Correlational Analysis of Macroinvertebrate Communities in Response to Watershed Catchment Characteristics in Vermont from 2010-2016 (60 Sites Included)

Corey Davis, Emily Lucie, Tony Wang, Faculty: Scott Worland, Todd Smith

Long Trail School, Dorset, VT

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Introduction

Monitoring macroinvertebrate communities offers a valuable tool to determine the overall water quality and the degree of human disturbance within a watershed catchment. A tremendous amount of work has been done to monitor various sites throughout the state and to build the current online database. Our goal was to analyze macroinvertebrate data from many regions throughout the state, to apply various community indices to this data, and to explore any possible correlations with available G.I.S. catchment characteristics.

What level of correlation exists when many sampling sites across different rivers and throughout the state are aggregated on the same graph?

Will our underlying assumptions about human activity and the benthic community be supported by this broad reaching of an analysis? Are there any unanticipated outcomes? What story might the numbers tell?

Methods

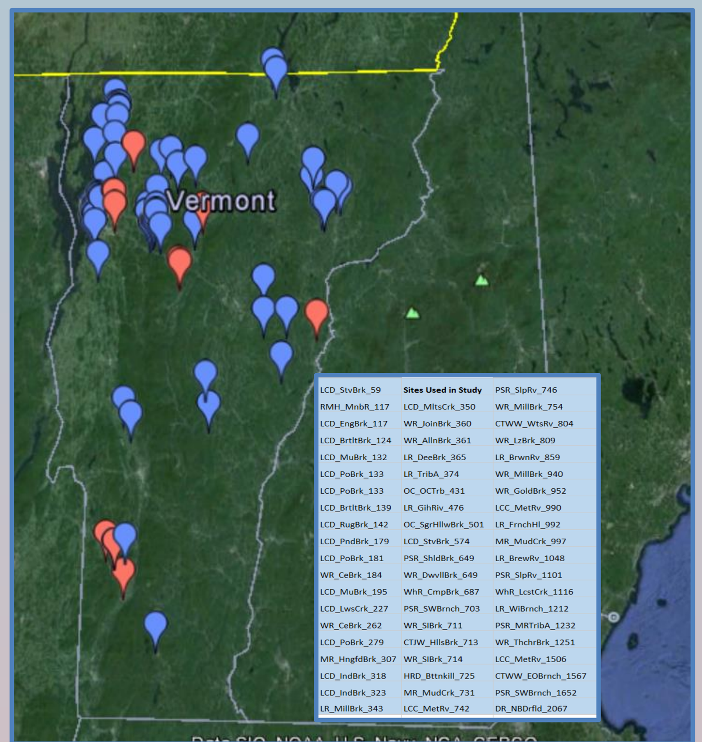
We began by downloading the available macroinvertebrate data from the EPSCoR search website. Due to the large amount of data, this was done in segments of 8-10 sites. The data were sorted into separate spreadsheets using Google Sheets based on the site code and elevation. Since elevation tends to address the rate of human activity, the collective human impact is smaller with increasing elevation. We estimated that elevation would have the greatest influence on the composition of invertebrates. All sheets were formatted and organized to have a similar layout with column designations consistent across each site. This was essential for the metrics calculation tool to work properly.

In order to create a comprehensive community index calculator we needed to ensure that all organisms found at all sites were included. After extensive manual and automated review we developed a data analysis tool that could be applied to any site location to calculate key community information such as density, EPT Index, HBI, Feeding Groups, and Community Composition. This calculator was applied to all sites and values were auto filled on a summary page. The number of replicates found on each site was manually tallied and added to the calculator tool. Sites with more replicates were weighted equally to those with fewer. Four or more collected samples were required for consideration.

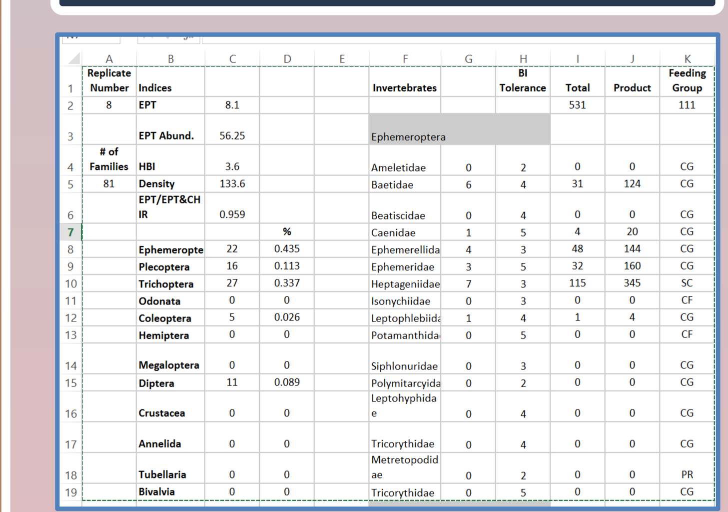
A catchment characteristics G.I.S. summary sheet for all sites was obtained from Lindsay Weiland with CWDD. Values included the size and percent composition of each catchment (forested, agricultural and urban development). We plotted these values against calculated macroinvertebrate indices and other community characteristics with Vernier Logger Pro to determine if a general correlational relationship could be ascertained.

Behind the Streams

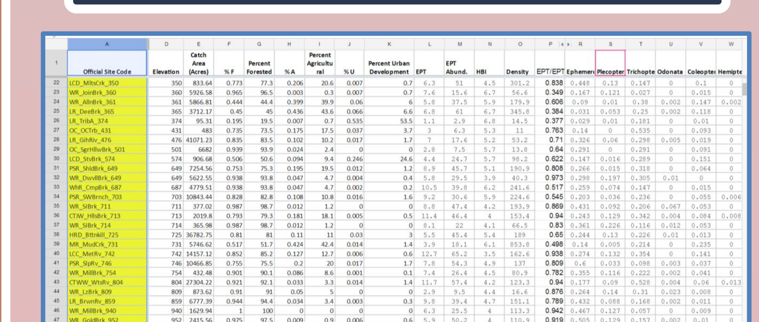
Sites Included in Study

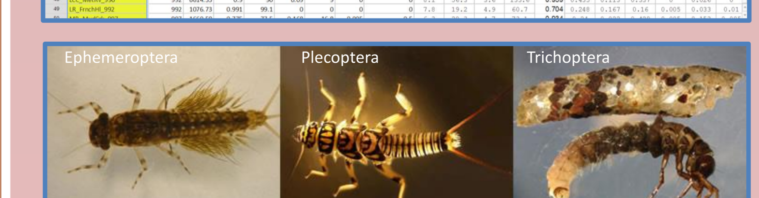


Section of of Metrics Calculator



Sample of Summary Sheet



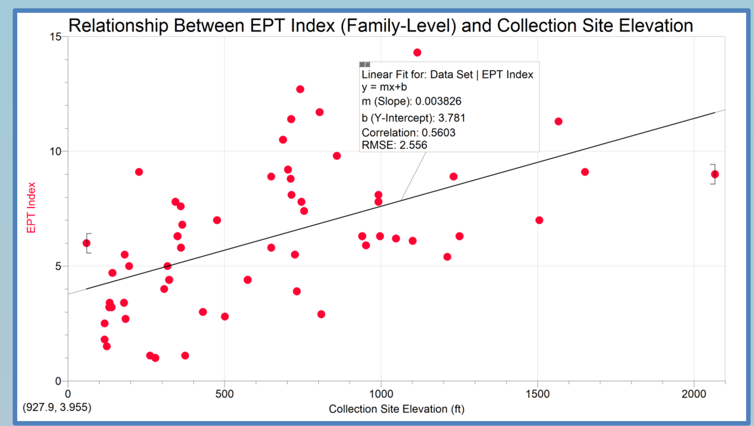


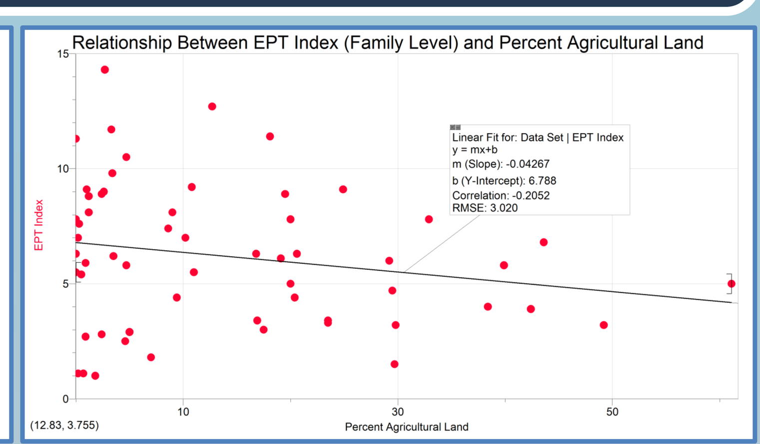
HBI Value	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

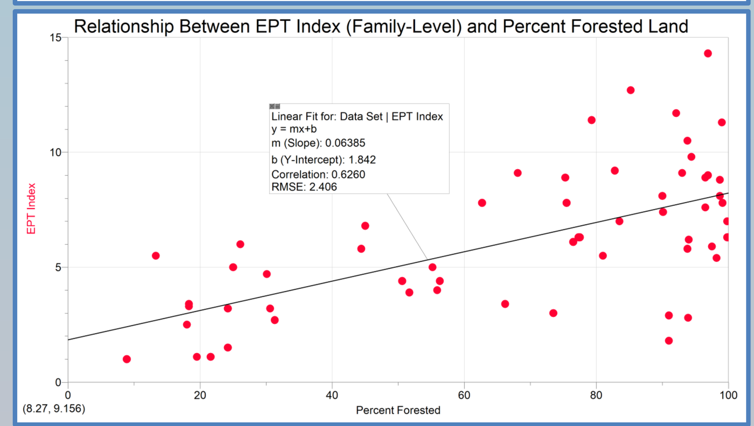
Water Quality Indices

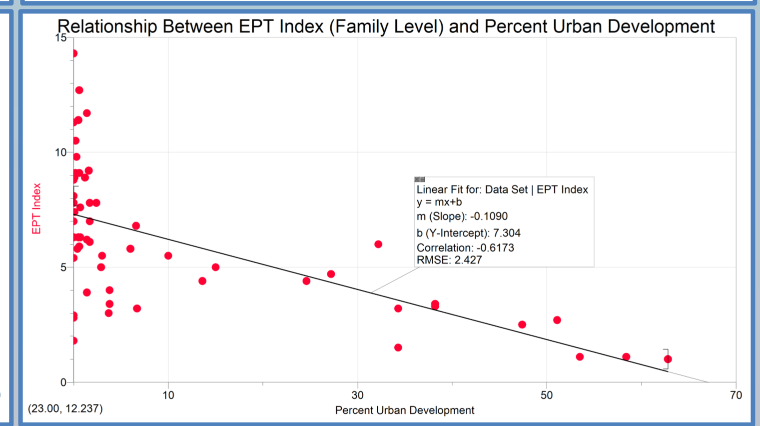
EPT Index Correlations

EPT Index is a richness and diversity index that is determined by the average number of families within the Ephemeroptera, Plecoptera, and Trichoptera orders from a sample. This index tends to be higher in less impacted stream systems.



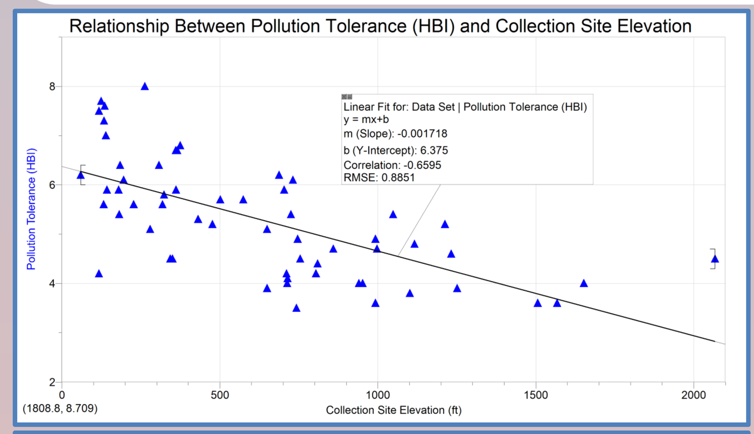


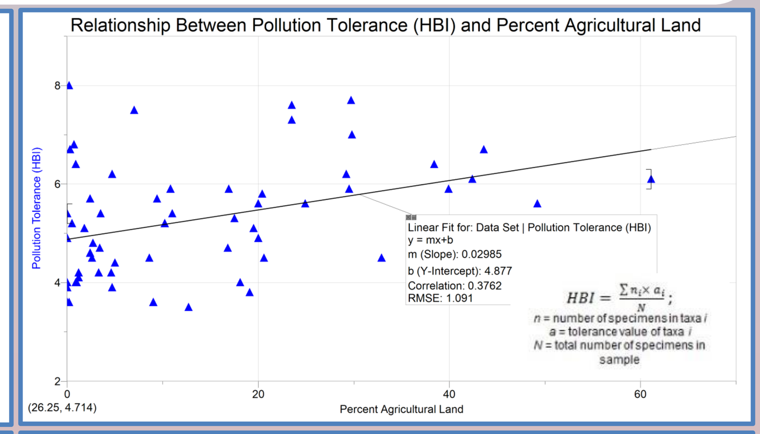


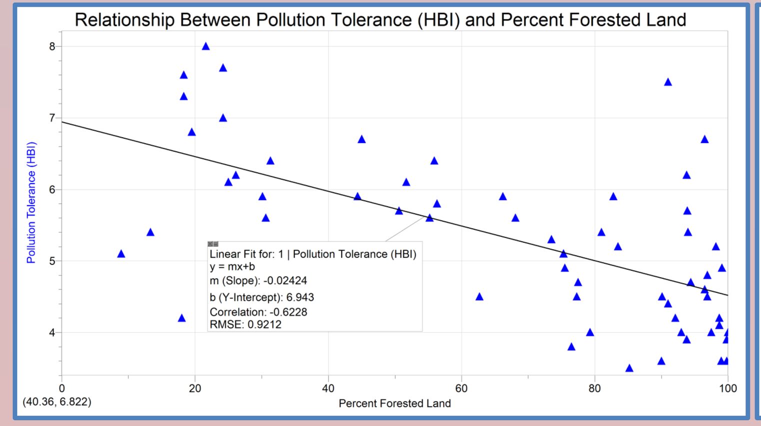


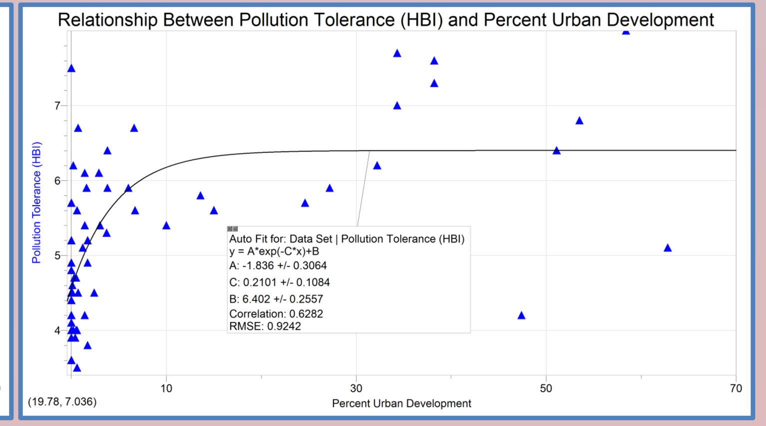
HBI Correlations

Hilsonhoff Biotic index (HBI) is an estimation of the overall pollution tolerance level of macroinvertebrates in an area. It is a weighted average (each family has its own assigned tolerance value). Higher values indicate more pollution-tolerate organisms and lower water quality.



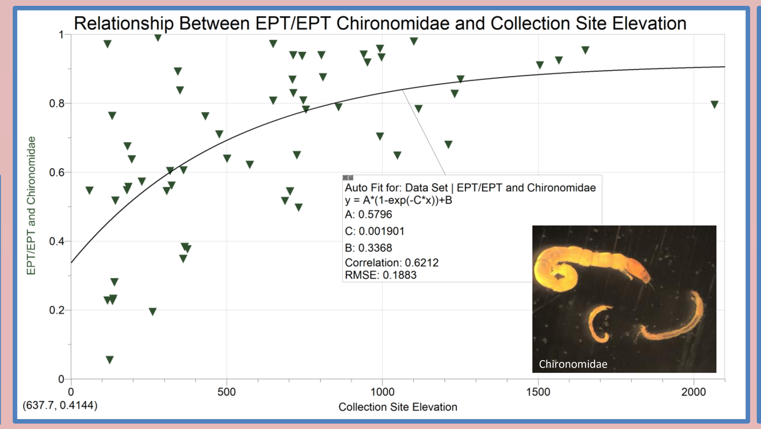


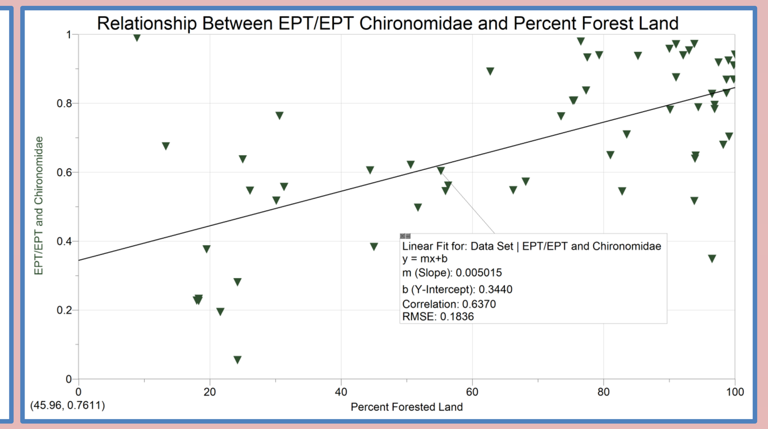




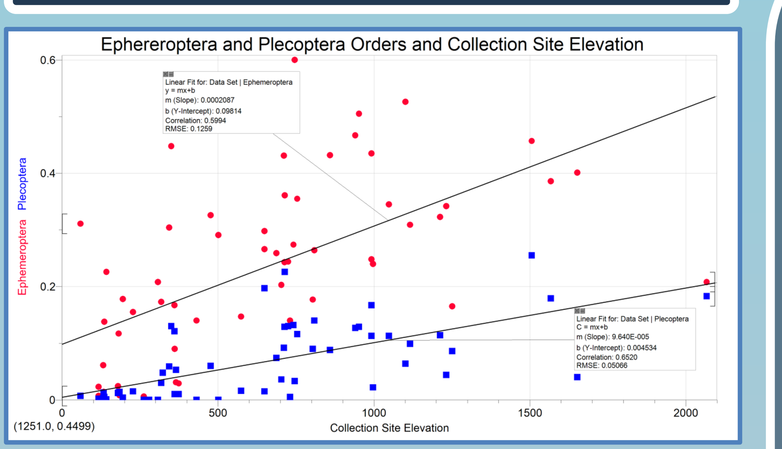
EPT/EPT & Chironomidae Correlations

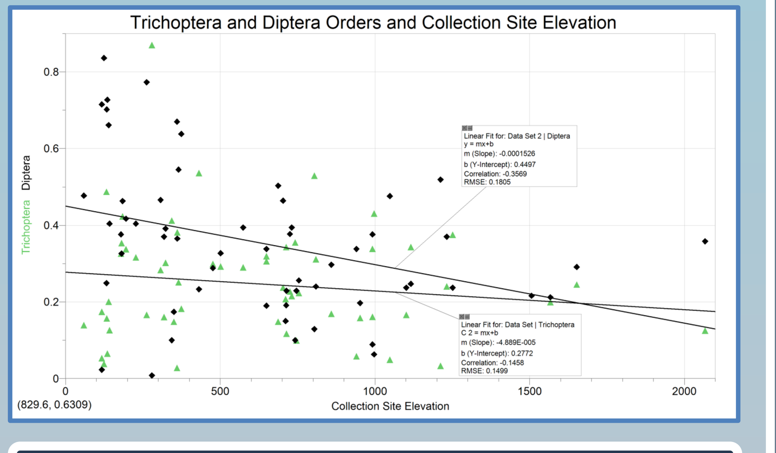
EPT/EPT Chironomidae considers the ratio of the relatively pollution intolerant orders of Ephemoroptera, Plecoptera, and Trichoptera to these same orders and the pollution tolerant Diptera Chironomidae family. Lower values suggest more impacted streams.



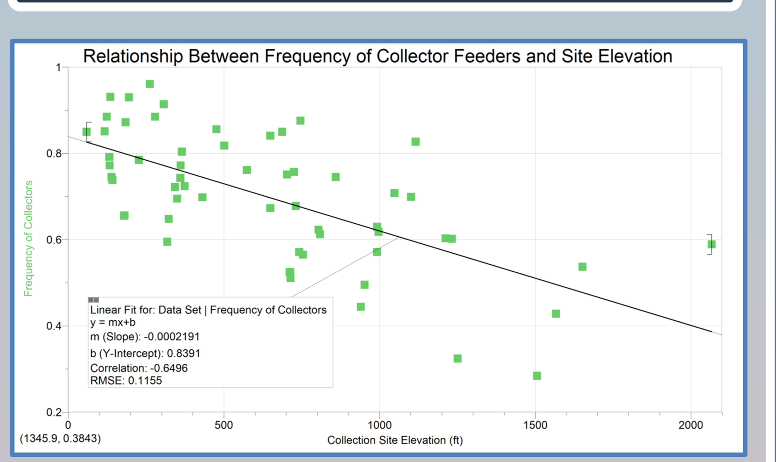


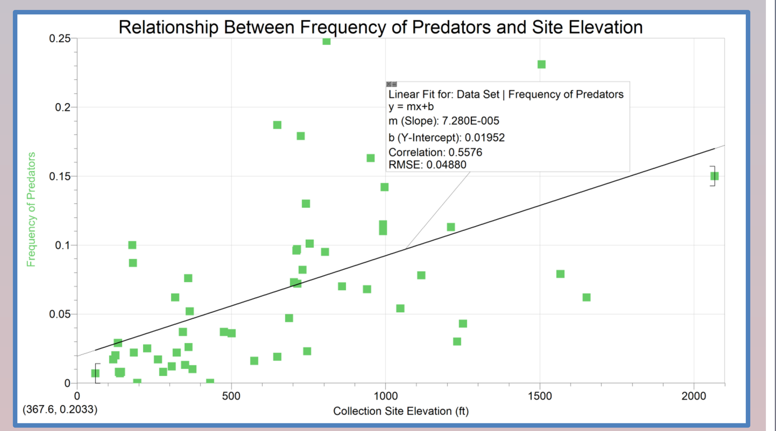
Insect Composition and Elevation

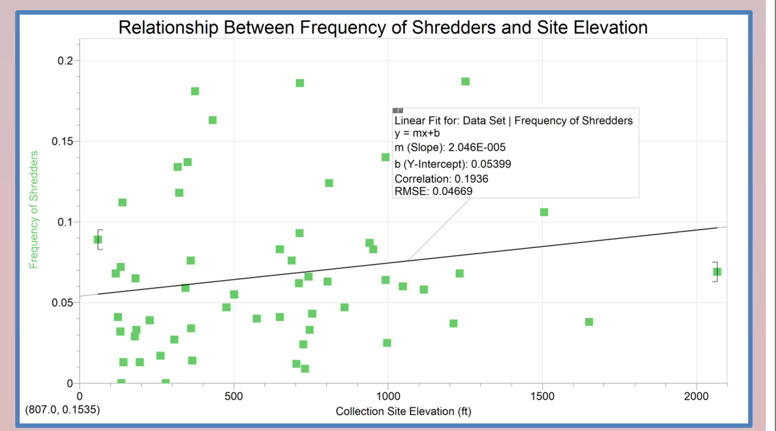


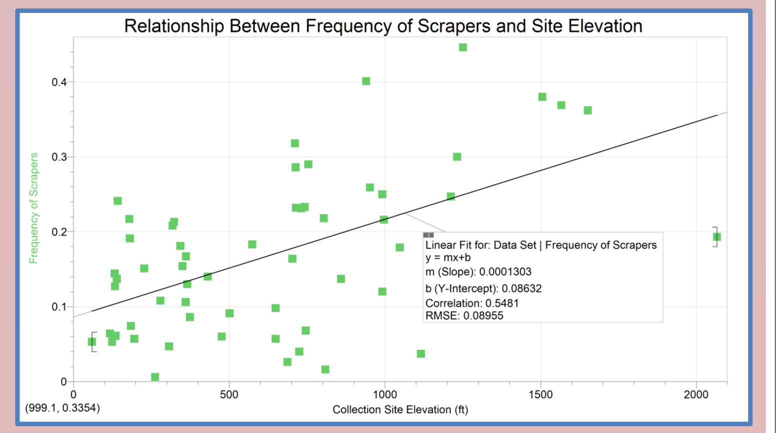


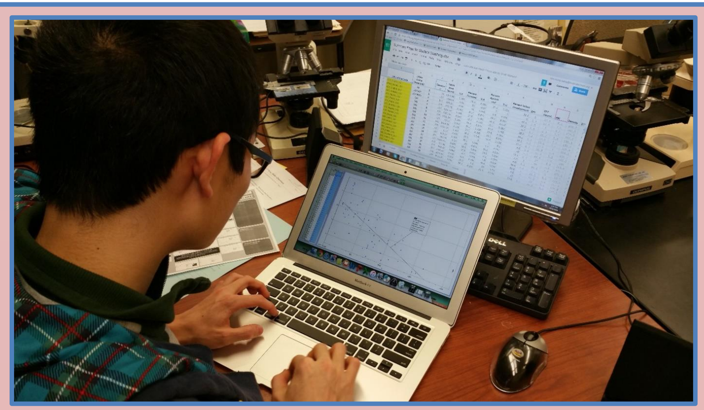
Functional Feeding Groups and Elevation











Conclusions

EPT indices correlate positively with elevation and percent forested land. A negative correlation exists with increasing percent agricultural and urban catchment characteristics. This is explained by the fact that human activities decrease with the rise of elevation and percent forestation, and increase with the rise of percent agricultural and urban development. Since human development usually produces negative effects on biodiversity, the overall correlation is therefore justified.

HBI correlations are, as expected, opposite to the correlations in the EPT analysis because high HBI indicates a higher pollution-tolerant macroinvertebrate community. Higher HBI values are correlated to lower water quality and greater human development (urban and agricultural). Less human impact at higher elevations and increasing percent forested catchments result in low weighted HBI levels. The results were consistent with expected outcomes.

Regarding **EPT/EPT & Chironomidae,** there is a positive correlation between this metric and both elevation and increasing catchment forested area. Catchments of higher elevation and forested area are less impacted by human development and foster more pollution-intolerant Ephemeroptera, Plecoptera, and Trichoptera insects relative to the pollution tolerant Chironomidae Diptera.

Insect orders of Ephemeroptera and Plecoptera are positively correlated with increasing elevation. The population of Ephemeroptera is less strongly correlated with elevation than Plecoptera (smaller R-value), butut it is more strongly impacted by elevation change (steeper slope). A weak negative correlation pattern between Trichoplera and Diptera orders is observed as elevation increases.

The **Functional feeding group** of collectors are most abundant in the lower reaches (lower elevation) due to an increase in particulate organics. Predator abundance is expected to remain more constant across the stream continuum although our analysis suggests a more positive correlation with elevation. Shredder abundance is expected to show a stronger positive correlation to elevation as the higher reaches in the river contain a larger amount of their preferred food- leaf detritus. Scraper populations follow an expected positive correlation to elevation. Lower reaches often contain a sandy substrate that is unsuitable to this feeding group.

In summary, this study combined sample collection sites from multiple rivers throughout the state into a series of single pairings or correlations. It is exciting to see that a generalized pattern can be observed considering the diversity of collection sites, invertebrate identifying scientists, and collection time periods. We look forward to more closely evaluating outliers, adding sample nutrient values, and making our processed spreadsheets available for others to utilize and to improve in the future.