ENV3040C - Course Project

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There are numerous studies that show the negative impacts of heavy metals in aquatic ecosystems. Mercury (Hg), a heavy metal, can be polluted into the environment by power production by the combustion of coal, as an example. However, mercury can become methyl mercury (MeHg) when anaerobically digested by bacteria, which is significantly more toxic. This poses a serious issue for wetlands since the soil is oxygen deprived. The purpose of this project is to see the anthropogenic impacts on two types of algae in the Everglades. Due to human activity, methyl mercury, a toxin, is a pollutant in the Everglades. The EPA collected this data in 2014 and there are two datasets, one for the field analysis and the other for the lab analysis. This assessment will incorporate both data sets. The two types of algae being studied are benthic (lives on soil) and epiphyte (floats or attaches to macrophytes) periphyton. I hypothesize that epiphyte periphyton will be more impacted by methyl mercury compared to benthic periphyton, indicating a lower bulk density and less algae. In addition to the bulk density for both species, other variables that will be analyzed are the flow rate of the water, and the concentration of methyl mercury in the surface water, soil, sawgrass, benthic periphyton, and epiphyte periphyton. All these variables will correspond to the station at which the sample was collected.

Even though methyl mercury is highly toxic, some ecosystems develop a tolerance towards the metal. Pollution-Induced Tolerance Concept (PICT) suggests that certain species will develop a phenotype adaptation, creating a tolerance towards a toxin, including methyl mercury (Val, Jonaton, et al., 2016). From my hypothesis, I believe that the soil will have a higher concentration of methyl mercury compared to the surface water due to accumulation. Therefore, benthic periphyton will have a higher tolerance towards the toxin due to PICT, leading to a higher bulk density. It is important to note the impacts of methyl mercury on species. For humans, our primary risk of methyl mercury exposure stems from bioaccumulation. Algae will only contain a small fraction of the amount of mercury when compared to larger species, such as humans. This correlates to the food chain, as herbivore species will eat the producers, followed by predators eating the herbivores. A person who consumes fish regularly from the Everglades will accumulate large quantities of mercury over time, leading to brain issues such as muscle tremors and memory loss. For algae, a serious impact is cell impairment. Mercury and its compounds bind to cell enzymes, leading to oxidative stress and the cell membrane becomes compromised, causing cell loss (Beauvais-Flück, Rebecca, et al., 2018).

The data description did prove to be helpful. One thing that I did not consider when I originally selected this topic is that I did not realize that the benthic and epiphyte species were not present at each station. I was assuming that they were present at each station, hence, why the sample was taken. Only a portion of the samples with a periphyton species were present. To make it more complicated, there are an uneven amount of benthic and epiphyte samples, forcing me to create a data table for each species instead of using just one data table. Nevertheless, taking the mean of each data table shows a better representation, disregarding the frequency of samples. Based upon the mean, benthic periphyton’s bulk density is more than doubled that of epiphyte. This could help support my hypothesis that benthic periphyton may be able to tolerate methyl mercury better. It is important to note that in Figure 1, even though epiphyte was more present (higher frequencies), do not mean that the average bulk density was higher than benthic, as seen by the mean averages.

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*Figure 1*

On the other hand, the correlations calculated prove to be not as helpful as initially thought. The best correlation calculated was the Spearman Correlation Coefficient for benthic bulk density and the flow rate (0.232). It showed a slight similarity. To help prove my hypothesis, the Spearman Correlation Coefficient for benthic bulk density and methyl mercury in the soil should be around 0.5, not -0.311. Furthermore, for epiphyte, the bulk density and methyl mercury in the water should also be around 0.5, not 0.109. Figure 2 shows the scatter plot with linear regression for benthic bulk density and flow rate and epiphyte bulk density and the amount of methyl mercury in the water.

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*Figure 2*

Principal Component Analysis is a useful way to visualize a dataset with many variables. In essence, standardizes the variables then combines them into components. There can be multiple components in a PCA but the first two components (PC1 and PC2) should show the greatest correlation to the target that it is being correlated to. Ideally, PC1 and PC2 should equal to around 90 to 95%, meaning that those two components contributed to about 95% of the correlation. For this analysis, the PC1 and PC2 did not come close to the 90-95% range. For benthic, my PC1 and PC2 were about 35% and 26%, resulting in a total of 61%. For epiphyte, my PC1 and PC2 were about 38% and 26%, resulting in 64%. Altogether, my PCA for benthic and epiphyte bulk densities were not that convincing, which will be further discussed in the conclusion. For the PCA plot, there isn’t a clear distinction between the bulk density classes. Red, which indicates a lower bulk density, tended to be near the left half of both plots. Green, which is medium bulk density, tends to be more to the right, at least righter than red. High bulk density, which is blue, appears to be a lost cause for the benthic periphyton but at least it was grouped close for epiphyte periphyton. Figure 3 is the PCA plot for the benthic and epiphyte species.

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*Figure 3*

In conclusion, I would not support my hypothesis that benthic periphyton tolerates methyl mercury more than epiphyte periphyton. I do not see a true correlation between benthic bulk density and the amount of methyl mercury in the soil and I also do not see a correlation between epiphyte bulk density and the amount of methyl mercury in the water. If anything, the flow rate has a greater impact, which is rather surprising. With that said, there has to be limitations to my study. I believe that there has to be another variable that is more impactful to the bulk density of each species. On the data sheet, there were other variables that I did not include, such as the amount of ash in the water or the amount of phosphorous in the soil. Furthermore, there could have been even more variables that simply were not recorded by the EPA. In the future, I should use all of the variables to see which one will have the largest impact because as in this instance, maybe both species are resistant to the amount of methyl mercury in the water. What if they are lacking nutrients, but I assumed that they wouldn’t since the Everglades is fed water through sugar cane fields up north. Finally, there could be human error, either by me calculating results or by contamination from whoever took the samples.

All Other Figures

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Sources

“Influence of global change-related impacts on the mercury toxicity of freshwater algal communities.” Val, Jonaton, et al. Science of the Total Environment. Vol 510. Science Direct. 1 January 2016. <https://www.sciencedirect.com/science/article/pii/S0048969715301005?casa_token=NjYII_7b4P4AAAAA:ntd0DhBA2ySkhWRfYD99ebOenpIqp43H7RJ0LoAX-j62Kvt5R8WPPz8WXdrZ2p4PVR05kVVOcZo>

“Molecular Effects of Inorganic and Methyl Mercury in Aquatic Primary Producers: Comparing Impact to A Macrophyte and A Green Microalga in Controlled Conditions.” Beauvais-Flück, Rebecca, et al. Geosciences. 2018. <https://www.mdpi.com/2076-3263/8/11/393>