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Drivers of water chemistry levels and trends in Nova Scotia, Canada; The Nova Scotia Freshwater Database (NSFwD)

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Dissolved inorganic aluminum (Al) in freshwaters is toxic to organisms, and is caused by terrestrial ecosystem acidification (Cronan & Schofield, 1979; Driscol et al., 1980). Dissolved Al in freshwaters and estuaries is lethal to salmonids (Exley et al., 1991; Lacroix & Townsend, 1987), and human exposure to Al is suspected as playing a role in the development of Alzheimer disease (WHO, 2003). Furthermore, presence of Al in freshwaters can cause issues in water treatment, increasing treatment costs (Driscol & Letterman, 1995). Toxic levels of Al in freshwater due to chronic acidification were a pressing environmental issue in Europe and North America during the acid rain crisis of the 1970's and 1980's (Likens et al., 1972; Lükewille et al., 1997). The problems of freshwater acidification and high Al levels were considered solved following sulphate reduction legislation enacted in the 1990's and 2000's, and several studies demonstrated that chronically acidified ecosystems had recovered (Evans et al., 2001; Hesthagen et al., 2011; Monteith et al., 2005). However, recently and unexpectedly, Al levels were found to be increasing in Nova Scotia (Sterling et al., 2017, in prep.), bringing into question the current acidification recovery model for freshwaters. The cause and extent of this increase is unknown, and there is little understanding of the drivers behind the increase (Sterling et al., 2017, in prep.).
This research aimed to model the spatial and temporal extent of the increasing Al trends in Nova Scotia, further the mechanistic understanding of the increasing Al trend by modeling dissolved Al in freshwaters in relation to other chemistry parameters (calcium, iron, dissolved organic carbon, and pH), and identify the key watershed-scale processes driving the increasing trend. In this research, a spatial dataset of 63 long-term monitoring sites ($\geq$ 20 years) across Nova Scotia, Canada, was compiled and analyzed for water chemistry trends and levels; these watershed behaviours were grouped by catchment and waterbody typologies, such as land use and land cover, to identify drivers of poor water quality and examine the spatio-temporal variability of the increasing Al trend. Preliminary results indicate that inorganic dissolved Al concentration in freshwaters exceeds the recommended 15 μg/L threshold for all sites across Nova Scotia (n = 63), and that high dissolved Al levels are correlated with known drivers of freshwater pH such as wetlands (= 0.386, p = 0.002), but also novel drivers such as mature forests and agricultural land (= 0.262, p = 0.038, and = -0.380, p = 0.004, respectively). Findings from this research indicate that the drivers and spatio-temporal variability of dissolved Al in freshwater are poorly understood, and that Al continues to be an environmental concern in Nova Scotia. Furthermore, this research indicates that further investigation of the drivers and spatio-temporal variability of the increasing dissolved Al trend is necessary to further the mechanistic understanding of Al in freshwaters within a watershed typologies framework.