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

Anna Nakae
Western Washington University

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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 (Skjelkvåle & 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 these differences in the water quality in the seven lakes and if so, does this mirror the phytoplankton assemblages found within?

Figure 1. The seven lakes sampled were Upper Bagley, Lower Bagley, Highwood, Picture, Sunrise, Heather Meadows Pond and Terminal. All seven are in the headwater watershed of the North Fork of the Nooksack River in the Mt. Baker-Snoqualmie National Forest.

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.

Results

Discussion & 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, 2019). 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.

Acknowledgements

I am incredibly grateful to the many people and entities the helped make this project possible. First and foremost, I would like to thank my independent research advisor, Dr. Robin Matthews. Her passion, expertise and hands-on help with the statistics and identification were key in completing the project, I thank Charles Wanderl and Erin Macri and the rest of the staff with the Western Washington University Scientific Technical Services for the guidance and training necessary for the project. I would also like to thank Katy Pfannenstein and Matthew Morassutti for collecting my samples. Additionally, I am grateful to Katy for helping me navigate the lab and prepare my SEM samples. Finally, I thank Joan Vandersyern and Institute of Watershed Studies at WWU for the water quality data and the laboratory space.

Citations

Introduction & Background

Phytoplankton as Bioindicators

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

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nakaea@students.wwu.edu, annanakae.wordpress.com

Methods

Sampling

Samples were collected in the summer of 2014, by Katy Pfannenstein and Matthew Morassutti, 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.

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.

Figure 3. A future with changing climate could greatly alter the ecology of lakes like Lower Bagley. Photo taken by the Institute for Watershed Studies.

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<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 Cyanobacteria</td>
<td>Bloom* 53</td>
</tr>
<tr>
<td>Terminal Pond</td>
<td>Dinoflagellate</td>
<td>Bloom 100</td>
</tr>
<tr>
<td>Sunrise Pond</td>
<td>Chrysophyta</td>
<td>Bloom 100</td>
</tr>
<tr>
<td>Upper Bagley Lake</td>
<td>Diatom</td>
<td>Group 1</td>
</tr>
<tr>
<td>Lower Bagley Lake</td>
<td>Diatom</td>
<td>Group 2</td>
</tr>
</tbody>
</table>

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

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