The Effects of Water Levels and Temperature on Salmon Count in Brothers Creek Watershed (2019)

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Wild Pacific salmon are a keystone species that return annually from the ocean to local rivers and streams to spawn, recycle nutrients and provide nutrient-dense food sources to all parts of the ecosystem. Over recent years, studies have shown continuous declines in the number of salmon returning to local rivers and streams. If this decline continues, other wildlife species and habitats, as well as communities will suffer. Therefore, this experiment was conducted to determine the impacts of factors such as water/air temperature and environmental/man-made barriers on the number and type of returning salmon in Brothers Creek Watershed. Data was recorded throughout the 2019 salmon run in weekly reports provided by Streamkeepers, and any further needed information was found on government websites.

Introduction:

Salmon are ray-finned fish, native to tributaries of the North Atlantic and the Pacific Ocean, which have become a vital part of B.C.'s ecosystems and communities. Salmon are not only an essential source of a nutrient-rich food, which is consumed by 74 percent of all Canadians, but they are the biological foundation of rivers and creeks (Chowder, 2018). For years, salmon have supported rural communities and tribal cultures by creating more stable jobs, world-renowned fishing opportunities, and healthy food. The presence of salmon in a river also shows that the surroundings are fit and habitable. Furthermore, they play an essential role in the transport of nutrients such as nitrogen or phosphorus and the energy between freshwater environments, estuaries, and oceans (Pacific Salmon and Wildlife n.d.).

However, the number of salmon present in our communities is declining, and if the population continues to decrease or reach extinction, many other species would experience suffering populations, as more than 135 fish and wildlife species benefit from wild salmon and steelhead (Davis, 2017). The salmon's feces even acts as a natural fertilizer and provides nutrients for the environment when dragged onto land and left behind by predators such as bears. These leftovers can be broken down by rain or microbial activities, which makes the nutrients available for plants and trees to absorb.

Lastly, Salmon follow a specific lifecycle, which includes the yearly salmon run of returning to rivers for spawning. The annual salmon runs are usually in the colder months such as November and December (Substancedev, 2016). The cold, clean, and well-oxygenated water are vital to their initial survival. Unlike most freshwater fish, salmon move freely between the two environments of fresh and saltwater. They are able to do this because the salmon's brain sends hormones to its body so it can adjust to change into a saltwater environment during the molting stage. The fish spend as many as eight years of swimming in the ocean (Biology & Lifecycle). They then make an incredible upstream journey to spawn in the same places that they were hatched. The mature spawning females then scoop out a hollow, called a redd, in the gravel of the streambed and deposit on average between 2,500 and 3,000 eggs (Biology & Lifecycle, 2018). These eggs are then immediately fertilized by the male salmon and then covered over with gravel by the female to incubate the eggs over the winter. When the salmon first hatch from the eggs, they are still under the gravel, and they are called alevins. By the spring, these alevins have grown into fry, at which point they resemble miniature salmon. These fry then further develop into smolts, which migrate to the ocean where they grow into adults. This study focuses on water and air temperature, as well as land and human-made barriers impacting the number of salmon returns in Brothers Creek, West Vancouver. The data collection took place over seven weeks by an organization called Streamkeepers, during the 2019 salmon run. Streamkeepers was established in 2001 and consists of students and volunteers, who continuously collect data on the stream conditions and yearly salmon runs, by visiting specific creeks several times a week during the year's spawning season. There are 22 creeks and tributaries in the district of West Vancouver and approximately 180,000 cohos and chum fry are stocked in the local streams each year by the fish hatchery they manage (Directors and Officers). This report looks at and compares several graphs outlining the data found within the seven weeks in order to spot trends and outliers, as well as discuss what the findings mean for the returning salmon. It will further discuss possible sources of error and how exactly this study took place. It

is essential to assess factors impacting the number of returning salmon, as salmon are significant for both people and the environment. Looking at variables that affect salmon return can help with understanding the conditions salmon need to survive and spawn, as well as the cycles they follow. Lastly, it can provide more information on ways wild salmon can be protected to prevent a further decline in numbers.

Materials & Methods:

Methods

The data for this report was collected by the West Vancouver Streamkeeper Society over the course of an eight-week timeframe. The Streamkeepers surveyed the banks and streams of the following water-bodies located in West Vancouver, British Columbia: Hadden Creek, Macbeth Creek, Westcott Creek, Brothers Creek, and West Brothers Creek. Each of the five creeks were divided into numbered zones and assigned a group to survey them on a weekly basis. Throughout the fall of 2019, a total of 141 live salmon were recorded; 81 of which were chum and 60 were coho. The Streamkeeper surveying method utilizes the eyes of everyone within groups ranging in size from 4 to 14. Each member of the group is responsible for counting the number of Adult salmon in their zone and observing the conditions and events that take place from week to week. The qualitative and quantitative data observed on the weekly study are sent to the Streamkeeper statisticians who then add it to the overall data.

Materials

As stated before, this survey recorded the number of Adult salmon, but there is a measure of other factors that are assumed to affect the number of salmon counted each week and ultimately over the eight-week course of the survey. These factors include water temperature, water condition, weather, and air temperature. Throughout this study, all surveyors wore Streamkeeper vests to show that they were conducting a study on the creeks. Surveyors in low water level creeks used rubber boots and those in high water level creeks used boot foot waders. Each group member had a ski pole to provide balance in the creeks, which were a potentially hazardous environment. To record the temperature of both the air and water, each group leader used a thermometer. Whereas only eyesight was used to record the water conditions and weather from week to week. Should a surveyor spot a dead fish, the group supervisor would use a Stanley Knife to open the salmon up to determine the gender and to see if they had died post or pre-spawn. In addition, group leaders had a waterproof notebook to collect data. Lastly, all surveyors had UV-glasses to enhance the vision of salmon underwater.

Results:

This experiment was conducted in order to get a deeper understanding of the effects of water levels and temperature have on the amount of salmon returning to our local communities. Over the course of 7 weeks, data on the number of returning salmon, dead or alive, was collected by various Streamkeepers groups at different creeks located in West Vancouver, British Columbia, Canada. This took place in the fall of 2019, beginning around mid-October and ending early in December.

The data from the Streamkeeper's surveys show that not a single dead salmon was spotted up till week 2. As can be seen in Figure 1, a gradual increase in dead salmon began to occur for both the Chum and Coho species, especially Chum. Week 4 was when the dead salmon count for Chum peaked at roughly 13 and began to decline, while the number of Coho stayed on a steady increase. Mid-way through week 5, the number of dead Chum was surpassed by Coho. On the other hand, the reason for the number of dead Chinook being at 0 is that throughout the 7 week period, not a single Chinook was spotted, as shown in Figure 2.

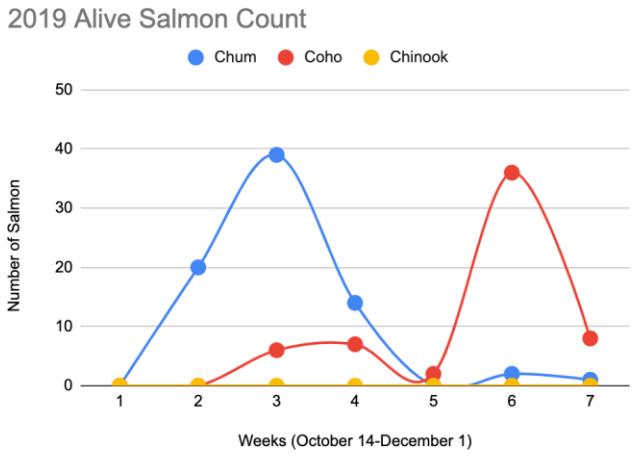

Figure 1

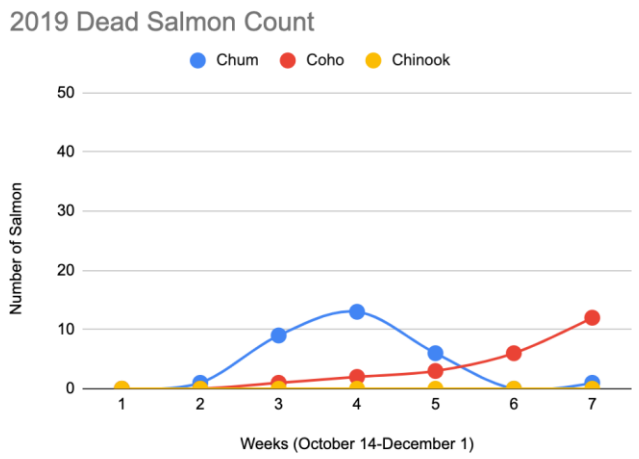

Figure 2

In correspondence to Figure 1, Figure 2 shows the number of live salmon counted. The first 2 weeks show a steep increase in Chum but a gradual one in Coho. At around week 3 however, the number of Chum began to dip significantly, while the number of Coho was just reaching its peak. By the end of week 4, almost no Coho or Chum were spotted, but by week 5, the number of Coho shot up while there were only a few Chum.

Looking closer at Figure 3, the water level of the Capilano was compared to the number of returning salmon in zone 1 of Brother's Creek. Throughout the month of October, despite all of the various water levels, not a single salmon was recorded. However, by the beginning of November, 2 salmon were spotted at the creek when the water level was approximately 2 meters high. As shown in the latter half of November, when the water level was at its highest, the number of salmon was also at its peak.

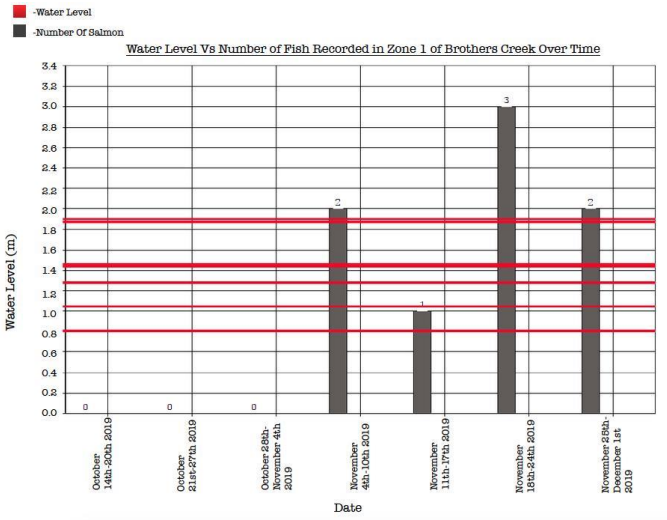

Figure 3

Discussion:

The results of this study suggest that all three variables: temperature, water level, and both man-made and natural barriers affect the number of salmon present in both Brothers Creek and Hadden Creek. However, each of the three main variables coexists and depend on other sub-variables. This is not only the case within the three selected variables this survey analyzed but additionally with an infinite number of external variables that lie outside the system of study. Such variables could be anything that comes into contact with a salmon during its life cycle: Fishing, disease, time, natural disasters, to name a few. Despite this, the three selected variables for this study were chosen with a considerable amount of foresight regarding their value and effect on the number of salmon present in both Brothers Creek and Hadden Creek.

The first of the three selected variables: temperature, is more of a dependent variable than an independent one. The temperature of a given watershed depends on an array of factors and is rarely consistent throughout even a small isolated part of a water body. This is proven in a previous study. The study determined that a given waterbody's (especially one with the flow like a stream or a river) temperature fluctuates over time: be it as large a time frame as a season or as minuscule as over the course of an hour or less. The temperature of a watershed also changes within a small area of proximity. The report continues to highlight an example where the water temperature of a side-channel is less variable than that of the main stem of the river (Steel, 2007). Reasons for temperature deviation within small proximity of water are tree canopies that can shield the water from direct sunlight in some areas and not others, thus decreasing and increasing the temperature of the water respectively. Precipitation (with a differing temperature to that of the water being studied) can cool or make the water warmer. With such a myriad of factors contributing to the temperatures of both Brothers Creek and Hadden Creek, this report cannot scientifically conclude whether or not the temperature of the water independently affects the number of salmon in Brothers Creek or Hadden creek, or whether the number of salmon depends on a combination of other or additional variables that were not specifically analyzed in this report.

Freshwater Salmon are immensely impacted by air temperatures. The leading element which controls the temperature of a river are natural environmental processes; the relative air temperature is directly correlated to changing water temperatures. Since the

early 20th century humans have impacted the earth's climate system primarily by burning fossil fuels. Fossil fuels have generated most of the energy used today in order to produce gasoline for cars, electricity in homes, and manufacture goods. Burning fossil fuels release carbon dioxide and greenhouse gasses, which trap heat in our atmosphere raising the earth's average surface temperature. As a result of rising air temperatures, many of the salmon hold in cool deep pools and will spawn later in the year when water temperatures lowered. Warmer water temperatures in habitats for cold-water species such as salmon can have negative effects. Biological effects on salmon include physiological pressure, a greater consumption of food, expanded weakness and exposure to disease and disruptions reproduction. As a result, salmon could be introduced to new development rates. The salmon egg development is heavily dependent on water temperature, increasing temperatures could cause juvenile salmon to enter the ocean before they are ready.

Turbidity can have a major impact on salmon. Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy or murky. Turbidity in river habitat is important to consider when counting salmon numbers. Turbidity can harm salmon by reducing food supplies available, degrading spawning grounds, and change the gill function. There have been multiple studies that investigated how human activity has increased erosion leading to increased turbidity in aquatic systems. Deforestation or logging is a large human impact on erosion. Removal of vegetation leaves the soil openly exposed to rain and wind which causes it to erode. Without soil, the land is almost desertified. The soil which was eroded from the land, along with pesticides and fertilizers get washed into the rivers and waterways inhabited by salmon. The Turbidity of the water is caused directly from erosion. Additionally, high turbidity can be related to the salmon count. Low numbers of salmon seen in a river could potentially be related to turbidity; if the salmon are in hiding deep pools and the water is very turbid it can be very challenging to spot them. Quantitatively measuring the turbidity of a salmon habitat with an accurate instrument is very important for determining the well-being of the environment.

For a future study, it would be beneficial to record more details regarding the location of where the temperature is being taken. Doing this would allow the study to conclusively state whether the temperature in isolation of all other variables affects the number of salmon in a watershed or whether the temperature is merely an easily measurable figurehead that fronts an assortment of more pressing variables, which more significantly impact the number of salmon more in a watershed. Ultimately, despite this report lacking precision regarding what else may be contributing to the number of salmon present in both the Brothers Creek and Hadden Creek watersheds, prior studies have proven that salmon and other fish react to temperature behaviorally and psychologically. A previous report found that salmon's behavioral reactions to water temperature stem from their cold-bloodedness. Salmon responds to uncomfortable water temperatures by moving from one location to another to maintain thermal comfort (Sauter, McMillan, Dunham, 2001). With this considered, it is decided that salmon do actively respond to temperature, in fact, they must respond simply to stay alive. But monitoring salmon's response to temperature in a lab is far different and less complex than monitoring a salmon's response to temperature in a natural environment. It is difficult to determine whether or not the number of fish in Brothers Creek and Hadden Creek is primarily due to water temperature or to a combination of other environmental variables, such as the other two main variables observed in this report along with the almost infinite number of additional sub-variables. However, water temperature is a controlling factor for all biological and ecological entities, and has been shown to pose a strong influence on salmon's behavior; thus it is possible to hypothesize the following: If the temperature of the water of Brothers Creek and Hadden Creek is within the given range of comfort for salmon, then the number of salmon present in the two water-sheds will increase.

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