A Pilot Study of Tree Mortality in Five North Saanich Parks

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1. Introduction

The parks of North Saanich are important areas for local flora and fauna and serve many purposes for the natural world as well as for human settlements. The land itself allows for thriving communities of plants and animals alike. However, the physical environment is not only a product of the rocks, soils, and water bodies found on and within the parks; trees also serve as important vertical components to the physical environment. Trees have long provided humans benefits such as fuel, food, erosion prevention, improved water quality, and temperature control, while also providing habitat and supporting biodiversity for many species of plants and animals (Government of Canada, 2021). Additionally, through the process of photosynthesis, trees provide oxygen while storing carbon dioxide, a greenhouse gas attributed to climate change (Government of Canada, 2021). The services that trees provide for the human and natural worlds are significant to say the least, a fact recognized by the Government of Canada, which is planting trees as a nature-based solution to mitigate the impacts of climate change on communities (Government of Canada, 2021).

The ability of trees to act as carbon sinks may be a crucial part of the solution to the wicked problem of climate change, while also providing the benefits described above to localized communities. However, when climate conditions do not favor the growth of a specific tree, this may negate the beneficial aspects through tree dieback and mortality. Tree dieback can be described as "a potential symptom of decline where foliage is dropped and whole branches die", with tree mortality being the complete death of the tree (Seebacher, 2007). As the climate continues to change, trees may be susceptible to dieback and mortality as their habitable zones shift poleward or to higher elevations, eliminating the benefits they provide. In this pilot study, five parks within the District of North Saanich, B.C., Canada, are analyzed to understand to what degree dieback and mortality is happening and what these parks could potentially look like in the future.

2. Literature Review

According to the Government of Canada, the increased pattern of tree mortality in recent decades can be attributed to climate change (2023). This is in large part due to increased severity and frequency of events such as heat waves and droughts, such as the 2001 drought in Alberta and Saskatchewan which led to mass die back of aspen (*Populus spp.*) forests (Government of Canada, 2023). While climate change is a global phenomenon, a changing climate may disproportionately

affect certain places over others. As Heather Klassen (2012) highlights, as a result of the CDFmm's warm, dry summers and mild, wet winters, the region could be subject to greater impacts from climate change due to it already being drier and milder than other coastal ecosystems in B.C. The CDFmm ecosystem type is currently confined to the southeastern side of Vancouver Island, the Gulf Islands, as well as a small area of coastal mainland B.C., constrained in the south by warm temperatures and dry soils, and in the north by cool temperatures (Klassen, 2012). The CDF ecosystem type, which comprises only 0.3% of the province (Klassen, 2012), contains about 50 rare plant species (Meidinger & Pojar, 1991). This small, but ecologically significant region in the rain shadow of the Insular and Olympic mountains currently has a mean average temperature of between 9.2 and 10.5°C and mean average precipitation between 647 and 1263 mm annually (Meidinger & Pojar, 1991). The CDF current distribution, along with countless other ecosystems in B.C., is likely to shift due to changes in the current temperature and precipitation regimes, which, as Klassen describes, will result in the southern portion of Vancouver Island falling outside of the of the area of persistence for the CDF ecosystem type (2012).

While the future of the CDF ecosystem type is likely one that will shift by the end of the century, within the current boundaries of the CDF zone we are already seeing the impacts of climate change. A study by Tanya Marie Seebacher (2007) found that summer moisture stress was likely closely tied to dieback of Western Redcedar (*Thuja plicata*) trees within the CDFmm. This aligns with the government of British Columbia's report on forest health finding that of the 108,345ha of drought induced foliage damage across B.C. in 2021, Western Redcedar was the most affected tree species (Duthie-Holt & Westfall, 2021). These findings are supported by local municipal governments having to water even mature Western Redcedar trees in urban parks under the current drought-like conditions to keep them alive. This is in stark contrast to the previous norm of only watering Western Redcedar trees until they were 5 years of age before they were able to sustain their own water needs (Strain, 2019).

Western Redcedars are not the only trees which will and are facing the impacts of climate change within the CDF zone. Pacific Madrone (*Arbutus menziesii*) (hereafter Arbutus) trees, the only evergreen broad-leaf tree in Canada, have become more susceptible to fungal leaf blight in the face of drier summers and human disturbances (Costain, 2018). This is not a novel infection to Arbutus trees, as partial defoliation due to the fungus is not abnormal every few years. Climate

change, however, is weakening the capacity of the trees to fight back against infection, resulting in total defoliation and increased frequency of infection (Costain, 2018).

Today, the average temperature on Vancouver Island is 1°C warmer than 100 years ago, and the island is facing prolonged and more extreme periods of drought (Harmer, 2021). With increased occurrences of summertime drought conditions, the regeneration of disturbed CDF sites is likely to be slower allowing for further encroachment of invasive species, further degrading ecosystems such as the red-listed Douglas-Fir/Oregon Grape CDFmm site association ecosystem type (Ministry of Environment, 2004).

3. Methods

Five parks of North Saanich in which the Friends of North Saanich Parks operate have been selected for this report. The parks are Quarry Park, Denham Till Park, Green Park (North), Lillian Hoffar Park, and Sumac Park. Satellite imagery was used to analyze the historic change between the springs of 2010 and 2021. Visible tree dieback and mortality from the photos were noted, and ground-truthing occurred in July of 2023. During ground-truthing, further dieback and mortality not visible in the satellite imagery was noted. Tree dieback and mortality was recorded based on three variables: species of affected tree, tree class (height), and degree of mortality. All parks in this study are within the CDFmm (Coastal Douglas-Fir moist maritime) biogeoclimatic zone.

It is important to acknowledge that the lands of North Saanich are located on the traditional territory of the W̱SÁNEĆ peoples consisting of the BOḰEĆEN (Pauqachin) and the W̱SÍḴEM (Tseycum) Nations, who have inhabited and stewarded the land since time immemorial. While the cultural significance of these specific parks to the W̱SÁNEĆ is unknown to the author of this report, the parks are the product of settler colonialism and have had many years of disturbances.

4. Limitations

The use of satellite imagery for this report proved to be difficult due to factors such as weather, shading, and resolution, as well as user error in identifying dead or dying treetops. More significantly, a lack of useable imagery in the form of satellite or airplane photography limited the scope of this study. Finally, one limitation from the ground analysis is that only cumulative morality could be reported since the study could not establish the onset of the tree mortality. To

determine the rate of dieback in future analyses, both aerial imagery and in situ assessment should be implemented to gather more meaningful data.

5. Results

5.1. Aerial Imagery

Table 1: Dead treetops observed in 2010 and 2021 in their respective parks through aerial image analysis.

Park	2010	2021
Quarry Park (2ha)	0	8
Denham Till Park (3.5ha)	2	22
Green Park North (2.5ha)	0	23
Lillian Hoffar Park (4ha)	0	14
Sumac Park (4ha)	2	43

Note: Aerial imagery used in this comparison was taken during the spring of their respective years. Source: Google Earth

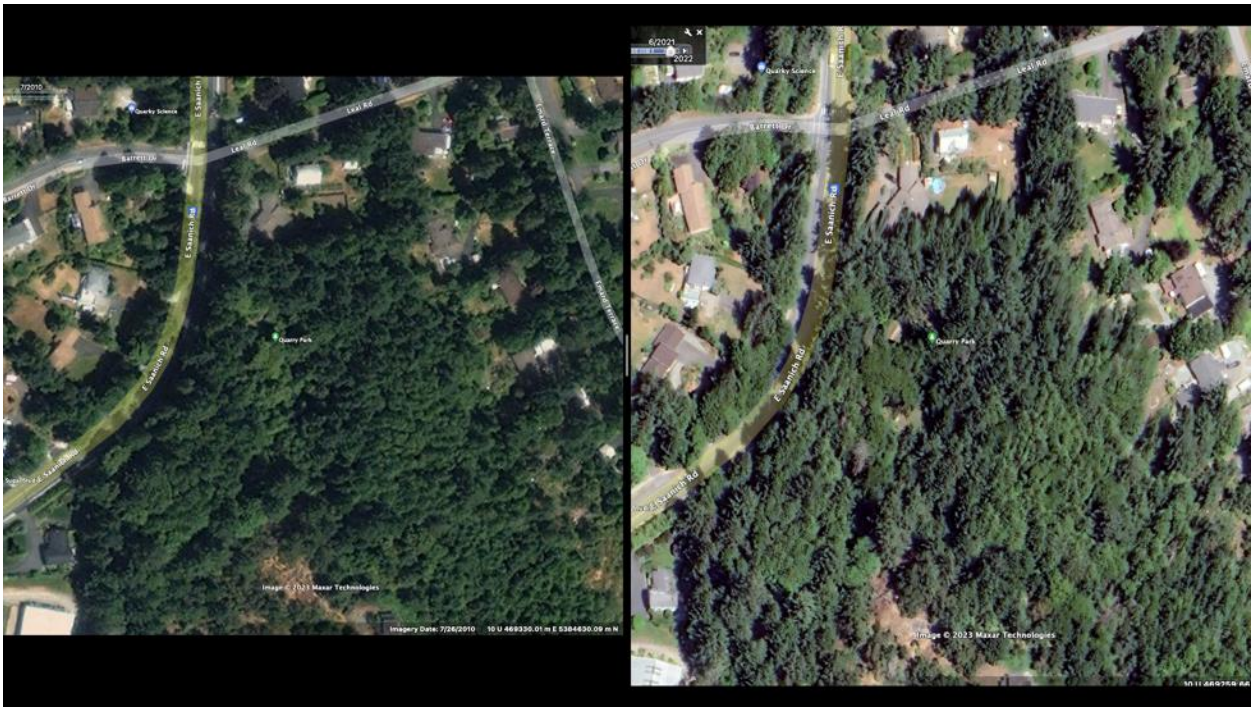

Figure 1: Aerial imagery of Quarry Park taken in the spring in 2010 (left) and 2021 (right).

Figure 2: Aerial imagery of Denham Till Park taken in the spring of 2010 (left) and 2021 (right).

Figure 3: Aerial imagery of Green Park North taken in the spring of 2010 (left) and 2021 (right).

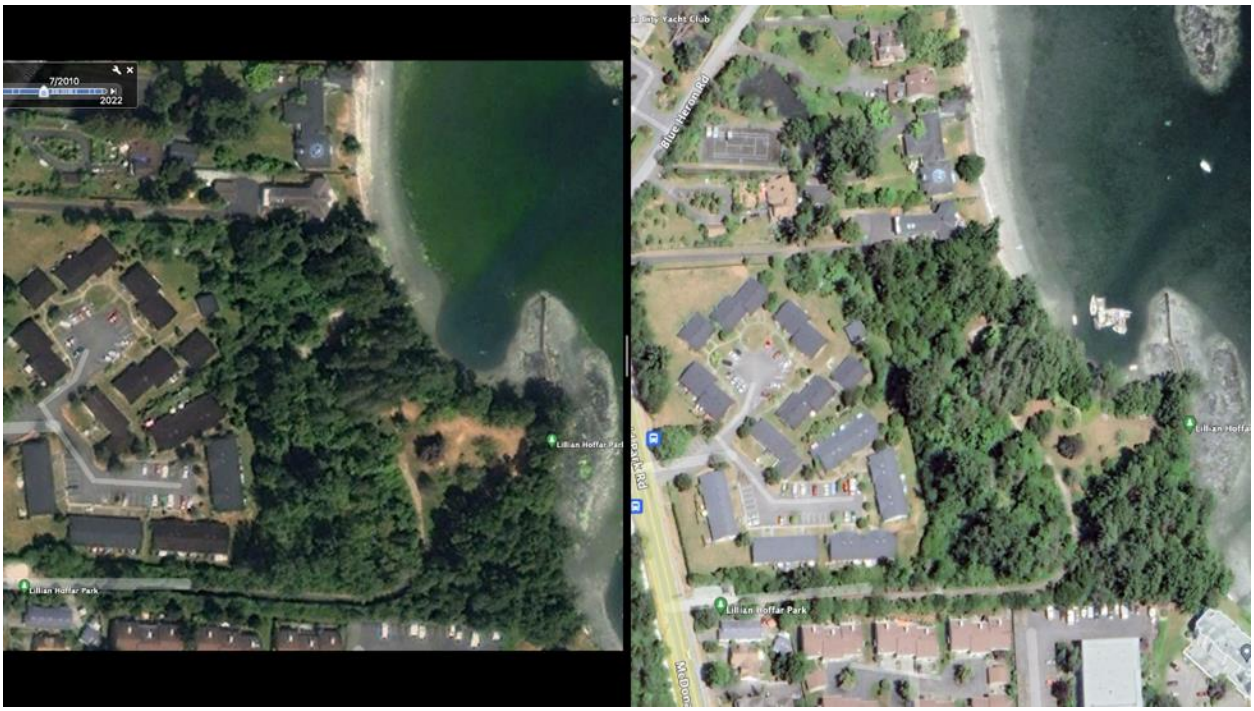

Figure 4: Aerial imagery of Lillian Hoffar Park taken in the spring of 2010 (left) and 2021 (right).

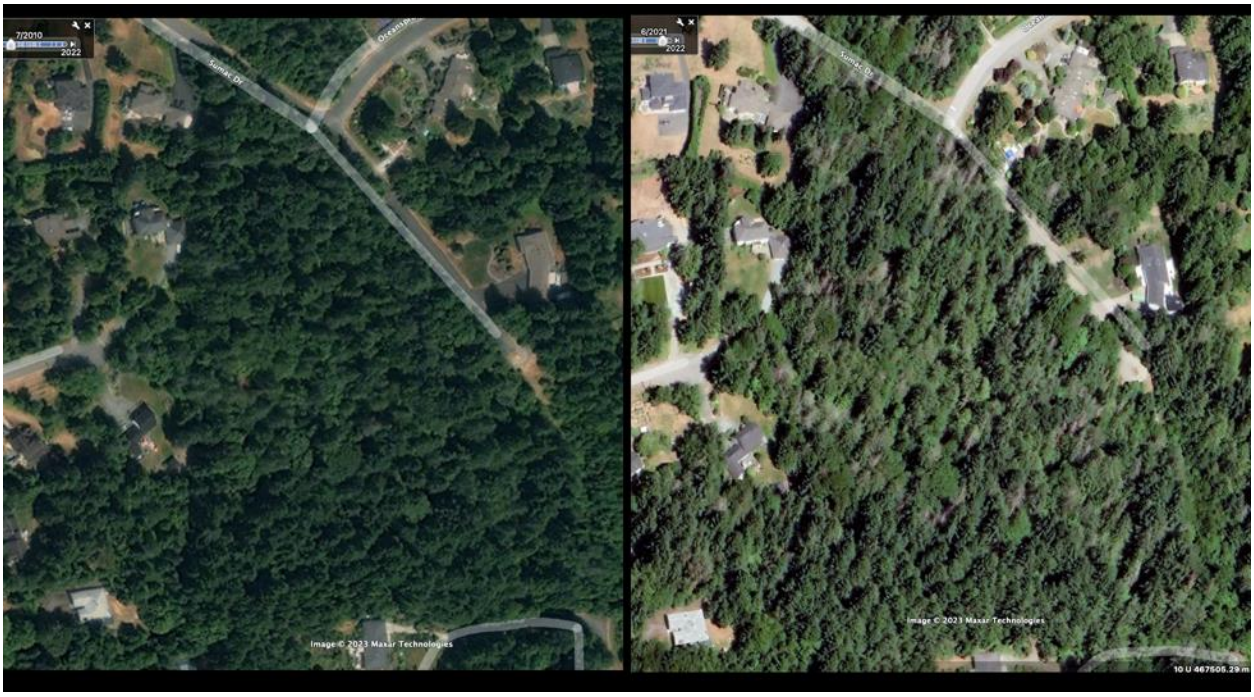

Figure 5: Aerial imagery of Sumac Park taken in the spring of 2010 (left) and 2021 (right).

5.2. Quarry Park

Quarry Park, located on the southern border of North Saanich consists of roughly 2ha of parkland dominated by Western Redcedar and Douglas-Fir (*Pseudotsuga menziesii*). The history of this park is evident in the quarry situated in the centre, where few trees have managed to establish themselves. Surrounding the quarry, the canopy cover is thick in the east, west, and north, allowing little to no light into the understory. This single-stand forest type is mature and conifer-dominated (Adams, 2021). In the south the canopy is more open, allowing for a more substantial shrub and herb layer to develop.

Table 2: Total dead or dying trees based on ground assessment for Quarry Park.

Tree	Spp.	Class	Mortality
1	Douglas-Fir	A3	Full
2	Alder	A3	Full
3	Alder	A3	Full
4	Unidentified	B1 (Broken top)	Full
5	Alder	B2	Full
6	Douglas-Fir	A1	Full
7	Alder	B2	Top 2/3
8	Western Redcedar	B1	Full
9	Western Redcedar	B1	Full
10	Western Redcedar	A3	Full
11	Western Redcedar	A3	Full
12	Western Redcedar	B1	Full
13	Western Redcedar	B2	Full
14	Western Redcedar	B2	Full
15	Western Redcedar	B2	Full
16	Western Redcedar	B2	Full
17	Western Redcedar	A3	Top 1/3
18	Western Redcedar	B1	Top 1/3
19	Western Redcedar	B2	Full
20	Western Redcedar	B1	Top 1/3
21	Western Redcedar	A3	Bottom 2/3
22	Alder	A2 (Broken top)	Full
23	Western Redcedar	B1	Top 1/3
24	Western Redcedar	B2	Full
Note: These data were collected in mid-July of 2023. The analysis was conducted for the park as a whole.			

Summary of ground assessment for Quarry Park:

- Total dead or dying trees by species:

        - Western Redcedar: 16
        - Douglas-Fir: 2
        - Alder: 5
        - Unidentified: 1
    - Total dead or dying trees by class:
        - A1: 1
        - A2: 1
        - A3: 7
        - B1: 7
        - B2: 8
    - Dead or dying trees by species per hectare (Quarry Park land area = 2ha):
        - Western Redcedar: 8.00/ha
        - Douglas-Fir: 1.00/ha
        - Alder: 2.50/ha
        - Unidentified: 0.50/ha

Figure 2: Cluster of dead Western Redcedar trees in Quarry Park.

Figure 3: Cluster of dead Western Redcedar trees in Quarry Park.

5.3. Denham Till Park

Denham Till Park occupies roughly 3.5ha of land in the western portion of the Saanich Peninsula and is highly disturbed as a result of farming activities (Adams, 2021). The ecosystem found at Denham Till is dominated by Douglas-Fir trees in a multi-storied stand composition.

Table 3: Total dead or dying trees based on ground assessment for Denham Till Park.

Tree	Spp.	Class	Mortality
1	Garry Oak	A3	Full
2	Arbutus	A3	Top 1/3
3	Garry Oak	A2	Full
4	Western Redcedar	A2	Top 1/3
5	Western Redcedar	A2	Top 1/3
6	Western Redcedar	A2	Top 1/3
7	Western Redcedar	A2	Top 1/3
8	Douglas-Fir	A1	Full
9	Douglas-Fir	A2	Full
10	Douglas Fir	A2	Full
11	Douglas-Fir	A1	Top 1/3
12	Western Redcedar	A3	Full
13	Douglas-Fir	A2	Full
14	Grand Fir	A1	Full
15	Douglas-Fir	A1	Bottom 2/3
16	Douglas-Fir	B2	Bottom 2/3
17	Douglas-Fir	A2	Bottom 2/3
18	Big Leaf Maple	A1	Full
19	Douglas-Fir	A2	Full
20	Douglas-Fir	A2	Full
21	Douglas-Fir	A1	Full
22	Garry Oak	A2	Bottom 2/3
23	Douglas-Fir	A2	Full
24	Arbutus	A1	Full
25	Unidentified	A2	Full
26	Douglas-Fir	A1	Top 1/3
27	Douglas-Fir	A1	Top 2/3
28	Douglas-Fir	A1	Top 1/3
29	Douglas-Fir	A1	Top 1/3
30	Douglas-Fir	A1	Full
31	Douglas-Fir	A1	Full
32	Douglas-Fir	A1	Full
33	Douglas-Fir	A1	Top 1/3
34	Western Redcedar	A1	Full

Note: These data were collected in mid-July of 2023. The analysis was conducted for the park as a whole.

Summary of ground assessment for Denham Till Park:

- Total dead or dying trees by species:
  - Western Redcedar: 6
  - Douglas-Fir: 20
  - Garry Oak: 3
  - Arbutus: 2
  - Grand Fir: 1
  - Big Leaf Maple: 1
  - Unidentified: 1
- Total dead or dying trees by class:
  - A1: 16
  - A2: 14
  - A3: 3
  - B1: N/A
  - B2: 1
- Dead or dying trees by species per hectare (Denham Till Park land area = 3.5ha)
  - Western Redcedar: 1.71/ha
  - Douglas-Fir: 5.71/ha
  - Garry Oak: 0.86/ha
  - Arbutus: 0.57/ha
  - Grand Fir: 0.28/ha
  - Big Leaf Maple: 0.28/ha
  - Unidentified: 0.28/ha

Figure 5: Cluster of dead and dying Douglas-Fir and Western Redcedar trees in Denham Till Park.

Figure 6: Dying Douglas-Fir tree in Denham Till Park.

Figure 7: Group of dead and dying trees in Denham Till Park.

5.4. Green Park North

Green Park North is located by Tsehum Harbour on the northeastern side of the Saanich Peninsula occupying roughly 2.5ha of land and two anthropogenic ponds. The plant community found in the park is one consisting primarily of Western Redcedar, Douglas-Fir, Red Alder (*Alnus rubra*). The tree strata composition of the park is multi-storied and primarily mixed, with the exception of the eastern portion of the park where conifer trees dominate.

Table 4: Total dead or dying trees based on ground assessment for Green Park North.

Tree	Spp.	Class	Mortality
1	Western Redcedar	A2	Top 1/3
2	Western Redcedar	A2	Top 1/3
3	Western Redcedar	A2	Top 1/3
4	Western Redcedar	A2	Top 1/3
5	Western Redcedar	A2	Top 1/3
6	Western Redcedar	A1	Top 1/3
7	Western Redcedar	A1	Top 1/3
8	Western Redcedar	A2	Full
9	Western Redcedar	A2	Full
10	Western Redcedar	A2	Full
11	Western Redcedar	A2	Full
12	Western Redcedar	A2	Full
13	Western Redcedar	A2	Full
14	Western Redcedar	A2	Full
15	Alder	A2	Bottom 2/3
16	Alder	A2	Bottom 2/3

17	Big Leaf Maple	A3	Full
18	Western Redcedar	A1	Full
19	Western Redcedar	A1	Full
20	Western Redcedar	A1	Full
21	Western Redcedar	A1	Full
22	Western Redcedar	A1	Full
23	Western Redcedar	A1	Full
24	Western Redcedar	A1	Full
25	Western Redcedar	A1	Full
26	Western Redcedar	A1	Full
27	Western Redcedar	A1	Full
28	Western Redcedar	A1	Full
29	Western Redcedar	A1	Full
30	Western Redcedar	A1	Full
31	Western Redcedar	A1	Full
32	Western Redcedar	A1	Full
33	Western Redcedar	A1	Top 1/3
34	Western Redcedar	A1	Top 1/3
35	Alder	A2	Full
36	Alder	A2	Full
37	Alder	A2	Full
38	Alder	A2	Full
39	Alder	A2	Full
40	Alder	A2	Full
41	Douglas-Fir	A1	Full
42	Douglas-Fir	A1	Bottom 2/3
43	Western Redcedar	A1	Bottom 2/3
44	Western Redcedar	A1	Full
45	Grand Fir	A2	Bottom 1/3
46	Western Redcedar	A1	Top 1/3
47	Western Redcedar	A1	Top 1/3
48	Western Redcedar	A1	Top 1/3
49	Western Redcedar	A1	Top 1/3
50	Western Redcedar	A1	Top 1/3
51	Western Redcedar	A2	Full
52	Western Redcedar	A2	Full
53	Alder	B1	Full
54	Alder	B1	Full
55	Alder	B1	Full
56	Alder	A3	Full
57	Alder	A3	Full
58	Alder	B1	Full
59	Alder	A3	Full
60	Alder	A3	Full
61	Western Redcedar	A2	Top 1/3
62	Western Redcedar	A2	Top 1/3

63	Western Redcedar	A2	Top 1/3
64	Douglas-Fir	A1	Full
65	Grand Fir	A1	Full
66	Douglas-Fir	A1	Full
67	Douglas-Fir	A1	Full
68	Grand Fir	A1	Full
69	Douglas-Fir	A1	Full
70	Western Redcedar	A1	Top 1/3
71	Western Redcedar	A3	Top 1/3
72	Grand Fir	A1	Full
73	Western Redcedar	A2	Top 1/3
74	Western Redcedar	A2	Full
75	Alder	A1	Bottom 1/3
76	Western Redcedar	A1	Full
77	Western Redcedar	A2	Full
78	Western Redcedar	A2	Full
79	Western Redcedar	A1	Full
80	Western Redcedar	A2	Full
81	Alder	A1	Bottom 2/3
82	Alder	A1	Bottom 2/3
83	Western Redcedar	A2	Full
84	Western Redcedar	A2	Full
85	Western Redcedar	A1	Full
86	Western Redcedar	A2	Full
87	Western Redcedar	A1	Top 1/3
88	Western Redcedar	A1	Top 1/3
89	Western Redcedar	A1	Top 1/3
90	Western Redcedar	A1	Top 1/3
91	Alder	A3	Full
92	Alder	A3	Full
93	Alder	A3	Full
94	Alder	A3	Full
95	Western Redcedar	A1	Top 1/3
96	Western Redcedar	A1	Top 1/3
97	Western Redcedar	A1	Full
98	Western Redcedar	A2	Full
99	Western Redcedar	A2	Full
100	Western Redcedar	A1	Full
101	Western Redcedar	A1	Full
102	Western Redcedar	A1	Full
103	Western Redcedar	A2	Full
104	Western Redcedar	A2	Full
105	Western Redcedar	A2	Full
106	Western Redcedar	A2	Full
107	Western Redcedar	A2	Full
108	Western Redcedar	A2	Full

109	Western Redcedar	A2	Full
110	Western Redcedar	A2	Full
111	Western Redcedar	A1	Full

Note: These data were collected in mid-July of 2023. The analysis was conducted for the park as a whole.

Summary of ground assessment for Green Park North:

- Total dead or dying trees by species:
  - Western Redcedar: 77
  - Alder: 23
  - Douglas-Fir: 6
  - Grand Fir: 4
  - Big Leaf Maple: 1
- Total dead or dying trees by class:
  - A1: 53
  - A2: 44
  - A3: 10
  - B1: 4
  - B2: N/A
- Dead or dying trees by species per hectare (Green Park North land area = 2.5ha):
  - Western Redcedar: 32.49/ha
  - Alder: 9.70/ha
  - Douglas-Fir: 2.53/ha
  - Grand Fir: 1.68/ha
  - Big Leaf Maple: 0.42/ha

Figure 9: Cluster of dead and dying Alder and Western Redcedar trees in Green Park North.

5.5. Lillian Hoffar

Lillian Hoffar Park located on the shore of Tsehum Harbour on in the northeastern part of the Saanich Peninsula and hosts both Indigenous and colonial heritage sites within its 4ha land area. Three distinct plant communities are found in the park. In the southeast of the park the driest ecosystem is dominated by Douglas-Fir. The two moist sites are dominated by Black Cottonwood (*Populus trichocarpa*) and Western Redcedar in the southwest and northwest respectively. All ecosystem types were multistoried, with the drier site having denser canopy than the two moist ones, which were relatively open.

Table 5: Total dead or dying trees based on ground assessment for Lillian Hoffar Park.

Tree	Spp.	Class	Mortality
1	Western Redcedar	A3	Full

2	Western Redcedar	A2	Top 1/3
3	Western Redcedar	A3	Top 1/3
4	Douglas-Fir	A2	Full
5	Alder	A3	Full
6	Alder	A3	Full
7	Alder	A2	Top 1/3
8	Western Redcedar	A1	Top 1/3
9	Western Redcedar	A1	Top 1/3
10	Alder	A3	Full
11	Western Redcedar	A1	Lower 2/3
12	Western Redcedar	A1	Full
13	Western Redcedar	A1	Full
14	Grand Fir	A1	Full
15	Grand Fir	A1	Full
16	Arbutus	A3	Full
17	Douglas-Fir	A3	Full
18	Arbutus	A2	Full
19	Arbutus	A3	Full
20	Western Redcedar	A1	Top 1/3
21	Willow	A3	Top 2/3
22	Western Redcedar	A1	Top 1/3
23	Western Redcedar	A1	Top 1/3
24	Western Redcedar	A1	Top 1/3
25	Western Redcedar	A1	Top 1/3
26	Western Redcedar	A1	Top 1/3
27	Western Redcedar	A1	Top 1/3
28	Western Redcedar	A1	Top 1/3
29	Western Redcedar	A1	Top 1/3
30	Western Redcedar	A1	Top 1/3
31	Western Redcedar	A1	Top 1/3
32	Western Redcedar	A1	Top 1/3
33	Western Redcedar	A1	Top 1/3
34	Western Redcedar	A1	Top 1/3
35	Western Redcedar	A1	Top 1/3
36	Western Redcedar	A1	Top 1/3
37	Western Redcedar	A1	Top 1/3
38	Western Redcedar	A1	Top 1/3
39	Unidentified	A3	Full
40	Western Redcedar	A1	Full
41	Western Redcedar	A1	Top 1/3
42	Big Leaf Maple	A3	Top 1/3
43	Western Redcedar	A2	Top 1/3
44	Western Redcedar	A1	Top 2/3
45	Big Leaf Maple	A3	Full
46	Big Leaf Maple	A3	Full
47	Alder	A2	Top 2/3

48	Western Redcedar	A2	Top 1/3
49	Big Leaf Maple	A3	Full
50	Big Leaf Maple	A3	Full
Note: These data were collected in mid-July of 2023. The analysis was conducted for the park as a whole.			

Summary of ground assessment for Lillian Hoffar Park:

- Total dead or dying trees by species:
  - Western Redcedar: 31
  - Big Leaf Maple: 5
  - Alder: 5
  - Arbutus: 3
  - Douglas-Fir: 2
  - Grand Fir: 2
  - Willow: 1
  - Unidentified: 1
- Total dead or dying trees by class:
  - A1: 28
  - A2: 7
  - A3: 15
  - B1: N/A
  - B2: N/A
- Dead or dying trees by species per hectare (Lillian Hoffar land area = 4ha)
  - Western Redcedar: 7.75/ha
  - Big Leaf Maple: 1.25/ha
  - Alder: 1.25/ha
  - Arbutus: 0.75/ha
  - Douglas-Fir: 0.50/ha
  - Grand Fir: 0.50/ha
  - Willow: 0.25/ha
  - Unidentified: 0.25/ha

Figure 11: Dead Arbutus tree in Lillian Hoffar Park.

5.6. Sumac Park

Sumac Park is a relatively undisturbed park consisting of roughly 4ha on the northern end of the Saanich Peninsula. The park contains an ephemeral stream, with different canopy composition at different slope positions. At the bottom the canopy is dominated by Western Redcedars growing along the shores of the stream. At the meso-slope position, the canopy consists of Western Redcedar, Grand Fir (*Abies grandis*) and Douglas-Fir. In the uppermost reaches of the

park, Douglas-Fir dominates with some Arbutus. The canopy is mostly two-storied, with tall A1 class trees dominating, and fewer A2 class trees which allows for dappled sunlight to reach the understory.

Table 6: Total dead or dying trees based on ground assessment for Sumac Park.

Tree	Spp.	Class	Mortality
1	Western Redcedar	A2	Top 1/3
2	Western Redcedar	A2	Top 1/3
3	Western Redcedar	A2	Top 1/3
4	Western Redcedar	A2	Top 1/3
5	Western Redcedar	A2	Top 1/3
6	Western Redcedar	A2	Top 1/3
7	Western Redcedar	A2	Top 1/3
8	Western Redcedar	A3	Full
9	Western Redcedar	A3	Full
10	Western Redcedar	A3	Full
11	Western Redcedar	A3	Full
12	Douglas-Fir	A3	Full
13	Western Redcedar	A1	Top 1/3
14	Western Redcedar	A3	Top 1/3
15	Western Redcedar	A1	Full
16	Western Redcedar	A2	Top 1/3
17	Western Redcedar	A2	Top 1/3
18	Western Redcedar	A1	Top 1/3
19	Western Redcedar	A1	Top 1/3
20	Douglas-Fir	A3	Full
21	Western Redcedar	A1	Top 1/3
22	Grand Fir	A1	Full
23	Grand Fir	A1	Full
24	Grand Fir	A1	Full
25	Douglas-Fir	A3	Full
26	Western Redcedar	A3	Full
27	Western Redcedar	A2	Top 1/3
28	Grand Fir	A2	Full
29	Western Redcedar	A1	Full
30	Western Redcedar	A1	Full
31	Western Redcedar	A1	Full
32	Grand Fir	A1	Full
33	Big Leaf Maple	A2	Full
34	Big Leaf Maple	A3	Full
35	Western Redcedar	A1	Full
36	Western Redcedar	A1	Full
37	Western Redcedar	A2	Full
38	Western Redcedar	A2	Full

39	Grand Fir	A1	Full
40	Western Redcedar	A2	Top 1/3
41	Western Redcedar	A1	Full
42	Western Redcedar	A1	Full
43	Western Redcedar	A1	Full
44	Western Redcedar	A1	Full
45	Western Redcedar	A2	Full
46	Western Redcedar	A2	Full
47	Western Redcedar	A2	Full
48	Western Redcedar	A2	Full
49	Western Redcedar	A2	Full
50	Western Redcedar	A1	Top 1/3
51	Western Redcedar	A1	Top 1/3
52	Western Redcedar	A1	Full
53	Western Redcedar	A1	Full
54	Western Redcedar	A1	Full
55	Western Redcedar	A1	Top 1/3
56	Western Redcedar	A1	Top 1/3
57	Western Redcedar	A1	Full
58	Western Redcedar	A1	Full
59	Western Redcedar	A1	Full
60	Western Redcedar	A1	Top 1/3
61	Western Redcedar	A1	Top 1/3
62	Western Redcedar	A1	Top 1/3
63	Western Redcedar	A1	Top 1/3
64	Western Redcedar	A1	Top 1/3
65	Western Redcedar	A1	Top 1/3
66	Western Redcedar	A1	Top 1/3
67	Western Redcedar	A1	Top 1/3
68	Western Redcedar	A1	Top 1/3
69	Western Redcedar	A1	Top 1/3
70	Western Redcedar	A1	Top 1/3
71	Big Leaf Maple	A1	Full
72	Western Redcedar	A1	Full
73	Western Redcedar	A1	Full
74	Western Redcedar	A1	Full
75	Western Redcedar	A1	Full
76	Western Redcedar	A1	Full
77	Western Redcedar	A1	Full
78	Western Redcedar	A1	Full
79	Western Redcedar	A1	Full
80	Western Redcedar	A1	Full
81	Western Redcedar	A1	Full
82	Douglas-Fir	A1	Full
83	Western Redcedar	A2	Full
84	Western Redcedar	A2	Full

85	Western Redcedar	A2	Full
86	Western Redcedar	A2	Full
87	Western Redcedar	A1	Top 1/3
88	Western Redcedar	A1	Top 1/3
89	Western Redcedar	A1	Top 1/3
90	Western Redcedar	A2	Full
91	Western Redcedar	A2	Full
92	Western Redcedar	A2	Full
93	Western Redcedar	A2	Full
94	Western Redcedar	A2	Full
95	Western Redcedar	A1	Full
96	Western Redcedar	A1	Full
97	Western Redcedar	A1	Full
98	Western Redcedar	A1	Full
99	Western Redcedar	A1	Full
100	Grand Fir	A1	Full
101	Western Redcedar	A2	Full
102	Western Redcedar	A2	Full
103	Western Redcedar	A2	Full
104	Western Redcedar	A2	Full
105	Western Redcedar	A2	Full
106	Western Redcedar	A2	Full
107	Western Redcedar	A2	Full
108	Western Redcedar	A1	Bottom 2/3
109	Western Redcedar	A1	Top 2/3
110	Western Redcedar	A1	Top 2/3
111	Western Redcedar	A1	Top 2/3
112	Western Redcedar	A1	Top 2/3
113	Western Redcedar	A1	Full
114	Western Redcedar	A1	Full
115	Western Redcedar	A1	Full
116	Western Redcedar	A1	Full
117	Western Redcedar	A1	Full
118	Western Redcedar	A1	Full
119	Western Redcedar	A1	Full
120	Western Redcedar	A1	Full
121	Western Redcedar	A1	Top 1/3
122	Douglas-Fir	A1	Full
123	Douglas-Fir	A1	Full
124	Douglas-Fir	A1	Full
125	Western Redcedar	A1	Full
126	Western Redcedar	A1	Full
127	Western Redcedar	A1	Full
128	Western Redcedar	A1	Full
129	Western Redcedar	A1	Full
130	Douglas-Fir	A1	Bottom 2/3

131	Douglas-Fir	A1	Bottom 2/3

Note: These data were collected in mid-July of 2023. The analysis was conducted for the park as a whole.

Summary of ground assessment for Sumac Park:

- Total dead or dying trees by species:
  - Western Redcedar: 112
  - Grand Fir: 7
  - Douglas-Fir: 9
  - Big Leaf Maple: 3
- Total dead or dying trees by class:
  - A1: 85
  - A2: 36
  - A3: 10
  - B1: N/A
  - B2: N/A
- Dead or dying trees by species per hectare (Sumac Park land area = 4ha)
  - Western Redcedar: 28/ha
  - Douglas-Fir: 2.25/ha
  - Grand Fir: 1.75/ha
  - Big Leaf Maple: 0.75/ha

Figure 13: Group of dead Grand Fir trees in Sumac Park.

6. Discussion

When comparing the aerial imagery data (Table 1), to the data collected on the ground (Tables 2-6), we can see there is a large difference in the number of dying trees. This is due to aerial imagery only being able to capture the tops of dead or dying trees in the A1 and sometimes A2 layer of the canopy. This effectively obscures other potential dead or dying trees in the understory and producing potentially misleading data. Aerial imagery is still important data to

collect, however, as it allows us to see the change in number of dead-topped trees over time. Solely relying on ground assessments for a pilot study such as this can also provide misleading data, as it would include trees which may have been dead for years in the 2023 data. This cumulative mortality, while important, would not give any insight into the onset or rate of mortality in the parks.

The overwhelming dieback of Western Redcedar trees and smaller percentage of Douglas-Fir dieback from the ground analysis suggests that moisture availability is likely the one of the main causes for dieback and mortality in the parks analyzed. This is because Western Redcedar are typically found in areas where moisture is more abundant, while Douglas-Fir trees are more tolerant to drier conditions (Pojar & Mackinnon). This is supported by the literature put forth by the Government of British Columbia in their 2021 summary of forest health, in which the majority of drought induced foliage damage was occurring on Western Redcedar trees (Westfall & Duthie-Holt, 2021).

The results of this study also found that A1 class trees were the most susceptible to dieback and mortality in all parks except for Quarry Park. This finding is of concern as the A1 trees found within the parks analyzed, and for much of the Saanich Peninsula, are not at the end of their life cycle, suggesting that other stressors may be acting on these trees. This is particularly troubling, as the Ministry of Water, Land and Air Protection predict that regeneration of CDF sites will likely be slowed as a result of climate change, further deteriorating previously healthy stands of forest year after year (Ministry of Environment, 2004).

It is interesting to highlight that of the five parks analyzed, the two parks with significant water features (Green Park North and Sumac Park) had the highest number of dead or dying trees, as well as the highest dead or dying Western Redcedar trees per hectare. However, this may be simply a result of the greater proportion of these moist sites being comprised of Western Redcedar to begin with.

Another interesting thing to note about Green Park North specifically is the surprising amount of Alder defoliation along the edges of the two ponds (Table 4). This suggests that water availability is likely not the sole factor resulting in declining tree health in the parks of North Saanich. Other stressors such as disease, pests, or pathogens might be responsible, likely in addition to climate stress. However, more research is needed to establish the cause of declining Alder health.

During the course of this study, five parks within the CDFmm ecosystem type were analyzed to determine the extent of tree die back and mortality. The findings aligned with current literature stating that trees within the CDF zone are experiencing this phenomenon, likely as a result of climate change. Continued monitoring will be needed to further understand why dieback is occurring, what the rate of dieback is, and how to manage it.

7. Conclusion

Trees are an important aspect of the physical environment in the parks of North Saanich and provide benefits for the natural world and human settlements alike. Trees serve as crucial habitat for plant and animal communities, help prevent erosion, provide clean drinking water, while also providing humans with fuel, food, building materials, and recreational enjoyment. Additionally, in urban settings such as parks, trees help to regulate temperatures, store carbon, and produce the oxygen which we breathe. However, the benefits we reap from trees may be limited if the rate of tree dieback and mortality continues to increase, as we have seen in recent years. Through this study, the number of dead or dying trees in five parks within North Saanich have been counted, and separated based on characteristics such as species, class, and mortality level, and the results should act as the first step in the monitoring of tree health in these parks. As the literature reviewed suggests, as the climate continues to change, we will see more frequent, prolonged, and extreme drought events, resulting in heightened tree mortality. It is the decisions we make now that will determine the future of the trees, and all the services they provide to the human and natural worlds.

8. Recommendations

As has been expressed, future research into tree die back and mortality should utilize both aerial as well as in situ assessments to better understand the rate at which die back and mortality are occurring. It is recommended to use this pilot study as the first step in the continued monitoring of the five parks highlighted, as well as provide a framework for future analyses of other forested regions.

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