Biodiversity of Aquatic Insects in Relation to Canopy Cover

A Bridal Veil Living Classroom Project
Telluride Institute's Watershed Education Project

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Abstract

The purpose of this study is to recognize the differences in the biodiversity of aquatic insects at two different elevations where canopy cover is significantly different. This experiment was conducted in Bridal Veil Basin near Telluride, Colorado in August of 2007. The project was done by collecting insects from each site, then counting, sorting, and labeling them. Other measurements in pH, conductivity, temperature, streamflow, substrate, and detritus were taken as well to provide support for the differences regarding the biodiversity index. One key component was canopy cover. The amount of vegetation along the stream banks relatively affects the richness and diversity among the aquatic insects. It was concluded that the lower site had a larger biodiversity index of aquatic insects than the site 1,400 feet higher, primarily due to increased canopy cover.

Introduction

The Bridal Veil Basin, near Telluride, Colorado, has an immense water supply, but extensive research exploring the quality of Bridal Veil Creek does not exist. The Town of Telluride plans on using the creek (and its drainage basin) as an additional water supply, so more information is being collected. The Telluride Institute has created a program called the Bridal Veil Living Classroom where research is being conducted based not only around the creek, but also on vegetation, climate, impacts, and animals in Bridal Veil Basin. This new program has jumpstarted the process of investigating Telluride's backyard. As the large amount of water produced is one of Bridal Veil Basin's biggest assets, it is necessary to obtain water-related data that can be stored and revisited for future analysis.

The purpose for this project is to understand, more in depth, the biodiversity of aquatic insects, as well as the water chemistry, in the Bridal Veil Creek. This information can be used to compare other sites or the quality of the creek in years to come, for the existence, activity, and conditions of the aquatic insects within a stream serves as a good reference to the health of the creek. Not only is this captivating information, it is the start of a scientific study that can be updated over the years and can eventually turn into consistent information that can help us understand our changing environment and determine the impacts that it will have on these precious habitats such as the Bridal Veil Basin, as well as other of the magnificent basins that surround the Telluride Area. Comparing the biological diversity of aquatic insects at 12,000 feet and 10,600 feet allows one to see the effect a draining mine adit has on the insects at 12,000 feet, as well as the change in the climate, altitude, and canopy cover.

This project predicts that there would be a greater biodiversity of aquatic insects at 10,600 feet than at 12,000 feet because there is more canopy cover at the lower elevation which provides detritus as a food source for the aquatic insects, causing them to be more abundant.

Site Description

The Bridal Veil Creek study location consists of two sample sites within the basin, which is a glacial valley that experiences large amounts of snow in the winter and unlimited wildflowers in the summer. The lower site rests at 10,600 feet. This area is surrounded by tall Sub-alpine Fir and Engelmann Spruce trees, as well as tall shrubs, plants, and flowers that grow big and untamed in the fertile soil. The upper site of Bridal Veil Creek lies at 12,000 feet. This sample site is above tree line. Sedges and wildflowers roll across hills, creating a colorful, green carpet. Willows are also present here, lining the sides of an old rocky "road" that enduring hikers travel upon.

The Bridal Veil Basin is a wet basin, due to several seeps and wetlands that occur here. There is also a large amount of snowmelt that runs down the steep sides of the basin. Glacial tarns can be found here, as well as a rock glacier at the higher altitudes. Several fresh-water lakes also exist at greater elevations, nestled in large rolling hills and peaks that all head towards the creek that runs down the center of this glacial valley. Avalanche paths are visible in this basin, as dead trees and less thriving wildflowers represent the paths.

Methods

Data collection began with the higher site in Bridal Veil Basin during the first week of August in 2007. Here the conductivity, pH, and temperature were measured with a Hannah Water Quality Meter. Then, a measuring tape was suspended above the creek and the width of the creek was taken. The discharge and stream flow data was calculated using a Marsh McBirney flow meter. Twenty measurements were taken along the creek's cross-section, allowing a time of 30 seconds per measurement to collect the stream flow value. After this data was measured and recorded, the insects were then collected. Using a D-frame net, three "kicks", or samples, were taken diagonally across the creek (the first starting farther down the creek and working up the creek with each kick). The net was held, touching the bottom, just downstream of an area that had rocks large enough to pick up and scrub. For thirty seconds, rocks directly in front of the net were picked up and scrubbed all over, allowing any insects or detritus to flow into the net. The net was emptied into a container filled with the stream water. The other two "kicks" were completed and emptied into the same bin.

Forceps were used to search the collection container for any insects or detritus. Detritus was placed in a dry container, while the insects were placed into a small container also filled with stream water. The time to collect both the detritus and the insects out of the largest container was not measured, for the objective was to collect as much detritus and insects as possible within those three "kicks". Once the sorting was done, insects of the same kind were grouped and counted, then put into jars with 70% alcohol. Labels were made that included the number of insects, the type if known a short description of the insect, the site (UBVC was for the higher site, LBVC for the lower), the time, and date. The detritus was put into a plastic bag with the label of the site, time, and date.

The order of operations for the lower site is analogous to that of the upper site, except that the stream flow and discharge was not taken for the lower site because the flow meter failed to work.

Then, the detritus was set out to dry on a paper plate, each site on a separate plate. Once the detritus was dry, the contents were put back into each bag and weighed. The weight was written on each bag, and then an empty bag of the same sort was weighed (tare weight). The weight of the bag was subtracted from the first weight to get the true weight of the detritus. The biodiversity of each site was then calculated using the Shannon Wiener biodiversity index equation:

$$H = -\sum_{i=1}^{s} p_i \ln p_i$$

The unknown insects were then sent to an aquatic entomologist to be identified. Canopy cover and substrate was estimated using a River Watch substrate data sheet. All information was recorded and put into Excel spreadsheets where the data was stored.

There was also a small acid mine drainage about 50 yards above UBVC where the pH, conductivity, and temperature were taken. This part of the creek consisted of ferricrete, a depositional layer of oxidized iron, which caused the substrate within the water to turn a rusty orange color.

Results

Both sites had similar streambed characteristics. They differed significantly in detritus weight, biodiversity, and amount of insects collected. They were, however, similar in their conductivity, pH, and temperature. The upper site was measured on August 7, 2007 and the lower site was measured on August 9, 2007.

Upper Bridal Veil Creek: At the higher site in Bridal Veil Basin, the conductivity, pH, and temperature was measured. The conductivity was 77, the pH was 7.2, and the temperature was 8 degrees Celsius (graph 1). The discharge was calculated and it equaled 18.91 cubic feet per second (cfs). The overall weight of the detritus for the higher site was 1.002 grams. The Shannon Weiner biodiversity index was 1.409. All of the insects were counted, identified, and recorded on an Excel chart (see chart). There were a total of 62 insects collected at this site, of eight different species. A River Watch Substrate data sheet was used to calculate the canopy cover of the stream bank, which was about 0.5 percent. This accounts for the minute amounts of free floating instream vegetation. The river has approximately 85% riffle, 5% pool, and 10% run. Here, the inorganic substrate was 20% boulder, 55% cobble, 22% gravel, and 3% sand. Less than one percent of the organic substrate composition was detritus. The average water depth was one foot, while the wet streambed width was 16 feet and the bank full width was about 20 to 25 feet. This site did not have any erosion, nor was it channelized.

Mine Drainage in Upper Bridal Veil Creek: This mine drainage which had an iron-laden streambed, had a conductivity of 104, a pH of 6.4, and a temperature of 5.5 degrees Celsius (graph 1).

Lower Bridal Veil Creek: The lower site of Bridal Veil Creek had a conductivity of 83, a pH of 7.6, and a temperature of 8.8 degrees Celsius (graph 1). The stream flow and discharge data was not taken due to an equipment error. The detritus weighed 4.12 grams. The Shannon Weiner biodiversity index of LBVC is 2.008. The TaxaId and total of insects can be seen on the Excel chart. The total number of insects collected was 107, with 10 different species existing at this site. Also using the substrate data sheet, the following was calculated. There is roughly 7% canopy cover along the stream of the bank. Willows and spruce trees dominate one side of the bank; mostly willows on the other. Attached algae is the most common type of instream vegetation and approximately 80% of the river is riffle, 11% run, and 9% pool within fifty meters above and below the site. Meanwhile, the inorganic substrate consists of 30% boulder, 60% cobble, 9% gravel, and 1% sand; there is 2% detritus within the organic substrate category. The average stream depth is one foot, the wet streambed width is 20 feet, and the bank full width is 25 feet.

Water Chemistry and Biological Distribution							
Sample Site	**Temp *C**	**pH**	**uS in tenths**	**Biodiversity Index**	**Detritus Weight g**	**Total Insect Count**	**Specie Count**
Upper BVC	8	7.24	7.7	1.409	1.0020	62	8
Lower BVC	8.8	7.64	8.3	2.008	4.1200	107	10
Mine Drainage in Upper BVC	5.5	6.38	10.4	n/a	n/a	n/a	n/a

Conclusion/ Discussion

The hypothesis was proven correct by the contrasting biodiversity index numbers of both the upper and lower sites at Bridal Veil Creek. The biodiversity at LBVC was 2.008, compared to UBVC's 1.409. The higher site shows to have a biodiversity index only of only 70.2 percent of the higher site. These numbers represent the biodiversity of aquatic insects within each part of the creek. The higher the number, the more diverse the aquatic insects are.

It was noticed that the conductivity, pH, and temperatures did not vary much between the higher and lower sites, so the difference in the biodiversity cannot be blamed on these factors. Even with a ferricrete-laden mine drainage directly above the upper site, the water chemistry did not differ substantially from that of the lower site. This shows that the iron in the water at the higher site was not the reason there was a lower biodiversity of insects.

The differences in the detritus weights can explain the discrepancy of insect diversity among sites. The lower site's detritus weight was 411% more than the higher site. Because detritus is dead organic matter that flows within the creek, the insects within the stream are provided with food. This significant difference shows that insects

are more prosperous when more detritus exists. Because detritus mainly consists of fallen twigs and leaves, it cannot amount to much without canopy cover along the creek.

Conditions allowing for more dense vegetation surrounding the creek include a warmer air temperature and less severe climatic conditions than the higher alpine site. At the lower site, a thicker canopy cover is more likely to grow due to a more forgiving climate. Although, at UBVC, there appeared to be a fair amount of detritus, it was only sedges and grass pieces, whereas, at LBVC, the detritus consisted of twigs and bark, which proved to be more substantial, weighing four times as much as that of UBVC. It can be said that a comparable creek with a greater amount of canopy cover will have a greater biodiversity of aquatic insects.

This project shows how important canopy cover can be to the health of aquatic insect populations, which also illustrates how healthy, overall, a stream is. If insects are able to thrive within a creek, the properties within the creek must be balanced and within the insect's range of tolerance. More diverse species creates a greater population of insects, which allows the insects to withstand more changes in the environment. By monitoring aquatic insects in the future, the creek's health can be tracked and any changes within it will be noticed. It can be recognized that as a stream bank changes, such as when de-vegetation and erosion take place due to new land use practices, the apparent aquatic insect population will fluctuate.

A suggestion for a further study would be to examine the tolerance values for the species that exist in Bridal Veil Basin, as well as which species are more vulnerable to environmental changes. It can be observed that a species that was extremely rich was the caddisfly (*Trichoptera)*. This species is normally found in rather healthy creeks, so this shows that this unique species has a decently large range of tolerance. It also shows that the upper Bridal Veil Creek site is considerably healthy, even with the mine drainage upstream. Another possibility for future experiments would be the comparison of LBVC's biodiversity to an area at the same elevation where devegetation, mining, or channalization has occurred. It would be interesting to see how factors such as these would affect the aquatic insects within the stream.

This experiment ran extremely smooth. All information that was needed was taken, and the time for the in-field work was minimal.

Overall, this study concludes that due to the increased amount of canopy cover, there is a greater biodiversity of aquatic insects at 10,600 feet than at 12,000 feet.

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