Stream Periphyton Community Dynamics under Varying Natural and Anthropogenic Factors

by

Emily Porter-Goff

An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the degree of

DOCTOR OF PHILOSOPHY

Major Subject: Biology

The original of the complete thesis is on file
In the Rensselaer Polytechnic Institute Library

Examining Committee:

Sandra Nierzwicki-Bauer, Thesis Co-Adviser

Charles Boylen, Thesis Co-Adviser

Blanca Barquera, Member

Marianne Nyman, Member

Bradford Lister, Member

Rensselaer Polytechnic Institute
Troy, New York

December, 2010
(For Graduation December, 2010)

ABSTRACT

Stream productivity is a result of natural and anthropogenic parameters of the subwatershed. Studies have shown that periphytic communities change in composition, biomass and function in response to these parameters. Understanding the effect of individual stressors is important for limiting human impact. To address this, several studies were carried out to isolate periphyton responses and interactions as a function of environmental stressors. These studies were conducted within three streams in the Lake George watershed, ranging from low to moderate development, which provided a gradient of development.

A baseline of the periphyton community along the gradient of development was initially established. Periphyton was collected and quantified (as algae, bacteria, and fungi) from both natural and artificial substrates during the summer of 2007. Results varied between substrates. However, the general trend was that the more developed sites supported significantly more periphytic growth than the less developed sites. Seasonal effects had greater impacts. Algal and fungal growth peaked early in the sampling period whereas, bacterial abundance and total organic material had the highest accumulation at the end of the growing season. These results indicate that periphyton increases in biomass and changes in community structure as a response to factors associated with anthropogenic development.

Human impact on streams often manifests as increased or altered nutrient availability. The periphyton community affected by these impacts would have an altered response to additional nutrients. To evaluate responses to additional nutrients, a nutrient diffusing substrate experiment was carried out to evaluate limitation by nitrogen, phosphorus, or nitrogen & phorphorus on glass and wood substrates. Periphyton from the nutrient amended substrates was analyzed for algal, bacterial and fungal biomass. Results indicated that substrate type and season had a stronger effect on growth than nutrients and indications of nutrient limitation were rare.

Periphyton communities had a stronger response to natural parameters from within their stream. Therefore it was hypothesized that if an intact community was taken from one stream and transferred to a second stream with higher levels of development,

and vice versa, the communities would adapt to more closely resemble the community structure of the second stream. Artificial wood substrates were deployed into the most and least developed streams. After a three-week acclimatization period, experimental groups of substrates were relocated to the second streams. Following the secondary acclimatization period, substrates were analyzed for ash free dry mass, chlorophyll *a* concentrations, ergosterol (a fungal biomarker), bacterial populations and diatom assemblages. Total organic matter, chlorophyll *a* concentrations, bacterial populations and diatoms from transferred communities most resembled their original colonized stream communities. These data disprove the original hypothesis and instead suggests that periphyton communities create their own microenvironment within the periphyton matrix which mediates the assimilation of impacts from the greater environment.

Previous work on Adirondack stream periphyton has established that there is a relationship between bacterial populations and diatom diversity. In this study, the community composition of diatoms and bacteria were analyzed for associations in order to clarify this relationship. PCR amplified 16S rRNA genes from total DNA extracted from periphytic bacteria were cloned and sequenced to determine taxonomic identifications. Slide mounted diatoms were classified to the species level. The streams examined each supported unique diatom communities but similar bacterial communities. From these data no relationship was established between bacterial and diatom diversity, suggesting that bacterial abundance, rather specific phylogenetic type, is the most important factor for diatom diversity.

The periphyton community is a viable model for assessing anthropogenic and natural environmental factors in an aquatic system. The data collected provides a baseline for further investigations for of these factors within the Lake George Watershed as well as providing a model for use in other aquatic systems.