

3.4 Carbon & Contaminant Cycling in the Coastal Environment

Summary

Project Leader(s)

Stern, Gary A.

Hudson Bay is a shelf sea with a coastal freshwater corridor supported by strong inputs of fresh water from land runoff. This freshwater corridor is the most important location for primary production and subsequent energy transfer to higher trophic levels (seals, bears, belugas) in the Bay. Recent studies suggest that Hudson Bay and its drainage basin are the recipients of enhanced loadings of contaminants such as organohalogenes and Hg – a circumstance that has probably existed for decades. Given that Hudson Bay is in the vanguard of change both in its sea ice cycle and in the basin's permafrost, it seems certain that Hg will become the most important contaminant in the system through release of Hg historically archived in frozen basin soils and through changes in wetland distribution and/or hydro reservoir flooding both of which are known sites of enhanced microbial methylation of inorganic Hg (II) to methyl Hg (MeHg is a toxic form of Hg that accumulates through food webs). The projected climate changes and their consequences to the organic carbon cycle seem likely not only to release Hg but they probably also enhance the efficiency of the production of methyl Hg (MeHg) within the basin and within Bay sediments. In addition, preliminary studies suggest that Hg depletion events (MDEs; the oxidation of tropospheric Hg (0) to Hg (II)), a phenomenon commonly observed in the high Arctic, may also be occurring over Hudson Bay in the spring, making Hg an ideal "tracer" for climate variation. The overarching objective of this project is to examine how the physical processes and climate associated variability being investigated in projects 3.1 and 3.2, and the biogeochemical response to this primary forcing (project 3.3), will affect organohalogen and trace metal contaminant cycling in the Hudson Bay ecosystem and ultimately, their levels in fish, marine mammals and the people who consume these tissues as part of their traditional diets (projects 3.5 and 3.6). In addition, links between sea-ice dynamics and extent of coverage (project 3.1), mercury depletion events (oxidation of Hg (0) to Hg (II)), feeding patterns, movements and dive behavior of beluga, narwhal and ringed seal (project 3.3) and contaminant up-take will be quantified.

People

Network Investigators

Ferguson, Steven (University of Manitoba)

Gagné, Jacques (Université Laval)

Macdonald, Robie W. (Fisheries and Oceans Canada - Institute of Ocean Sciences)

Papakyriakou, Tim N. (University of Manitoba)

Pollard, Wayne (McGill University)

St-Louis, Vincent (University of Alberta)

Stern, Gary A. (University of Manitoba)

Wang, Feiyue (University of Manitoba)

Post-Doctoral Fellows

Hoque, Azharul (McGill University)

PhD Students

Chambellant, Magaly (University of Manitoba)

Couture, Nicole (McGill University)

Hare, Alex

Kirk, Jane (University of Alberta)

Kuzyk, Zou Zou (University of Manitoba)

Lehnherr, Igor (University of Alberta)

Masters Students

Chmelnitsky, Elly (University of Manitoba)
Darnis, Gerald (Université Laval)
Kelley, Trish (University of Manitoba)
Kelley, Patricia
Pazerniuk, Monica (University of Manitoba)
Smith, Alexander (Fisheries and Oceans Canada - Freshwater Institute)

Undergraduate Students

Hare, Jonathon (University of Manitoba)
Hoffman, Harmoni

Technical Staff

Armstrong, Debbie (University of Manitoba)
Boila, Gail (Fisheries and Oceans Canada - Freshwater Institute)
DeLaronde, Joanne (Fisheries and Oceans Canada - Freshwater Institute)
MacHutchon, Allison (Fisheries and Oceans Canada - Freshwater Institute)
Rondeau, Jean-Guy (Fisheries and Oceans Canada - Maurice Lamontagne)
Rosenberg, Bruno (Fisheries and Oceans Canada - Freshwater Institute)
Thorne, Marilyn (Université Laval)

Partners

Environment Canada
Manitoba Conservation
Government of Manitoba
Nunavut Wildlife Management Board
Nunavut Implementation Fund
EPCOR
Makivik Corporation
Natural Resources Canada - Polar Continental Shelf Project
Indian and Northern Affairs Canada - Northern Scientific Training Program
Indian and Northern Affairs Canada - Northern Contaminants Program
Churchill Northern Studies Centre
McGill University
University of Manitoba
Fisheries and Oceans Canada - Science Sector
Fisheries and Oceans Canada - Maurice Lamontagne Institute
Canadian Circumpolar Institute
Manitoba Hydro
University of Alberta
Nunavut Wildlife Research Trust
Fisheries and Oceans Canada - Freshwater Institute
Fisheries and Oceans Canada - Institute of Ocean Sciences

Publications

Articles Published in Refereed Publications

Ferguson, Steven H., Ian Stirling, Philip McLoughlin, 2005, Climate change and ringed seal (*Phoca hispida*) recruitment in western Hudson Bay, *Marine Mammal Science*, 21:121-135, Published

Kirk, J.L., 2006, Potential sources of monomethyl mercury in Arctic and Subarctic seawater, *Arctic* v.59, no.1, 108-111, Published

Kirk, J. L., St.Louis, V. L., Sharp, M. J., 2006, Rapid Reduction and Reemission of Mercury Deposited into Snowpacks during Atmospheric Mercury Depletion Events at Churchill, Manitoba, Canada, *Environmental Science and Technology* 40, 7590-7596, Published

Higdon, J.W., O.R.P. Bininda-Emonds, R. Beck, and S.H. Ferguson, 2007, Phylogeny and divergence of the pinnipeds (Carnivora: Mammalia) assessed using a multigene supertree with fossil calibrations, *BMC Evolutionary Biology* , 2007, 7:216 doi:10.1186/1471-2148-7-216., Published

Kuzyk, Z.A., Macdonald, R.W., Granskog, M.A., Scharien, R.K., Galley, R.J., Michel, C., Barber, D. and Stern, G. , 2008, Sea ice, hydrological, and biological processes in the Churchill River estuary region, Hudson Bay, *Estuarine, Coastal and Shelf Science*, 77, 369-384, Published

Laidre, K.L., I. Stirling, L.F. Lowry, Ø. Wiig, M.P. Heide-Jørgensen, and S.H. Ferguson, 2008, Quantifying the sensitivity of Arctic marine mammals to climate-induced habitat change, *Ecological Applications*, 1, Accepted

Hare, A., Stern, G.A., Macdonald, R.M. Kuzyk, Z., Wang, F., 2008, Contemporary and preindustrial mass balance budgets of mercury in the Hudson Bay marine system: The role of lateral sediment recycling transport, *Science of the Total Environment*, 1, Submitted

Kuzyk, Z.A., Miguel A.G., Stern, G.A., Macdonald, R.W., 2008, Sources, pathways and sinks of particulate organic matter in Hudson Bay: evidence from lignin distributions, *Marine Chemistry*, 1, Submitted

Non-Refereed Contributions

Hare, A., Stern, G. and Wang, F., 2005, Changing terrestrial-marine relationships in Hudson Bay and their effect on mercury and trace metal cycling, 2005 ArcticNet Annual Conference Proceedings, 61-62, Published

Kuzyk, Z., Granskog, M., Macdonald, R., Scharien, R., Stern, G. and Barber, D., 2005, Characteristics of two coastal regimes (Churchill River plume and adjoining marine waters) during the winter-spring transition, 2005 ArcticNet Annual Conference Proceedings, 65-66, Published

Kuzyk, Z., Macdonald, R. and Stern, G., 2005, Carbon and Contaminant Cycling in Hudson Bay: Preliminary Insights, 2005 ArcticNet Annual Conference Proceedings, 66, Published

Pazerniuk, M., 2005, Contaminants in the Pelagic Food Web of Hudson Bay, 2005 ArcticNet Annual Conference Proceedings, 84, Published

Stern, G., Mundy, C.J. and Barber, D.G., 2005, A Journey into the Unknown: The 2005 ArcticNet Hudson Bay Expedition, 2005 ArcticNet Annual Conference Proceedings, 29, Published

Wang, F., Stern, G., Hare, A., Lean, D., Papakyriakou, T. and Bello, R., 2005, Atmospheric Deposition and Post-Depositional Diagenesis of Mercury in a Tundra Pond in Churchill , 2005 ArcticNet Annual Conference Proceedings, 102, Published

Black, P. and Lean, D., 2005, Methylmercury in the Canadian Arctic: Implications to Human Health, 2005 ArcticNet Annual Conference Proceedings, 37, Published

St.Louis, V.L., Graydon, J.A., and Kirk, J.L., 2006, Are we doing a good job at measuring the net deposition of mercury to ecosystems?, *Society of Canadian Limnologists Meeting*, Calgary AB, 1, Published

Kirk, J.L., St.Louis, V.L. and Hintelmann, H., 2006, What is the source of methyl mercury in Canadian Arctic Oceans?, 2005 ArcticNet Annual Conference Proceedings, 1, Published

St.Louis, V.L., Barker, J., Hintelmann, H., Kirk, J.L., Graydon, J.A., Sharp, M. and Steffen, A., 2006, What is the net springtime deposition of Hg(II) and methyl Hg to Arctic regions?, *Interdisciplinary Workshop for Research on Mercury in Polar Regions*. Toronto, ON, 1, Published

St.Louis, V., Graydon J. and Kirk, J. , 2006, Are we doing a good job of quantifying the net deposition of mercury to ecosystems?, International Conference on Mercury as a Global Pollutant, Madison, Wisconsin, 1, Published

Kirk, J., St.Louis, V.L., Hintelmann H. and Lehnerr, I., 2006, Potential sources of monomethyl Hg to Arctic marine ecosystems, International Conference on Mercury as a Global Pollutant, Madison, Wisconsin, 1, Published

Lehnerr, I., Kirk, J., St.Louis, V. and Hintelmann, H., 2006, Methylated mercury species in Arctic seawater, 2006 ArcticNet Annual Conference Proceedings, 1, Published

Hare A., Macdonald R., Stern G., Wang F., Lean D., Papakyriakou. , 2006, The effect of snow, ice, and open water on methyl mercury in the Arctic Ocean. , 8th International Conference on Mercury as a Global Pollutant. Madison, Wisconsin, USA., 1, Published

Kuzyk, Z.A., Macdonald, R.W., Goni, M.A., Stern, G., 2006, First Assessment of the Importance of Land-derived vs. Marine Organic Matter in Surface Sediments from Hudson Bay, 2006 American Geophysical Union Conference Proceedings, 1, Accepted

Kuzyk, Z.A., Macdonald, R.W., Goni, M.A., Stern, G., 2006, First Assessment of the Importance of Land-derived vs. Marine Organic Matter in Surface Sediments from Hudson Bay, 2006 ArcticNet Annual Conference Proceedings, 1, Accepted

Kuzyk, Z.A., Granskog, M.A. Macdonald, R.W., Scharien, R.K., Stern, G., and Barber, D.G., 2006, River influence on the coastal waters of western Hudson Bay during the winter-spring transition, 2006 American Society of Limnology and Oceanography (ASLO) Conference Proceedings, 1, Accepted

Kuzyk, Z.A., Macdonald, R.W., Hare, A., Wang, F., and Stern, G., 2006, Carbon Cycling and Contaminant Fate in the Hudson Bay Marine System, Northern Contaminants Program Synopsis of Research, 1, Accepted

Higdon, J., W. Bernhardt, E. Chmelnitsky, M. Chambellant, and S. Ferguson, 2006, Are killer whales (*Orcinus orca*) increasing in Hudson Bay?, 2006 ArcticNet Annual Conference Proceedings, 1, Published

Kelley, T., J. Higdon, and S. Ferguson, 2006, Determination of cetacean mating systems through testes size and sexual dimorphism., 2006, ArcticNet Annual Conference Proceedings, 1, Published

Chambellant, M. and S. Ferguson, 2006, Ageing live ringed seals (*Phoca hispida*): which tooth to pull? , 2006, ArcticNet Annual Conference Proceedings, 1, Published

Chmelnitsky, E. and S. Ferguson, 2006, Classification of beluga whale, *Delphinapterus leucas*, vocalizations in Hudson Bay., 2006, ArcticNet Annual Conference Proceedings, 1, Published

Luque, S. and S.H. Ferguson, 2006, Comparison of beluga growth, mortality, and population structure of Beaufort beluga population with other Canadian Arctic populations, 2006, ArcticNet Annual Conference Proceedings, 1, Submitted

Lapenskie, K., Lobb, D., Stern, G., Wang, F., Tenuta, M., Papakyriakou, Armstrong, D., Bello, R., Young, K., and Macdonald, R., 2006, Preliminary investigation into the contribution of the terrestrial ecosystems of surrounding lowland to carbon and mercury observed in the water of Hudson Bay, 2006 ArcticNet Annual Conference Proceedings, 76, Published

Alex, H., Stern, G., Wang, F., Lean, D., Pazerniuk, M., Kuzyk, Z., and Macdonald, R., 2006, Mercury speciation and distribution in the Hudson Bay marine ecosystem, 2006 ArcticNet Annual Conference Proceedings, 66, Published

Alex, H., Macdonald, R., Stern, G., Wang, F., Lean, D., and Papakyriakou, T. , 2006, The effect of snow, ice, and open water on methyl mercury distribution in the Arctic Ocean, 2006 ArcticNet Annual Conference Proceedings, 67, Published

Armstrong, D., Steffen, A., Stern, G., and Wang F., 2006, Temporal variations of tropospheric mercury in Churchill, 2006 ArcticNet Annual Conference Proceedings, 36, Published

Pazerniuk, Monica and Gary Stern, 2006, Mercury, stable isotope, and food web relationships in Hudson Bay zooplankton, 2006 ArcticNet Annual Conference Proceedings, Victoria BC, 68-69, Accepted

Monica Pazerniuk , Alex Hare, Gary Stern and Fei Wang, 2006, Mercury in the pelagic food web of Hudson Bay, 8th International Conference on Mercury as a Global Pollutant, Madison WS, 1, Accepted

Kuzyk, Z.A., Macdonald, R.W., Goni, M.A., Stern, G., 2007, First Assessment of Sedimentary Organic Material in Hudson Bay (Canada), 2007 Arctic Frontiers Conference Proceedings, 1, Accepted

Kuzyk, Z.A., Macdonald, R.W., Goni, M.A., Stern, G., 2007, First Assessment of Sedimentary Organic Material in Hudson Bay (Canada), 2007 Arctic Frontiers Conference Proceedings, 1, Accepted

Lehnherr, I., Kirk, J.L., St. Louis, V.L. and Hintelmann, H., 2007, The Biogeochemistry of Methylated Mercury in Arctic Marine Waters, ArcticNet Annual Scientific Meeting, Collingwood, Ontario, Canada, 1, Published

Hare, A., Armstrong, D., Stern, G., Wang, F., Lean, D., Pazerniuk, M., Kuzyk, Z., Macdonald, R., 2007, Mercury Assessment of the Hudson Bay Marine Ecosystem, 2007 ArcticNet Annual Conference Proceedings, 59, Published

Kuzyk, Z., Macdonald, R., Goni, M., Stern, G., 2007, The Implications of Lignin Distribution and Composition in Hudson Bay Sediments for Riverine Sources and Transport Pathways, 2007 ArcticNet Annual Conference Proceedings, 67, Published

Specialized Publications

Chambellant, Magaly, Ian Stirling, Steven H. Ferguson, 2004, Climate change and population dynamics of Hudson Bay ringed seals (*Phoca hispida*), ArcticNet Annual Conference, 1, Accepted

Kirk, J.L. and V.L. St.Louis, 2004, Exchange of mercury between the atmosphere and snowpack in western Hudson Bay: cycles of oxidation and reduction, *RMZ-Materials and Geoenvironment* 51, 1625-1627, Accepted

Hare, A. Stern, G., Wang, F., Macdonald, R.W., Pazerniuk, M., and Z. Kuzyk., 2006, Mercury Cycling in Hudson Bay and its Response to Changing Terrestrial-Marine Relationships., *ArcticNet Newsletter*, Fall, vol.1(2), 9-10, Accepted