SML Briefing: SSIWPA-TAC is at work to understand in-lake phosphorus sources

By M Squires with assistance from TAC colleagues

What is P-internal? P-internal is one of several sources of phosphorus (P) in St. Mary Lake (SML). It comes not from inflowing streams, not from seeping groundwater, and not from falling rain. Instead it comes from within the lake when P associated with lake sediments moves into the overlying water and becomes available for growth of floating algae, called phytoplankton. In SML, P-internal appears to be variable due to natural causes and not constant from year-to-year.

Can P-internal increase algal growth? In addition to plentiful sunlight, the other main element needed for algal growth is P, which tends to be relatively plentiful in the spring, depleted during summer when surface waters are isolated from deeper more nutrient-rich bottom waters, and plentiful again in the fall. Depletion of available P can occur as groups of algae bloom, die, and settle out of the water column taking P along for the ride to the deeper, darker, and cooler waters below. In the absence of sunlight, some algal cells break down, or decompose. Decomposition of algae that has settled onto lake sediments can draw-down oxygen levels in bottom waters. When oxygen levels in bottom waters get quite low, some of the P stored in lake sediment is released to overlying waters. In SML, bottom waters are isolated from contact with air at the surface between April and November (the period of stratification when warmer, lighter water floats on top of cooler, heavier water). But how does P in deeper, darker, cooler waters affect algal growth in sunlit surface waters? There are several ways this can happen. First, during the long summer, relatively small amounts of P can travel by diffusion along a steep vertical gradient in P concentration between bottom and surface waters. Second, during fall when surface waters cool, eventually the lake is the same temperature and mixes from top to bottom. In the fall, as lake waters mix and oxygen returns to deep waters, some bottom water P is mixed into surface waters, and some P is restored in lake sediment until the following summer. In short, P-internal occurs when P from sediments is mixed with surface waters and becomes available to promote algal growth.

How is P-internal measured? A main goal of the SSIWPA field project is to evaluate the relative importance of the different sources of P promoting algal growth in SML. P-internal is 'defined' any increase in total amount of P in the lake that may occur between onset of stratification in spring/early summer and full mixing and reoxygenation of lake waters in the fall. The 'spring to fall' period coincides with low to negligible input of P form external sources.

(see next)

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Is there uncertainty in past estimates of P-internal? Uncertainty in the amount of P attributable to P-internal may be related to the timing of lake water measurements in the spring and fall. Additional uncertainty can come from inconsistencies in the way P is measured in the lab, and in the depths that correspond with water sampling. The SSIWPA-TAC field program aims to reduce uncertainty in estimates of P-internal by increasing sampling to twice from once a month, sampling at a pair of stations instead of one, sampling at a sufficient number of depths to quantify vertical P-gradients, and by measuring P that is available for algal uptake as well as P that is bound to algae and suspended sediment.

Artificial aeration, P-internal, and the SSIWPA field program Between 2009 and 2013, to decrease P-internal, 'artificial' aeration was used in SML to prevent deep-water anoxia and P release from sediments. During 2009-2011, aeration prevented severe anoxia, and in 2009-2010 P-internal may have been lower than in some years in the long-term record. Between 2011 and 2013, anoxia occurred despite aeration, and SML experienced a particularly long-lived algal bloom and also relatively low water clarity. Using historic records along with new data from the current field program, the SSIWPA-TAC is working to quantify P sources and sinks and to explain fluctuations over time in P level, water clarity, and algal and cyanobacterial abundance.