CYANOBACTERIAL NITROGEN FIXATION IN SUBALPINE, OLIGOTROPHIC
WATERSHEDS: SPATIAL AND TEMPORAL VARIATIONS

by

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ABSTRACT

Cyanobacterial Nitrogen Fixation in Subalpine, Oligotrophic Watersheds: Spatial and Temporal Variations

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I conducted field surveys and experiments to examine the role of dinitrogen (N\textsubscript{2}) fixation in oligotrophic lakes and streams in the Sawtooth Mountains of Idaho. N\textsubscript{2} fixation surveys in three inlet-lake-outlet systems showed that N\textsubscript{2} fixation rates were higher in outlet than inlet streams and high between 0.5 – 5 m in the benthic zone of lakes. Scaling N\textsubscript{2} fixation rates to whole lakes and streams revealed that N\textsubscript{2} fixation could contribute nitrogen (N) equal to 12, 18, and 32\% of the nitrate flux into three lakes and 4, 15, and 136\% into three outlet streams on a single day in July. These comparisons are conservative, as N\textsubscript{2} fixation estimates made using our slurry incubation technique are underestimated 7.5 ± 1.8 (SE) times compared to less disturbed algal communities. Comparing N\textsubscript{2} fixation rates to stream nitrate and ammonium uptake rates revealed that N\textsubscript{2} fixation rates in two outlets were statistically similar to nitrate uptake rates and between 10 and 100\% of ammonium uptake rates, suggesting an important role for N\textsubscript{2} fixation in these streams.
Experiments showed the temperature and nutrient supply interacted to control N₂ fixation rates in Sawtooth mountain streams. A field bioassay using nutrient diffusing substrata (NDS) showed that N additions, with or without simultaneous P addition, suppressed N₂ fixation by 73% at 9 of 19 study sites. P additions alone significantly stimulated N₂ fixation by an average of 2500% at five sites. A reciprocal transplant experiment where periphyton were grown on NDS in a cold lake inlet (7.1°C) and a warm lake outlet (18.0°C) showed that periphyton on P-enriched NDS grown in the warm outlet had the greatest N₂ fixation rates and largest percentage of N₂ fixing taxa of any treatment. These results were confirmed by a streamside temperature experiment using cold (13° C) and warm (18° C) mesocosms. After 45 days, warm temperatures and P enrichment stimulated *Anabaena* sp. in the periphyton community and caused the greatest rates of N₂ fixation in the experiment, indicating that N₂ fixation and periphyton community composition were controlled by both temperature and P supply with temperature modulating the response to P.