Re-evaluating the relationship between nitrogen and algae blooms in Florida springs

James B. Heffernan[1,2], Matthew J. Cohen[1], Thomas K. Frazer[3], Jason M. Evans[1], and Dina M. Liebowitz[4]

[1]School of Forest Resources and Conservation, University of Florida, Gainesville, FL 32611-0410
[2]Water Institute, University of Florida, Gainesville, FL 32611
[3]Department of Fisheries and Aquatic Sciences, University of Florida, Gainesville, FL 32653
[4]School of Natural Resources and the Environment, University of Florida, Gainesville, FL 32611

Abstract

Nitrate (NO_3^-) concentrations in many Florida springs have increased significantly over the past fifty years, primarily owing to increasing inputs from urban and agricultural sources. Observed changes in the vegetative character of springs and associated runs during the same time period, particularly the increase in nuisance algal blooms, have often been attributed to alleviation of nitrogen limitation. Policy and management aimed at preserving and restoring spring ecosystems have therefore focused largely on NO_3^- reduction and remediation efforts in springsheds, despite the weakness of evidence supporting a causal relationship between NO_3^- inputs and algal abundance. Using available data on discharge, channel morphometry, and primary production, we constructed nitrogen mass balance estimates for hypothetical and actual spring runs under a variety of assumptions regarding NO_3^- concentrations, plant and algal nitrogen content, and rates of internal nutrient recycling. Even under the most generous assumptions (low historical nitrate concentrations, no internal nutrient recycling, high tissue nitrogen content, and high primary productivity), NO_3^- inputs greatly exceeded demand by submersed aquatic vegetation, suggesting that nutrient availability is (and was) unlikely to constrain algal and macrophyte growth in springs. These results are consistent with studies showing that nutrient concentrations are generally poorly correlated with gross primary production and macroalgal abundance in both space and time. While our general conclusion is that alleviation of nitrogen limitation is unlikely to have been the primary cause of changes in vegetative character in most springs, several other strong rationales remain for reducing NO_3^- loading (downstream N-limited aquatic systems, animal nitrate toxicity, human health). Further testing of viable alternative hypotheses, including the importance of grazers as regulators of algal biomass, are needed to inform management and policy decisions aimed at protecting the ecological integrity of Florida springs.

Keywords: macroalgae, nitrate, springs, mass balance, nutrient limitation

Topic: Nutrient enrichment of surface, ground and coastal waters