**Introduction**

We decided to test whether increasing amounts of Total Phosphorus present in Vermont streams will have an inverse effect on the populations of Mayfly (Ephemeroptera) and Stonefly (Plecoptera) macroinvertebrates. We chose Ephemeroptera and Plecoptera because they are plentiful in Vermont streams, easy to collect, and, due to their need for dissolved oxygen, they respond quickly to excessive total phosphorus levels. Studies by the State of Vermont and others show that total phosphorus is directly related to the levels of oxygen in the water. Phosphorus is a necessary nutrient for all life forms. When phosphorus increases, plant growth immediately responds both in vitality and in the quantity of plants themselves. The plants then compete with other aquatic life to use the available oxygen in the water. Thus, the greater the phosphorus levels, the lower the oxygen levels that are available for macroinvertebrates to breathe. Additionally, plants at the water’s surface prevent the wind from agitating the water. The amount of oxygen absorbed into the water is then further decreased. The result is that too much phosphorus makes it difficult for Ephemeroptera and Plecoptera macroinvertebrates to survive. We hypothesized that since Vermont has urban areas, agricultural areas and national forests, we would find streams with a wide range of total phosphorus concentrations (see Figure 3). This makes it possible to test our hypothesis that oxygen sensitive macroinvertebrates will respond inversely to phosphorus concentrations.

**Methods**

As participants in the Vermont EPSCoR Streams Project, our methods were as follows:

- Sampled total phosphorus in streams across Vermont twice a month (Figure 1).
- Sent the samples to be tested at University of Vermont (UVM).
- During the sampling period, macroinvertebrates were collected from four different riffles in each stream.
- Selected the different specimens using a random sampling method.
- Identified the macroinvertebrates using the Guide to Aquatic Invertebrates of the Upper Midwest, a Stereoscope, and the assistance of the Biology Department at St. Michael’s College.
- Designated total phosphorus as our independent variable.
- Percentage populations of Ephemeroptera and Plecoptera macroinvertebrates were designated as our dependent variable.
- Retrieved data from eight (8) other stream sites. (Figure 1).
- Averaged the percentage of Ephemeroptera and Plecoptera versus the total phosphorus average of each stream.
- Compared the quantities of Ephemeroptera and Plecoptera to the total phosphorus (ug/L) in each stream site using the correlation coefficient and the R² value.
- Tested our hypothesis by using a regression chart and trophic bar graph (Figures 2 and 3).

**Phosphorus vs. Percentage of E-P**

<table>
<thead>
<tr>
<th>Phosphorus (%)</th>
<th>Percentage of E-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 14 ug/L</td>
<td>0.0201x + 0.677</td>
</tr>
</tbody>
</table>

In conclusion, our study shows, through statistical analysis, that the total populations of Ephemeroptera and Plecoptera are strongly dependent on changes in Total Phosphorus. Ephemeroptera and Plecoptera macroinvertebrates only moderately react to total phosphorus in 0-14 ug/L, which is a healthy range of nutrients for plant and aquatic life. Once the presence of Phosphorus increases beyond the 14 u/L, plant growth explodes and consumes too much of available dissolved oxygen. The result is that Ephemeroptera and Plecoptera macroinvertebrates correspondingly decrease due to lack of oxygen. Our study indicates that the presence of Ephemeroptera and Plecoptera in aquatic environments is a reliable indicator of the health of Vermont Streams. Future experiments might include the relationship between macroinvertebrates and chlorophyll, dissolved oxygen, turbidity or water temperatures to better understand whether the presence Ephemeroptera and Plecoptera in streams is a reliable indicator of clean water from different perspectives.

**Acknowledgments**

We would like to thank: Christine Salda, Alex Huntley, Jason Dalmann and Richard Mackay for helping with the fieldwork, collecting the macroinvertebrates, writing the report, the graphs, the photos and so much more. The Critical and the Civil Society for donating as a member of the state crew, Professor Darren McCabe and his team for regressing the data, Courses for the GPS map and the data, and everyone at UVM, St. Michael’s College and Vermont EPSCoR Streams Project for all of their hard work making the streams project a success.

**References**