The Effect of Riparian Soil Phosphorus Concentrations on the Phosphorus Levels in Streams, and on the Macroinvertebrate Life Found within the Streams.

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Abstract: When we first observed the data two data concepts seemed most valuable to us. These two data points were phosphorus levels in both soil and water and the presence of water quality indicator species in the streams. We were attracted to these ideas mostly because it was known to us that phosphorus is the limiting nutrient in fresh water environments and is therefore an excellent indicator of how pristine a stream is. Another way to estimate the level of cleanliness of a stream is to look at macro invertebrates that are indicators of good or bad water quality. For example it is commonly accepted that Ephemeroptera, Trichoptera and Plecoptera are indicators of good water quality. On the other hand Chironomidae or the midges tend to be indicators of poor water quality. Using this data and prior knowledge, our goal was to attempt to show that there was a correlation between the level of phosphorus in the soil and water, and an additional correlation between the amount of phosphorus in the water and the ratio of good water quality indicators to poor water quality indicator macro invertebrates.
To make these correlations we gathered the data from our two streams and the data from seven other streams and made the correlations shown below. As some streams were lacking data points our correlations included anywhere from seven to nine streams. The correlations that were found were not as strong as we had hoped they would be but proved to be stronger when we set them up as logarithmic correlations rather than linear ones.

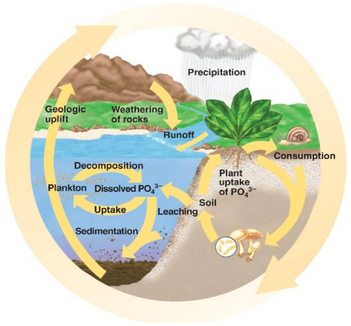
The Story of P

Phosphorus as a Nutrient

Phosphorus is a required nutrient of many plants. In many cases, phosphorus could be considered a "limiting factor", meaning that it limits the population growth of species in a certain environment. Since it can be a limiting nutrient, it is often used as a fertilizer to remove limits on growth. Using phosphorus as a fertilizer also has its drawbacks. Freshwater ecosystems are limited in their plant growth by amounts of phosphorous. This limitation keeps a balance in the river and helps control certain populations that would otherwise grow exponentially. Adding more phosphorous to aquatic environments through runoff from fertilized areas can cause eutrophication (excessive nutrient input). This leads to excessive growth and domination of certain plant species. In the case of Lake Champlain, it leads to algal blooms.

Sources of Phosphorous

Pure elemental phosphorus is actually extremely rare. Typically phosphorous is found as phosphate ions. (Combination of phosphorus and oxygen.) Unlike many nutrients phosphorus is not found in the atmosphere. The main sources of phosphorus are rocks containing phosphate salts, water and organisms. Since rock is a reservoir of phosphates the data showing phosphate amounts in the soil is very significant. Although water is listed above as a location of phosphates, the cause is mostly erosion and the input of phosphate from soil and rock into water. This explains our correlation between soil phosphorus and total phosphorus in the water. Organisms hold phosphorus because plants absorb what they can from their environment since it is an essential nutrient. Phosphorus is then passed down the food chain and eventually cycled back into the water or stored away in rock.



Summary of Phosphorus Tests Done

Total phosphorus is all of the phosphorus in the solution regardless of its form.
Available phosphorus is the phosphorus estimated to be available to organisms.
Water quality P is also a total phosphorous measurement meaning that it is a measurement of all the phosphorus in the solution regardless of its form. (Nuzzo, Chambers 2013)

Table of the stream sites used in our data analysis and what data points were present.

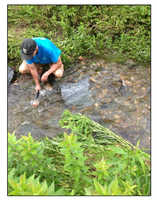
STREAM	Town	School	Phosphorus in Water	Available Phosphorous in Soil	Total Phosphorus in Soil	Macroinvertebrates Data
Pond Brook	Colchester	Colchester High School	YES	YES	YES	YES
Indian Brook	Essex	Colchester High School	YES	YES	YES	YES
Gold Brook	Stowe	Stowe High School	YES	YES	YES	YES
West Branch Little River Tributary A	Stowe	Stowe High School	YES	YES	YES	YES
Black Creek	East Fairfield	Bellows Free Academy Fairfax	YES	YES	YES	NO
Bartlet Brook	South Burlington	Rice Memorial High School	YES	YES	YES	YES
Mill Brook	Fairfax	Bellows Free Academy Fairfax	YES	YES	YES	NO
Lozelle Brook	Duxbury	Harwood Union High School	YES	YES	YES	YES
Dowsville Brook	Moretown	Harwood Union High School	YES	YES	YES	YES
Halls Brook	Newbury	Oxbow	YES	YES	NO	YES

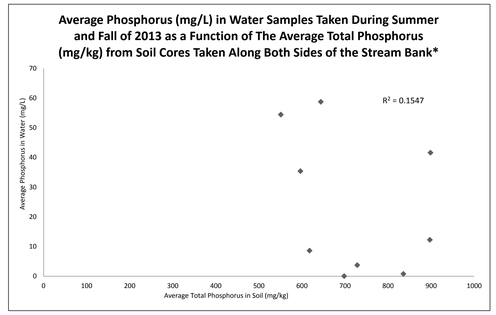
Table showing the R squared values for our different correlations.

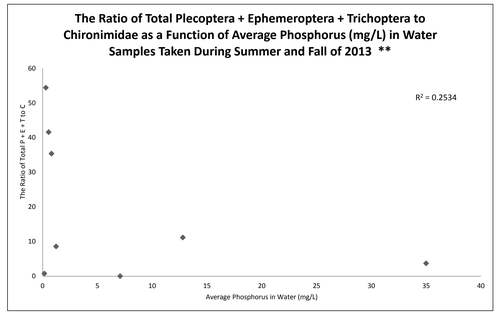
Correlation	R Squared Value
Water Phosphorus vs Soil Total Phosphorus	0.1547
Macro Index vs Water Phosphorus	0.2534
Water Phosphorus vs Soil Available Phosphorus	0.4348
Macro Index vs Soil Available Phosphorus	0.1288

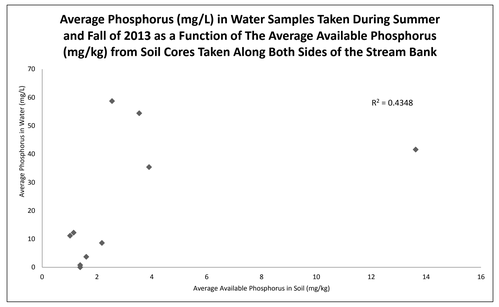
Lower P Level

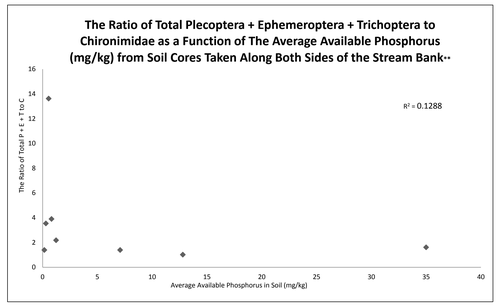
Higher P Level











Conclusion: As is often the case with scientific inquiry the data did not provide perfect support for our hypothesis. None of the correlations, even after they were made to be logarithmic, had r squared numbers over .5. In other words none of our correlations showed a clear trend. When the correlation between the total phosphorus in the soil and the phosphorus in the water was tested, its r squared value was amongst the lowest that we found. The total phosphorus data also did not bare a good correlation to the macroinvertebrate ratio data. What we concluded based off of these findings was that the total phosphorus in the soil was not as valuable an indicator of stream health as was the available phosphorus in the soil.

The correlation between available phosphorus in the soil and the phosphorus in the water was a relatively good correlation. The r squared value was not quite a .5 correlation (0.43). This was expected by us since one of the most significant sources of phosphorus in our river would be runoff from the soil surrounding the stream. Thus high levels of phosphorus in the soils we expected would translate to high levels of phosphorus in the stream.

The second correlation from our data was one between the ratio of TPE/C (total good water quality macros divided by total bad water quality macros) and the amount of phosphorus in the water. In a similar way we correlated the ratio of TPE/C and the amount of available phosphorus in the soil. Neither of these correlations proved to be excellent ones, and were both significantly under 0.5. While our data did not provide concrete support for our hypothesis, we are not convinced that our hypothesis was incorrect. Two explanations for the low r squared values found in our correlations were the limited number of streams we were able to use as data points. If we had had more streams we are confident that the data would better support our hypothesis. Another possible explanation is the fact that none of the phosphorus values in our study were actually that high. Since there were no very high phosphorus levels in our study we are not sure if the levels of phosphorus we found were high enough to have the expected effect on the macro invertebrates.

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