Water Quality and Invertebrate Analysis of the Englishman River, Parksville, BC

Prepared By:
RMOT 306 Environmental Monitoring Students
Kade Pilton
Emily Maijenburg
Mallory Blake

Prepared For:
Mr. Owen Hargrove, Vancouver Island University

December, 2020

Executive Summary

The purpose of this report is to provide insight into the current water quality and invertebrate presence in the CW Young spawning channel which is located within the Englishman River watershed near Parksville, British Columbia on Vancouver Island. The channel was built in the 1990's primarily for spawning the enhancement of Coho salmon (*Oncorhynchus kisutch*), and was lengthened in 2007. Other salmonid species, which historically occurred in the Englishman River, have also been observed utilizing the spawning channel including Chum (*Oncorhynchus keta*), Pink (*Oncorhynchus gorbuscha*), Chinook (*Oncorhynchus tsawytscha*), and Sockeye (*Oncorhynchus nerka*) (Clough 2013).

Three degree students from Vancouver Island University's Environmental Monitoring (RMOT 306) class spent two days taking water quality and invertebrate samples, which were then analyzed using various methods discussed further in this report. Unfortunately, due to laboratory limitations, no microbiology analyses were conducted in spite of the current COVID-19 pandemic.

Four Sites along the lower 2.5 km of the CW Young spawning channel were sampled over the course of the two days, with two sites used alternatively due to a high water event which occurred over the second sampling period. Quality assurance and control methods which were described to us in class by Professor Owen Hargrove, as well as guidelines found in the Guidelines for Interpreting Water Quality Data (RISC 1998) were followed closely when taking and preserving water samples.

Acknowledgements

This research was done on the traditional territories of the Nanoose First Nations and the Qualicum First Nations. This area is rich in cultural history and significance and it is with great appreciation that we were able to conduct this study in the area.

We would like to acknowledge that the Englishman River research project presented in this paper was undertaken under the professional guidance of Professor Owen Hargrove. We would like to express our deepest appreciation as his knowledge and flexibility, permitting the team to adjust to difficult scheduling and equipment availability. We would also like to thank Mike Lester for his assistance in assuring that all of the equipment was set up and put away properly to give us the best opportunity to make full use of our time in the lab. We would also like to thank health officials for their efforts in establishing COVID-19 protocols that allowed each participant to feel safe in the working environment. Additionally, we would like to thank Vancouver Island University (VIU) for allowing students in the Bachelor's Degree of Natural Resource Protection on campus in order to conduct the laboratory analyses. This project would not have been possible without utilizing the equipment and facilities provided.

Without the joint efforts of those mentioned above, the completion of the Englishman River Water Quality and Invertebrate Analysis in the midst of a global pandemic would not have been made possible.

Sincerely,

Kade Pilton Mallory Blake & Emily Mayenburg

Table of Contents

List of Figures and Tables

1.0 Introduction

1.1 Project Overview

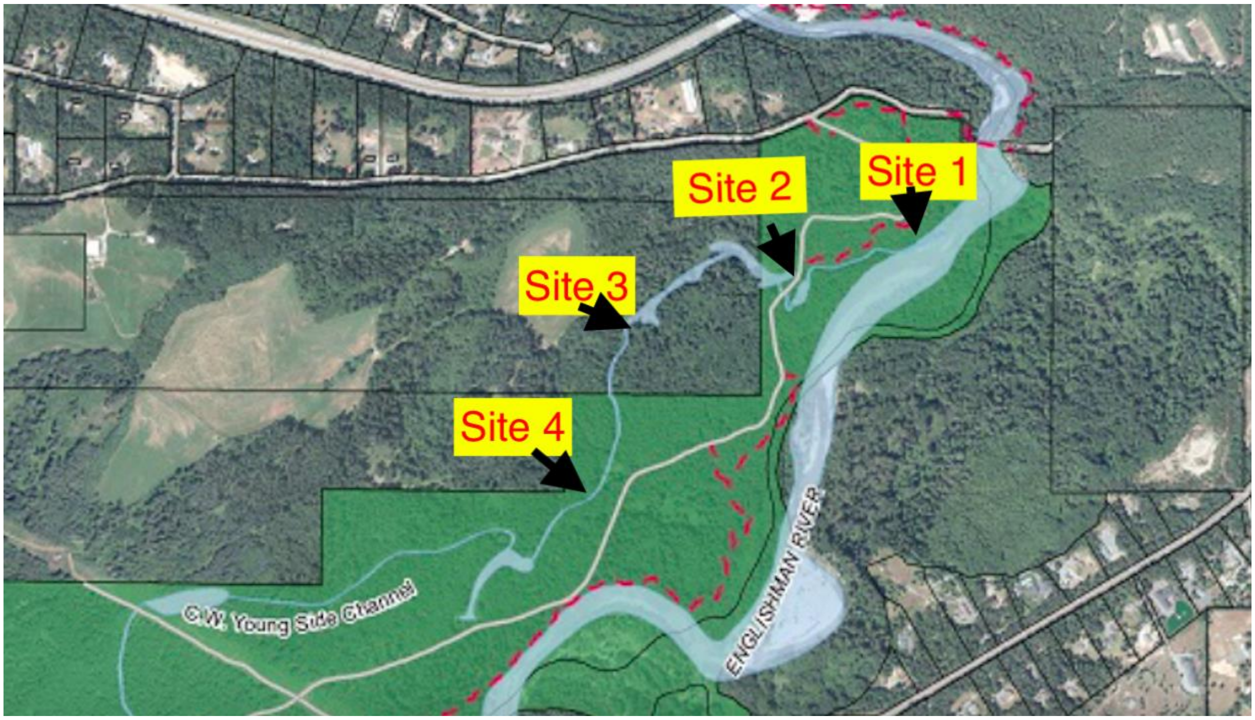

Figure 1: Map of the Englishman River Sampling Sites

This research has been conducted to continue the environmental monitoring project of the Englishman River located southwest of Parksville, BC. Under careful guidance of the project supervisor, Owen Hargrove, three Vancouver Island University (VIU) students have conducted environmental sampling of water quality and invertebrates across four sites at the Englishman River. Sampling occurred on October 26, 2020 and November 25, 2020.

The purpose of this paper is to provide an overview of water quality measurements and invertebrate samples taken at the Englishman River. The results will demonstrate the river's overall health as it related to fish within the system. This information will aid in determining any possible issues within the system as well as short-term and long-term impacts from agriculture, logging, and different land-uses in the surrounding area.

1.2 Historical Review

The Englishman River is known as one of Vancouver Island's most scenic and historically, productive rivers relative to its size. A large portion of the river is included in regional and provincial parks and recreation trails which provide users with a great opportunity to witness some of the most picturesque views in the Parksville area, including waterfalls, old growth forest, and wildlife in abundance at various times of year. There is also a First Nation's midden within the park boundaries. Because there aren't any trails to access the midden, it is kept at minimal disturbance for human disturbances. Nonetheless, this site is rich in resources, making it highly vulnerable to extensive modifications over the years such as logging by Island Timberlands which has taken a large portion of the old growth forest and riparian area originally bordering the river. The area has been extensively logged at the turn of the century due to the value of Douglas fir (*Pseudotsuga menziesii*) timber, making most of the area second growth forest (Rueggeberg et al. 2008).

The channel was built in the 1990's, primarily for spawning enhancement for Coho salmon (*Oncorhynchus kisutch*), and was lengthened in 2007. Other salmonid species, which historically occurred in the Englishman River, have also been observed utilizing the spawning channel including Chum (*Oncorhynchus keta*), Pink (*Oncorhynchus gorbuscha*), Chinook (*Oncorhynchus tsawytscha*), and Sockeye (*Oncorhynchus nerka*) (Clough 2013).

1.3 Potential Environmental Concerns

As previously mentioned, about 90% of the Englishman River watershed has been logged. This has led to a multitude of erosion and sedimentation issues which have led to a decrease in salmonid populations amongst the watershed as a whole (Decker et al. 2003). With most of the land being owned by private timber companies, the integrity of the watershed falls at the mercy of their decisions when it comes to timber harvesting. The Englishman River sees heavy claybank erosion in large rainfall events, and sediment not only from the banks of her own portion of the watershed, but those of the tributaries of which there are 4 majors which have been logged as well. The city of Parksville and surrounding areas are expanding at a rapid rate which has seen large increases in urban development, which led to the installment of a new water intake in recent years. The intake was an invasive project which included clearing riparian area directly aside the river, approximately five kilometers upstream of the estuary at the highway 19 bridge crossing, in crucial fish and wildlife habitat. Due to its adjacent logging, the Englishman River sees dramatic floods during periods of heavy rainfall, which leads to high levels of discharge and turbidity.

2.0 Objectives

The primary objective of sampling the Englishman River is to collect data that will allow researchers to determine the overall health of the river as it relates to fish health and abundance. Samplers will collect water quality measurements, hydrology measurements, and invertebrate abundance data, comparing it to previous years of data collection. These measurements, along with previous years of compiled data, give researchers an accurate understanding of the current health of the river system. Undertaking these field measurements annually is of great importance as it reveals general health of the stream year after year, allowing samplers to observe any changes over the course of each new year of measurements. This will immediately show any differences in measurements if something (i.e. a chemical) has been introduced to the system.

The collected samples will be analyzed in the VIU laboratory. Primarily, the objective of these measurements and analyses is to understand the current health of the Englishman River and to compare it to previous years, ensuring that nothing has been dramatically altered within the stream. Secondary objectives include, but are not limited to, educating the public by providing interpretation when necessary and cleaning up garbage found on site.

3.0 Methods

3.1 Sample Stations and Characteristics

Over the course of the two sample periods, 6 total sample sites were used. The target was to sample four sites but two alternative sites were utilized during the second sampling period due to unsafe sampling conditions. During both of our sampling periods we were under time constraints due to a multitude of factors including lab time restrictions and travel obstructions to and from the site. As a result, the sample sites were selected in closer proximity to the access point than in years prior. The four sites are all located within 2.5 kilometers of the confluence of the Englishman River and the CW Young channel, which is about a ten minute walk from the top bridge parking lot which was our muster point for this project.

3.1.1 Site 1

Site 1 is located in the CW Young side channel and is approximately 2.5 kilometers upstream of the confluence of the channel and the main body of the Englishman River. This site is approximately 150 meters off the main walking trail used for recreation which runs along the main body of the Englishman River. Water comes into this site through a narrow riffle and spreads out into a large corner pool. The area contained about 60% canopy cover and had a substrate of 20% fines, 70% gravel, and 10% organic matter. The pool also contained some LWD suitable for both juvenile and adult fish habitat. Spawning Coho salmon were observed at this site during the second sample period.

3.1.2 Site 2

Site 2 is located about 600 m downstream of Site 1 in the CW Young side channel. This site is approximately 200 m off the main walking trail. Water also enters this site through a narrow riffle which then opens into a medium sized pool and narrows again in the tail out. This site contained about 75% canopy cover and had a substrate of 20% fines, 50% gravel, 20% cobble, and 10% organic matter. This pool also contained LWD suitable for juvenile and adult fish habitat. Spawning Coho salmon were also observed at this site during the second sample period, and appeared to be of high abundance.

3.1.3 Site 3

Site 3 is located about 600 meters downstream of Site 2 and differs between the first and second sampling periods. During the first sampling period, Site 3 was located in the tail out of a large pool where the channel crosses the recreational foot path. This site had 50% canopy cover and a substrate composition of 10% fines, 30% gravel, 10% cobble, 40% boulder, and 10% organic matter. No LWD was observed at this site. Unfortunately, due to a high water event during the second sampling period, this site was unsafe to sample. Instead, we opted to sample a riffle located approximately 15 meters downstream. This site had 60% canopy cover and a substrate composition of 10% fines, 50% gravel, 30% cobble, and 10% boulder. This site contained a fair amount of LWD which was being utilized by both Chum and Coho spawners during the second sampling period.

3.1.4 Site 4

Site 4 is located about 600 meters downstream of Site 3 and is located about 50 meters downstream of the confluence where the CW Young channel meets the Englishman River main stem. This site had no canopy cover but it did have tall trees on either side of the river which provide shade at different times throughout the day. The substrate composition for this site is 10% fines, 20% gravel, 20% cobble, and 50% boulder.

It was also unsafe to sample this site during the second sampling period due to the high precipitation event leading to higher water levels. Instead, we opted to sample the closest safe location approximately ten meters upstream from the confluence of the CW Young channel and the Englishman River mainstem. This site had 20% canopy cover with an unobservable substrate composition due to the fast-moving, turbid water conditions.

3.2 Basic Hydrology

The velocity, water depth, substrate type, wetted width, bank full width, gradient, along with crown canopy, percent cover, dominant cove and discharge for all four sample site locations. The float method will also be used to determine flow.

3.3 Water Quality

3.3.1 Field Measurements

Conductivity (ɥm/cm), pH, dissolved oxygen (mg/L), temperature (˚C) and turbidity were taken using a YSI probe and Hach Q1000 Turbidimeter in the field. Meters were re-calibrated before usage and submerged for the recommended time period of 2-3 minutes before readings were recorded.

3.3.2 Water Collection Procedures and Quality Control

Two sampling events occurred and samples were taken on October 28th, 2020 and November 18, 2020. Samples taken on October 28, 2020 were drawn during a low flow event, where samples taken on November 18 were drawn during a high-flow event.

The samples were taken in conjunction with the Ambient Freshwater and Effluent Sample manual, which includes sampling downstream working upstream, as to eliminate contamination while working in the stream; sampling within the middle of the stream when safe to do so; using gloves to eliminate contamination; sampling below the surface as to eliminate surface contamination; and samples will also be kept in a cooler to preserve them. Sample bottles for the VIU lab were rinsed 3 times with water from the stream before being filled with the final sample for analyses. Water samples which were taken for ALS lab analyses were not rinses considering they came steril. Each time we collected water samples we carried a trip blank along with us to ensure no contamination occurred during the process of transport between sites and the lab. Samples remained in a cooler at roughly 5°C until they entered the laboratory fridge at VIU.

To ensure proper sampling protocols and consistency, the sampling events were hoped to occur in the same spots for both visits, unfortunately this was impossible due to the high water event. Sample blanks including one trip blank and one field blank were used, eliminating any potential of contamination. The bottles used for sampling were also rinsed three times before final collection of the sample, as mentioned earlier.

3.3.3 VIU Laboratory Analyses

Measurements which were not recorded in the field were examined in the VIU laboratory within 24 hours post-sampling. These parameters included water hardness (mg/L $CaCO_3$), total alkalinity (mg/L $CaCO_3$), total suspended solids (TSS), phosphorus (mg/L PO_4^{3-}) and nitrate (mg/L NO_3).

3.3.4 ALS Laboratory Analyses

The samples were shipped to ALS laboratories in Vancouver, BC to test conductivity, hardness, pH, anions, nutrients, and total metals. They were shipped in a styrofoam container with ice to keep them at the ideal temperature in order to preserve the quality of the samples. Samples for both nutrients and metals were preserved using sulphuric and nitric acids.

3.3.5 Data Analyses

The analysis of the data was cross-referenced to previous studies and compared to BC Water Quality Guidelines to determine if the data meets these guidelines, and what characteristics may need work to support aquatic life.

3.4 Stream Invertebrates

3.4.1 Invertebrate Sample Collection Procedures and Quality Control

Invertebrates collected during the sampling events have been analyzed at the VIU laboratory and at the VIU students' residences. Data collected will be used to determine overall aquatic health of the ecosystem. The samples were filled with 90% ethanol to preserve the organisms in transport and for ease of counting and identifying.

3.4.2 VIU Laboratory Analyses

3.4.3 Data Analyses

The invertebrates collected are organized into order and family, and placed into ascending order of pollution intolerance to pollution tolerant organisms. Diversity, abundance, and density have also been measured. The data collected have also been used in the Shannon-Wiener index to calculate the overall diversity of the stream.

4.0 Results and Discussion

4.1 General Field Conditions

During the first sampling period on October 28, 2020 the ambient air temperature ranged from 12 degrees to 14 degrees celsius. Weather conditions were overcast but stable during the duration of the sampling period. Flows during the first sampling period were low - mid. During the second sampling period on November 18, 2020, ambient air temperatures ranged between 10 degrees and 12 degrees celsius. Weather conditions saw mixed precipitation with periods of sun and cloud. Flows during the second sampling period increased dramatically which inhibited the ability to safely measure some specific parameters including discharge, wetted widths, and depths.

Figure 2: High water levels due heavy precipitation event.

4.2 Water Quality Field Measurements

During the first sampling period on October 28, 2020 the average water temperature was 6.975°C. During the second sampling period on November 18, 2020 the average water temperature was 6.9°C for a very slight decrease in temperature correlating with an ambient air temperature drop of only a couple of degrees. Both of these averages fall within the ideal range for spawning salmon and embryo survival (RISC 1998).

Dissolved Oxygen readings during the first sampling period ranged between 11.95 - 12.8 mg/L. During the second sampling period DO readings ranged between 10.19 - 12.06 mg/L indicating that the DO levels found in both sampling periods were well within the guidelines for aquatic life (RISC 1998).

Conductivity readings during the first sampling period ranged between 75 - 85 μS/cm, and lower readings during the second sampling period between 38 - 59 μS/cm which is believed to have been caused by the highwater event flushing of ions. These readings also met the guidelines for aquatic life in RISC 1998.

pH readings during the first sampling period ranged from 8.6 - 9.3, and readings taken from the second sample period indicated a pH range between 8.4 - 9.1 which is also acceptable in the guidelines for aquatic life. Lethal concentrations of pH in aquatic life are below 4.5 and above 9.5 (RISC 1998). As this reading is slightly on the high side for pH. It would be of interest to return to the channel at a later date to re-monitor this attribute, and perhaps try another measuring device to prevent a biased result.

4.2.1 Field Measurement Procedures and Quality Control

To ensure that results were as accurate as possible, samples were taken from the same sites or as close to the sites as possible. Because of the state of the river during the second sampling period, the third and the fourth sampling sites were slightly altered due to high water levels making it difficult to traverse. These sites were chosen because it was aimed to add to the previous years of data collected by previous student technicians since 2008.

During the field sampling session, water samples were stored in a cooler to maintain the temperature of the samples. Additionally, temperature and dissolved oxygen were measured onsite for best accuracy, with the rest of the measurements being taken to the lab for further testing.

4.2.2 VIU Laboratory Analyses

Alkalinity during the first sampling period ranged from 20.6 - 22 mg/L for a low sensitivity to acidic inputs, while readings during the second sampling period in high flow ranged between 75 - 166 mg/L for extremely low sensitivity to acidic inputs (RISC 1998).

Hardness during the first sampling period ranged between 30 - 35 mg/L CaC03 while readings from the second sample ranged between 20 - 31 mg/L CaC03. These readings are typical of streams located in coastal BC (RISC 1998).

Turbidity during the first sampling period ranged between 0.47 - 1.06 NTU which reflects on the clear state the flow was in during this time. The second sampling period, during an event of high flows saw a dramatic rise in turbidity. Sites 1-3 which are located in the side channel saw a range of 13.2 - 13.5 NTU, where site 4 where the side channel meets the main stem increased dramatically for a reading of 30.6 NTU. The dramatic increase in sediment in the main body of the river is due in part to the quickly eroding claybank located approximately 2.5 km upstream of site 4, as well as heavy logging across most of the upper river.

Nitrate levels for the first sampling period ranged between 0.06 - 0.78 mg/L. The reading of 0.78 mg/L is extremely high but makes sense for the location at which it was sampled, in the tailout of a very stagnant, sediment filled pool which was filled with decay from years of salmon decomposition. This reading did not line up with the highest reading of the second sample period because due to the high water event, we were unable to safely sample from this same location. Nitrate levels from the second sampling period ranged between 0.02 - 0.06 mg/L. For the second sample, rather than measuring the large deep pool as a site, it was replaced with a riffle section approximately 15 meters downstream which was much safer to sample.

Phosphates during the first sampling period ranged between 0.01 - 0.07 mg/L, and for the second sample period between 0.04 - 0.06 mg/L.

4.2.3 ALS Laboratory Analyses

Two sampling periods were completed on sites 2, 3, and 4, being sent off to the ALS laboratory to be analyzed on October 29, 2020 and November 20, 2020. The ALS results are extensive, however, conductivity, hardness, pH, and some anions, nutrients, and total metals will be noted.

Physical tests such as conductivity, hardness, and pH were consistent with the results analyzed by the student technicians' result listed above. Conductivity during the first sampling period ranged from 86.2 - 93.9 µS/cm. Results from the second sampling period ranged more than the first sampling period, with a range of 38.3 - 58.9 µS/cm. Because conductivity varies heavily, there is no guideline for this water quality specification (RISC 1998). Hardness during the first sampling period ranging between 27.9 - 31.8 mg/L CaCO3. Although results were lower for the second sampling period, the range remained relatively close at 16.8 - 22.9 mg/L CaCO3. During both sampling periods, pH remained very stable sitting just above 7 pH units. During the first sampling period, pH ranged between 7.53 - 7.57 pH units. Whereas, the second sampling period ranged 7.05 - 7.17 pH units. Aquatic life requires a pH of 6.5 - 9.0, making these measurements perfect for species within the Englishman River (RISC 1998). These results were, however, lower than the results analyzed in the VIU laboratory.

Anions and nutrients such as ammonia, nitrate, nitrite, nitrogen, phosphate, and phosphorus were provided in the ALS analytical results. However, nitrate and phosphate will be highlighted.

Nitrate ranged from 0.0505 - 0.0783 during the first sampling period and 0.0860 - 0.286 mg/L N during the second. Phosphates during the first sampling all remained under 0.0010 mg/L P. During the second sampling period, phosphates ranged much more at 0.0035 - 0.0077 mg/L P.

Total metals, such as aluminum, arsenic, calcium, copper, iron, lead, and more, were also presented in the ALS results. High levels of these metals could lead to the ultimate destruction of all life within the system as metals can be very harmful (Chapman 1978; RISC 1998; Mothersill et al. 2007). Aluminum during the first sampling period ranged 0.0400 - 0.0478 mg/L. However, during the second sampling period, results ranged from 0.798 - 1.86 mg/L, making it well above the criteria set out by the Guidelines for Interpreting Water Quality Data (RISC 1998). This criteria recommends a maximum of 0.1 mg/L of dissolved aluminum when the pH is above or equal to 6.5 pH units. This elevated amount of aluminum could be harmful to aquatic life within the system (RISC 1998). The source may be coming from industrial effluent or another source. Cadmium during both sampling periods remained well below the recommended criteria of 0.02 (at 30 mg/L) and 0.03 (at 90 mg/L) (RISC 1998). Molybdenum results remained well below the maximum 2.0 mg/L threshold for aquatic life for both sampling periods (RISC 1998). Molybdenum is needed for nitrogen fixation, bioaccumulates in plants, and is an essential micronutrient (RISC 1998).

4.3 Stream Invertebrate Results

Invertebrate samples were taken on October 28, 2020 and November 28, 2020 at all four stations, and at each site samples were replicated 3 times for a total of 24 samples at 6.48m². After analysis, there were a total of 124 vertebrates collected. Overall, mayflies were the most predominant species at all four sites, on both sampling occasions. October 28's site 1 had the highest count of invertebrates with 47 total, meanwhile October's site 2 had the lowest, with one stonefly. Overall site ratings and assessments are made by separating species and taxa, recording the counts onto data sheets for each site, and running the counts through a series of formulas (see Appendix). Overall site ratings are made on a scale of 1 (bad) - 4 (good). These calculations are made based on the averages of population tolerance index, EPT index, EPT to total ratio, and predominant taxa ratio (see Appendix). The average of overall site ratings (6) is 2.42, between marginal and good. The missing data from site 3 October 28, 2020 and site 4 November 18, 2020 are not recorded in this average.

4.3.1 Total Density and Overall Assessment Rating

Density of invertebrates is an aspect of overall stream health and assessment. Higher density is indicative of productive and high nutrient levels in streams. It is also an indicator of healthy riparian areas for all stages of invertebrate life cycles. Density for this assessment is rated through the Shannon-Weiner index which is measured on a scale of 0 (very poor) - 1 (excellent). Looking at the first sampling set on October 28th, 2020, site 1 saw a Shannon-Weiner index of 0.866 with 7 different taxa. Site 2 saw a score of 0. Site 3 data is missing. Site 4 had a score of 0.619.

November 18, 2020 sample results were more consistent throughout the sites. Site 1 had a score of 0.700. Site 2 had a score of 0.775. Site 3, however, had a higher score of 0.953 but it is not reflective in the taxon diversity. Site 4 data is missing.

4.3.2 Taxon Diversity

Both October and November 2020 sampling events had lower counts of taxa diversity due to a low number of invertebrates. The highest density of all the sites was 174 per m^2 and the lowest density being almost 4 (3.7) invertebrates per m^2. The invertebrates crucial for indicating healthy streams are EPT (Ephemeroptera, Plecoptera, and Trichoptera) as they are pollution sensitive and usually abundant year round. However, having a diversity of all pollution intolerant and pollution tolerant organisms is still indicative of a healthy, productive stream.

Looking at overall taxon diversity, the first sampling set on October 28, 2020, Site 1 saw seven different taxa. Site 2 had one taxon group. Site 3 data is missing. Site 4 had five different taxa. Mayflies and Caddisflies had a large presence in the overall count of invertebrates.

November 18, 2020 sample results had lower counts but higher diversity. Site 1 had five taxon groups. Site 2 had five. Site 3, however, had two taxon groups. Site 4 is missing data. Mayflies had a bigger presence in the second sampling event.

Overall site ratings looking at population tolerance index, EPT index, EPT to total ratio, and predominant taxa ratio for are listed in Tables 1 to 6 below.

Table 1. Site Assessment of Site 1, October 28th, 2020

Assessment	**Rating**
Total Number of Invertebrates	47
Total Taxa	7
Population Tolerance	18 (acceptable)
EPT Index	5 (acceptable)
EPT to Total Ratio	0.723 (acceptable)
Predominant Taxa	0.340 (good)
OVERALL RATING	**3.25**

Table 2. Site Assessment of Site 2, October 28th, 2020

Assessment	**Rating**
Total Number of Invertebrates	1
Total Taxa	1
Population Tolerance	3 (poor)
EPT Index	1 (poor)
EPT to Total Ratio	1 (poor)
Predominant Taxa	1 (poor)
OVERALL RATING	**1.75**

Table 3. Site Assessment of Site 4, October 28th, 2020

Assessment	**Rating**
Total Number of Invertebrates	17
Total Taxa	5
Population Tolerance	12 (marginal)
EPT Index	3 (marginal)
EPT to Total Ratio	0.88 (good)
Predominant Taxa	0.705 (marginal)

OVERALL RATING	**2.5**

Table 4. Site Assessment of Site 1, November 18th, 2020

Assessment	Rating
Total Number of Invertebrates	19
Total Taxa	5
Population Tolerance	12 (marginal)
EPT Index	3 (marginal)
EPT to Total Ratio	0.315 (marginal)
Predominant Taxa	0.631 (marginal)
OVERALL RATING	**2**

Table 5. Site Assessment of Site 2, November 8th, 2020

Assessment	Rating
Total Number of Invertebrates	24
Total Taxa	5

Population Tolerance	12 (marginal)
EPT Index	3 (marginal)
EPT to Total Ratio	0.916 (good)
Predominant Taxa	0.458 (acceptable)
OVERALL RATING	**2.75**

Table 6. Site Assessment of Site 3, November 18th, 2020

Assessment	**Rating**
Total Number of Invertebrates	16
Total Taxa	2
Population Tolerance	6 (poor)
EPT Index	2 (marginal)
EPT to Total Ratio	1 (poor)
Predominant Taxa	0.625 (marginal)
OVERALL RATING	**2.25**

4.4 Limitations

Due to limited time, resources and there was a delay in sampling for final field samples. This would generally not be an issue, however, there was a large amount of precipitation overnight which resulted in altered field conditions. This includes the river being blown out and dangerous. The water was incredibly turbid and dangerous to traverse and work around in some of the sites. The large amounts of precipitation on the Englishman caused sections of the riverside trail to be flooded and difficult to navigate. This did alter two sampling locations slightly. Additionally, the stream was too dangerous to cross at nearly all points due to its increased velocity. Therefore, wetted width, velocity, and average depth were not measured during the second sampling period. Other considerations include time constraints, loss of data, access to sampling locations and access to laboratory equipment.

Figure 3: High water levels limiting trail access.

4.5 COVID-19 Protocols

COVID-19 is a respiratory illness, causing infections in the nose, throat, and lungs. Although the virus can render anyone ill, individuals that are immuno-compromised and/or aged 65 years and over are at an increased risk of more severe outcomes. The coronavirus is spread through droplets released into the air by infected individuals. These droplets do not travel more than a few feet before falling to the ground. Symptoms (include but are not limited to a cough, fever, shortness of breath, muscle aches, sore throat, unexplained loss of taste or smell, diarrhea, and headaches) generally become active within 14 days of exposure to the virus, however, some infected individuals may remain asymptomatic.

Figure 4: Ensuring proper COVID-19 protocols.

COVID-19 protocols were established prior to conducting fieldwork at the Englishman River and VIU laboratory. In the field, each team member: (1) completed the VIU Health and Safety Application for COVID-19 and received their badge prior to leaving their house; (2) drove their own vehicle to the sampling site to ensure proper distancing of a minimum of two meters; (3) Remained at a distance of a minimum of two meters from one another in the field; and (4) wore gloves when touching the same equipment and sampling containers. In the laboratory, each team member: (1) entered the laboratory one at a time, keeping a safe distance; (2) sanitized their hands; (3) wore gloves, masks, lab coats, and eye protection; and (4) sanitized surfaces. These protocols were strictly followed to ensure the project lead, Owen Hargrove, and each team member's safety was number one priority in the workplace.

5.0 Conclusions and Recommendations

The overall environmental quality of the Englishman River is good. VIU and ALS laboratory results were relatively consistent. Invertebrate abundance and diversity is different this year than in previous years, especially than in 2019. However, pollution intolerant organisms were still prevalent in most of the sites. One metal that was noted in the laboratory results was aluminium. Aluminum was relatively high during the second sampling period. These results are consistent with results in years past where aluminum was noted as one of the most abundant metals in the stream overtaking the guidelines for aquatic life (Lukas et al. 2011). We would recommend that the pH levels, which were around 9 in the VIU laboratory analysis, be monitored closely to see that the reading does not continue to rise above 9.5 which would then be considered lethal to aquatic life (RISC 1998). Further testing spread out throughout the entire channel may be necessary to determine whether the attributes are fairly consistent throughout the system or there's a certain location depositing more of the aluminum and or acids. We would recommend that VIU's Environmental Monitoring class continue to monitor the system for the foreseeable future to watch for any trends that may be of harm to the aquatic environment.

6.0 References

Chapman G.A. 1978. Toxicities of cadmium, copper, and zinc to four juvenile stages of chinook salmon and steelhead. Transactions of the American Fisheries Society 107(6): 841-847.

Clough D.R. 2013. Englishman River Habitat Status Report.

Decker AS., Lightly MJ., Ladwig AA. 2003. The contribution of two constructed side-channels to coho salmon smolt production in the Englishman river. Canadian Technical Report of Fisheries and Aquatic Sciences. 2442: 53p.

Lukas S, Peace B, Sigal S, Wilde B. 2011. Water Quality and Stream Invertebrate Assessment for the C.W. Young Spawning Channel, Englishman River.

Mothersill C., Salbu B., Heier L.S., Teien H.C., Denbeigh J., Oughton D., Rosseland B.O., Seymour C.B. 2007. Multiple stressor effects of radiation and metals in salmon (*Salmo salar*). Environmental Radioactivity 96: 20-31.

RISC. 1998. Guidelines for Interpreting Water Quality Data. Resources Information. Standards Committee, Victoria, BC.

Rueggeberg H., Sifton L., Gaboury M., Hawkes V., Tamasi R. 2008. Englishman river regional park: a conservation area along the river corridor.