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Climate and Environmental Change in Arctic Canada: Observations from Upper and Lower Murray Lakes, Ellesmere Island, Nunavut

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Abstract
This study was designed with the overriding goal of improving our understanding of the nature, causes, and impacts of past climatic conditions in the High Arctic and to evaluate the potential impacts of future climatic warming. Specifically, the focus of this project was centered on Upper and Lower Murray Lakes (81° 21' N, 69° 32' W) on northern Ellesmere Island, Nunavut, Canada. Sediment cores were collected from each of the lakes in order to reconstruct past climate and environmental variability and space-borne synthetic aperture radar (SAR) data were used to evaluate recent variability in the ice cover of these lakes. The climatic setting and physical characteristics of Lower Murray Lake has led to the formation and preservation of annually laminated sediments (varves). Varve deposition began ca. 5200 calendar years BP and continued through 2004 AD, providing an annual record of sediment accumulation spanning the past 5200+ years. Annual mass accumulation

was correlated to regional July temperatures providing a means of quantitatively evaluating past temperature changes in the region. The temperature reconstruction suggests that recent temperatures are ~2.6° C higher than minimum temperatures observed during the Little Ice Age, maximum temperatures during the past 5200 years exceeded modern values by ~0.6°C, and that minimum temperatures observed approximately 2900 varve years BC were ~3.5°C colder than recent conditions. SAR observations of the ice cover Upper and Lower Murray Lake were used to assess the potential effects of past and future temperatures on lake-ice conditions. Under current climatic conditions the lakes average several weeks of ice-free conditions in August and early September, although in some years a continuous ice cover persists throughout the year. The relationship between summer temperature and ice melt at the lakes suggests that recent warming in the High Arctic has forced the lakes across a threshold from a state of perennial ice cover to seasonal melting. Projected future warming will significantly increase the duration of ice free conditions on Upper and Lower Murray Lakes. Ice-out is predicted to occur between 6 and 28 days earlier for every 1°C of warming.