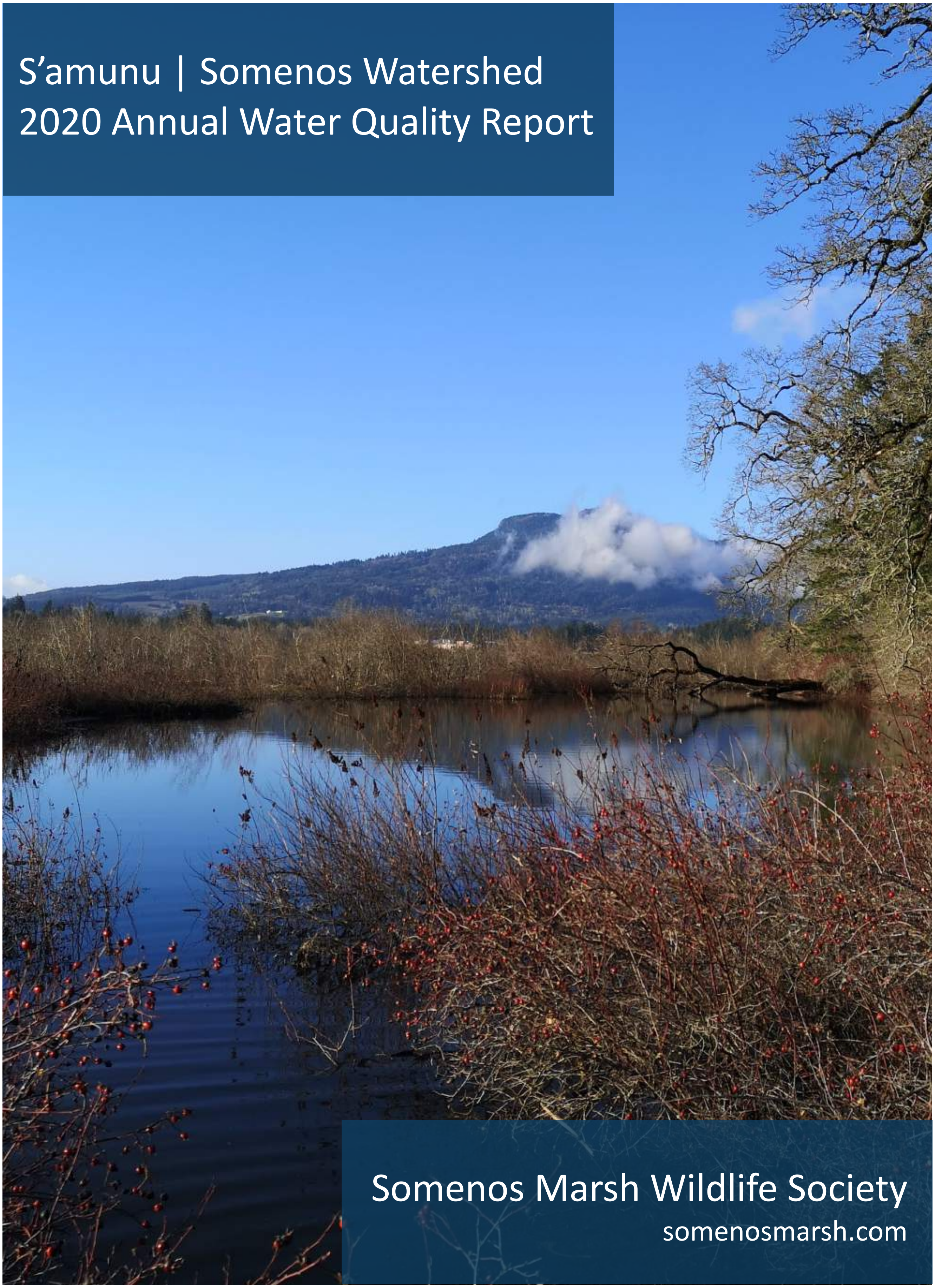
S'amunu | Somenos Watershed
2020 Annual Water Quality Report



Somenos Marsh Wildlife Society

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Gratitude

The Somenos Marsh Wildlife Society acknowledges with gratitude that its activities are conducted with care in the unceded Indigenous territory of the Quw'utsun people.

The Somenos Marsh Wildlife Society shows great appreciation to the numerous volunteers, board members and local residents who contributed weekly to the recording and monitoring of water quality in S'amunu | Somenos Lake and its tributary creeks. Without your enthusiasm, support and stewardship, the data present in this report would be incomplete.

Finally, this work would not have possible without the financial support of the Municipality of North Cowichan, Environment and Climate Change Canada, TD Friends of the Environment Foundation and Pacific Salmon Foundation. Several other organizations lent their expertise, personnel and equipment to help in data collection and analysis. The groups included the District of North Cowichan (Dave Conway, Dr. Dave Preikshot, Shaun Chadburn), Cowichan Tribes (Tracy Fleming, Tim Kulschesky), Cowichan Land Trust (Stephanie Cottell), Somenos Marsh Wildlife Society (Emma Ross, Spencer Lapp, Chelsea Eaglestone-April, Makenna Stobbe and board members), Nature Trust of BC (Tom Reid, Shawn Luckas), Department of Fisheries and Ocean Canada (Melissa Nottingham, Ian Douglas and Christie Wilson), BC Ministry of Environment (Deb Epps, Rosie Barlak), Madrone Environmental Services (Trystan Willmott, Dan Lamhonah), Cowichan Watershed board (Tom Rutherford and the CWB's working groups) and Cowichan Stewardship Roundtable (Genevieve Singleton, Parker Jefferson and its participants).

Huy ch q'u Siem

Thank You

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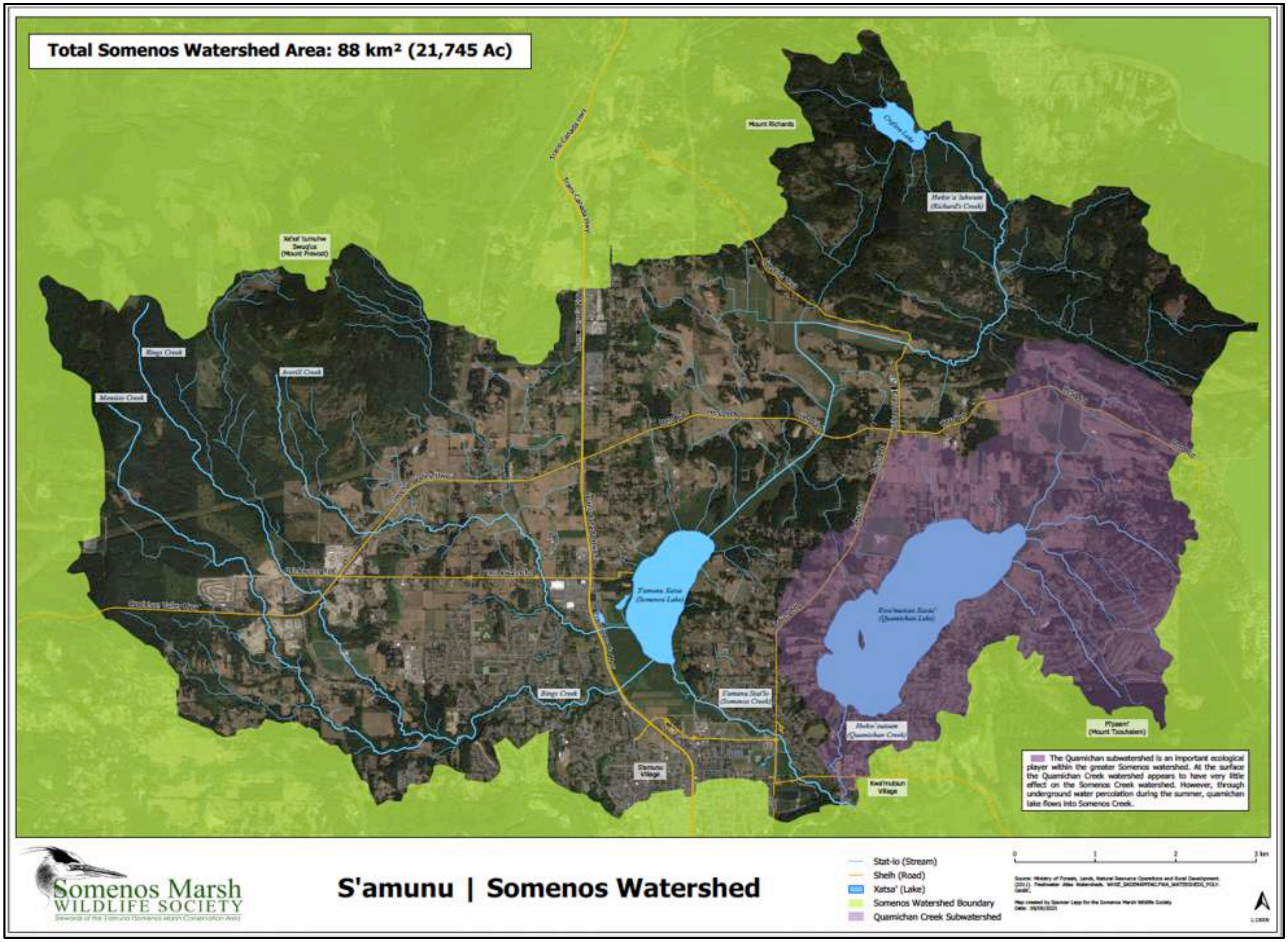
Map of the S'amunu | Somenos Watershed



Introduction

The study of watersheds is the unit that enables us to understand the land-water connections and advise the monitoring and management of land uses and their impacts. The Somenos Marsh Wildlife Society ("The Society") has coordinated water quality monitoring in Somenos Lake since 2014. In 2020, the Society expanded its monitoring program to four tributary creeks of S'amunu | Somenos watershed as seen on the map. This process took place simultaneously with the development of partnerships with municipal actors and local organizations to harmonize water quality data collection practices in the Cowichan watershed. This partnership included:

- Cowichan Estuary Restoration and Conservation Association meetings
- Cowichan Watershed Board water quality working groups
- Cowichan Valley Regional District partnership for water sustainability in BC

This report compiles the water quality monitoring initiatives undertaken in the S'amunu | Somenos watershed in 2020 and summarizes the data collected. Recommendations are made at the end of the report for the sustainable and effective monitoring of aquatic habitat quality in the Somenos Lake and its tributaries.

Map 1: 2020 Water quality monitoring stations in S'amunu | Somenos watershed

Land Uses and Hydrology

Hydrology

The S'amunu | Somenos Watershed spreads across 88km^2 (21,745 acres^2). The S'amunu | Somenos Watershed represents the total land area that drains into S'amunu Xatsa (Somenos Creek). It is made of a vast network of water channels (Figure 1) that feed into five major hydrological features:

- Somenos Lake, an exorheic lake that drains into Somenos Creek and located 23 meters below Quamichan Lake elevation to sea level.
- Richards Creek, a ~9.6 kms long Creek feeding into of Somenos Lake (North).
- Averill Creek, a ~7.6 kms long Creek feeding into of Somenos Lake (North-West).
- Bings Creek, a ~9.7 kms long water way feeding into of Somenos Lake (West).
- Somenos Creek, a ~3.1 kms long Creek flowing South into the Cowichan River and flowing through the Municipality of North Cowichan and Cowichan Tribes Land.

Water flow, velocity and water level in Somenos Creek and Somenos Lake are influenced by the topography of the area, the streambed elevation and the sediments deposition from Cowichan River (Preikshot, 2019 Management).

For instance, Quamichan Creek watershed overlaps with the S'amunu | Somenos Watershed in its South-East corner. At the surface, the Quamichan watershed appears to have little effects on the S'amunu | Somenos Watershed hydrology. However, through underground water percolation, water from Quamichan Creek watershed feeds into Somenos Creek and contribute to its atypical hydrology and backwatering events (upstream flow).

In 2005, Chilibeck (2005) also suggested that Somenos Creek 0.6 meter elevation difference between the mouth and the head of the Creek is sufficient to contribute to the drainage issues observed in Somenos Lake (Vander Sluys, 2986, Chilibeck 2005, Lyle & O'Conner, 2009). In recent years, the infestation of Somenos Creek by invasive species *Myriophyllum aquaticum* and the presence of beavers downstream of Somenos Creek have added to Somenos Lake drainage issues and concerns (Roger, 2020, Chilibeck, 2005).

The plain surrounding Somenos Creek floods every year between November and March. During that period, over 7,000 hectares of land turn into an ephemeral wetland and become home to returning migratory waterfowl that overwinter in the Somenos Basin.

Land Uses in S'amunu | Somenos Watershed

The Somenos creek flood plain has evolved in the 20th Century towards various land uses and ownership. These land uses includes the Somenos Marsh Conservation Area, an Important Bird and Biodiversity Area established in 2001, conservation land, private properties and agricultural fields. Land uses in the upper Somenos watershed include agricultural and industrial activities, forestry and other mixed uses. Figure 2 provides an example of land-uses surrounding to Bings Creek and Menzies Creek. The S'amunu | Somenos watershed forest cover is made of 52% Crown Land and 48% private forests. 1% of the forest cover in this watershed was un-assigned during our mapping exercise (Figure 3).

Land-water Connection

Wetlands in Canada and around the World are considered as one of the most endangered ecosystems. Due to increasing urban encroachment, water pollution and habitat fragmentation, wetland health and ecological services are at risk. Ecosystem services and assets met by wetlands include (and are not limited to) climate change adaptation, flood mitigation, water quality treatment and purification, habitat creation for wildlife and supporting the health and wealth of its community. For instance, scientific research shows that the economic value of wetlands is estimated at $22,000 (CDN) per hectar per year (in 1994), of which 80% is attributed to flood control, water supply and water treatment (denitrification) costs. The remaining 20% is attributed to other ecological services such as cultural and recreational activities, provision of habitat for species at risk (Constanza et al, 1997).

Due to the low elevation terrain and topography, Somenos Lake and its surrounding wetland environment, made of three tributary creeks that feed into Somenos Lake, offer a lowland catchment for water storage. This pivotal catchment drains over 7,000 hectares of land (Williams & Radcliffe, 2001) and provides a bio-diverse and unique ecosystem that contributes to mitigation floods and climate change related processes. Based on Constanza et al (1997)'s research, the Somenos wetland ecosystem would leverage flood and climate change costs to Municipalities by $154 Million.

Understanding the relationship between terrestrial and aquatic habitat matrix is therefore key to build resilient communities and informing community development endeavors. The integration of past and current land uses and studies can only inform how to best address pollution sources points, flood mitigation and habitat loss. Multiple reports and studies were conducted over the years to understand the unique hydrology of this watershed. To avoid reiterating the information, the author invites you to consults the following literature:

- Willis *et al.* (1981)
- Van der Gugten & Blanchet (1982)
- Vander Sluys (1986)
- Radcliffe (1990)
- Williams & Radcliff. (2001)
- Williams *et al.* (2003)
- Chilibeck (2005)
- Westland Resource Group (2007)
- Lyle & O'Connor (2009)
- NHC (2009)
- Preikshot and Kulchesky (2018)
- Preikshot (2019)

The next section introduces the partnerships and programs undertaken in 2020 to enhance the protection and restoration of the S'amunu | Somenos watershed for the benefit of its residents and wildlife.

2020 Water Quality Monitoring Programs

Water quality was monitored using a combination of programs that aimed to verify the accuracy of the techniques used and validate the contribution of citizen-science programs to science.

Citizen-Science Program
Number of programs: 2
Number of volunteered hours: 162 hours

Program I: Somenos Lake Water Quality Monitoring Program
Area: Somenos Lake (Buoy and Trestle)
Data Recorded: Temperature, DO, Temp, pH, SPC, TDS, Lake level, Clarity
Frequency: Weekly (March to Oct.), Monthly (Nov. to Feb)
Number of data point recorded in 2020: 918 WQ data points (27 sheets * 34 data points)
Number of volunteered hours: 110 hours

Program II: Watershed Ecological Monitoring
Area: Bings Creek, Averill Creek, Richards Creek, Somenos Creek, Somenos Lake (Dock)
Data Recorded: Temperature, DO, Temp, pH, SPC, TDS
Frequency: Weekly Oct - Dec 2020
Number of WQ data point recorded in 2020: 420 data points (14 data sheets * 30 data points)
Number of volunteered hours: 52

HOBO Pendants: Permanent data loggers
Area of focus: Somenos Lake
Number installed: 6 pendants MX2201
Data Recorded: Temperature
Frequency: Hourly recording, Year round

Area of focus: Somenos Creek
Number installed: 10 Pendants MX2202
Data Recorded: Temperature and Light Intensity
Frequency: Hourly recording, June - Dec 2020

Other contributions
Sir John Smith
Area of focus: Somenos Creek
Data Recorded: Temperature, DO, Temp, pH, SPC, TDS, water level
Frequency: Weekly, year round
Number of data point recorded in 2020: 225
Number of volunteered hours: 120 hours

Equipment Maintenance

Effective calibration is vital to the accurate collection of data. Calibrating the equipment enables the surveyors to offset changes in data reading that naturally occur over time.

The YSI unit used to collect physical water characteristics is calibrated on a monthly basis to address potential drifts in data reading. Dissolved Oxygen, pH, conductivity and temperature probes quality are verified and calibrated. A record of maintenance, calibration dates and results are kept on file for long term equipment maintenance.

Hobo Pendant Data loggers do not necessitate to be calibrated. However, the Society experienced a loss of data in 2020 due to battery failures after just over a year of operation for 2/6 data loggers. As a result, the 6 data loggers in Somenos Lake were equipped with new batteries (Lithium 3V CR2032) in January 2021 to mitigate the further loss of data in 2021. Data was downloaded inconsistently between January 2020 and September 2020 due to COVID19 and resulted in the loss of 2 months of data. Subsequently, new data collection protocols were established to download the loggers on a monthly basis.

The YSI 9300 photometer is designed to ease calibration requirement. This device is pre-program to calibrate each test parameter. This photometer is built to sustain indoor and outdoor uses. Maintenances involves cleaning the device and drying the test tubes according to the manufacturer's instructions, after each use in the field. The carrying case is kept clean and dry after each session in the field.

Water Quality Monitoring

Water Level in the S'amunu | Somenos Watershed

Low flow monitoring is the most relevant to wetlands management (and restoration) as summer discharge will decrease substantially with Climate Change. Climate change is one of the primary concerns that Municipalities are mandated to address. Challenges related to Climate change include increase in flood events frequency and intensity, decrease in water availability for people, ecosystems and wildlife. These changes will also pause a high risk to vulnerable species including salmon and red and blue listed wetland dependant species and also provide more favourable condition for invasive species to spread.

One way of monitoring the spread of these Climate change related events is to identify an indicator species (for instance salmon and benthic life), monitor water quality, monitoring low flow at regular intervals, build long-term data sets, photo document the area and share the data with regional public database and decision-makers.

Somenos Lake water level reached a maximum of 6.9 meters on January 23rd 2020 and a minimum 4.4 meters on August 13th 2020. These hydrological events extend to the Somenos Creek. Twenty-two years of weekly data collection reveal that Somenos Creek high and low water marks have increased in intensity over the past 4 years. Figure 1 shows that low water mark events are lasting longer since 2017 and that high waters in Somenos Creek are characterized by flash flush events. This also reveals the ecosystem's inability to retain and store water, leading to fast water rising events and floods. The absence of riparian area vegetation, invasive anthropogenic uses of the land and modifications of soil characteristics all contribute to increasing the flow of water through a system.

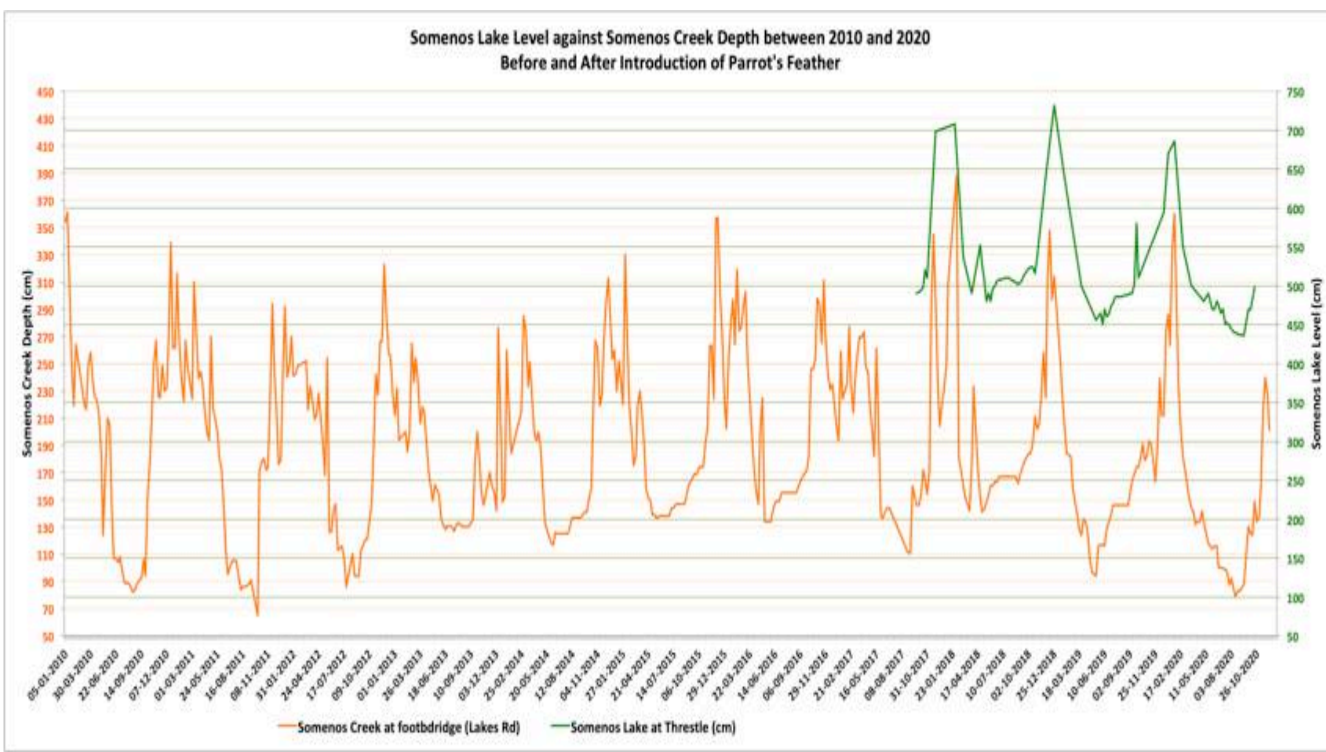


Figure 1: Water level fluctuation for Somenos Lake and Somenos Creek, 2010 - 2020

Turbidity

Turbidity measures the extent to which water loses its transparency due to suspended particles. On February 1st, 2020, the Cowichan Valley experienced unprecedented flooding, at which point a state of emergency was declared by the Cowichan Valley District (CVRD, 2020). This event was followed with an increase in turbidity in Somenos Creek, which usually remains consistently low (between 5-15 NTU) throughout the year. Somenos Creek returned to its average turbidity level within days after the event (Figure 2)

In addition to turbidity readings, water clarity in Somenos Creek was greatly inhibited due to the presence of dense mats of *Myriaphillum aquaticum*, an invasive species also known as Parrot's Feather introduced in Somenos Creek in 2015. Water clarity was compromised between June and September, ie outside of the Fish migration window observed for Coho and Chum salmon (Figure 3)

Historically, schools of Coho have been observed to wait for water quality to improve significantly in Somenos Creek. It is not rare to see Coho and Chum enter the Somenos System later in the season, between November and January. This historical data matches with the current state of the Marsh. While clarity improves in Somenos Creek in September (as Parrot's Feather dies back), water quality such as dissolved oxygen and temperature might have played a larger role in the return of Salmon through Somenos Creek.

Under healthy circumstances, Somenos Creek water quality provides adequate turbidity and clarity for aquatic life to thrive. The Society is unable to answer with certitude the extent to which low light intensity levels affect benthic and other aquatic life, as each species shows different tolerances to clarity fluctuations. However, according to our Salmon sightings in the watershed, it seems that Parrot's Feather plant biomass permitted Coho and Chum to travel through the water column despite the presence of Parrot's Feather obstructing large sections of the creek until November 2020.

Water clarity in Somenos Lake varied from 0.4 meters depth in July to 2.5 meters depth in January 2020 (using Secchi disk technique).

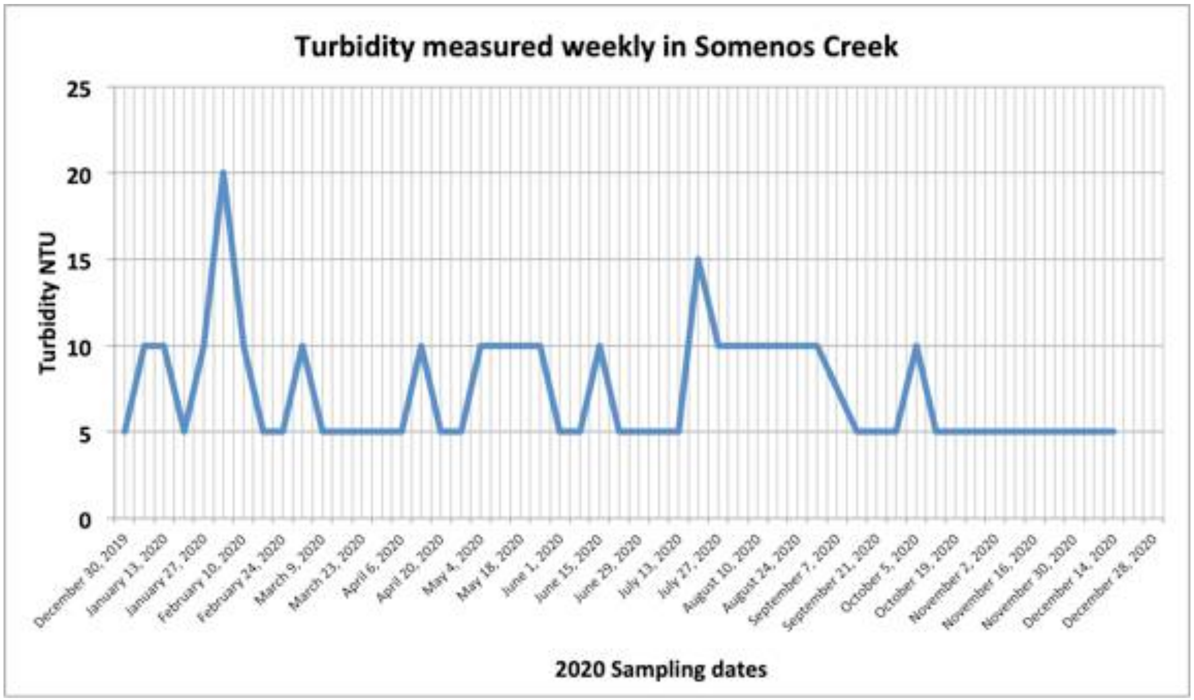


Figure 2: Somenos Creek turbidity measured weekly at the footbridge (Lakes Rd, Duncan), in 2019 and 2020 by Mr. Smith, citizen-scientist.

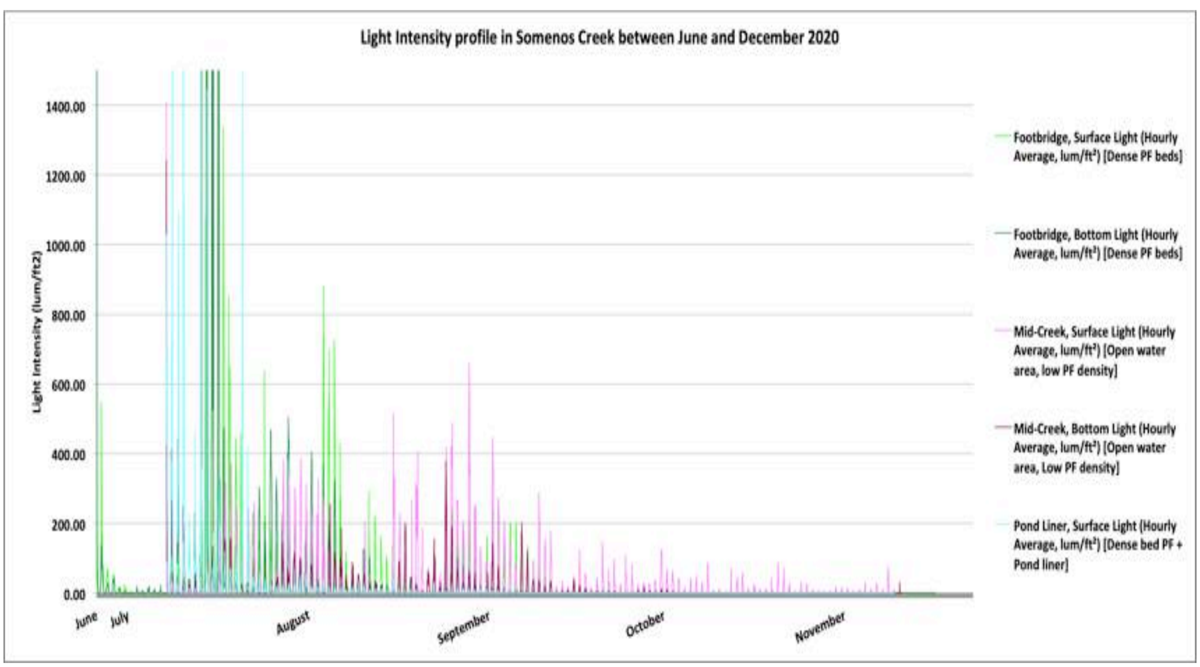


Figure 3: Light intensity in Somenos Creek between June and December 2020: Surface and bottom light intensity at three stations on Somenos Creek.

Temperature

Temperature is a physical characteristic of water. Seasonal variations in temperature are natural processes. However, significant changes in water temperature can affect dissolved oxygen levels available to fish and other aquatic life forms. Of all the fish families, Salmonidae have the lowest thermal tolerance. Lethal temperatures change depending on life-stage and are generally found deadly from 20 to 26°C depending on species. Optimal water temperature for salmonid egg survival is 6-10°C (USEPA, 2001). Furthermore, higher temperatures contribute to the reduced availability of dissolved oxygen due to increased algae bloom and the consumption of oxygen by decaying plants.

Figure 4 compares Somenos Lake and Somenos Creek water temperature at comparable depth and identifies lethal water temperature for four months of the year in Somenos Lake. Maximum temperature in Somenos Lake reached 25.1 degrees at the surface and 19 C at the bottom of the Lake. Minimum temperature observed occurred on January 22 with 3.2 C at the surface and 3.3 C at the bottom.

Figure 5 shows temperatures recorded by permanently installed data loggers in Somenos Creek. Bottom and surface temperatures at Station 1 appear almost identical as water level decreases considerably during the summer. Station 2, mid-creek, shows no significant temperature difference between surface and bottom temperatures. Station 3, upstream, was equipped with surface temperature data loggers only, which appear significantly warmer than other stations. This is explained by the fact the pond liner is a black thick sheet of liner, which increased water temperature in its vicinity.

Water temperature in Somenos Creek ranged from optimal to sub-optimal in the fall, winter and spring, and only became harmful to Salmonid species in the summer months. Our data recorded shows how shade can significantly reduce water temperature in a Creek. Stations located mid-creek and by pond liner sheets (with no canopy overhead) registered temperatures on average 2-3 C higher than shaded areas (at footbridge). These differences in temperature remained until the return of cooler fall temperatures and rain, at which point water temperature throughout Somenos creek became homogenous.

Comparatively, water temperature in Somenos Lake turned homogenous (indicated by lack turnover) on October 8th 2020, three weeks later than in 2019.

Between Oct 1st and December 31 2020, water quality was sampled at three additional locations: Richards Creek water temperature fluctuated between 11 C (Oct 13) and 1.9 C (Dec 24) at the intersection with Herd Road. Bings Creek and Averill Creek maximum temperatures were reached on October 16 with 10.6 C and 11.3 C respectively. Minimum temperatures were reached with 6.1 C in Bings Creek (November 12th) and 7 C in Averill Creek on November 26th 2020 . Somenos Creek registered the highest temperature amplitudes (10.1 C difference) with a maximum of 13.6 C (October 1st) and a minimum of 3.5 C on Christmas Eve.

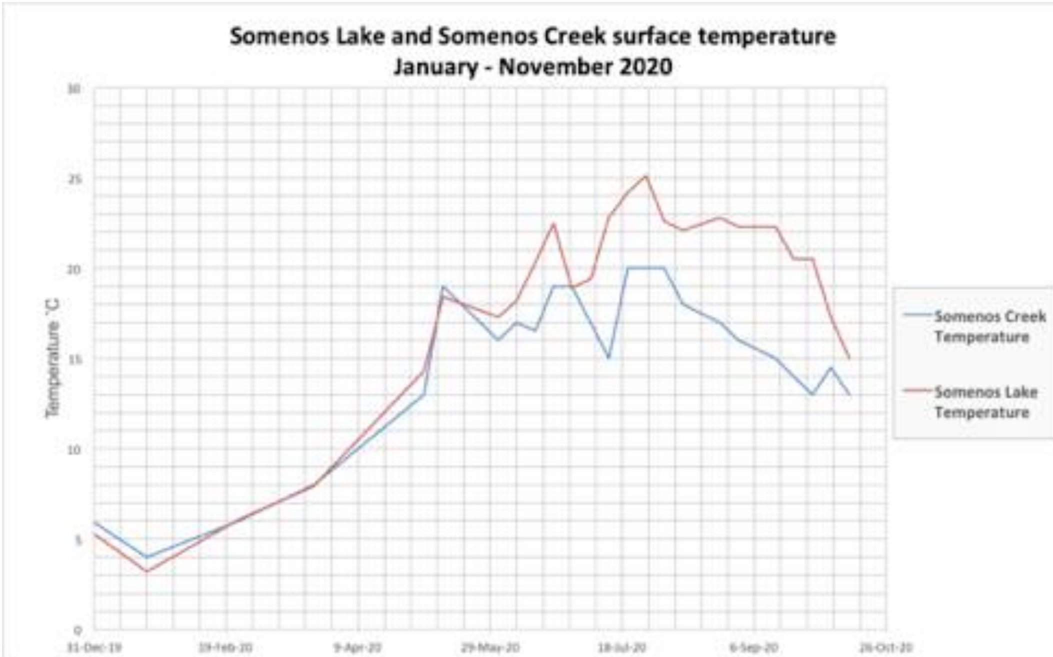


Figure 4: Surface temperature profiles for Somenos Lake and Somenos Creek, 2020. Data collected under the guidelines of the Society's citizen-science program

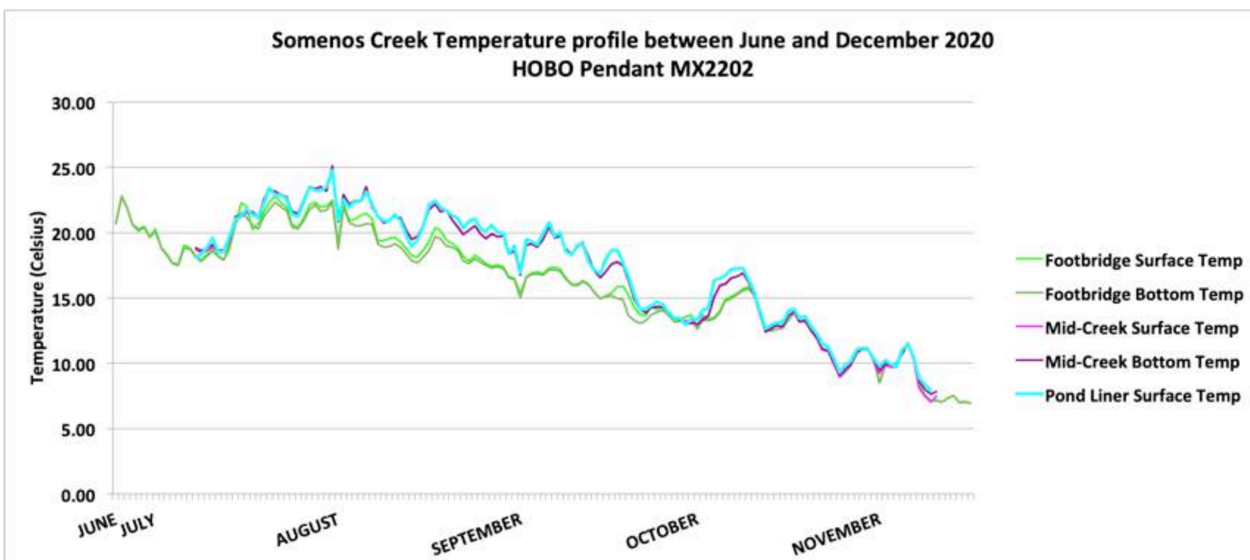


Figure 5: Water Temperature in Somenos Lake recorded at three stations using HOBO Pendant MX2202, 2020.

Dissolved Oxygen

Minimal dissolved oxygen (DO) requirements for aquatic life varies amongst species and life stages (Davis, 1975).

Dissolved oxygen levels in Somenos Lake (Figure 6, 7) were lower in the summer and recovered to higher levels in the fall with a lake turn-over occurring on October 8th 2020:

- Surface water (0-2m) remained optimal or sub-optimal (above 7 DO mg/L) throughout the year
- Anoxic conditions (below 4 DO mg/L) were met between May 5th and Oct 10th 2020 at depth 2m and below
- Maximum DO reached 20.9 mg/L on October 1st for the surface of the lake and reached a minimum of 7.1 mg/L on August 7th.
- Maximum DO for the Lake bottom was 10.2 mg/L in January 2020, and remained at 0mg/L from June to October 2020.

Dissolved oxygen concentrations in Somenos Creek were anoxic between June and November 2020 (Figure 7). Field surveys and data monitoring suggest that the dense coverage of Parrot's Feather suppresses oxygenation of the water by surface diffusion. Decomposition of Parrot's Feather and other aquatic weeds may also consume dissolved oxygen in the Creek. Somenos Creek anoxic conditions extended until Nov 6th (1.2mg/L) and increased gradually to reach a maximum of 9.7 mg/L on New Year's Eve. The rise to higher DO levels correlates with salmon sightings in the tributary creeks to Somenos Lake.

Sub-surface dissolved oxygen concentrations were sampled between October 1st and December 31st 2020 in the 4 tributary creeks.

- Bings Creek DO level tends to fluctuate from week to week. DO concentration fluctuated from 10.7 to 9 between October 16 and 22. Maximum DO was reached on Nov 19th with at 13.2 mg/L concentration before decreasing to 12.1mg/L on New Year's Eve.
- Averill Creek DO level remained consistently optimal throughout the sampling period. DO concentrations varied from 11.7 to 13.2 mg/L between October 29th and December 31st 2020. As a result, Averill Creek shows the lowest DO variations of all four creeks.
- Richards Creek registered the highest DO amplitude within the three months sampling period. Minimum DO concentration of 0.9 mg/L was reached on October 29th after which it slowly increased to 10mg/L on December 24th at the intersection with Herd Rd. Maximum readings were registered on Oct 16th at 13.9mg/L against 11.7mg/L on Oct 29th (min). Comparatively, DO samples from Richards Creek intersection with Richards Trail Rd shows more consistent and optimal DO readings, with only 2.2 mg/L DO concentration difference against 10mg/L for Herb Rd. Such discrepancies between Herb Rd and Richards Trail sampling locations stem from the absence of riparian vegetation along Herd Rd.

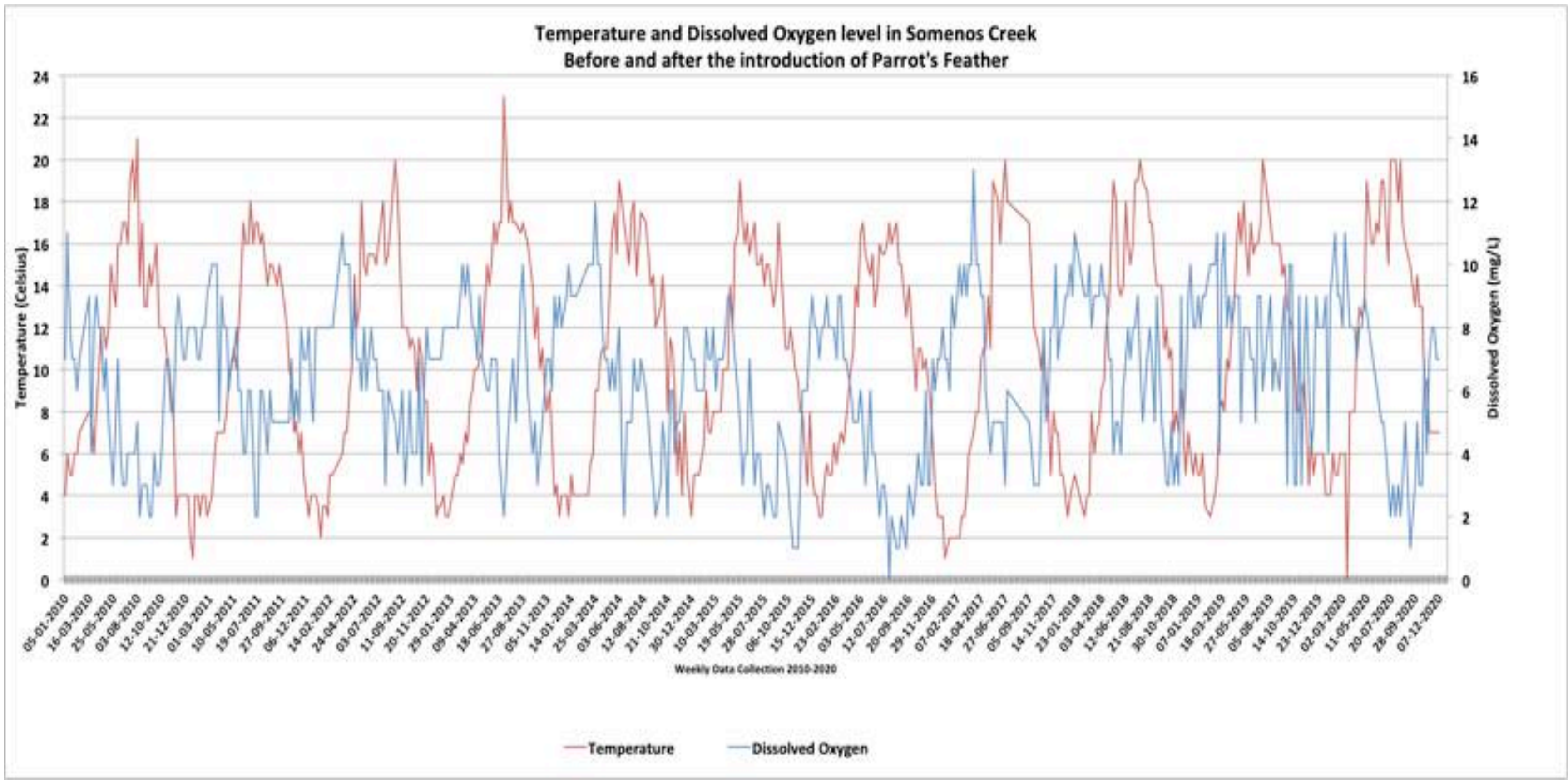
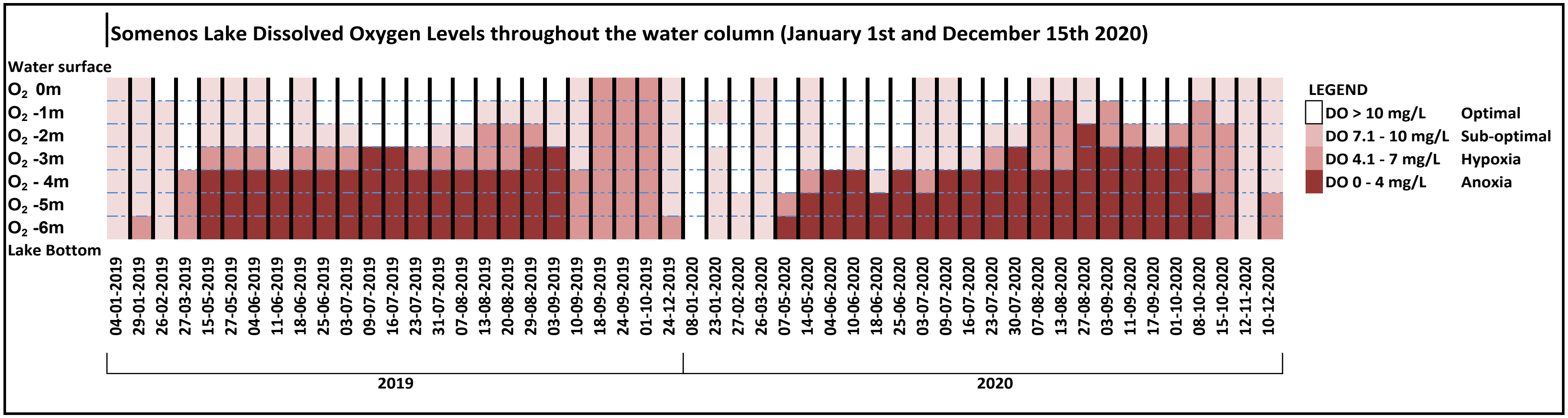


Figure 6: Temperature and dissolved oxygen concentrations in Somenos Creek between 2010 and 2020.



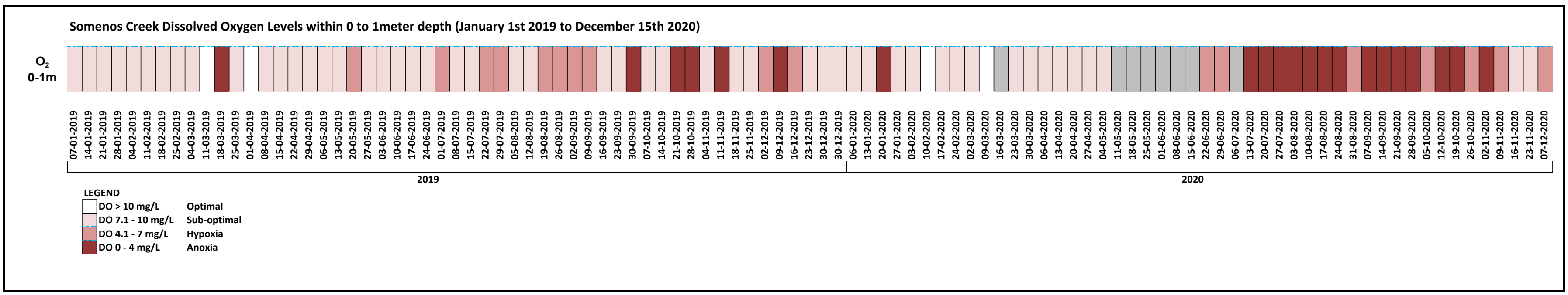


Figure 7: Dissolved oxygen levels in Somenos Creek and Somenos Lake for 2019 and 2020.
This table shows Somenos Lake (upper table) DO levels in its water column throughout the seasons, at depth ranging from 0 meter (surface) to 6 meters below the surface. DO measurements were collected using YSI technology weekly in the summer and monthly in the winter by the Society citizen-science program. DO levels are colour coded according to their level of toxicity to Salmonid species: Anoxia ranging from 0-4 O_2mg/L; hypoxia occurring between 4.1-7 O_2mg/L, sub-optimal DO threshold identified between 7.1-10 O_2mg/L and optimal oxygen concentrations above 10 O2mg/L. A similar profile was established for Somenos Creek (lower table) with DO measurements being recorded weekly by Mr. Smith, volunteer citizen-scientist.

pH

The pH of water is a measure of its acidity. pH can affect significantly the level at which certain contaminants and nutrients are available to aquatic and terrestrial organisms. For instance, acidic low pH water contributes to Aluminum toxicity to Salmonidae, which is otherwise harmless to fish. Canadian Drinking Water Guidelines recommend the pH ranging between 6.5-8.5 as healthy water (CVRD, 2018). Somenos Creek data recording shows that the creek remains between 6.5 and 8.0 year-round.

Water Quality and Contaminants

Wetlands are the most efficient at filtering and cleaning water, especially reducing nitrate and phosphorous levels. However, water quality degradation is the most important threat to natural or constructed wetlands. The Province of British Columbia provides guidelines to restore or construct wetlands for denitrification, removal of agricultural wastes and minimizing nitrate loading. While these guidelines exist, consistent funding is key to ensure the sustainability of monitoring practices and address natural or anthropogenic emergency disaster (spills and pollution events, fish kills and other incidents).

Contaminants were analyzed in Somenos Creek on November 6th 2020 downstream, mid-stream and upstream at three sampling stations. The study included identifying presence and concentrations of hydrocarbons (BTEX, VPH, VPEH, LEPH, PAHS), inorganic compounds, glyphosate, heavy metals, total nitrites, ammonia and a screening of basic water chemistry.

The Society cannot accurately determine the threshold concentration considered harmful to Salmonid fish for each of the contaminants analyzed as their toxicity is dependent on surrounding abiotic factors such as hardness, pH, that can inhibit or accentuate the threat posed to fish. For instance, aluminum affects fish survival rate if found in acidic water mostly (Kroglund et al., 2007), and its greatest lethal effect were observed when combined with high calcium ion concentrations (Grassie et al., 2013). High acidity levels can be caused by chemical runoff and decomposition processes. Fish exposed to Aluminum in low pH waters will experience physiological and neuroendocrine changes that disrupt homeostasis and alter learning performances, physiological stress response and led to elevated plasma cortisol and glucose levels (Grassie et al., 2013).

According to the Guidelines and Standards provided by AGAT Lab, no contaminants and hydrosoluble metals were found in excess concentrations in Somenos Creek. Upstream and downstream sampling allowed the Society to identify increase and decrease in concentrations as the creek flows downstream. Results found indicated the following:

- Aluminum was found in higher concentrations downstream (149µg/L) than upstream (28 µg/L) identifying inputs of Aluminum along Somenos Creek.
- Ammonia was found in low concentration throughout, at 0.41mg/L upstream against 0.06mg/L downstream.
- Nitrogen concentrations upstream were much higher than downstream with values at 7.65mg/L and 0.64mg/L respectively
- Phosphorous was omitted by the Laboratory and should be included to the next water quality analysis
- Cadmium was found at the threshold detection limit of 0.01 µg/L upstream and below the detection limit downstream
- Glyphosate were present below the detection limit set by the lab (<20 µg/L)

The Society recommends that contaminant concentrations be monitored monthly in 2021 to address seasonal fluctuations, and that particular attention should be given to phosphorous, aluminum, ammonia, cadmium, zinc, copper iron, and nitrite. A full detail of the results from the water quality lab analysis is available in Appendix.

Recommendations

Based on activities and results obtained in 2020, the Society recommends the following course of actions for year 2021:

Water Quality Monitoring

- Somenos Lake weekly monitoring in Summer and monthly monitoring, including monthly download and monitoring of permanent data loggers
- Monthly monitoring of water quality in tributary creeks for Temperature, dissolved oxygen, pH, Conductivity, TDS, water level
- Monthly monitoring of contaminants using portable YSO 9300 photometer unit, with emphasis on first snow melt (spring) and fish flush (fall) in all 4 Creeks
- Monthly maintenance of monitoring devices and equipment

Reporting and Data Sharing

- Submit secchi data and profile data to BC Lake Stewardship Society
- Updating protocols to meet EMS Database standards for field data collection
- Sharing annually Somenos Watershed water quality data with the Provincial EMS database accessible to the public
- Coordinating lab analysis with Rosie Barlak (Ministry of Environment) ahead of time to ensure the direct transfer of data into EMS
- Publish Water Quality Monitoring Annual Report onto the Society's website

Partnerships

- Attending meetings set by regional partner organizations for the development of water quality indicators and monitoring protocols
- Working with Municipalities and local stakeholders on using wetland monitoring data collected for community development planning and enhancement
- Acknowledging partners and volunteers contribution to monitoring programs
- Raising fund for sustainable water quality monitoring in the S'amunu | Somenos watershed (including Emergency Fund)

Citizen-Science Programs

- Encouraging citizen-science participation in water quality monitoring during Summer monitoring
- Recruiting a team of Volunteers for May-October 2021 season with training provided early in the season
- Organizing a volunteer appreciation event in the Fall 2021
- Weekly volunteer coordination through communication database (slack or other)
- Scheduling volunteers across the watershed, with a focus on residents stewardship for each tributary

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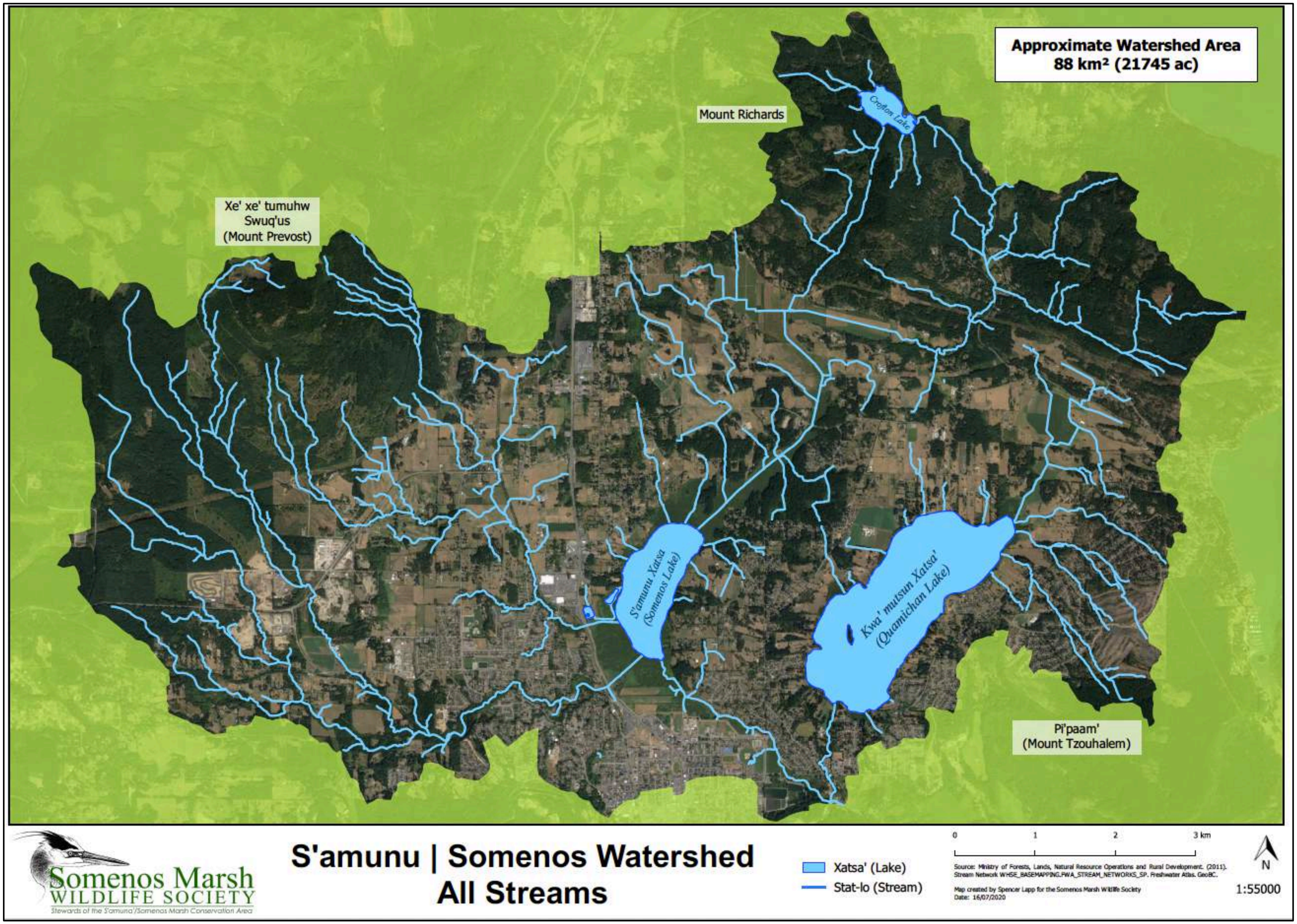
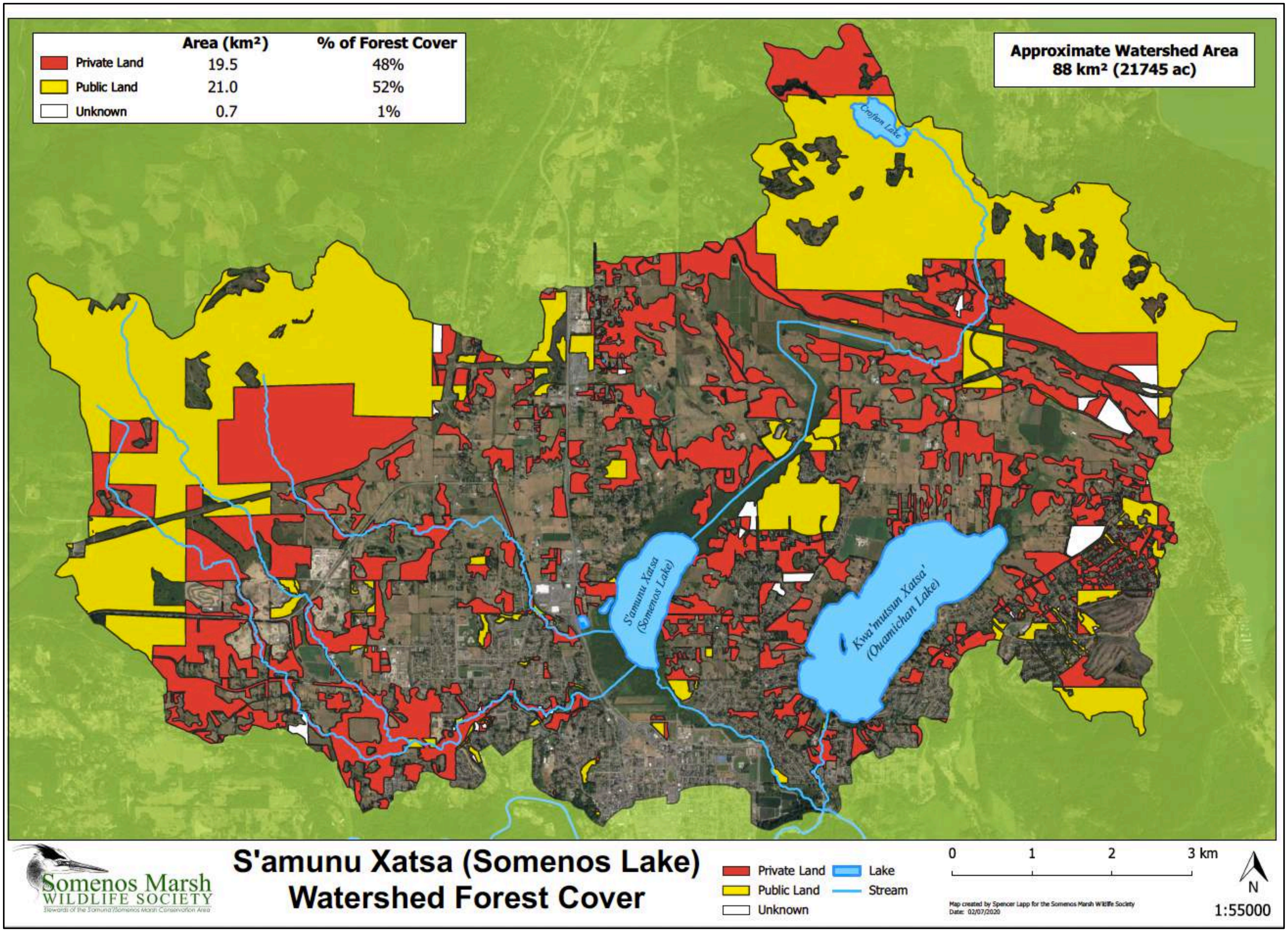
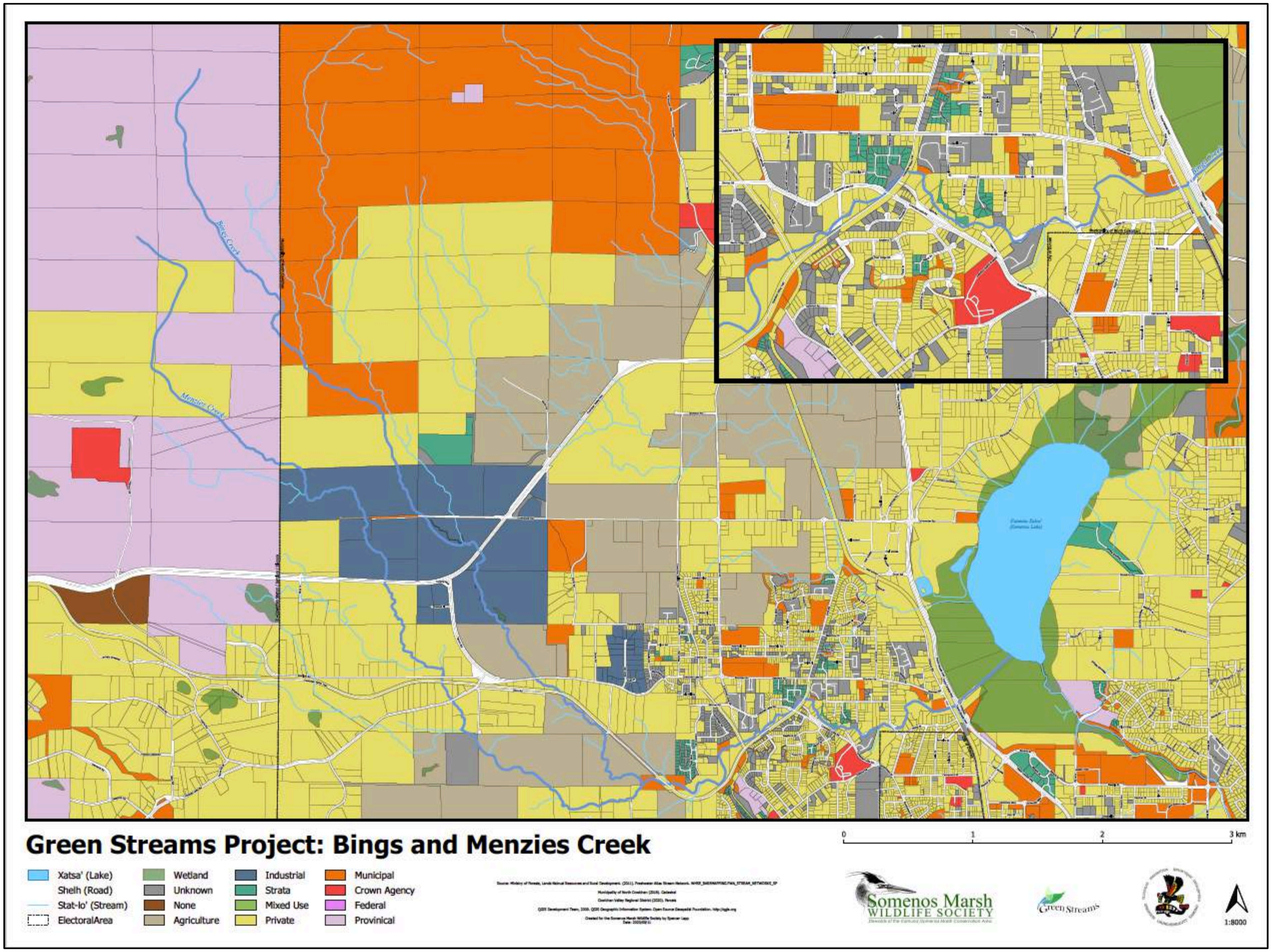
Appendix A: S’amunu | Somenos Watershed Water Network



Appendix B: S’amunu | Somenos Watershed Forest Cove



Appendix C: S'amunu | Somenos Upper Watershed Land Use



Appendix D: Lab results for contaminant sampling in Somenos Creek

BTEX / VPH (C6-C10) Water

Sample Description				**Upstream**	**Downstream**
Date Sampled				**11/06/2020**	**11/06/2020**
Parameter	**Unit**	**G / S**	**RDL**	**1659108**	**1659145**
Methyl tert-butyl ether (MTBE)	µg/L	34000	1	<1	<1
Benzene	µg/L	400	0.5	<0.5	<0.5
Toluene	µg/L	5	0.5	<0.5	<0.5
Ethylbenzene	µg/L	2000	0.5	<0.5	<0.5
m&p-Xylene	µg/L	300	0.5	<0.5	<0.5
o-Xylene	µg/L	300	0.5	<0.5	<0.5
Xylenes	µg/L	300	0.7	<0.7	<0.7
Styrene	µg/L	720	0.5	<0.5	<0.5
VPH	µg/L	1500	100	<100	<100
VH	µg/L	15000	100	<100	<100
Bromofluorobenzene	%			101	98.6
Dibromofluoromethane	%			106	105
Toluene - d8	%			101	99.5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

1659108-1659145 VPH results have been corrected for BTEX contributions.

Analysis performed at AGAT Vancouver

Lab Results for Ammonia in Somenos Creek

Ammonia in Water

Sample Description				Upstream	Downstream
Date Sampled				11/06/2020	11/06/2020
Parameter	Unit	G / S	RDL	1659108	1659145
Ammonia-N	mg/L		0.01	0.41	0.06

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Vancouver

Lab Results for Glyphosate in Somenos Creek

Glyphosate in Water

Sample Description				Upstream	Downstream
Date Sampled				11/06/2020	11/06/2020
Parameter	Unit	G / S	RDL	1659108	1659145
Glyphosate	µg/L		20	<20	<20

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard
Analysis performed at AGAT Calgary

Lab results for low level contaminants in Somenos Creek

LEPH/HEPH in Water Low Level

Sample Description				**Upstream**	**Downstream**
Date Sampled				**11/06/2020**	**11/06/2020**
Parameter	**Unit**	**G / S**	**RDL**	**1659108**	**1659145**
Naphthalene	µg/L	10	0.05	<0.05	<0.05
Quinoline	µg/L	34	0.05	<0.05	<0.05
Acenaphthylene	µg/L		0.02	<0.02	<0.02
Acenaphthene	µg/L	60	0.02	<0.02	<0.02
Fluorene	µg/L	120	0.02	<0.02	<0.02
Phenanthrene	µg/L	3	0.04	0.07	0.04
Anthracene	µg/L	1	0.01	<0.01	<0.01
Acridine	µg/L	0.5	0.05	<0.05	<0.05
Fluoranthene	µg/L	2	0.02	<0.02	<0.02
Pyrene	µg/L	0.2	0.02	<0.02	<0.02
Benzo(a)anthracene	µg/L	1	0.01	<0.01	<0.01
Chrysene	µg/L	1	0.01	<0.01	<0.01
Benzo(b)fluoranthene	µg/L		0.01	<0.01	<0.01
Benzo(j)fluoranthene	µg/L		0.01	<0.01	<0.01
Benzo(k)fluoranthene	µg/L		0.01	<0.01	<0.01
Benzo(b+j)fluoranthene	µg/L		0.01	<0.01	<0.01
Benzo(a)pyrene	µg/L	0.1	0.01	<0.01	<0.01
Indeno(1,2,3-c,d)pyrene	µg/L		0.01	<0.01	<0.01
Dibenzo(a,h)anthracene	µg/L		0.01	<0.01	<0.01
Benzo(g,h,i)perylene	µg/L		0.01	<0.01	<0.01
1-Methylnaphthalene	µg/L		0.05	<0.05	<0.05
2-Methylnaphthalene	µg/L		0.05	<0.05	<0.05
EPH C10-C19	µg/L	5000	200	<200	<200
EPH C19-C32	µg/L		200	<200	<200
LEPH C10-C19	µg/L	500	200	<200	<200
HEPH C19-C32	µg/L		200	<200	<200
Naphthalene - d8	%			93.6	81.8
Pyrene-d10	%			105	77.2
P-Terphenyl - d14	%			106	94.4
Sediment				TRACE	TRACE

Comments:

1659108-1659145

RDL - Reported Detection Limit; G / S - Guideline / Standard

LEPH & HEPH results have been corrected for PAH contributions.

Sediment parameter is comment only based on visual inspection of the sample prior to extraction and is not an accredited test.

Sediment present in sample.

Analysis performed at AGAT Vancouver