Implications of Phosphorus Loading Pathways on Harmful Algal Blooms in a Coastal Estuary

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Internal phosphorus (P) loading in shallow eutrophic lakes can drive the formation of harmful algal blooms (HABs). Understanding the spatial distribution of P across a watershed can assist in predicting and mitigating these HABs. This study constructed a watershed-scale budget for P throughout Lake Pontchartrain Estuary in southeastern Louisiana, USA. The estuary regularly experiences HABs across its heavily populated north shore. This study presents a comprehensive P sediment distribution map of the sediment and a calculation of the externally loaded components of riverine P. Our goal was to assess the relative proportion of internally loaded P from lake sediments vs watershed-derived P, which was a majority contributor of P to the estuary. Monthly water quality samples were collected from six of the estuary's main tributaries for total suspended solids, dissolved and particulate P in organic and inorganic forms, and ambient water quality parameters. Additionally, the sediment bed in 0-5 and 5-10 cm increments across 160 stations of the 1,631 km^2 estuary was sampled and analyzed for moisture content, bulk density, loss on ignition (organic content), total P, carbon, nitrogen, and inorganic and organic P. Results indicated total P in lake sediment ranged from 5.67-757.31 mg kg^{-1} (median= 408) and was primarily inorganic P (93% of TP on average). Sediment P was concentrated in the fine-grained silty southwestern to central portions of the lake (129- 757 mg kg^{-1}, median=460), the direct area of influence of the large-scale Bonnet Carre Spillway, introducing sediment and nutrient-rich Mississippi River water into the estuary. The north shore sediments were predominantly sandy and included the lowest levels of total P ranging between 5.67-481.68 mg kg^{-1} (median 264). While north shore sediments likely contributed to a lower internal P loading, they received a significant flux of bioavailable P from the lake's tributaries. The SRP concentration from the northern tributaries averaged 0.04 mg L^{-1} over a 5-month study period, with SRP as the primary P form accounting for roughly 80% of the total riverine P fraction. These findings suggest that P loaded by the Bonnet Carre Spillway is buried in lake sediment to be released if water column P concentrations drop. Soluble P loaded through the northern tributaries is a likely source of nutrients contributing to HAB occurrence along the north shore, indicating runoff management throughout the northern tributaries may help reduce the HAB occurrences.