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WHOLE-LAKE FERTILIZATION EFFECTS ON DISTRIBUTION OF PRIMARY PRODUCTION BETWEEN BENTHIC AND PELAGIC HABITATS

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Abstract. The perception that primary production in lakes is positively related to phosphorus loading is based almost entirely on studies of phytoplankton. This is partly because benthic and pelagic habitats in lakes are often treated as separate ecosystems, the processes of which can be evaluated independently. However, light and nutrients often limit primary producers in both benthic and pelagic habitats. We tested the hypothesis that reductions in light associated with increases in phytoplankton could cause compensatory decreases in benthic algal (periphyton) primary production. We monitored production of periphyton on sediments (epipelon), periphyton on wood (epixylon), and phytoplankton in four lakes in upper Michigan, USA, from 1991 to 1995. During the summers of 1993–1995, we stimulated phytoplankton production in three of the lakes by fertilizing with nitrogen and phosphorus (N:P $\geq$ 25 by atoms) at rates between 0.3 and 2.0 mg P·m^{-3}·d^{-1}. The response of periphyton to fertilization was substratum specific: epixylon increased with fertilization, but epipelon decreased. However, when area-specific production was extrapolated to the whole-lake scale, epixylon never constituted >4% of benthic primary production. Thus, the decline in epipelic production dominated the benthic response to fertilization. We also estimated whole-lake (epipelon + phytoplankton) primary production. Epipelic algae constituted 50–80% of whole-lake primary production at ambient nutrient levels. However, only 10–40% of primary production was benthic at the highest fertilization rates. The increase in whole-lake primary production caused by water column fertilization was greatly overestimated when we did not include the compensatory decline in epipelic algae as they were shaded by increases in phytoplankton concentrations.

Key words: algae; benthic–pelagic links; eutrophication; lakes; light attenuation; nutrients; periphyton; phytoplankton; substratum; whole-lake primary production.