

Comparing Levels of Aquatic Insect Populations and Detritus Levels in Relation to Elevation

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Abstract:

This study was an attempt to further Sarah Carlson's research from a small high altitude mountain stream in Southwestern Colorado, and compare detritus levels and aquatic insects populations by testing on a small low elevation river on the East Coast. This research analyzes whether there is a relationship between the population of aquatic insects and the amounts of stream detritus. The prediction was that there would have been higher levels of in New Hampshire detritus because of the low wet environment, and therefore higher levels of benthic insects. The Exeter River a small river in Exeter, NH, was tested in August of 2009. A total of 37 bugs and 10 families were found when three "kicks" were taken. This resulted in much lower insect and detritus levels than Carlson had recorded in the Telluride region in Colorado in 2007. It was recorded that at her upper alpine site had less canopy cover and less detritus levels, and therefore less of an insect population than the lower site, which had the highest of all of the detritus and insect population count and diversity. This demonstrated that the experiment conducted was proven incorrect, but the hypothesis formulated was proven correct because of the relationship between insects and detritus levels (more detritus, more insects, less detritus, less insects).

Intro:

Detritus is a key controlling factor in the determining aquatic insect population health. Detritus is nonliving decaying or disintegrating organic matter. Some studies done have proven that higher levels of aquatic detritus result in more aquatic insects, considering the detritus is the only food source for many aquatic insects including "shredders." Shredders are benthic macro invertebrates that consume dead plants, algae and rooted aquatic plants, leaves, and grasses. They break down organic materials into finer materials for consumption- *Mountain Stream Insects of Colorado*. Many environmental factors influence the growth and depreciation of

detritus levels. Some controlling factors include temperature, discharge, current, substrate, and vegetation in and around the stream.

In the Telluride area, in the Southwest corner of Colorado, the diversity of benthic insects has been high in healthy stream systems not affected by heavy metal contents from the rich mining history of the area. The pristine mountain valleys of Colorado have had ideal insect habitats considering the Telluride snowmelt provides clean water and high levels of dissolved oxygen (DO). These high levels of DO are a result of big mountain streams causing turbulence, and cold snowmelt water. The water insects rely on DO to receive oxygen to breathe.

In 2007 a student of Telluride Institute's Bridal Veil Living Classroom (BVLC), Sarah Carlson, conducted a research project in the upper Bridal Veil Creek, in Bridal Veil Basin in Telluride, Colorado. Sarah Carlson's experiment compared two different elevation areas on Bridal Veil Creek. She tested both of these areas for aquatic insects, and for detritus levels. She found that with a more abundant canopy cover, in a lower elevation site, the amount of detritus and the population of the aquatic insects were significantly greater.

In agreement with Carlson's results, the following study predicts that in the lower elevation state of New Hampshire, there will be higher amounts of detritus and greater diversity of aquatic insects. It is presumed that the lower elevation Exeter River area in NH, will have higher air temperatures at lower elevations resulting in more canopy cover, thus resulting in higher food levels (detritus) for stream insects which all together will result in higher population and biodiversity of aquatic macro invertebrates.

Site Description:

The sample area of the previous experiment conducted in 2007 consisted of two sites in the Bridal Veil Basin near Telluride, a small town in the southwest region of Colorado. The small creek is mostly a result of snowmelt paths. The glacial valley experiences mass amounts of snowfall in the winter and beautiful vegetation and wild flowers in the summer season. The lower site of Carlson's experiment lies at 10,600 FT and is surrounded by tall Sub-Alpine Fir and Engelmann Spruce trees as well as tall shrubs, plants, and flowers. The upper site however rests at 12,000 FT. This sample site is above tree line and instead of trees dominating most of the area; there are mostly wild flowers and grasses. The first sample site's

stream width was approximately 6.10 meters and the lower site's creek bed had a width of 7.62 meters.

Bridal Veil Basin is a damp basin considering there are several seeps and wetlands caused from mainly the runoff of the snowmelt and rain. Many larger bodies of fresh-water are located at high elevations and flow to the valley forming Bridal Veil Creek. Avalanche paths are visible throughout the valley, sometimes containing human made footpaths and an access road ascends hills of the basin.

The second part of the experiment was conducted in the Exeter River in Exeter New Hampshire. Exeter is a small city located about 40 miles from the ocean, and is located about 33 ft above sea level. The sample site on the Exeter River had a constant cobble substrate and had a small bridge that ran over the section of river. The river section which was sampled had a decent canopy cover consisting of small shrubs, flowering plants, grasses, birch trees and other lowland tree species. Just downstream from the sample site the river flows into a larger pond. The width of the River before it flows into a larger pond is approximately 14.5 meters. Exeter is surrounded by lush seacoast forest dispersed between large summer and residential homes.

Methods:

Data collection for the sampling event on the Exeter River on August 22nd 2009 attempted to precisely duplicate Sarah Carlson's field methodology in 2007 from Bridal Veil Creek (Carlson, 2007). Using personal observation and local interviews, a stream similar to Bridal Veil Creek was located in New Hampshire. Once the streambed was located, the temperature and width of the river were taken. A measuring tape suspended over the river was used to measure the width of the river. It was required that a canopy of vegetation such as trees or bushes surrounded the stretch of running water located.

After the temperature and the width of the river of the stream were collected, the detritus and insect samples were then collected. Three "kicks" were taken diagonally up the river, starting below first so not to disturb other test areas further up the river. The D-frame net was held on the bottom of the riverbed just below an area of stream that has rocks large enough to pick up and rub or scrape (2.5-10 inches which is considered cobble). The rocks were scraped directly in front of the net for thirty seconds, and then the net was removed from the water. This scrubbing allowed the detritus and any aquatic insects in the flowing creek to be collected into the D-Frame net. After this sample was taken, the materials collected were dumped into a large bin containing river water.

Two more “kicks” were taken diagonally up stream from “kick” number one, and the results collected were emptied into the same bin along with “kick” number one.

After all three “kicks” were taken; the insects were separated from the detritus. Then, the detritus was emptied into a dry bin, and the insects, whether living or dead, were emptied into another bin filled with stream water. Once detritus and insects were separated, the same kinds of insects were put together with insects of their type. One or more of each type of insect was put in a jar with 70% alcohol, causing preservation. Each jar filled with an insect required a label stating how many of this specimen were found, where they were found, if the kind of insect is known, and the time and date. The detritus was also put into a bag labeled with the time, date and site.

The detritus was then dried in an oven for two hours at 66 degrees (C). It was made sure that the detritus was not left to burn. After the detritus was dry, the sample was weighed in a bag. Then, the weight of the bag was subtracted from the total weight of the detritus. The weight was written on the bag, resulting in a sample comparable to Sarah Carlson’s research from 2007. The insects were then sent to be identified, and were also compared to Carlson’s results.

Chester Anderson, a Colorado area entomologist helps identify the unknown insects. This information was entered into information sheets where the data was kept. Then, the Shannon-Weiner Bio Diversity Index was calculated using the equation:

$$H = \sum p_i (\ln p_i)$$

Results:

Water Temperature, the width of the river, elevation, aquatic insects and detritus were all recorded on the test day, August 22nd 2009, in Exeter, New Hampshire located 33 feet above sea level. These results were then compared to Sarah Carlson's results from 2007. The temperature of the Exeter River was 25 degrees (C), at 11:00am and the river width at the study site was 14.5 meters. There were five families of aquatic insects recorded (see chart below) there were a total of 37 individual insects collected. The detritus was then weighed totaling .462 grams. The Shannon Weiner Biodiversity Index was calculated and 1.098 was the result. These results were then compared to Carlson's results from 2007 in Bridal Veil Basin.

Sarah Carlson had two sites in Bridal Veil Basin. Site one was located at 12,000 feet in Upper Bridal Veil Creek and the water temperature was 8 degrees (C) and the width of the riverbank was 4.9 meters. The weight of Carlson's collected detritus samples was 1.002 grams. She collected a total of 62 insects from 8 families and her biodiversity index was 1.409. Carlson had a second site located at Lower Bridal Veil Creek 10,600 feet above sea level, and the water temperature was 8.8 (C). The width of the river was recorded at 6.1 meters. Her detritus samples were weighed in at 4.12 grams, and she had a total of 107 insects collected. Her Shannon Weiner the biodiversity index was 2.008.

| Sample Site | Width (m) | Elevation (ft) | Flow (cfs) | Detritus (g) | Species Count | Total Insects | Temperature Degrees (C) | Biodiversity Index |
|--------------|-----------|----------------|------------|--------------|---------------|---------------|-------------------------|--------------------|
| Exeter River | 14.5 | 33 | 60 | .462 | 5 | 37 | 25 | 1.098 |
| UBVC | 10.1 | 12,000 | 35 | 1.002 | 8 | 62 | 8 | 1.409 |
| LBVC | 6.1 | 10,600 | 35 | 4.12 | 10 | 107 | 8.8 | 2.008 |

The temperature of the water in NH compared to the temperature of the water in Bridal Veil Basin was considerably higher. The discharge and current of the stream varied greatly from the Exeter River to Bridal Veil

Creek (BVC). BVC had an average summer flow of 35 cfs, while the Exeter River had an average summer flow of approximately 61 cfs. BVC is a small fast moving mountain stream while the Exeter River is a larger, slower flowing stream. The substrates of the two rivers were strangely similar (a cobble stone substrate {2.5-10 inch rocks}). Considering the location of both sites, the vegetation of both sites was quite abundant. Barely any areas in the Bridal Veil Basin are developed and the Exeter River site is right in the city of Exeter, NH. In comparison, the Lower Bridal Veil site had more vegetation than the NH site and the Upper Bridal Veil site. The Upper site was above tree-line, so in result there was not much canopy cover.

Discussion:

Carlson's 2007 study's hypothesis was proven correct by comparing the two Shannon Weiner Biodiversity index numbers at the two sites on Bridal Veil Creek (UBVC and LBVC). Her first site, UBVC, had a biodiversity Index of 1.409, while the LBVC site had a biodiversity index of 2.008. The higher the bidiv number, the more diverse the aquatic insects are. The temperature of the two sites did not vary substantially, so therefore the temperature cannot be the blame for the different biodiversity numbers. On the other hand, the two sites varied immensely in detritus weight. The LBVC had a much heavier weight of detritus, while the UBVC

had much lower levels; the lower site was more than 411% more than the upper site. This shows that the more detritus, the more insects there will be. The two different vegetation levels at the two different sites can explain this conclusion. UBVC was limited in vegetation other than short grasses and flowering plants, while the lower site had tall trees, shrubs and vegetation along the bank-side.

The recent study in the Exeter River attempted to use Carlson's findings to further test the relationship between detritus weight and aquatic insect biodiversity, using the Shannon Weiner equation. The prediction was that there would be higher levels of detritus due to the warmer temperatures of air and water, the wetter land, and the lower elevation in an East Coast location. As stated in the hypothesis, the temperature was substantially higher, but, as the study continued, it was found that there were lower amounts of detritus and insects. The detritus weighed in at .462 grams from the NH site, which was 53.9% lower than the UBVC detritus level and 88.8% lower than the LBVC detritus level. The biodiversity index of the Exeter River was 1.098. This would have proved the hypothesis wrong, if the problem was not investigated further.

The detritus levels were substantially lower than the samples obtained in the Bridal Veil Basin. Some of the reasons for this may be the

width of the rivers. This may have caused the detritus levels to be more spread across the river versus in Bridal Veil Basin, the creek being narrower, where the detritus would have been more concentrated and yet only 3 kicks were taken in BVC. Another reason could be the location of the two rivers. Although the Exeter River is surrounded by forest, the section of river at the study site has less canopy cover considering it was located in the town of Exeter itself. Even though there wasn't much canopy cover in the town of Exeter, there could have been even more detritus than the Telluride sites. This is considering there could be a higher canopy cover, and a wider river verses less amounts of canopy cover and a narrow river. Another reason for these lower levels of detritus could be from the higher temperature in New Hampshire. The higher the temperature the more microbial activity that breaks down detritus.

Considering the detritus levels were so low, this may be a result to why the insect levels were so low as well. Exeter River insect results were 40.3% lower than UBVC and 65.5% less than LBVC. Reasons for this disparity may include above mentioned lower detritus weight (or decreased food source), poor water quality (not measured), increased fish population, and the amount of dissolved oxygen (DO). The water quality, as far as pollution goes, is unknown in the scope of this study for the Exeter area; it is probable that there is more pollution in the Exeter River because there is civilization around the river area. In the Bridal Veil Creek area on the other

hand, there are no developed areas above the study sites, likely causing a cleaner and overall better habitat for the aquatic insects. The next reason could be more fish. The New England area is one of the most popular for fishing in the nation, which means that the New Hampshire waters are more populated with fish than the Bridal Veil Basin waters. There has never been any fish activity recorded in Bridal Veil Creek. One more reason that there would be less benthic macro invertebrates could be the levels of dissolved oxygen (DO). The amount of DO is higher in colder and more turbulent streams; these less turbulent and warmer streams of the east coast therefore would have lower levels of DO. Aquatic insects require DO to obtain oxygen, so the bugs enjoy higher elevation for more oxygen.

This study could have been controlled in a more efficient way than was completed. One major thing that could have been improved on was the choice of river. The reason for this is that the Bridal Veil Creek has an average cfs of 35, and an average width of 6.1 meters. The Exeter River on the other hand had a width of 14.5 meters, more than twice of Bridal Veil Creek. The Exeter River also had cubic feet per second flowage of about 60 cfs. This may have thrown off my result considering some insects may not live in wide un-turbulent waters. Another control that could have been taken into further consideration is the water quality, or documenting the pollution even though you may find that every river in the New England

region is going to be more polluted considering the locations of each river approach industrial or municipal boundaries. As stated above, the water quality of the Exeter River was unknown and it was quite probable that the region was more polluted.

Even though the experiment was proven incorrect, the hypothesis was concluded partially correct. The relationship between the levels of detritus and the population of the insects were proven correct because the amount of benthic insects depends on the amount of detritus considering the detritus is a food supply for the macro invertebrates. In conclusion, my experiment was proven incorrect because despite higher temperature and more dense canopy cover in the East, the ultimate detritus and insect levels were lower than Carlson's results from Bridal Veil Basin in 2007.

Works Cited

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