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Regulation of bacteria by resources and predation tested in whole-lake experiments

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Abstract

Food webs in three lakes were manipulated by altering fish communities to promote or suppress the abundance of large *Daphnia*. These lakes and an unmanipulated reference lake were monitored for 2 yr. The three experimental lakes were then fertilized for 2 yr with nitrogen and phosphorus. Bacterial responses to these manipulations were examined by means of weekly measurements of abundance and production. Bacterial production, measured both by thymidine and leucine incorporation, increased substantially in the fertilized lakes, whereas abundance increased a small amount. Time-series models based on P loading explained substantial variation in both measures of bacterial production, suggesting strong regulation by P. Phytoplankton also increased with fertilization, but covariation of primary production and chlorophyll with bacterial production was relatively weak. Protozoans did not consume the increased bacterial production observed in the fertilized lakes. Bacterial abundance was instead regulated by consumption by *Daphnia* in at least two of the three fertilized lakes. Interannual variation in bacterial production during the 2 yr of fertilization was related to variation in pH, suggesting that environmental conditions also drive variability in bacterial activity. Overall, the experiments indicate that bacterial abundance and production are regulated by nutrients and, at high nutrient loading, by metazoan rather than by protozoan predators. With fertilization, bacterial production increased more rapidly than did abundance because bacterial predators limited abundance. The primary response of bacteria to eutrophication was higher specific growth rates.