



# Benthic invaders control the phosphorus cycle in the world's largest freshwater ecosystem

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**The productivity of aquatic ecosystems depends on the supply of limiting nutrients. The invasion of the Laurentian Great Lakes, the world's largest freshwater ecosystem, by dreissenid (zebra and quagga) mussels has dramatically altered the ecology of these lakes. A key open question is how dreissenids affect the cycling of phosphorus (P), the nutrient that limits productivity in the Great Lakes. We show that a single species, the quagga mussel, is now the primary regulator of P cycling in the lower four Great Lakes. By virtue of their enormous biomass, quagga mussels sequester large quantities of P in their tissues and dramatically intensify benthic P exchanges. Mass balance analysis reveals a previously unrecognized**

which need to account for mussel biomass and modified benthic–pelagic exchanges. The problem extends well beyond the Great Lakes: dreissenids have now been documented in thousands of inland lakes and rivers in North America (19) and Europe (20, 21) and may affect freshwater nutrient dynamics on continental scales.

The dynamics of P concentrations in lake water are regulated by the balance of P sources and sinks. These include inputs from the watershed, removal with outflow, and net burial in sediments (16, 22). The role of the benthic system is significant. Sediments can recycle a large fraction of the deposited P and resupply it to

