Phytoplankton Ecology: Algal Assemblages in Correlation with Water Quality in High Elevation Lakes, North Cascades, WA

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Phytoplankton within high elevation aquatic systems are part of relatively simple food webs and can be influenced by the chemical components of the surrounding environment. This relationship allows phytoplankton assemblages to act as bioindicators in sensitive areas that are regarded as “early-warning” systems of environmental change (Skjelkvik & Wright, 1998). This study builds upon the more in-depth research done by Siana Wong, who received her masters at Huxley. Instead of four lakes, the study area was expanded to seven. The main question was are there differences in the water quality in the seven lakes and if so, does this mirror the phytoplankton assemblages found within?

**Methods**

**Sampling**

Samples were collected in the summer of 2014, by Katy Pfannenstein and Matthew Morassuti, using a sampling pole and were preserved with acidic Lugol’s iodine.

**Scanning Electron Microscopy (SEM)**

The SEM was used to identify algae to a species level. Samples were prepared following the Scientific Technical Services Standard Operating Procedure, substituting distilled deionized water to rinse the samples instead of a Sorenson’s Phosphate buffer (Silver & Gowing, 1991). After an ethanol drying sequence, the samples were critical point dried, mounted on aluminum stubs and sputter coated. Images were acquired using a Vega TS 5126 SEM.

**Relative Abundance Counts**

Algal counts were done by Dr. Matthews using light microscopy. The samples were concentrated using a modified EPA settling technique (EPA, 1994). 100 mL of each sample was settled for 100 hours, after which the top 90 mL was siphoned off. The remaining 10 mL was used for the counts.

**Clustering Statistics**

Scaled centered principal components analysis was used to ordinate the water quality data. Then, lakes were clustered based on the first three principal components using hierarchical clustering with Euclidean distance and Wards minimum variance cluster method (Matthews, personal communication, March 8, 2015). The water quality characteristics used to cluster were dissolved oxygen, temperature, pH, conductivity, chlorophyll a, alkalinity and turbidity. As with the algal counts, Dr. Matthews performed the cluster analysis.

**Results**

**Phytoplankton Families**

Table 1. The relative abundance counts for each lake highlighted some parallels with the clustered water quality data (Figure 2). The Bagley lakes were dominated by diatoms, which generally indicates a different environment from systems dominated by other taxa.

<table>
<thead>
<tr>
<th>LAKE</th>
<th>DOMINATE TAXA</th>
<th>% RELATIVE ABUNDANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heather Meadows Pond</td>
<td>Green Diatom</td>
<td>bloom^</td>
</tr>
<tr>
<td>Picture Lake</td>
<td>Dinoflagellate</td>
<td>53</td>
</tr>
<tr>
<td>Terminal Pond</td>
<td>Chrysophyceae</td>
<td>bloom</td>
</tr>
<tr>
<td>Sunrise Pond</td>
<td>Chrysophyceae &amp; Green Diatom</td>
<td>100</td>
</tr>
<tr>
<td>Upper Bagley Lake</td>
<td>Diatom</td>
<td>100</td>
</tr>
<tr>
<td>Lower Bagley Lake</td>
<td>Diatom</td>
<td>100</td>
</tr>
</tbody>
</table>

*In samples where blooms were occurring, the number of individuals was not counted.

**Figure 2.** The clustering analysis of the water quality data resulted in two distinct clusters: one containing the Bagley Lakes and one containing the other 5 lakes. This graph shows the two clusters when comparing alkalinity and temperature. Overall, the Bagley lake cluster had water quality less favorable to productive conditions.

**Discussion and Conclusions**

The results of the clustering analysis and phytoplankton assemblages were consistent with each other. Systems dominated by diatoms indicate lower productivity, as other taxa such as chrysophytes, require higher levels of nutrients. The Bagley cluster was dominated by diatoms and had water quality less conducive to phytoplankton growth, like lower temperatures. This correlation is further enforced as these results are similar to ones obtained by Wong’s research. Her analysis focused on Upper and Lower Bagley, Highwood and Picture lakes. She found that the Bagley lakes formed a distinct group based on water quality and were dominated by diatoms (Wong, 2013). The results of this research, along with previous data, can be used to create a baseline of the ecology of lakes in the North Cascades. Further monitoring and research of a similar nature for these lakes will be key in detecting any changes that may occur in these sensitive areas in the face of changing climate due to both natural and anthropogenic sources.