MEMORANDUM

To: Dr. Kerri Hickenbottom

From: Ana Maria Zurawski

Subject: Calculating Alkalinity and Hardness in a Sample

Date: 11/06/2015

Introduction

Alkalinity is a measure of the buffering capacity of water. Its value indicates the content of carbonate, bicarbonate, and hydroxyl ions in water. Certain levels of alkalinity are needed for water to maintain the pH necessary for the survival of aquatic life. Hardness is a measure of the divalent ions in the water and is categorized into carbonate and non-carbonate hardness, the former taking place when divalent ions react with carbonate ions and the latter taking place when divalent ions react with salts. Certain levels of divalent ions, such as calcium and magnesium, are needed for maintenance of the biological processes of aquatic life. In this lab, we used a chemical titration method to obtain the information necessary to calculate the alkalinity and hardness in ground and surface water samples.

Materials and Methods

We used the titration procedure outlined in Standard Methods to measure the change in pH of two different water samples; one obtained from the College Creek (surface water) and one obtained from the tap in the Water Quality Lab (ground water). To obtain the data necessary to calculate alkalinity, we added phenolphthalein indicator into a flask with a measured volume of 100 mL of our sample before performing triplicate titrations with a 0.02 N H_2SO_4 solution. To obtain the data necessary to calculate hardness, we added 2 mL of buffer solution and dry eriochrome black indicator into a flask with a measured volume of 50 mL of our sample before performing triplicate titrations with a 0.01 M EDTA solution.

Results

Table 1: Alkalinity and hardness values calculated from data obtained through titration.

Water Sample	**Alkalinity (mg $CaCO_3$/L)**	**Hardness (mg $CaCO_3$/L)**
College Creek	54	72
Tap Water	91	114

The alkalinity values seen in Table 1 were calculated using the following formulas: the product of the volume of H_2SO_4 used in the titration, the normality of H_2SO_4, and a conversion factor of 50,000 all divided by the volume of the water sample; the value of hardness was calculated from the product of the volume of EDTA used in the titration, the equivalency factor of $CaCO_3$ in mg to EDTA in mL, and the conversion factor of 1,000 all divided by the volume of the sample.

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Discussion

A minimum alkalinity value of 20 mg $CaCO_3$/L is needed for a body of water to have good productivity. For fish life to thrive, the alkalinity values necessary are between 75 and 200 mg $CaCO_3$/L (Wurtz and Durborow). The sample from College Creek had an alkalinity value of 54 mg $CaCO_3$/L, showing satisfactory quality to support aquatic life. Since the initial pH of the sample was under 8.3 (see Appendix 1a), the alkalinity in the sample was bicarbonate alkalinity only. This means that our calculated value is the total alkalinity of the sample. Bicarbonate alkalinity is due to reactions between carbon dioxide and the soil. The sample from the tap had an alkalinity value of 91 mg $CaCO_3$/L, and because of its pH (see Appendix 1b) the alkalinity was also bicarbonate only. Since the tap water was a ground water sample, it was expected that the alkalinity value was higher because it is less disturbed by rain, which lowers alkalinity values.

Hardness works alongside pH to determine the ideal conditions for aquatic life to exist, and ranges from as low as 10 mg $CaCO_3$/L to as high as 250 mg $CaCO_3$/L (Wurtz and Durborow). The sample from College Creek had a hardness value of 72 mg $CaCO_3$/L and as such is classified as soft water. Generally, surface water such as the creek water is softer than ground water (Sawyer et al.). At the value obtained from our experiment, our water is classified as soft water. The sample from the tap had a calculated value of 114 mg $CaCO_3$/L, and is classified as moderately hard. When the alkalinity value is lower than the hardness value, the alkalinity value represents the value of carbonate hardness and the remainder is non-carbonate hardness (Sawyer et al). It was expected that a sample from the College Creek would show values of alkalinity and hardness that indicate good productivity for that body of water, and that the tap water would behave similarly, since Humboldt County's ground water harbors good aquatic life.

Conclusion

The alkalinity and hardness values for the sample from College Creek were both low compared to the ground water, which could be due to run off, rain, and other interventions in the surface water. The alkalinity and hardness values for the sample from the tap water were higher than the creek samples, possibly due to flowing through geological formations which would contribute to a higher level of $CaCO_3$.

References

APAA, AWWA, and WEF (2005). *Standard Methods for the Examination of Water and Wastewater - 21st Edition*. Port City Press, Baltimore, MD.

Hickenbottom, K. (2015), October 15th, *Alkalinity and Hardness Lab Handout*

Sawyer et al. (2003). *Chemistry for Environmental Engineering and Science.* McGraw Hill, NewYork, NY.

Wurtz and Durborow (1992). *Interactions of pH, Carbon Dioxide, Alkalinity and Hardness in Fish Ponds*. United States Department of Agriculture.

Appendix

Appendix 1a: Raw data from chemical titrations done to the College Creek sample

	Run 1	Run 2	Run 3
Initial pH	7.0	7.0	7.0
Initial Volume (mL)	1.9	7.3	12.6
Final Volume (mL)	7.3	12.6	18
Total Volume (mL)	5.4	5.3	5.4

Appendix 1b: Raw data from chemical titrations done to the tap water sample

	Run 1
Initial pH	7.0
Initial Volume (mL)	18
Final Volume (mL)	27
Total Volume (mL)	9

Appendix 1c: Raw data from chemical titrations done to the College Creek sample

	Run 1	Run 2	Run 3
Initial Volume (mL)	6.0	9.6	13
Final Volume (mL)	9.6	13	17
Total Volume (mL)	3.6	3.6	3.6