

# Characterization of Phosphorus and Its Dynamics in Lake Biwa and Attached Lagoon Lakes

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Phosphorus (P) is the essential macronutrient for all living organisms, and mostly limited for phytoplankton primary production in freshwater lakes. Phosphate is the most important P form because it is easily available for biological processes in the lakes. It is critical, therefore, to accurately determine phosphate concentration, in order to clarify characterization of P and its dynamics through biogeochemical processes. However, there were few information on spatio-temporal distributions of phosphate in epilimnion of meso- and oligotrophic lakes due to quite low levels under detection limit of a conventional spectrophotometrical estimates as soluble reactive phosphorus (SRP). Lake Biwa is mesotrophic and the largest lake in Japan, having remarkable geographical features with attached lagoon lakes. In this study, I accurately determined orthophosphate concentrations using an ion chromatography to clarify the availability and distributions of P and its dynamics in Lake Biwa and attached lagoon lakes.

Firstly, concentrations of orthophosphate and SRP were measured with an ion chromatography and spectrophotometry, respectively, in small and shallow lagoon lakes connected to Lake Biwa. The results showed that SRP concentrations frequently overestimated orthophosphate ones (Fig. 1), and the discrepancy between the two estimates might be affected by organic matters associated with biological activities. Secondly, phosphate oxygen isotope, which could be employed to track P sources and dynamics, showed that degrees of P recycling increased with biologically mediated effect through the waterflow in a shallow lagoon lake system (Fig. 2). Finally, spatiotemporal distributions of orthophosphate in the north basin of Lake Biwa were determined with the ion chromatography. The orthophosphate concentrations were during the study period from April to October

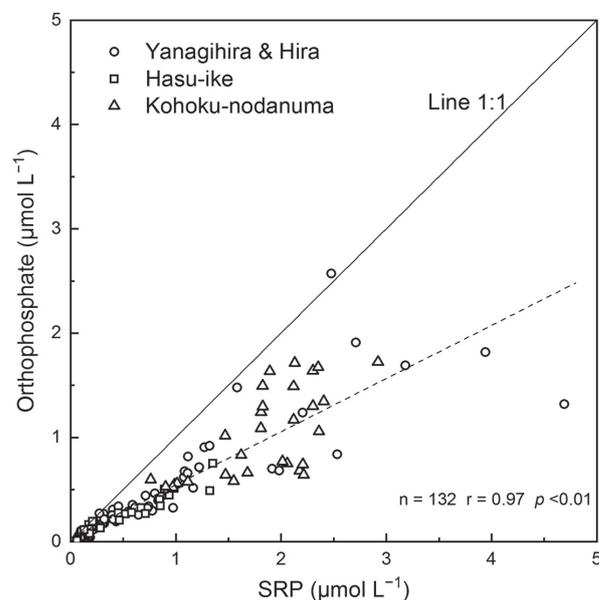


Fig. 1 Scatter plot of orthophosphate concentrations against soluble reactive P (SRP) concentrations in four lakes studied between July 2016 and October 2017. The solid diagonal line indicates an orthophosphate/SRP ratio of 1. The dotted line represents the result of the regression analysis using a pooled data set showing the number of data plotted (n), correlation coefficient (r) and significant level (p).

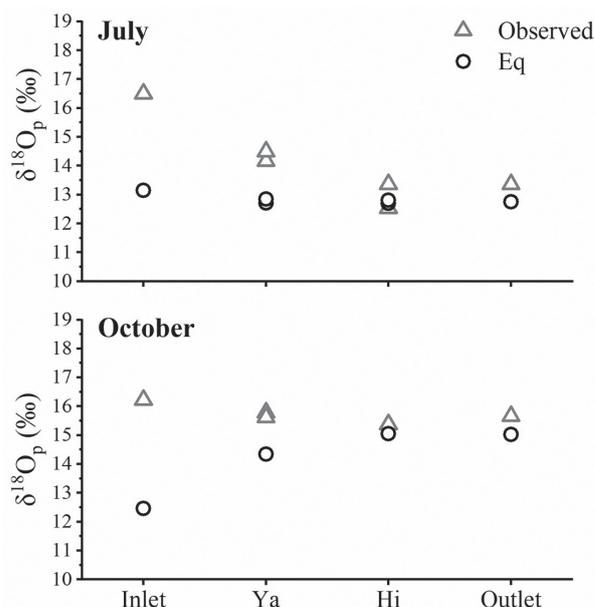


Fig. 2 Oxygen isotope composition of phosphate ( $\delta^{18}O_p$ ) at inlet, outlet and pelagic sites in Lakes Yanagihira-ko (Ya) and Hira-ko (Hi) during the two sampling dates. Circles indicate expected equilibrium values and triangles indicate observed values.

2018, and sporadically increased below 30 m, suggesting the P input to the epilimnion by typhoon-driven convection. Additional P enrichment experiments demonstrated that phytoplankton growths were P limited throughout the study period, suggesting that threshold concentration for in situ growth of the phytoplankton assemblage would be 0.02  $\mu\text{M}$  of phosphate.

Reference: Yi, R., P. Song, X. Liu, M. Maruo, and S. Ban. 2019. Differences in dissolved phosphate in shallow-lake waters as determined by spectrophotometry and ion chromatography. *Limnology*:1-11