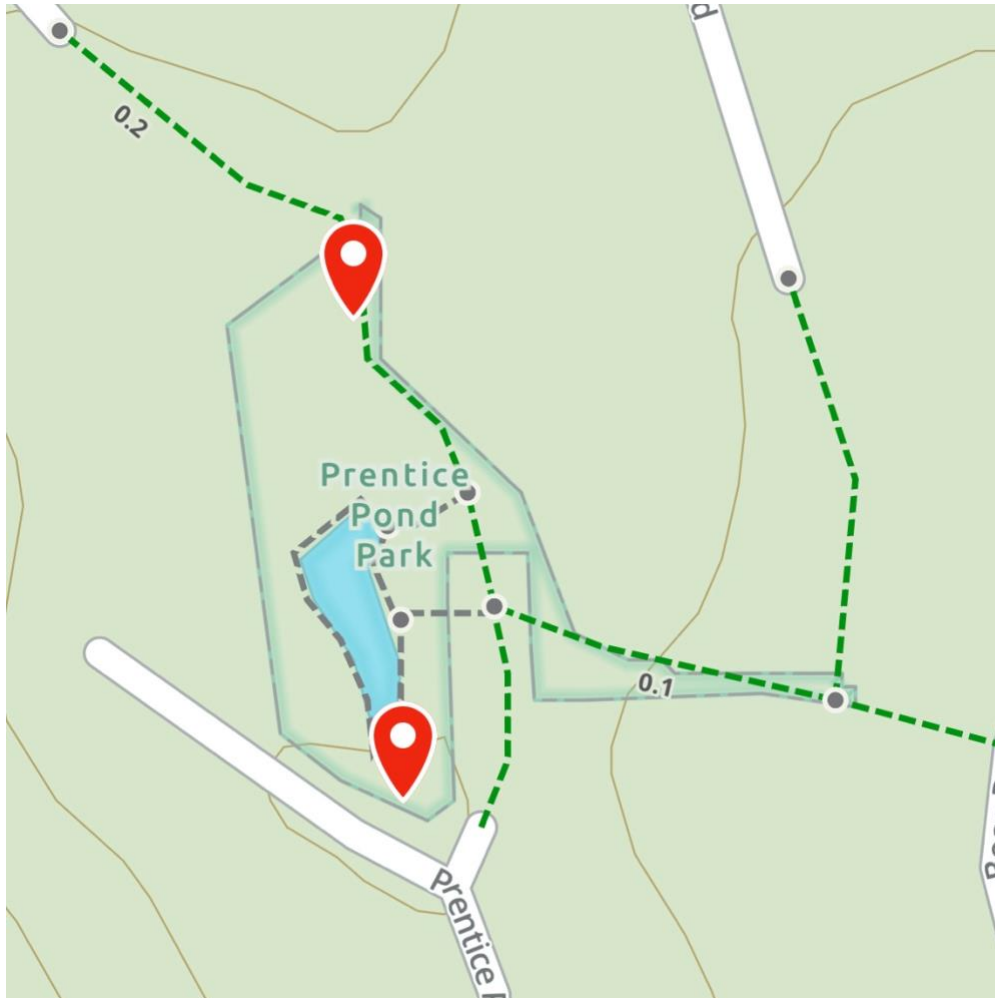


Figure 13: Location of the moss and lichen plots within Prentice Pond Park.

Table 17: Mosses and lichens present in Plot 1 (North) within Prentice Pond Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Green Dust Lichen	<i>Lepraria spp.</i>	Snag (conifer)	2
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil and decaying wood	20
Lyell's Bristle Moss	<i>Pulvigeria lyellii</i>	Decaying wood	<1
Slender Beaked Moss	<i>Kindbergia praelonga</i>	Conifer tree base	<1

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Hooded Bone Lichen	<i>Hypogymnia physodes</i>	Deciduous shrub	<1
Antlered Perfume	<i>Evernia prunastri</i>	Snag (unidentified)	<1
Note: This 10x10m plot is in a moist depression with a mixed canopy. This area received no direct sunlight but breaks in the canopy allowed light through.			

Table 18: Mosses and lichens present in Plot 2 (South) within Prentice Pond Park.

Common Name	Scientific Name	Substrate	Percent Coverage
Oregon Beaked Moss	<i>Kindbergia oregana</i>	Soil and decaying wood	10
Cat's Tail Moss	<i>Isothecium stoloniferum</i>	Decaying wood	<1
Green Dust Lichen	<i>Lepraria spp.</i>	Conifer tree	<1
Antlered Perfume	<i>Evernia prunastri</i>	Deciduous tree	<1
Shield Lichen	<i>Parmelia sulcata</i>	Deciduous tree	<1
Nuttall's Yellow Moss	<i>Homalothecium nuttallii</i>	Deciduous tree	<1
Smooth-footed Powderhorn	<i>Cladonia ochrochlora.</i>	Decaying wood	<1
Note: This 10x10m plot is on a gentle with a northern aspect under a mixed canopy. This area is moist and received dappled sunlight.			

6. Discussion

Over the course of this study, some patterns emerged in the data. For example, the most widespread and dominating moss among the ten parks is Oregon Beaked Moss (Figure 14). This moss is present in all but three plots (Gulf View plot 1 and Nymph Point plots 1 and 2). It is important to note this, as the three plots where Oregon Beaked Moss is absent, there is a lower frequency of mosses in general. This may be due to the microclimates associated with the plots as all three of the above plots experience higher sun exposure when compared to the other plots. It is not surprising that areas with higher sun exposure tend to lack abundant moss diversity and coverage, as higher sun exposure likely means higher temperatures and faster rates of evaporation of water. This can create habitats too dry for many moss species to survive (Sales et al., 2016). This has implications for the parks of North Saanich and the district as a whole as climate change continues to alter temperature regimes on the Saanich Peninsula.

The literature surrounding the significance of mosses and lichens to human and ecological health suggests that both people and governing bodies should take note of these tiny organisms as bioindicators. The presence or absence of certain mosses and lichens give us insight into the environmental conditions within the ten parks analyzed and could be of particular significance for

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determining not only changes to the hydrology but also pollution levels in the parks and North Saanich as a whole. The potential use of cheap and effective tools for monitoring pollution and climate change can create an opportunity for better-informed policymaking in the interest of both human and ecological health, creating opportunities for community and ecosystem resilience.

Comparing the literature reviewed to the data collected from the ten parks in this study, we find that Lyell's Bristle Moss, a potential bioindicator for heavy metals such as cadmium (USDA Forest Service - Pacific Northwest Research Station (2016)), is present in four of the parks – Green, Nymph Point, Lillian Hoffar, and Prentice Pond parks. These findings could allow for heavy metal pollution monitoring to be implemented in the four parks, which may be of significance to human health due to the proximity to residential developments in the cases of Green, Lillian Hoffar and Prentice Pond parks.

Additionally, the presence or absence of lichens can give us valuable insight into common pollutants such as nitrogen dioxide and sulphur dioxide, as highlighted in the literature review. In the study conducted by Nash (1973), lichens in the genus *Cladonia* and the genus *Parmelia* were used as bioindicators for sulphur dioxide. This is significant as both genera of lichen were present in at least one of the parks analyzed in this study.

It is interesting to note the relative lack of mosses and lichens in R.O. Bull Park, an old-growth site (Adams, 2021), and the relative abundance of mosses and lichens in Sumac Park, a relatively younger site (Figures 4 & 11) (Tables 1 & 14). This is interesting because as Sales et al. highlight, older trees, such as the ones found at R.O. Bull Park, tend to provide a more suitable habitat for epiphytes due to increased texture as they age (2016). This would suggest that more species and cover of mosses and lichens would be present in R.O. Bull Park as opposed to a younger site such as Sumac Park. This may be due to other factors such as the small size of R.O. Bull Park or the higher moisture availability due to the ravine at Sumac Park, however, more research will be needed to definitively find the cause.



Figure 14: Oregon Beaked Moss (*Kindbergia oregana*).

7. Conclusion

Due to their small stature, it is easy to overlook the mosses and lichens present in the beloved parks of North Saanich. It is important, however, to understand the potential of these tiny organisms and the services they provide. Services to both humans and non-humans in the form of food, habitat, and cultural practices. More significantly for this report, mosses and lichens have the potential to be bioindicators for ecosystem and human health. It is because of their dependence on the air around them for nutrients and water that makes them so responsive to pollutants and climate change. This is of significance to North Saanich since mosses and lichens which are already being used as bioindicators are also found within the parks, and can serve as cost-effective and highly responsive bioindicators for the municipality as a whole.

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It is through observations, testing, and data collection that these parks can be sites not only for recreation, education, and habitat, but also sites for ecological monitoring. Ecological monitoring can help to inform and create more robust and resilient legislation for human and non-human park-goers alike, ensuring better health for all parties involved. It is through cooperation with the natural world and the implementation of ‘new’ technologies that we can better understand and anticipate impacts, in turn forming better solutions to the problems facing North Saanich.

Acknowledgements

I would like to thank Juliet Pendray and Kem Luther, who shared their valuable expertise in their respective fields. The knowledge shared was fundamental in the creation of this report and set the foundation for this study.

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Appendix A: Some mosses and lichens found in the parks analyzed.



Figure A1: Antlered Perfume (*Evernia prunastri*)



Figure A2: Cat's Tail Moss (*Isothecium stoloniferum*)

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Figure A3: *Lepraria* spp. (Green Dust Lichen)



Figure A4: Smooth-footed Powderhorn (*Cladonia ochrochlora*)



Figure A5: Pencil Script Lichen (*Graphis scripta*)



Figure A6: Cumberland Rock Shield (*Xanthoparmelia cumberlandia*)



Figure A7: Rag bag (*Platismatia glauca*)