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# Introduction—Environmental Change in the Hudson and James Bay Region

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*There are two distinct views of the north: one as frontier, the other as homeland.*

—Thomas Berger (Berger, 1977)

The general study region examined in this special issue is the drainage to the southern portion of Hudson Bay and James Bay, which together comprise the world's largest polar inland sea. This area is vast, spanning the northern areas of three Canadian provinces, Manitoba, Ontario, and Québec. It is sparsely populated, with the most northerly areas almost solely the home of First Nations and Inuit peoples who have a close attachment to the land and a strong dependence on natural resources. The region is unique, containing the southernmost non-alpine tundra and southernmost population of polar bears (*Ursus maritimus*) in North America. The immense peatlands and extensive permafrost areas are a globally significant store of carbon. Despite the uniqueness and importance of the Hudson and James Bay region, its ecosystems have been greatly understudied (Far North Science Advisory Panel, 2010; Abraham et al., 2011).

The Hudson and James Bay region covers parts of two of the major physiographic regions in Canada, the Canadian Shield and the Hudson Bay Lowlands (Fig. 1). The Canadian Shield, defined by its hard, weathering-resistant Precambrian bedrock, is a glacially scoured landscape, sometimes with high relief, covered in lakes and rivers. Further north is the Hudson Bay Lowlands Physiographic Region, stretching from Manitoba to Québec, mainly along the western edge of Hudson Bay and James Bay. Here, Paleozoic and Proterozoic sedimentary bedrock, a legacy from marine inundation, slopes gradually to the coast, and numerous former beachfronts are evident far inland. The flat, low elevation terrain and poor drainage result in the development of the largest wetland complex in North America, and the second largest (after Siberia) northern wetland system in the world. Thousands of lakes

and ponds dot the landscape. Large rivers, many with their headwaters on the Shield, flow through the Lowlands to Hudson Bay and James Bay.

The cold conditions in this relatively southern subarctic region are largely due to Hudson Bay and the persistence of sea ice on this large inland sea, the effect of which extends far inland (McKendry and Roulet, 1994). The region has very low year-round average temperatures for its latitude. For example, the average annual temperature at Churchill, Manitoba (59°N) is –5 °C in comparison to Arkangelsk in northern Russia (64°N), which has an average temperature of +2 °C. Unlike most Arctic and subarctic regions of the world, paleolimnological evidence suggests that climate in the Hudson Bay region has been particularly stable over at least the past few hundred years and likely longer (Pienitz et al., 2004).

Because of its remoteness, the Hudson and James Bay region has remained relatively inaccessible and largely undisturbed by anthropogenic activities throughout most of history. There has been natural change, of course, very slow change as the land has risen after the retreat of the glaciers and recession of the Tyrrell Sea. Some areas close to Hudson Bay exhibit the highest rates of isostatic rebound in the world. A number of the papers contributing to this special issue address the long-term changes that have occurred over the past thousands of years. In this issue, O'Reilly et al. (2014) reconstruct vegetation succession patterns and carbon accumulation at a fen site in the Attawapiskat River drainage in northern Ontario since its emergence from the Tyrrell Sea. Holmquist et al. (2014) examine the magnitude and rate of carbon accumulation since peatland initiation at a variety of sites across the Hudson and James Bay Lowlands. Fillion et al. (2014) examine the development of palsa fields in subarctic Québec near Whapmagoostui-Kujuarapik and investigate factors affecting the changes that have occurred. Cayer and Bhiry (2014) reconstruct post-glacial evolu-



**FIGURE 1.** Map of the general study region showing Canadian provinces, physiographic regions, and the arctic watershed divide.

tion of the landscape near Lake Kaapuntikumac, northern Québec, using geomorphology and lake sediment data.

However, now the Hudson and James Bay region faces a much faster pace of change. Over the past few decades the cold, relatively stable climatic conditions typical of the region have given way to a clear warming trend (Gagnon and Gough, 2005; Hochheim and Barber, 2010; Bhiry et al., 2011). In this issue, Hochheim and Barber (2014) update the ice climatology of the Hudson Bay system and document large recent changes in the extent and duration of sea ice on Hudson Bay, which have led to greatly increased air temperatures. These recent changes in ice phenology and air temperature in the Hudson Bay system have large implications for terrestrial and aquatic ecosystems in the region.

As well, resources in the north are being exploited, particularly for hydropower generation and mineral extraction, and for forest harvesting in more southern areas. Demands for natural resource based developments are continuing, large regional developments that will have important consequences for many northern ecosystems. Although the Hudson and James Bay drainage is vast in size and remote, it is also not protected from large-scale, global anthropogenic stressors. Long-range atmospheric transport of contaminants, like mercury, to northern ecosystems is an important ongoing concern (Brazeau et al., 2013). And, the overarch-

ing reality of a changing climate makes the future uncertain for northern ecosystems and northern peoples. It is certain that major environmental changes in the north are coming, and that some are already happening, as papers in this special issue demonstrate. The remaining papers in this special issue document the current status of terrestrial and aquatic ecosystems, investigate recent changes that have occurred, and determine some likely future changes.

Extensive peatlands are a dominant feature of much of the study area. In this issue, McLaughlin and Webster (2014) review the peatland literature and propose potential climate change indicators and hypotheses of climate change effects that may influence peatland carbon budgets in northern Ontario. Also in Ontario, Humphreys et al. (2014) compare the CO<sub>2</sub> flux between a temperate ombrotrophic bog and bogs in the Hudson Bay Lowlands, and identify site characteristics related to CO<sub>2</sub> flux. Tam et al. (2014) use current climate data and future climate projections to predict the future distribution of palsas in northern Ontario.

Another dominant feature of the Hudson and James Bay drainage is open water. Innumerable ponds, lakes, rivers, and streams cover much of the landscape. Surprisingly, given their abundance, ecological significance, and importance to northern peoples, these aquatic ecosystems have been little studied. Paterson et al. (2014) provide first assessments of water chemistry, and

zooplankton and phytoplankton assemblages in lakes of the Hawley Lake–Sutton River area, near the western Hudson Bay coast in Ontario. Analyses of a number of paleolimnological indicators in lake sediments from this region demonstrate that substantial climate-related change has already occurred in lake communities (Rühland et al., 2014). Symons et al. (2014) examine the factors potentially affecting the composition of zooplankton communities in Wapusk National Park on the western coast of Hudson Bay in Manitoba. Eichel et al. (2014) employ experiments with microcosms to assess the effects of pulses in nutrient concentrations, a possible consequence of climate change, on planktonic and benthic algal communities in Wapusk National Park. Also in Wapusk Park, MacDonald et al. (2014) examine the effects of high populations of lesser snow geese (*Chen caerulescens caerulescens*) on the hydrological, limnological, and biogeochemical conditions in ponds.

Flow characteristics may directly affect the chemical and resultant biological conditions in surface waters. To date very little is known about the hydrology of subarctic peatlands and how the nature, extent, and distribution of surface waters may have changed or will be likely to change. White et al. (2014) demonstrate linkages between hydrological connectivity and seasonal limnological patterns in ponds in the Hudson Bay Lowlands, Manitoba. Orlova and Branfireun (2014) apply a chemical mixing model approach to investigate runoff-generating processes in peatland streams in the Attawapiskat River drainage, northern Ontario. Bouchard et al. (2014) and Macrae et al. (2014) use field measurements and remote sensing data to examine temporal changes in the distribution of ponds in northern Québec, and northern Manitoba, respectively.

The papers in this special issue add substantially to our knowledge on terrestrial and aquatic ecosystems in the Hudson and James Bay region. They reveal how various aspects of these systems have changed in the past, what they are like now, and how they are likely to change in the future. Many of these papers provide important assessments of baseline or reference conditions, which will permit evaluations of future changes.

However, much work still needs to be done to provide the necessary science on which to base wise resource management decisions. These, in turn, will be required to effectively manage and protect this vast, globally important area. One of the most complex questions and one of the most compelling is, How will northern peoples be best able to adapt to the environmental changes in the landscape? It is our hope that multidisciplinary northern science, as presented in this special issue, will help with understanding and meeting the future challenges of living in the North.

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## References Cited

- Abraham, K. F., McKinnon, L. M., Jumeau, Z., Tully, S. M., Walton, L. R., and Stewart, H. M., 2011: *Hudson Plains Ecozone: Status and Trends Assessment*. Canadian Biodiversity: Ecosystem Status and Trends 2010. Ottawa, Canada: Canadian Council of Resource Ministers, Technical Ecozone Report, 445 pp.
- Berger, T. R., 1977: *Northern Frontier, Northern Homeland: the Report of the Mackenzie Valley Pipeline Inquiry*. Vol. 1. Ottawa, Canada: Minister of Supply and Services Canada, 1–2.
- Bhiry, N., Delwaide, A., Allard, M., Bégin, Y., Filion, L., Lavoie, M., Nozais, C., Payette, S., Pienitz, R., Salmier-Talbot, E., and Vincent, W., 2011: Environmental change in the Great Whale River region, Hudson Bay: five decades of multidisciplinary research by Centre d'études nordiques (CEN). *Ecoscience*, 18: 182–203.
- Bouchard, F., Francus, P., Pienitz, R., Laurion, I., and Feyte, S., 2014: Subarctic thermokarst ponds: investigating recent landscape evolution and sediment dynamics in thawed permafrost of northern Québec (Canada). *Arctic, Antarctic, and Alpine Research*, 46(1): 251–271.
- Brazeau, M. L., Poulain, A. J., Paterson, A. M., Keller, W., Sanei, H., and Blais, J. M., 2013: Recent changes in mercury deposition and primary productivity inferred from sediments of lakes from the Hudson Bay Lowlands, Ontario, Canada. *Environmental Pollution*, 173: 52–60.
- Cayer, D., and Bhiry, N., 2014: Holocene climate and environmental changes in western subarctic Québec as inferred from the sedimentology and the geomorphology of a lake watershed. *Arctic, Antarctic, and Alpine Research*, 46(1): 55–65.
- Eichel, K. A., Macrae, M. L., Hall, R. I., Fishback, L., and Wolfe, B. B., 2014: Nutrient uptake and short-term responses of phytoplankton and benthic algal communities from a subarctic pond to experimental nutrient enrichment in microcosms. *Arctic, Antarctic, and Alpine Research*, 46(1): 191–205.
- Far North Science Advisory Panel, 2010: *Science for a Changing North. The Report of the Far North Science Advisory Panel*. Toronto, Canada: A report submitted to the Ontario Ministry of Natural Resources. ISBN 978-1-4435-3540-3.
- Fillion, M.-È., Bhiry, N., and Touazi, M., 2014: Differential development of two palsa fields in a peatland located near Whapmagoostui-Kuujuaraapik, northern Québec, Canada. *Arctic, Antarctic, and Alpine Research*, 46(1): 40–54.
- Gagnon, A. S., and Gough, W. A., 2005: Climate change scenarios for the Hudson Bay region: an intermodal comparison. *Climate Change*, 69: 269–297.
- Hochheim, K. P., and Barber, D. G., 2010: Atmospheric forcing of sea ice in Hudson Bay during the fall period, 1980–2005. *Journal of Geophysical Research*, 115: C05009, doi: <http://dx.doi.org/10.1029/2009JC005334>.
- Hochheim, K. P., and Barber, D. G., 2014: An update on the ice climatology of the Hudson Bay system. *Arctic, Antarctic, and Alpine Research*, 46(1): 66–83.
- Holmquist, J. R., MacDonald, G. M. and Gallego-Salla, A., 2014: Peatland initiation, carbon accumulation, and 2 ka depth in the James Bay Lowland and adjacent regions. *Arctic, Antarctic, and Alpine Research*, 46(1): 19–39.
- Humphreys, E. R., Charron, C., Brown, M., and Jones, R., 2014: Two bogs in the Canadian Hudson Bay Lowlands and a temperate bog reveal similar annual net ecosystem exchange of CO<sub>2</sub>. *Arctic, Antarctic, and Alpine Research*, 46(1): 103–113.
- MacDonald, L. A., Farquharson, N., Hall, R. I., Wolfe, B. B., Macrae, M. L., and Sweetman, J. N., 2014: Avian-driven modification of seasonal carbon cycling at a tundra pond in the Hudson Bay Lowlands (northern Manitoba, Canada). *Arctic, Antarctic, and Alpine Research*, 46(1): 206–217.
- Macrae, M. L., Brown, L. C., Duguay, C. R., Parrott, J. A., and Petrone, R. M., 2014: Observed and projected climate change in the Churchill region of the Hudson Bay Lowlands and implications for pond sustainability. *Arctic, Antarctic, and Alpine Research*, 46(1): 272–285.
- McKendry, I., and Roulet, N., 1994: Sea breezes and advective effects in southwest James Bay. *Journal of Geophysical Research*, 99: 1623–1634.
- McLaughlin, J., and Webster, K., 2014: Effects of climate change on peatlands in the far north of Ontario, Canada: a synthesis. *Arctic, Antarctic, and Alpine Research*, 46(1): 84–102.
- O'Reilly, B. C., Finkelstein, S. A., and Bunbury, J., 2014: Pollen-derived paleovegetation reconstruction and long-term carbon accumulation at a fen site in the Attawapiskat River watershed,

- Hudson Bay Lowlands, Canada. *Arctic, Antarctic, and Alpine Research*, 46(1): 6–18.
- Orlova, J., and Branfireun, B. A., 2014: Surface water and groundwater contributions to streamflow in the James Bay Lowland, Canada. *Arctic, Antarctic, and Alpine Research*, 46(1): 236–250.
- Paterson, A. M., Keller, W., Rühland, K. M., Jones, F. C., and Winter, J. G., 2014: An exploratory survey of summer water chemistry and plankton communities in lakes near the Sutton River, Hudson Bay Lowlands, Ontario, Canada. *Arctic, Antarctic, and Alpine Research*, 46(1): 121–138.
- Pienitz, R., Saulnier-Talbot, E., Fallu, M.-A., Laing, T., Ponader, K., Swadling, K., and Walker, I. R., 2004: Long term climate stability in the Québec-Labrador (Canada) region: evidence from paleolimnological studies. The Arctic Climate Impact Assessment (ACIA) international scientific symposium on climate change in the Arctic: extended abstracts. Reykjavik, Iceland, 9–12 November 2004. Arctic Monitoring and Assessment Programme Report 2004: 4.
- Rühland, K. M., Hargan, K. E., Jeziorski, A., Paterson, A. M., Keller, W., and Smol, J. P., 2014: A multi-trophic exploratory survey of recent environmental changes using lake sediments in the Hudson Bay Lowlands, Ontario, Canada. *Arctic, Antarctic, and Alpine Research*, 46(1): 139–158.
- Symons, C. C., Pedruski, M. T., Arnott, S. E., and Sweetman, J. N., 2014: Spatial, environmental, and biotic determinants of zooplankton community composition in subarctic lakes and ponds in Wapusk National Park, Canada. *Arctic, Antarctic, and Alpine Research*, 46(1): 159–190.
- Tam, A., Gough, W. A., Kowal, S., and Xie, C., 2014: The fate of Hudson Bay Lowlands palsas in a changing climate. *Arctic, Antarctic, and Alpine Research*, 46(1): 114–120.
- White, J., Hall, R. I., Wolfe, B. B., Light, E. M., Macrae, M. L., and Fishback, L., 2014: Hydrological connectivity and basin morphometry influence seasonal water-chemistry variations in tundra ponds of the northwestern Hudson Bay Lowlands. *Arctic, Antarctic, and Alpine Research*, 46(1): 218–235.

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