**Phytoplankton Ecology: Integrative Research from Single Cells to Systems**

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Phytoplankton form the base of the food web and account for approximately half of the world’s primary production.  Phytoplankton communities are constantly changing over space and time, and human activities have caused or exacerbated some of the more notable assembly shifts.  In this talk, I will present three areas of research that address fundamental questions in phytoplankton community ecology and draw upon our understanding of physiology, life history, and functional traits.  First, I will describe *Effects of Stormwater Runoff and Sewage Plumes on Phytoplankton Communities*in an upwelling dominated system: the Southern California Bight.  By mapping and adaptively sampling plumes, I characterized changes in phytoplankton production and assembly with plume development.  I documented rapid responses to plumes and found differences in community shifts between runoff and effluent, attributable, in part, to the initial conditions of the system prior to new nutrient inputs.  This work contributed to the growing body of knowledge that runoff and effluent can alter phytoplankton communities to favor harmful taxa, even in upwelling dominated systems.  Second, I will discuss *Biodiversity, Productivity and Stability: A Test of the Insurance Hypothesis and Applications to the Algal Biofuel Industry*.  Global biodiversity losses have motivated researchers to elucidate the relationships between species biodiversity and stability.  One mechanism offered to explain the link between diversity and stability is the insurance hypothesis, which argues that diverse communities are buffered against changes because individual species have different responses to perturbations.  I tested this hypothesis and found that polycultures were more productive, stable, and resilient than monocultures after perturbations by a predator; however, the mechanisms for these emergent properties were different than hypothesized.  My findings have important implications not only for understanding ecosystems, but also for designing stable cultures for mass cultivation.  Third, I will describe work that explores *Effects of Nutrient Limitation on Toxin Content of the Harmful Algal Bloom species Karenia brevis.*Phycotoxins are ecologically important metabolites that have evolved as phytoplankton have interacted with predators, competitors, parasites and symbionts. Environmental factors, including nutrient limitation, can affect toxin synthesis directly or indirectly. I detangled the direct effects of nutrient limitation on toxin content from the indirect effects on growth rate by growing cultures in continuous systems, or chemostats. I found that nitrogen limitation decreased toxin content, contrary to previous work in which growth rate co-varied with nutrient limitation. These results highlight the importance of studying phytoplankton populations at steady-state to understand physiological processes.  Finally, I highlight other ongoing projects and research interests.