Stream Water Data Summary

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Data was gathered over four days across sections of a stream running adjacent to the four predetermined microclimates utilized by E.S.S.R.E. 2018. Stream test sites were renamed according to their positions along the course of the stream, with Site 1 located furthest upstream. In each site, water from four separate locations, each five meters downstream of the last, was tested for various factors. Location A data from each of the four sites was collected on July 18th, 2018, followed by Location B data on July 19th, 2018, and Location C data on July 20th, 2018, and Location D data on July 23rd, 2018. All data was t-tested for any statistical difference between the locations sampled.

When analyzing the data collected, it was observed that the pH values calculated in Site 3 on the last day did not demonstrate the expected results. Sites 1, 2, and 4 showed roughly the same pH levels over the first three days of testing until the fourth day, after a major rainfall. After a weekend of rain the pH levels in these three sites all dropped 0.5 since their last testing, which is expected given the amount of rainfall that occured. However, there was no pH drop in Site 3. On the last day of testing, pH values in Site 3 stayed consistent with the values recorded before the rainfall. It is possible that the preservation of neutral pH values in Site 3 is due to a neutralizing factor such as a metal object in the water. Site 3 Location D serves as a junction of two streams. Along one stream are Sites 1, 2, and 3. The other, if followed upstream, leads to a tunnel acting as an underpass for the water, as well as various debris. Due to the unique position of Location D, water from both streams meet at the water testing location. Although the rainfall between July 20th and July 23rd would presumably lower stream pH, it is possible that said rainfall also stimulated the release of nutrients from debris, including metal debris, found upstream of Location D. Nutrient runoff from upstream could have introduced a neutralizing factor into the water in Location D, explaining the consistency between pre-rainfall and post-rainfall pH readings in Site 3.

The relationship between the dissolved oxygen (D.O.) levels and water temperature also showed some unexpected results. In comparison to the data collected in 2017, Sites 1, 2, and 3 all show the expected relationship between dissolved oxygen and temperature. The data collected in 2017 showed the expected trend of a higher temperature leading to lower D.O. values. The data collected this year, 2018, shows that the inverse of this is true: lower temperatures lead to higher D.O. levels. This is demonstrated in all sites except Site 4, in which the D.O. levels are lower than expected. While the average D.O. value collected in Site 4 in 2018 was the highest D.O. value collected in 2018, it is still less than the average D.O. value collected in Site 4 in 2017. This might be because the average D.O. level in Site 4 in 2017 seems to be an outlier, with contributory values almost double the values in other sites. The stat map from 2017 supports this because it shows no significant difference between Site 3 and Site 4, indicating there is most likely an outlier in the Site 4 data that pushes up the average. When looking at the data there is a clear outlier in Site 4 of 25, almost four times the values calculated in all other samples. However, due to the small number of data collections, it remains uncertain whether or not Site 4's 2017 D.O. values represent a deviation from normal Site 4 dissolved oxygen levels. If the data collected in Site 4 was not an outlier, it is possible that there is an unknown factor in Site 4 that either contributed to the increase of D.O. levels in 2017 or to the decrease of D.O. levels in 2018.

The results of the t-test for D.O. in 2018 showed there was a significant difference between Site 3 and Site 4 ($p=0.184$). However, there was no statistically significant temperature change found between the two, which contradicts the expected result. Because there is an inverse relationship between D.O. and temperature, the D.O. levels would be expected to decrease as temperature rises and vice versa. In 2017, there was a significant difference found in the temperature between Sites 3 and 4 ($p=0.178$) but there was no significant difference of D.O. levels between the two sites. Therefore, in both years there must have been an outside factor influencing the temperature and the D.O. levels. It is possible that the difference between D.O. levels in Site 3 and Site 4 in 2018 is due to the amount of sunlight each site receives. Site 3 has much more tree coverage than Site 4, allowing Site 4 to receive more sunlight. This could cause more algae growth in Site 4, which could contribute to the increase of D.O. levels and the difference between Site 3 and Site 4.

Levels of NO_3- observed this year in comparison to last year also show interesting trends. In 2017, NO_3- levels seemed to fluctuate slightly but with no great difference from site to site. In 2018, the calculated NO_3- values steadily increased from Site 1 to Site 4. One possible explanation for this increase is nitrate runoff from nearby gardens. Site 2, Site 3, and Site 4 are adjacent to many residential homes with many yards and gardens. It is possible that fertilizer from the gardens and yards was washed into the stream, increasing the nitrate levels as it travels downstream. However, after analyzing the data from each site in 2018, there is a significant drop in nitrate levels after a major rainfall, indicating that this might not be the case. A possibility for the significant drop could simply be a lower concentration of nitrate because of a higher amount of water being introduced into the stream. There is also the possibility that any matter that was being decomposed and releasing nitrates into the water got washed away by the rain, and therefore not only is less nitrate being released but remaining nitrate may have gotten washed downstream.

The fluctuating coliform counts between sites also show noteworthy trends. Sites 1, 2, and 3, all had decreasing values of coliform counts over the course of the first three days of testing. After a rainfall, the coliform counts in all of those three sites spiked. This is to be expected as the rain would have washed any animal feces into the stream. However Site 4 does not demonstrate this trend. Coliform counts in Site 4 greatly fluctuate over the course of the four days of testing with no spike on the fourth day, after the rain. The constant fluctuation can be explained simply by an animal defecating in or near the stream before the test was carried out. Yet the low coliform count on the last day of testing is still a mystery. Keeping consistent with the trends of the other three sites, the coliform count in Site 4 was expected to spike after the rainfall, but it did not. It could be understandable if the coliform count was significantly higher, rather than lower, because Site 4 is located downstream from a concrete tunnel that serves as a possible underpass for polluted water. Yet the opposite is true. Thus, with only the limited amount of data collected, there is not enough information to make an educated guess about the cause of this anomaly.

Statistical analysis of $CaCo_3$ levels showed a significant difference between Site 1 and Site 2 (p=0.117) and Site 1 and Site 4 (p=0.134). This difference has been examined and explained in the 2017 Stream Water Data Summary, and the same trends are seen in the 2018 data. As determined in 2017, a likely cause of the higher calcium carbonate levels in Site 1 is the presence of limestone in the stream bed. However, p-values shown between Site 1 and the other sites in 2017 were notably lower than those of 2018: p=0.057 between Sites 1 and 2; p=0.047 between Sites 1 and 3.

The continuation of last year's water testing allowed the 2018 E.S.S.R.E. teaching assistants to further investigate stream ecology, contributing to a larger understanding of the unique relationships and properties of the Backwoods portion of the Roland Park Country School stream. Based on the trends of the data gathered over these subsequent years, future teaching assistants may begin to research and solve the anomalies that have appeared thus far. One possible area of further study is algae populations in the stream. Algae are impacted by decomposition, dissolved oxygen, and the availability of many nutrients; an examination of the health of algae populations may shed more light on the causes and effects of changing stream compositions.