Slide 1: Ammonia and Phosphate in Algonquin Park

David: The concentrations of Ammonia and Phosphate in Algonquin Park's water system have been observed and analyzed over the past 20 years. We are here today to present our research on the gathered data. To begin, I would like to introduce our team: my name is _Walji and these are my colleagues, _ Patel, _ Peng, and _Wu.

David: We would like to thank everyone who was involved in making the AP20 trip possible, including Mr. van Bemmel and Ms. Hermanovsky, the other teachers of AP 20, seniors, parents and students of AP 20, and all those involved in previous expeditions.

Slide 2: Introduction

David: The two explanatory variables involved in this study are ammonia and phosphate. We will be covering the correlation between the two variables over the span of 12 years from AP 9 to AP 20.

Slide 3: Experiments

Slide 4: Procedure

Amy: Data for ammonia and phosphate was collected using water samples from various bodies of water in Algonquin Park. First, at each sample station, 5mL of water would be taken to fill 2 test tubes. 8 drops of ammonia 1 and 6 drops phosphate 1 were dropped into each test tube. After shaking each test tube for 15 seconds each, another 8 and 6 drops of ammonia 2 and phosphate 2 would be respectively dripped into the test tubes and shaken for another 15 seconds. Waiting times were 5 minutes for Ammonia and 3 minutes for phosphate and then they were compared to the PCE colour chart.

Slide 5: Calibrations

Slide 6: Sources of uncertainty

Amy: As we were observing the data, we found a few sources of uncertainty. While the theory of the experiment is sound, there is still some room for possible errors.
They mainly include the accuracy of the ammonia and phosphate dropper bottles and the system used to measure the concentration of the solutions. __________. Not to mention, the method the system uses to determine the concentration of the solution may not be 100% accurate.

Slide 7: Data

Jenny: Since the nature of the expedition is an observational study, conclusions about causality cannot be made because of potential confounding variables. Therefore, only conclusions about associations between variables can be made.

Slide 8: Ammonia and Phosphate Observations

Jenny:To compare and contrast the ammonia and phosphate samples, the mean, standard deviation, and the median were calculated and recorded in parts per million, or ppm. For the ammonia samples, the mean was 1.797 ppm, the standard deviation was 1.33 ppm and the median was 1.44 ppm. As for phosphate, the mean was calculated to be 2.503 ppm, the standard deviation was 2.949 ppm, and the median was 1.33 ppm.

Slide 9: Highway Relations

Jenny:To study potential associations between sample stations and concentrated human activity, we took 6 sample stations and divided them into 2 groups - the first being greater than 2km away from highway 60 and the second being less than 2km. Group 1 consisted of the sample stations at Coon Lake, Madawaska River and Smoke Lake. Group 2 consisted of sample stations at Starling Lake, Pog Lake and Costello Lake.

Slide 10 Group Mean Ammonia
Dhrumil: To understand the trends in the ammonia concentrations of both Groups, the mean ammonia concentrations were graphed and compared. Group 1 had a mean of 1.51 ppm and a standard deviation of 0.59 ppm, while Group 2 had a greater mean of 1.68 ppm and a greater spread, with a standard deviation of 0.91 ppm.

Slide 11: Group Mean Phosphate
Dhrumil: The trends in the phosphate concentrations of both Groups were approached similarly. Group 1 had a mean of 2.52 ppm and a standard deviation of 1.97 ppm, while Group 2 had a greater mean of 3.02 ppm and a greater spread, with a standard deviation of 2.18 ppm.

Slide 12: Trends
David: Least Squares Regression was applied to the sample collected to predict the future concentrations of ammonia and phosphate within Algonquin's water systems. The residual plots produced from each of the graphs supported that a linear model was the best fit for the data.

Slide 13: Mean ammonia trends
Dhrumil: There was a very weak positive correlation between ammonia concentration and time, as evidenced by the very low coefficient of correlation of 0.06 and a coefficient of determination of only 0.4%, and it was predicted that the mean ammonia concentration will rise by $9.51*10^{-3}$ ppm on average per year. The weak positive association was caused greatly by the dramatic decrease and subsequent increase from AP 14 to AP 16 and then AP 16 and 18,

which suggested that external factors outside of the natural nitrogen cycles in Algonquin Park affected the ammonia concentrations in the park.

Slide 14: Mean phosphate trends

Dhrumil: There was a very weak positive correlation between the mean phosphate concentrations per year as well, as it had a very low coefficient of correlation of 0.04 and a low coefficient of determination of only 0.2%. The regression line predicted that, for every year in the future, the mean phosphate concentration will increase by $9.78*10^{-3}$ ppm on average. The results from considering both the mean ammonia and phosphate concentrations suggests that a number of confounding variables affected the data, demonstrating that further study into the data that comprises the mean concentrations is necessary.

Slide 15: Group 1 Ammonia

Dhrumil: There is a strong positive association between time and the mean ammonia concentration of Group 1, as shown by the coefficient of correlation of 0.44, and the coefficient of determination of 19%. Moreover, the regression line predicts that the mean ammonia concentration will increase by an average of 0.08 ppm per year.

Slide 16: Group 1 Phosphate

Dhrumil: There was a weak negative association between the AP year and mean phosphate concentration, as shown by the coefficient of correlation of -0.04, and the coefficient of determination of 0.2%. Moreover, the regression line predicts that the mean phosphate concentration will decrease by an average of 0.03 ppm per year.

Slide 17: Group 2 Ammonia

Dhrumil: There is a moderate positive association between AP year and the mean ammonia concentration of Group 2, given by the coefficient of correlation of 0.24, as well as the coefficient of determination of 5.9%. Moreover, the regression line predicts that the mean ammonia concentration will increase, on average, by 0.07 ppm per year.

Slide 18: Group 2 Phosphate

Dhrumil: There is a weak negative association between AP year and the mean phosphate concentration in Group 2, given by the coefficient of correlation of -0.06, as well as the coefficient of determination of 0.4%. Moreover, the regression line predicts that each subsequent year, the mean phosphate concentration will decrease, on average, by 0.04 ppm. The important detail to note from the analysis of phosphate concentrations in both Group 1 and 2 is that the mean phosphate concentrations are predicted to decrease, while the sample mean phosphate concentrations is predicted to increase.

Slide 19: Highway Ammonia Associations

Dhrumil**:** The Group mean ammonia concentrations showed that a greater distance from human activity is associated with lower ammonia concentrations and the converse applies as well. This association is currently present, evidenced by Group 2 having a greater mean than Group 1, and this trend will continue in the future for the next 5 years based on the predicted growth rates. Moreover, the coefficients of correlation and determination for each Group support that the linear model can accurately predict the data.

Slide 20: Highway Phosphate Associations
Gremlin: The Group mean phosphate concentrations showed a similar result to the group mean ammonia concentrations, as a greater distance from human activity is associated with lower phosphate concentrations. This association is currently present, as evidenced by Group 2 having a greater mean than Group 1, and this trend is predicted to continue for the near future, as evidenced by the growth rates of both Groups and their coefficients of correlation and determination.

Slide 21: Implications

Slide 22: Eutrophication

Jenny: From the collected data, there is reason to believe that Algonquin's water bodies have abundant levels of algae. This is correlated to the high level of phosphate. Phosphate levels have been gradually increasing due to organic pollutants. An impact of excessive phosphate concentrations is eutrophication, which is caused by runoff of nutrients into a body of water. These nutrients encourage the excessive growth of algae blooms. These algae blooms then become decomposed by bacteria who use up the oxygen in the water and cause hypoxia, low oxygen content. Before the algae is decomposed, it also causes problems as it covers the surface of the water and blocks out sunlight from effectively reaching underwater photosynthesizing plants. Some types of algae also produce dangerous toxins that may be lethal to primary and secondary consumers such as fish. This decreases the overall habitability of the body of water. This suggests a positive correlation between the amount of algae and phosphate levels.

Slide 23: Anoxic Hypolimnia
Amy: Lake Trout, Brook Trout and Lake Whitefish, which are at the top of the fish food web in Algonquin Park all require high levels of dissolved oxygen as they are thermally sensitive. A decrease in oxygen from eutrophication would cause in increase in temperature deeming the area uninhabitable. Situations become worse when Anoxic hypolimnia, a phenomena caused by reduced levels of dissolved oxygen in areas with limited sunlight access by the decomposition of the algae, further increases the oxygen deficiency by releasing additional phosphorus and nitrogen from the sediment in the lower layers of water.

Slide 24: Ammonia

David: Similarly, ammonia also has many negative impacts on aquatic ecosystems. Although ammonia is a necessary nutrient for aquatic wildlife, an overabundance can result in an alteration in metabolism, as well as an increase in body pH levels.

Slide 25: Future Research

Slide 26: Future Research

David: If this research study were to be continued, further studies would include the observation regarding the lack of specificity of the correlation between ammonia and phosphate concentrations.

David: Although the findings of this paper support associations between the distance from human activity affecting the ammonia and phosphate concentrations, the associations begin to break down when being applied to the individual sample stations within each group. Further research is needed to determine the specificity of these correlations.

Amy: Surprisingly, Simpson’s Paradox plays a role in the phosphate concentrations within the park. Although the mean phosphate concentrations are predicted to increase, studying the concentrations of two individual Groups of sample stations more and less than 2 km from the highway reveals that the mean phosphate concentrations of both groups are predicted to decrease rather than increase.

Amy: In the future, the ammonia and phosphate concentrations of more sample stations of equal distance from Highway 60 would be taken into consideration and into the calculations, so the data would be more precise.

Conclusion

Amy: After measuring and observing the trends in the data of the ammonia and phosphate concentrations from AP 9 to AP 20, it can be predicted that the ammonia and phosphate concentrations are expected to increase over the years. This is also expected to cause an increase in algae blooms, resulting in detrimental effects on the organisms in the aquatic ecosystem. Overall, more data is needed to further support these claims, however there is undoubtedly a causality between the factors.

Now we will be taking questions :)

Introduction

1. Experiment Procedure
2. Calibration
3. Raw Data
4. Analysis
5. Implications
6. Future Research
7. Credits and Sources

8. Questions

20 (2007 to 2019). Ammonia (NH_3) and Phosphate (PO_4)

Archived

Slide 28: Ammonia cont.

Fish that are exposed to ammonia with concentrations that exceed 0.1ppm could be affected by skin, eye, and gill damage. The overabundance of ammonia in the water could also deteriorate hatching success and decrease their growth rate. These effects may be long-term, as the toxins are extremely difficult to excrete.

Slide 3: Ammonia

Ammonia is a chemical compound composed of nitrogen, and hydrogen. Ammonia is the main source of nitrogen, which is the most common element in the biosphere. Ammonia can also be converted to ammonium with fungi, through a process called ammonification. It is naturally found in the ground, and in water, and with high concentrations, it can be lethal to all living organisms.

Slide 4: Phosphate

Phosphate is a chemical compound composed of phosphorus and oxygen. It is essential to all organisms as it supports human, animal, and plant life. Phosphate also increases nutrient levels, and causes eutrophication.