Beach Seine Surveys of Aquatic Species in the Gorge Waterway of Esquimalt Gorge Park, Esquimalt BC

This study was done in partial fulfilment of the requirements for the Gorge Waterway Action Society Youth Community Partnership Program

Date Conducted: January - March 2021

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GORGE WATERWAY NATURE HOUSE

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Background

The Township of Esquimalt has proposed the restoration of Gorge Creek with the goal to improve water quality and the biodiversity of the creek. The Gorge Waterway Action Society (GWAS) aims to collect a variety of ecological baseline data on the creek prior to restoration to measure the effect of the restoration project. The Gorge Waterway is a narrow tidal inlet that connects Victoria Harbour to Portage Inlet, which covers a total of 54.5ha of area with an average harbour depth of less than 5m. The area is a protected migratory bird sanctuary with multiple species at risk residing within the area (CRD, 2013). There were many decades where pollution entered the Gorge from sewage and industrial waste that negatively impacted the water quality. Cleanup efforts began in the 1990s and the water quality has improved significantly but continuous work is required to further improve the ecosystem health of the Gorge Waterway.

When a river meets the ocean, an estuary is formed. An estuary is where freshwater mixes with salt water in a partially enclosed body of water and continuous nutrient cycling is driven by the tides and the variable flow of freshwater. Estuaries are important because they are well protected from wave action and act like nurseries for both freshwater and saltwater species. The Gorge Waterway forms an estuary. Gorge Creek is a freshwater source and the Gorge Waterway is part of the Pacific Ocean. The semi-protected waterway is a regionally distinct coastal water feature that contributes to an extremely productive estuarine ecosystem. The shallow nearshore estuary zones provide refuge, food and nursery grounds for small fish and crustaceans. The fish that use this waterway play a significant role in the food web for species such as otters, seals, larger fish and birds. The nearshore area with its variable habitats can play a vital role in the survival, nurturing and growth of its juvenile fish and crustacean inhabitants and therefore it is a vital part of the coastal ecosystem.

The Gorge Waterway is typically calm and protected but at the rocky reversible falls under Tillicum bridge, the currents are strong. During low tides, many large mudflats are exposed near the mouth of the Gorge Creek. At high tides, the shoreline vegetation experiences direct contact with sea water. The Gorge Creek carries suspended sediments and terrigenous nutrients into the Gorge Waterway, contributing to the productive ecosystem. Eelgrass is a perennial plant that has dark green, ribbon leaves that grows in low-tide impacted habitats. The eelgrass present in the estuary helps prevent erosion by anchoring sediment and dampening wave action but is negatively impacted by pollutants in the water.

Purpose, Goals and Objectives

The goal of the beach seining is to better understand the community structure and dynamics of the fish and crustaceans that live in the estuary habitat of the Gorge Waterways. Collecting data on which species are present in this habitat within the Gorge Waterway and Gorge Creek estuary can be used as baseline data for future decision making, develop an understanding of the ecosystem health, and measure the effect of the restoration project after completion.

Study Area Description

Project currently has a sampling location within Esquimalt, BC:

- Site 1, Gorge Creek estuary base (48.446944, -123.406911) beach adjacent to the playground outside the Nature House as seen in Figure 1.

The nearshore zone within the Gorge Creek is shallow, with occasional high energy tidal flows and variable creek flow influenced by precipitation events. The shoreline composition varies and includes sandy beach, coarse wood debris, emergent vegetation, and man-made components. The sediments within each seine site are also variable and may include mud, sand, stones, clay or a mix of each. Site 1 is largely dominated by pebbles followed by a transition to silt sediments deeper in the intertidal zone. The beach area outside the Nature House experiences a large range of water height due to shifting tides travelling up the Gorge Waterway.

Figure 1. View of the nearshore area of the Gorge Creek/Gorge Waterway estuary from the Nature House in Esquimalt Gorge Park, Esquimalt, British Columbia.

Materials

- Beach seine net
- 2-3 dip nets
- 2-3 buckets
- Chest waders (preferably not felt bottom waders to prevent spread of invasive species)
- Rubber boots
- Meter stick and measuring tape
- Phone camera for site photos
- Log books

Budget

The budget to conduct beach seines can be reduced when collaborating with World Fisheries Trust (WFT) through equipment sharing. GWAS was able to borrow buckets, dip nets

and a beach seine net form WFT, which significantly lowered the budget requirements . Additionally, technicians were able to use their personal waders, further reducing the cost of the surveys. Remaining equipment was either already possessed by GWAS or owned by the surveyors (i.e. cell phone cameras). By borrowing equipment, GWAS was able to conduct multiple beach seines without new equipment costs.

Methods

We used a 14x2 meter seine net of 3x3mm mesh for sampling that had floaters attached to the top and weights attached to the bottom with the intention to capture everything in the water column that would get caught in the mesh. For each sample, one person is stationed on the shoreline and second person meters away from the shore. The second person pulls the net in a half circle, trapping any organisms in the water column. All organisms that are caught in the net are identified, photographed, counted, and either returned unharmed back into the water or retained for scientific, educational, or public display purposes. Retained organisms were collected under permit with a scientific collections license from the Department of Fisheries and Oceans (DFO). Sampling was repeated at the same site to determine spatial and temporal changes in species composition, population size structure and abundance. An example illustration of beach seining can be seen in Figure 2, alongside the seine net in an active beach seine event.

Step by Step Beach Seine method

- Person A will stay on the beach with one end of the seine net. The other end of the net remains the water with person B. Person B pulls the net in the water around in a semi-circle to point B about 30ft up the beach to person C. If the tide is low enough, this can be done without a boat by people in waders.
- The seine net is then slowly pulled in by person A & B until the net is up on the shore. When pulling the net in, be sure the weighted side of the net drags along the bottom of the water & the float side of the net stays at the surface.
- At the beach shore there should be several clean buckets of Gorge water (always from the same water source being sampled to ensure no water shock to the species) filled prior to seining. The seining will stir up sediments, making it difficult to fill buckets with clear water.
- Have dip nets ready for person C-D to recover any fish once the net is brought in
- Fish should immediately be put into buckets. A small amount of vegetation should be added to the buckets to give fish a feel of cover safety.
- Photograph each species front & back against a ruler then carefully release back into the Gorge. Take a photo of each species sampled so future identification can be done remotely.
- Clean and organize all gear after the seine is complete to ensure that everything is ready for the next beach seine. Ensure there are no tangles in the net. If any have developed, mend by hand before the next scheduled beach seine.
- After all beach seines have been conducted, rinse all nets and equipment with fresh water so the salt water from the sampling is washed off, after which equipment should be hung to dry completely.

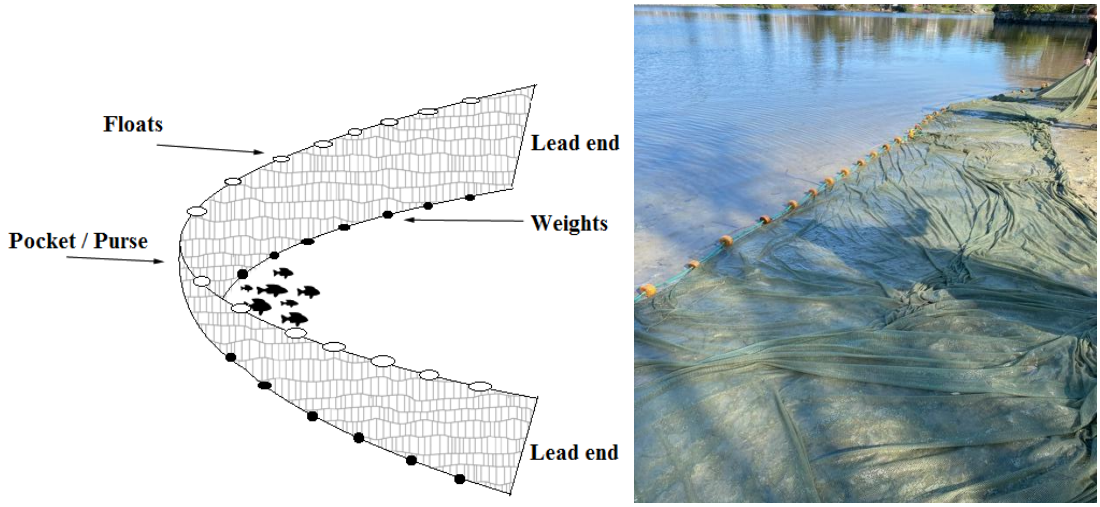

Figure 2. A) Illustrated example of a beach seine. Source: https://www.researchgate.net/profile/ Heather-Ylitalo-Ward. B) The seine net used to survey marine organisms at Esquimalt Gorge Park beach in Esquimalt, BC.

Collaborators

The Gorge Waterway Action Society (GWAS)
Primary surveyor: Taylor Ball
Supervisor: Jameson Clarke
Location: Esquimalt Gorge Park, 1070 Tillicum Rd, Victoria, BC V9A 2A1
Contact: Telephone: 778-265-5119 and gorgewaterway@gmail.com

World Fisheries Trust
Supervisor: Yogi Carolsfeld
Location: Esquimalt Gorge Park, Clover Point Beach on Dallas Road, potentially others TBD
Contact: yogi@worldfish.org

Timetable

Approximately once a week, resulting in about 3-4 beach seines being conducted between February 26th and the end of March 2021. Ideally performed on a clear day/ overcast to reduce the hazard of precipitation driven high-water levels. Sampling should be carried out by wading when water levels permit, and by boat when wading is not possible.

Results

First Beach Seine

The first beach seine was conducted on February 26th, 2021 at 10:30pm. This time was determined based on wanting to conduct the beach seine at low tide which was at 12:37am on February 27th, 2021 at the height of 0.2m. Catch information for the beach seine can be seen in Table 1.

Table 1. Species found in the 1st beach seine at Esquimalt Gorge Park, Esquimalt, BC, on February 26th, 2021, at 10:30pm.

Common Name	Scientific Name	Quantity	Rough Size	Figure #
Three-spined Stickleback	*Gasterosteus aculeatus*	28	Between 25-50mm	4
Caridean Shrimp	*Crangon crangon*	26	Between 12-20mm	5
Oriental Shrimp	*Palaemon macrodactylus*	3	Between 12-20mm	6
Opossum Shrimp	*Mysida*	Many +40	12mm	7
Pacific Staghorn Sculpin	*Leptocottus armatus*	22	Between 10-60mm	8
Surf Smelt	*Hypomesus pretiosus*	1	110mm	9
Arthropod	*Unknown*	2	10mm	10

Figure 3. Three-spined stickleback (*Gasterosteus aculeatus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on February 26th, 2021, at 10:30pm. Caliper included for scale.

Figure 4. Caridean shrimp (*Crangon crangon)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on February 26th, 2021, at 10:30pm.

Figure 5. Oriental shrimp (*Palaemon macrodactylus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on February 26th, 2021, at 10:30pm.

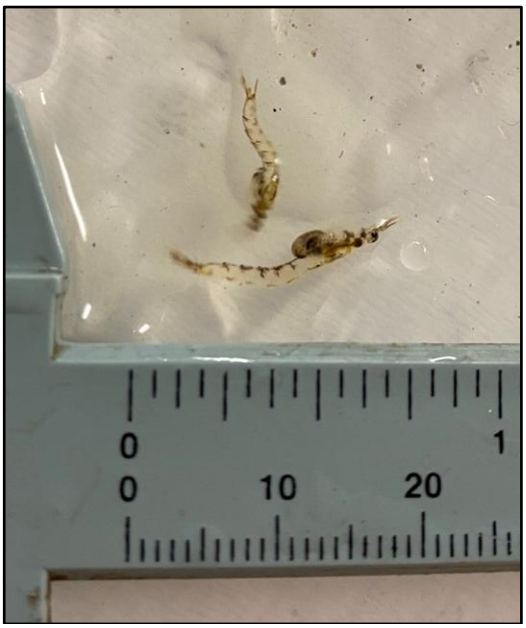

Figure 6. Opossum Shrimp (*Mysida sp.)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on February 26th, 2021, at 10:30pm. Caliper included for scale.

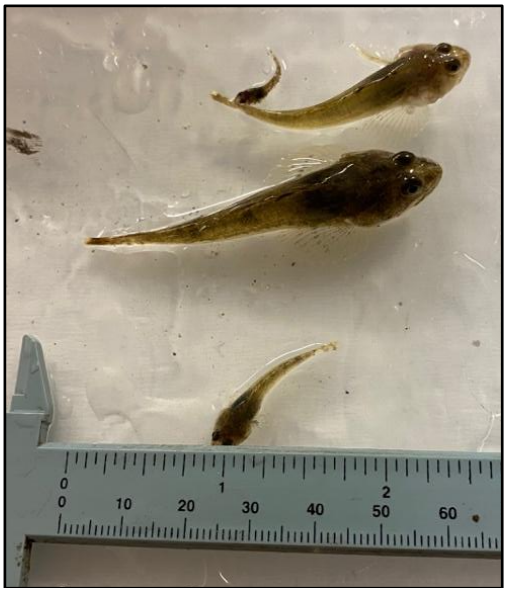

Figure 7. Pacific Staghorn Sculpin (*Leptocottus armatus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on February 26th, 2021, at 10:30pm. Caliper included for scale.

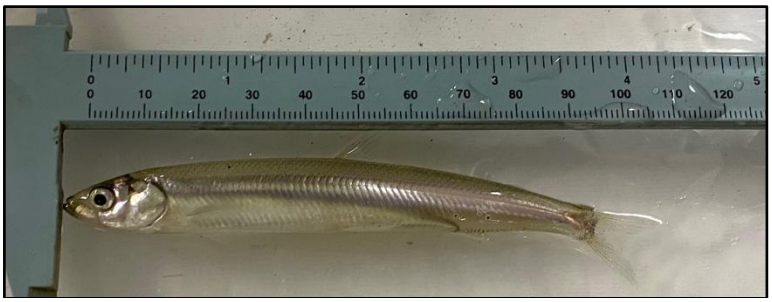

Figure 8. Surf Smelt (*Hypomesus pretiosus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on February 26th, 2021, at 10:30pm. Caliper included for scale.

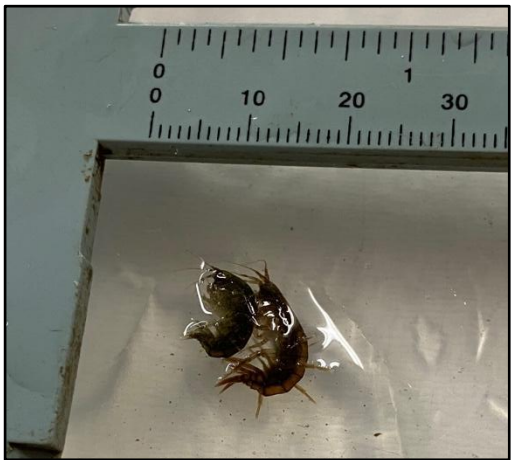

Figure 9. Arthropod (*Unknown species)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on February 26th, 2021, at 10:30pm. Caliper included for scale.

2nd Beach Seine

The 2nd beach seine was conducted on March 8th, 2021 at 12:00pm. This time was determined based on availability of volunteers during the day. The tide was at a medium height with the lowest tide of 0.1m at 9:05pm and highest tide of 1.2m at 9:19am on March 8th, 2021. This beach seine resulted in 1 Pacific Staghorn Sculpin (*Leptocottus armatus)* being recovered. See Table 2 and Figure 11 for the results.

Table 2. Species found in the 2nd beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 8th, 2021, at 12:00pm.

Common Name	Scientific Name	Quantity	Rough Size	Figure #
Pacific Staghorn Sculpin	*Leptocottus armatus*	1	55mm	11

Figure 10. Pacific Staghorn Sculpin (*Leptocottus armatus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 8th, 2021, at 12:00pm. Ruler included for scale.

3rd Beach Seine

The 3rd beach seine was conducted on March 10th, 2021 at 12:00pm. This time was determined based on availability of volunteers during the day. The tide was at a high height with the lowest tide of 0.2m at 10:52pm and highest tide of 1.1m at 11:39am on March 10^{10h}, 2021. This beach seine resulted in no species being recovered from the seine net. The shell remains of Dungeness crab (*Metacarcinus magister)* were found in the net as seen in Figure 12.

Table 3. Species found in the 3rd beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 10th, 2021, at 12:00pm.

Common Name	Scientific Name	Quantity	Rough Size	Figure #
Dungeness Crab (shell)	*Metacarcinus magister*	1	Unknown	12

Figure 11. Dungeness Crab (*Metacarcinus magister*) shell found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 10th, 2021, at 12:00pm.

4th Beach Seine

The 4th beach seine was conducted on March 17th, 2021 at 4:00pm. This time was determined based on wanting to conduct the beach seine at low tide with volunteers available. The tide was at a low height with the lowest tide of 0.4m at 4:44pm and highest tide of 1.0m at 7:29am on March 17th, 2021. Figure 16 appears to be a mat of diatoms washed in from the eelgrass. These are probably expanding now with increased daylength after daylight savings. The bubbles that are present in the photo form with photosynthesis as well as getting trapped as the mat swishes around in the water and the seine net. All species found can be seen in Figure 21 inside the sample bucket.

Table 4. Species found in the 4th beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm.

Common Name	Scientific Name	Quantity	Rough Size	Figure #
Pacific Staghorn Sculpin	*Leptocottus armatus*	2	40mm	13
Arthropod	*Unknown*	4	8mm	14
Caridean shrimp	*Crangon crangon*	1	35mm	15
Three-spined stickleback	*Gasterosteus aculeatus*	1	30mm	16
Didymo Diatoms Algae	*Didymosphenia geminate*	Many	NA	17
Dungenous Crab (Arm)	*Metacarcinus magister*	1	65mm	18
Japanese Mud Snail	*Batillaria attramentaria*	6	20mm	19
Opossum Shrimp	*Mysida*	Many 20+	12mm	NA
Eelgrass	*Zostera*	Many	NA	20
Butter Clam	*Saxidomus giganteus*	1	NA	21

Figure 12. Pacific Staghorn Sculpin (*Leptocottus armatus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm. Ruler included for scale.

Figure 13. Arthropod (*Unknown species)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm. Ruler included for scale.

Figure 14. Caridean Shrimp (*Crangon crangon)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm. Ruler included for scale.

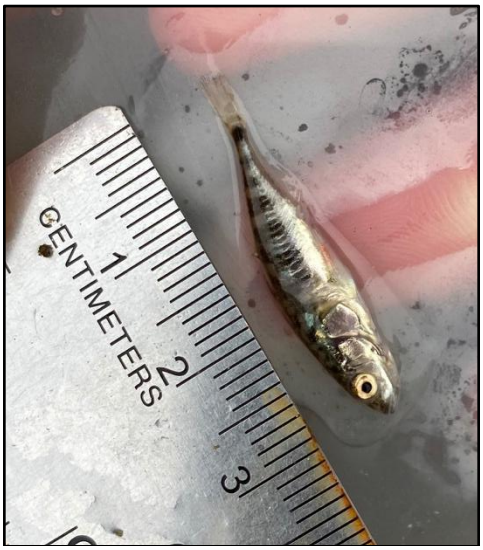

Figure 15. Three-Spined Stickleback (*Gasterosteus aculeatus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm. Ruler included for scale.

Figure 16. Didymo Diatoms Algae (*Didymosphenia geminate)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm.

Figure 17. Dungeness Crab arm (*Metacarcinus magister)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm. Ruler included for scale.

Figure 18. Japanese Mud Snail (*Batillaria attramentaria)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm.

Figure 19. Eelgrass *(Zostera marina)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm.

Figure 20. Butter Clam (*Saxidomus giganteus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm.

Figure 21: All species sampled during the 4th beach seine event at Esquimalt Gorge Park, Esquimalt, BC, on March 17th, 2021, at 4:00pm. Most of the small swimming crustaceans are *Mysida* shrimp.

5th Beach Seine

The 5th beach seine was conducted on March 22nd, 2021 at 8:00pm. This time was determined based on wanting to conduct the beach seine at low tide. The tide was at a low height with the lowest tide of 0.1m at 9:07pm and highest tide of 1.1m at 8:45am on March 22nd, 2021. The waters were at low tide and during the evening hoping to achieve as many species as possible that reside in the low tide and are nocturnal. There were an overabundance of Japanese Mud Snails and Opossum Shrimp viewed in the water before the seine started.

Table 5. Species found in the 5th beach seine event at Esquimalt Gorge Park, Esquimalt, BC, on March 22nd, 2021, at 8:45am.

Common Name	Scientific Name	Quantity	Rough Size	Figure #
Three-spined Stickleback	*Gasterosteus aculeatus*	3	Between 25-50mm	23
Caridean Shrimp	*Crangon crangon*	Many +30	Between 12-20mm	24
Oriental Shrimp	*Palaemon macrodactylus*	Many +20	Between 12-20mm	NA
Opossum Shrimp	*Mysida*	Many +40	12mm	25
Pacific Staghorn Sculpin	*Leptocottus armatus*	6	Between 10-60mm	26
Arthropod	*Unknown*	5	10mm	NA
Japanese Mud Snail	*Batillaria attramentaria*	11	20mm	27
Arrow Goby	*Clevlandia ios*	3	30mm	28

Figure 22. Three-spined Stickleback (*Gasterosteus aculeatus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 22nd, 2021, at 8:45am. Ruler included for scale.

Figure 23. Caridean Shrimp (*Crangon crangon)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 22nd, 2021, at 8:45am. Ruler included for scale.

Figure 24. Opossum Shrimp (*Mysida sp.)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 22nd, 2021, at 8:45am.

Figure 25. Pacific Staghorn Sculpin (*Leptocottus armatus)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 22nd, 2021, at 8:45am.

Figure 26. Japanese Mud Snail (*Batillaria attramentaria)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 22nd, 2021, at 8:45am.

Figure 27. Arrow Goby (*Clevlandia ios)* found in the beach seine at Esquimalt Gorge Park, Esquimalt, BC, on March 22nd, 2021, at 8:45am.

Baseline Water Quality Data Analysis

The biology team conducted a baseline water quality survey by monitoring the water of Gorge Creek within Esquimalt Gorge Park in Esquimalt, BC. Monitoring included

collecting data near the water surface on water temperature, dissolved oxygen and salinity from 8 sites along the Gorge Creek as seen in Figure 29.

Baseline water quality parameters can inform our interpretation of the results . Oxygen enters a stream by gas exchange with the atmosphere, particularly in areas where the water flows over and around obstacles, producing bubbles that maximize the surface area available for gas exchange. This dissolved oxygen allows aquatic organisms to breathe. Dissolved oxygen is used by all forms of aquatic life, so it is often used as an indicator of stream health. Bacteria in the water can consume oxygen as organic matter decays, exemplified by the high coliform levels Gorge Creek experiences. Aquatic life can have a hard time in stagnant water, especially in the summer as the concentration of dissolved oxygen is related to surface area and water temperature (YSI Environmental, 2005).

Temperature exerts a major influence on biological activity and growth. Cold water can hold more dissolved oxygen than warm water. In winter and early spring, when the water temperature is low, the dissolved oxygen concentrations are high. The GWAS biology stream was conducting water quality monitoring from February to March 2021 thus only collecting a limited seasonal dataset.

Salinity is the concentration of salt in water, usually measured in parts per thousand (ppt). Salinity in estuaries varies according to daily tides and the volume of fresh water flowing into the system. Salinity levels are generally highest near the mouth of the stream where the water enters the estuary but can vary due to tidal influences. The salinity levels typically decline in the spring when snowmelt and rain increase the fresh water flow while salinity levels rise in the summer when higher temperatures increase evaporation and precipitation is reduced. Estuarine organisms have varying tolerances and responses to salinity levels and changes in water chemistry. Many bottom dwelling species like crab and oysters can tolerate higher salinity levels. Salinity affects chemical conditions in the estuary, such as the dissolved oxygen, thus salinity, water temperature, and dissolved oxygen are interconnected. The amount of oxygen that can dissolve in water decreases as the salinity increases (National Oceanic and Atmospheric Administration, 2013).

As the tide height rises, so does the average salinity because more salt water is moving into the system. Average temperature, average O2 mg/L, and average O2 by percentage remain fairly consistent given the heterogeneous geography of the creek (See Table 6). Figure 30 shows the comparison of salinity with tide height in the creek. The aquatic species that were sampled in the beach seines are tolerant and often require salt water meaning it is possible during high tides for species to travel up the creek but may experience difficulties after sample site 1: Craigflower culvert due to anthropogenic obstacles. Figure 31 shows the average salinity per sampling site within the c reek. The beach seines were all conducted along the beach outside the Nature House which corresponds best with sample site 8 near the mudflats. This area is within the estuary of Gorge Creek that receives the highest level of salt water that travels up the Gorge Waterway from the Pacific Ocean. The salt water is required for the unique habit of an estuary and the salinity significantly drops after sample site 6 GC pool 2 inhibiting marine species from residing further up the creek. All raw data for the baseline water monitoring project for the Gorge Creek and Colquitz Estuary sites can be found in the GWAS google drive or at this link: https://docs.google.com/spreadsheets/d/1e7hJ-54AlLspy9j_TiApGmAyM30goXoV/edit?rtpof=true.

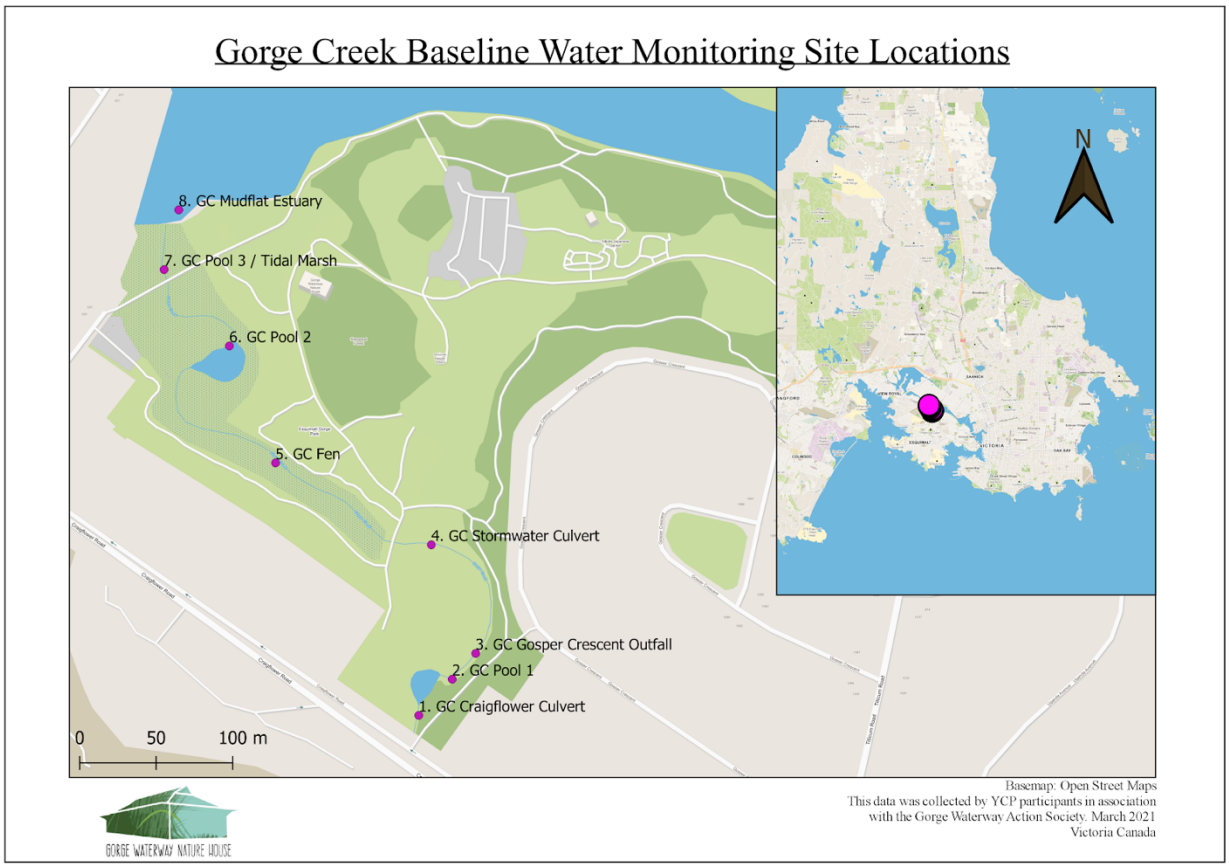

Figure 28. Water monitoring sites used in the Gorge Waterway Extended Baseline Project to measure water quality. The sites lie along Gorge Creek in Esquimalt Gorge Park, Esquimalt, BC.

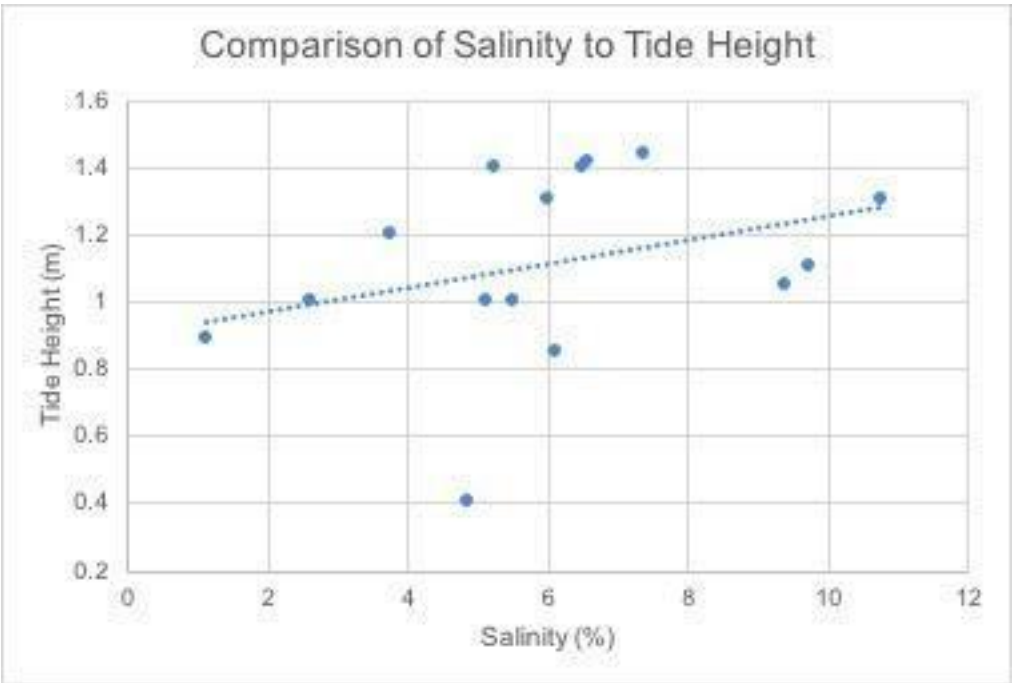

Figure 29. Comparison of salinity to tide height in the section of Gorge Creek that lies in Esquimalt Gorge Park, Esquimalt, BC.

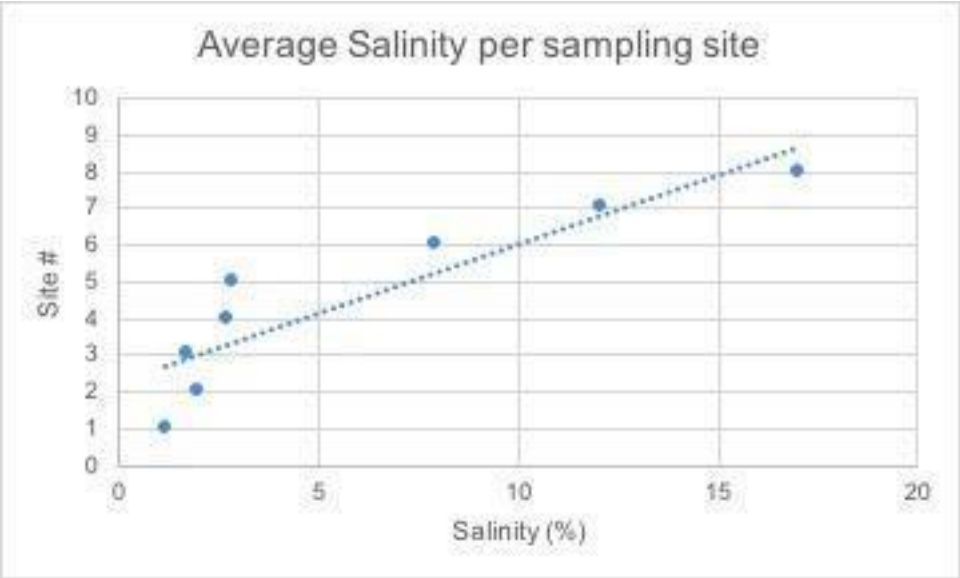

Figure 30. Comparison of average salinity per sampling site for each sample site along Gorge Creek in Esquimalt Gorge Park, Esquimalt, BC. Site 1 is at the Craigflower culvert and site 8 is where the creek joins the Gorge Waterway.

Table 6. Average water quality metrics taken at 8 sites along Gorge Creek as part of the Gorge Waterway Extended Baseline Project in Esquimalt Gorge Park, Esquimalt, BC.

Sample Site	Average Salinity	Average Temperature	Average O2 (mg/L)	Average O2 (%)
1	1.166666667	7.58	11.77333333	96
2	2	7.54	11.9	97
3	1.733333333	7.413333333	12.11333333	97.13333333
4	2.733333333	7.133333333	12.01333333	96.46666667
5	2.866666667	6.842666667	12.16666667	97.4
6	7.933333333	7.186666667	12.24666667	98.06666667
7	12.06666667	7.14	11.94666667	96.73333333
8	17	7.28	11.86	96.93333333

Conclusion

When conducting the beach seines during all five events it was surprising to find virtually no trash caught in the beach seine net. Time of day was a large factor in seining results. The surf smelt that was caught during the nighttime sampling event is unlikely to be captured in a daytime setting and mysids are likely to be less abundant. The sculpins are a more benthic species thus likely to be similar. The tidal height is the dominant factor in the abundance of aquatic species being sampled during the survey events.

Species Information

Three-spined Stickleback (*Gasterosteus aculeatus)*

- Three-spined stickleback are small schooling fish that inhabit fresh and salt waters. It is found in slow moving backwaters and feeds on small crustaceans, insect larvae, fish larvae and fish eggs (NatureServe, 2015).

Caridean Shrimp (*Crangon crangon)*

- Caridean shrimp are vital species in a shallow water ecosystem. They are a major prey species for fish, birds and other animals. The Caridean shrimp is common in shallow water habitats as it lives in sandy sediments (Food and Agriculture Organization, n.d)

Oriental Shrimp (*Palaemon macrodactylus)*

- Oriental shrimp is a crustacean native to northeast Asia, and is considered an invasive species in the waters surrounding Vancouver Island. This species inhabits brackish waters (water with salinity levels between seawater and freshwater) in estuaries favouring protected water. Oriental shrimp are omnivores, and their diet consists of mysids, amphipods, barnacles and fish / insect larvae (De Grave, 2010).

Opossum Shrimp (*Mysida)*

- The Opossum shrimp species that were found during the first sampling event have not been categorized by Yogi at World Fisheries Trust, but based on local records they could be Neomysis (Mees, 2013). Mysids are an order of small shrimp like crustaceans that are found in both shallow and deep marine fresh and brackish water ecosystems. Mysids are filter feeders, omnivores that feed on algae and zooplankton within the water columns.

They are extremely sensitive to water pollution and can be used as bioindicators to monitor water quality. The article by Feyrer and Duffus in 2011 discusses their populations through predatory disturbance by grey whales in Clayoquot Sound, BC (Feyrer, 2011).

Pacific Staghorn Sculpin (*Leptocottus armatus)*

- Pacific staghorn sculpin is found in shallow saltwater or brackish habitats along the Pacific coast, commonly in estuaries and sandy bottomed areas like tidal flats. This species has spined antler-like projections on its gill covers that it can raise as a defense mechanism. Sculpins have the ability to breathe air when out of water and will move out of tidepools if conditions force them too (Froese, 2006).

Surf Smelt (*Hypomesus pretiosus)*

- Surf smelt are small marine fish native to the north Pacific Ocean that reside close to shore. They are a schooling fish found in coastal estuaries on sand or fine gravel beaches. Spawning occurs at night to avoid predation between May and October. Surf smelt feed off of worms, larval fish, and small crustaceans but are an important food source salmon and halibut (Fitch, 1975).

Arthropod

- An arthropod is an invertebrate animal that has an exoskeleton, a segmented body and paired jointed appendages which includes insects and crustaceans (Garwood, 2012).

Dungeness Crab (*Metacarcinus magister*)

- Dungeness crabs inhabit eelgrass beds in inlets and estuaries of the west coast of North America and is a popular seafood for human consumption. They are scavengers that feed on fish, crustaceans, clams and worms. Crabs grow by producing a new shell under its old one and shedding the old shell when ready. This process is called moulting. For the first several weeks the new shell is soft and easily damaged making it vulnerable for predation. Harding of the shell requires roughly two months (Ng, 2008).

Eelgrass (*Zostera marina)*

- Eelgrass is a marine plant that grows in the intertidal and subtidal zones. It is considered a species at risk as it has been heavily impacted by pollution and changes in land use. It is usually found in shallow coastal waters of Western and Eastern Canada along with additional locations around the world. These plants are a keystone species in an ecosystem that provides a nursery habitat, refuge and food for numerous species. Eelgrass beds assist in coastal protection by promoting sedimentation and reducing coastline erosion (CRD, 2013).

Japanese Mud Snail (*Batillaria attramentaria)*

- The Japanese mud snail also known as Asian horn snail is an invasive species. It displaces native snails by competing with food resources and it is resistant to parasites that affect native snail species. They generally reside in saltwater marshes, mudflats and estuaries. Its diet consists primarily of diatoms that grow on the surface of mud (Unknown, 2010).

Didymo Diatoms Algae (*Didymosphenia geminate)*

- Didymo is a freshwater diatom alga that is native to North America. It grows attached to solid surfaces such as the case of these beach seines it was found attached to eelgrass. Through carbon fixation, diatoms remove CO2 from the atmosphere. The CO2 is converted to organic carbon in the form of sugar and O2 is released. We breathe the oxygen that diatoms release. Diatom species are particular about the quality of water where they live. Species have distinct ranges and tolerances of pH and salinity as they can be used to assess and monitor biotic conditions of water (Unknown, 2014).

Butter Clam (*Saxidomus giganteus)*

- Butter clams are large, edible, saltwater clams found on the west coast of North America. They can be found buried in soft sediments in low intertidal zones and are filter feeders that remove phytoplankton from the water. It is often the prey for Dungeness crabs and shorebirds (Cowles, 2005).

Arrow Goby (*Clevlandia ios)*

- Arrow goby is a species of goby fish native to marine and brackish waters of the Pacific coast of North America. They reside in sand or mud sediments as it burrows in holes made by invertebrates to shelter from prey and during low tide. The adults consume diatoms, algae, staghorn sculpins, shrimp eggs and juvenile shrimp (Sherriff, 2014).

Educational Component

Present educational components that GWAS can include adding the aquatic species found during the beach seine to the species gallery so the public can better understand what species are found in the water through interpretive signs, Facebook video series, displays at the Nature House and educational videos during sampling events. The species that have been identified can be found in the Species Information section of this report. In the future, after public events are allowed without social distancing practices, the public could be invited to observe a beach seine and learn about the process. This could encourage further public engagement with GWAS. GWAS has the ability to partner with its sister organization, World Fisheries Trust, to educate youth on biological and environmental issues in their local area.

To test the effectiveness of a beach seine as a public engagement tool, we organized a private beach seine with an elementary school class. We convened on March 24th, 2021 to conduct a beach seine along Dallas Road at Clover Point, Victoria, BC. This location was chosen because the students are from a school located near Clover Point, meaning they would have a close connection with the site being in their immediate neighbourhood. There were roughly 20 kids that participated in the educational event to teach them what a beach seine is, why it is conducted, what types of species may be found and to explore intertidal zones. The beach seine did not result in any fish species being caught in the net primarily due to the time of the survey during the day and the strong winds with high wave action. There was a harbour seal (*Phoca vitulina)* spotted in the waters while the beach seine was being conducted, feathers, bull kelp (*Nereocystis luetkeana*), and body parts of various crab species were retrieved from the seine net. There were multiple children that showed interest and expressed their excitement in participating in this event despite the rain conditions that were occurring, potentially future biologists in the making.

Benefits

The project contributes to the baseline water quality data project and collects biodiversity data to further illustrate the aquatic ecosystem in the Gorge. The goal of the beach seining survey is to identify aquatic species present in the Gorge Creek estuary. This information will be used to create an aquatic species macrofauna inventory of the Gorge Creek estuary and allow the public to better visualize this special aquatic ecosystem.

Recommendation

For further studies of the aquatic population in the Gorge Waterways, it is recommended that additional beach seines be conducted more frequently to better understand spatial and temporal changes in the ecosystem. By conducting more beach seines throughout the year, we could document seasonal changes in aquatic species and better understand local migration, spawning and seasonal fluctuations. By collecting samples at a range of tide heights and at various times of the day we could expand our species inventory and learn more about the daily cycle of species activity. In the future after public events are allowed without social distancing practices it would be recommended to conduct beach seines that include the public. That way the public can physically see some of the species that are present around them and would help encourage further public support and engagement for GWAS.

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