Ecology, 81(1), 2000, pp. 183–200

EFFECTS OF GRAZER COMMUNITY STRUCTURE ON PHYTOPLANKTON RESPONSE TO NUTRIENT PULSES

KATHRYN L. COTTINGHAM[1,3] AND DANIEL E. SCHINDLER[1,2]

[1]*Center for Limnology, University of Wisconsin, Madison, Wisconsin 53706 USA*
[2]*Department of Zoology, University of Washington, Box 351800, Seattle, Washington 98195 USA*

Abstract. Sensitivity, the magnitude of change following perturbation, and return rate, the rate of recovery, are two key components of ecological stability. We quantified these properties for phytoplankton in lakes using pulsed nutrient loading as the perturbation. Theory predicts that grazer community structure should influence how phytoplankton respond to pulsed nutrient loading. In particular, phytoplankton in lakes with large, effective grazers such as *Daphnia* are expected to be less sensitive to, but recover more slowly from, nutrient perturbations than phytoplankton in lakes with smaller grazers. We tested these predictions by adding standardized small and large pulses of nutrients (~10 and ~100 μg P/L of epilimnion; with N at an N : P ratio of ~25:1 by mass) to two natural ponds with contrasting grazer communities that resulted from the deliberate addition of planktivorous fishes to one pond. Site-specific responses were examined by conducting the experiment in the same ponds over two consecutive summers (1994 and 1995), but switching the fish treatments between years.

In both years, phytoplankton in the pond with large-bodied zooplankton grazers were less sensitive to small pulses of nutrients than were phytoplankton in the pond with small grazers, confirming the expectation that large zooplankton can buffer lakes against nutrient perturbations. However, responses to the large nutrient pulse were less consistent: phytoplankton in the pond with large zooplankton were less sensitive to the large perturbation only in 1995. This unexpected result appears to be due mainly to a 2.6 times greater total zooplankton biomass in the pond with small grazers on the day of the large pulse in 1994. Thus, although the presence of large-bodied zooplankton appears to reduce phytoplankton sensitivity to small nutrient pulses, other factors, including zooplankton biomass, need to be incorporated into predictions for phytoplankton responses to large perturbations.

Consistent with expectations, larger zooplankton appeared to slow recovery from nutrient perturbations, since the pond with fish and small grazers had faster return rates following the large nutrient pulse in both years of the experiment. Differences in life history traits between small and large species of zooplankton appear to account for these differences in recovery rates. Our results thus provide some support for theoretical expectations that management activities which alter grazer community structure may also affect the stability of phytoplankton communities to nutrient perturbations; additional experiments are needed to confirm the generality of this result.

Key words: Bayesian time series analysis; Daphnia; *grazing; nitrogen; phosphorus; phytoplankton; pulse perturbation; resilience; resistance; stability; zooplankton.*