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EMPHASIZING NEW IDEAS TO STIMULATE RESEARCH IN ECOLOGY

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THE RELATIONSHIP IN LAKE COMMUNITIES BETWEEN PRIMARY PRODUCTIVITY AND SPECIES RICHNESS

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Abstract. An understanding of the relationship between species richness and productivity is crucial to understanding biodiversity in lakes. We investigated the relationship between the primary productivity of lake ecosystems and the number of species for lacustrine phytoplankton, rotifers, cladocerans, copepods, macrophytes, and fish. Our study includes two parts: (1) a survey of 33 well-studied lakes for which data on six major taxonomic groups were available; and (2) a comparison of the effects of short- and long-term whole-lake nutrient addition on primary productivity and planktonic species richness.

In the survey, species richness of all six taxa showed a significant quadratic response to increased annual primary productivity (¹⁴C estimate, g C·m⁻²·yr⁻¹) when lake area is taken into account. However, the richness–productivity relationship for phytoplankton and fish was strongly dependent on lake area. The relationship for phytoplankton, rotifers, cladocerans, copepods, and macrophytes was significantly unimodal. Species richness generally peaked at levels of primary productivity in the range of 30–300 g C·m⁻²·yr⁻¹. For the average lake size, the highest biodiversity tended to occur in lakes with relatively low primary productivity, such as those found in the Northern Temperate Lakes Long-Term Ecological Research (LTER) site in the upper Midwest (United States) and in the Experimental Lakes Area of Ontario (Canada).

Based on short-term (3 yr) and long-term (21–24 yr) experiments, we tested whether individual lakes respond to whole-lake enrichment experiments in the manner suggested by analyses of survey data. Experimental addition of nutrients produced varied and unpredictable responses in species richness, probably due to transient dynamics and time lags. Responses to nutrient addition were taxon and lake specific.

Phytoplankton showed a variety of relationships between species richness and pelagic primary productivity (PPR), depending on the history of enrichment and recovery. No significant effect of primary productivity on rotifer richness occurred in any of the experimental lakes, whereas richness of crustacean zooplankton was negatively correlated with primary productivity in both the short- and long-term experiments.

Key words: *biodiversity; cladocera; copepoda; fish; freshwater; macrophyte; phytoplankton; primary productivity; rotifer; unimodal.*