**A phosphorus mass-balance model for the Lake St. Clair-Lake Erie system: How important is in-lake phosphorus loading?**

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Management of eutrophication in lakes usually focuses on reducing external phosphorus (P) loads. However, several in-lake mechanisms can add significant amounts of new and recycled P to the water column, hence, contributing to eutrophication and altering a lake's response to changes in its external P loading. For large lakes, these in-lake mechanisms remain poorly characterized, although they can potentially have a major impact on the effectiveness of nutrient control measures within the watershed. Direct measurements of in-lake P inputs may not only be difficult to obtain, but their scaling up in time and space is also fraught with uncertainties, especially in large lakes. Mass balance modeling provides a conceptually simple theoretical framework to estimate the magnitude of in-lake P loads when estimates of external loads and export fluxes of P can be estimated. Furthermore, when integrated over a sufficiently long time span, the various P inputs and outputs can be assumed to be in balance (steady state condition). We built a post-2000 (2003 through 2016) steady-state model of the net annual total P (TP) budget for the Lake St. Clair–Lake Erie system. The budget shows that the net TP output from the lake system substantially exceeds the sum of all external TP inputs. To balance the budget, in-lake processes must add 3783 metric tons per year (MTA) to the water column, or about one third of all externally derived TP inputs combined. For Lake Erie alone, the in-lake generated load is 3563 MTA, or about one half of all the external P inputs from the lake's watershed. We further estimate the in-lake P loading fluxes for the individual basins along the Lake St. Clair–Lake Erie system and discuss the applicability of the TP mass balance approach to inform decisions about nutrient control measures.