

EARTHWATCH INSTITUTE FIELD REPORT

Project Title: Climate Change at the Arctic's Edge

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Research Site:

Churchill Northern Studies Centre, Churchill MB, Canada. 58E 45' N, 93E 50' W

Local Management Status of the Research Site:

The research sites are within the Churchill Wildlife Management Area, part of a Province of Manitoba management area. This is part of the summer range for polar bears and includes the world's highest density of maternity dens.

Key Research Objectives:

Evaluate climate change impacts on key environmental factors regulating dominant terrestrial ecosystems at the Arctic treeline.

- Establish and monitor permanent Long-Term Environmental Monitoring Sites
- Maintain year-round monitoring of key abiotic ecosystem components (e.g., microclimate, soils, snowpack, and permafrost)
- Conduct growing season studies to quantitatively characterize key biotic ecosystem components (e.g., organic carbon budgets, plant phenology, plant species diversity and composition, small mammal populations)
- Conduct winter studies to characterize the ecosystems during the freeze season (e.g., snowpack depth, density, temperature profiles)
- Experimentally manipulate microenvironments to
 - Facilitate revegetation on anthropogenic disturbances
 - Assess what factors limit tree growth on the tundra and control the position of the Arctic treeline

Date this report was completed: 10 September 2005

Data Collection and Results

a) Give a concise account of the data you have collected during the past field season.

Representatives of the dominant ecosystems of the Hudson Bay Lowland have been included in the network of the 10 Long-Term Environmental Monitoring Sites. Key ecosystem components being quantified in each include:

Abiotic Ecosystem Components

Microclimate:

- automated microclimate stations (11) have now been established and a full year of data has been added to the archive for each except one where a faulty battery resulted in a loss of 70 days of information

Snowpack:

- mid-winter snowpack has been sampled in mid-February since 2002 to provide data on thickness, density, snow water equivalent, layers, temperature profile, hardness and crystal type

Permafrost:

- a continuous permafrost temperature record has been compiled with the microclimate dataloggers
- thaw depth was measured on the peat plateaus using the probe method
- ground-penetrating radar surveys have been completed on the 10 Long-Term Environmental Monitoring Sites

Soil:

- replicate pits have been excavated and sampled on an horizon basis in six of the Long-Term Environmental Monitoring Sites
- lab processing (e.g., total N, C, P, K, OM, moisture) of the samples has been completed

Biotic Ecosystem Components

Primary Producers:

- tree coring has been completed for all forest and tree stands to assess production and response to climate

Primary Consumers:

- three years of small mammal live trapping has been completed

b) What progress have you made towards achieving your original objectives?

The establishment of the network of monitoring sites has been achieved. The characterisation of the sites is in progress since some have only been monitored for a year while others were set up in 2000.

c) Please provide a summary of your results.

- Microclimate differences result from external (e.g., distance from coast) and intrinsic factors (e.g., height and density of plants).
- Snowpack characteristics vary with the height and density of the woody plants on a site.
- Permafrost temperature is warm and the depth of thaw (active layer) varies from a few decimetres to several meters depending on the surface cover and sediment characteristics.
- Status of landforms in peatlands varies from stable to degrading permafrost.
- Soil characteristics vary with topographic setting, parent material characteristics, and elevation (a proxy for age).
- The oldest "tree" in the tree island predated 1780 and the island has been gradually expanding since then.

- Primary production in woody plants is greatest in the boreal forest zone. The oldest trees colonised these sites in the 1840's. These forests are fire-origin so the live trees data from the last wildfire
- Primary consumers' populations have been low, vary from year to year and the species diversity is low.

Significance/Benefits of Research

a) What is/are the significance/benefits of your research at the following levels?

- Local (in the area of the research site)

The network that has been established will permit local authorities to determine if changes in the climate are forcing ecological processes that can affect the ecotourism industry. This is the mainstay of the economy.

Historical resources such as the Hudson Bay buildings as York Factory are threatened by permafrost melt and associated river bank erosion. Results from our permafrost studies can be directly applied to the preservation of historical resources in the area.

- National

Results of the monitoring programme are being used by researchers from four different provinces. In particular the microclimate data base is proving valuable for other researchers attempting to understand ecosystem processes.

- International

Observed responses to climate change in the Churchill region can be incorporated into studies of the Circumpolar North. With the documentation of conditions at Churchill using internationally-accepted protocols it is possible to compare results with studies in other countries such as USA, Russia, Norway, Finland, and Sweden.

b) How do your findings contribute to issues of sustainability?

Results of these investigations will provide a sound basis for managers attempting to predict the direction of environmental change in the region. Species at risk such as the polar bear are being affected by these changes and predicting the future will better prepare authorities to respond to the forecasted changes.

Dissemination of Results

a) Have you provided details of results from your research to or within:

- Scientific papers (indicate status; e.g., peer reviewed or in progress/press)
- Peer-Reviewed:
 - In Press Kershaw, G. P. Headwater wetland storage changes following permafrost degradation, Mackenzie Mountains, Northwest Territories, Canada. The Environmental Role of Headwater Wetlands. M. Haigh and J. Krecek (eds.), NATO Publishing Unit, Kluwer Academic Publishers, Dordrecht. accepted Jan 2004, 8 single-spaced pages, 3 figs.
 - 2003:Kershaw, G. P. Snowpack-vegetation-terrain relationships across the Arctic treeline, Churchill MB. In. 60th Eastern Snow Conference. Sherbrooke. pp. 141-147.

- 2003:Kershaw, G. P. Long-term tundra disturbances: Successful colonizers. In. Rasmussen R.O. and Koroleva, N.E. (eds.), Social and Environmental Impacts in the North: Methods in Evaluation of Socio-Economic and Environmental Consequences of Mining and Energy Production in the Arctic and Sub-Arctic. Kluwer Academic Publishers, Dordrecht. NATO Science Series, IV. Earth and Environmental Sciences 31:159-171.
- 2003:Kershaw, G.P. Permafrost landform degradation over more than half a century, Macmillan Pass/Caribou Pass region, NWT/Yukon, Canada. In. Proceedings of the 8th International Conference on Permafrost. 1: 543-548
- Management plans and reports (in progress or completed)
 - By who, for whom, and used by which agencies
 - 2005: Kershaw, G.P. Small mammal research, Churchill Manitoba: Annual report for 2004. Submitted to Manitoba Conservation. Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton. 6pp
 - 2004: Kershaw, G.P. and Mamet, S. Dendroclimatological Investigations In Wapusk National Park And Adjacent Churchill Wildlife Management Area. Submitted to Parks Canada, Wapusk National Park. Department of Earth & Atmospheric Sciences, University of Alberta, Edmonton. 8pp.
 - Kershaw, G.P. Small mammal research, Churchill Manitoba: Annual report for 2003. Submitted to Manitoba Conservation. Department of Earth and Atmospheric Sciences. University of Alberta, Edmonton. 6pp.
- Presentations (given or planned)
 - 2005:**
 - Fishback, L. and Kershaw, G.P. Snowpack geochemical loading in selected environments across the Arctic treeline near Churchill, Manitoba. 62nd Eastern Snow Conference, Annual Meeting, p. 26.
 - Kershaw, G. P., Fishback, L., McCulloch, J., Rausch, J., and Edye, E. Mid-winter snowpack characteristics across the Arctic treeline, Churchill, MB. . 62nd Eastern Snow Conference, Annual Meeting, p. 80.
 - Kershaw, G.P. Soil and near-surface permafrost temperatures in discontinuous permafrost, Mackenzie Mountains, NWT, Geological Association of Canada, Program Volume 30, p. 71.
 - Kershaw, G.P., Fishback, L., McCulloch, J. Rausch, J. and Edye, E. Snowpack variations within and between ecosystems across the Arctic treeline: 2002-2005. 35th. Annual International Arctic Workshop, Edmonton, AB, p. 42.
 - Fishback, L. and Kershaw, G.P. Variability of snowpack geochemistry across the arctic treeline, Churchill, Manitoba, Canada. 35th. Annual International Arctic Workshop, Edmonton, AB, p. 73.
 - Mamet, S. and Kershaw, G.P. Reconstructing climatic conditions as inferred from tree rings near Churchill, Manitoba, Canada. 35th. Annual International Arctic Workshop, Edmonton, AB, p. 82.
 - Rausch, J. and Kershaw, G.P. Use of organic amendments and snow fencing to mitigate substrate limitations to revegetation on gravel-dominated human-induced disturbances, Churchill, Manitoba, Canada. 35th. Annual International Arctic Workshop, Edmonton, AB, p. 91.
 - Kershaw, G.P. Permafrost is not as cool as it used to be - implications of global warming. 20th Annual BioForum, California Academy of Sciences, Oakland, CA
 - 2004:**
 - Blade, M.K. and Kershaw, G.P. Larix laricina, Picea glauca and P. mariana annual growth ring response to climate at Churchill, MB. PCAG (Prairie Division, Canadian Association of Geographers), Muenster, SK. p. 8.

- Kershaw, G.P. Mid-winter snowpack variation across the Arctic treeline, Churchill, MB. PCAG (Prairie Division, Canadian Association of Geographers), Muenster, SK. p. 14.
- Mamet, S. and Kershaw, G.P. Dendroclimatological variations within the Subarctic zone at the treeline near Churchill, MB. PCAG (Prairie Division, Canadian Association of Geographers), Muenster, SK. p. 15.
- Markowski, W. and Kershaw, G.P. Distribution of small mammals in the Hudson Bay Lowlands PCAG (Prairie Division, Canadian Association of Geographers), Muenster, SK. p. 16.
- Rausch, J. and Kershaw, G.P. Mitigation of environmental limitations to reclamation on gravel-dominated human-induced disturbances, Churchill, MB, Canada. PCAG (Prairie Division, Canadian Association of Geographers), Muenster, SK. p. 18.
- Kershaw, G.P. Global warming: Is nature's freezer set on defrost? Rosza Center, Michigan Technological University, Houghton, MI
- Kershaw, G.P. Permafrost-climate variation in the Mackenzie Mountains, NWT, Canada. 38th Congress of the Canadian Meteorological and Oceanographic Society. Edmonton. p. 113.
- Kershaw, G.P. and McCulloch, J. Mid-winter snowpack variation across the Arctic treeline, Churchill MB. 5th Circumpolar Ecosystems Workshop and Symposium, Churchill MB. p. 39
- Kershaw, G.P. Permafrost-snowpack relationships in mountainous terrain, Mackenzie Mountains, NWT. 5th Circumpolar Ecosystems Workshop and Symposium, Churchill MB. p. 40.
- Mamet, S. and Kershaw, G.P. Dendroclimatological studies at the treeline near Churchill, Manitoba, Canada. 5th Circumpolar Ecosystems Workshop and Symposium, Churchill MB. p. 47
- Rausch, J. and Kershaw, G.P. Short-term performance on gravel-dominated human-induced disturbances, Churchill, MB, Canada. 5th Circumpolar Ecosystems Workshop and Symposium, Churchill MB. p. 50.

2003:

- Kershaw, G.P. A brief overview of Canadian water relations. NATO Advanced Research Workshop, Environmental Role of Headwater Wetlands. Marienbad, Czech Republic.
- Kershaw, G.P. Headwater wetland hydrological changes after permafrost degradation, Mackenzie Mountains, Northwest Territories, Canada. NATO Advanced Research Workshop, Environmental Role of Headwater Wetlands. Marienbad, Czech Republic.
- Kershaw, G.P. Environmental change in the Hudson Bay Lowland: Long-Term Environmental Monitoring Sites (LTEMs). Association of Canadian Universities for Northern Studies, 7th Student Conference on Northern Studies, Edmonton.
- Mamet, S. and Kershaw, G.P. Dendroclimatological variations within the Subarctic zone at the treeline near Churchill, Manitoba, Canada. University of Alberta, Circumpolar Students' Association, Edmonton.
- Kershaw, G.P. Environmental change in the Hudson Bay Lowlands. Annual Meeting Prairie Division, Canadian Association of Geographers, Program and Abstracts, Gimli, Manitoba, p. 14.
- Kershaw, G.P., Fedorak, P. and McInnis, R. The state of crude-oil spills on tundra after more than half a century. Assessment and Remediation of Contaminated Sites in Arctic and Cold Climates, Edmonton, p. 396.

- Kershaw, G.P. Permafrost landform degradation over more than half a century, Macmillan/Caribou Pass region, NWT/Yukon, Canada. 8th International Conference on Permafrost. Zurich, p. 49.
- Kershaw, G.P. Snowpack-permafrost relationships in the discontinuous permafrost zone. 60th Annual Eastern Snow Conference. Sherbrooke, p. 17.
- Kershaw, G.P. Snowpack-vegetation-terrain relationships across the arctic treeline, Churchill, Manitoba. 60th Annual Eastern Snow Conference. Sherbrooke, p. 33.

2002:

- Kershaw, G.P. and Scott, P.A. Midwinter snowpack and temperature relationships across treeline, Churchill, Canada. 59th Annual Eastern Snow Conference. Stowe, p. 19.

- Media Interviews

- Quirks and Quarks, CBC radio, 6 June 2004
- CBC Television Morning show, 9 October 2004