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Regional variability in stream dissolved organic matter characteristics across forested regions of Canada, and its implications for drinking water treatability

Julia Orlova[1], David Olefeldt[6], Fariba Amiri[2], Alyssa Bourgeois[1], Jim Buttle[3], Erin Cherlet[1], Monica Emelko[2], Bill Floyd[4], David Foster[5], Ryan Hutchins[1], Rob Jamieson[5], Mark Johnson[6], Hannah McSorley[4,6], Nan Qi[3], Uldis Silins[1], Suzanne Tank[1], Lauren Thompson[1], and Chris Williams[1]

[1]University of Alberta, Edmonton, Canada (olefeldt@ualberta.ca)
[2]University of Waterloo, Waterloo, Canada (mbemelko@uwaterloo.ca)
[3]Trent University, Peterborough, Canada
[4]Vancouver Island University, Nanaimo, Canada
[5]Dalhousie University, Halifax, Canada
[6]University of British Columbia, Vancouver, Canada

Forested watersheds are a major source of drinking water for more than two thirds of Canadians. However, drinking water security is increasingly pressured by the combination of higher demands resulting from population growth and industrial development and climate change-exacerbated landscape disturbances (e.g., wildfires, hurricanes). These may lead to deteriorated, more variable source water quality that can challenge treatment operations beyond their response capacities and have the potential to cause service disruptions. The character and concentration of dissolved organic matter (DOM), as well their shifts in response to seasonal and event-based changes in streamflow, make DOM a key driver of drinking water treatment infrastructure needs and operational challenges. As part of the *for*Water NSERC Network, which seeks to evaluate the impacts of pre-emptive forest management approaches on drinking water treatability in Canada, the objective of this study is to characterize differences in DOM concentrations and composition in headwater streams in different forested regions, including both undisturbed and disturbed catchments, and to evaluate the implications for drinking water treatability.

Our pan-Canadian study was conducted using existing long-term research sites, which span an area from 48.5° to 63° N between Canada's east and west coasts, and represent six major forested ecozones. These ecozones exhibit significant differences in soils, vegetation, hydrological systems, and consequently surface water chemistry. At each research site, 2 to 6 headwater streams were sampled several times in 2019 and 2020 to characterize seasonal and spatial variations in water chemistry. Where relevant, both disturbed (harvested or burned) and undisturbed catchments were sampled.

The spatial and temporal variability in DOM characteristics, including the effects of disturbances, were evaluated, and the links between DOM characteristics and drinking water treatability were

explored. Distinct regional differences in the concentrations of major ions, dissolved organic carbon and nutrients were observed. Variations in DOM composition, as assessed through UV-vis absorbance and excitation-emission matrix (EEM) fluorescence spectroscopy, Fourier-transform ion cyclotron mass spectrometry (FT-ICR-MS), and asymmetric flow field-flow fractionation (AF4), were also detected. To characterize drinking water treatability, relative implications to coagulant demand, membrane fouling, and distribution system stability were evaluated. The true disinfection by-product formation potential for trihalomethanes and haloacetic acids after complete oxidation resulting from chlorination was also assessed. Collectively, the results of this study underscore the importance of better understanding and anticipating natural variations in stream DOM as well as the impacts of landscape disturbance to ensure the uninterrupted supply of safe drinking water.