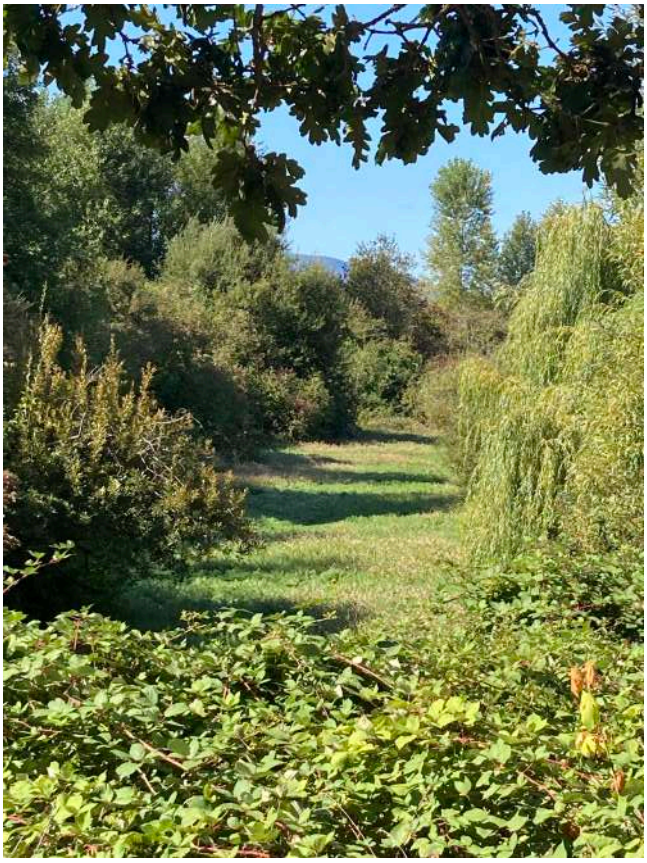

2021 SOMENOS CREEK PARROT'S FEATHER REPORT

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Somenos Marsh
WILDLIFE SOCIETY
Stewards of the S'amunu/Somenos Watershed

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Executive Summary

Parrot's feather (*Myriophyllum aquaticum*) is an invasive aquatic plant that was introduced into Somenos Creek within the last decade. Since being introduced in 2014, the plant has spread prolifically, and now covers over 70% of the creek during high season in July and August. There are concerns that it may fundamentally change water chemistry characteristics such as dissolved oxygen concentration as well as potentially creating a physical barrier through the thick growth of their roots, stolons and shoots. The latter and the former could both contribute to creating a movement/migration barrier to local populations of salmon.

The Somenos Marsh Wildlife Society (SMWS) staff has been surveying the plant's growth throughout the year. Parrot's feather follows a fairly predictable growth pattern in the Somenos system, with rapid growth and coverage expansion in the spring and summer months, followed by a substantial die-off in the fall and winter where swaths of the plant get ejected from the creek into the Cowichan River, on into the ocean via Cowichan Bay. This year (2021), the growth of parrot's feather followed this pattern nearly to a T. Overall, the creek saw coverage climb from 57% in June to 73% in August followed by a crash in December down to 45%. This report further breaks down coverage into the individual reaches of Somenos Creek as well. The reach coverages break down as follows:

Reach 1: 53% (June), 58% (July), 68% (August), 57% (December)
Reach 2: 78% (June), 91% (July), 96% (August), 57% (December)
Reach 3: 54% (June, N/A (July), 70% (August), 23% (December)

The SWMS has further research to undertake regarding parrot's feather in the system. This research includes investigation into two conspicuous stretches of the creek where the plant is nearly absent, as well as a deeper dive into the habitat and water flow impacts that parrot's feather may have. These factors include but are not limited to the alteration of water chemistry and the creation of a physical barrier that may have a negative impact on fish movement and migration within the system.

Finally, treatment is underway in various phases. Experimental treatment in the form of the addition of pond liner to a section of the creek to see if smothering the parrot's feather is a viable option is currently in year two and will re-evaluate it in the coming summer. Planting along creekbanks to provide shade to the creek has been ongoing for several years and is slated to continue. Shade is a factor that will hopefully hamper the growth of parrot's feather as it prefers to grow in full sun. Finally, further research into a parrot's feather harvester for the purpose of manual removal is in the works for the coming year for the SMWS. None of the solutions alone are perfect, but the SMWS hopes that a combination of the above-outlined treatments may help to limit the growth and help creek health in the future.

Introduction

Parrot's feather (*Myriophyllum aquaticum*) is an invasive aquatic plant that has been taking a hold of Somenos Creek ever since being introduced back in 2014 (Preikshot, 2019). It is a plant that has been introduced from the Amazon River in South America and has spread throughout North America and many other parts of the world including Africa, Asia, and Europe. Parrot's feather thrives in warm, freshwater and is commonly found in relatively shallow and slow-moving water and is well adapted to nutrient-rich environments (Washington State Department of Ecology, 2001). Unfortunately, these are the exact conditions that Somenos Creek experiences in the summer months.

Although introduced relatively recently, parrot's feather has quickly taken a hold of Somenos Creek and the expansion of its coverage in recent years has been drastic. Somenos Creek is a roughly 3km long stretch of water that drains Somenos Lake into the Cowichan River (Figure 1). This creek is high in nutrients, in part because the watershed is host to extensive agriculture that includes both crop growth and livestock. This leads to nutrient-rich runoff that ends up in the lake and ultimately in the creek as well. As mentioned above, these create ideal conditions for this unwelcome invader. It's reasonable to

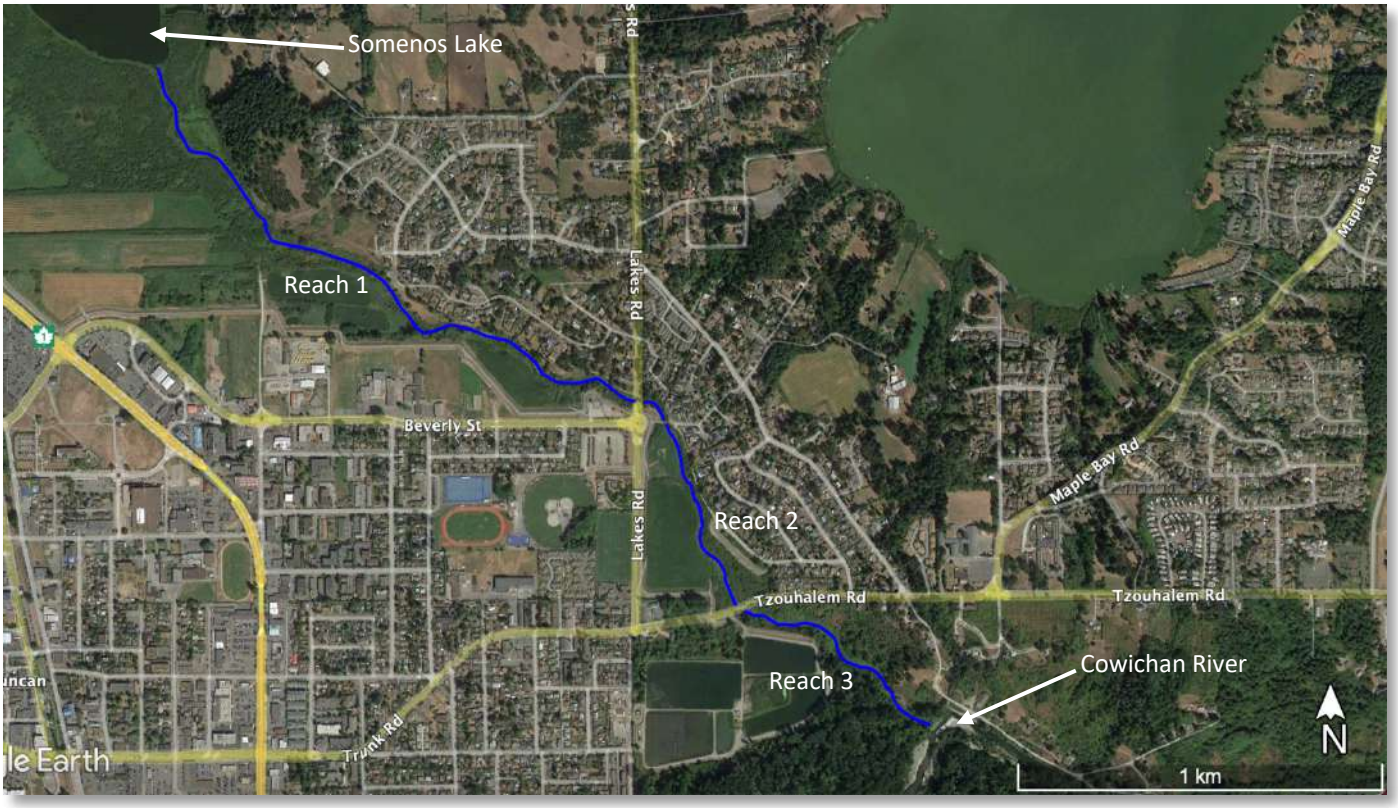

Figure 1: Somenos Creek

think that with incoming drier and hotter summers attributed to anthropogenic climate change, the growth season of parrot's feather will increase in length, thus leading to greater coverage, thicker mats, and more permanent changes to the ecology of the creek system.

The main concerns around parrot's feather in Somenos Creek right now revolve around physical and chemical alterations within the ecosystem. The two primary concerns are whether or not the mats of organic matter will create a physical barrier, and whether or not the plant directly and negatively affects the water quality of the creek. Both of these points of focus revolve around the fact that Somenos Creek is the gateway to the Somenos watershed, a watershed that has supported substantial populations of salmon throughout history. Populations of coho (*Oncorhynchus kisutch*) and chum (*Oncorhynchus mykiss*) salmon currently use the watershed's tributaries (Richards Creek, Averill Creek, and Bings Creek) as their spawning grounds (Burns, 2002), along with historical use by chinook (*Oncorhynchus tshawytscha*). While the exact impacts are still under investigation, it has been posited that the mats of parrot's feather in the creek could present as a physical barrier to fish migration into the system. If so, it's possible that fish migration could be delayed until the water gets colder and the parrot's feather die off begins, allowing for easier passage. Another impact is that of parrot's feather on local water quality. There is some question as to whether the plant may negatively affect the waterway's dissolved oxygen levels. This year, during SMWS water quality testing, it was seen that oxygen levels in the creek weren't high enough to support fish passage until parrot's feather started breaking up in November. We are currently unsure as to whether low early-spring oxygen levels can be directly attributed to the presence of parrot's feather or if it's cause by other factors.

The Somenos Marsh Wildlife Society has been formally surveying and cataloguing the extent of the parrot's feather since the summer of 2020. The surveys are aimed at monitoring the fluctuation of parrot's feather coverage in Somenos Creek year-to-year, and month-to-month. In 2021, the SMWS performed 4 such surveys, with one in each of June, July, August, and December. The intention of this survey schedule was to monitor the plant's growth throughout the summer season, and to determine how much remains a month or so into the rainy season.

Methods

Staff members of the SMWS were tasked with performing these surveys. The surveys were performed through observations from the streambank in conjunction with in-water observations through the use of kayaks. The kayak observation method had limited application this year as the parrot's feather quickly became too thick and large swaths of Somenos Creek became impassable by boat. The kayak method was used only for the first survey, in June.

The abundance of Parrot's Feather was determined by visual inspection and the percentage was recorded based length and width of channel. Channel widths were measured and averaged for area calculations using a combination of Google Earth Pro and Gaia GPS. As the SMWS staff walked Somenos Creek, waypoints were taken (Gaia GPS Android app) when there was an obvious change in the amount of parrot's feather coverage observed. The change in coverage was noted at each of these points, and the data (in KML form) was then inputted into Google Earth Pro in order to create colour-coded parrot's feather coverage maps (see Results section).

Somenos Creek was surveyed for parrot's feather coverage in June, July, August, and December (after the plant started breaking up during the cold/rainy season). The highlighted months link to the specific reports associated with each respective survey.

For the purpose of these surveys, Somenos Creek was split into three reaches (Figure 1):

- Reach 1: Somenos Lake to Lakes Road Footbridge (Municipality of North Cowichan)
- Reach 2: Lakes Road Footbridge to Tzouhalem Road (Municipality of North Cowichan)
- Reach 3: Tzouhalem Road to Cowichan River (Cowichan Tribes)

Reach 3 runs exclusively through Cowichan Tribes land, permission to access this reach of the creek was given by Cowichan Tribes members, Tim Kulchyski and Tracy Fleming. Results of all surveys along with this final 2021 report are shared with Cowichan Tribes. The SMWS thanks Cowichan Tribes for welcoming us onto their land to perform this work. We look forward to continued collaboration with them in effort to control the spread of this plant.

Results

Reach 1

Reach 1 of Somenos Creek begins at the Southeastern end of Somenos Lake and runs Southeast to the Lakes Road Bridge (Figure 2). This reach is characterized by slow flow velocity (even in high-water season), unremarkable canopy coverage, a relatively large flood plain area, and runs through portions of agricultural and residential land. This reach has also been dredged in 2004 (Municipality of North Cowichan, 2019), in order to remove sediment and organic material buildup which was thought to affect the depth of the creek thus reducing its drainage capacity.

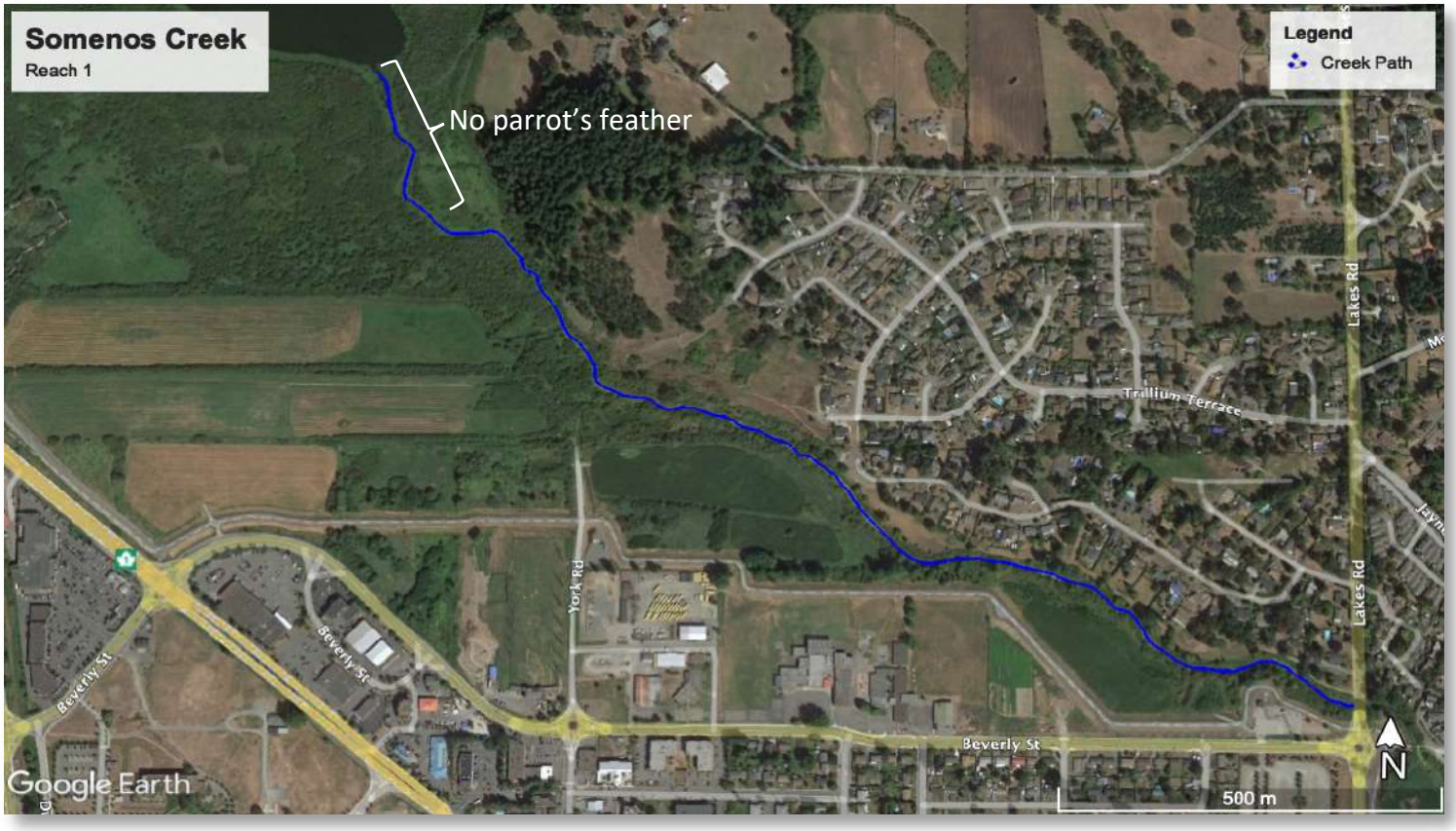

Figure 2: Reach 1 of Somenos Creek. This reach runs from Somenos Lake to the Lakes Road Bridge

In reach 1, we witnessed a substantial increase in the coverage of parrot's feather throughout the growth season of 2021 (Table 1).

Table 1: Parrot's feather coverage in reach 1

Month	June	July	August	December
Coverage (%)	53	58	68	57

As we see in the above table, there was a consistent increase in coverage throughout the growth season, with a larger jump from July to August (10%) than June to July (5%). This increase is followed by a fairly dramatic decrease through the fall and early winter; August to December (11%). December's coverage being higher than that in June could mean one of two things, either there's going to be more parrot's feather die-off and expulsion through the winter, or the mats of the plant are too thick to get pushed out by the relatively slow flow velocities experienced in this reach of the creek and will stay stuck in this reach. More observation throughout the winter and into next growth season will be required to answer this question.

A main point of interest in this reach for the summer was the top-end of the reach, at the mouth of Somenos Creek. The mouth of the creek was an interesting case this summer, as there was no parrot's feather growth whatsoever for the first 200-250m of the creek. This is a departure from past trends as parrot's feather had been observed in this area in the past. It is currently unclear as to why parrot's feather seems to be retreating from the edge of Somenos Lake, however it has been considered that perhaps water conditions in the lake affected that part of the creek this summer. We had abnormally hot weather, abnormally little precipitation, and an extreme algal bloom in the lake this year. Again, whether there is a return of parrot's feather to this area next year remains to be seen, however it is something that needs to be monitored and further researched.

All raw data for reach can be found in Appendix 1.

Reach 2

Reach 2 of Somenos creek begins at the Eastern side of the Lakes Road Bridge and flows South Southeast to the North side of the Tzouhalem Road Bridge (Figure 3). This reach is characterized by an essentially completely open canopy, with little to no shade. It flows directly adjacent to agricultural fields on its Western bank, and a residential development on the Eastern bank. The agriculture consists of a hay field and a corn field that are actively cultivated each year. The agricultural fields bordering this reach provide a substantial floodplain which is used in the wet season by many species of waterfowl for overwintering and migration. This reach has also been dredged in 2004 (Municipality of North Cowichan, 2019) however sedimentation continues to plague it.

Figure 3: Reach 2 of Somenos Creek. This reach runs from Lakes Road Bridge to Tzouhalem Road Bridge

Reach 2 showed the most significant fluctuation in parrot's feather coverage of all three reaches of Somenos Creek this season (Table 2).

Table 2: Parrot's feather coverage in reach 2

Month	June	July	August	December
Coverage (%)	78	91	96	57

The parrot's feather in reach 2 went through substantial transformation in the summer of 2021. This reach saw the most dramatic changes of all three reaches, both in the increase in coverage from June to August (18%), but also in the decrease from August to December (39%). Interestingly, in this reach, while the coverage decreased drastically, we are unsure as to whether or not much of the parrot's feather has actually left the system. During the December survey, it was noted that several larger areas of open water had opened up, however, it appeared that the sections of parrot's feather that had broken free had

drifted downstream and been blocked by other clumps that had not become dislodged. This was evidenced by apparent thickening of the downstream mats.

A point of concern in this reach is the fact that there are a couple of pinch points that are associated with substantial mats of parrot's feather. These mats were assessed by the SMWS in August in preparation for rainy season to see if they could potentially increase the flood risk in the area (Link to assessment). The first of the two pinch points is a narrowing and sharp bend in the creek about 70m downstream of Lakes Road Bridge. This area has been cleared by fall flows and doesn't seem to present a current hazard. The second pinch point is just downstream of where Chesterfield Creek joins Somenos Creek about one third of the way through the West bank farmer fields (Figure 3). This point is a narrowing portion of the creek where a tree has fallen from the Eastern bank and is now a potential blockage hazard. As of December, this appears to be the main point of collection for parrot's feather drifting downstream. This area is prone to flooding even when clear, so it's difficult to determine the risk this pinch-point may create with regards to flooding. The main concern with this area is that if the mats get thick enough, they may present a physical barrier which could negatively impact fish migration through Somenos Creek and into the rest of the watershed.

All raw data for reach 2 can be found in appendix 2.

Reach 3

Reach 3 of Somenos Creek begins at the South side of Tzouhalem Road Bridge and flows Southeast before joining forces with the Cowichan River. This reach is characterized by a more natural shape and bank, as it has not been dredged in the past, as reaches 1 and 2 have. It is crossed about a third of the way downstream by an overhead water pipeline. The banks are higher than elsewhere in the creek, and while they are wide enough to give the creek access to some floodplain, it is generally a more confined reach than the other two. This reach also boasts the most natural vegetation on its banks, and the greatest riparian depth, supporting large trees in its Southern half. Although greater than reaches 1 and 2, reach 3's canopy cover certainly still leaves something to be desired. This reach is entirely located on Cowichan Tribes land.

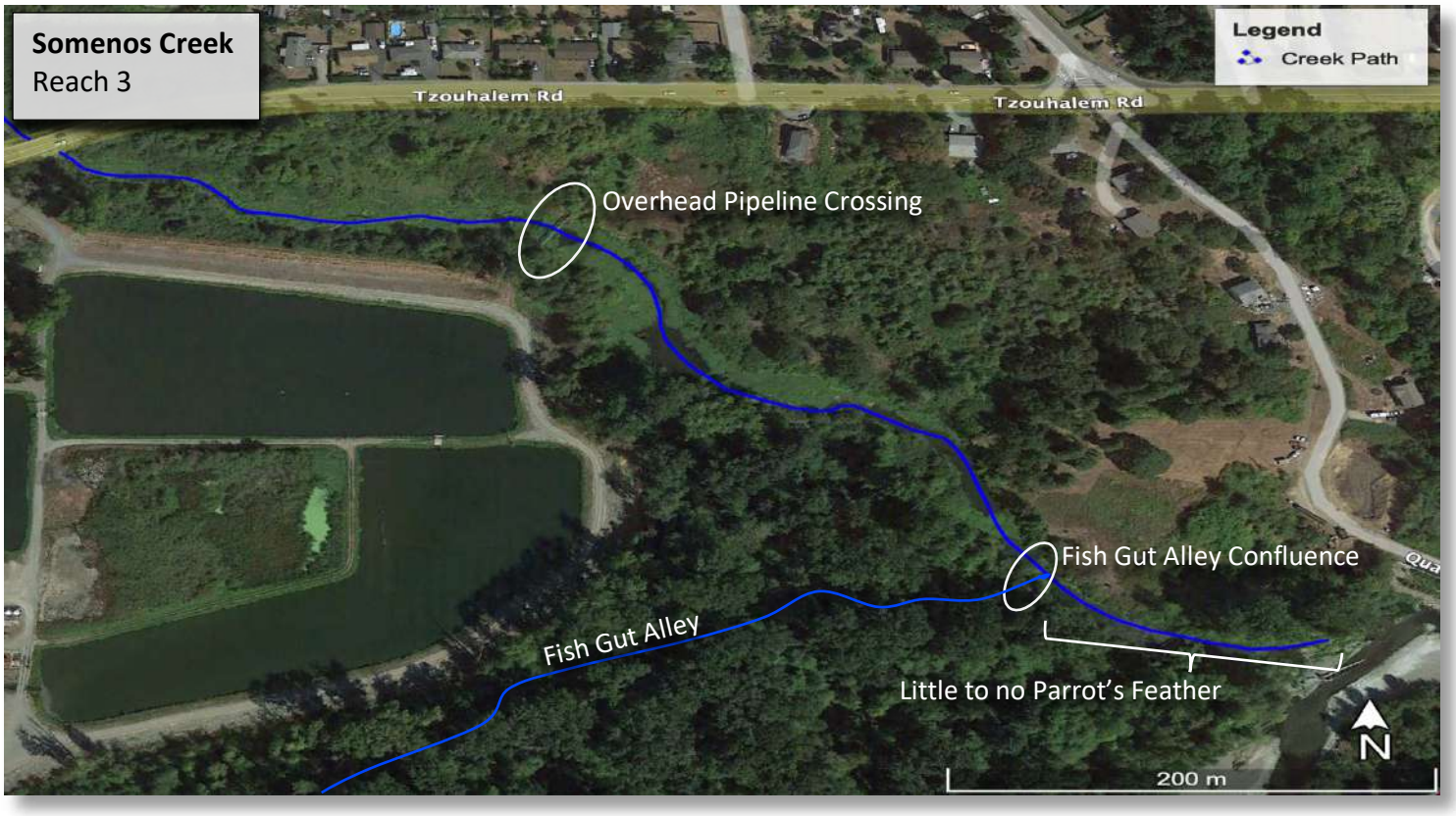

Figure 4: Reach 3 of Somenos Creek. This reach runs from the Tzouhalem Road Bridge to the Cowichan River

Reach 3 was surveyed three times this season, whereas the other two reaches were surveyed 4 times. However, the trends remain consistent, with a quick climb in coverage during the summer, followed by a sharp drop off in the fall and early winter (Table 3).

Table 3: Parrot's feather coverage in reach 3

Month	June	July	August	December
Coverage (%)	54	N/A	70	23

Reach 3 of Somenos Creek showed the lowest start and endpoints with regards to parrot's feather coverage. There are several points of note within this reach. First, there is an overhead water pipeline crossing about one third of the way downstream in this reach (Figure 4). This area is accompanied by the lowest canopy coverage in the reach and consequently experienced the most consistent complete coverage of parrot's feather in this area. Even during the December survey, there was still a bank-to-bank mat underneath and directly adjacent-downstream of this pipeline. Beyond the lack of shade, we are

unsure if this pipeline or the infrastructure required to install it has any direct impact on parrot's feather. The second point of interest is the confluence with a stream referred to as "Fish Gut Alley" (Figure 4). In June, large portions upstream of this confluence had high coverage, while below this confluence, there was no parrot's feather at all. The water coming from Fish Gut Alley (FGA) was much colder and flowing much more quickly than the water upstream in Somenos Creek. When we returned in August, FGA was experiencing very low flow and consequently the coverage of parrot's feather had drastically increased downstream of the confluence. We tested water in FGA (Table 4, Figure 5) and found it to be much colder and more oxygenated than that in the rest of the creek (Table 5), potentially creating conditions that were too harsh for parrot's feather to thrive. Remember, it's an Amazonian plant and does better in warmer water.

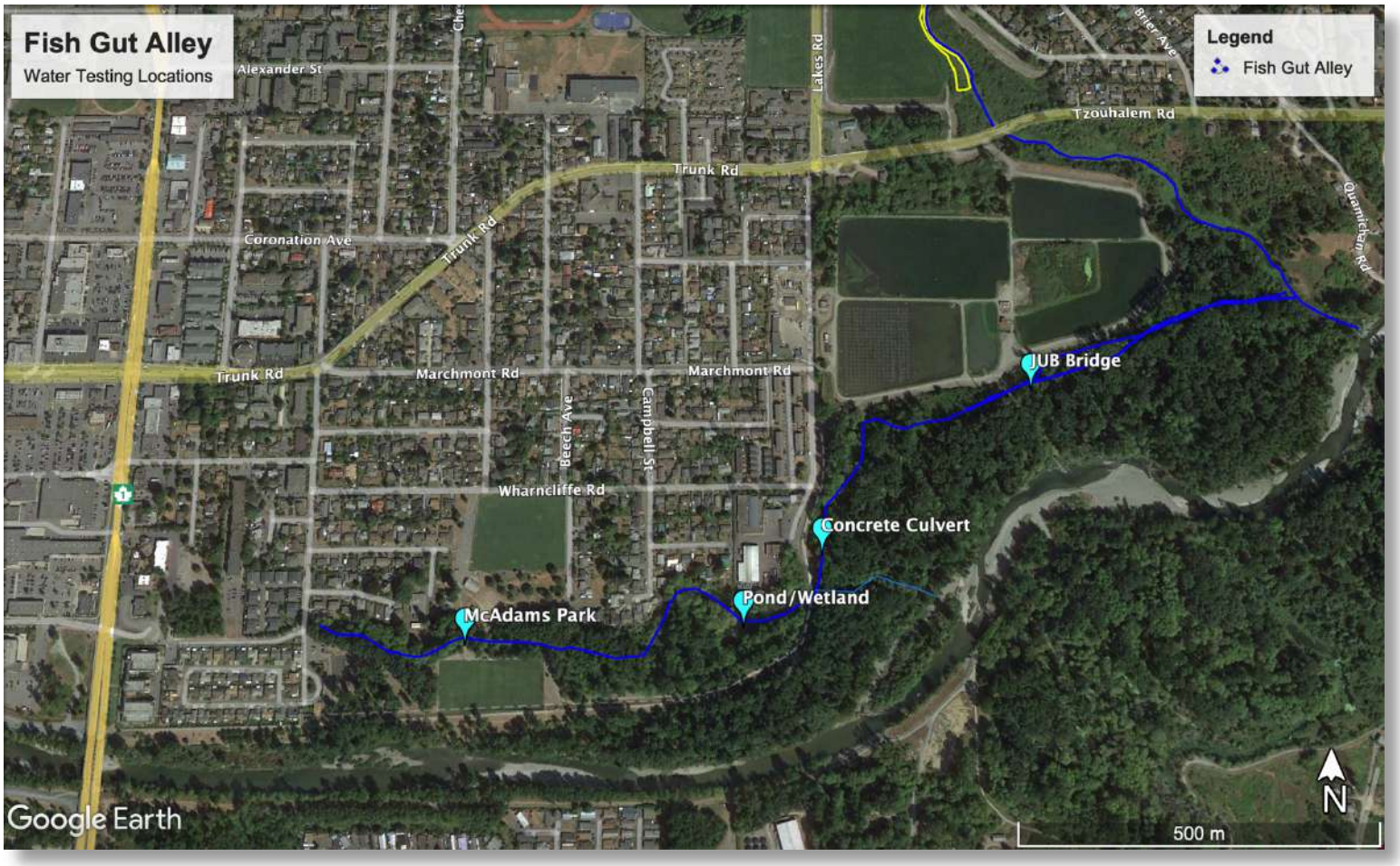

Figure 5: Fish Gut Alley Water Quality Monitoring Points

Table 4: Water quality results in different areas of FGA

WQ Parameters	Site 1: McAdams Park	Site 2: Wetland	Site 3: Concrete Culvert	Site 4: Bridge
Temperature (°C)	12.1	20.7	12	11.8
Dissolved Oxygen (mg/L)	5.04	5.7	10.68	10.01
pH	6.79	7.45	7.78	7.1
Total Dissolved Solids (mg/L)	43.55	35.27	53.95	49.2
Specific Conductivity (µS)	66.8	55.7	76.6	74.3
Phosphate (mg/L)	-	-	0.27	0.31

Table 5: Water quality results upstream of FGA

WQ Parameters	Open Channel	Underneath Parrot's Feather
Temperature (°C)	22.3	22.4
Dissolved Oxygen (mg/L)	2.44	2.71
pH	6.45	6.86
Total Dissolved Solids (mg/L)	104.66	104.65
Specific Conductivity (µS)	161.4	161

Something else of note in reach 3, is the fact that it saw the greatest drop (47%) in coverage from its peak in August to its low in December. There are several possible explanations for this dramatic fall decrease. Firstly, this is the terminal reach of Somenos Creek that flows directly into the Cowichan River, meaning that when parrot's feather dies and breaks off, it has less distance to travel to be ejected. Simply put, less distance travelled means it's likely to encounter fewer blockages and pinch points. Secondly, there's the aforementioned influence from the water entering the creek from FGA. Perhaps since it had a shorter growing season downstream of FGA, the root systems weren't as well established, allowing for easy ejection come rainy season. Finally, while the banks along reach 3 are fairly wide, there is far less floodplain when compared to the first two reaches. This could lend itself to higher flow velocities in this reach due to a more constricted flow path, thus making ejection of the parrot's feather easier as it begins to die off. The upper two reaches have such extensive floodplains that during high-flow, water simply flows around the parrot's feather mats, rather than pushing them downstream, as we see in reach 3.

All raw data for reach 3 can be found in Appendix 3.

Overall Impressions and Conclusions

Overall, the coverage of parrot's feather seen on Somenos Creek in 2021 followed a familiar and relatively predictable pattern. There were, however, a few anomalies sprinkled into the data. The overall coverage for the entire creek in 2021 is presented below in table 6.

Table 6: Overall Parrot's Feather Coverage in Somenos Creek

Month	June	July	August	December
Coverage (%)	57	N/A	73	45

Throughout the year, we found a general inverse relationship between canopy cover (shade) and parrot's feather coverage. This is clearly seen in how much higher the summer coverage is in reach 2 when compared to reaches 1 and 3. Reach 2 has by far the lowest canopy coverage of all three reaches and sports a substantially higher maximal parrot's feather growth than the other two as well. Now when we consider the shading hypothesis on a more micro-scale, the numbers aren't perfect, but show a familiar story. In appendices one and two, canopy coverage percentages are included in the raw data tables for July. In this, we can still observe a fairly close relationship between high canopy coverage and low parrot's feather coverage and vice versa. This leads us to believe that planting trees to provide shade along the creek banks could be an effective way to curb the ever-thickening growth of parrot's feather.

Two points of emphasis that require further investigation are also mentioned above. Firstly, a point of concern is the "matting" of clumps of parrot's feather in certain points in the creek, usually coinciding with pinch points. These mats require two points of further investigation and monitoring:

1. Are they creating an increased risk of flooding, or exacerbating "normal" flooding in the creek?
2. Are they creating a physical barrier that will negatively impact fish migration? (fall salmon spawning)

These mats will be important to monitor into the future. In past years, the vast majority of parrot's feather has been ejected from the system in the high winter flows. However, that does not appear to be happening this year, and the mats are still thick and holding strong into January. If these mats stay in the system, subsequent growth seasons will only serve to thicken and expand them, potentially creating further issues in the future, and making parrot's feather a year-round hazard in Somenos Creek.

Secondly, there are substantial stretches both the upstream and downstream mouths of the creek that are largely devoid of parrot's feather presence as of 2021. The vacant upstream section starts right at the mouth where Somenos Lake flows into Somenos Creek. There is no clear or obvious landmark to indicate where the parrot's feather growth begins, and no discernible change in water or creek characteristics, making this gap in growth something of a mystery. Further inquiry and research into this part of the creek is required to determine the exact reason why parrot's feather has stopped growing here. Possible factors could include deeper water than the rest of the creek, outcompeting of parrot's feather by smartweed (an aquatic plant with similar growth habit), and possible negative interaction with the major algal bloom that Somenos Lake experienced this summer (2021). The vacant downstream section has a more discernible cause in the form of a confluence with an ephemeral waterway, known locally as Fish Gut Alley. The water coming from FGA showed drastically different characteristics than the rest of the creek, these characteristics are mentioned above in the "Reach 3" section. Recreating these conditions in the rest of the creek likely isn't possible, however it does tell us that water quality, especially certain important parameters, will have a major impact on how parrot's feather grows and proliferates throughout a system.

Going Forward

There are several potential solutions and projects that the SMWS has on tap to combat the further spread and infestation of parrot's feather in Someons Creek. These solutions are currently in various stages of implementation, from being earnestly implemented, to being in the experimental stage, to being in the research phase. The three main ideas to combat parrot's feather are outlined below, and their locations are shown in Figure 5.

Pond Liner Smothering

Over the last two years, the SMWS, in conjunction with the Municipality of North Cowichan has been engaged in an experimental parrot's feather treatment that involves smothering the plant using a rubberized pond liner in the creek. The general method with this treatment is to first set the pond liner

on top of the above water (leafy) growth of the plant in the summer growth season, and then to sink the liner to the bottom of the creek in the fall in attempt to smother the roots and rhizomes during the plant's dormant season. We are currently in year 2 of this experiment, and with fairly tepid results, it's likely the liner will be removed permenantly this summer. This method has the potential to yield strong results, if the infestation is on a smaller scale. The main issue we have run into is that the parrot's feather in Somenos Creek is so prolific that once the pond liner is set, the parrot's feather outside of its boundaries just grows overt top of it and envelops it, resulting in the same surface coverage, even with the liner in place. This would be a difficult, if not impossible, method to successfully implement in the Somenos system purely based on the size of the area and the sheer amount of material/labour required. A full report on our pond liner efforts can be found here. In Figure 5, the red box near the northern (upstream) terminus refers to the location where the pond liner is currently located.

Planting

As mentioned above, parrot's feather is not very tolerant of shade. It prefers to grow in warm areas with full sun exposure and struggles more to get a strong footing in the areas where there's a solid tree canopy covering the creek. In this vein, the SMWS has planted and plans to continue planting trees in the riparian area of Somenos Creek. The planting of trees has focused primarily on the south side of the creek, as to maximize the shade cast by said trees. The primary species used thus far have been cottonwood (*Populus balsamifera*), red alder (*Alnus rubra*), and bigleaf maple (*Acer macrophyllum*). These trees were selected because they grow tall, are quick to establish, don't mind having "wet feet", and can survive inundation, which they will experience every winter. Of course, this type of project is for the long term, as we won't be reaping the benefits of these trees for several decades. About 200 trees have been planted thus far, with many more slated to get into the ground in the next couple of years. In Figure 5, there are two main planting areas outlined, the green outline refers to the area we planted in 2021, and the yellow outline refers to the area we hope to plant in 2022.

Harvesting

The final treatment method the SMWS is currently exploring is the use of a harvester to physically remove the parrot's feather from the creek. While the harvester would not completely solve the parrot's feather issue, it could potentially be used to ensure that there's a channel of open water maintained within the creek for the whole year. This could potentially help with water flows and fish migration. There are harvesting machines that are specifically geared towards the efficient and safe removal of parrot's

feather. In 2022, the SMWS plans on performing further research and preparing a report with regards to the types of harvesters available and the efficacy of using one of these machines in Somenos Creek as a combative measure to our parrot's feather infestation.

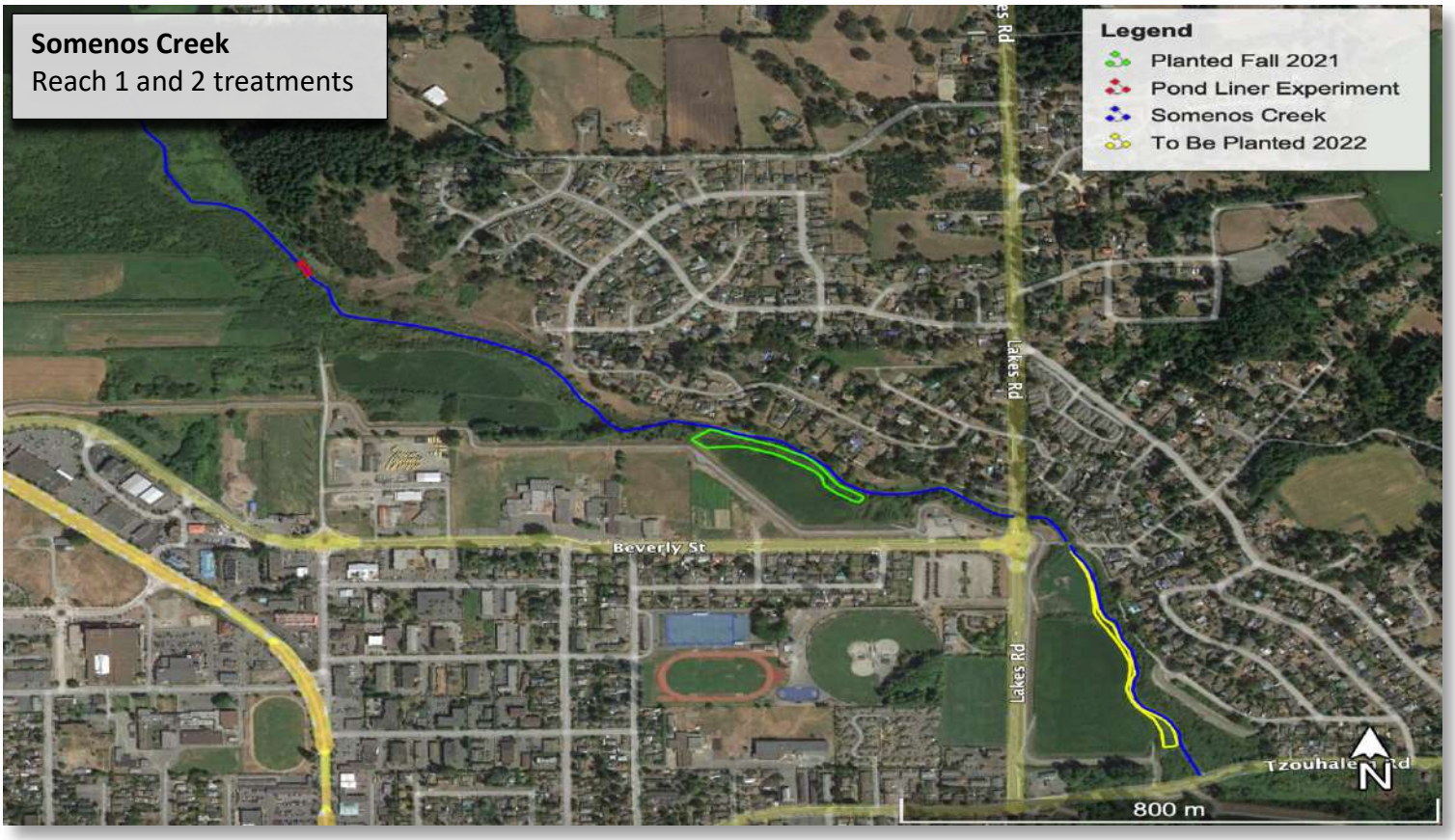

Figure 6: Current and Future Parrot's Feather Mitigation and Treatment Projects

Parrot's Feather Photos 2021

June Growth

July Growth

August Growth

December Die Off

Appendix 1

Raw data for reach 1

June:

Somenos Creek Reach: 1	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
85%	87.9	7.2	6.8	8		644.6	547.91		
5%	99.7	7.3	10.5	5.3		767.69	38.3845		
25%	25.9	7.9	5.5			173.53	43.3825		
75%	33.8	5.2	7.7	6.9		223.08	167.31		
40%	37.2	7.1	6.4	7.6		261.64	104.656		
20%	152	5.3	7.5	9.5	6.3	1086.8	217.36		
100%	44.1	7.6	7.1			324.135	324.135		
10%	78.9	7.1	5.7	8.6		562.82	56.282		Culvert with flowing water enters Somenos Creek
85%	37.4	9.2	7.1			304.81	259.0885		
10%	64.8	6	6.9			417.96	41.796		
20%	36.1	6.7	6.8			243.675	48.735		
100%	87	7.9	9.7	9.8		794.6	794.6		
5%	114	6.4	6.8	6.9		763.8	38.19		
95%	431	8.9	7.8	10.3	9.4	3922.1	3725.995		
80%	179	8.9	9.1	9.9		1664.7	1331.76		
50%	63.6	8	7.6	7.7		493.96	246.98		No PF between Somenos Lake and this point
Totals	1572.4					12649.9	7986.565	**63%**	

This table failed to include the 250 or so metres at the top of the reach with no parrot's feather, when included, it brings the coverage for June down to **53%*

July:

Reach 1: Somenos Lake to	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Canopy Coverage (%)
65%	94	7.2	6.8	8		689.3333	448.0667		25%
15%	35	7.3	10.5	5.3		269.5	40.425		40%
80%	32	8	7.6			249.6	199.68		45%
90%	45	7.9	6.7	6.4		315	283.5		40%
75%	56	7.1	6.4	7		382.6667	287		20%
20%	79	6	7.5	9.2		597.7667	119.5533		20%
40%	32	7.6	7.1			235.2	94.08		20%
100%	57	8.2	7.5	7.9		448.4	448.4		40%
25%	86	7.1	5.2	6		524.6	131.15		40%
10%	24	8.6	7			187.2	18.72		70%
15%	30	9.2	7.1			244.5	36.675		20%
100%	42	9.5	8.7	8.2		369.6	369.6		25%

75%	152	6.9	7.4	7.1		1084.267	813.2		20%
70%	52	7.2	7.9			392.6	274.82		25%
10%	68	7	6.8	6.9		469.2	46.92		20%
95%	314	8.9	7.8	10		2794.6	2654.87		20%
90%	90	8.9	9.1	9.9		837	753.3		10%
80%	225	7.8	10.3	9.4		2062.5	1650		10%
5%	52	8	7.6	7.7		403.8667	20.19333		5%
0%	234	9.1	8.6	12		2316.6	0		5%
Totals	1799					14874	8690.153	**58%**	% Coverage of total reach

August:

Somenos Creek Reach: 1	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
50%	175	7.2	6.8	8		1283.333	641.6667		
95%	26.2	7.3	10.5	5.3		201.74	191.653		
100%	73.1	7.9	5.5			489.77	489.77		
95%	47.2	5.2	7.7	6.9		311.52	295.944		
30%	81	7.1	6.4	7.6		569.7	170.91		
75%	21.1	5.3	7.5	9.5	6.3	150.865	113.1488		
100%	42.3	7.6	7.1			310.905	310.905		
75%	66.5	7.1	5.7	8.6		474.3667	355.775		
50%	35.8	9.2	7.1			291.77	145.885		
95%	15.2	7	6.9			105.64	100.358		
90%	32.2	6.7	6.8			217.35	195.615		
100%	149	7.9	8.8	9.1		1281.4	1281.4		
10%	32.6	7.1	6.8	6.9		226.0267	22.60267		Culvert outflow (no water 08/21)
95%	46.8	8.9	7.8	10.3	9.4	425.88	404.586		
30%	76.6	8.9	9.1	9.3		697.06	209.118		
100%	240	8.8	8.4	10.2		2192	2192		
95%	130	9	9.1	8.6		1157	1099.15		
100%	165	8.7	8.8	9.2		1468.5	1468.5		PF competition with smartweed
0%	250	8.2	10.1	9.9		2350	0		Last 250m leading up to the lake
Totals	1705.6					14204.83	9688.987	**68%**	

December:

Somenos Creek Reach: 1	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
0%	209	13.2	8.7	11.1	8.6	2173.6	0		
75%	275	9.7	11	7.2	5.9	2323.75	1742.813		Parrot's feather begins
90%	431	7.1	7.2	9.7	8.3	3480.325	3132.293		
25%	30.7	6.3	6.7	6.7		201.5967	50.39917		
85%	48.2	6.4	8.6	8.4		375.96	319.566		
10%	41.6	7.7	7.2	5.4		281.4933	28.14933		

100%	117	6.8	8.2	6.2	6.7	816.075	816.075		
10%	37.4	7.9	7.5	6.2		269.28	26.928		
90%	28.7	6.3	6	5.3		168.3733	151.536		
50%	111	6	8.5	8.4	6.9	826.95	413.475		
90%	48.7	7.3	7	7.4		352.2633	317.037		
20%	90.9	8	9.5	9		802.95	160.59		
90%	111	8.6	10.2	7.1		958.3	862.47		
5%	128	6.8	9.8	8.9	9.2	1110.4	55.52		
Totals	1708.2					14141.32	8076.851	**57%**	

Appendix 2

Raw data for reach 2

June:

Somenos Creek Reach: 2	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
95%	207	9.9	12.1	7.1	7.3	1883.7	1789.515		
50%	46.1	7.6	7.4	7.8		350.36	175.18		
95%	17.3	8.5	7.7			140.13	133.1235		
70%	173	6.1	7.7	8.4	8.3	1319.125	923.3875		
95%	43.3	7.2	8			329.08	312.626		
50%	54.7	6.1	8.7	7.6		408.4267	204.2133		
5%	21.8	5	3.8			95.92	4.796		
Totals	563.2					4526.742	3542.841	**78%**	

July:

Reach 2: Lakes Rd Footbbridge to Tzouhalem Rd Bridge	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Canopy Coverage (%)
100%	209	12	7.1	7.3		1839.2	1839.2		15%
95%	228	7.4	8.2	7.7		1770.8	1682.26		10%
60%	49	7.2	8	9		395.2667	237.16		25%
85%	32	6.1	7.7	7.6		228.2667	194.0267		20%
50%	46	6.2	5.6			271.4	135.7		35%
Totals	564					4504.933	4088.347	**91%**	

August:

Somenos Creek Reach: 2	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
100%	246	9.9	12.1	7.1	7.3	2238.6	2238.6		
95%	31	7.6	7.4	7.8		235.6	223.82		
100%	91.8	8.5	7.7			743.58	743.58		
95%	68.4	6.1	7.7	8.4	8.3	521.55	495.4725		
85%	32.4	7.2	8			246.24	209.304		
95%	29.9	6.1	8.7	7.6		223.2533	212.0907		
85%	33	5	3.8	4.4		145.2	123.42		
45%	31	5	3.8			136.4	61.38		
Totals	563.5					4490.423	4307.667	**96%**	

December:

Somenos Creek Reach: 2 Coverage %	length(m)	Channel widths (m) - Google Earth, 2016 aerial photo				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
0%	197	7.4	7.1	7.3	7.5	1443.025	0		
100%	89	7.6	9.1	6.9	8.1	705.325	705.325		Very thick clumping
80%	296	7.8	7.2	8	8.8	2353.2	1882.56		
Totals	582					4501.55	2587.885	**57%**	

Appendix 3

Raw data for reach 3

June:

Somenos Creek Reach: 3	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
0%	13.4	8.77				117.518	0		under Tzouhalem road bridge
20%	41.4	8.77	7.48			336.375	67.275		
10%	61	6.63	7.76			438.895	43.8895		
75%	94.6	10.7	27.82			1821.996	1366.497		
25%	28.7	9.8				281.26	70.315		
100%	107	30.8	21.1	23	15.6	2420.875	2420.875		overhead pipeline crossing
95%	72	24.9	12.2	10.7		1147.2	1089.84		
10%	135	17	8.6	10.5					
5%	65.8	9.75				641.55	32.0775		
0%	128	12.4	23.8	17.8		2304	0		unnamed tributary enters Somenos Creek to Cowichan River
Totals	746.9					9509.669	5090.769	**54%**	

July: N/A

August:

Somenos Creek Reach: 3	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
50%	43.8	8.77				384.126	192.063		under Tzouhalem road bridge
70%	42	8.77	7.48			341.25	238.875		
85%	20.3	6.63	7.76			146.0585	124.1497		
100%	26.2	10.7	12.2			299.99	299.99		
50%	25	9.8				245	122.5		
99%	242	22.3	21.1	23	15.6	4961	4911.39		overhead pipeline crossing
65%	32.3	24.9	12.2	10.7		514.6467	334.5203		
85%	65	17	8.6	10.5					
50%	120	9.75				1170	585		
5%	128	12.4	12	17.8		1800.533	90.02667		unnamed tributary enters (less than 5% PF coverage)
Totals	744.6					9862.605	6898.515	**70%**	

December:

Somenos Creek Reach: 3	length(m)	measured channel widths (m) - Google Earth, 2016				Area (m^2)	PF Area (m^2)	% PF in entire reach	Comments
30%	514	12.8	13.5	16.1	11.9	6977.55	2093.265		
5%	228	10.2	12.8	14.7	12.2	2844.3	142.215		Below Fish Gut Alley confluence
Totals	742					9821.85	2235.48	**23%**	

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