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Influence of topographic setting on the geomorphology and subsurface hydrochemistry of northern forested wetlands

M.C. Richardson (1), C.P.J. Mitchell (2), B.A. Branfireun (1), and R.K. Kolka (3)

(1) Department of Geography, University of Toronto at Mississauga, Mississauga, Ontario, CANADA Phone: (905) 569-4372 Fax: (905) 828-5273 Email: murray.richardson@utoronto.ca, (2) Department of Physical and Environmental Sciences, University of Toronto at Scarborough,Toronto, Ontario, CANADA , (3) Northern Research Station, U.S. Department of Agriculture Forest Service, Grand Rapids, Minnesota, USA

Biogeochemical hot spots across upland-wetland ecotones are strongly influenced by upslope runoff, yet this is often overlooked as a factor affecting landscape-scale biogeochemical cycling in boreal forest ecosystems. New techniques are therefore required to quantify the relative contributions of upland-wetland interactions to landscape-scale processes in these regions, such as carbon cycling and terrestrial-aquatic fluxes of nutrients and contaminants. A residual analysis of bare earth returns from airborne Light Detection and Ranging (LiDAR) surveys was therefore conducted to derive characteristic geomorphologies for 14 forested wetlands in central Ontario, Canada, northwestern Ontario, Canada and northern Minnesota, USA. Several geomorphic indices were developed including objective quantifications of the width of the upland-wetland interface zone (LWI), and the slope of the lateral, meso-scale topographic gradient from wetland-edge to wetland-centre (LSI). At four wetland sites sampled extensively for near-surface porewater chemistry, there is marked spatial correlation between the statistical properties of sulphate and methylmercury (MeHg) concentrations and the LIDAR-derived upland-wetland interface or 'lagg'area. Furthermore, the LWI and LSI indices are systematically correlated to a Peatland Topographic Index (PTI) describing the relative openness of a wetland to inputs from the surrounding landscape due to upslope contributing area and local drainage conditions (r^2=0.58 and r^2=0.64 respectively, $p<=0.001$). The results of this study indicate strong potential to use high-resolution topography for quantifying and scaling the influence of upland-wetland interactions on biogeochemical cycling in northern forested landscapes.