Winter Severity Influences Carbon Availability and Microbial Activity in The Laurentian Great Lakes

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Abstract (300 words or less):

Variation in ice cover is used as an indicator for winter severity in limnological studies because ice creates a physical barrier between lake water and atmospheric and terrestrial inputs. Understanding how ice drives ecological and biogeochemical processes is important because winter processes have inter-seasonal effects. Recent studies have shown that differences in the severity of winter can influence the availability of nutrients and impact the activity of microbial communities. Here, we present findings that show how microbial activity and nutrient availability are both influenced by degrees of winter severity across the Laurentian Great Lakes. We hypothesized that more severe winters would result in reduced concentrations of DOC and reduced quality of organic carbon substrates. We also expected that microbial activity would shift towards bacterial maintenance with increasing winter severity. Water samples from the Great Lakes and Lake St. Clair were collected during the winters of 2022, 2024, and 2025. We used the water samples to determine dissolved organic carbon (DOC) concentrations and characterized fluorescent dissolved organic matter (fDOM) using fluorescence excitation-emission matrix spectroscopy. Bacterial production was measured via incubations with tritiated leucine and thymidine. Winter severity was assessed by measuring ice quality and thickness and snow thickness at each sampling site. We found that more severe winters were associated with lower concentrations of DOC and changes in carbon quality. We also found that more severe winters were characterized by a shift in microbial activity from growth to maintenance. Our findings provide insight into how interannual variation in winter severity impacts carbon quality and quantity and microbial activity in the Great Lakes.