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Mt. Bethel Fens: Bartlett Fen Soil Alkalinity

ABSTRACT

Soil samples were taken from three different sites at three different elevations from the Bartlett Fen. Within each site, three samples of soil were taken at three different sub-elevations. These samples were used to measure the alkalinity by using the titration method. In total, 27 soil samples were run and analyzed in the Gran Plot. The results of this experiment proved that the method worked, with values of alkalinity falling within the range of 100-200 mg/L. However, there were some values that were questionable, possibly due to the fact that the return in water weight of the soil was not taken into account, and other various reasons which have not yet been looked into.

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INTRODUCTION

Background:

Alkalinity is a measurement of the buffering capacity of an ecosystem. It is important because it determines the ability of the soil to resist a change in pH, which can be affected by acid rainfall, wastewater, and surrounding bodies of acidic matter. Soils with low alkalinity will be prone to changes in the pH and vice versa (Murphy, 2002). Specifically, values ranging from 100-200 (mg/L of CaCO₃) stabilized the pH, while values of 10 and below has a very poor buffering affect (Murphy, 2002).

Changes in pH level can be very drastic, and often times detrimental to a habitat's biota. Specifically, soil pH directly affects plant production. Depending on the pH level, soils carry different amounts of nutrients, such as calcium and magnesium, which are needed in specific amounts for plants to survive. Varying levels of nutrients allow plants to grow, thrive, and ward off diseases. If the soil has low alkalinity, the pH level is more prone to change, which can lead to a significant loss in vegetation due to malnutrition and toxicity (Spector, 2001).

A soil is considered alkaline if the pH is greater than 7. Alkaline soil, also known as "sweet" soil, is usually found in arid regions where less than 25 inches of rain is received. In these arid regions, calcium carbonate (limestone) is abundant, which is very basic (Harris, 2001). In these basic regions, the vegetation varies from that of acidic regions. Thus, any adjustments in the pH level can be quite detrimental to the vegetation in the area and surrounding habitats.

Site Description:

The Mt. Bethel Fens are considered to be an alkaline or calcareous wetland. This is due to the ground water source, which is rich in calcium-magnesium-bicarbonates, having a pH above 6.0. Specifically, the Bartlett Fen has a pH between 7.19-7.57 (2003 LEO fens data).

This level of pH is home to a wide variation of vegetation, most of which is made up of basic-loving plants. To name a few, the fen is made up of sedges and grasses.

In addition to the domestic vegetation, there are some invasive plants, such as the purple loosestrife and Phragmites, also known as the common reed grass. These plants, which appear to be harmless, may be a key disadvantage to the fens. The purple loosestrifes are capable of altering the soil chemistry by displacing native vegetation and blocking sources of water, which carries the nutrients for the plants. The Phragmites also crowd out the native plants, which are better at “stabilizing sediment and improving water quality through nutrient removal” (phragmites.org, 2002).

Objective:

The goal is to come up with a method for measuring soil alkalinity in the Mt. Bethel Bartlett Fen. If this is successful, it will be used for measuring the alkalinity in the other fens, as well. Because the literature on measuring soil alkalinity is very limited, the method will be developed from procedures of measuring alkalinity in water.

Hypothesis:

The outcome of this experiment, if performed correctly, should result in very high alkalinity levels, most likely between 100 and 200 mg/L of CaCO₃. However, because of the varying elevations within the fen, the alkalinity may vary significantly enough that there needs to be more than one plot that needs to be analyzed. For even more accuracy, samples taken at different elevations can be separated into two or three sub-samples. This allows for the measure of standard deviations and variances between the sub-samples, which could later suggest that a more involved procedure may be necessary or vice versa.

EXPERIMENTAL PROCEDURES

The first step was collecting the soil samples. Three sites along an elevation gradient were selected for sampling. Within each site, three sub-sites were marked with a flag. At each sub-site, soil was collected for sampling. This was done by picking out three different sites within the fen, at three different elevations. Three samples were collected from each site and was properly labeled and stored for further analysis in the lab. For detailed procedures, refer to Appendix A.

The alkalinity of each soil sample was found using the titration method, which can be found in the LEO Guidelines Handbook. The sample was first prepared by measuring 15 g from the plastic bag and was placed into a labeled tray. Then, 30 mL of DI was added to the sub-sample, which was mixed very well into a slurry. The mixture was set aside for 30 minutes to equilibrate with atmospheric CO₂. Once this was done, the sample was vacuum filtered, using a GF/F filter (47 mm Ø) and was poured into a labeled, sterile, plastic bottle. This process was repeated for all three sub-samples of each sample. Once the preparation was done, the titration method was used. For detailed procedures, refer to Appendix B or the LEO guidelines.

After all the samples were analyzed, the alkalinities were calculated using the Gran Plot on Excel.

RESULTS

The alkalinity value for site A did not vary by much. The values ranged from 211.7 mg/L to 228.3 mg/L. At site B, the values were very inconsistent, ranging from 163.3 mg/L to 620.0 mg/L. Finally, site C showed some discrepancy with average alkalinity values ranging from 115.0 mg/L to 438.3 mg/L. The comparisons, between the alkalinity values of each analytical repetition, can be seen in Figure 1.

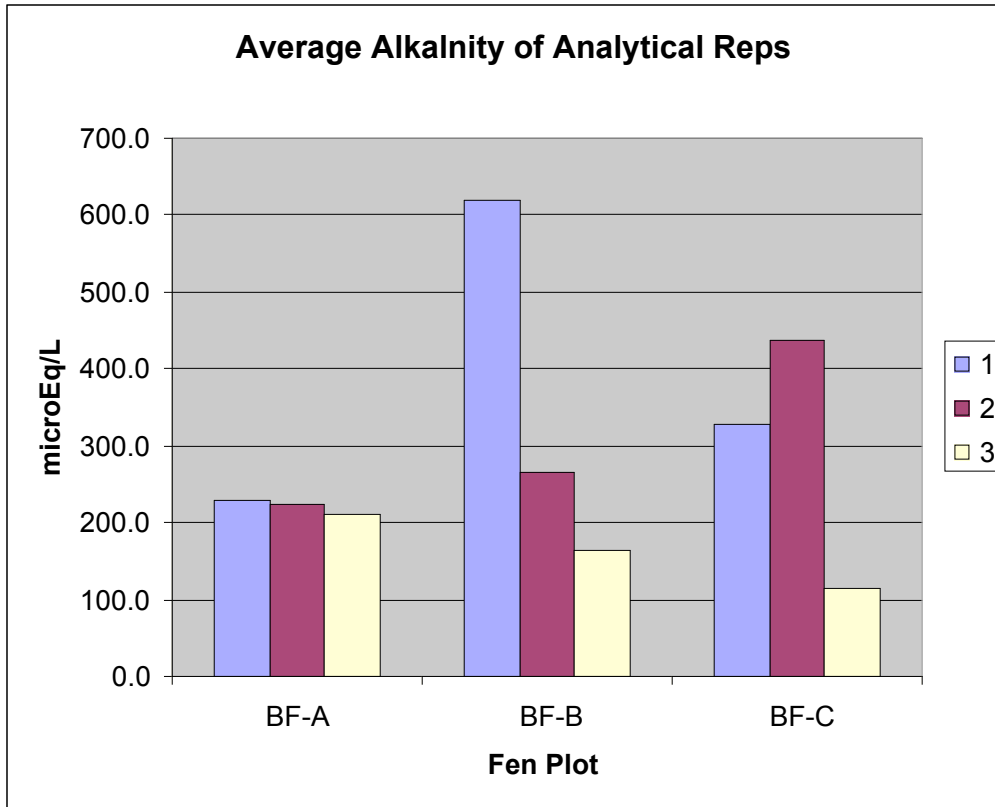


Figure 1. Average alkalinity values of analytical repetitions.

The standard deviations can be seen in Table I. The values for site A ranged from 2.89 mg/L to 98.28 mg/L, site B ranged from 62.45 mg/L to 68.07 mg/L, and site C ranged 63.64 mg/L to 255.95 mg/L.

Table I. Summary Table of Alkalinity Values of Analytical Repetitions

site	alkalinity avg (analytical reps) [mg/L]	stand dev (analytical reps)
A1	228.3	2.89
A2	222.5	74.25
A3	211.7	98.28
B1	620.0	62.45
B2	266.7	68.07
B3	163.3	66.40
C1	328.3	165.40
C2	438.3	255.95
C3	115.0	63.64

The average alkalinity values within the plots can be seen in Figure 2; site A had a value of 220.63 mg/L, site B had a value of 350.0 mg/L, and site C had a value of 316.25 mg/L. The standard deviation values can be found in Table II, below.

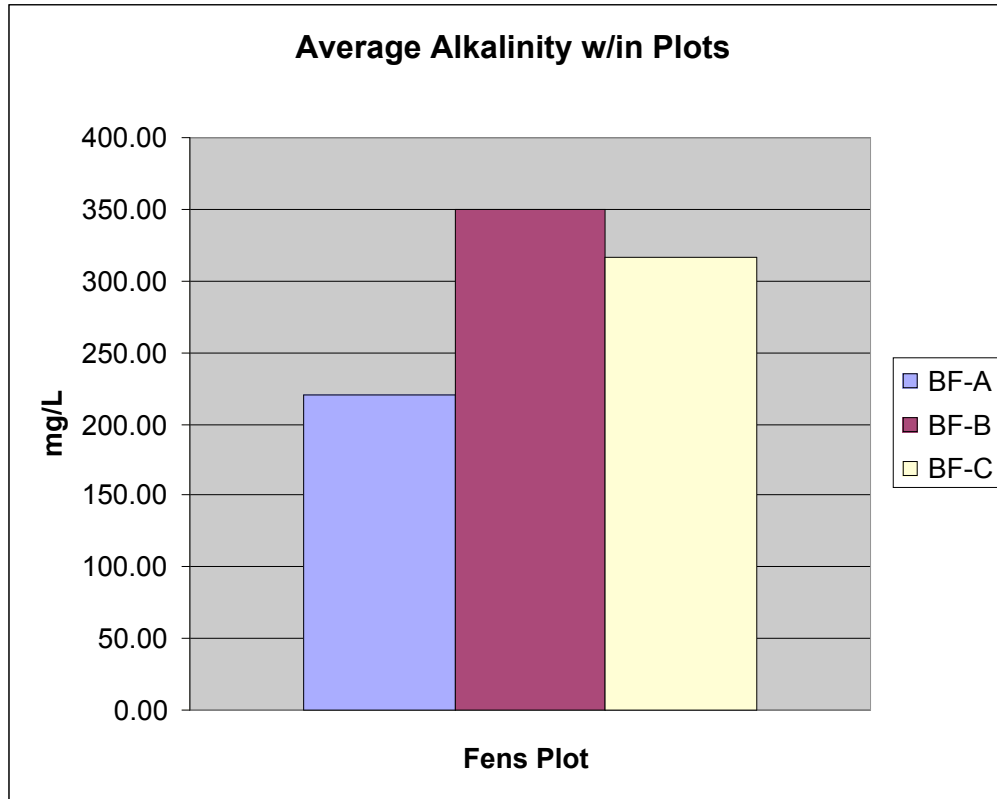


Figure 2. Average alkalinity values of plots.

Table II. Summary Table of Alkalinity Values of Plots

site	alkalinity avg [mg/L]	stand dev
A	220.6	60.09
B	350.0	215.04
C	316.3	212.45

Finally, the average alkalinity for the entire site was calculated to be 297.8 mg/L, with a standard deviation of 180.98 mg/L. The entire table of values can be in Appendix C, Table III.

DISCUSSION

The calculated alkalinities for each sub-sample varied for all three sites. For instance, in plot C2, the alkalinity value for A was 210.0 mg/L, for B it was 715.0 mg/L, and for C it was 390.0 mg/L. All three samples should have produced the same alkalinity value, ideally. The reasons for such large variations within the plots cannot be speculated because the amount of water from the soil that was returned during the filtration process was not measured.

The average alkalinity values within the analytical repetitions did not vary by much for site A. This could be due to the fact that the surrounding vegetation did vary by much; most of the vegetation was shrubs and grasses. The elevation between the samples did not vary by more than 9 cm, which also may have been a factor for the consistency in alkalinity values.

In site B, the averages varied quite a bit, most likely due to the fact that the calculated alkalinities were not consistent within the samples, but it could also be contributed from the varying vegetation. Sample B1 was surrounded Solidago, also know as golden rods, B2 was dominantly sedges and grasses, and cattails were the primary vegetation within sample B3. The elevation did not vary by more than 6 cm, but the distance apart from B1 and B2 was 50 cm and the distance between B2 and B3 was 41 cm. Although the elevations did not vary by much, the distance apart may have been enough to produce varying alkalinities.

Site C varied in average alkalinity values, as well, with the highest standard deviations. Once again, this could be strongly influenced by the return in soil water from the slurry during the filtration process. Additionally, the vegetation could have also played a role in producing the inconsistency between the samples. First of all, sample C1 was mostly red moss with very little soil, thus the soil alkalinity value may be invalid all together. Second, the elevations varied greatly. Sample C1 was taken at an elevation of 50 cm, sample C2 was taken at an elevation of

34.5 cm, and C3 was taken at an elevation of 13.5 cm. The distance apart was also relatively far apart with distances of 53 cm between C1 and C2 and 56 cm between C2 and C3.

The layout of the plots can be seen in Appendix D, Figures 3 and 4.

CONCLUSION

Overall, the calculated values proved that the method for measuring soil alkalinity in the fens worked. Some of the values were questionable, with varying sub-sample values and large standard deviations. However, this may be able to be eliminated by measuring the water weight within the samples next time, thus being able to calculate the water return percentage within the liquid samples. Also, the distances between each plot were not taken into account, which may have an affect on the alkalinity values. These will be accounted for the next time soil samples are taken.

APPENDIX A

Procedure for setting up site and collecting samples

1. Take two rods and tie a string of a known distance (1.414 m) to the end of each rod – the distance of the string was designated by first placing a 1 m X 1 m plot onto a site and tying the string diagonally across it.
2. Stick the rods into the site, preferably into an area with hummocks and varying elevations, making the string as taut as possible.
3. Select sub-plot sites along an internal elevation gradient. Mark each sub-site with a label.
4. Level the string with a line level and measure the elevation of each sub-plot, referenced to the height of the string.
5. Record the distance.
6. Collect about 50 g of soil using a hand trough.
7. Place into a sterile plastic bag (Whirlpak bag) or container and seal it, extracting as much as air as possible, thus preventing the air from reacting with the organisms in the soil.
(EPA, 1992)
8. Label the bag accordingly.
9. Place the bag into a cooler to minimize biological activity, which could alter results.
10. Rinse the hand trough with DI, so as not to contaminate the next sample.
11. Repeat steps 6-10 for each sub-site.
12. Once all three samples are collected, measure the distance between each sub-site from the center of each area in which the sample was collected to the center of the adjacent area in

which the second sample was collected. Do this for the second and third sub-site, as well.

13. Record the distances.

14. Repeat steps 2-6 for each site.

15. Rinse the rods with DI before placing them at another site, so as not to contaminate the next site.

16. Refrigerate the samples at 4°C -5°C and analyze as soon as possible. The maximum number of days for refrigeration is 10 days.

APPENDIX B

Titration Method

1. Measure out 30 mL from the bottle into a small beaker. If the liquid sample collected is less than 30 mL, measure out 20 mL from the bottle.
2. Place the beaker on a magnetic stirrer to the lowest setting.
3. Place the pH probe in the sample and allow it to stabilize.
4. Record the initial pH (this is optional).
5. Add 0.1 N HCl until the pH equals approximately 4.2.
6. Record the volume of HCl added.
7. From about 4.2 pH, add small increments of HCl until the pH equals approximately 3.7.
At least ten data points between 4.2 and 3.7 are needed. Therefore, add increments of HCl so that at least ten increments will be added within 4.2 and 3.7 pH.