

Yost Lake
Watershed Profile Assessment
37.74460°N, 119.09577°W

Proudian Interdisciplinary Honors Program
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I. Introduction

Section 1.1 ~ Sierra Nevada Background

The Sierra Nevada is a large mountain range that covers 63,118km² in California and Nevada (Davis and Stoms 2014). Its primary habitat includes the alpine ecosystem, which is the focus of this study. According to Davis and Stoms, the Sierra Nevada consists of a collection of private lands and public lands including, but not limited to the Bureau of Land Management, National Forests and National Parks (2014). The purpose of this study was to closely examine Yost Lake, situated in the June Lake and specifically in the Inyo National Forest, for chemical nutrients and contaminants in the water, soil and atmosphere. These results will offer not only information on the lake's vulnerability to climate change and nutrient loading, but will also offer information as to the best management practice and policy to help ensure the health of the ecosystem is maintained.

Section 1.2 ~ Study Area: Yost Lake

Yost Lake is situated at 37.74460°N, 119.09577°W in the Sierra Nevada mountains, in the designated Inyo National Forest. The lake is at a high elevation, sitting at 9,100 feet. The lake itself is a small body of water with a surface area of 14,000m² and a depth of 8 meters. It sits in the watershed Subbasin HUC8: Mono Lake.

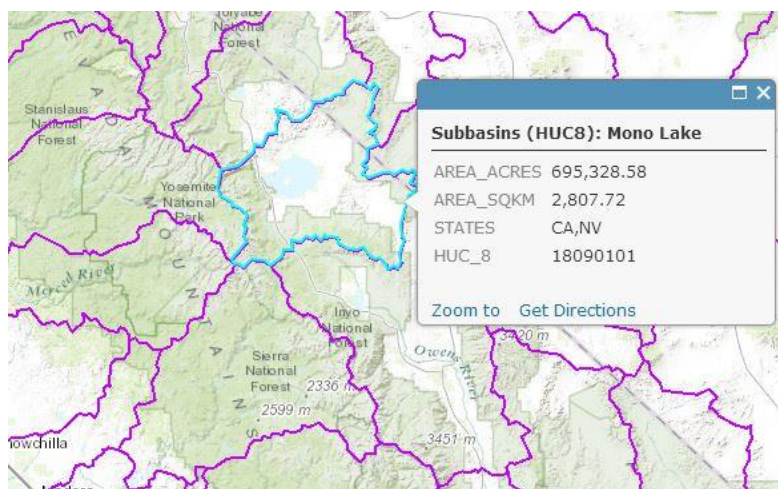


Fig. 1. A GIS screen shot of the Subbasins in Southern

Inside that subbasin, it sits inside the Rush Creek Watershed (HUC10) and specifically inside that watershed it takes up the Grant Lake-Rush Creek Watershed (HUC12).

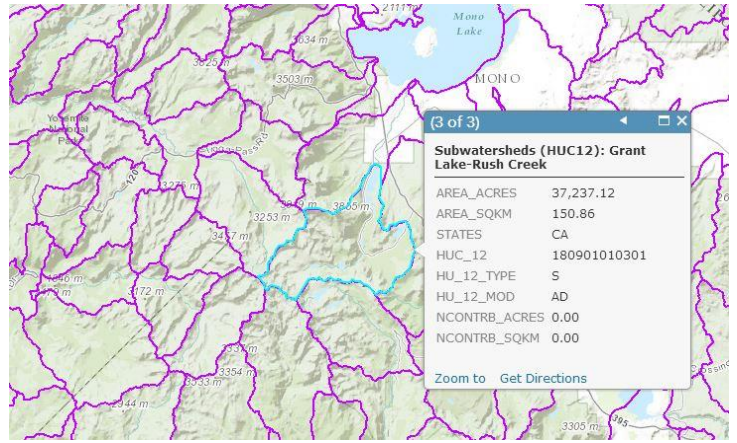
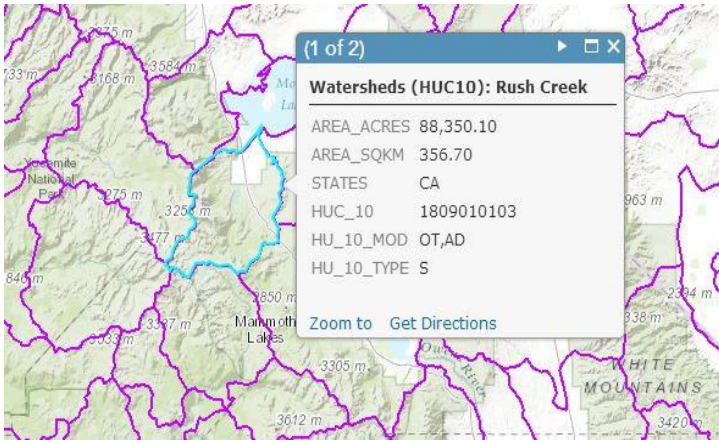


Fig. 2. A GIS Screenshot of the watersheds in the Mono Lake subbasin.

Fig. 3. A GIS Screenshot of the sub-watersheds in the Mono Lake subbasin.

Section 1.3 ~ Wilderness Designation Background

Yost Lake is located in the Inyo National Forest, which means it is located in federally recognized wilderness. Wilderness was federally designated in the 1964 Wilderness Act. The definition reads “A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain” (U.S. Forest Service 1964).

There are restrictions the act puts on wilderness, which include: “no commercial enterprise...no permanent road within any wilderness area designated by this act...there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area” (US Forest Service 1964).



Fig. 4. Wilderness Designation at Yost Lake

Section 1.4 ~ Yost Lake Present Policy

What the act means for Yost Lake is that there are no roads leading to the lake, only hiking trails. It also means no motorized equipment can be used in the wilderness, which includes equipment (such as a chainsaw) that might help clear fallen trees, and finally no structure can be built on the property. This helps significantly reduce possible point source pollution. One example would be pollution coming from marinas (and therefore motorized boats) that are found in lakes used for tourism and recreation.

At Yost Lake, a permit is also necessary to camp overnight. There are 8 available spots for campers on a given night, which helps reduce physical impact from numerous campers making several campsites at the same time. There are also specific restraints on the permit to camp overnight. Camping must occur within 100 feet of lakes, streams and trails (or no closer than 50 feet if that is not possible). A bear canister or bear bags are mandatory for food and toiletries, and campfires are prohibited above 10,000 feet in the Yost Lake/Fern Lake area, meaning fires are allowed in the wilderness.

II. Sampling

Section 2.1 ~ Methods

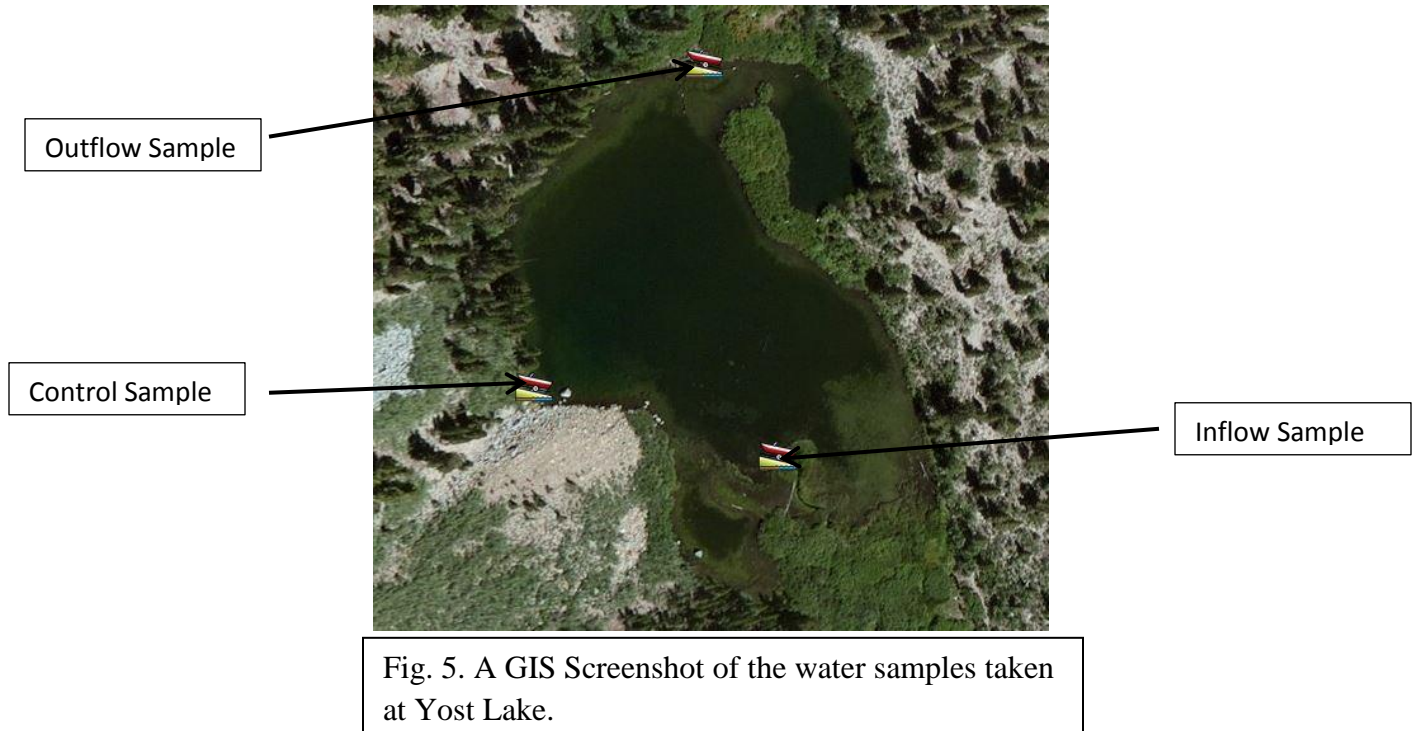
Water Samples

We took three water samples from Yost Lake: Control Sample, Inflow Sample and Outflow Sample. For each of our samples, we wore gloves, and took a grab sample. We wore gloves to prevent contaminants on our hands (sweat, lotions, etc.) from mixing in the water, and interfering with our samples. To take a grab sample, we submersed the bottle, uncapped it and capped it before bringing it back out, and using those bottles to transport the samples back to the classroom, where we kept the samples stored at 4°C.

Our Control Sample was taken on the rocky SW shore of the lake, about 100 feet from the end of the trail. There was no plant life, point sources or inflow or outflow of the lake to alter any GLX unit readings.

For the Inflow Sample, we took it near the inflow of the lake, on the southern edge of a grassy, marshy area. This was well out of any path designed for leisurely travel, preventing from any influencing point source for pollution at this spot of the lake.

Finally for the Outflow Sample, we grabbed our sample from the North end of the lake, near the outflow. This area was not as marshy, but bramble bushes extended to the shore, where a large barricade of rotting logs lined the shore. It was quite isolated from any point sources, just like the previous samples. It should also be noted that without precipitation, this end dries up resulting in an outflow that seeps underground, rather than flowing down through a riverbed, resulting in zero cubic feet (meters) for the outflow stream flow.



Deep Water Sample

We collected one deep water sample. Taking the raft out to the lake, we used the depth finder to determine the lake was 8 meters deep. We then used a Kemmerer Sampler, and took a water sample at 2 meters deep. Even at this depth, we collected large quantities of mud.

Soil Samples

We took three soil samples from Yost Lake as well: Control Sample, Outflow Sample and East Side Sample. Using the soil core sampler, we took a soil sample near our water control sample site again, because there were no point sources (or inflow or outflow sources) near the rocky sample site to influence the data collected.

We took a soil sample near the edge of the dried up outflow, which gave us our wettest soil sample we collected.

Instead of taking a sample near our Inflow Sample site (for water), we decided to take a sample on the East Side of the lake to gather soil a little farther up from the lake, and soil on a steeper slope as well.

To take the samples, we used a soil core sampler. We found the sample spot we wanted, drove the core into the ground with a mallet, and then measured how much soil came up with the core sampler. We took the soil pH while out in the field, to get the most accurate reading possible. We did this by mixing DI Water with a handful of soil from the site, to make a wet solution, and using that muddy water to then apply a pH strip to. We brought our samples back in small plastic bags.

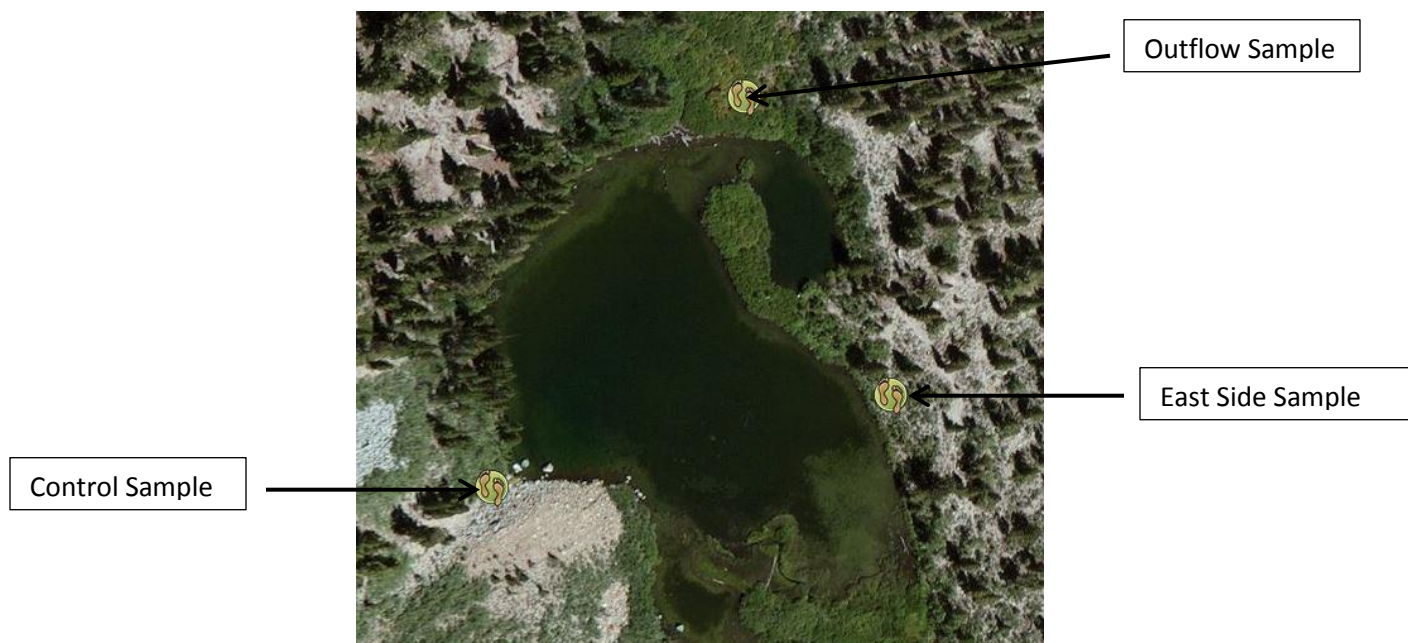


Fig. 6. A GIS Screenshot of the soil samples taken at Yost Lake.

Atmospheric Samples

Bulk Sampler

This measurement took two parts: first we set up the field air sampler in the lab, and then we took it out to our lake to run it. To set up the field air sampler (GilAir5 Personal Air Sampler) we poured Barium Hydroxide acid (BaOH_2) into an Erlenmeyer Flask that had a rubber stopper with a hole for a tube to connect (via rubber tube) to the particulate air filter. We added enough to cover the filter resting in the flask. Once the flask was clamped in place, and the tube connected between the flask and the filter cartridge, we took the system out to the field.

Before setting up the filter cartridge, we weighed the filter, to get an initial weight. Once taken, making sure to wear gloves while working with the filter and cartridge, we connected it to the air sampler.

At the lake, we set the air sampler near the edge of the lake, away from the base of trees, and turned the air circulator (set to 5L/min) on. We let the circulator run for 60 minutes. Once we brought the sample back, we weighed the filter to determine the weight of the particulate matter collected in grams).

GilAir5 Personal Air Sampler

We used a passive sampling technique – a bulk sampler – to gather our total (wet and dry) precipitation in the atmosphere. The materials we needed were a funnel and screen (which we were missing) that funneled into a smaller, acid washed jar. We let it sit outside for a period

of 8 days. Bringing it back to the lab, we measured the volume of the wet precipitate (in ml) using a graduated cylinder, took the pH using the GLX reader and measured the Nitrogen and Phosphorus using their respective strip tests.

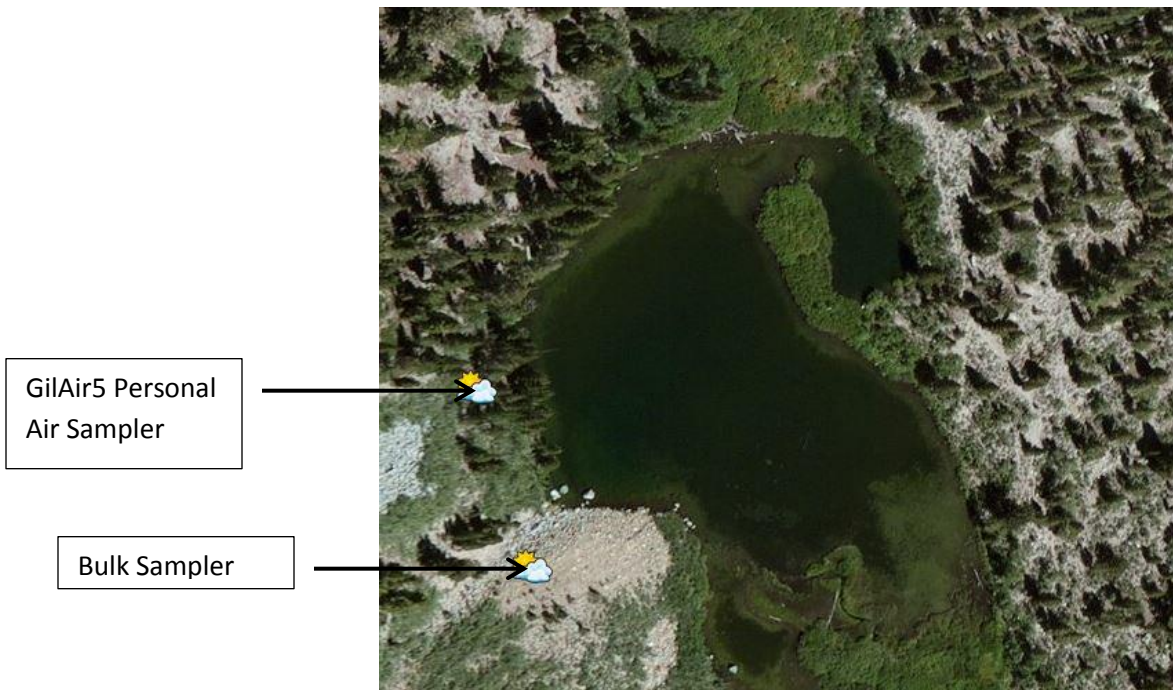


Fig. 7. A GIS Screenshot of the soil samples taken at Yost Lake.

III. Stream Flow

Section 3.1 ~ Methods

Stream Flow is the quantity of water that is either entering or leaving a watershed such as a lake or pond. It is important to measure, because stream flow offers the information to calculate the hydraulic residence time. The hydraulic residence time is the amount of time a soluble compound remains in a body of water, and so knowing the HRT can give an indication as to how long a pollutant will stay in the body of water.

We measured Yost Lake's inflow, because at the time of measurement, the outflow dried at the shore and so seeped underground, rather than flowing out over the lake's edge into a riverbed. The inflow to the lake is a narrow stream, which was flowing quite slowly at the time. Our procedure was to measure the stream first, and we measured four feet. From there, we decided to use the tape measure to count out 6 inch sections, creating 8 data points which we would use to compile the stream flow.

When we began to measure the flow, we started at 6 inches for the first flow count (0 inches and 0 counts being the starting point). Using a Stream Flowmeter (Geopacks Model MFP51), we used a stopwatch to time the Flowmeter rotations for 60 seconds at every interval. We did this until we hit 4 feet (0 counts).

Section 3.2 ~ Results

DIST	DEPTH	COUNTS	VEL (m/s)	VEL (ft/s)	AREA	FLOW
0.5	0	-	-	-	-	-
1	0.42	1	0.050854	0.166801	0.21	0.035028
1.5	0.6	2	0.051708	0.169602	0.3	0.050881
2	0.825	4	0.053416	0.175204	0.4125	0.072272
2.5	0.975	4	0.053416	0.175204	0.4875	0.085412
3	0.9	7	0.055978	0.183608	0.45	0.082624
3.5	0.85	4	0.053416	0.175204	0.425	0.074462
4	0	-	-	-	-	-

Fig. 8. The data table collected for the Stream Flow calculations.

Stream Flow ft³/sec
0.400678ft³/sec

Stream Flow m³/sec
0.12213m³/sec

Hydraulic Residence Time = 0.02906 years
10.61407 days



Fig. 9. The site where stream flow measure was taken

Section 3.3 ~ Discussion

We discovered that Yost Lake has a slow inflow to the lake during periods where there has been little or no precipitation lately. What this means is that any pollutants that might be entering the watershed further up and following the stream flow will not be entering the lake at a fast rate, meaning groundwater pollutants in the soil should also be a noted factor for pollutants if the lake ever rapidly changes in chemical pollutant levels. The hydraulic residence time is the amount of time it a soluble compound stays in a watershed.

IV. Water Quality

Section 4.1 ~ Methods

Water Quality

We conducted three lake status check-ups at three different sites over the course of a month. Our three sites were chosen because of their locations, as addressed in *Section 2.1 in Sampling*, and at each of these sites, we observed the following: pH, Conductivity, D.O., Water Temperature, Air Temperature, Relative Humidity, Wind Speed, Wind Direction (when applicable) using the water quality probe, GLX Explorer Pasco Scientific brand. We did not record Barometric Pressure, because our water quality probe did not respond to any Barometric Pressure readings, offering only the NAN error message.

To conduct the check-up, we traveled by foot to each site, and made our way above the area we wanted to drop the sensors into. After each reading, we made it a practice to wash off the sensors with deionized water (DI Water).

Lake Depth & Turbidity

We determined our lake depth by taking a raft out into the lake, and measuring the middle of the lake with a depth finder.

Turbidity refers to the organic and particulate matter in the lake water, which affects its clarity. We determined the turbidity by taking the raft out to the middle of the lake, and using a Secchi Disk whose rope was marked in increments of 1 meter.

Section 4.2 ~ Results

The average water temperature rose from 9.07°C to 11.49°C between the first two weeks, but then fell to 7.72°C for the last week. The dissolved oxygen (D.O.) gradually rose over the three weeks, with the average starting at 8.5mg/L and rising to 8.9mg/L and 9.27mg/L for week three. The pH stayed near a neutral pH, reading 7.0 for the first week, 7.5 for the second and 7.23 for the third week, making it a slightly basic lake. The average conductivity gradually rose starting at 3.7mS/cm the first week, rising to 4.63mS/cm for the second and 5.57mS/cm for the third.

The lake depth is 8 meters and the turbidity was read at 2 meters.

Section 4.3 ~ Discussion

The water temperature rose during the second week because there was a 4 day period of weather in the 70s (°F) after a 6 day period of weather in the 40s (°F), which is when we took our first water temperature reading. The third week's reading was taken after 3 days of 50°F weather and precipitation, which at the 9,100 ft. elevation Yost Lake is situated at. The D.O. rose gradually over the three week period, indicating that oxygen is being added to the lake through the seasonal snowmelt. Given that the pH stayed near a neutral reading, and fluctuated slightly is likely a result of the snowmelt changing the water's pH in trace amounts. The pH's neutral level indicates a healthy range for plant life. The conductivity gradually rose, which makes sense

because of the snowmelt. The snowmelt would bring more minerals and more nutrients, which would account for the increased conductivity.

V. Alkalinity

Section 5.1 ~ Methods

Alkalinity refers to a lake's natural ability to protect itself from acidification. Alkalinity is the presence of bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) that allow the water to neutralize acidity. The more carbonate or bicarbonate a lake has, the greater its alkalinity, the more protected the lake is from acidic pollution (usually in the form of acid rain).

To figure out the Alkalinity of our Water Samples, we mixed a sulfuric acid solution (H_2SO_4) into the samples at a concentration of 0.002 M acid. To start the procedure, we measured the base pH reading of the water sample (30ml), using the GLX reader. At this point, using a buret clamped into a buret holder, we added a few drops of acid at a time. After each addition, we swirled the mixture in the beaker, and measured the pH again, using the GLX reader. Also after each addition, we recorded the amount of acid added and the pH that the solution dropped to in an excel spread sheet. Our goal was to record the pH within a change of 0.2 every addition. We continued this pattern until we reached a pH level of 3.5. Using the data in our excel spread sheet, we were able to graph the titration curve of the data.

Section 5.2 ~ Results

The alkalinity for our control sample and duplicate was 16.67 and 18 mgCaCO₃/L. For our inflow sample and its duplicate, it was 16.67 and 16.67 mgCaCO₃/L. For our outflow sample and its duplicate, it was 17 and 17.67 mgCaCO₃/L. Finally, the deep water sample and its duplicate read at 20.67 and 20 mgCaCO₃/L. Our standard deviation was calculated to be ± 0.221 mgCaCO₃/L and the CI95 to be between 17.768 and 18.072 mgCaCO₃/L.

Section 5.3 ~ Discussion

Initially our alkalinity was quite low, especially for the 3 water samples. This means that Yost Lake has a very little buffer against acidification. If acid rain were to come in over the mountain range, it would not take much before the acidity of the lake's pH started to drop drastically, thereby altering sustainable life in the lake. When we measured our deep water sample however, we recorded a higher alkalinity by 2-3mg/L. This raised the possibility that Yost Lake may not be quite as vulnerable to acidification as originally thought, and one possible explanation for this increase in alkalinity may be that because colder water has a greater solubility with solids and gases, that there is a greater concentration of CaCO₃ in the deep water sample, and so a greater alkalinity.

VI. Nitrogen

Section 6.1 ~ Methods

Nitrogen is a major source of nutrients for plants in aquatic environments such as lakes. Nitrogen is taken by plants in two forms: an ammonium ion (NH_4^+) and a nitrate ion (NO_3^-). Nitrogen contributes to plant growth, and because plants can only take it in these two forms, it is most often limited in availability. If there is too much Nitrogen in the water, it can lead to hypereutrophication, which is the occurrence of life extinction in a lake, because too much decaying life leads to oxygen consuming decomposers (bacteria). Determining how much Nitrogen there is in a lake can help one identify the eutrophic health of a lake.

Before we could test for Nitrogen in our Water Samples, we had to establish a standard curve. The standard curve is necessary together with the absorbance readings of the samples to calculate the total Nitrogen of all the samples (and duplicates). To establish the standard curve, we used a stock nitrate solution of 0.7218g of KNO_3 in 1 L of water, adding 1 ml of chloroform as a preservative. We then had 6 different stock nitrate solution concentrations: 0.5, 1, 2, 3, 4, and 10. These were the amounts we added to a volumetric flask with DI water, for a total 100ml of solution. We then proceeded to conduct the following procedure on those samples, skipping the digestion solution, to determine the absorbance levels of the samples.

To test the water samples (and duplicates) we started with 20 ml of the water sample. We then added 10 ml of digestion solution (a mixture of 20.1g of $\text{K}_2\text{S}_2\text{O}_8$ - Potassium persulphate, 3.0g of NaOH – Sodium hydroxide, and 1000ml of deionized water) to the water sample. We mixed them together, and then heated for 30 minutes on a hot plate at the “3” setting. After letting it cool, we checked to see if there was still 30ml of liquid with a graduated cylinder, adding DI water as needed. We then added 1ml of borate buffer (61.8g of Boric acid [H_3BO_3], 8.0g of Sodium hydroxide [NaOH], and 1000ml of DI water) to the sample. We mixed it again, and then added 3 drops of 6 N NaOH using a pipette. Having prepared all three of our samples like this, we then distributed 5ml of each sample to 2 acid washed test tubes, which served as the duplicates. To each set of test tubes, we added 725 μl NaOH reagent and mixed it in a vortex shaker, we added 420 μl of freshly made reducing agent and again mixed it in the vortex shaker, let it sit for 5 minutes and then added 725 μl of Colour reagent, and mixed it in the vortex shaker. We let it sit for 30 minutes, and then used a Spectrophotometer to determine the absorbance.

Section 6.2 ~ Results

The visibilities of the control sample and its duplicate in the Spectrophotometer were 1.068 and 1.141, for the inflow sample they were 1.08 and 1.06, for the outflow sample they were 0.921 and 0.945 and for the deep water they were 0.85 and 0.812. This translated to Nitrogen levels of 27.625 and 29.526 mg/L for the control sample, 27.938 and 27.417 mg/L for the inflow sample, 23.797 and 24.422 mg/L for the outflow sample, and 21.948 and 20.958 mg/L for the deep water sample. The standard deviation was ± 0.054 mg/L and the CI95 fell between 32.427 and 32.513 mg/L.

Section 6.3 ~ Discussion

The Nitrogen levels that we found were notably high for a standard, healthy lake. It is reasonable to conclude that the seasonal snowmelt that is occurring is in part responsible. As the

snow melts, it brings Nitrogen and other nutrients from high elevations into this watershed, creating a Nitrogen pulse. In John Stoddard's article *Long-Term Changes in Watershed Retention of Nitrogen*, Nitrogen stages of lakes are addressed. A lake a stage 0 is a lake whose aquatic plant life is taking Nitrogen faster than it is coming in. With the excess of Nitrogen in the lake currently, it is clear this is not happening. However, as Yost Lake does not have enough plant life to support the characterization of a stage 2 lake, it is logical to conclude Yost Lake is a stage 1 lake. If this is true, then one would expect to find, if further Nitrogen tests were conducted in following weeks that Nitrogen would become a limited nutrient by early summer (Stoddard 1994).

VII. Soil Analysis

Section 7.1 ~ Methods

Water Content & Bulk Density

Water content is affected by soil's organic matter, porosity and compaction. The higher the organic matter content, the more water the soil can hold. To account for soil's water content is important because it indicates what type and how much vegetation the soil can grow.

Bulk Density is also affects organic matter, soil compaction and porosity. Bulk density is the weight of dry soil per unit of volume (typically expressed in grams/cm³). The volume consists of about 50% solids (about 45% particles and 5% organic matter) and about 50% pore space which can be filled with air or water.

To determine the bulk density and soil water content, we first took 3 samples (and duplicates) with the soil core sampler (see *Section 2.1, Soil Samples*) and brought the soil back to the lab in a small plastic bag. Back in the lab, we weighed 3 soil tins without the soil, put one duplicate in each tin and weighed them again, to find out the weight of our three soil samples. We then put the soil in an oven to dry, checking to see if the soil was dry by occasionally weighing the soil until the weight stopped going down. Once we dried the soil, we calculated the water content and the bulk density. For the water content, we subtracted the weight of the oven dried soil from the moist soil and divided that by the weight of the tin can subtracted from the weight of the oven dried soil. For the bulk density, we subtracted the weight of the tin from the weight of the oven dried soil, and divided that by the volume of the soil sample.

pH

Soil's pH allows us to determine the alkalinity of the soil. Just like in water, the alkalinity determines the buffering capacity of the soil to protect against acidification. A soil pH higher than 7 is more alkaline and lower than 7 is more acidic.

To determine soil pH in the lab, we took a scoop from each of our sample bags and put them into beakers. We then took one scoop (same scoop for a 1:1 volume ratio) of DI water and mixed it in with the soil. We then mixed the solution for 5 minutes, and let it settle for a minute. Then we used a pH strip, and followed the instructions on the pH strip bottle. Ultimately we compared the color of the pH strip to the color chart on the bottle to determine the pH of the soil.

Porosity

Soil porosity refers to the pore space in the soil. Pore space can either be filled with air or water, and that in turn determines how well vegetation can grow in the soil. The amount of water in soil pores is referred to as water-filled pore space. To calculate soil porosity percentage, we divided the soil bulk density by 2.65 (taken from the average bulk density of rock with no pore space) and subtracted that from 1.

Soil Organic Matter

We first took the weight of the three crucibles we used for drying the soil. Then we measured the crucibles with the soil in them. Having both pieces of information, we then burned away all the organic matter on a hot plate. Once it was burned away, we then weighed the crucible with the now burned soil, and the difference in weight of wet soil and dry soil gave us the weight of the soil organic matter in grams. Knowing the weight of the crucible gave us the exact weight (in grams) of the soil both wet and dry.

CaCO₃ – (Calcium Carbonate)

To determine whether or not our soil samples had Calcium Carbonate (CaCO₃) we first dried soil in the oven in a Soil Tin, and waiting for at least 30 minutes to ensure it was completely dry, we added acid to the soil, watching for a fizzing reaction between the acid and the soil. Signs of CO₂ bubbles would tell us whether there was CaCO₃ in the soil.

Soil Nitrogen and Phosphorus

Using the soil samples we brought back to the classroom, we mixed DI Water in with the soil in a beaker, stirred for a few minutes, and let it sit for 5 minutes. We then dipped the respective strips (Nitrogen and Phosphorus) into the beakers, following the directions on the strip bottles.

Section 7.2 ~ Results

For the Control Sample, we found the bulk density to be 0.893 g/cm³, the water content was 0.033 g/cm³, a pH of 7, a porosity of 66.31%, the SOM 26.67%, no CaCO₃, Nitrate 10ppm, Nitrite 0ppm and Phosphate 15ppm.

For the Outflow Sample, we found the bulk density to be 1.675 g/cm³, the water content was 0.37 g/cm³, a pH of 6.5, a porosity of 36.81%, the SOM 62.41%, no CaCO₃, Nitrate 10ppm, Nitrite 0ppm and Phosphorus 30ppm.

For the East Side Sample, we found the bulk density to be 2.107 g/cm³, the water content was 0.009 g/cm³, a pH of 6.5, a porosity of 20.5%, the SOM 15.82%, no CaCO₃, Nitrate 50ppm, Nitrite 0ppm, and Phosphorus 30ppm.

Section 7.3 ~ Discussion

Bulk Density, Water Content and Porosity

The bulk densities for our samples were all over the place. Our control sample, taken on the SW shore of the lake, was considered organic matter (with a bulk density of 0.89g/cm^3). This was visually evident at the sample site with twigs and decaying plant life in the soil. Our outflow sample most closely resembles Sandy Clay Loam (an average bulk density of 1.63 g/cm^3 against our measured bulk density of 1.68 g/cm^3). Our East Side sample had a much higher bulk density than the classifications given, but it is closest to Sandy Clay Loam with a bulk density of 2.11 g/cm^3 . Our measured bulk densities were higher than the ideal amount for sandy clay loam, which is considered to be $< 1.40\text{ g/cm}^3$. This means there is lower soil porosity and therefore a lower water capacity, which restricts plant growth in the soil. In the control sample however, there was a much higher porosity (and therefore water content) because it was much closer to soil identified as organic matter, which is able to hold up to 90% of its weight in water.

Soil Organic Matter

What these data show us is that the soil taken near the outflow has a significantly higher percentage of soil organic matter than the other two samples do. What the outflow tells us is that there is a high water-holding capacity in that soil (organic material holds 90% of its weight in water) and it releases almost all that water back to plants for use, unlike a clay-like soil which holds much water, but retains almost all of it instead of it being available for plant use. Seeing more water and more organic matter in this part of the lake makes sense, because it was taken near the outflow, where the water seeps underground for its outflow rather than flowing into a riverbed. These data also tell us that there should be a bigger reservoir of nutrients in the soil near the outflow sample.

CaCO₃

Given the negative reaction (of an approximate experiment), we can tell there is none or trace amounts of Calcium Carbonate (CaCO₃). This means there is no chemical limestone in the water, which indicates that the soil has a very low buffer zone against Nitrogen.

Soil Nitrogen and Phosphorus

The Nitrogen level is rather low for soil nutrients, in regards to growing crops. An early season measurement (which is what we took) of 20 ppm is sufficient to produce a good corn harvest and 14 ppm is sufficient, if an additional Nitrogen/nutrient source such as animal manure is applied. The low Nitrogen reading in the soil also supports the theory that the high Nitrogen reading in the water comes from a Nitrogen pulse as a result of the snowmelt, rather than groundwater pollution seeping through the soil.

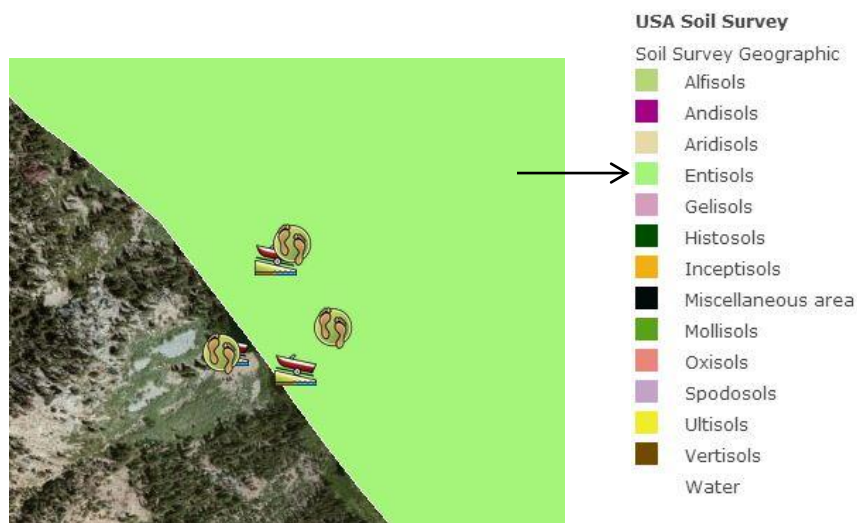


Fig. 10. GIS soil survey. There is entisol soil in the area. Entisol soil is characteristic of possessing only an A horizon, and is unaltered from its parent rock.

Considering the Basin Characteristics study by David Clow, the discussion on steep slopes with un-vegetated terrain was highly relevant. The SW shore of the lake is a steep slope, un-vegetated and covered with young debris not yet eroded (fist-sized rocks and larger). In Clow's study, such environments indicated dilute bodies (of water) because of minimal soil development. This was in accordance with the GIS USA Soils Survey, which indicated an Entisol soil (included above). Entisol soil is characteristic of lacking soil beyond the A-horizon, and is unaltered from its parent rock.

Clow also addressed the low alkalinity these types of lakes have. Again, this corresponded with the finding of our lake, whose alkalinity levels were < 20mg/L. The consequence is the lake has a low buffer to acidification of its environment.

Another feature positively correlated with steep slopes, little vegetation and young debris is runoff. This is in agreement with our findings as well. We found high Nitrogen levels in our lake, and the conclusion is, it is from the recent snowmelt flooding into the lake (Clow 2000).

VIII. CO₂ in the Atmosphere

Section 8.1 ~ Methods

In the atmosphere, there are only two major gases: oxygen and nitrogen. Other gases, such as CO₂ only occur in trace amounts. CO₂ however, is increasing in concentration in the global atmosphere, recently hitting an average of 401ppm in May 2014. CO₂ is a contributing gas to helping heat the surface of the Earth, and with increasing abundance, a contributing gas to global warming. Measuring CO₂ can determine how effected an area has been with CO₂ emissions, and what effects that area might see as a result.

This measurement took two parts: first we set up the field air sampler in the lab, and then we took it out to our lake to run it. To set up the field air sampler (GilAir5 Personal Air Sampler) we poured Barium Hydroxide acid (BaOH₂) into an Erlenmeyer Flask that had a rubber stopper

with a hole for a tube to connect (via rubber tube) to the particulate air filter. We added enough to cover the filter resting in the flask. Once the flask was clamped in place, and the tube connected between the flask and the filter cartridge, we took the system out to the field.

Before setting up the filter cartridge, we weighed the filter, to get an initial weight. Once taken, making sure to wear gloves while working with the filter and cartridge, we connected it to the air sampler.

At the lake, we set the air sampler near the edge of the lake, away from the base of trees, and turned the air circulator (set to 5L/min) on. We let the circulator run for 60 minutes. Once we brought the sample back, we weighed the filter to determine the weight of the particulate matter collected in grams).

Bringing the air sampler back to the lab, we used gravimetric analysis to measure BaCO_3 . We then poured the solution through a pre-weighed filter. To prevent the precipitate from reverting back into a mixture, we rinsed it with barium nitrate as we filtered it. Then we washed it with ammonium nitrate to replace the barium with the ammonium ion. Then we dried it in a drying oven and took a second weight of the filter. We then used the mass of BaCO_3 and the ideal gas law to determine the concentration of CO_2 in ppm.

Section 8.2 ~ Results

The initial weight of the cellulose filter was measured at 0.009g. Our particulates therefore had a weight of 0.11721g. The BaCO_3 had a mass of 0.12621g, and when using the ideal gas law, gave the CO_2 a measure of 294.78ppm.

Section 8.3 ~ Discussion

As a result of our active air sampler, we found that CO_2 in the atmosphere is about 294.78 ppm. This is below the current global average of 401ppm. A lesser concentration means a less powerful CO_2 greenhouse warming effect on the local environment. There are three likely reasons. One, because we are in a higher elevation, we are away from geologic basins that collect atmospheric pollutions (industrial CO_2 emission sources). Two, because of the elevation, there are less concentrations of the gases. Three, because seasonally the region is near the end of Spring, meaning plants are taking in lots of CO_2 for growth. It means that this ecosystem is less effected by CO_2 emissions from industrial sources than areas with greater concentrations of CO_2 .

IX. Atmospheric Deposition

Section 9.1 ~ Methods

Using a bulk sampler allows you to collect both the wet and the dry precipitation in a region's atmosphere. Once you have the deposition, you can check wet deposition for volume, pH and Nitrogen and Phosphorus levels. These measurements allow you to assess what kind of nutrients and pollution might be entering the watershed through the atmosphere.

We used a passive sampling technique – a bulk sampler – to gather our total (wet and dry) precipitation in the atmosphere. The materials we needed were a funnel and screen (which we were missing) that funneled into a smaller, acid washed jar. We let it sit outside for a period of 8 days. Bringing it back to the lab, we measured the volume of the wet precipitate (in ml)

using a graduated cylinder, took the pH using the GLX reader and measured the Nitrogen and Phosphorus using their respective strip tests.

Section 9.2 ~ Results

The precipitation overflowed in our bulk sampler, so we cannot include conclusive results about the precipitation gathered, but what can be included is nutrients and pH. The phosphates were found to be 5ppm, but the Nitrogen had 0ppm. The pH was read at 7.2.

Section 9.3 ~ Discussion

Over the 8 day period of letting our bulk sampler sit out, we collected more precipitation than the sampler could hold. What we ultimately were able to collect was 720 ml of precipitate. We discovered it had a pH of 7.2 and that the precipitate had no Nitrogen in it, and small amounts of phosphates. The lack of nitrogen means that this ecosystem is not receiving any NO_x gases from cars on the other side of the mountain range. A possible explanation for the phosphates is that organo-phosphate pesticides being used in the Central Valley are being carried by the wind over the mountains, and being dumped into the ecosystem as an atmospheric pollutant. Phosphorus is normally a limiting nutrient, which means that there is more demand from plant life for phosphorus than there is phosphorus present. What happens when too much phosphorus enters an aquatic ecosystem is an algal bloom occurs, which ultimately leads to animal life being suffocated (lacking oxygen), which is called hypereutrophication (EPA Phosphorus 2012).

X. Conclusion

Section 10.1 ~ Conclusion

Our analysis of Yost Lake through water, soil and analysis revealed that the lake is largely untouched by anthropogenic sources. The nutrient levels were measured at levels that would be expected by a nutrient pulse from the seasonal snowmelt. The lake is presently at a healthy stage, with the expectation that Nitrogen becomes a limited nutrient in early summer. The alkalinity is rather low (at an average 17.2mg/L near the shore and 20.33mg/L deeper in the lake), which is not surprising in a high-altitude, alpine lake that does not have CaCO₃ in it to help increase the buffer capacity. Ultimately, if acid rain (an anthropogenic source) were to enter this eco-system, Yost Lake would acidify quickly. The soil was found to bring no Nitrogen to the lake, but rather large amounts of phosphates (15-30ppm) in the soil, which may be a result of precipitation seeping into the soil. The atmospheric precipitation again has no Nitrogen in it, which means there are no NO_x gases from cars in the atmosphere, but it has phosphorus in it. This is possibly from organo-phosphate pesticides being sprayed in the central valley, that are being carried by the wind over the mountains and into this ecosystem. The CO₂ was found to be well below the global average, meaning this area is not directly affected by industrial CO₂ emissions.

Given that this is a relatively untouched ecosystem, the best policy management would be to keep the status quo, and to raise awareness. It is highly recommended that current wilderness designations and permit restrictions are kept in place, as they already reduce environmental

impact to these wilderness areas. Action that can be taken is to raise awareness of the vulnerability of this lake. This can include information placed at the trail head, as well as information that is given when permits are handed out.

The policy for other lakes in the area is to stock them with fish (despite being naturally fishless) as this creates recreation, and therefore revenue for mountain towns such as Mammoth Lakes. This would not be advisable for Yost Lake, as there is not enough life in the lake to support the sustenance of the fish, and given the moderately difficult hike up to the lake, is unlikely there would be adequate recreation revenue to make spending the money worthwhile.

In conclusion, it is recommended that current wilderness designations remain in place with the goal to keep the ecosystem healthy and intact, and that recreational policy procedures for more accessible lakes in the Eastern Sierra Nevada not be followed.

References

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XI. Appendices

Appendix A ~ Lake Check-up

Week 1

Control Sample:

Latitude:	37.744259°
Longitude:	-119.096361°
Elevation	9,100 feet
Air Temp:	5°C
Wind Speed:	6 mph
Wind Direction:	30°
Relative Humidity:	32%
Water Temp:	10°C
Conductivity:	39mS/cm
pH:	7
Dissolved Oxygen:	9.5 mg/L

Fig. 11 Control Sample water quality data for week 1

Inflow Sample:

Latitude:	37.744030°
Longitude:	-119.095328°
Elevation	9,100 feet
Air Temp:	12°C
Wind Speed:	2 mph
Wind Direction:	-
Relative Humidity:	29%
Water Temp:	7.2°C
Conductivity:	37 mS/cm
pH:	7.01
Dissolved Oxygen:	9.0 mg/L

Fig. 12 Inflow Sample water quality data for week 1

Outflow Sample:

Latitude:	37.745343
Longitude:	-119.095645
Elevation	9,100 feet
Air Temp:	8°C
Wind Speed:	1 mph
Wind Direction:	30°
Relative Humidity:	32%
Water Temp:	10°C
Conductivity:	36mS/cm
pH:	7
Dissolved Oxygen:	7 mg/L

Fig. 13 Outflow Sample water quality data for week 1

Week 2

Control Sample:

Latitude:	37.744259°
Longitude:	-119.096361°
Elevation	9,100 feet
Air Temp:	10.1°C
Wind Speed:	0
Wind Direction:	-
Relative Humidity:	24%
Water Temp:	11.82°C
Conductivity:	4.8 mS/cm
pH:	7.52
Dissolved Oxygen:	9.9 mg/L
D.O. Corrected	8.183
% Saturation D.O.	120.976

Fig. 14 Control Sample water quality data for week 2

Inflow Sample:

Latitude:	37.744030°
Longitude:	-119.095328°
Elevation	9,100 feet
Air Temp:	14.2°C
Wind Speed:	4.2
Wind Direction:	35°
Relative Humidity:	18%
Water Temp:	11.53°C
Conductivity:	4.4mS/cm
pH:	7.50
Dissolved Oxygen:	9.5 mg/L
D.O. corrected	7.532
% Saturation D.O.	126.134

Fig. 15 Inflow Sample water quality data for week 2

Outflow Sample:

Latitude:	37.745343
Longitude:	-119.095645
Elevation	9,100 feet
Air Temp:	10.2°C
Wind Speed:	2.5
Wind Direction:	65°
Relative Humidity:	29%
Water Temp:	11.13°C
Conductivity:	4.7 mS/cm
pH:	7.45
Dissolved Oxygen:	7.3 mg/L
D.O. Corrected	8.183
% Saturation D.O.	89.204%

Fig. 16 Outflow Sample water quality data for week 2

Week 3

Control Sample:

Latitude:	37.744259°
Longitude:	-119.096361°
Elevation:	9,100 feet
Air Temp:	6.6 °C
Wind Speed:	0
Wind Direction:	-
Relative Humidity:	55%
Water Temp:	9.03 °C
Conductivity:	80 mS/cm
pH:	7.33
D.O.:	10.5 mg/L
D.O. Corrected:	9.0525
% Saturation:	115.990058

Fig. 17 Control Sample water quality data for week 3

Inflow Sample:

Latitude:	37.744030°
Longitude:	-119.095328°
Elevation:	9,100 feet
Air Temp:	5 °C
Wind Speed:	0
Wind Direction:	-
Relative Humidity:	86%
Water Temp:	5.5 °C
Conductivity:	47 mS/cm
pH:	7.35
D.O.:	9.8 mg/L
D.O. Corrected:	9.26976
% Saturation:	105.720105

Fig. 18 Inflow Sample water quality data for week 3

Outflow Sample:

Latitude:	37.745343
Longitude:	-119.095645
Elevation:	9,100 feet
Air Temp:	5.9 °C
Wind Speed:	0
Wind Direction:	-
Relative Humidity:	62%
Water Temp:	8.62 °C
Conductivity:	40 mS/cm
pH:	7
D.O.:	7.5 mg/L
D.O. Corrected:	9.0525
% Saturation:	82.8500414

Fig. 19 Outflow Sample water quality data for week 3

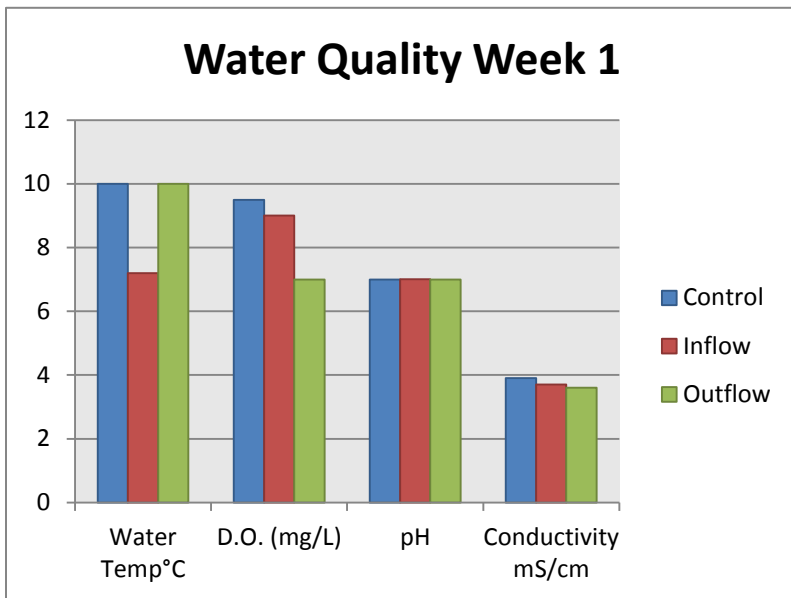


Fig. 20 Water Quality Bar Graph for week 1

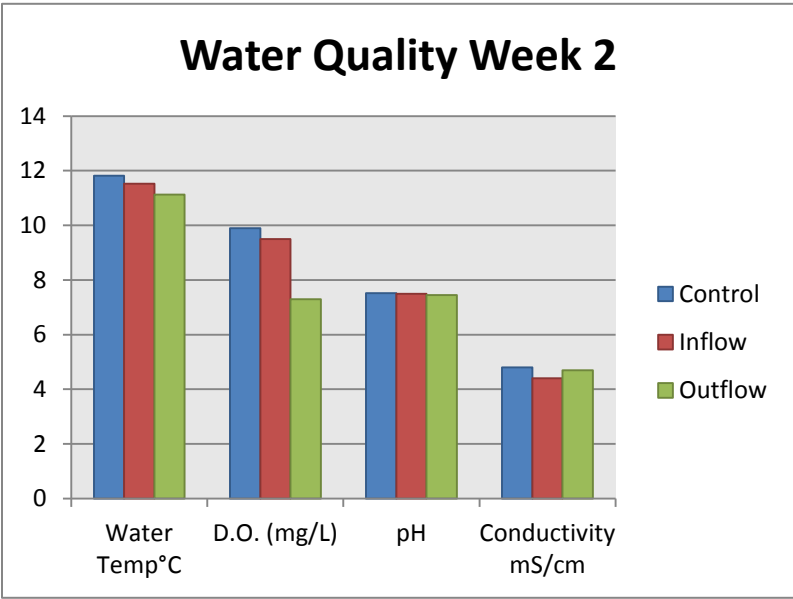


Fig. 21 Water Quality Bar Graph for week 2

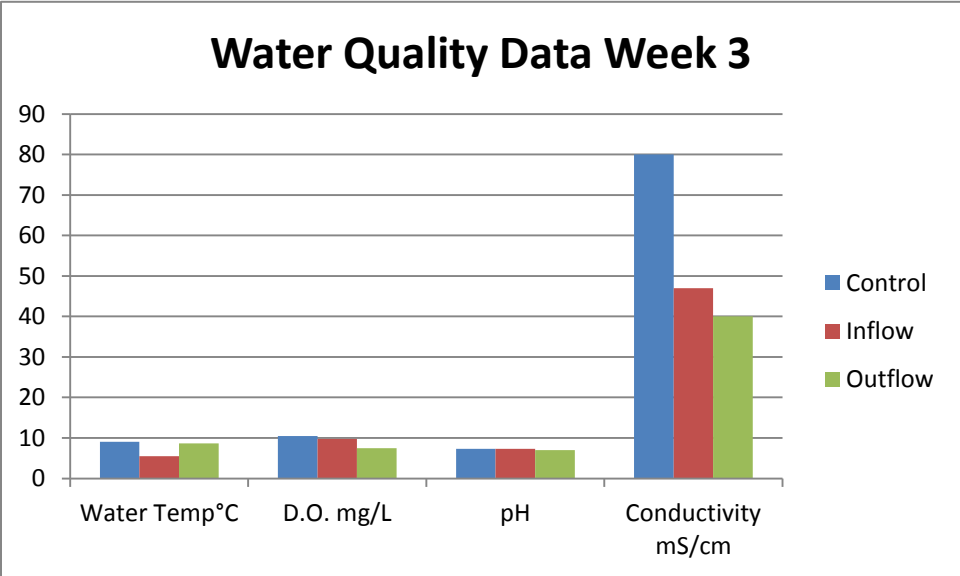


Fig. 22 Water Quality Bar Graph for week 3

Appendix B ~ Alkalinity

Control Sample Trial 1

Addition of .002 M acid	pH levels
0	6.5
1.2	6.3
1.6	6.1
1.9	5.9
2.1	5.6
2.2	5.4
2.3	5.12
2.4	4.85
2.5	4.72
2.6	4.63
2.7	4.51
2.8	4.42
2.85	4.36
2.95	4.25
3.1	4.14
3.4	4.03
3.7	3.92
4	3.84
4.3	3.77
4.7	3.7
5.1	3.63
5.6	3.57
6	3.52
Alkalinity:	16.67 mg/L

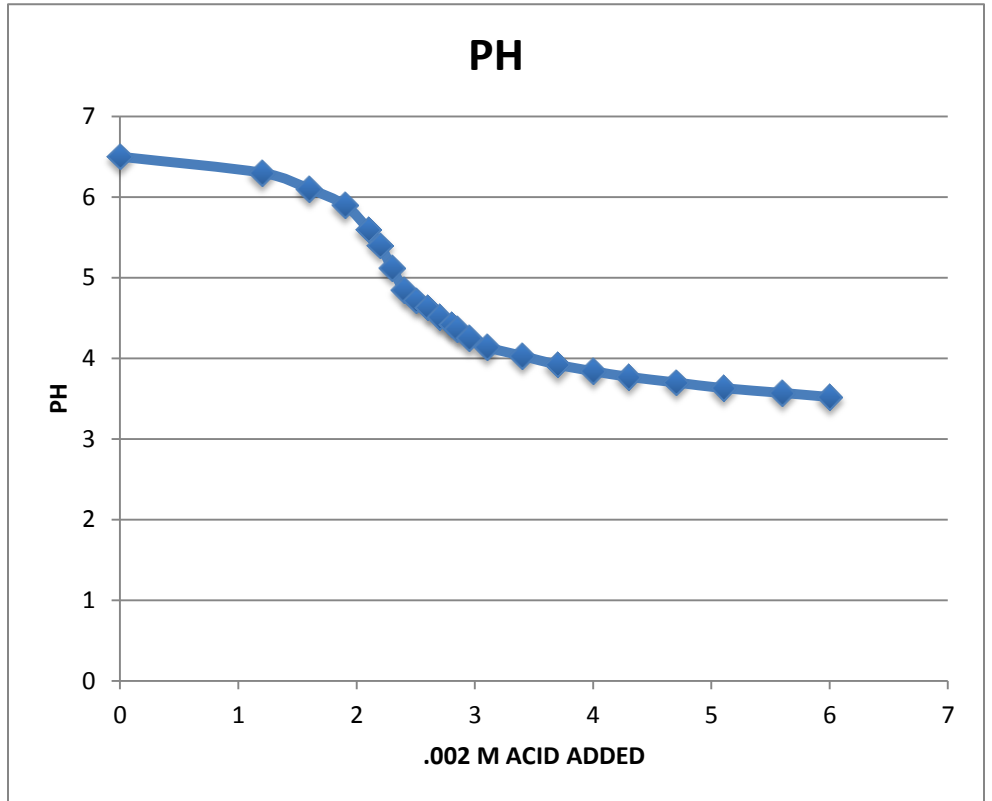


Fig. 24 Control Sample titration graph for Alkalinity Trial 1

Fig. 23 Control Sample data table for Alkalinity Trial 1

Control Sample Trial 2

Addition of .002 M acid	pH levels
0	7.71
0.4	7.25
0.5	7.18
0.6	7.12
0.8	7.08
1	6.88
1.1	6.8
1.3	6.7
1.6	6.5
2	6.25
2.2	5.93
2.4	5.7
2.5	5.46
2.6	5.21
2.7	4.74
2.8	4.55
2.85	4.44
2.87	4.35
2.9	4.3
2.95	4.28
3.15	4.18
3.6	4.0
4	3.87
4.2	3.8
4.5	3.74
5	3.66
6	3.54
Alkalinity:	18 mg/L

Fig. 25 Control Sample data table for Alkalinity Trial 2

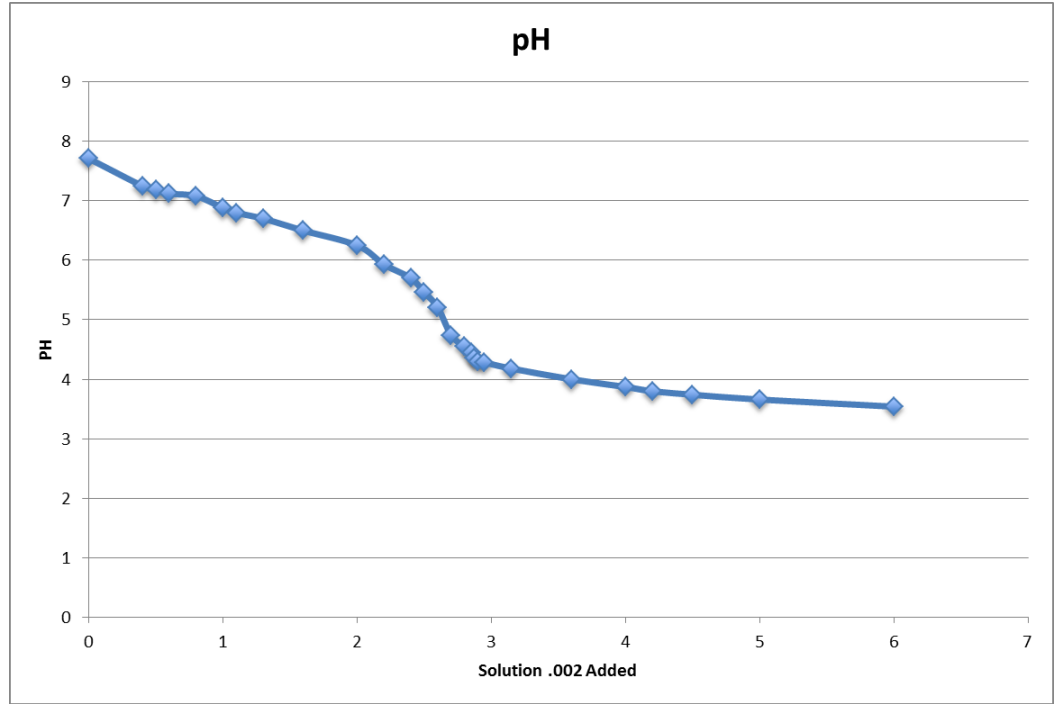


Fig. 26 Control Sample titration graph for Alkalinity Trial 2

Inflow Sample Trial 1

Addition of .002 M acid	pH levels
0	6.78
0.2	6.76
0.5	6.73
0.8	6.71
1.5	6.18
1.8	5.88
2	5.73
2.2	5.44
2.4	4.88
2.5	4.71
2.55	4.6
2.6	4.5
2.65	4.43
2.8	4.29
3	4.18
3.2	4.04
3.5	3.95
3.9	3.85
4.5	3.74
5	3.65
Alkalinity:	16.67 mg/L

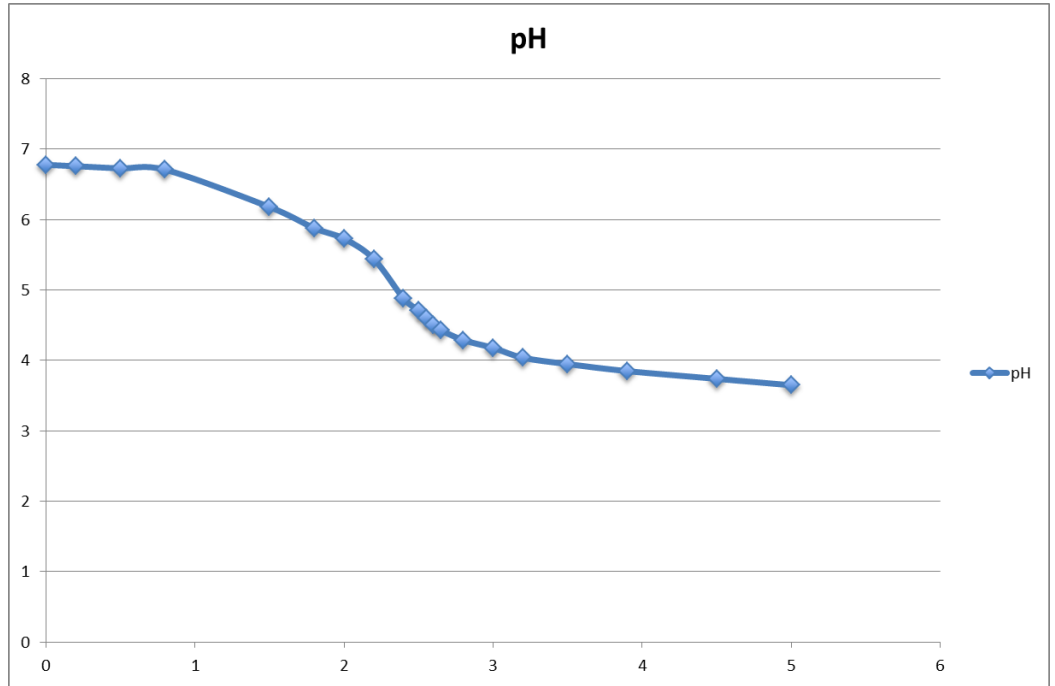


Fig. 28 Inflow Sample titration graph for Alkalinity Trial 1

Fig. 27 I Sample data table for Alkalinity Trial 1

Inflow Sample Trial 2

Addition of .002 M acid	pH levels
0	6.61
0.2	6.6
0.5	6.57
1	6.52
1.5	6.45
2	5.92
2.1	5.78
2.15	5.68
2.2	5.63
2.3	5.43
2.4	5.15
2.5	4.9
2.6	4.72
2.7	4.58
2.8	4.49
2.9	4.37
3.1	4.2
3.3	4.08
3.7	3.96
4.1	3.84
4.5	3.74
4.7	3.68
4.9	3.68
Alkalinity:	16.67 mg/L

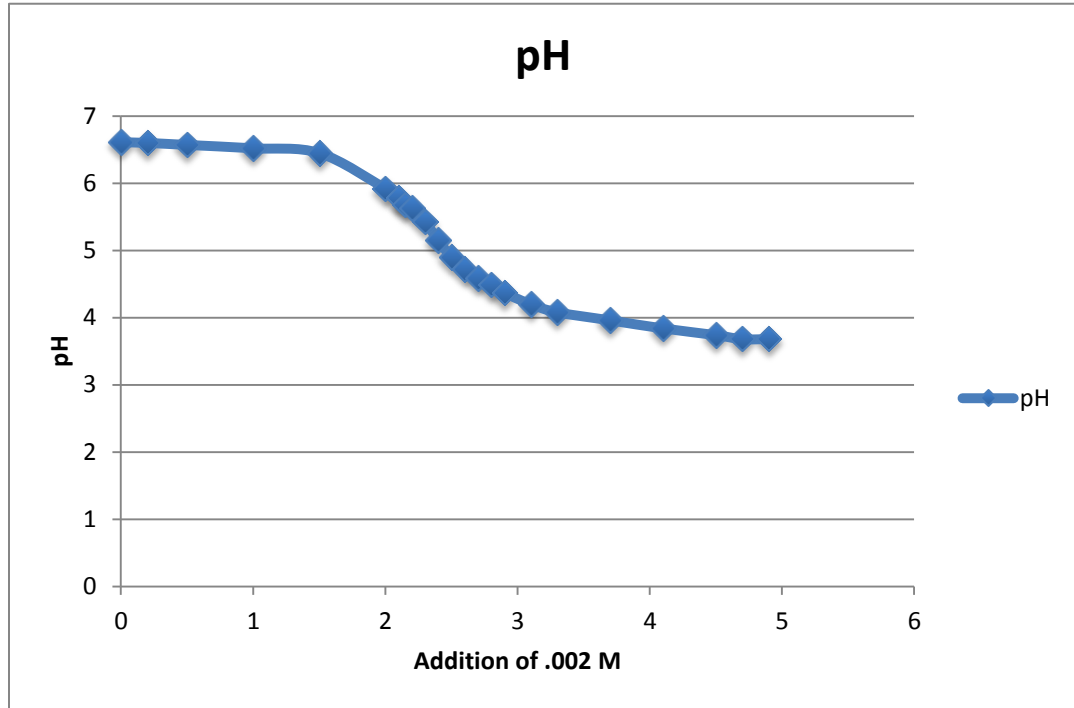


Fig. 30 Inflow Sample titration graph for Alkalinity Trial 2

Fig. 29 Inflow Sample data table for Alkalinity Trial 2

Outflow Sample Trial 1

Addition of .002 M acid	pH levels
0	6.77
0.2	6.76
0.5	6.73
0.7	6.68
1	6.65
1.3	6.56
1.5	6.45
1.8	6.12
2	5.89
2.1	5.7
2.2	5.58
2.3	5.47
2.35	5.32
2.4	5.12
2.5	4.9
2.55	4.78
2.6	4.65
2.65	4.53
2.8	4.38
3	4.24
3.2	4.16
3.4	4.04
3.6	3.95
3.9	3.87
4.3	3.79
4.7	3.72
Alkalinity:	17 mg/L

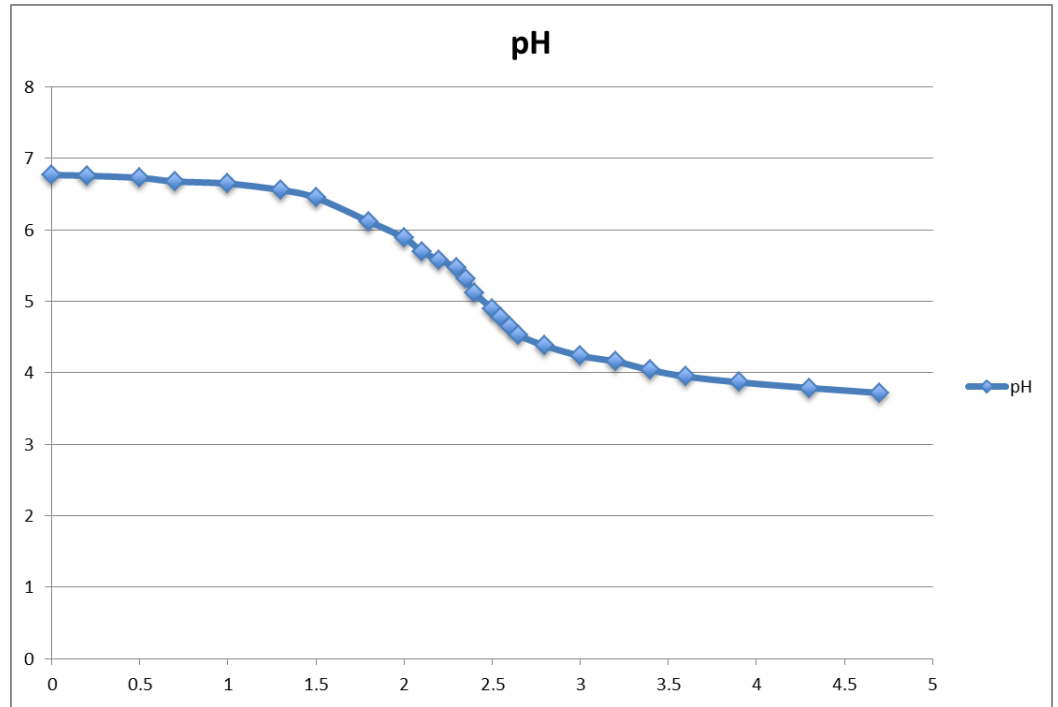


Fig. 32 Outflow Sample titration graph for Alkalinity Trial 1

Fig. 31 Outflow Sample data table for Alkalinity Trial 1

Outflow Sample Trial 2

Addition of .002 M acid	pH levels
0	6.78
0.3	6.73
0.5	6.66
0.7	6.65
1.4	6.48
1.5	6.44
1.7	6.34
2	6.21
2.1	6
2.3	5.75
2.4	5.52
2.45	5.33
2.5	5.14
2.6	4.94
2.62	4.82
2.65	4.71
2.8	4.61
2.9	4.41
3.1	4.3
3.3	4.16
3.5	4.07
3.8	3.95
4.1	3.87
4.4	3.8
5	3.7
Alkalinity:	17.67 mg/L

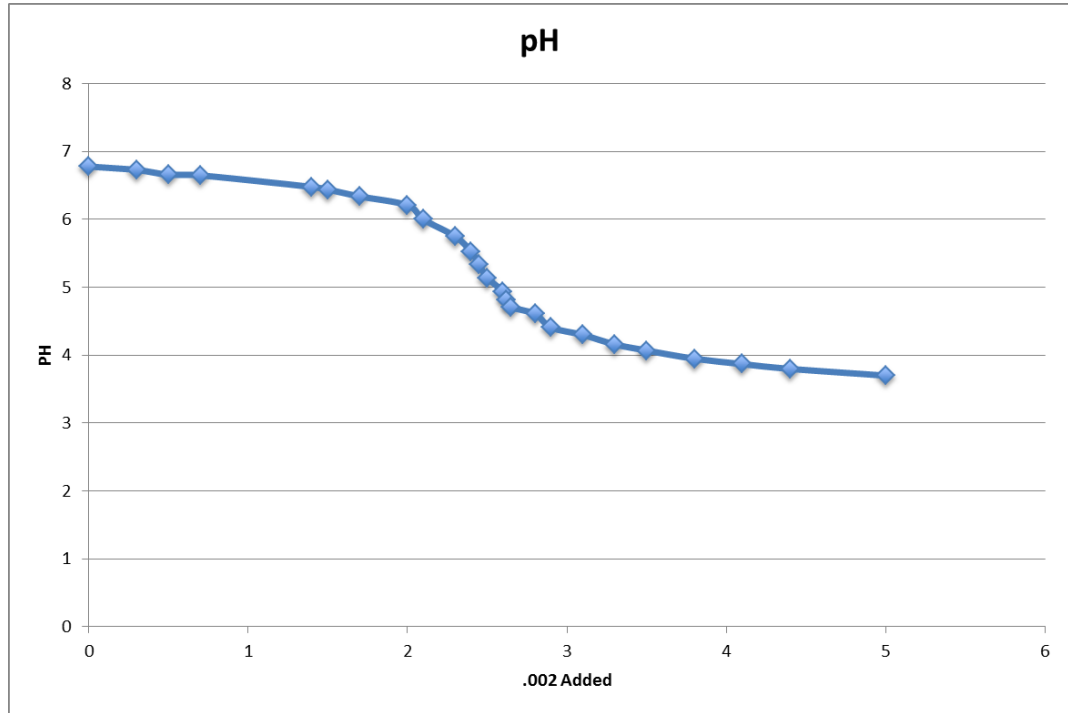


Fig. 34 Outflow Sample titration graph for Alkalinity Trial 2

Fig. 33 Outflow Sample data table for Alkalinity Trial 2

Addition	pH
0	6.83
0.2	6.775
0.4	6.77
0.6	6.76
0.9	6.73
1.1	6.67
1.3	6.54
1.4	6.48
1.5	6.45
1.6	6.43
1.8	6.36
2	6.26
2.1	6.19
2.2	6.09
2.3	6.02
2.4	5.98
2.5	5.92
2.6	5.84
2.7	5.73
2.8	5.52
2.9	5.32
3	5.17
3.1	4.89
3.2	4.68
3.4	4.5
3.5	4.34
3.6	4.24
3.8	4.14
4	4.03
4.2	3.96
4.4	3.89
4.6	3.84
4.9	3.78
5.1	3.73
5.5	3.68
6	3.61
6.5	3.55
7	3.5
Alkalinity:	20.67 mg/L

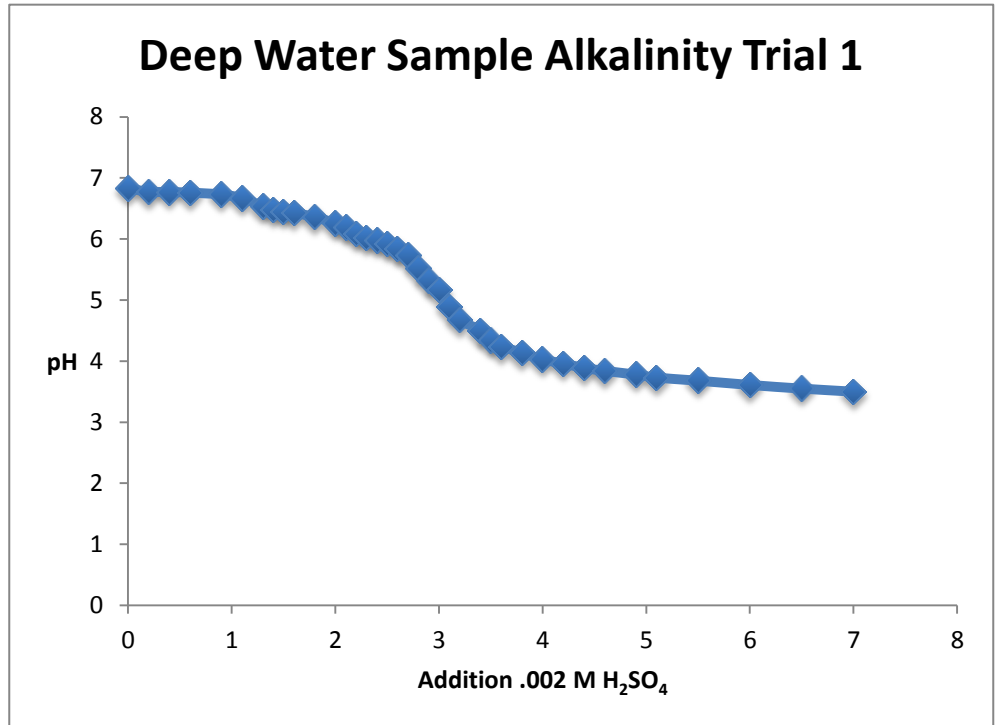


Fig. 36 Deep Water Sample titration graph for Alkalinity Trial 1

Fig. 35 Deep Water Sample data table for Alkalinity Trial 1

Deep Water Sample Trial 2

Addition	pH
0	6.68
0.2	6.66
0.3	6.65
0.5	6.61
0.8	6.56
1.1	6.48
1.3	6.38
1.6	6.2
1.8	6.12
2	5.97
2.2	5.81
2.3	5.74
2.4	5.55
2.5	5.48
2.6	5.35
2.7	5.19
2.8	5.07
2.9	4.88
3	4.72
3.1	4.62
3.3	4.44
3.5	4.29
3.7	4.17
4	4.08
4.3	3.98
4.6	3.89
5	3.8
5.5	3.75
6	3.67
6.5	3.61
7	3.55
Alkalinity:	20 mg/L

Fig. 37 Deep Water Sample data table for Alkalinity Trial 2

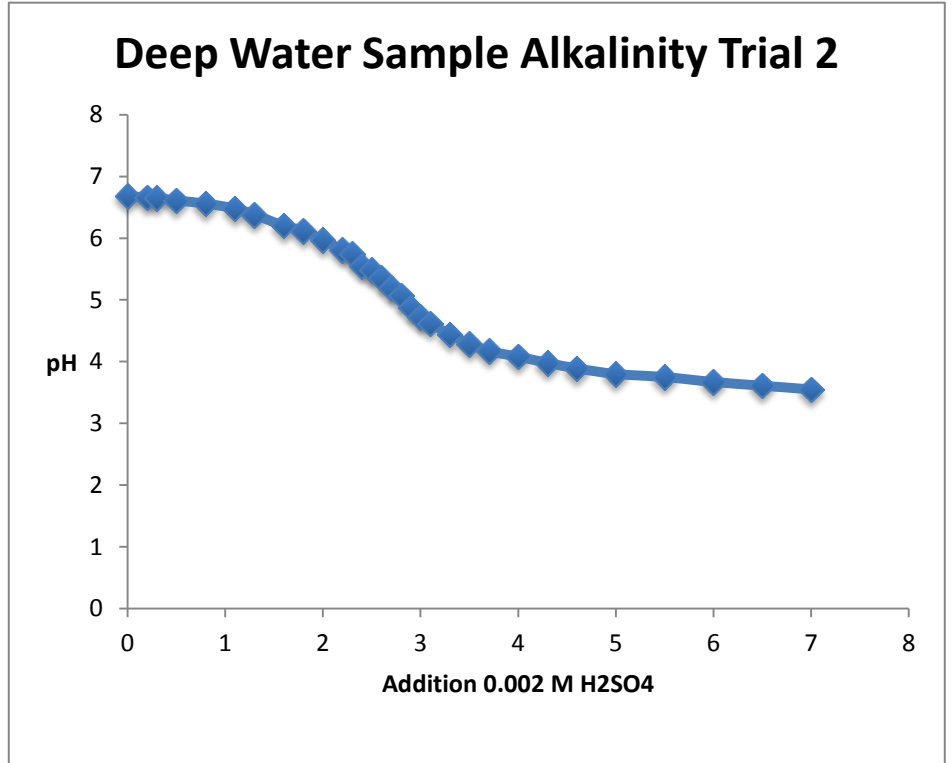


Fig. 38 Deep Water Sample titration graph for Alkalinity Trial 2

Appendix C ~ Nitrogen

Sampling site	Visibility	Nitrogen Level (mg/L)	Visibility 2	Nitrogen Level (mg/L) 2
Control	1.068	27.625	1.141	29.52604167
Inflow	1.08	27.9375	1.06	27.41666667
Outflow	0.921	23.796875	0.945	24.421875
Deep Water	0.85	21.94791667	0.812	20.95833333

Fig. 39 Data table of measured visibilities for the water samples and measured Nitrogen levels for the water samples.

Water Samples Visibility

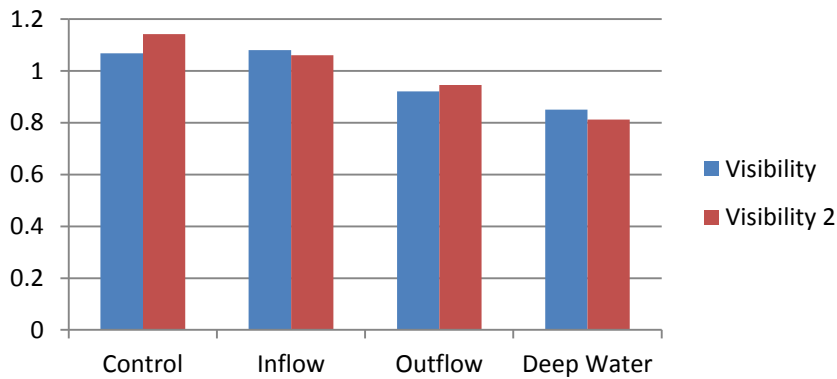


Fig. 40 Bar graph for the measured water sample visibilities with Spectrophotometer.

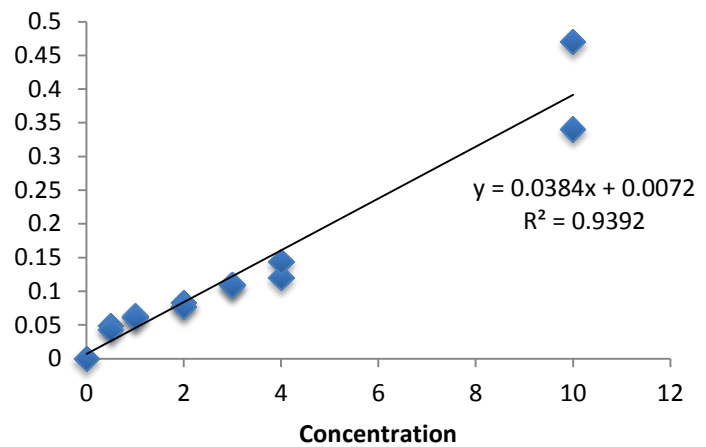


Fig. 41 Linear graph for sample solution standard curve. Used to help figure out Nitrogen levels.

Water Samples Nitrogen Levels

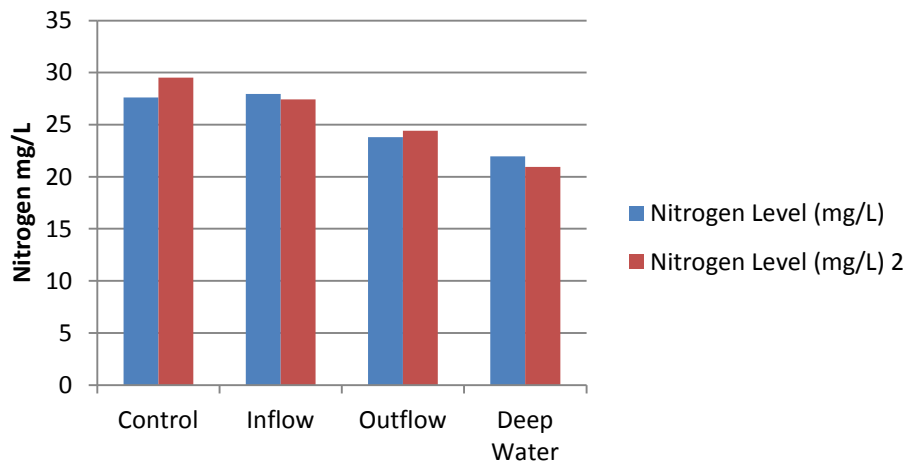


Fig. 42 Bar graph for the measured water sample Nitrogen levels

Appendix D ~ Soil Analysis

	Depth In	Depth cm	Volume	pH	Slope (degrees)	Total Weight (g)	Dry Weight (g)	H2O (g)
Outflow	7.25	18.415	44.2708109	6.5	11.3	90.52	74.133	16.387
Control	5.75	14.605	35.1113328	7	12.95	32.51	31.3467	1.1633
East Side	3.5	8.89	21.3721156	6.5	10.61	45.2128	45.0273	0.1855

Fig. 43 Data table for Soil Sample measurements

	Soil Water Content	Bulk Density	Volumetric Water Content	Porosity %	Water-filled pore space
Outflow	0.22104866	1.67453449	0.3701536	36.8100191	100.5578395
Control	0.03711076	0.89278012	0.03313175	66.3101841	4.996480298
East Side	0.00411972	2.10682465	0.00867953	20.4971831	4.234500799

Fig. 44 Data table for Soil Sample moisture measurements

	Crucible weight	Total Weight	Post Burn Weight	Soil Weight	Organic Content	SOM %
Control	24.2315g	37.0465g	33.6293g	12.815g	3.4172g	26.6656262
East	17.6657g	27.7006g	26.1135g	10.0349g	1.5871g	15.8158028
Outflow	17.7555g	30.514g	22.5509g	12.7585g	7.9631g	62.4140769

Fig. 45 Data table for Soil Organic Matter calculations

	Nitrate (ppm)	Nitrite (ppm)	Phosphate (ppm)
Control	10	0	15
East	50	0	30
Outflow	10	0	15

Fig. 46 Data table for Soil Nutrients

Appendix E ~ CO₂ in the Atmosphere

Filter 1 (g)	0.009
Particulates (g)	0.11721
moles air	0.1549819
μmol CO ₂	45.6852792
ppm CO ₂	294.778151

Fig. 47 Data table for with the atmospheric CO₂ calculations.

Appendix F ~ Atmospheric Deposition

Nitrogen (ppm)	0
Phosphates (ppm)	5
pH	7.2

Fig. 48 Data table for with the viable atmospheric deposition information.