

Influence of experimental, environmental, and geographic factors on nutrient limitation patterns in freshwater streams

Whitney S. Beck¹, Amanda T. Rugenski², and N. LeRoy Poff¹

¹Department of Biology and Graduate Degree Program in Ecology, Colorado State University

²Department of Ecology and Evolutionary Biology, Cornell University

Abstract. Stream algal growth is often limited by the availability of nitrogen, phosphorus, or both nutrients. For over thirty years, investigators have completed nutrient diffusing substrata (NDS) experiments to quantify algal nutrient limitation. Previous meta-analyses of NDS have shown that algae are commonly co-limited by nitrogen and phosphorus, and that in-stream nutrients are weakly predictive of limitation. However, no meta-analysis has comprehensively addressed the experimental, environmental, and geographic covariates affecting NDS experiments. We surveyed the literature and extracted data for algal biomass effect sizes and 30 potential covariates (n = 649 experiments). We built meta-regression models to identify significant covariates and gain insight about algal ecology. We found that experimental methods significantly changed the degree of nutrient limitation in phosphorus treatments. Furthermore, environmental variables such as in-stream nutrients, season, light, temperature, stream discharge, and stream velocity significantly affected nutrient limitation. Land use and ecoregion were also important predictors of nutrient limitation, whereby land uses with greater nutrient loadings and ecoregions with higher population development had smaller effect sizes. From these conclusions, we provide recommendations for future experiments and advocate greater reporting of environmental covariates and algal stressors such as herbivory and streamflow disturbance.