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LONG-TERM CONSEQUENCES OF WINTER ROAD MANAGEMENT PRACTICES TO WATER QUALITY AT HIGH-ALTITUDE LAKES WITHIN THE ADIRONDACK STATE PARK (NEW YORK STATE)

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Abstract

The long-term impacts to water quality from the use of sodium chloride (rock salt) anti-icer and sand abrasive was evaluated at two high elevation lakes along a highway in the Adirondack Park, New York State.

Upper Cascade and Lower Cascade Lakes are two hydrologically connected water bodies in the Adirondack Park of New York State. The lakes are bordered by NYS Route 73, the primary transportation route for visitors to the tourist center of Lake Placid. The Cascade Lakes lie within a long, narrow, high elevation gorge that is notorious for some of the worst winter weather in the New York State highway system. The lakes themselves are a popular recreational destination and contain the largest population of a fish that is officially listed as endangered in New York State (round whitefish, *Prosopium cylindraceum*). There has been widespread concern from both governmental agencies and the general public about the impact of winter road management in this area, provoked by an apparent dieback of paper birch along the roadside and evidence of rising chloride levels in the lakes.

We have been funded by the New York State Department of Transportation (NYSDOT) to assess the impacts to soil, vegetation, lake water quality, and lake biota at the Cascade Lakes caused by use of deicing road salt (mainly sodium chloride) and sand abrasive. We also modeled future changes to lake water quality, resulting from current management practices and alternatives.

Chloride levels within soils adjacent to State Highway 73 are generally low, indicating that chloride is rapidly transported away via surface and ground water flow. Upper and Lower Cascade Lakes now have chloride levels 100 to 150 times higher than expected for a comparable Adirondack Lake. Within the last five years, there has been a 250% increase in chloride concentrations within the Cascade Lakes, which has been caused by the recent dramatic increase in road salt applications. The concentration of chloride in Chapel Pond is slightly elevated, about twice as high as the average for Adirondack

A strong concentration gradient of chloride occurs in Upper and Lower Cascade Lakes, with as much as a 57% difference in concentration between surface water (epilimnion) and bottom water (hypolimnion). Although the chloride concentrations and magnitude of the concentration gradients are within the range that results in a permanent stratification on some lakes (meromixis), Upper and Lower Cascade Lakes remain dimictic (i.e. complete turnover occurs twice a year, caused by thermal mixing). Lower Cascade Lake turns-over earlier than Upper Cascade Lake, indicating that there is little resistance to thermal mixing at present in this more heavily chloride-contaminated lake.

Twenty years of data on watershed loadings of sand and road salt at the Cascade Lakes indicate that lake chloride levels closely match loadings. Upper Cascade Lake contains 80,000 - 130,000 kg chloride, and Lower Cascade Lake contains 50,000 - 75,000 kg chloride. Seasonal changes in chloride concentrations in the lakes appear to be gradual, peaking in summer, suggesting that there is no shock elevation of concentrations associated with seasonal events (e.g. snow melt), and that sizeable input into the lakes are via groundwater discharge. Based on the mass balance model of chloride transport through the Cascade Lakes, simulated over a period of 20 years, chloride concentrations are predicted to rise over the next five years in the Cascade Lakes, with the biggest increases in the Lower Cascade hypolimnion (a 40% increase). Under present salt loadings, peak chloride concentrations in the Lower Cascade Lake hypolimnion are predicted to approach the USEPA recommended maximum limits for chronic exposure to aquatic life. Lower Cascade Lake also remains at risk of becoming meromictic. Doubling the annual salt loading will double the lakes concentrations of chloride, halving the salt loading will halve the concentration of chloride in each lake (as was empirically observed in the early 1990s). Changes in salt loadings result in a new equilibrium concentration of chloride within about seven years.