LIMNOLOGY
and
OCEANOGRAPHY

Limnol. Oceanogr. 00, 2015, 00–00

doi: 10.1002/lno.10247

Productivity and depth regulate lake contributions to atmospheric methane

William E. West, Kevin P. Creamer, Stuart E. Jones*
Department of Biological Sciences, University of Notre Dame, Notre Dame, Indiana

Abstract

Despite significant contributions of inland lakes to the global methane cycle, we lack a process-based understanding of what regulates inter-lake variation in methane emissions. Previous comparative work has identified a potential link between lake primary productivity and methane emissions; also, lab-scale experiments suggest that the addition of algal substrate to anoxic sediments rapidly enhances rates of methanogenesis. This existing work indicates that primary productivity could enhance lake contributions to the global methane cycle. However, a more systematic investigation of the links between lake primary production, methanogenesis, and methane emission to the atmosphere is required to quantify the implications of increased cultural eutrophication for methane evasion from lakes. Using paired measurements of methanogenesis and methane emissions on 16 north temperate lakes, we documented a positive relationship between lake productivity and sediment methanogenesis rates. However, increased methanogenesis rates did not result in an increase in diffusive methane emissions. Rather, they generated greater methane storage during summer stratification and enhanced methane emission to the atmosphere via bubbling (ebullition), dependent on site depth. Ebullition most frequently occurred at sites less than 6 m deep and where methanogenesis rates were high. The relationships between lake productivity, methanogenesis, and depth-dependent ebullition suggests it is likely that shallow, productive lakes contribute significantly more methane to the atmosphere than deep, clear lakes and will continue to do so in light of the growing prevalence of lake eutrophication.