UNIVERSITY OF OTTAWA DECEMBER 2022

The Record

The 2022 newsletter for the Blais lab; Issue 6

Highlights for 2022

August 2022. Several members of our Climate Accountability and Adaptation Project (CCAAP) sampling lakes on Victoria Island (Nunavut) to study the impacts of climate change.

FIELD SITES

Canadian High Arctic Research Station; Northern Sask.; Cultus Lake, BC

RESEARCH VIGNETTES

Uranium mines; Climate change; Paleoclimate; Arctic history

MISCELLANEOUS

Sabbatical in France, visiting professor from China

Climate change in the Arctic
New ways to study climate change

Uranium mines in northern Saskatchewan
Examining radiation from uranium mines

Combining lake studies with archeology
New results on the history of Arctic peoples

Who we are in 2022:


Jules Blais


Linda Kimpe


David Eickmeyer


Brayden Gregory


Bowen Xiao


Raphael Siegel


Jennifer Keir


Jennifer Kissinger


Daniel Dagodzo


Stephanie Walsh


Adriana Raats

Collective Climate Accountability and Adaptation Project (CCAAP)

We are working with northern communities in Saskatchewan and Nunavut to promote climate literacy, climate science and climate action.

Our lab is a member of the Collective Climate Accountability and Adaptation Project (CCAAP), an Indigenous-led program funded by Environment and Climate Change Canada to support programs in climate literacy, climate science, and climate action in northern Saskatchewan and Nunavut. In August 2022, our CCAAP project team traveled to Cambridge Bay to conduct field work involving sample collections of lakes in the region. Our work is to determine how recent climate change is affecting landscapes, ecosystems, and aquatic resources in northern regions. Four students from the Clearwater River High School joined the team of researchers on this field work.

As part of this field research, our team is specifically studying how changes in vegetation due to climate warming will affect the global carbon cycle. With climate warming, northward expansion of tree lines and thawing permafrost are expected to alter the global carbon cycle. Our work in conjunction with Clearwater River Dene Nation and the Université de Québec à Rimouski is investigating how different ecoregions in Canada (grassland, aspen parkland, boreal plain, boreal shield, and tundra landscapes) affect the flow of carbon to and from lakes.

As part of our 2022 expedition to Cambridge Bay, our team had the pleasure to spend a day fishing and talking with a family at their fishing camp near Cambridge Bay (Image 2). Our team heard from Elders about their early lives in Cambridge Bay, and many stories about how the world has changed since their childhood. They shared their traditions and recipes for preparing fish and Bannock, they shared their memories of hunting and fishing with their parents, and they spoke of residential schools that took them away from their families. This day was a life-changing experience for our team members. .

August 2022. The CCAAP team sharing a fishing day with an Inuit family near Cambridge Bay, Nunavut. Photo: Jules Blais

Tracking historical climate changes across Canada's diverse ecoregions.

We are analyzing new sediment biomarkers to track warming temperatures in the Canadian Arctic.

The Canadian Arctic is one of the most rapidly warming areas in the world due to anthropogenic climate change. However, due to a process called polar amplification this warming is very uneven across the Arctic, with some areas not warming much and others warming drastically, causing changes in sea ice melt, faster snow melt in the spring, and permafrost thaw. At many locations across the Arctic, weather station data only extends back to about the 1950's, so longer climate records from lake sediments can provide insight into how the Arctic changed in times before our current records.

One of the ways we can track temperature changes is through the use of microbial membrane lipids called glycerol dialkyl glycerol tetraethers (GDGTs). Microbes alter the structures of these GDGTs to maintain homeostasis at different temperatures, specifically to maintain fluidity of their membranes. These GDGTs then preserve in sediments allowing us to track how temperatures changed in the past by examining how GDGT structures changed over time.

In 2022, we traveled to Cambridge Bay, Nunavut, on the southern end of Victoria Island. This trip was done in conjunction with the CCAAP project (above), studying environmental change across ecozones in Canada. Our objective was to collect sediment samples from a selection of lakes and ponds to analyze the GDGTs and other biomarkers in the sediments to study patterns of climate warming in the Cambridge Bay area.

This year, we focused on applying GDGT analysis of lake sediments to track historical climate change in many areas across Canada, including Cambridge Bay, Nunavik (Quebec), and British Columbia (see more details below). Our goal is to determine how GDGTs relate to climatic factors and other past environmental changes.

August 2022. The Canadian High Arctic Research Station (CHAR) in Cambridge Bay, Nunavut (top panel). Our field team collecting cores (bottom left, Adriana at left, and Bowen). Bottom right: Adrianna, Linda, and Bowen preparing for off road travel by all-terrain vehicles near Cambridge Bay. Photos: Jules Blais

Studying climate change impacts in Nunavik

A comparison of how lakes have changed across a gradient of northern ecotones in Quebec.

The Nunavik region of northern Quebec lies in both the Arctic and subarctic climate zones, is studded with lakes and ponds, and has multiple vegetation ecotones, from boreal forest to shrub and herb tundra. These transition areas are susceptible to shifting environmental conditions and can be used as early indicators for how terrestrial and aquatic ecosystems are reacting to a changing world.

By resampling lakes previously studied in 1995, our collaborators at Université Laval have had the opportunity to determine how climate warming has changed the chemistry and biology of lakes across Nunavik in the past 25 years. In July 2022, Daveid Eickmeyer from our team joined the Laval crew to collect water, sediment, and soil samples from 33 lakes in a transect along the eastern coast of Hudson Bay, between Kuujjuarapik/Whapmagoostui and Salluit. They accessed remote sites by helicopter, hopping from lake to lake, and then eventually to the next community. This approach required traveling light, taking only the absolute necessities of personal items/ clothing. Dave lived out of a 5 L bag for 5 days. The animal sightings were sensational as well: black bear, muskoxen, and caribou.

Adriana will be analyzing these sediments for GDGTs to construct an eastern Canada latitudinal gradient temperature calibration set across the vegetation ecozones, and Bowen is studying the n-alkanes of the vegetation preserved in the sediment of the different ecozones.

July 2022. Lakes in the four vegetation zones sampled showing some of the diversity of landscapes in Nunavik (Photos: David Eickmeyer).

July 2022. Map showing the sites our group sampled in August 2022 along a transect from mid-latitude Quebec to the northern tip of Nunavik.

Tracking polonium-210 and lead-210 near uranium mines in Northern Saskatchewan

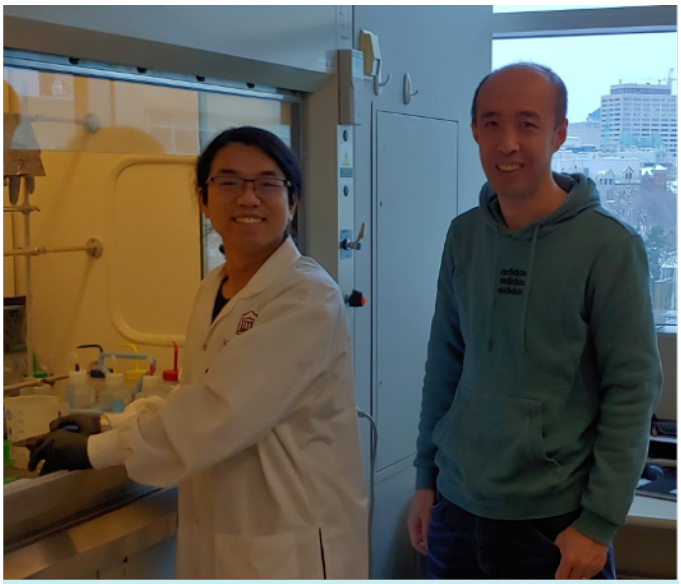
Our team is part of an effort to assess radioisotopes in lakes and rivers in northern areas, with this year's focus on northern Saskatchewan, home to Canada's prolific uranium mining industry.

Canada is the world's second largest uranium producer, with its mines located mainly in northern Saskatchewan. We are working in conjunction with Canadian Nuclear Laboratories to determine factors affecting the abundance of polonium-210 and lead-210, two important members of the uranium-238 decay series that may be found naturally, but may also be enriched in the environment due to human activities. Our second field season in support of understanding the environmental behaviour of polonium-210 (Po-210) and lead-210 (Pb-210) was completed in June of 2022 as part of a collaboration with the Clearwater River Dënë First Nation in Saskatchewan. With the help of a community representative and 4 students and a teacher from the Clearwater River Dënë School, water, sediment, macrophyte, algae and lower trophic level biota (benthic invertebrates and bait fish) were collected from 11 aquatic systems in the Dënësułinë Treaty 8 Territory in Saskatchewan, as well as two aquatic systems south of the region.

Looking ahead to 2023, the team will be returning to the Dënësułinë Treaty 8 Territory region as well as the Northeastern Athabasca Basin to collect plankton and upper foodweb samples to complete the sampling for the project.

Summer 2022: Our team with members of the Clearwater River High School in northern Saskatchewan, chasing down radioisotopes in water.

Visiting professor



November 2022: Our lab welcomed Prof Bin He (at right), a visiting scholar from Guizhou University in Bijie, China. Prof He will work with Bowen (at left) to find new ways to track past changes in tree line.

Can we track the Pacific Decadal Oscillation and historical changes in Pacific salmon abundance from biomarkers in lake sediments?

We are applying a new chemical toolkit to track past temperature anomalies and their impact on Pacific salmon on the West Coast of British Columbia.

Cultus lake is a relatively small low elevation coastal lake in the eastern Fraser Valley, British Columbia. Cultus Lake is a warm monomictic lake whose temperature is influenced by the oceanic climate prevailing over the West Coast. In the 20th century, ocean surface temperatures in this region changed in a cyclic pattern of warmer and cooler periods over a multi-decadal scale, a phenomenon known as the Pacific Decadal Oscillation (PDO). The PDO phases alternated from warm (between 1925 and 1946) to cool (between 1947 and 1976) and then again to a warm phase starting in 1977. These changes in ocean surface temperature influences many natural systems such as aquatic resources and marine fisheries in the North Pacific. Scientific evidence suggests that the PDO influences the abundance of Pacific salmon with low salmon abundance occurring during the warm phase and high salmon in the cool phase in British Columbia.

We are investigating the potential for microorganisms, such as archaea and bacteria, to help us track these changes in temperature. The principle is fairly simple. In order to survive, microorganisms must keep their membrane lipids fluid. Any change in ambient temperature causes microbes to alter the lipid structures of their membranes to keep their cells functional. These lipid structures then preserve in sediments, leaving a record of past temperature changes in the sediments.

Our objective with this study is to collect sediment cores from Cultus Lake and analyze the lipid structures to see if they track the warm and cool phases of the PDO. We are also applying the method to characterize the lipid composition of the Cultus Lake watershed soils and its water column to better understand whether these lipids derive mainly from soil or in the lake itself. We are also applying this method to large Sockeye salmon nursery lakes in BC and Alaska to see how salmon populations have been affected by climate in the past based on lake sediment core records.

October 2022. Raphael Siegel (left) and Daniel Dagodzo on a Fisheries and Oceans Canada (DFO) vessel on Cultus Lake British Columbia collecting lake sediment cores.

SABBATICAL IN PARIS

May 2022: Jules spent part of his 2022 sabbatical working with Dr. Arnaud Huguet at the "Institut Pierre Simon Laplace", a paleoclimate institute affiliated with the Sorbonne in Paris. The goal was to learn new methods to track past changes in climate from sediment archives using some of the most modern and advanced techniques.

A taste of research in 2022...

May 2022: Linda visiting Marie Curie's laboratory at the Pierre and Marie Curie Radium Institute in Paris. Photo: Jules Blais

October 2022: Collecting sediment cores on Cultus Lake, British Columbia (from left, Raphael, Daniel, and Dan Selbie). Photo: Jules Blais

August 2022. The Collective Climate Accountability and Adaptation Project (CCAAP) team at the Canadian High Arctic Research Station in Cambridge Bay, Nunavut. Our team included four students from the Clearwater River High School in Laloche, Saskatchewan.

August 2022. Members of the CCAAP team at the Clearwater River Dënë Nation in Laloche Saskatchewan.

Publications in 2022:

Séguin JY, Mason J, Hanson ML, Hollebone BP Orihel DM, Palace VP, Rodriguez-Gil JL, Blais JM. 2022. Bioaccumulation and toxicokinetics of polycyclic aromatic compounds and metals in giant floater mussels (Pyganodon grandis) exposed to a simulated diluted bitumen spill. Aquatic Toxicology, 252: 106316. https://doi.org/10.1016/j.aquatox.2022.106316

Timlick L, Dearnley J, Blais JM, Hanson M, Hollebone B, Orihel D, Rodriguez Gil J, Peters L, Stoyanovich S, Palace V. 2022. Responses of wild finescale dace (Phoxinus neogaeus) to experimental spills of Cold Lake Blend diluted bitumen at IISD Experimental Lakes Area, northwestern Ontario. Environmental Toxicology and Chemistry https://doi.org/10.1002/etc.5457

Cheney C, Pothier M, Thomas PJ, Sarma SN, Poulain AJ, Blais JM. 2022. Paleoecotoxicology: Developing methods to assess the toxicity of lake sediment records influenced by legacy gold mining. Aquatic Toxicology 250: 106248 https://doi.org/10.1016/j.aquatox.2022.106248

Savarajah B, Korosi JB, Thienpont JR, Kimpe LE, Blais JM, Smol JP. 2022. Algal responses to metal(loid) pollution, urbanization, and climatic changes in sub-Arctic lakes around Yellowknife, Canada. Arctic Science http://dx.doi.org/10.1139/AS-2021-0052

Azdajic M, Blais JM, Poulain AJ. 2022. Arsenate decreases production of methylmercury across increasing sulfate concentration amendments in freshwater lake sediments. Environmental Science: Processes and Impacts 24, 1508-1516. https://doi.org/10.1039/D1EM00543J

Gregory BRB, Kissinger JA, Clarkson C, Kimpe LE, Eickmeyer DC, Kurek J, Smol JP, Blais JM. 2022. Are fur farms a source of persistent organic pollutants or mercury to nearby freshwater ecosystems? Science of the Total Environment 833: 155100. http://dx.doi.org/10.1016/j.scitotenv.2022.155100

Michelutti N, Hargan K, Kimpe LE, Smol JP, Blais JM. 2022. Using stable water isotope composition (d18O and d2H) to track the interannual responses of Arctic and tropical Andean waterbodies to rising air temperatures. Journal of Geophysical Research - Biogeosciences 127, e2021JG006719. https://doi.org/10.1029/2021JG006719

Duda MP, Cyr F, Robertson GJ, Michelutti N, Meyer-Jacob C, Hedd A, McFarlane LT, Montevecchi WA, Kimpe LE, Blais JM, Smol JP. 2022. Climate oscillations drive millennial-scale changes in seabird colony size. Global Change Biology, https://doi.org/10.1111/gcb.16171

Patterson SA, Denton DTJ, Hasler CT, Blais JM, Hanson ML, Hollebone BP, Rodriguez-Gil JL, Langlois VS, Patey G, and Orihel DM. 2022. Resilience of wood frogs (Rana sylvatica) to hydrocarbons and other compounds released from naturally weathered diluted bitumen in a boreal lake. Aquatic Pollution, 245: 106128 https://doi.org/10.1016/j.aquatox.2022.106128

Wilkinson JL, Boxall ABA, Kolpin DW, Leung KMY, … Blais JM, Kimpe LE, ….Teta C (125 authors). 2022. Pharmaceutical pollution of the world's rivers. Proceedings of the National

Academy of Science 119 No. 8 e2113947119 https://doi.org/10.1073/pnas.2113947119

Stoyanovich S, Yang Z, Hanson M, Hollebone B.P, Orihel D.M, Palace V, Rodriguez-Gil JR, Mirnaghi F, Shah K, Blais JM. 2022. Fate of polycyclic aromatic compounds from diluted bitumen spilled into freshwater limnocorrals. Science of the Total Environment 819: 151993. https://doi.org/10.1016/j.scitotenv.2021.151993

Smythe KK, Cooke CA, Drevnik PE, Cornett RJ, Blais JM. 2022. Tracking historical sources of polycyclic aromatic compounds (PACs) in dated lake sediment cores near in-situ bitumen operations of Cold Lake, Alberta. Environmental Pollution 294: 118567. https://doi.org/10.1016/j.envpol.2021.118567

Saunders LJ, Rodriguez-Gil JL, Stoyanovich SS, Kimpe LE, Hanson ML, Hollebone BP, Orihel DM, Blais JM. 2022. Effect of spilled diluted bitumen on chemical air-water exchange in experimental lake enclosures. Chemosphere, 291: 132708 https://doi.org/10.1016/j.chemosphere.2021.132708

Thomas PJ, Eickmeyer DC, Eccles KM, Kimpe LE, Felzel E, Brouwer A, Letcher RJ, Maclean BD, Chan HM, Blais JM. 2022. Paleotoxicity of petrogenic and pyrogenic hydrocarbon mixtures in sediment cores from the Athabasca oil sands region, Alberta (Canada). Environmental Pollution 292: 118271 https://doi.org/10.1016/j.envpol.2021.118271

Conference presentations in 2022:

Prėskienis V, Kivilä H, Blais JM, Cheecham-Uhrich D, Rautio M. Organic matter cycling in lakes across north-south gradient in Western Canada: from Arctic tundra through boreal forest to temperate grasslands. ArcticNet Annual Scientific Meeting, Toronto, ON. Dec. 4-8, 2022

Walsh S, Bond MJ, Guérin N, Blais JM, Rowan D. A sensitive method to detect 210Po and 210Pb in environmental samples by alpha spectrometry using CuS microprecipitation. 48th Annual Canadian Ecotoxicity Workshop, Winnipeg, MB, October 2-4, 2022.

Graves SD, Mason JJ, Rodriguez-Gil JL, Séguin JY, Blais JM, Hanson ML, Hollebone BP, Palace VP, Layton-Matthews D, Leybourne MI, Orihel DM. Stable and radio- carbon isotope analyses reveal minimal assimilation of petrogenic carbon into a freshwater food web after experimental oil spills. 48th Annual Canadian Ecotoxicity Workshop, Winnipeg, MB, October 2-4, 2022.

Séguin JY, Mason J, Hanson M, Hollebone BP, Orihel DM, Palace VP, Rodriguez-Gil JL, Blais JM. Bioaccumulation and toxicokinetics of polycyclic aromatic compounds and metals in giant floater mussels (Pyganodon grandis) exposed to a simulated diluted bitumen spill. 48th Annual Canadian Ecotoxicity Workshop, Winnipeg, MB, October 2-4, 2022.

Blais JM. Developments in paleoenvironmental studies. Part 3: Technical advances and new approaches. Invited seminar at Sorbonne

University (Institut Pierre Simon Laplace) in Paris, France, May 26, 2022.

Blais JM. Developments in paleoenvironmental studies. Part 2: Can we relate animal migration histories with past changes in climate? Invited seminar at Sorbonne University (Institut Pierre Simon Laplace) in Paris, France, May 20, 2022.

Blais JM. Developments in paleoenvironmental studies. Part 1: Sediment cores and seabird colonies. Invited seminar at Sorbonne University (Institut Pierre Simon Laplace), in Paris, France, May 13, 2022.

Prėskienis V, Kivilä H, Rautio M, Blais JM, Cheecham-Uhrich D. Implications of potential migration of the southern tree-line to the ecology of boreal lakes in Saskatchewan. Presented to the Groupe de Recherche Interuniversitaire en Limnologie (GRIL) in Montreal, QC, March 12-15, 2022.

Keir JL, Kirkham TL, Aranda-Rodriguez, R, White, PA, Blais JM. Post-fire dermal decontamination of firefighters does not appreciably reduce exposures to polycyclic aromatic hydrocarbons (PAHs). Presented at the Health Canada Science Forum (virtual), February 14-18, 2022.

Keir JL, Kirkham TL, Aranda-Rodriguez, R, White, PA, Blais JM. Evaluating post-fire skin decontamination as a method of reducing firefighters' exposures to carcinogens and mutagens. Presented at the Society of Toxicology 61st Annual Meeting and ToxExpo in San Diego, California, March 27-31, 2022.