

ASSESSING BIOLOGICAL RESPONSES TO NITROGEN AND PHOSPHORUS LEVELS ACROSS THE SOUTH CAROLINA COASTAL ZONE

Dianne I. Greenfield^{1,2}, Charles Keppler², Larissa Brock², Michelle Reed³,
Suzanne Kacenas¹, Sarah Hogan², and Robert Van Dolah²

AUTHORS: ¹ Belle W. Baruch Institute for Marine and Coastal Sciences, University of South Carolina, Columbia SC 29208
² Marine Resources Research Institute, SC Department of Natural Resources, Charleston SC 29412
³ Grice Marine Program, College of Charleston, Charleston SC 29412

REFERENCE: *Proceedings of the 2012 South Carolina Water Resources Conference*, held October 10-11, at the Columbia Metropolitan Convention Center.

It is generally accepted that elevated levels of nitrogen (N) and phosphorus (P) are commonly associated with eutrophication in a wide range of aquatic systems. Consequently, these nutrients are routinely measured for research and monitoring. Numeric criteria are available for total N and P, chlorophyll *a*, and a variety of pollutants and heavy metals for freshwater systems across the US, including South Carolina (SC) lake and reservoir systems. However, numeric criteria for N and P are lacking for SC estuarine and coastal systems. In order for regulatory agencies to establish appropriate nutrient standards, it is pivotal that biological responses are taken in to account, and these responses are often seasonal and system-specific. The goal of this ongoing study is to assess seasonal biological (phytoplankton) responses to various N and P conditions in SC coastal and estuarine systems and thereby provide information that can be used by regulators for developing management strategies for coastal water quality.

This project entails a combination of field monitoring, *in situ* experiments, and laboratory studies to elucidate phytoplankton growth and community responses to N and P in coastal SC. Monitoring involves seasonal, inter-agency collaborations for obtaining surface water samples in tandem with SC Estuarine and Coastal Assessment Program (SCECAP) collections over a two-year period. Samples are analyzed for a variety of biological and chemical (nutrient) parameters that influence phytoplankton production. Analyses are preliminary and sampling is ongoing, however, initial results suggest a high degree of spatial variability with respect to total nutrient levels across stations.

To evaluate phytoplankton responses to N and P, a series of *in situ* nutrient addition bioassays are being conducted seasonally at four sites characterized by distinct land cover patterns and presumably different nutrient conditions. Stations are located within (a) the ACE Basin, where land cover ranges from managed wetlands to salt marsh (Felber et al. 2010) and phytoplankton growth and community composition correlates with nutrient form (Johnson et al. 2006; Greenfield et al. 2012); (b) Kiawah Island, where golf courses and residential development dominates the landscape, harmful algal blooms have been frequently reported (e.g., Lewitus et al. 2003, 2008), and field experimentation has shown that nitrogen form affects cyanobacteria community composition (e.g., Siegel et al. 2011); (c) the urbanized Charleston Harbor region, where long-term records of water quality are available (e.g., SCECAP and others), and (d) Winyah Bay, the third largest estuary on the east coast, where water quality has been influenced by agriculture and industrialization (e.g., Buzzelli et al. 2004). Briefly, whole water samples are amended with various forms of N, singularly or with the addition of P, and evaluated for

phytoplankton growth and community composition. A YSI datasonde and an Isco autosampler are deployed in tandem with each experiment to elucidate any changes in water quality over a 24-hr period. Consistent with results from previous work (Siegel et al. 2011; Greenfield et al. 2012), initial observations reveal that N form substantially influences phytoplankton biomass and community composition with organic and certain forms of inorganic N being primary drivers. In summary, preliminary results from this study suggest that biological responses (as phytoplankton growth and community composition) are highly mediated by temporal (seasonal, interannual) and spatial (station location) variability. Future laboratory studies will focus on evaluating the influence of nutrient concentration on phytoplankton growth.

LITERATURE CITED

- Buzzelli, C., O. Akman, T. Buck, E. Koepfler, J. Morris, and A. Lewitus. 2004. Relationships among Water-Quality Parameters from the North Inlet-Winyah Bay National Estuarine Research Reserve, South Carolina. *Journal of Coastal Research* 45: 59-74.
- Felber, J., L.M. Brock, D. Bergquist, D.I. Greenfield, and C.K. Keppler. 2010. Investigation of water quality conditions in the Ashepoo-Combahee-Edisto (ACE) Basin NERR: A GIS approach. Water Resources Conference, Columbia, SC.
- Greenfield, D.I., L.M. Brock, J. Felber, C. Keppler, D. Bergquist, and J. Ragland. 2012. Linking phytoplankton assemblage variability and nutrient loading with land use: A 3-year study of the Ashepoo-Combahee-Edisto (ACE) Basin, South Carolina, USA. *Ocean Sciences*, Salt Lake City, UT.
- Johnson, W., A.J. Lewitus, and M. Fletcher. 2006. Linking bacterioplankton community structures to environmental state variables and phytoplankton assemblages in two South Carolina salt marsh estuaries. *Aquatic Microbial Ecology*. 45: 129-145.
- Lewitus, AJ, L.B. Schmidt, L.B., Mason, J.W. Kempton, S.B. Wilde, J.L. Wolny, B.J. Williams, K.C. Hayes, S.N. Hymel, C.J. Keppler, and A.H. Ringwood. 2003. Harmful algal blooms in South Carolina residential and golf course ponds. *Population and the Environment*. 24: 387-413.
- Lewitus, A.J., L.M. Brock, M.K. Burke, K.A. DeMattio, and S.B. Wilde. 2008. Lagoonal stormwater detention ponds as promoters of harmful algal blooms and eutrophication along the South Carolina coast. *Harmful Algae* 8: 60–65.
- Siegel, A., B. Cotti-Rausch, D.I. Greenfield, and J. Pinckney. 2011. Nutrient controls of planktonic cyanobacteria abundance in coastal stormwater detention ponds. *Marine Ecology Progress Series*. 434: 15-27.